TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS
TCEQ PERMIT NO. MSW-1417D

MAJOR PERMIT AMENDMENT APPLICATION

VOLUME 3 OF 6

Prepared for

Texas Regional Landfill Company, LP

February 2022

STATE OF TEXAS
NEVZAT TURAN
84059
LICENSED
PROFESSIONAL ENGINEER

02/22/22

Prepared by

Weaver Consultants Group, LLC
TBPE Registration No. F-3727
6420 Southwest Boulevard, Suite 206
Fort Worth, Texas 76109
817-735-9770

WCG Project No. 0771-368-11-123

This document intended for permitting purposes only.

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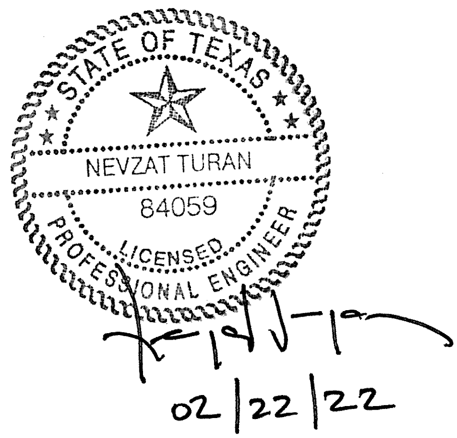
CONTENTS



TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS
TCEQ PERMIT NO. MSW-1417D

MAJOR PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
APPENDIX IIIF
SURFACE WATER DRAINAGE PLAN

Prepared for

Texas Regional Landfill Company, LP

February 2022

STATE OF TEXAS
NEVZAT TURAN
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STATE OF TEXAS
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STATE OF TEXAS
CHARLES R. MARSH
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PROFESSIONAL ENGINEER
2-22-22

CONTENTS (Continued)

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STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

FIGURES

1 INTRODUCTION

1.1 Purpose

This appendix addresses §330.63(c)

The Surface Water Drainage Plan is prepared as part of a permit amendment application for the Turkey Creek Landfill consistent with Title 30 Texas Administrative Code (TAC) Chapter 330. This plan addresses surface water drainage design and erosion control. Permit level plans and details are presented for the proposed drainage system in this appendix. Appendix IIIF also includes a demonstration consistent with Title 30 TAC §330.305(a) confirming that the proposed landfill development will not adversely alter permitted drainage patterns.

This appendix includes the design of the final cover erosion control structures (i.e., chute and swale system), perimeter drainage channels, detention ponds, as well as hydrologic calculations. Consistent with Title 30 TAC §330.63(c) and §330.305(b) and (c), these facilities are designed to convey run-off produced from the 25-year storm event. In addition, an Erosion Control Plan for all phases of landfill development is included in Appendix IIIF-F. All drainage facilities will be constructed and maintained in accordance with this plan.

1.2 Drainage Demonstration

Section 4 of this appendix includes a demonstration that the proposed landfill development will not adversely alter the existing permitted drainage patterns. As noted in Section 4, the proposed condition represents the final configuration of the site after the expansion of the landfill has been developed. Consistent with Title 30 TAC §330.63(c)(1)(C), §330.63(c)(1)(D)(iii), and §330.305(a), the proposed condition is compared to the existing permitted condition to demonstrate that the proposed expansion will not adversely alter the existing permitted drainage patterns.

1.3 Floodplain

As a part of the proposed expansion, a CLOMR was prepared for the landfill area as the 100-year floodplain is located within the proposed development areas. The current effective FEMA Flood Insurance Rate Map for the area of the landfill is provided on Figure 4.6 and excerpts from the proposed CLOMR are included in Appendix IIIF-G. As shown in the excerpts, the 100-year floodplain will be contained around the landfill footprint and will not encroach on the limit of waste.

2 STORMWATER MANAGEMENT

2.1 Drainage System Layout

Stormwater runoff collected in swales located on the top dome and sideslopes of the landfill will be conveyed to drainage letdown structures (chutes) down the slopes to the perimeter channel system. The perimeter channels will be constructed before fill is placed above existing grade in each adjacent landfill sector. The perimeter drainage system will be constructed as the site is developed. Additional details regarding the existing condition of the perimeter drainage system and the sequence of development for the drainage system is listed below.

- Currently the site drains toward the south/southeast through perimeter channels on the south and east sides, and toward the north through perimeter channels on the north and west sides of the fill area as previously (or currently) permitted.
- Consistent with the natural drainage patterns, the currently developed areas drain toward the southeast and north portion of the permit boundary as previously (or currently) permitted.
- The final stage in the perimeter drainage system construction is shown on the landfill completion plan on Drawings I/IIA.3 and IIIF.1. A detailed drawing of the perimeter channels located along the permit boundary is provided on Drawings IIIF.4 through IIIF.6.

As shown on Drawing IIIF.1 – Drainage Structure Plan, runoff generated from within the permit boundary will discharge north to Turkey Creek, which flows in a northwest to southeast direction on the north side of the landfill property adjacent to the landfill boundary on the north. Stormwater discharge from the north and west sides of the landfill will be attenuated by a detention pond located at the northeast side of the permit boundary before flowing off the permit boundary at the northeast. Stormwater from the west side of the landfill will be routed through proposed channels and attenuated by a detention pond and discharged into Turkey Creek from the northwest. Stormwater from the south side of the landfill will be routed through proposed channels and discharged into an unnamed tributary of Turkey Creek from the southeast.

The facility has been designed to prevent discharge of pollutants into waters of the state or waters of the United States, as defined by the Texas Water Code and the Federal Clean Water Act, respectively. Turkey Creek Landfill has a current Texas Pollution Discharge Elimination System (TPDES) multi-sector general permit for industrial activity as stipulated under Section 402 of the Clean Water Act and under Chapter 26 of the Texas Water Code, the TPDES program. A copy of the multi-sector permit is included in Parts I/II, Appendix I/IIE. Any stormwater that has become contaminated by contact with the working face or with leachate will be handled in accordance with Appendix IIIC – Leachate and Contaminated Water Management Plan. The facility maintains a current Stormwater Pollution Prevention Plan prepared consistent with TPDES permit requirements.

2.2 Erosion and Sedimentation Control Plan

The Turkey Creek Landfill will use various interim and permanent erosion and sedimentation controls throughout the life of the site. The interim controls will be used around active areas and external embankment sideslopes and top dome surfaces. These controls will include temporary letdown structures, soil berms, and vegetation of intermediate cover areas to minimize the erosion potential from these areas. These interim controls will be used during all phases of landfill development to provide effective erosion stability for the external sideslopes and top dome surfaces. Refer to Appendix IIIF-F – Erosion Control Plan for All Phases of Landfill Operation for more information.

Permanent controls include swales and chutes that will be constructed upon completion of the final cover. As part of the final cover construction, an erosion layer capable of sustaining vegetation will be constructed. Areas that receive final cover will be vegetated in accordance with Appendix IIIJ – Closure Plan upon completion of final cover placement. Final cover vegetation will protect the erosion layer soil against erosive runoff velocities. A soil loss and sheet flow velocity demonstration for the erosion layer is included in Appendix IIIF-D. The erosion layer will include a vegetation layer that provides for a 90 percent ground coverage, to keep soil loss below the required design values. If there are areas that do not maintain at least 90 percent vegetative coverage, vegetation in these areas will be reestablished to maintain at least 90 percent vegetative cover.

Erosion will be controlled by vegetation in drainage structures with flow velocities less than or equal to 5 feet per second (fps). For drainage structures with flow velocities greater than 5 fps, rock riprap, gabions, or other surface reinforcing materials as designed will be used for surface reinforcement as depicted on the plans.

During site development, measures such as best management practices (BMPs) and sedimentation ponds will be employed to control erosion and sedimentation. BMPs may include the use of temporary rock riprap, silt fences, straw bales, check dams, interceptor swales and berms, temporary and permanent seeding and sodding, surface roughening, matting and mulching, sediment traps, and surface wetting for dust control (refer to Appendix IIIF-F for more information).

Sedimentation ponds used as erosion control BMPs may consist of (1) existing borrow areas converted to sedimentation ponds, (2) future cell excavation areas, (3) temporary ponds in undeveloped footprint areas, (4) permanent detention pond that will be installed at the south side of the permit boundary, and/or (5) temporary ponds outside the permitted footprint, all of which will be constructed to meet the requirements of the temporary sedimentation pond and located within the permit boundary. See Appendix IIIF-F for more information.

Runoff volume (25-year, 24-hour storm event) from the active fill area (i.e., working face of the landfill operation) will be contained by the containment berm (see Part III, Appendix IIIC – Leachate and Contaminated Water Management Plan for details) to prevent potential discharge of contaminated runoff from the site.

2.3 Stormwater System Maintenance Plan

In accordance with Title 30 TAC §330.305(e)(1), Turkey Creek Landfill will restore and repair constructed stormwater systems such as channels, drainage swales, and chutes in the event of wash-out or failure from extreme storm events. Stormwater BMPs installed during all phases of landfill development will also be replaced or repaired in the event of failure. Excessive sediment will be removed, as needed, so that the drainage structures (i.e., perimeter channels and detention ponds) function as designed. Site inspections by landfill personnel will be performed weekly or within 24 hours after any significant rainfall event (e.g., a rainfall event with 0.5 inch or more precipitation). Documentation of the inspection will be included in the Site Operating Record.

The following items will be evaluated during the inspections as further discussed in Appendix IIIF-F and Part IV – SOP:

- Erosion of daily and intermediate cover areas, final cover areas, perimeter ditches, chutes, swales, detention ponds, berms, and other drainage features.
- Settlement of intermediate cover areas, final cover areas, perimeter ditches, chutes, swales, and other drainage features.
- Silt and sediment build-up in perimeter ditches, chutes, swales, and detention ponds. Removed silt and sediment can be used as daily cover or to replenish intermediate cover soils.
- Obstructions in drainage features.
- Presence of erosion or sediment discharge at offsite stormwater discharge locations.
- Presence of sediment discharges along the site boundary in areas which have been disturbed by site activities.

- Presence of erosion over the bed and banks of the unnamed tributary of Turkey Creek. If any erosion problems are noted, necessary actions will be implemented to repair damaged locations.

Maintenance activities will be performed to correct damaged or deficient items noted during the site inspections. These activities will be performed as soon as possible after the inspection. The time frame for correction of damaged or deficient items will vary based on weather, ground conditions, and other site-specific conditions that may prevent access to the area requiring repair.

Maintenance activities will consist of the following, as needed:

- Vegetation reestablishment.
- Placement, grading, and stabilization of additional soils in eroded areas or in areas which have settled.
- Replacement or repair of riprap or other surface lining materials.
- Placement of additional riprap in eroded areas.
- Removal of obstructions from drainage features.
- Removal of silt and sediment build-up from drainage features.
- Repairs to erosion and sedimentation controls.
- Installation of additional erosion and sedimentation controls.

3 DRAINAGE SYSTEM DESIGN

3.1 Methodology

Drainage calculations for the final cover system erosion control structures and perimeter drainage system are based on the peak flow rates resulting from the 25-year frequency rainfall event for the area. The United States Army Corps of Engineers (USACE) HEC-1 computer program was used to compute peak flow rates produced from the design storm for the completion conditions. The hydraulic methods employed in this study are consistent with those presented in the TCEQ *Guidelines for Preparing a Surface Water Drainage Report for Municipal Solid Waste Facility* (RG-417, May 2018) and the TxDOT Bridge Division Hydraulic Design Manual, September 2019.

Water surface profiles were determined for the perimeter channels using the Channel Analysis Program (HYDROCALC HYDRAULICS Version 2.0.1 for Windows, Dodson & Associates, 1996-2010) that is based on Manning's formula for uniform flow and HEC-RAS, A river analysis system computer program (version 6.0.0 2021) that is based on the solution of one-dimensional energy equation with energy loss due to friction. The perimeter channels are designed to collect and route runoff from the 25-year frequency storm event to the detention pond. Manning's *"n"* values for the channels and culverts were taken from the TxDOT Bridge Division Hydraulic Design Manual (Table 4-7, page 4-43; and Table 4-9, page 4-46), September 2019.

3.2 Hydrologic Analysis

3.2.1 Description of Computer Program

HEC-1 was developed by the USACE Hydrologic Engineering Center to simulate the surface runoff response of a watershed. The HEC-1 model represents a watershed as a network of hydrologic and hydraulic components. The modeling process results in the computation of stream-flow hydrographs at desired locations in the watershed. The hydrologic analysis for the post-development condition is presented in Appendix IIIF-A. The hydrologic analysis for the permitted landfill completion condition is included in Appendix IIIF-E.

3.2.2 Watershed Subareas and Schematization

The landfill areas that contribute flow to each detention pond were delineated into subareas to derive peak flow rates for the design of the perimeter channel and final cover drainage letdowns. Hydrographs are developed for each subarea and appropriately combined and routed through the swales and perimeter channels. The subareas are shown on Drawing IIIF.2 – Post-Development Drainage Area Plan as well as in Appendix IIIF-E for the permitted completion condition.

Offsite areas (areas outside the permit boundary) incorporated into the hydrologic analyses as appropriate have been delineated using topography obtained from the United States Geological Survey 7.5-Minute Quadrangle for Alvarado, Texas and Grandview, Texas. The offsite drainage area delineation is shown on Figure 4.3 for the post-development discharge analysis. The offsite areas are also included in the hydrologic analysis for the permitted landfill completion condition, as shown in Appendix IIIF-E.

3.2.3 Time Step

The time step, or the program computation interval, is the time interval at which the flow rates for the hydrographs are generated by the program. Time step used for a design storm event hydrograph generation is 5 minutes.

3.2.4 Hypothetical Precipitation

The hypothetical storm data used in the post-project analysis was obtained from the NOAA Atlas 14 for the project area and is consistent with the existing permitted data. For the design storm event analysis, a return period (frequency) of 25 years and a duration of 24 hours is used. The precipitation is assumed to be evenly distributed over the entire area modeled for each time interval.

3.2.5 Precipitation Losses

Precipitation losses (the precipitation that does not contribute to the runoff) are calculated using the Soil Conservation Service (SCS) Curve Number (CN) method. CN is a function of soil cover, land use, and antecedent moisture conditions. A CN of 86 was selected to represent the final cover sideslopes, and a CN of 85 was selected for final cover top dome surfaces. A CN of 100 was used for the detention pond areas. Further discussion on selection of CN values is provided in Appendices IIIF-A and IIIF-E for post-development and permitted landfill completion conditions, respectively.

3.2.6 Hydrograph Information

Two different types of hydrograph generation methods have been used in the drainage analyses: distributed runoff methods and the Snyder unit hydrograph method using the Espey "10-Minute" method for parameter estimation. Muskingum-Cunge and pond storage discharge methods were used for hydrograph routings. Example hydrograph development information for both distributed runoff and Snyder unit hydrograph methods is provided in Appendix IIIF-A.

Distributed Runoff Methods

The distributed runoff method (e.g., kinematic wave method) is applicable to small stormwater catchments with uniformly sloped overland flow plains that drain into channels. Landfill final cover areas consist of relatively short (typically 100 feet on 3.5H:IV sideslopes) overland flow lengths that drain into landfill final cover swales. Distributed runoff estimation methods are applicable to landfill final cover areas because of the following:

- These methods were developed for uniform slopes that drain to collection channels. For a landfill final cover area, this translates to an overland flow segment of final cover that drains to a swale.
- These methods were developed for a network of relatively small drainage areas. Typically, to design the various perimeter channels, landfill drainage areas need to be subdivided to determine a peak flow at several points.
- These methods are also inherently conservative because it is based on watershed dimensions as opposed to other methods that use empirical information. Also, this method is conservative because flow attenuation is not accounted for.
- This method is also more conservative than the rational method because watershed lag time is computed as a function of real flow time without any limitations such as using a minimum time of concentration (i.e., 10 minutes), which is common practice for the rational method.

The kinematic wave method has been used for estimating peak runoff rates from the landfill final cover areas. A hydrograph from each drainage area with channelized flow (e.g., landfill final cover areas to swales) was developed using the kinematic wave method to simulate both overland and channelized flow. This method utilizes a simplified form of the energy equation and is based on the characteristics of the drainage area, swale, or channel. This method uses physical (measurable) characteristics (e.g., flow lengths, slopes, surface roughness coefficients, channel cross sections) of a watershed to estimate peak discharges.

Snyder Unit Hydrograph Method

The Snyder unit hydrograph method has been used mainly for non-landfill drainage areas (e.g., offsite drainage areas). The method is applicable to drainage areas with a wide range of characteristics. Several different methods have been developed to estimate Snyder unit hydrograph parameters (watershed lag and peaking coefficient). Espey "10-Minute" method was used in this project to estimate Snyder unit hydrograph parameters. The Espey "10-Minute" method was developed using flow records from 41 different watersheds in Texas and other states. The main advantage of the Espey "10-Minute" method is that it is one of the best methods for small-size drainage areas.

Hydrograph Routing

The Muskingum-Cunge Method (RD record in HEC-1) was used for routing of the flood wave through the drainage channels. This method is capable of accounting for hydrograph attenuation based on physical channel properties such as length, bottom slope, channel shape, and channel roughness.

Hydrographs at pond outlets were generated by routing the combined incoming flow hydrographs through the ponds. Pond routings (RS – Storage Routing record in HEC-1) were performed by using storage/elevation relationships for each pond by defining pond surface area versus depth. Additionally, discharge structure (low level outlet and spillway) characteristics of each pond are used for pond routing.

3.3 Hydraulic Analysis

3.3.1 Swale and Channel Analysis

Drainage structure details are illustrated on Drawings IIIF.7 through IIIF.12. The swales and channels are designed to convey the peak flow rate generated by the design storm event. These swales and channels will also reduce maintenance at the site after closure by minimizing erosion.

Hydraulic analyses of the swales and channels are conducted using Manning's uniform flow formula. The uniform flow assumption is applicable to long prismatic channels of uniform slope, as proposed at the site.

The general form of Manning's equation is

$$V = \frac{1.49\, R^{0.667}\, S^{0.5}}{n}$$

in which

V = *Velocity of flow, fps (feet per second)*

n	= *Manning's "n" (unitless)*
R	$= \frac{A}{P}$ = *Hydraulic radius, ft (feet)*
S	= *Friction slope for nonuniform flow or channel slope for uniform flow, ft/ft*
A	= *Area of water perpendicular to direction of flow, sf (square feet)*
P	= *Wetted perimeter, ft.*

Using the relationship

$$Q = VA$$

Manning's equation can be written as

$$Q = \frac{1.49 A R^{0.667} S^{0.5}}{n}$$

The uniform flow assumption equates the channel slope to the friction slope; therefore, the slope of the channel can be used for "S" in Manning's formula for computation of uniform flow.

Typical values for Manning's "*n*" are presented in the 2019 TXDOT *Bridge Division Hydraulic Design Manual* ("Suggested Manning's Roughness Coefficients" Table, Chapter 6, Section 1). A value of 0.030 is used for "*n*" for swales, a value of 0.040 is used for gabion-lined chutes, and a value of 0.030 is used for perimeter channels. These values represent typical roughness coefficients to the proposed drainage structures, after vegetation has become established.

3.3.2 Drainage Letdown Structure (or Chute) Analysis

A typical chute detail is illustrated on Drawing IIIF.9. The final cover drainage letdown structures are designed to convey the flow rate generated by the design storm event. Hydraulic analysis of the letdown structures is conducted under the principles of tumbling flow. Tumbling flow is a function of channel slope, discharge, spacing and sizing of energy dissipating elements. The tumbling flow regime consists of a series of hydraulic jumps and overfalls that maintain critical velocity down the chute. The spacing and sizing of the energy dissipators controls the velocity and flow of the water in the chutes, thereby reducing erosive conditions at slope transitions with the perimeter road low water crossings and chute/perimeter channel confluences.

Appendix IIIF-C presents calculations for the energy dissipators.

4 DRAINAGE PATTERNS

Consistent with Title 30 TAC §330.63(c)(1)(C), §330.63(c)(1)(D)(iii), and §330.305(a), this section provides a demonstration showing that the proposed changes to final cover grades will not adversely alter the existing permitted drainage patterns. The drawings depicting the two drainage conditions analyzed are listed below.

- Appendix IIIF-A (Post-Development Condition Hydrologic Calculations) – This condition represents the proposed configuration of the site after development of the expanded landfill is complete.
- Appendix IIIF-E (Permitted Condition Hydrologic Calculations) – This appendix contains analysis and supporting calculations for the updated permitted configuration of the facility. Section 4.3.1 includes a discussion of how the existing permitted drainage analysis has been updated to provide an equivalent comparison to the post-development condition.

Supporting calculations are presented in Appendices IIIF-A for post-development conditions and IIIF-E for existing permitted conditions.

The following three sections discuss: (1) regional drainage associated with the site; (2) site drainage patterns; and (3) effect of the proposed development on peak flows, volumes, and velocities discharged from the site.

4.1 Regional Drainage Information

As shown on Figure 4.1, the Turkey Creek Landfill permit boundary is located near the headwater of Turkey Creek. The permit boundary area drains to Turkey Creek on the northeast side of the permit boundary and to an unnamed tributary of Turkey Creek on the southeast side of the permit boundary. Turkey Creek discharges to North Fork Creek approximately 2 miles east of the landfill. North Fork Creek discharges to Chambers Creek approximately 7.5 miles northwest of Italy, Texas. Chambers Creek discharges into Richard Chambers Reservoir approximately 6.5 miles east of Corsicana, Texas.

4.2 Site Drainage Patterns

The permitted and proposed site drainage patterns are shown on Figures 4.4 and 4.5. As shown on Figures 4.4 and 4.5, the proposed drainage patterns are consistent with the currently permitted and drainage patterns. As shown on these two figures, most of the permit area drains from southwest to northeast and is discharged from the north and southeast corners of the permit boundary.

4.3 Effect of Site Development on Drainage from the Site

The purpose of this section is to evaluate the peak flow rates, runoff volumes, and peak flow velocities of the updated, permitted, and post-development hydrologic conditions. A summary of peak flow rates, runoff volumes, and peak flow velocities entering and exiting the permit boundary are provided in Table 4-1 and are shown on Figure 4.5.

4.3.1 Peak Flow Rates

As shown in Table 4.1, post-development peak flow rates for the 25-year frequency storm (design storm) are lower than the existing permitted design peak flow rates at the stormwater discharge location at the permit boundary. The major discharges from the site occur at discharge locations DCP1, DCP2, and DCP3. The proposed addition of two stormwater detention ponds results in lower post-development peak flow rates at the northeast, north, and southeast discharges of the site. Peak flow rates to the northeast have been reduced due to slightly lower total drainage area in the post-development condition. The peak flow rates to north and southeast have been reduced due to the additional detention ponds P1 and P3, and to different delineation of drainage areas.

4.3.2 Discharge Volumes

The total volume of runoff discharged from the site is increases slightly at DCP1 and DCP3 and decreases at DCP2. The increase in DCP1 and DCP3 is mainly due to the increased developed landfill final cover areas, sideslopes, and perimeter channels and the proposed stormwater detention ponds. The increased volume of runoff generated by the proposed development is mitigated by the drainage improvements proposed to be constructed that release at lower peak rates than the permitted condition.

4.3.3 Discharge Velocities

Consistent with the decreased flow rates at the permit boundary, the velocities at the permit boundary for the post-development condition are lower than the currently permitted condition because no change has been made to the drainage conveyances at the permit boundary. Since the post-development peak design storm discharge rates are lower at the permit boundary, the velocities are lower compared to the currently permitted condition.

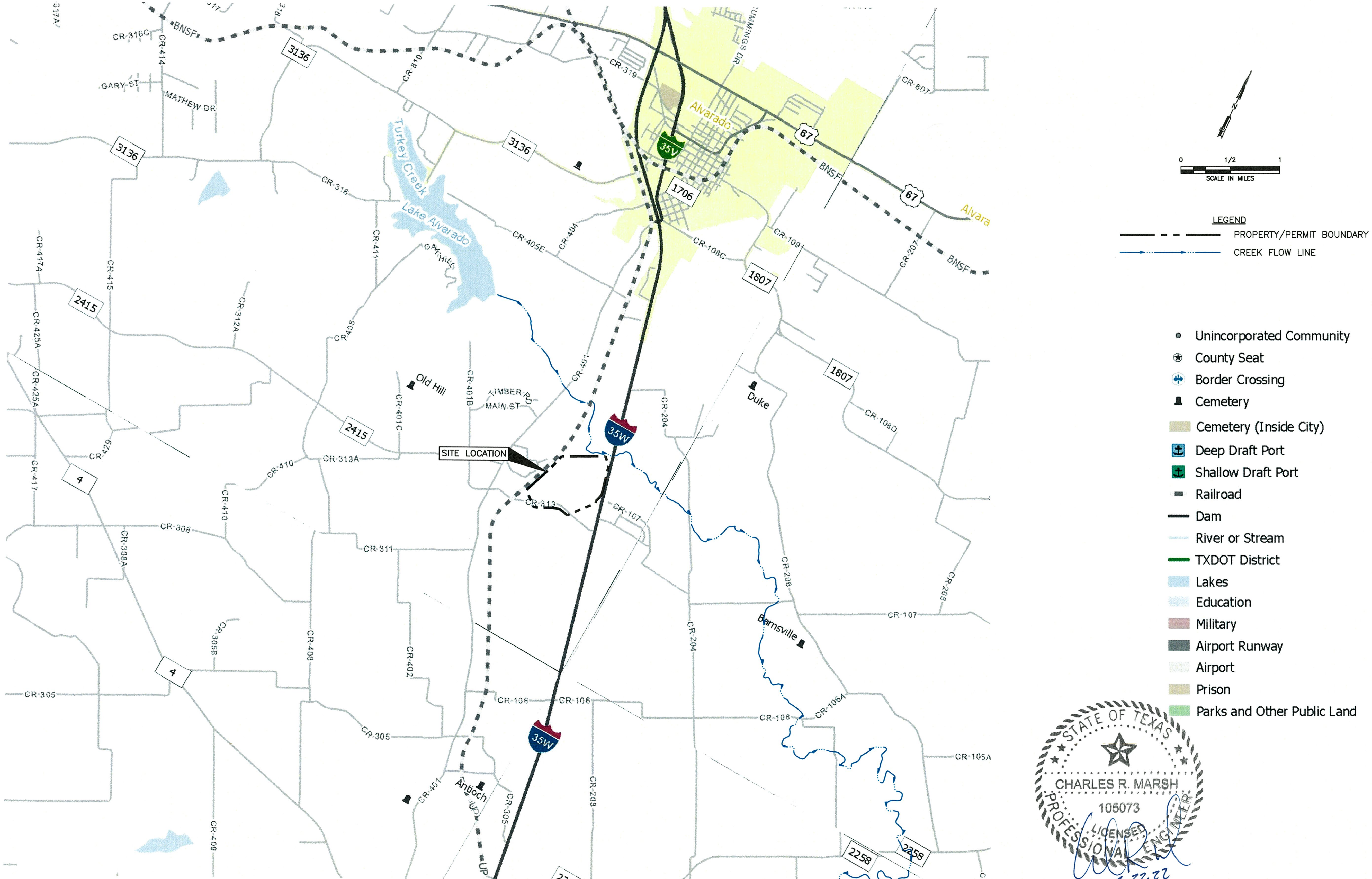
4.4 Summary

From the hydrological evaluations of the permitted and post-development conditions, the permitted drainage conditions at the permit boundary will not be adversely altered by the proposed development. Given that: (1) drainage patterns are not adversely altered, (2) total design stormwater peak discharge rate at the permit boundary is less than the permitted total stormwater peak discharge rate, (3) post-development runoff velocity at the permit boundary will not be increased from the currently permitted condition, and (4) the stormwater discharge outfall locations are consistent with the permitted configuration, it is concluded that the proposed landfill development will not adversely alter permitted drainage patterns consistent with Title 30 TAC 330.63(c)(1)(C), §330.63(c)(1)(D)(iii), and §330.305(a).

Table 4-1
Permitted and Post-Development 25-Year Site Drainage Summary

Stormwater Discharge Point[1]	Permitted Condition					Post-Development Condition				
	Flow Rate (cfs)	Drainage Area (acres)	Time to Peak (hrs)	Runoff Volume[2] (ac-ft)	Velocity at Permit Boundary[2] (fps)	Flow Rate (cfs)	Drainage Area (acres)	Time to Peak (hrs)	Runoff Volume[2] (ac-ft)	Velocity at Permit Boundary[2] (fps)
DCPO1	466	180.49	12.58	82.0	8.38	466	180.49	12.58	82.0	8.38
DCPO2	188	74.63	12.67	33.9	5.34	188	74.63	12.67	33.9	5.34
DCPO3	206	69.25	12.50	31.5	6.47	206	69.25	12.50	31.5	6.47
DCPO4	179	61.05	12.50	27.7	3.93	179	61.05	12.50	27.7	3.93
DCP05	22	6.34	12.42	2.9	1.84	22	6.34	12.42	2.9	1.84
DCP1 (Northeast)	297	69	12.17	32.6	7.37	289	67	12.83	34.1	7.31
DCP2 (North)[3]	664	330	12.67	149.9	9.83	623	316	12.25	144.0	3.35
DCP3 (Southeast)[4]	564	213	12.50	97.6	14.11	558	228	12.33	109.2	1.45

1 Stormwater discharge points are shown on Figure 4.6. The volume shown is the total volume of runoff for the hydrograph duration.
2 Runoff volume and velocity calculations are provided in Appendix IIIF-A and IIIF-E.
3 Discharge point DCP2 includes DCP01 and DCP02.
4 Discharge Point DCP3 includes DCP03, DCP04, and DCP05.

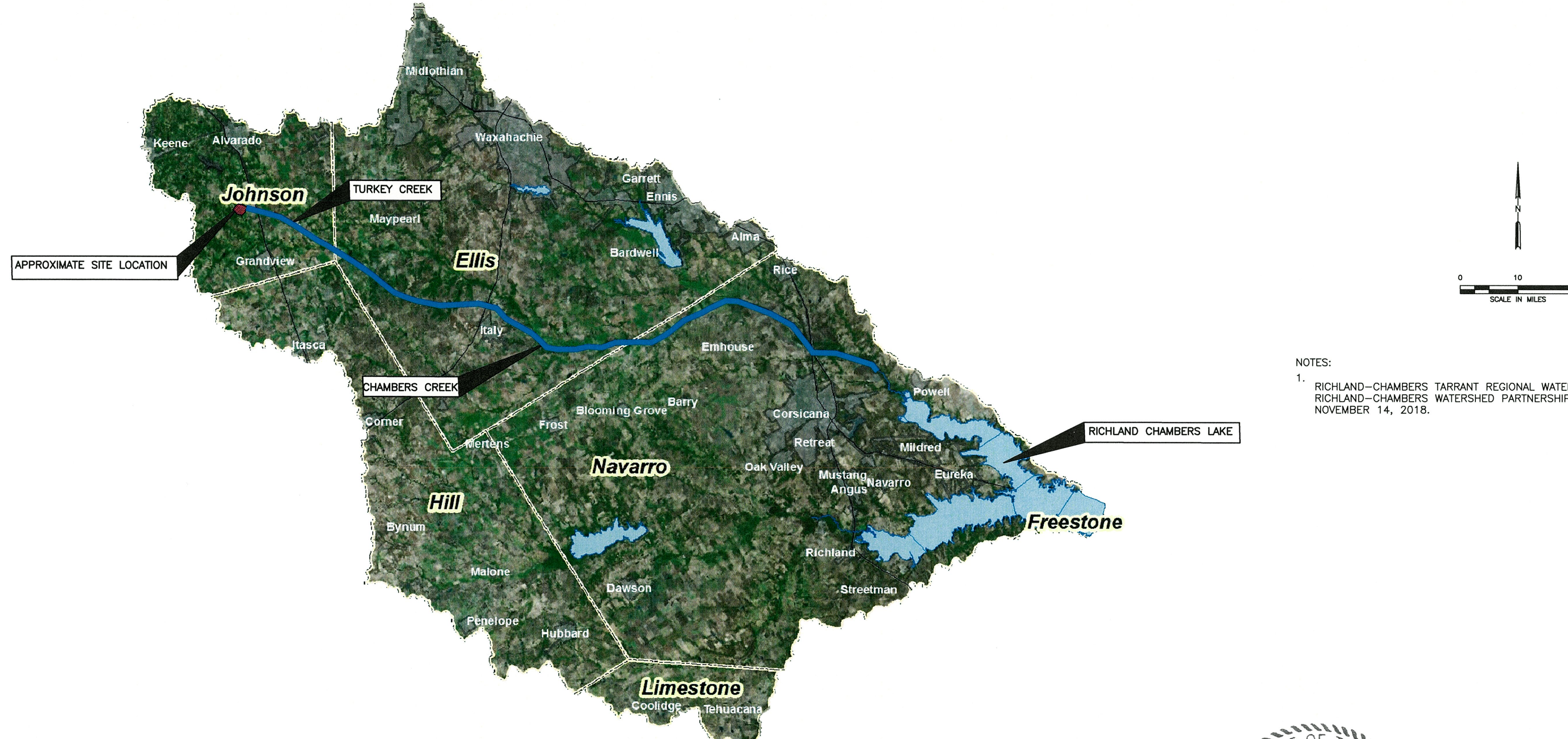


NOTE:

1. REPRODUCED FROM 2018 TEXAS DEPARTMENT OF TRANSPORTATION COUNTY MAPS, JOHNSON COUNTY.

☐ DRAFT ☒ FOR PERMITTING PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR TEXAS REGIONAL LANDFILL COMPANY, LP	MAJOR PERMIT AMENDMENT SITE LOCATION MAP TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS	
DATE: 02/2022 FILE: 0771-368-11 CAD: 4.1-SITE LOCATION MAP.DWG DRAWN BY: JDW DESIGN BY: BPY REVIEWED BY: CRM	REVISIONS NO. / DATE / DESCRIPTION		
Weaver Consultants Group TBPE REGISTRATION NO. F-3727		WWW.WCGRP.COM	FIGURE 4.1

O:\0771\368\EXPANSION 2021\PART III\IIIF\FIGURES\4.1-SITE LOCATION MAP.dwg, rarrington, 1:2

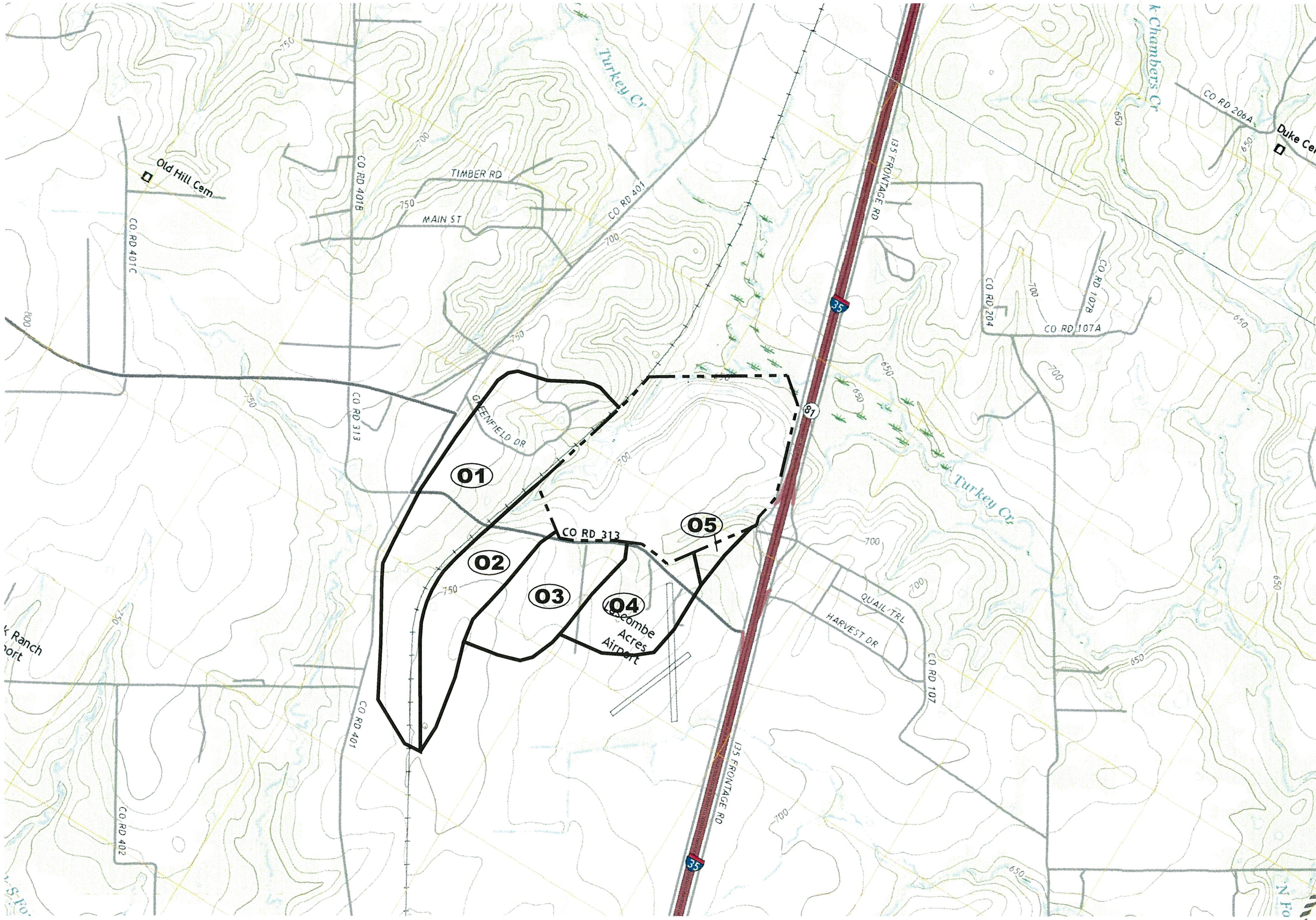


NOTES:

1. RICHLAND-CHAMBERS TARRANT REGIONAL WATER DISTRICT'S RICHLAND-CHAMBERS WATERSHED PARTNERSHIP PRESENTATION, NOVEMBER 14, 2018.

☐ DRAFT ☒ FOR PERMITTING PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR TEXAS REGIONAL LANDFILL COMPANY, LP		MAJOR PERMIT AMENDMENT REGIONAL WATERSHED MAP TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS
DATE: 02/2022 FILE: 0771-368-11 CAD: 4.2-REGIONAL WATERSHED.DWG	DRAWN BY: JDW DESIGN BY: BPY REVIEWED BY: CRM	REVISIONS	
Weaver Consultants Group TBPE REGISTRATION NO. F-3727			WWW.WCGRP.COM — FIGURE 4.2

NO.	DATE	DESCRIPTION



0 1000 2000
SCALE IN FEET

LEGEND

PERMIT BOUNDARY

DRAINAGE AREA BOUNDARY

O2 DRAINAGE AREA LABEL

DRAINAGE AREA NO.	AREA (ACRES)
O1	180.49
O2	74.62
O3	69.25
O4	61.05
O5	6.34
TOTAL	391.75

ALVARADO, TX
2019

GRANDVIEW, TX
2019

NOTES:

1. DRAINAGE AREA DELINEATION WITHIN THE PERMIT BOUNDARY IS INCLUDED ON DRAWING IIIF-A-26.
2. ALL TOPOGRAPHIC INFORMATION REPRODUCED FROM UNITED STATES GEOLOGICAL SURVEY 7 1/2 MINUTE QUADRANGLE SHEETS FOR ALVARADO, TX AND GRANDVIEW, TX.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-22-22

O:\0771\368\EXPANSION 2021\PART III\IIIF\FIGURES\4.3 OFFSIDE DRAINAGE.dwg, rarrington, 1:2

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DATE: 02/2022
FILE: 0771-368-11
CAD: 4.3-OFFSITE DRAINAGE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

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TEXAS REGIONAL LANDFILL COMPANY, LP

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MAJOR PERMIT AMENDMENT
OFFSITE DRAINAGE AREA MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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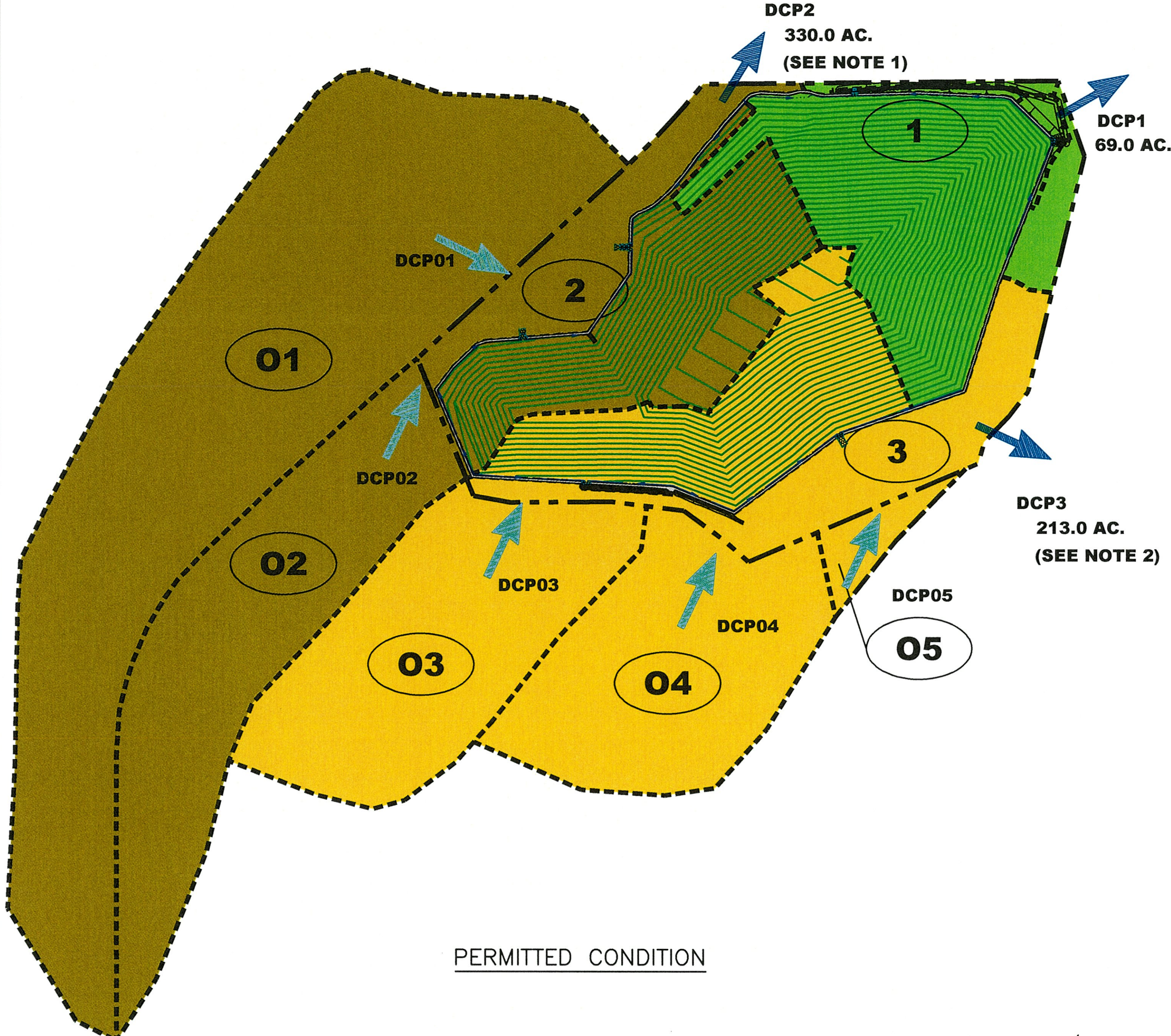
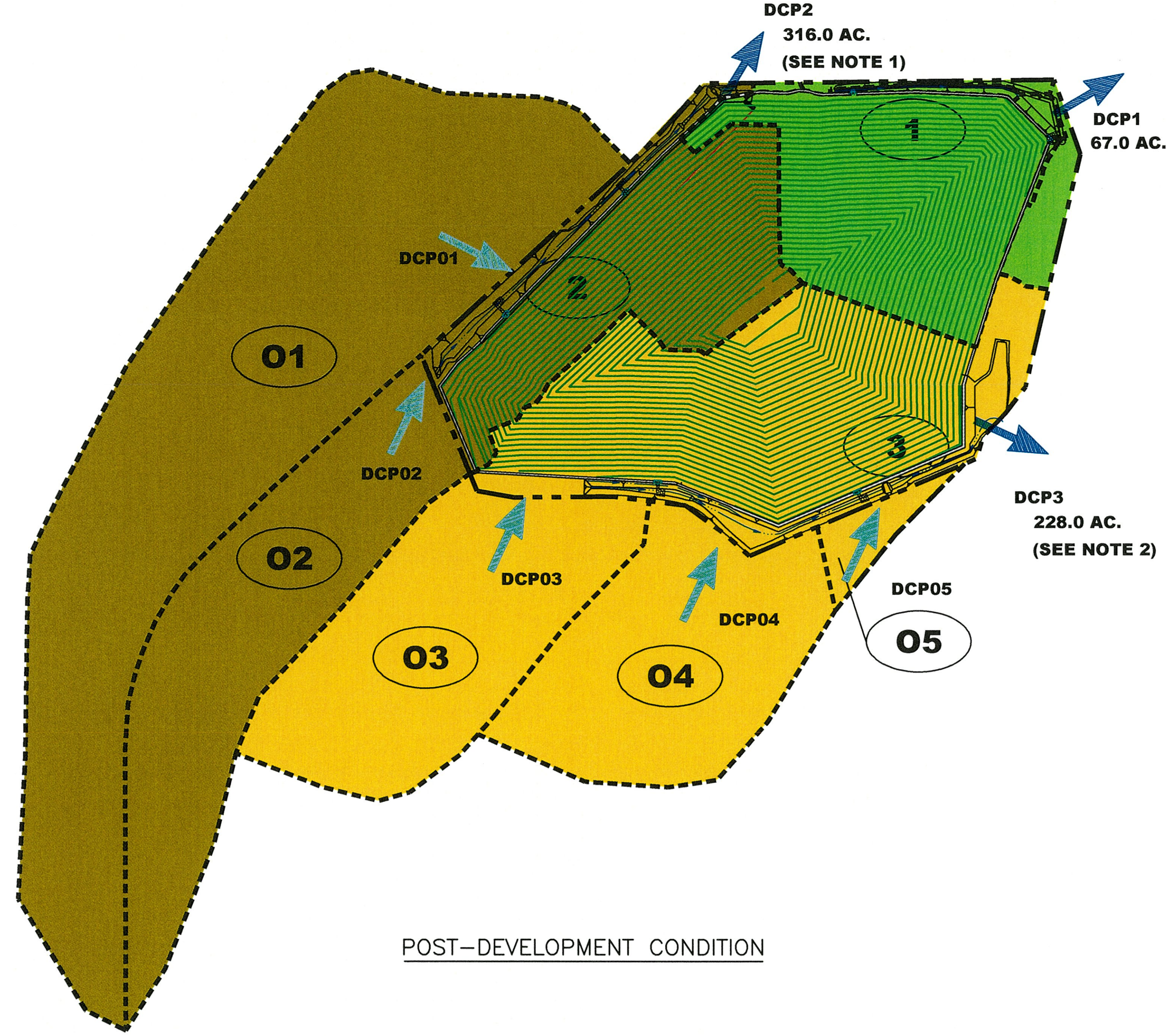
FIGURE 4.3



PERMITTED CONDITION



POST-DEVELOPMENT CONDITION

Permitted Condition

DISCHARGE POINTS TOTAL = 391.76 ACRES

OFF-SITE AREAS

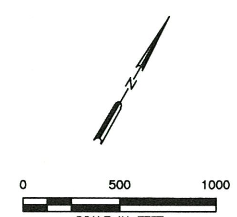
01 = 180.49 ACRES
02 = 74.63 ACRES
03 = 69.25 ACRES
04 = 61.05 ACRES
05 = 6.34 ACRES

OFF-SITE TOTAL = 391.76 ACRES

ON-SITE AREAS

1 = APPROX. 68.89 ACRES
2 = APPROX. 74.46 ACRES
3 = APPROX. 76.29 ACRES

PERMIT BOUNDARY TOTAL = 219.60 ACRES
GRAND TOTAL = APPROX. 611.36 ACRES



Post-Development Condition

DISCHARGE POINTS TOTAL = 391.76 ACRES

OFF-SITE AREAS

01 = 180.49 ACRES
02 = 74.63 ACRES
03 = 69.25 ACRES
04 = 61.05 ACRES
05 = 6.34 ACRES

OFF-SITE TOTAL = 391.76 ACRES

ON-SITE AREAS

1 = APPROX. 67.15 ACRES
2 = APPROX. 60.77 ACRES
3 = APPROX. 91.68 ACRES

PERMIT BOUNDARY TOTAL = 219.60 ACRES
GRAND TOTAL = APPROX. 611.36 ACRES

STATE OF TEXAS
CHARLES R. MARSH
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2-22-22

NOTES:

1. DCP1 AREA INCLUDES THE DRAINING AREAS FROM DCP01 AND DCP02.
2. DCP3 AREA INCLUDES THE DRAINING AREAS FROM DCP03, 04 AND 05.

LEGEND

PROPERTY BOUNDARY
LIMITS OF WASTE
DRAINAGE DIVIDE
PERMITTED/PROPOSED FINAL COVER CONTOUR
05 DRAINAGE AREA LABEL
UPLAND DRAINAGE ENTERING SITE
STORMWATER DISCHARGE POINT

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MAJOR PERMIT AMENDMENT
SITE DRAINAGE PATTERNS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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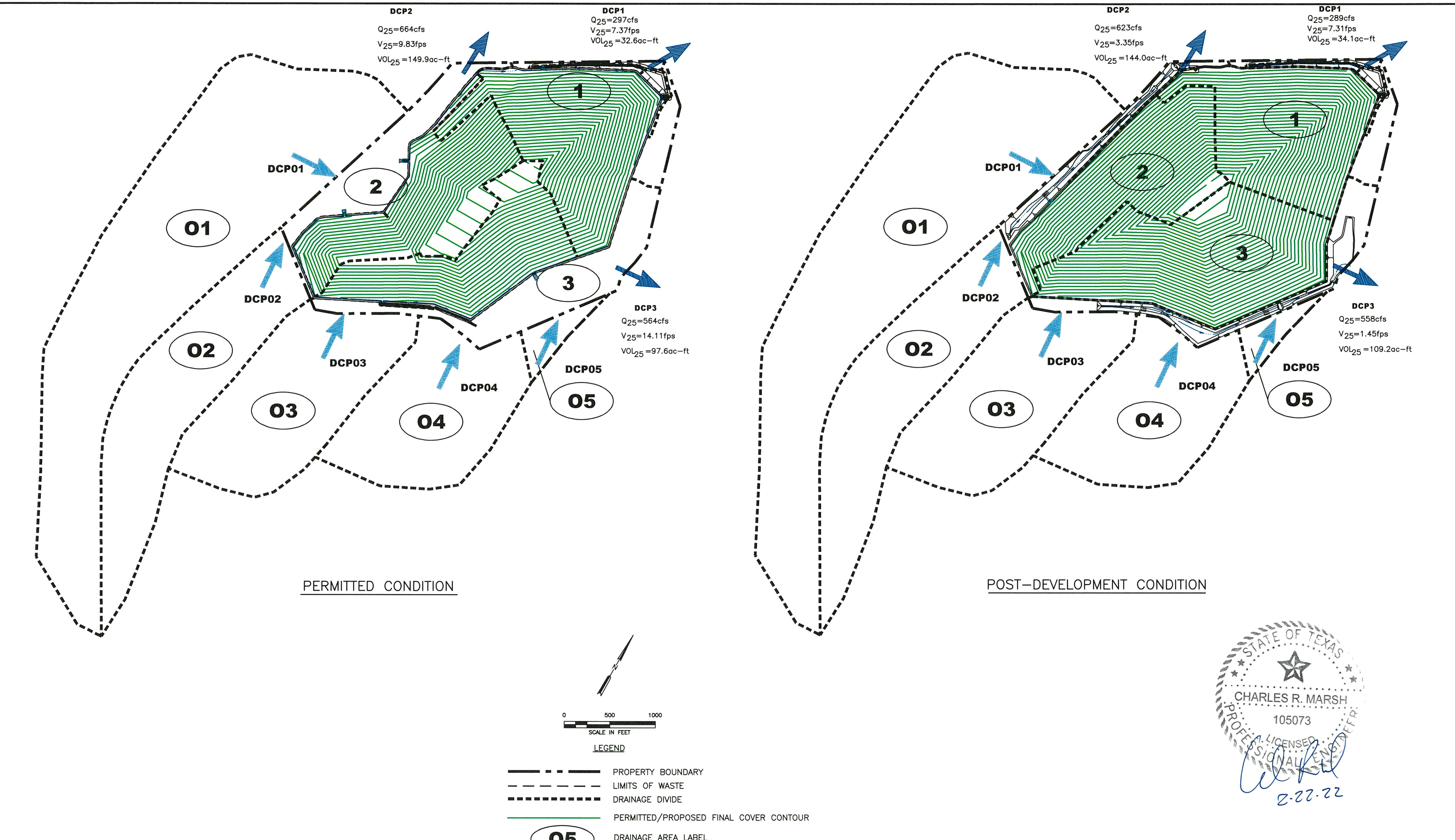
FIGURE 4.4



☐ DRAFT ☒ FOR PERMITTING PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR TEXAS REGIONAL LANDFILL COMPANY, LP	MAJOR PERMIT AMENDMENT SITE DRAINAGE PATTERNS RUNON/RUNOFF
DATE: 02/2022 FILE: 0771–368–11 CAD: 4.5 RUNON RUNOFF.DWG DRAWN BY: JDW DESIGN BY: BPY REVIEWED BY: CRM	REVISIONS NO. / DATE / DESCRIPTION	TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS
Weaver Consultants Group TBPE REGISTRATION NO. F–3727		WWW.WCGRP.COM — FIGURE 4.5

O:\0771\368\EXPANSION 2021\PART III\IIIF\FIGURES\4.5– RUNON RUNOFF.dwg, rarrington, 1:2

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

NO SCREEN Area of Minimal Flood Hazard *Zone X*

- Effective LOMRs

OTHER AREAS
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

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105073
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2-22-22

0 500 1000
SCALE IN FEET

LEGEND

PROPERTY BOUNDARY

NOTES:

1. REPRODUCED FROM FEMA FIRM NUMBERS 4808810350J AND 4808790350J FOR CITY OF GRANDVIEW, AND JOHNSON COUNTY, UNINCORPORATED AREAS, EFFECTIVE DECEMBER 4TH, 2010.

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MAJOR PERMIT AMENDMENT
FLOOD INSURANCE RATE MAP (FIRM)

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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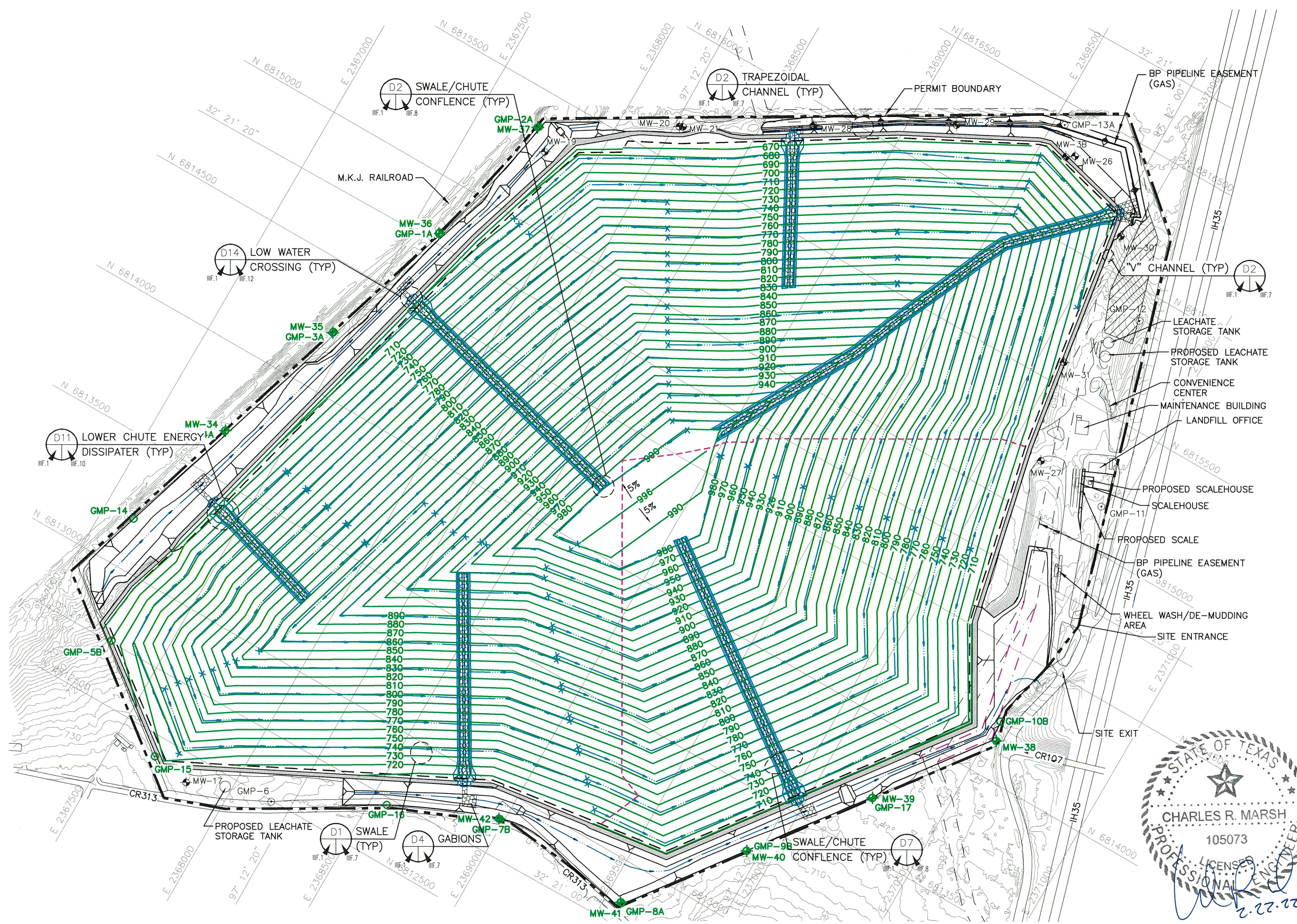
FIGURE 4.6

O:\0771\368\EXPANSION 2021\PART III\IIIF\FIGURES\4.6-FIRM.dwg, rarrington, 1:2

DRAWINGS

IIIF.1 – Drainage Structure Plan
IIIF.2 – Post-Development Drainage Area Plan
IIIF.3 – Post-Development Offsite Drainage Areas
IIIF.4 – Perimeter Drainage Plan
IIIF.5 – Perimeter Channel Profiles
IIIF.6 – Perimeter Channel Profiles
IIIF.7 – Drainage Details
IIIF.8 – Drainage Details
IIIF.9 – Drainage Details
IIIF.10 – Drainage Details
IIIF.11. – Drainage Details
IIIF.12. – Drainage Details
IIIF.13 – Pond P1 Plan
IIIF.14 – Pond P2 Plan
IIIF. 15 – Pond P3 Plan



LEGEND

	PERMIT BOUNDARY
	LIMITS OF WASTE
750	EXISTING CONTOUR
N 6816000	STATE PLANE COORDINATE
32° 21' 20"	GEODETIC COORDINATE
	EASEMENT
	PROPOSED EASEMENT (SEE NOTE 4)
800	FINAL COVER CONTOUR
	LIMIT OF CLASS 1 WASTE DISPOSAL AREA
	DRAINAGE LETDOWN
	DRAINAGE SWALE
	PROPOSED PERIMETER CHANNEL
	GABIONS
MW-7	EXISTING GROUNDWATER MONITORING WELL
GMP-12	EXISTING GAS MONITORING PROBE
MW-37	PROPOSED GROUNDWATER MONITORING WELL
GMP-17	PROPOSED GAS MONITORING PROBE
	FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.
3. MAXIMUM FINAL COVER ELEVATION IS 996.0 FT-MSL. MAXIMUM TOP OF WASTE ELEVATION IS 992.5 FT-MSL.
4. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

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MAJOR PERMIT AMENDMENT
DRAINAGE STRUCTURE PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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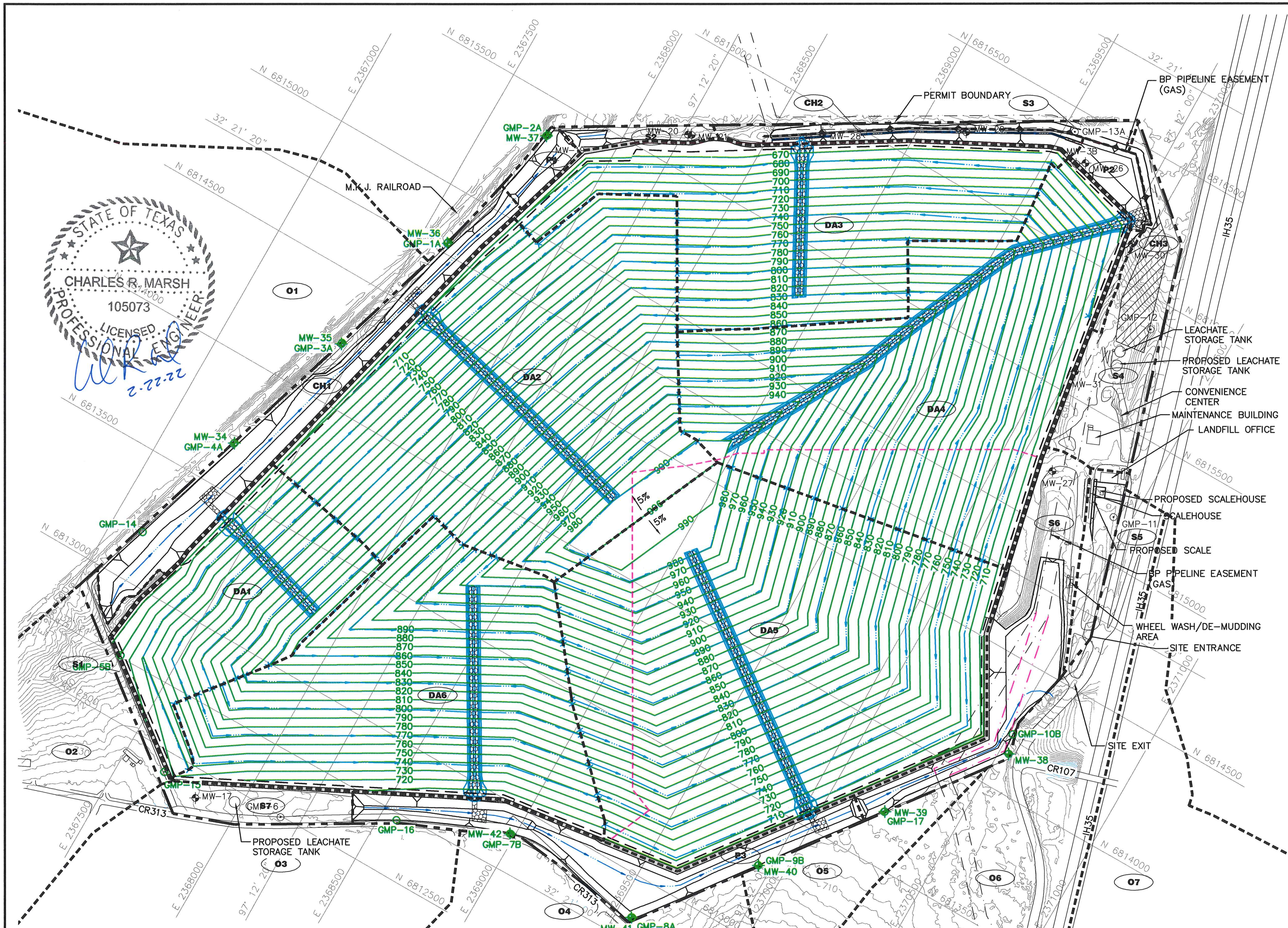
DRAWING IIIF.1

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-1-COMPLETION PLAN.dwg, rarrington, 1:2



0 200 400
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 EXISTING CONTOUR
- N 6816000 STATE PLANE COORDINATE
- 32° 21' 20" GEODETIC COORDINATE
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 4)
- 800 FINAL COVER CONTOUR
- LIMIT OF CLASS 1 WASTE DISPOSAL AREA
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- MW-7 EXISTING GROUNDWATER MONITORING WELL
- GMP-12 EXISTING GAS MONITORING PROBE
- MW-7 PROPOSED GROUNDWATER MONITORING WELL
- GMP-17 PROPOSED GAS MONITORING PROBE
- DRAINAGE DIVIDE
- DA2 DRAINAGE AREA DESIGNATION
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.
3. MAXIMUM FINAL COVER ELEVATION IS 996.0 FT-MSL. MAXIMUM TOP OF WASTE ELEVATION IS 992.5 FT-MSL.
4. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

DRAINAGE AREA NO.	AREA (ACRES)	DRAINAGE AREA NO.	AREA (ACRES)
DA1	12.96	P1	1.04
DA2	36.87	P2	1.27
DA3	22.58	P3	6.68
DA4	33.25	CH1	7.79
DA5	44.98	CH2	1.49
DA6	27.53	CH3	0.37
O1	180.49	S1	1.14
O2	74.63	S2	0.99
O3	69.25	S3	1.71
O4	61.05	S4	6.49
O5	6.34	S5	1.93
O6	52.40	S6	8.14
O7	48.73	S7	2.40

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DRAWN BY: JDW
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REVIEWED BY: CAM

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MAJOR PERMIT AMENDMENT POST-DEVELOPMENT DRAINAGE AREA PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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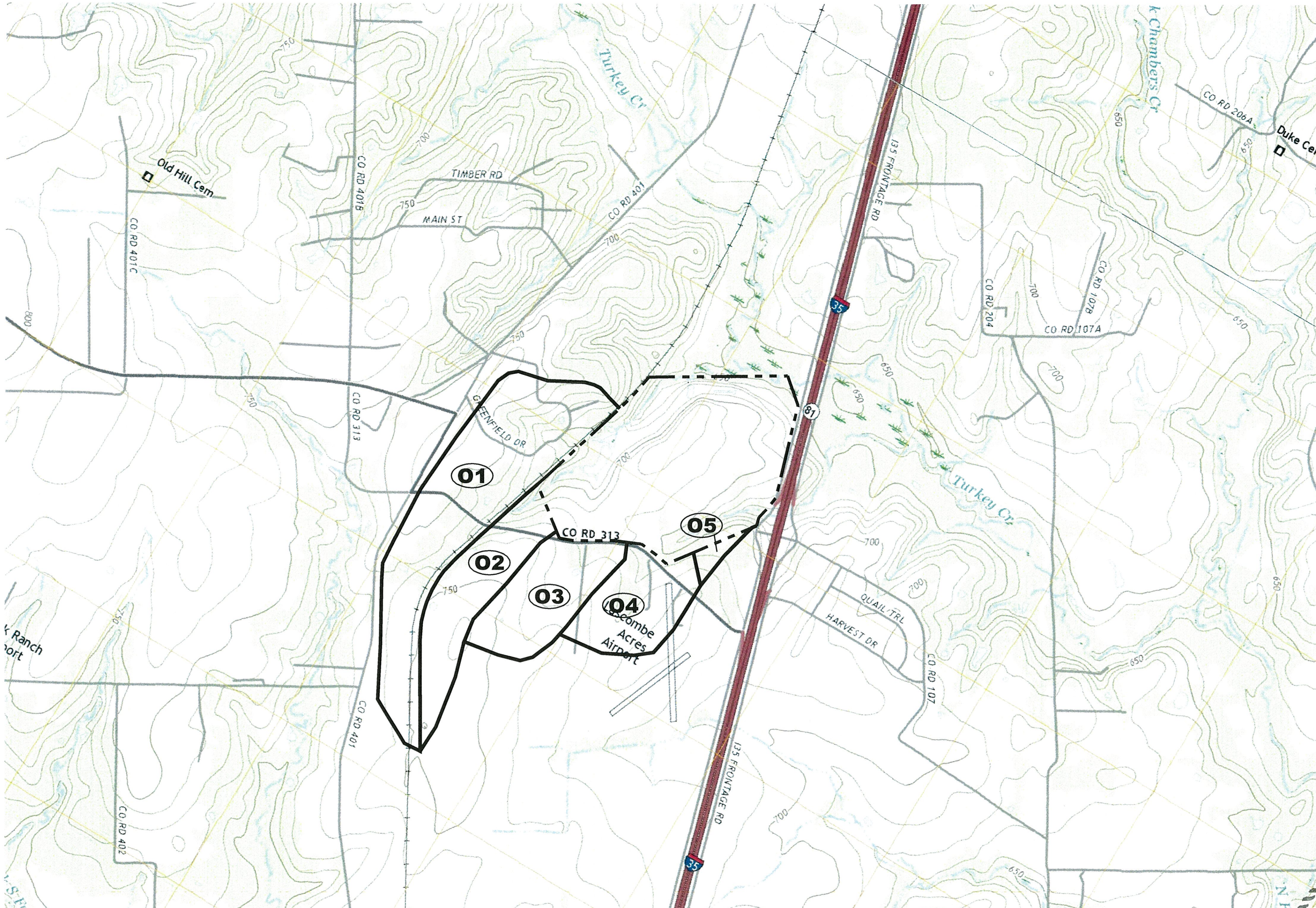
DRAWING IIIF.2

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-2-POST DEV DRAINAGE.dwg, jwilson, 1:2



0 1000 2000
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- DRAINAGE AREA BOUNDARY
- O2 DRAINAGE AREA LABEL

DRAINAGE AREA NO.	AREA (ACRES)
O1	180.49
O2	74.63
O3	69.25
O4	61.05
O5	6.34
TOTAL	391.75

ALVARADO, TX 2019

GRANDVIEW, TX 2019

NOTES:

1. DRAINAGE AREA DELINEATION WITHIN THE PERMIT BOUNDARY IS INCLUDED ON DRAWING IIIF–A–26.
2. ALL TOPOGRAPHIC INFORMATION REPRODUCED FROM UNITED STATES GEOLOGICAL SURVEY 7 1/2 MINUTE QUADRANGLE SHEETS FOR ALVARADO, TX AND GRANDVIEW, TX.

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CAD: IIIF.3-OFFSITE DRAINAGE MAP.DWG

DRAWN BY: JDW
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TEXAS REGIONAL LANDFILL COMPANY, LP

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MAJOR PERMIT AMENDMENT
POST-DEVELOPMENT
OFF-SITE DRAINAGE AREAS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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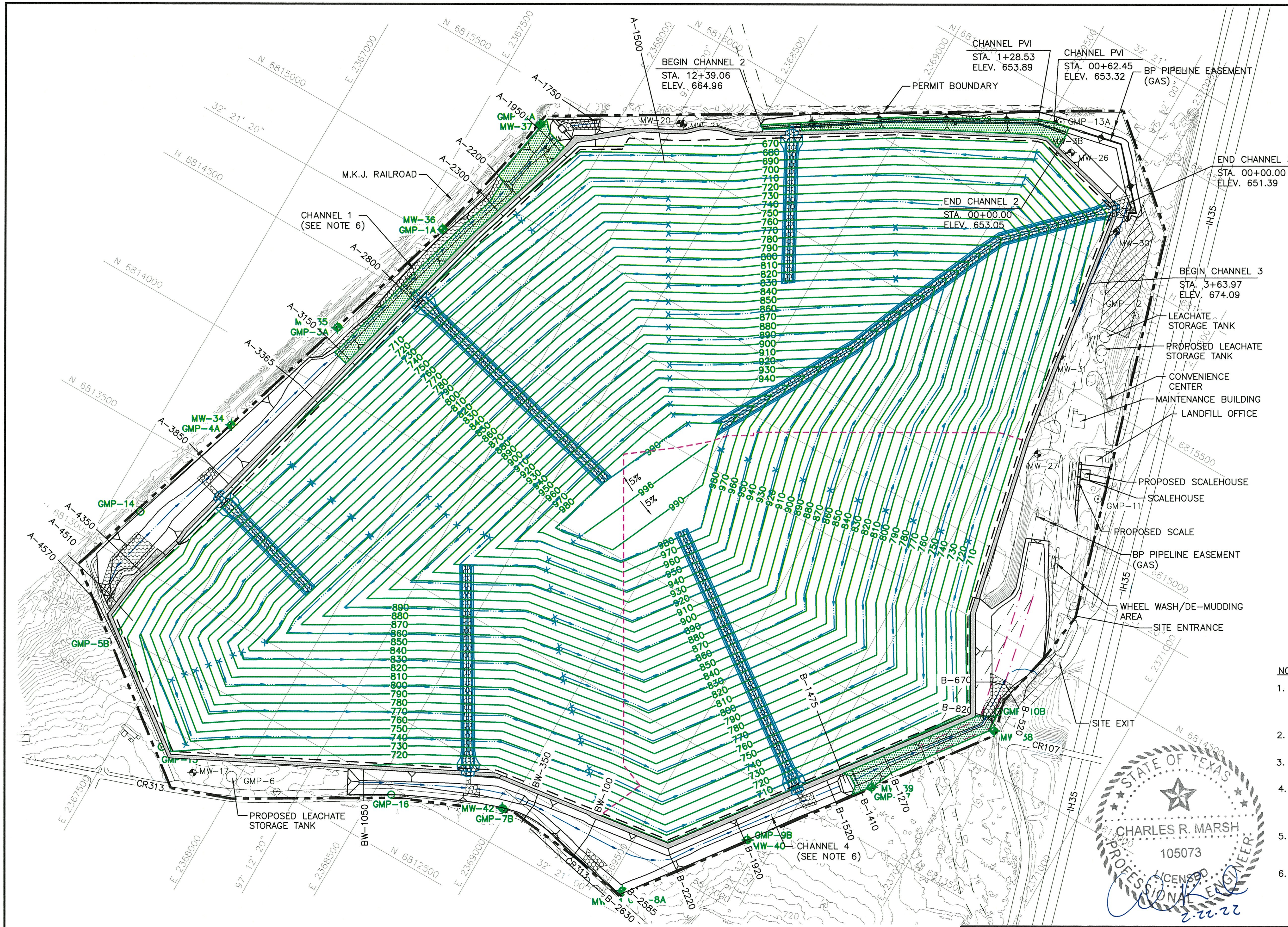
DRAWING IIIF.3

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-3-OFFSITE DRAINAGE.dwg, rarrington, 1:2



SCALE IN FEET: 0 200 400

LEGEND

- PERMIT BOUNDARY
- PERMITTED LIMITS OF WASTE
- EXISTING CONTOUR (750)
- STATE PLANE COORDINATE (N 6816000)
- GEODETIC COORDINATE (32° 21' 20")
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 4)
- FINAL COVER CONTOUR (800)
- HEC-RAS CROSS SECTION (SEE NOTE 5) (A-4350)
- LIMIT OF CLASS 1 WASTE DISPOSAL AREA
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- TURF REINFORCEMENT MAT
- EXISTING GROUNDWATER MONITORING WELL (MW-7)
- EXISTING GAS MONITORING PROBE (GMP-12)
- PROPOSED GROUNDWATER MONITORING WELL (MW-37)
- PROPOSED GAS MONITORING PROBE (GMP-17)
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.
3. MAXIMUM FINAL COVER ELEVATION IS 996.0 FT-MSL. MAXIMUM TOP OF WASTE ELEVATION IS 992.5 FT-MSL.
4. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.
5. CH1 AND CH4 WERE MODELED IN HEC-RAS AS STREAM A AND STREAM B RESPECTIVELY. REFER TO APPENDIX IIIF-B HEC-RAS OUTPUT FILES FOR STREAM A AND B.
6. CHANNELS 1 AND 4 ARE EQUIVALENT TO STREAM A AND STREAM B/STREAM B WEST IN THE HEC-RAS OUTPUT FILE IN APPENDIX IIIF-B.

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DRAWN BY: JDW
DESIGN BY: CAM
REVIEWED BY: NT

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

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MAJOR PERMIT AMENDMENT PERIMETER DRAINAGE PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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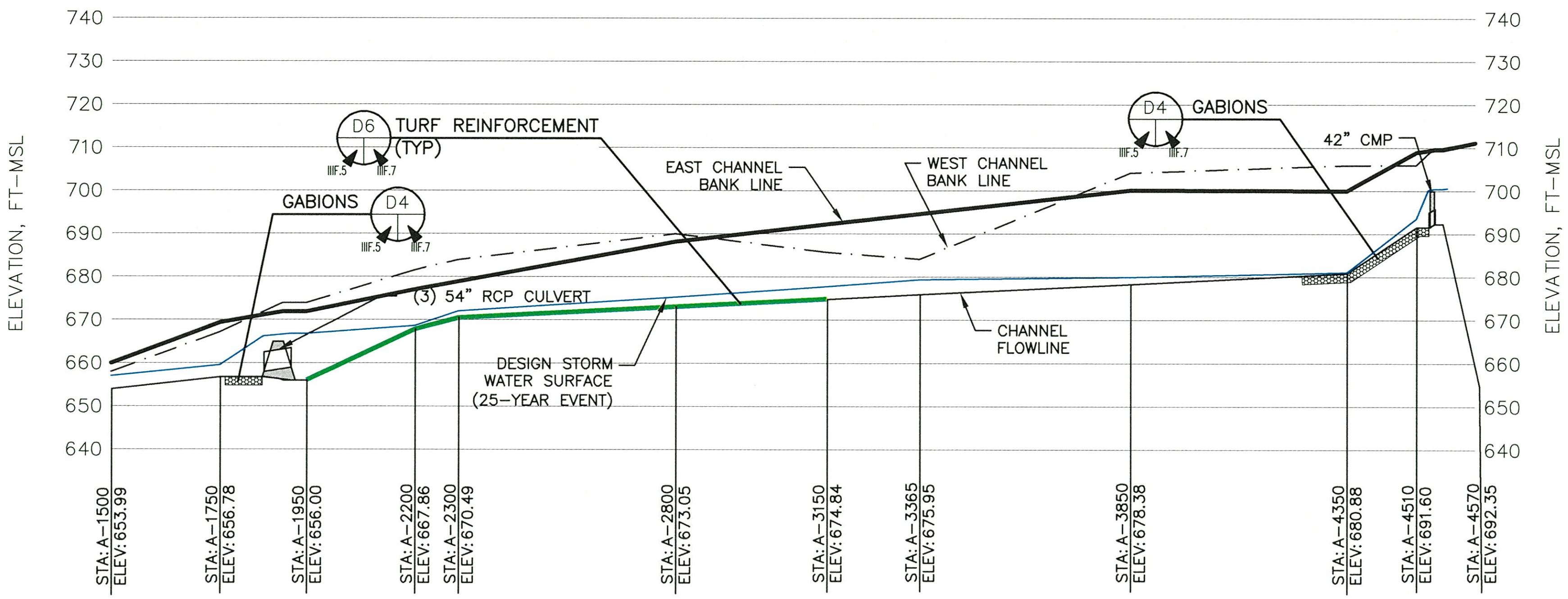
DRAWING IIIF.4

0:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-4-PERIMETER DRAINAGE.dwg, farrington, 1:2



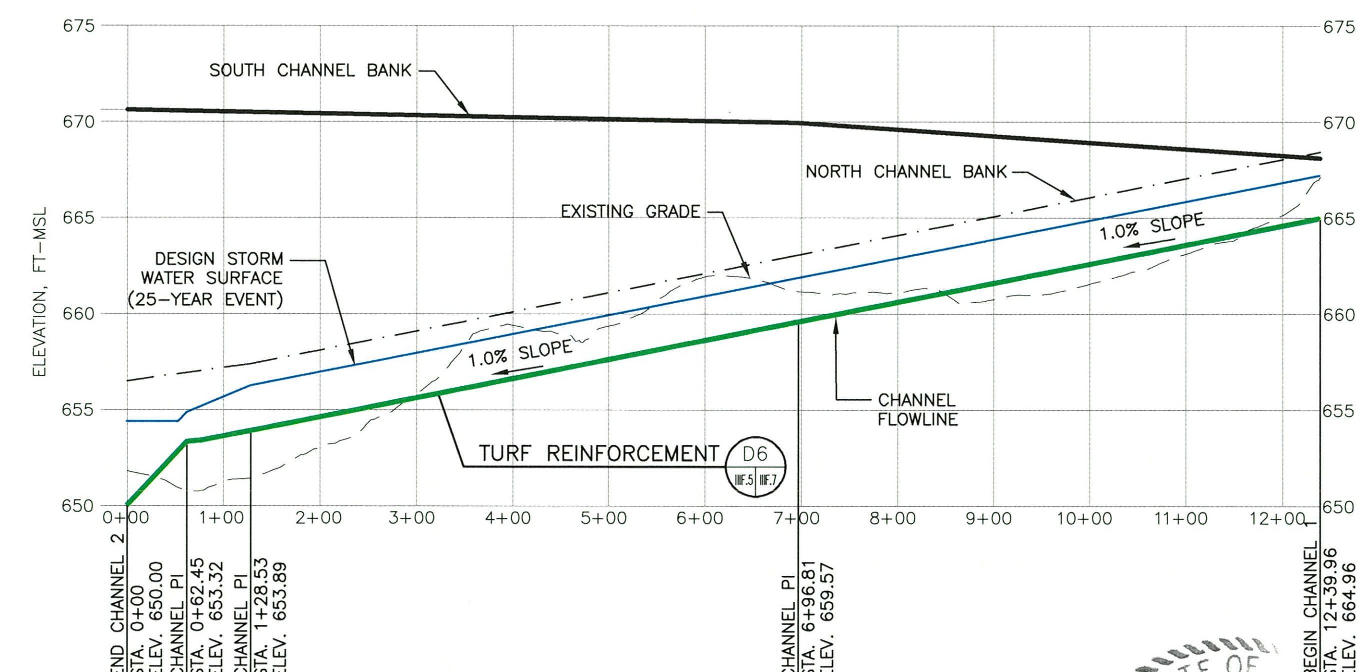
CHANNEL "1" (STREAM A) 1 IIIF.4 IIIF.5

0 200 400 SCALE IN FEET (HORIZONTAL)

0 20 40 SCALE IN FEET (VERTICAL)

25-YEAR CHANNEL "1" INFORMATION

STATION	FLOW RATE (CFS)	FLOW DEPTH (FT.)	FLOW VELOCITY (FPS)	FROUDE NO.	FLOW AREA (SQ.FT.)	TOP WIDTH OF FLOW (FT.)
A-4350	201.0	0.19	13.27	5.36	15.15	79.43
A-3850	201.0	1.59	3.13	0.46	64.15	44.41
A-3365	595.0	3.40	2.46	0.25	241.98	79.64
A-3150	595.0	2.91	8.72	1.01	68.26	29.28
A-2800	624.0	2.22	11.54	1.48	54.07	28.75
A-2300	624.0	1.53	13.03	1.95	47.89	34.40
A-2200	625.0	0.77	17.10	3.51	36.55	49.54
A-1950	625.0	10.74	0.88	0.06	706.3	92.79
A-1750	622.0	2.75	8.95	1.01	69.49	43.51
A-1500	632.0	2.97	3.40	0.51	185.96	132.81



CHANNEL "2" 2 IIIF.4 IIIF.5

0 100 200 SCALE IN FEET (HORIZONTAL)

0 5 10 SCALE IN FEET (VERTICAL)

25-YEAR CHANNEL "2" INFORMATION

CHANNEL STATION FROM	CHANNEL STATION TO	BOTTOM WIDTH (FT)	PEAK INFLOW (CFS)	SLOPE (%)	FLOW DEPTH (FT.)	VELOCITY (FT/S)
0+00	0+62.45	6	157	4.0	1.52	11.39
0+62.45	1+28.53	6	157	0.9	2.35	6.23
1+28.53	6+96.81	6	157	1.0	2.29	6.47
6+96.81	12+39.06	6	157	1.0	2.29	6.47

NOTE: NORMAL DEPTH CALCULATION DOES NOT ACCOUNT FOR BACK WATER WHICH WILL INCREASE FLOW DEPTH (SEE PROFILE) AND DECREASE VELOCITY.

STATE OF TEXAS
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2-22-22

NOTES:

1. REFER TO DRAWING IIIF.4 FOR PROFILE LOCATIONS.
2. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021.
3. HYDRAULIC CALCULATIONS INCLUDED IN APPENDIX IIIF-B.
4. GABIONS SHALL BE USED FOR VELOCITIES OF 20 FT/SEC OR HIGHER.
5. CULVERT CALCULATIONS INCLUDED IN APPENDIX IIIF-B.

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DRAWN BY: JDW
DESIGN BY: CAM
REVIEWED BY: NT

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REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
PERIMETER CHANNEL PROFILES

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF.5

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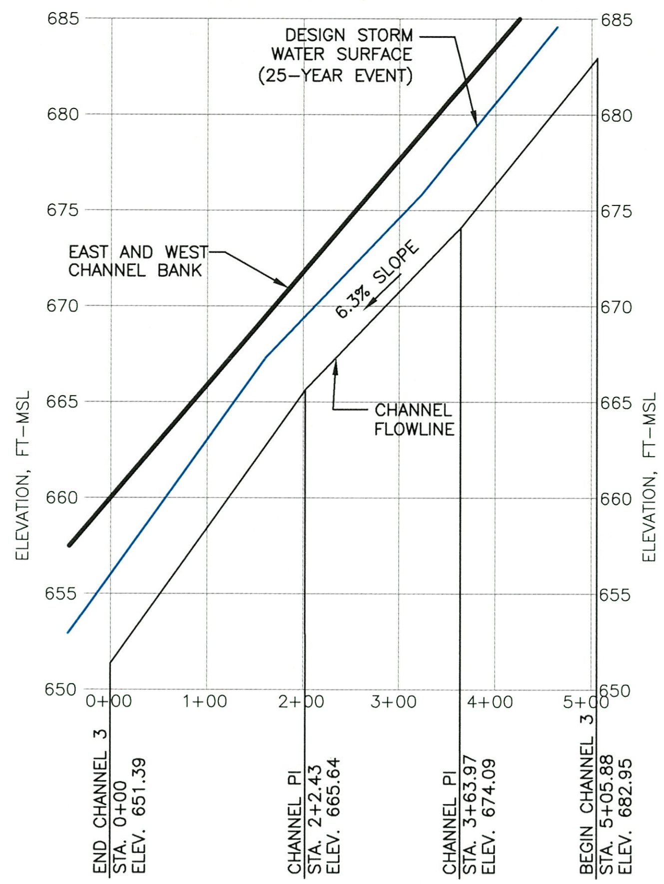
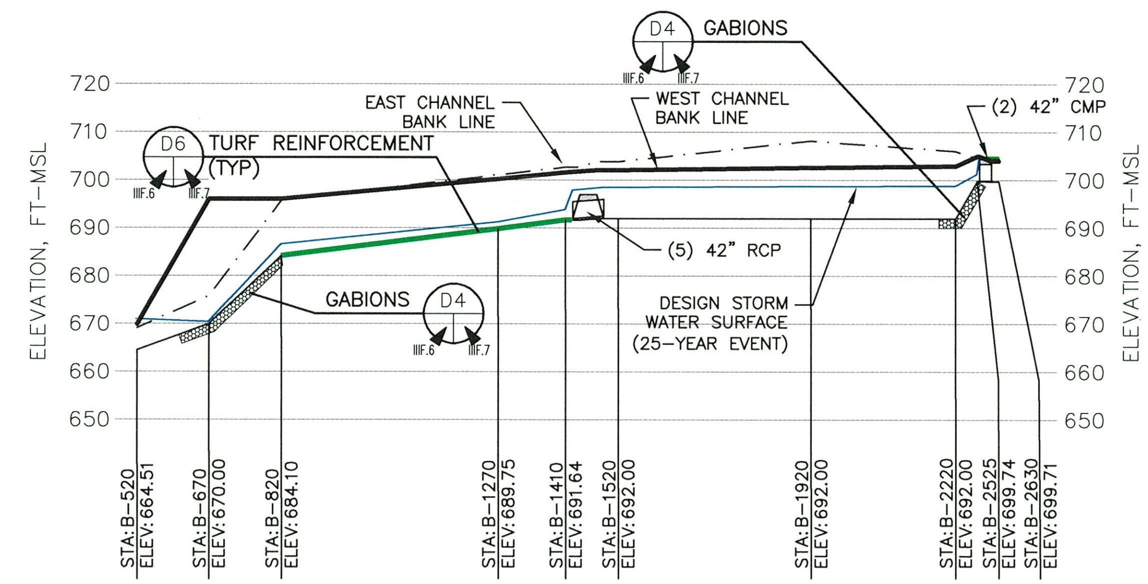


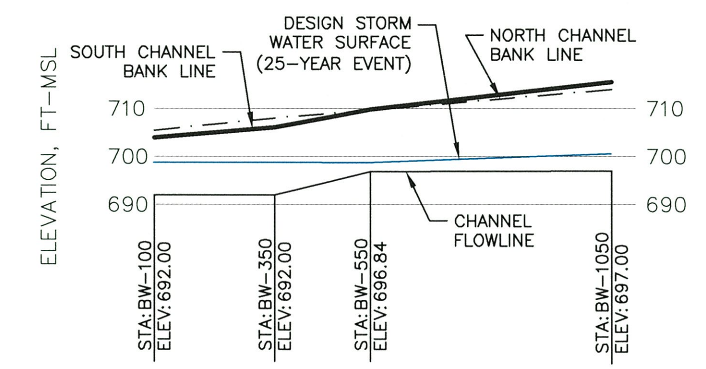
CHANNEL "3" 5 IIIF.4 IIIF.5

0 100 200 SCALE IN FEET (HORIZONTAL) 0 5 10 SCALE IN FEET (VERTICAL)



CHANNEL "4" (STREAM B) 4 IIIF.4 IIIF.5

0 200 400 SCALE IN FEET (HORIZONTAL) 0 20 40 SCALE IN FEET (VERTICAL)



CHANNEL "4" (STREAM B WEST) 4 IIIF.4 IIIF.5

0 100 400 SCALE IN FEET (HORIZONTAL) 0 20 40 SCALE IN FEET (VERTICAL)

25-YEAR CHANNEL "3" INFORMATION

CHANNEL STATION FROM	CHANNEL STATION TO	BOTTOM WIDTH (FT)	PEAK INFLOW (CFS)	SLOPE (%)	FLOW DEPTH (FT.)	VELOCITY (FT/S)
0+00	1+24.29	0	3	6.3	0.47	4.58
1+24.29	2+2.43	0	3	6.3	0.47	4.58
2+2.43	3+63.97	0	3	6.3	0.47	4.58

NOTE: NORMAL DEPTH CALCULATION DOES NOT ACCOUNT FOR BACK WATER WHICH WILL INCREASE FLOW DEPTH (SEE PROFILE) AND DECREASE VELOCITY.

25-YEAR CHANNEL "4" INFORMATION

STATION	FLOW RATE (CFS)	FLOW DEPTH (FT.)	FLOW VELOCITY (FPS)	FROUDE NO.	FLOW AREA (SQ.FT.)	TOP WIDTH OF FLOW (FT.)
BW-1050	315.0	3.53	3.83	0.42	82.19	32.08
BW-550	315.0	1.82	3.49	0.48	90.20	54.18
BW-350	315.0	6.70	1.15	0.09	273.98	57.70
BW-100	315.0	6.71	0.38	0.03	818.55	138.88
B-2220	442.0	6.68	1.35	0.11	328.04	65.56
B-21920	442.0	6.62	1.50	0.12	294.81	60.12
B-1520	798.0	6.46	2.13	0.17	375.10	72.65
B-1410	513.0	2.12	8.25	1.00	62.19	55.83
B-1270	513.0	1.43	13.87	2.19	36.99	29.64
B-820	513.0	2.40	8.08	1.02	63.50	32.81
B-670	513.0	0.30	20.90	6.74	24.54	82.18
B-520	513.0	6.42	1.45	0.12	422.34	129.65

NOTES:

1. REFER TO DRAWING IIIF.4 FOR PROFILE LOCATIONS.
2. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021.
3. HYDRAULIC CALCULATIONS INCLUDED IN APPENDIX IIIF-B.
4. GABIONS SHALL BE USED FOR VELOCITIES OF 20 FT/SEC OR HIGHER.
5. CULVERT CALCULATIONS INCLUDED IN APPENDIX IIIF-B.

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DATE: 02/2022
FILE: 0771-368-11
CAD: IIF.6-PERIMETER CHANNEL PROFILE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

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MAJOR PERMIT AMENDMENT
PERIMETER CHANNEL PROFILES

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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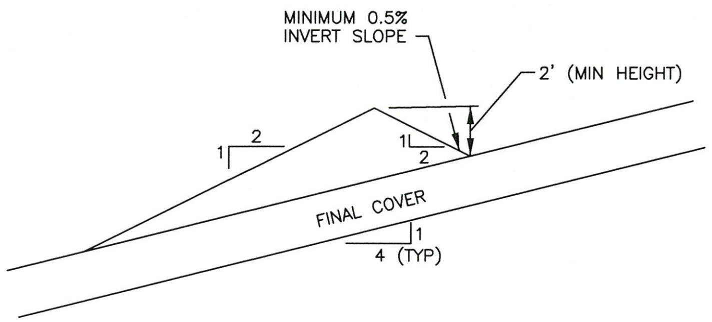
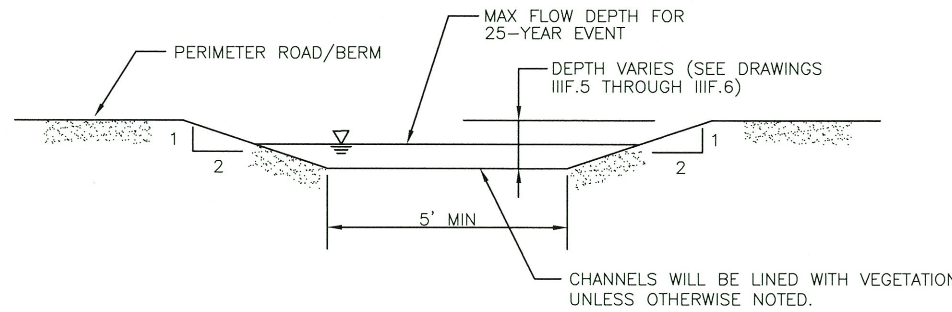
DRAWING IIIF.6



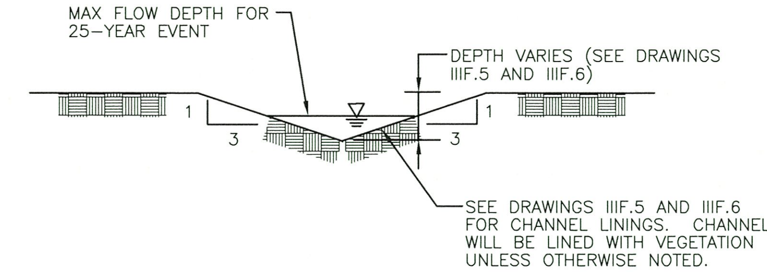
SWALE (TYP) D1 IIF.1 IIF.7

0 4 8
SCALE IN FEET



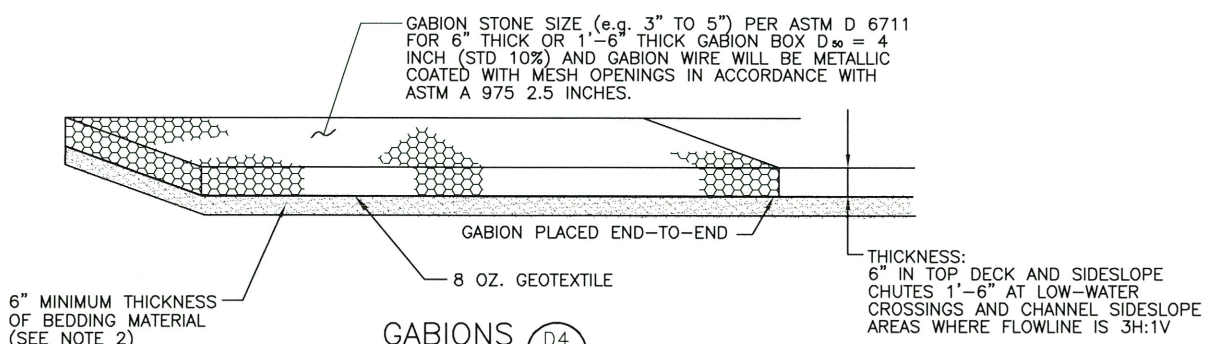
TRAPEZOIDAL CHANNEL (TYP) D2 IIIF.1,IIIF.8 IIIF.7

0 2 4
SCALE IN FEET



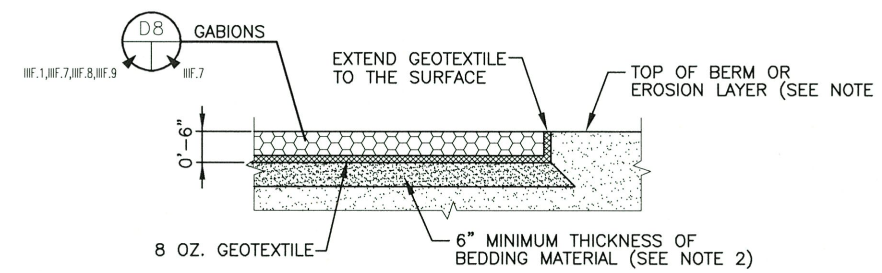
"V" CHANNEL (TYP) D3 IIIF.1 IIIF.7

0 2 4
SCALE IN FEET



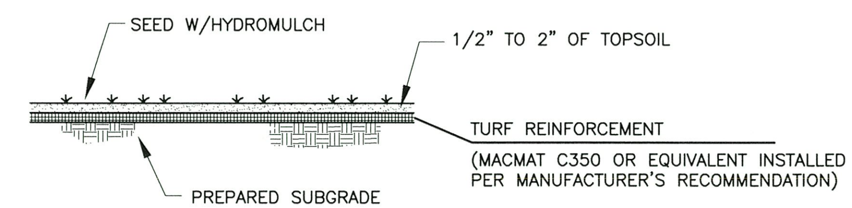
GABIONS D4 IIIF.1 IIIF.7

0 2 4
SCALE IN FEET



GABION TERMINATION D5 IIIF.7 IIIF.7

0 2 4
SCALE IN FEET



TURF REINFORCEMENT D6 IIIF.5,IIIF.6 IIIF.7
NOT TO SCALE
(SEE NOTE 2)

NOTES:

1. REFER TO DRAWING IIIF.1-DRAINAGE STRUCTURE PLAN FOR LOCATION OF DETAILS.
2. BEDDING MATERIAL WILL CONSIST OF CLAYEY SOILS COMPACTED TO PROVIDE FIRM BASE THAT WILL BE OVERLAIN BY 8 oz/sy GEOTEXTILE PRIOR TO PLACEMENT OF GABIONS.

STATE OF TEXAS
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105073
LICENSED
PROFESSIONAL ENGINEER
2.22.22

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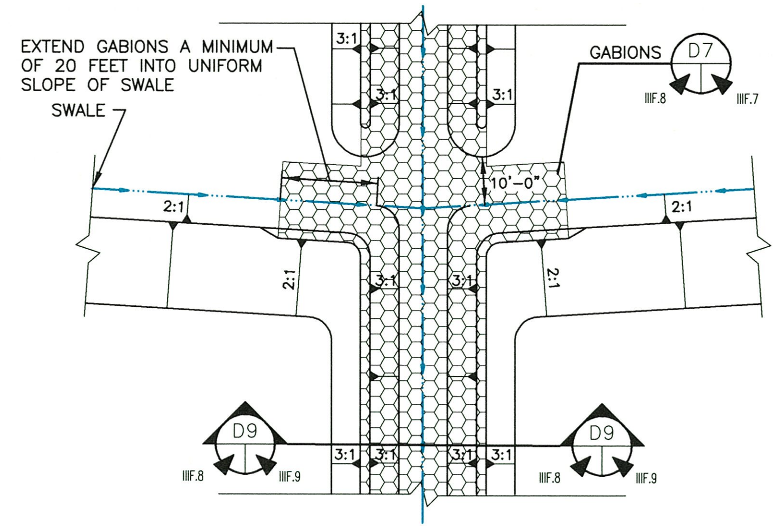
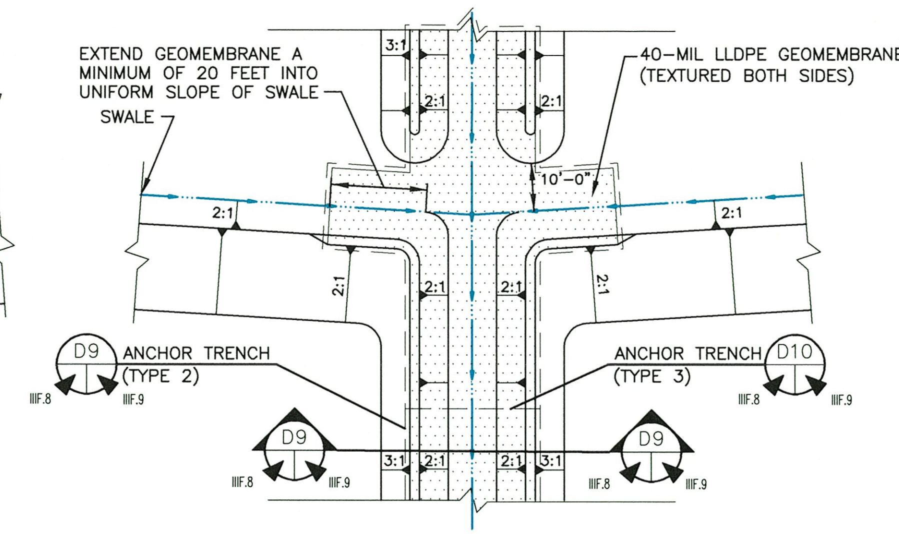
DATE: 02/2022 FILE: 0771-368-11 CAD: IIIF.7-DRAINAGE DETAILS.DWG	DRAWN BY: JDW DESIGN BY: CAM REVIEWED BY: NT	REVISIONS NO. | DATE | DESCRIPTION	TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS
Weaver Consultants Group TBPE REGISTRATION NO. F-3727			WWW.WCGRP.COM | DRAWING IIIF.7

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-7-DRAINAGE DETAILS.dwg, rarrington, 1:2



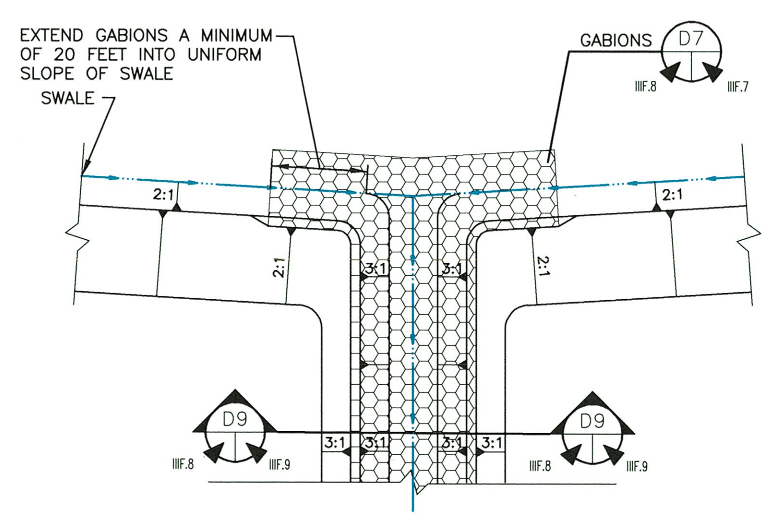
GABION OPTION



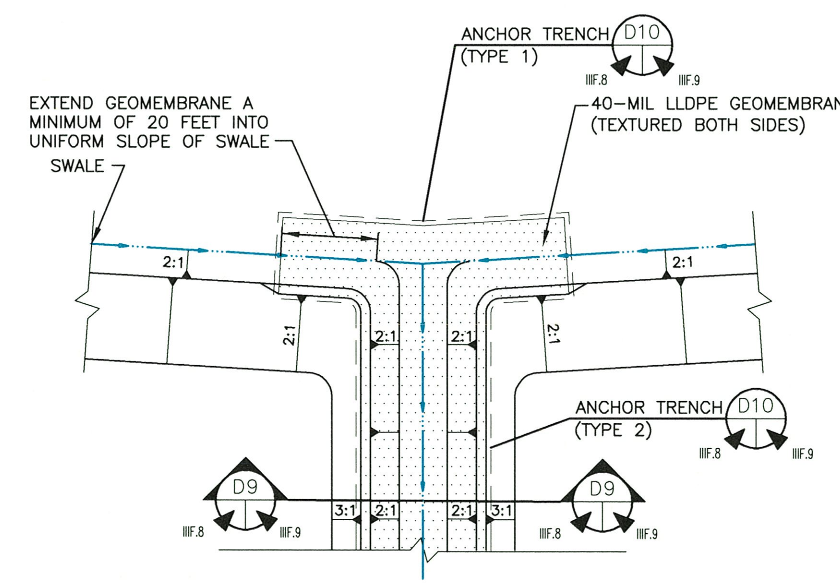
GEOMEMBRANE LINER OPTION

SWALE/CHUTE CONFLUENCE (TYP) D7 IIIF.1 IIIF.8

0 20 40
SCALE IN FEET



GABION OPTION



GEOMEMBRANE LINER OPTION

TOP OF CHUTE (TYP) D8 IIIF.1 IIIF.8

0 20 40
SCALE IN FEET

NOTES:

1. REFER TO FIGURE IIIF.1 DRAINAGE STRUCTURE PLAN FOR LOCATION OF DETAILS.
2. SEE APPENDIX IIIF-C FOR BOTTOM WIDTHS OF EACH INDIVIDUAL CHUTE.

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MAJOR PERMIT AMENDMENT
DRAINAGE DETAILS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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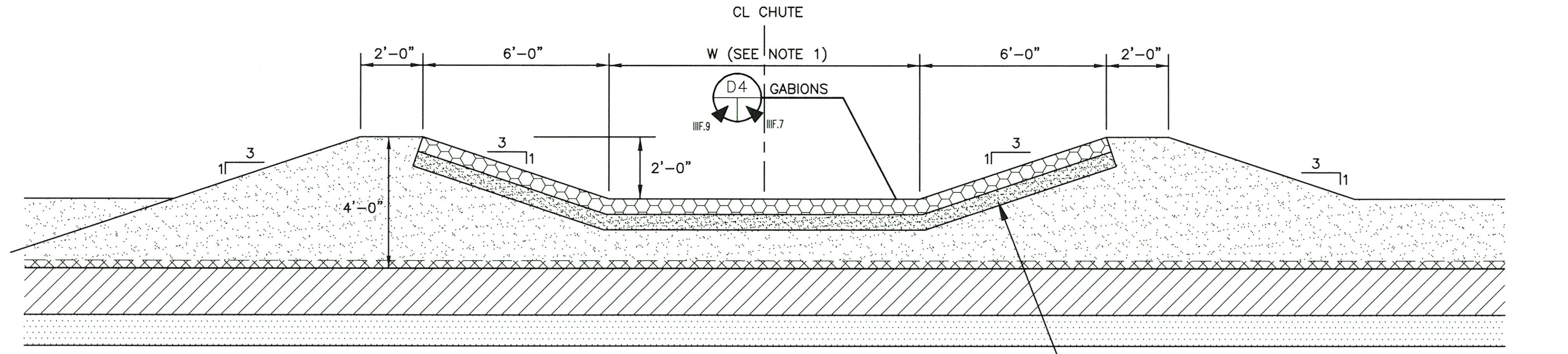
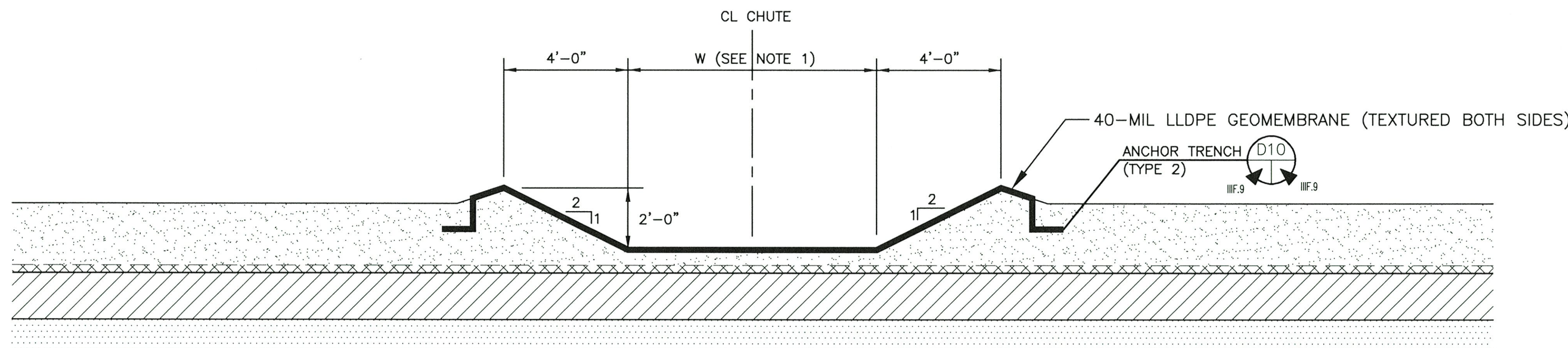
DRAWING IIIF.8



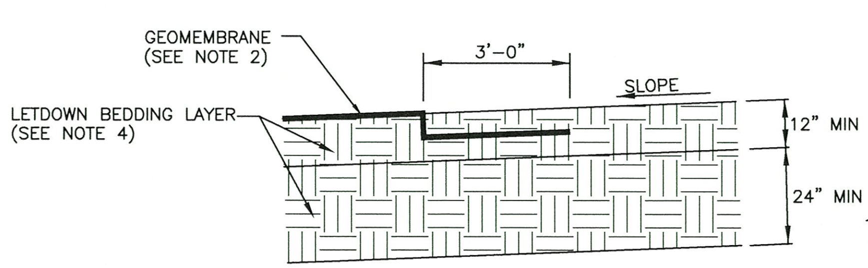
GABION OPTION



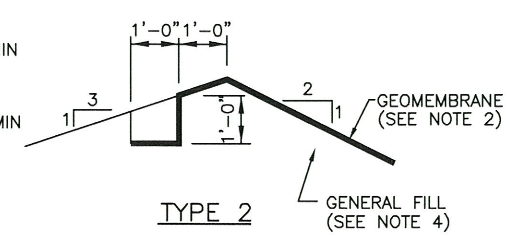
GEOMEMBRANE OPTION

UPPER CHUTE SECTION (TYP) D3 6-11 6-12

0 2.5 5
SCALE IN FEET



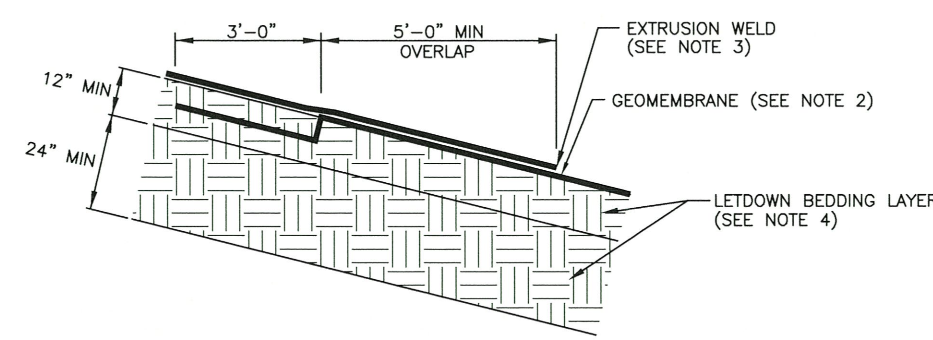
TYPE 1



TYPE 2

ANCHOR TRENCH D10 H-1-5, H-1-6 IIIF.8

0 2 4
SCALE IN FEET



TYPE 3

NOTES:

1. SEE APPENDIX IIIF–C FOR BOTTOM WIDTHS OF EACH INDIVIDUAL CHUTE.
2. 60 MIL HDPE GEOMEMBRANE TEXTURED BOTH SIDES SHALL BE USED FOR GEOMEMBRANE LETDOWN LINING.
3. EXTRUSION WELD UPSTREAM PANEL OVER DOWNSTREAM PANEL USING 1'–0" LONG EXTRUSION WELD WITH A SPACING OF 1'–0" BETWEEN EACH WELD.
4. SOIL PLACED UNDER GEOMEMBRANE LETDOWN AND CONCRETE DISSIPATER SHALL NOT CONTAIN TOPSOIL THAT WILL BE USED FOR VEGETATION LAYER.

STATE OF TEXAS
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105073
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MAJOR PERMIT AMENDMENT
DRAINAGE DETAILS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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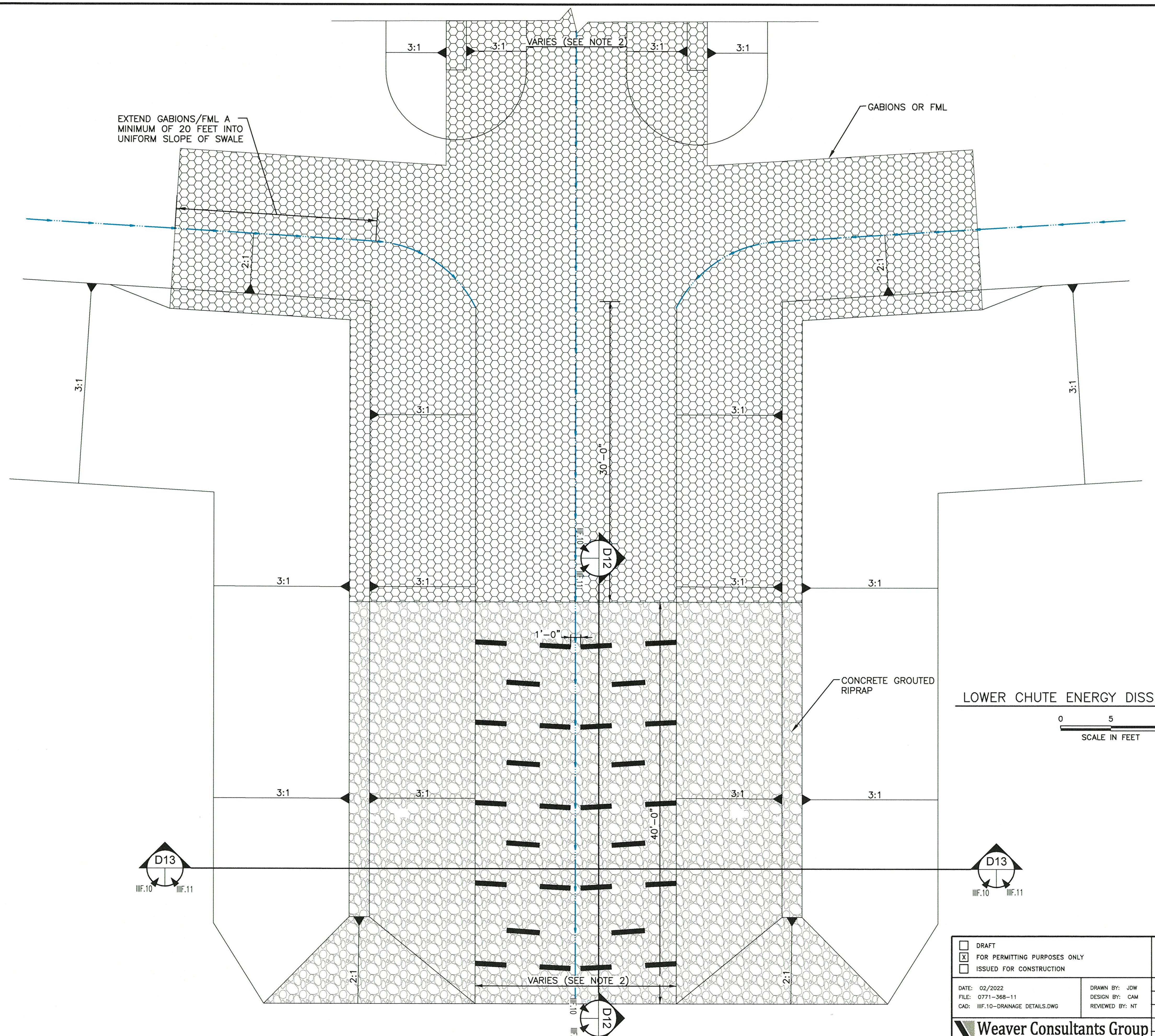
DRAWING IIIF.9



LOWER CHUTE ENERGY DISSIPATER (TYP) D11 IIIF.1 IIIF.10

0 5 10
SCALE IN FEET

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NOTES:

1. REFER TO FIGURE IIIF.1 DRAINAGE STRUCTURE PLAN FOR LOCATION OF DETAILS.
2. SEE APPENDIX IIIF-C FOR BOTTOM WIDTHS OF EACH INDIVIDUAL CHUTE.

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DRAWING IIIF.10

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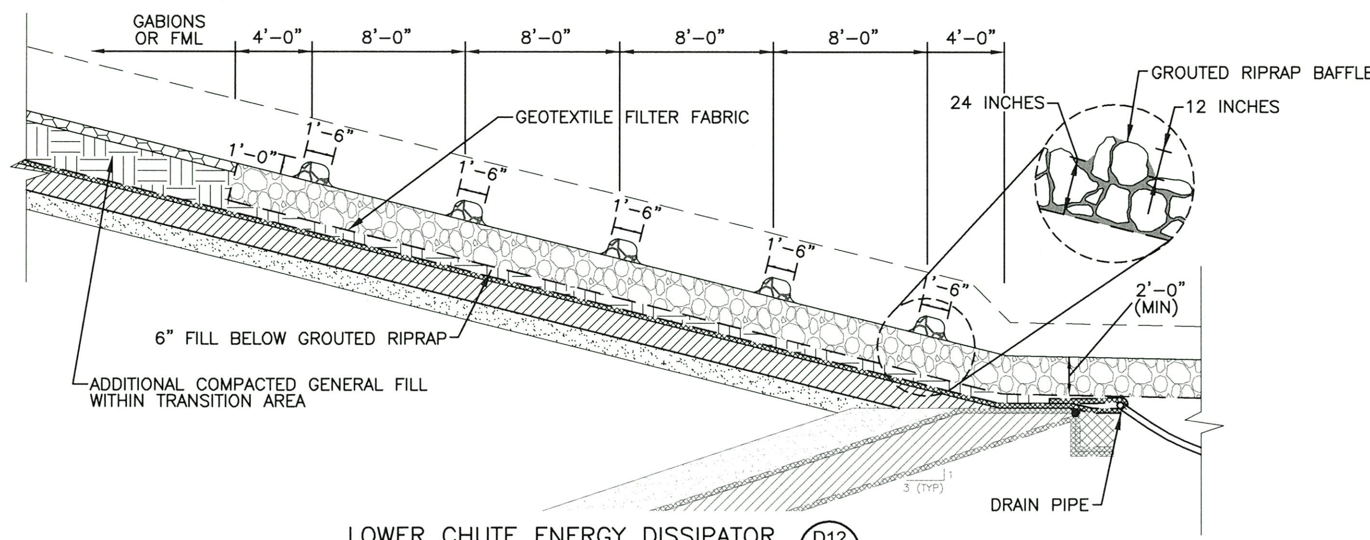
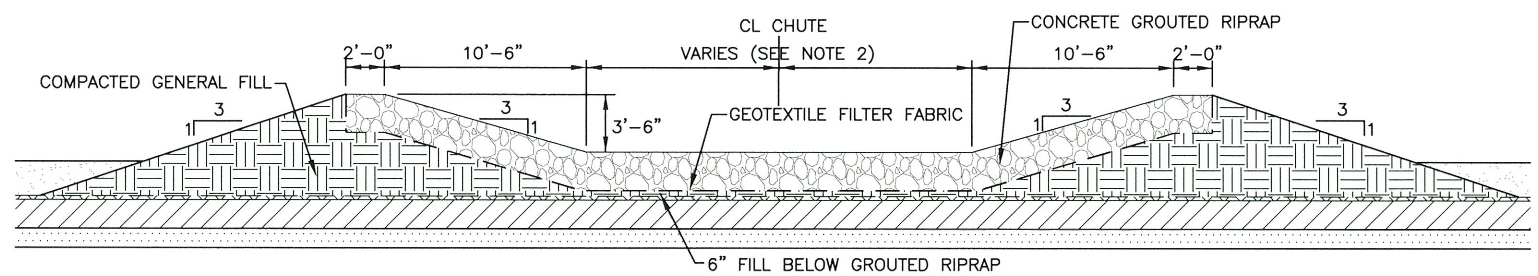


LOWER CHUTE ENERGY DISSIPATOR SECTION (TYP) D12 IIIF.10 IIIF.11

0 5 10
SCALE IN FEET



LOWER CHUTE SECTION (TYP) D13 IIIF.10 IIIF.11

0 5 10
SCALE IN FEET

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-22-22

NOTES:

1. REFER TO FIGURE IIIF.1 DRAINAGE STRUCTURE PLAN FOR LOCATION OF DETAILS.
2. SEE APPENDIX IIIF–C FOR BOTTOM WIDTHS OF EACH INDIVIDUAL CHUTE.

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MAJOR PERMIT AMENDMENT
DRAINAGE DETAILS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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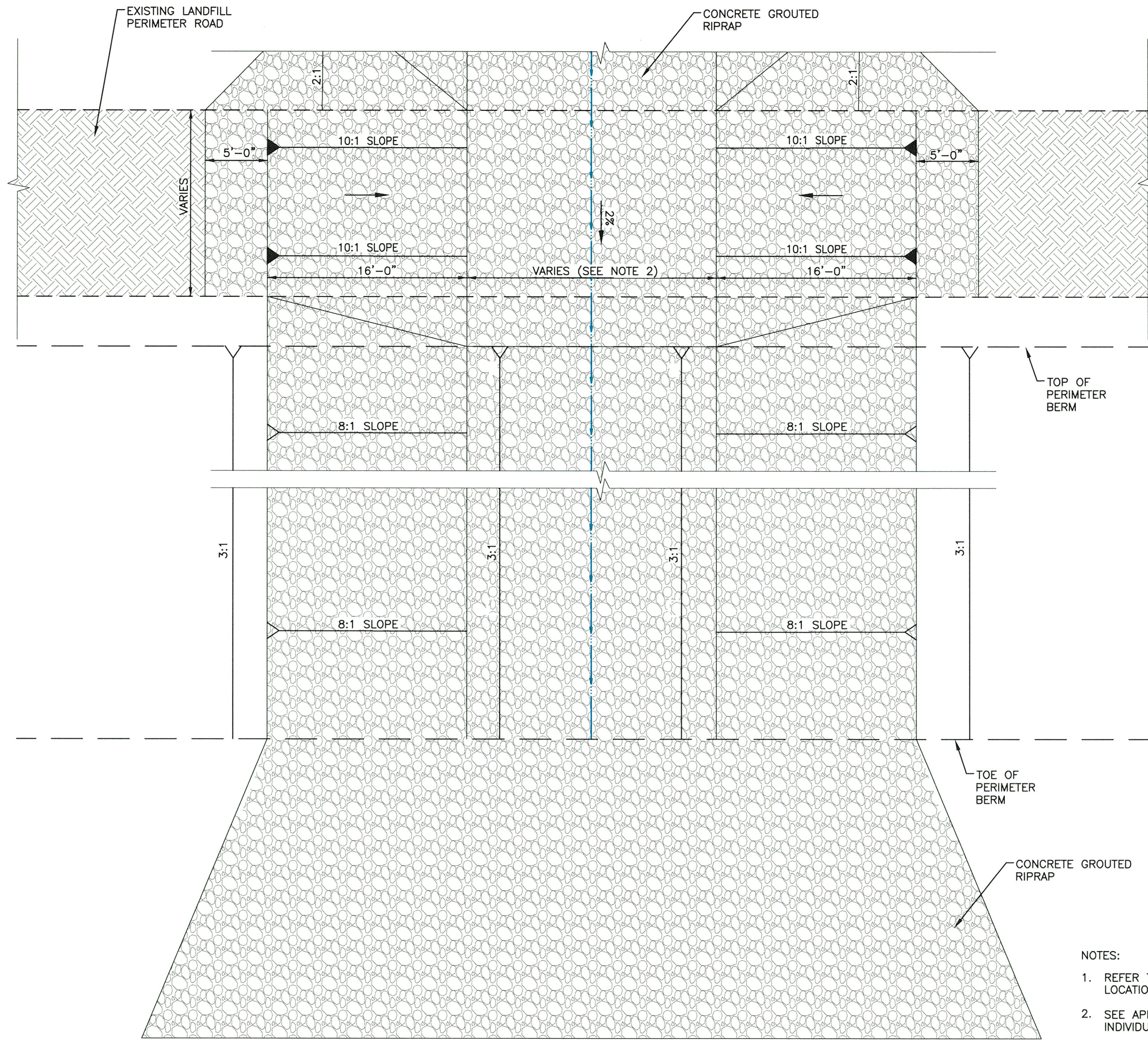
DRAWING IIIF.11



LOW WATER CROSSING (TYP)

D14 IIIF.1 IIIF.12

0 5 10
SCALE IN FEET

NOTES:

1. REFER TO FIGURE IIIF.1 DRAINAGE STRUCTURE PLAN FOR LOCATION OF DETAILS.
2. SEE APPENDIX IIIF-C FOR BOTTOM WIDTHS OF EACH INDIVIDUAL CHUTE.

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CAD: IIIF.12-DRAINAGE DETAILS.DWG

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DESIGN BY: CAM
REVIEWED BY: NT

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MAJOR PERMIT AMENDMENT
DRAINAGE DETAILS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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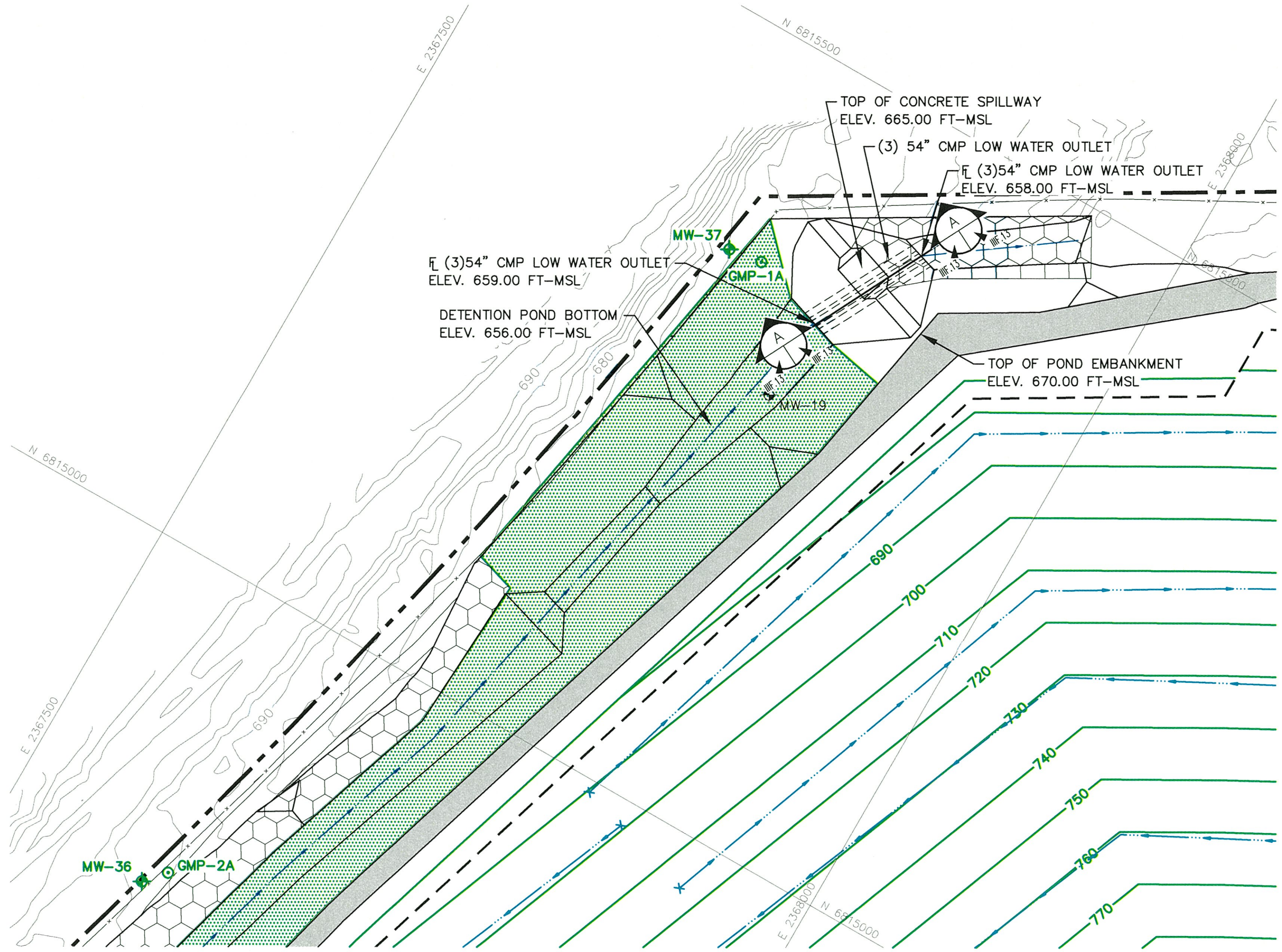
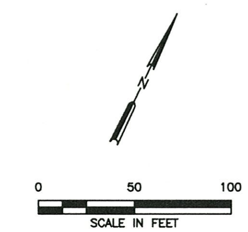
DRAWING IIIF.12

O:\0771\368\EXPANSION 2021\PART III\IIF\IIIF-12-DRAINAGE DETAILS.dwg, rarrington, 1:2



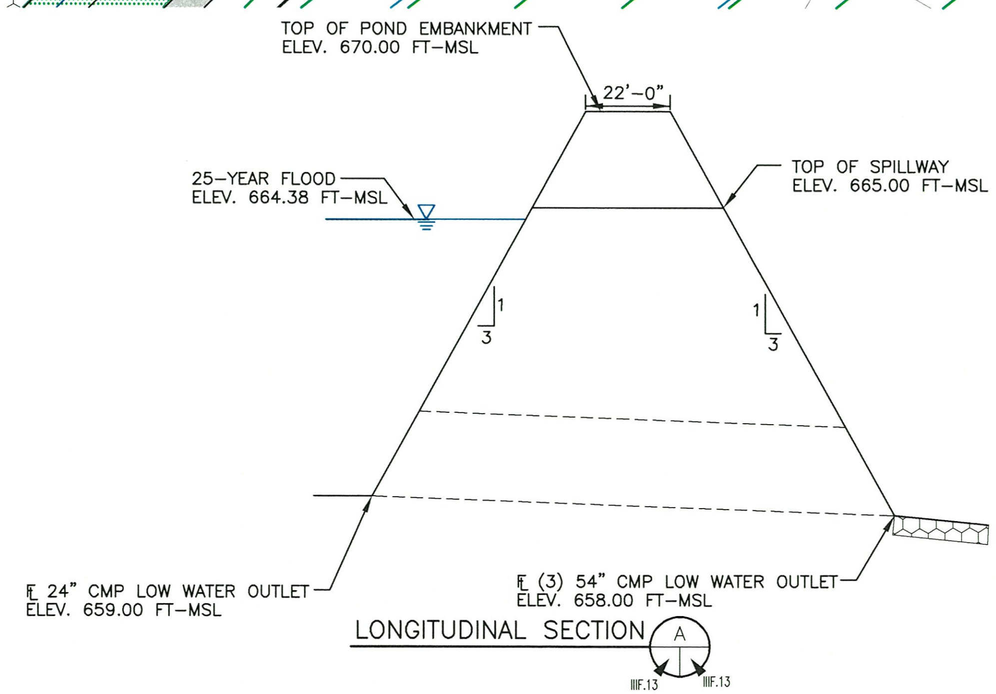


LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 — EXISTING CONTOUR
- N 6816000 — STATE PLANE COORDINATE
- EASEMENT
- 800 — FINAL COVER CONTOUR
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- TURF REINFORCEMENT MAT
- MW-7 — EXISTING GROUNDWATER MONITORING WELL
- MW-37 — PROPOSED GROUNDWATER MONITORING WELL
- GMP-1A — PROPOSED GAS MONITORING PROBE

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.



LONGITUDINAL SECTION A (IIIF.13 / IIIF.13)

0 25 50 SCALE IN FEET (HORIZONTAL) — 0 5 10 SCALE IN FEET (VERTICAL)

DETENTION POND DESIGN SUMMARY

POND BOTTOM	656.00 FT-MSL
TOP OF EMBANKMENT	670.00 FT-MSL
SPILLWAY ELEVATION	665.00 FT-MSL
25-YEAR PEAK STAGE	664.38 FT-MSL
25-YEAR STORAGE VOLUME	1.0 AC-FT
LOW WATER OUTLET	(3)54" CMP
OUTLET UPSTREAM ELEVATION	659.00
OUTLET DOWNSTREAM ELEVATION	658.00

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FILE: 0771-368-11 — DESIGN BY: CAM
CAD: IIIF.13-POND P1 PLAN.DWG — REVIEWED BY: NT

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PREPARED FOR
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REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
POND P1 PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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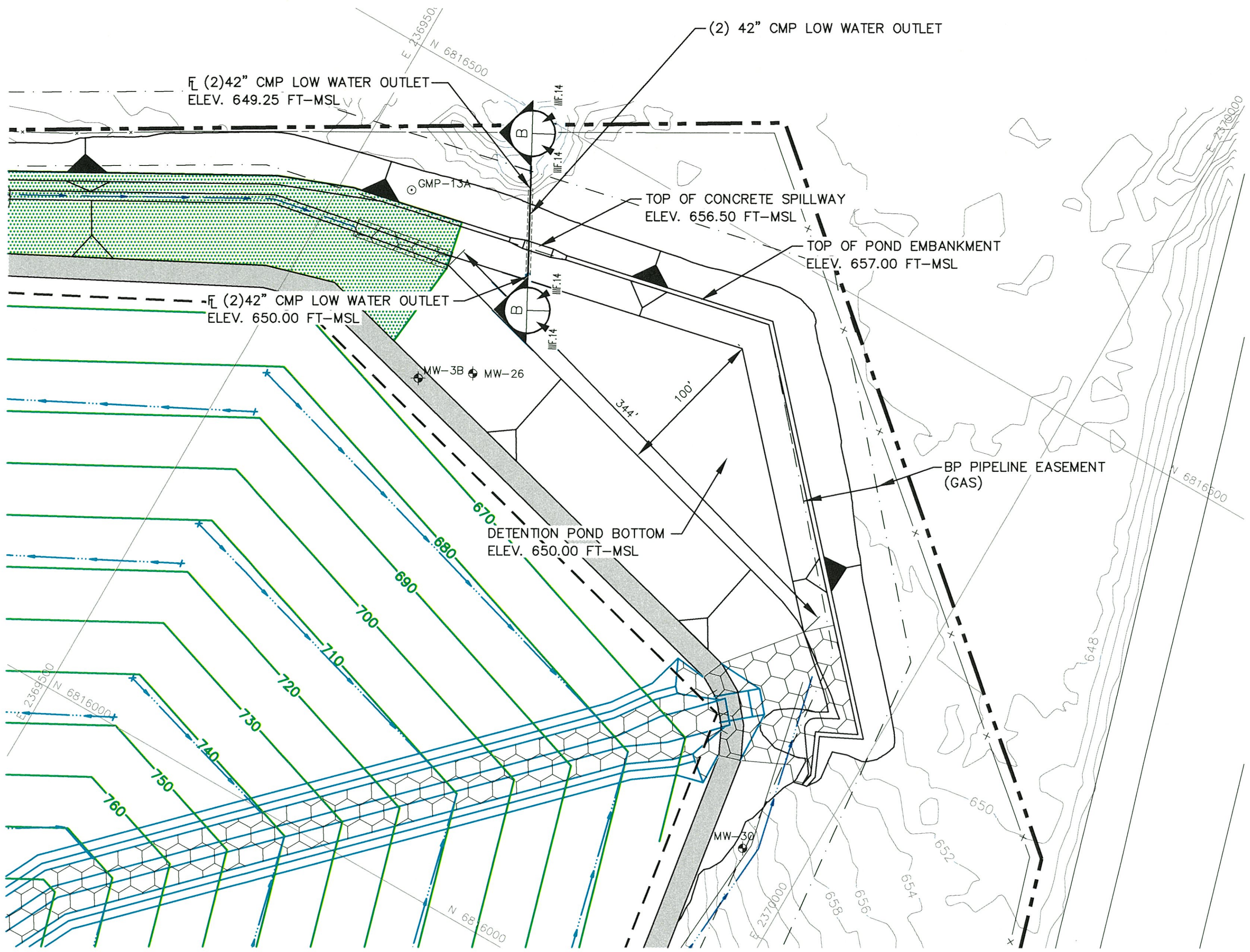
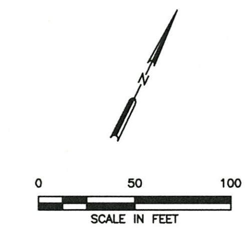
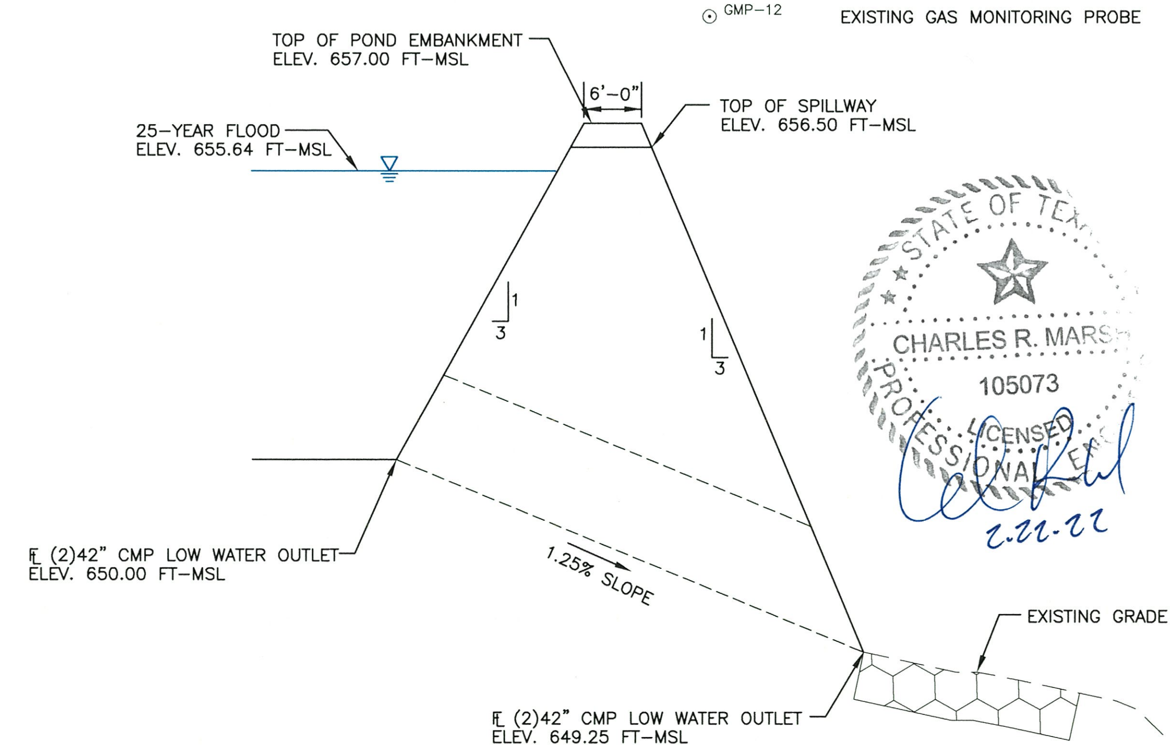
O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-13-POND P1 PLAN.dwg, rarrington, 1:2





LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 EXISTING CONTOUR
- N 6816000 STATE PLANE COORDINATE
- EASEMENT
- 800 FINAL COVER CONTOUR
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- TURF REINFORCEMENT MAT
- MW-7 EXISTING GROUNDWATER MONITORING WELL
- GMP-12 EXISTING GAS MONITORING PROBE



LONGITUDINAL SECTION B IIIF.14 IIIF.14

0 10 20 SCALE IN FEET (HORIZONTAL)

0 2 4 SCALE IN FEET (VERTICAL)

DETENTION POND DESIGN SUMMARY

POND BOTTOM	650.00 FT-MSL
TOP OF EMBANKMENT	657.00 FT-MSL
SPILLWAY ELEVATION	656.50 FT-MSL
25-YEAR PEAK STAGE	655.64 FT-MSL
25-YEAR STORAGE VOLUME	3.0 AC-FT
LOW WATER OUTLET	(2)42" CMP
OUTLET UPSTREAM ELEVATION	650.00
OUTLET DOWNSTREAM ELEVATION	649.25

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.

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DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF.14-POND P2 PLAN.DWG

DRAWN BY: JDW
DESIGN BY: CAM
REVIEWED BY: NT

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TEXAS REGIONAL LANDFILL COMPANY, LP

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MAJOR PERMIT AMENDMENT
POND P2 PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF.14

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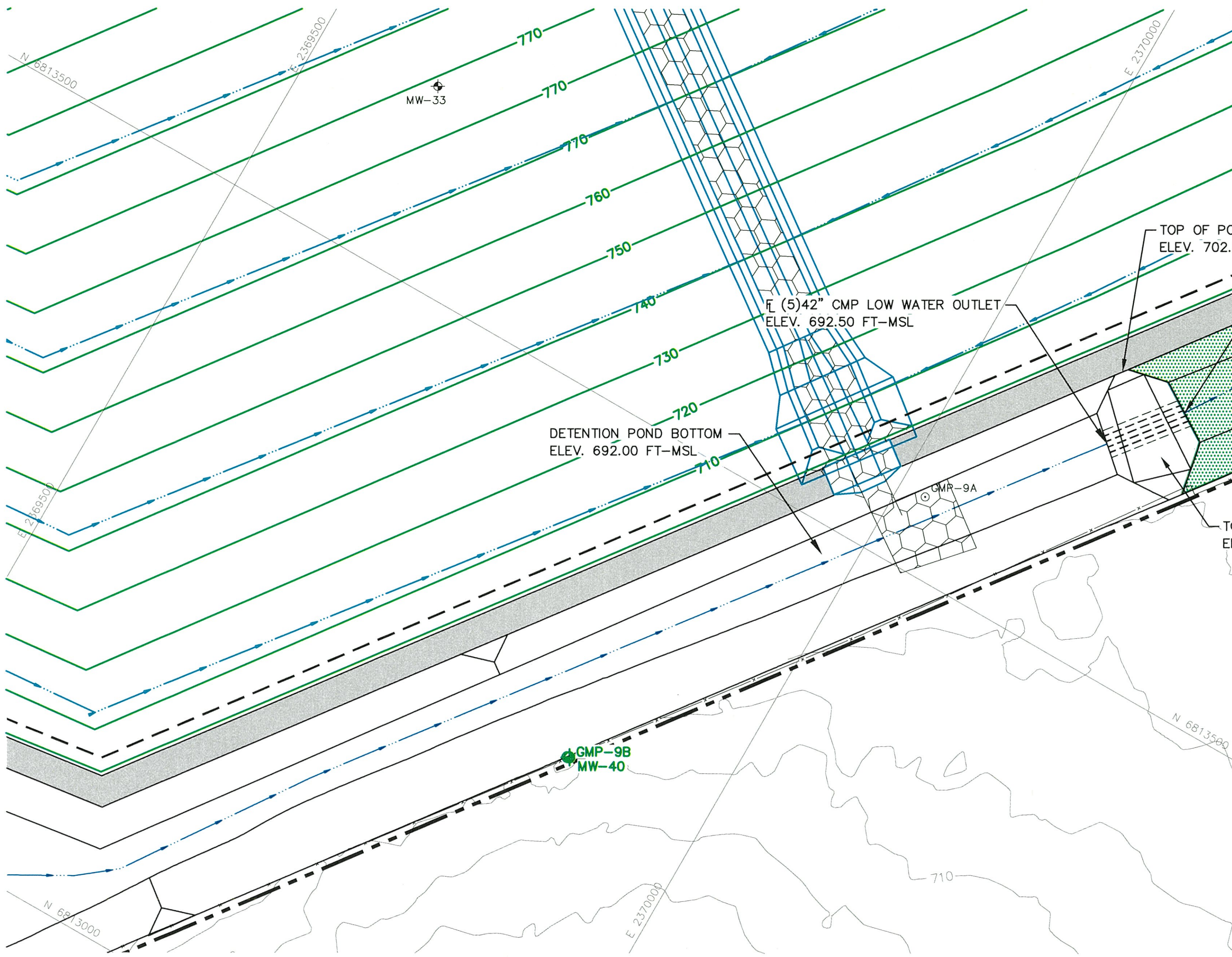
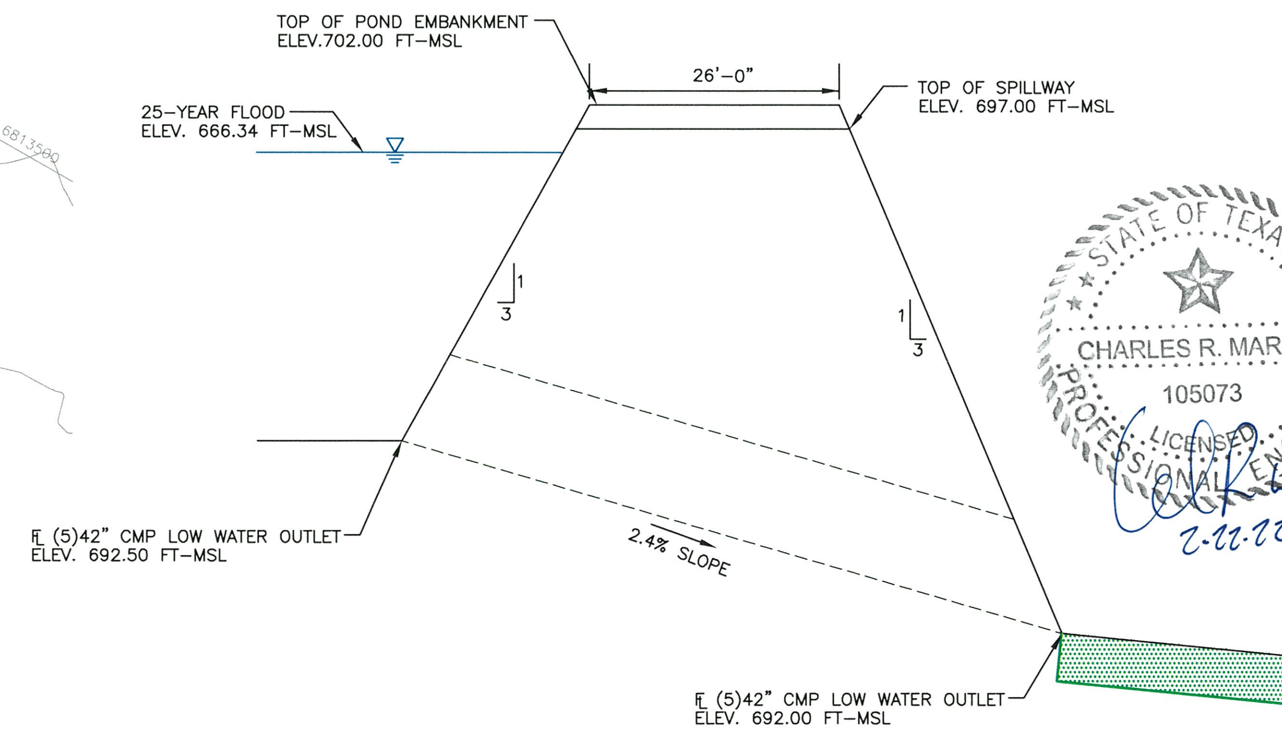


0 50 100
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 EXISTING CONTOUR
- N 6816000 STATE PLANE COORDINATE
- EASEMENT
- 800 FINAL COVER CONTOUR
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- TURF REINFORCEMENT MAT
- MW-33 EXISTING GROUNDWATER MONITORING WELL
- GMP-9A EXISTING GAS MONITORING PROBE
- MW-40 PROPOSED GROUNDWATER MONITORING WELL
- GMP-9B PROPOSED GAS MONITORING PROBE



LONGITUDINAL SECTION A (IIIF.11, IIIF.12 / IIIF.12)

0 10 20
SCALE IN FEET (HORIZONTAL)

0 2 4
SCALE IN FEET (VERTICAL)

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-22-22

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.

DETENTION POND DESIGN SUMMARY

POND BOTTOM	692.00 FT-MSL
TOP OF EMBANKMENT	702.00 FT-MSL
SPILLWAY ELEVATION	697.00 FT-MSL
25-YEAR PEAK STAGE	696.34 FT-MSL
25-YEAR STORAGE VOLUME	7.0 AC-FT
LOW WATER OUTLET	(5)42" CMP
OUTLET UPSTREAM ELEVATION	692.50
OUTLET DOWNSTREAM ELEVATION	690.00

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DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF.15-POND P3 PLAN.DWG

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REVIEWED BY: NT

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
POND P3 PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF.15

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APPENDIX IIIF-A

POST-DEVELOPMENT CONDITION HYDROLOGIC CALCULATIONS

Includes pages IIIF-A-1 through IIIF-A-74

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER

2.22.22

CONTENTS

STATE OF TEXAS
CHARLES R. MARSH
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LICENSED
PROFESSIONAL ENGINEER
2-22-22

HYPOTHETICAL STORM DATA

Hypothetical Storm Data

Precipitation data taken from NOAA Atlas 14 rainfall data.

Time	5 min	15 min	60 min	2 hr	3 hr	6 hr	12 hr	24 hr
25-Year Event	0.85	1.69	3.07	3.88	4.38	5.30	6.27	7.33

NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0: Texas (*U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, 2018*) was used to identify precipitation values for storm durations ranging from 5 minutes to 24 hours.

PRECIPITATION LOSS DATA

Required: Determine the SCS curve numbers for both on-site and off-site drainage areas for use in the HEC-1 analysis.

References:

1. Dodson's and Associates, Inc., *ProHec-1 Plus Program Documentation*, 1995.
2. United States Department of Agriculture, National Resource Conservation Service, Web Soil Survey for Johnson County, Texas (http://websoilsurvey.nrcs.usda.gov).
3. The Hydrologic Evaluation of Landfill Performance (HELP) Model - Engineering Documentation for version 3. EPA/600/R-94/168b, September 1994.

Note: Approximate non landfill areas within the permit boundary on SCS map (page IIIF-A-5).

Solution: Based on the soil survey information found in Ref. 2, hydrologic group D soils predominate the soils within the permit boundary drainage area (see pages IIIF-A-5 through IIIF-A-8).

The curve number for the offsite drainage areas around the site, large non-landfill drainage basins within the permit boundary, and drainage channels (O1, O2, O3, O4, O5) S1, S2, S3, S4, S5, S6, S7, CH1, CH2, and CH3) was calculated using the table on IIIF-A-11, assmunig pasture land in fair conditions. The majority of the area is undeveloped and assumed to compare to the off-site and on-site subasins near the site.

Use:	CN = 84

The final cover system was assumed to be in place and the erosion layer will control precipitation loss. A curve number that is corrected for the surface slope of the erosion layer may be computed first using the chart on page IIIF-A-11 to select an un-adjusted curve number. Calculate the adjusted curve number using equation 34 from Ref. 3 (see page IIIF-A-10).

$$CN_{II} = 100 - (100 - CN_{II\,o}) * (L^{*\,2} / S^{*}) \wedge (CN_{II\,o}^{-0.81})$$

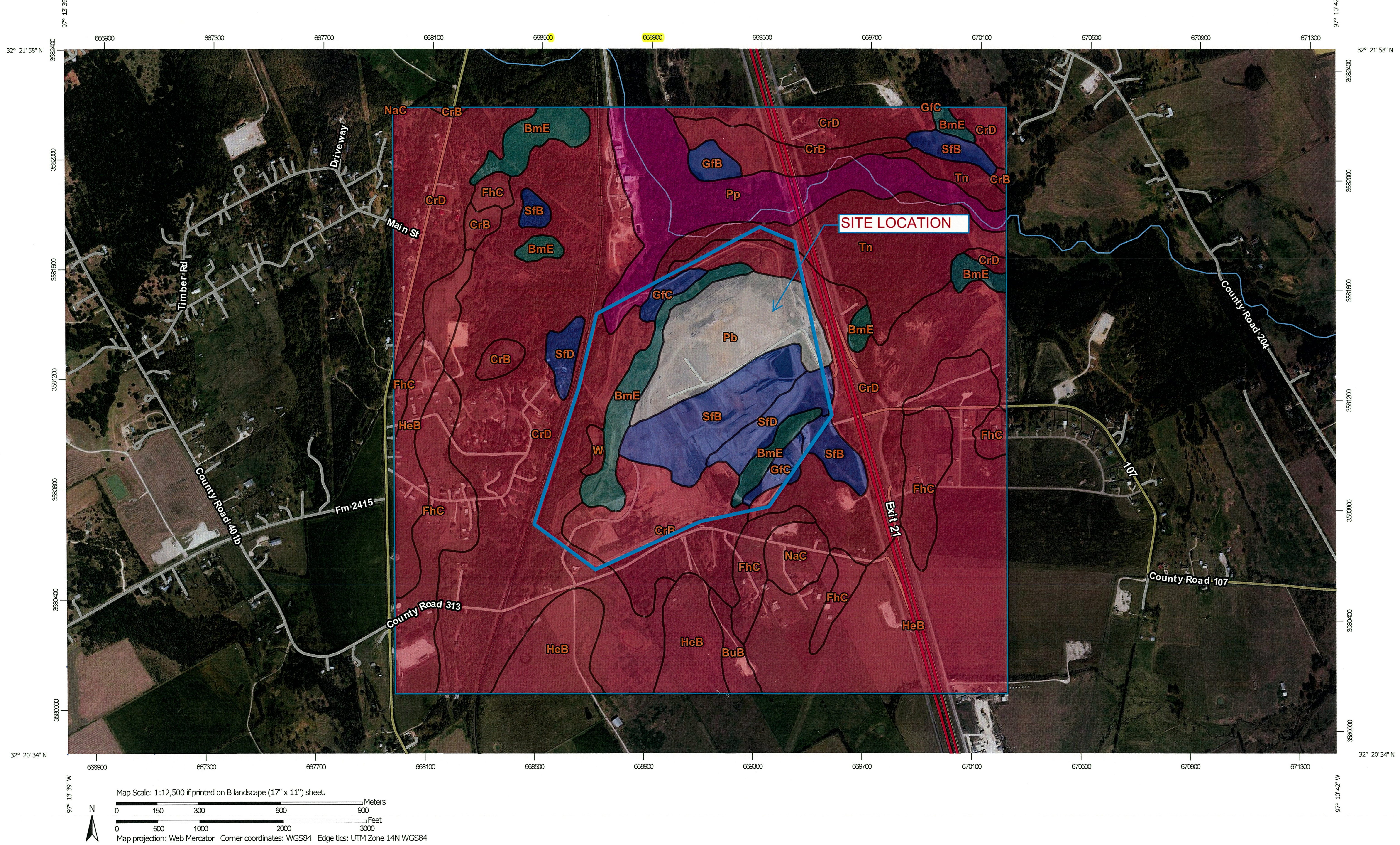
Use:	$CN_{II\,o}$ = 84 , L^* = (500/500) , S^* = (.06/.04)	for top dome surfaces
Use:	$CN_{II\,o}$ = 84 , L^* = (120/500) , S^* = (.29/.04)	for side slopes

Calculate:	CN = 85	for top dome surfaces
Calculate:	CN = 86	for side slopes

- Use curve number calculated for side slopes for the entire final cover area, inculding top dome areas, conservatively.

The pond areas are assumed to collect all precipitation for their areas:

Use:	CN = 100


97° 13' 39" W
97° 10' 42" W
32° 21' 58" N
32° 20' 34" N
666900
667300
667700
668100
668500
668900
669300
669700
670100
670500
670900
671300
3582400
3582000
3581600
3581200
3580800
3580400
3580000
SITE LOCATION
Driveway
Main St
Timber Rd
County Road 401b
Fm 2415
County Road 313
County Road 204
County Road 107
107
Exit 21
NaC
CrB
CrD
BmE
GfB
GfC
SfB
FhC
Pp
Tn
Pb
SfD
HeB
W
CrB
BuB
Map Scale: 1:12,500 if printed on B landscape (17" x 11") sheet.
N
0
150
300
600
900
Meters
0
500
1000
2000
3000
Feet
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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Johnson County, Texas
Survey Area Data: Version 15, Sep 14, 2018

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

Date(s) aerial images were photographed: Nov 27, 2014—Mar 19, 2017

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
BmE	Birome-Rayex complex, 5 to 20 percent slopes	C	50.9	4.3%
BuB	Burleson clay, 1 to 3 percent slopes	D	7.2	0.6%
CrB	Crosstell fine sandy loam, 1 to 3 percent slopes	D	85.8	7.3%
CrD	Crosstell fine sandy loam, 3 to 8 percent slopes	D	433.7	36.7%
FhC	Ferris-Heiden complex, 2 to 5 percent slopes	D	91.4	7.7%
GfB	Gasil fine sandy loam, 1 to 3 percent slopes	B	5.0	0.4%
GfC	Gasil fine sandy loam, 3 to 8 percent slopes	B	9.2	0.8%
HeB	Heiden clay, 1 to 3 percent slopes	D	216.3	18.3%
NaC	Navo clay loam, 2 to 5 percent slopes	D	11.9	1.0%
Pb	Pits, 0 to 45 percent slopes		49.6	4.2%
Pp	Pulexas fine sandy loam, frequently flooded	A	74.9	6.3%
SfB	Silstid loamy fine sand, 1 to 3 percent slopes	B	52.7	4.5%
SfD	Silstid loamy fine sand, 3 to 8 percent slopes	B	19.6	1.7%
Tn	Tinn clay, 0 to 1 percent slopes, frequently flooded	D	72.3	6.1%
W	Water	D	2.3	0.2%
Totals for Area of Interest			**1,182.6**	**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

where

CN_{II_o} = AMC-II curve number for mild slope (unadjusted for slope)

C_0 = regression constant for a given level of vegetation

C_1 = regression constant for a given level of vegetation

C_2 = regression constant for a given level of vegetation

IR = infiltration correlation parameter for given soil type

The relationship between CN_{II}, the vegetative cover and default soil texture is shown graphically in Figure 8. Table 7 gives values of C_0, C_1 and C_2 for the five types of vegetative cover built into the HELP program.

4.2.3 Adjustment of Curve Number for Surface Slope

A regression equation was developed to adjust the AMC-II curve number for surface slope conditions. The regression was developed based on kinematic wave theory where

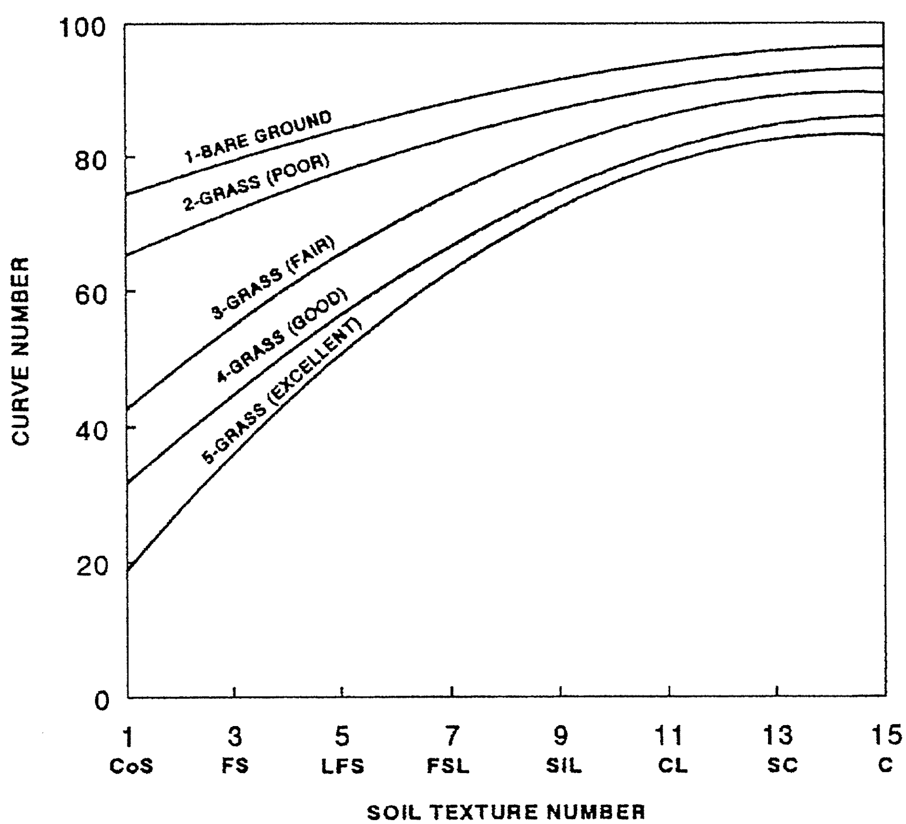


Figure 8. Relation between SCS Curve Number and Default Soil Texture Number for Various Levels of Vegetation

loam, and clayey loam as specified by saturated hydraulic conductivity, capillary drive, porosity, and maximum relative saturation, Two levels of vegetation were described--a good stand of grass (bluegrass sod) and a poor stand of grass (clipped range). Slopes of 0.04,0.10,0.20,0.35, and 0.50 ft/ft and slope lengths of 50, 100, 250, and 500 ft were used. Rainfalls of 1.1 inches, l-hour duration and 2nd quartile Huff distribution and of 3.8 inches, 6-hour duration and balanced distribution were modeled.

The resulting regression equation used for adjusting the AMC-II curve number computed for default soils and vegetation placed at mild slopes, CN_{II_o}, is:

$$CN_{II} = 100 - (100 - CN_{II_o}) \cdot \left(\frac{L^{*2}}{S^*} \right)^{CN_{II_o}^{-0.81}} \tag{34}$$

where

L^* = standardized dimensionless length, (L/500 ft)

S^* = standardized dimensionless slope, (S/0.04)

This same equation is used to adjust user-specified AMC-II curve numbers for surface slope conditions by substituting the user value for CN_{II_o} in Equation 34.

4.2.4 Adjustment of Curve Number for Frozen Soil

When the HELP program predicts frozen conditions to exist, the value of CN_{II} is increased, resulting in a higher calculated runoff. Knisel et al. (1985) found that this type of curve number adjustment in the CREAMS model resulted in improved predictions of annual runoff for several test watersheds. If the CN_{II} for unfrozen soil is less than or equal to 80, the CN_{II} for frozen soil conditions is set at 95. When the unfrozen soil CN_{II} is greater than 80, the CN_{II} is reset to be 98 on days when the program has determined the soil to be frozen. This adjustment results in an increase in CN_I and consequently a decrease in S_{mx} and S' (Equations 19, 26, and 30).

From Equations 19 and 21, it is apparent that as S' approaches zero, Q approaches P. In other words, as S' decreases, the calculated runoff becomes closer to being equal to the net rainfall which is most often, when frozen soil conditions exist, predominantly snowmelt. This will result in a decrease in infiltration under frozen soil conditions, which has been observed in numerous studies.

4.2.5 Summary of Daily Runoff Computation

The HELP model determines daily runoff by the following procedure:

TABLE 5.3 Values of SCS Curve Number for Rural Areas

Source: [McCuen, 1982]

Land Use Description	Hydrologic Soil Group A	B	C	D
Fallow:				
Straight Row	77	86	91	94
Row Crops:				
Straight Row, Poor Condition	72	81	88	91
Straight Row, Good Condition	67	78	85	89
Contoured, Poor Condition	70	79	84	88
Contoured, Good Condition	65	75	82	86
Contoured and Terraced, Poor Condition	66	74	80	82
Contoured and Terraced, Good Condition	62	71	78	81
Small Grain:				
Straight Row, Poor Condition	65	76	84	88
Straight Row, Good Condition	63	75	83	87
Contoured, Poor Condition	63	74	82	85
Contoured, Good Condition	61	73	81	84
Contoured and Terraced, Poor Condition	61	72	79	82
Contoured and Terraced, Good Condition	59	70	78	81
Close-Seeded Legumes or Rotation Meadow				
Straight Row, Poor Condition	66	77	85	89
Straight Row, Good Condition	58	72	81	85
Contoured, Poor Condition	64	75	83	85
Contoured, Good Condition	55	69	78	83
Contoured and Terraced, Poor Condition	63	73	80	83
Contoured and Terraced, Good Condition	51	67	76	80
Pasture or Range:				
Poor Condition	68	79	86	89
Fair Condition	49	69	79	84
Good Condition	39	61	74	80
Contoured, Poor Condition	47	67	81	88
Contoured, Fair Condition	25	59	75	83
Contoured, Good Condition	6	35	70	79
Meadow, Good Condition	30	58	71	78
Woods or Forest Land:				
Poor Condition	45	66	77	83
Fair Condition	36	60	73	79
Good Condition	25	55	70	77
Farmsteads:	59	74	82	86

Initial and Uniform Loss Rate

An initial loss in inches (*STRTL*) and a constant loss rate (*CNSTL*) in inches per hour are specified for this method. All rainfall is lost until the volume of initial loss is satisfied. After the initial loss is satisfied, rainfall is lost at the constant rate.

This section provides guidance in selecting the values used for the initial loss and uniform loss rate in two ways:

1. By consulting previous studies of actual rainfall events for a particular watershed or region.
2. By relating the parameters to the SCS Curve Number, which can be estimated using the information presented earlier in this chapter.

Previous studies by the U.S. Army Corps of Engineers or other public agencies may provide guidance on selecting appropriate values for the initial loss and uniform loss rate for a particular location. Tables 5.4 through 5.6 list the values of initial and

HYDROGRAPH DEVELOPMENT INFORMATION

HYDROGRAPH DEVELOPMENT INFORMATION

Landfill Areas

Direct runoff methods, (i.e., kinematic wave) have been used for the majority of the landfill final cover areas. The kinematic wave method has been used to model the 4 percent topslope areas and 25 percent side slope areas before the flow is intercepted by the drainage swales. The kinematic wave method is a physically based method using slope, surface roughness, catchment lengths and areas. This method does not consider attenuation for flood wave; as a consequence, this method provides for a conservative analysis. The following typical parameters for the kinematic wave method have been developed for landfill areas.

Kinematic wave parameters for overland flow:

Slope: Varies from 0.04 to 0.25 ft/ft landfill slopes

N: 0.35 Manning's friction coefficient (based on using a value between dense grass (N = 0.24) and Bermuda grass (N = 0.41) listed in Soil Conservation Services TR-55)

L: Represents a typical distance between swales for overland flow for each drainage area. For example, as shown on Sheet IIIF-A-17, the swale spacing on 4H:1V sideslopes is 120 feet.

The percentage of the drainage area represented by these parameters is typically 100 percent.

Kinematic Wave routing for channels:

- Channel length (ft): The length of the channel section.
- Channel slope (ft/ft): Varies from 0.005 to 0.0625 (0.005 for swales).
- Channel roughness coefficient: 0.03 for grass lined channels and swales.
- Channel type: A trapezoidal channel was used with varying width and 3:1 side slopes ("V" ditch with varying side slopes for swales).

Non-Landfill Final Cover Areas

Hydrographs for the majority of non-landfill final cover areas within and near the permit boundary (e.g., pond areas) were developed using the Snyder unit hydrograph method. Espey "10-Minute" method has been used to estimate Snyder parameters. Snyder parameter estimations are provided on pages IIIF-A-18 through IIIF-A-23.

As discussed in Section 2 of Appendix IIIF, hydrographs for the areas outside of the permit boundary (O, O2, O3, O4, and O5), and larger areas inside the permit boundary (S1, S2, S3, S4, S5, S6, and S7) were developed using the Snyder unit hydrograph method. The percent imperviousness ranges from 2 percent to 25 percent, indicating the majority of each watershed is undeveloped. Pond areas are assumed to be 100 percent impervious, and areas with significant channel surface or paved surfaces were assigned higher percentages of impervious area, as shown on IIIF-A-19.

Drainage Areas

The drainage areas used for this analysis are shown on Sheets IIIF-A-25 and IIIF-A-26. The routing scheme for the post-development condition is shown in the HEC-1 output file presented on pages IIIF-A-27 through IIIF-A-65.

DISTRIBUTED RUNOFF METHOD
KINEMATIC WAVE EXAMPLE

Drainage area "DA4" is used in this example (refer to Sheet IIIF-A-17 for location of drainage area).

Watershed Specific Parameters:

A =	33.25	acres	Watershed Area (acres)
A =	0.0520	sq-miles	Watershed Area (sq-miles)
CN=	86		SCS Curve Number (see sheet IIIF-A-4 for more information)

Kinematic Wave parameter for overland flow:

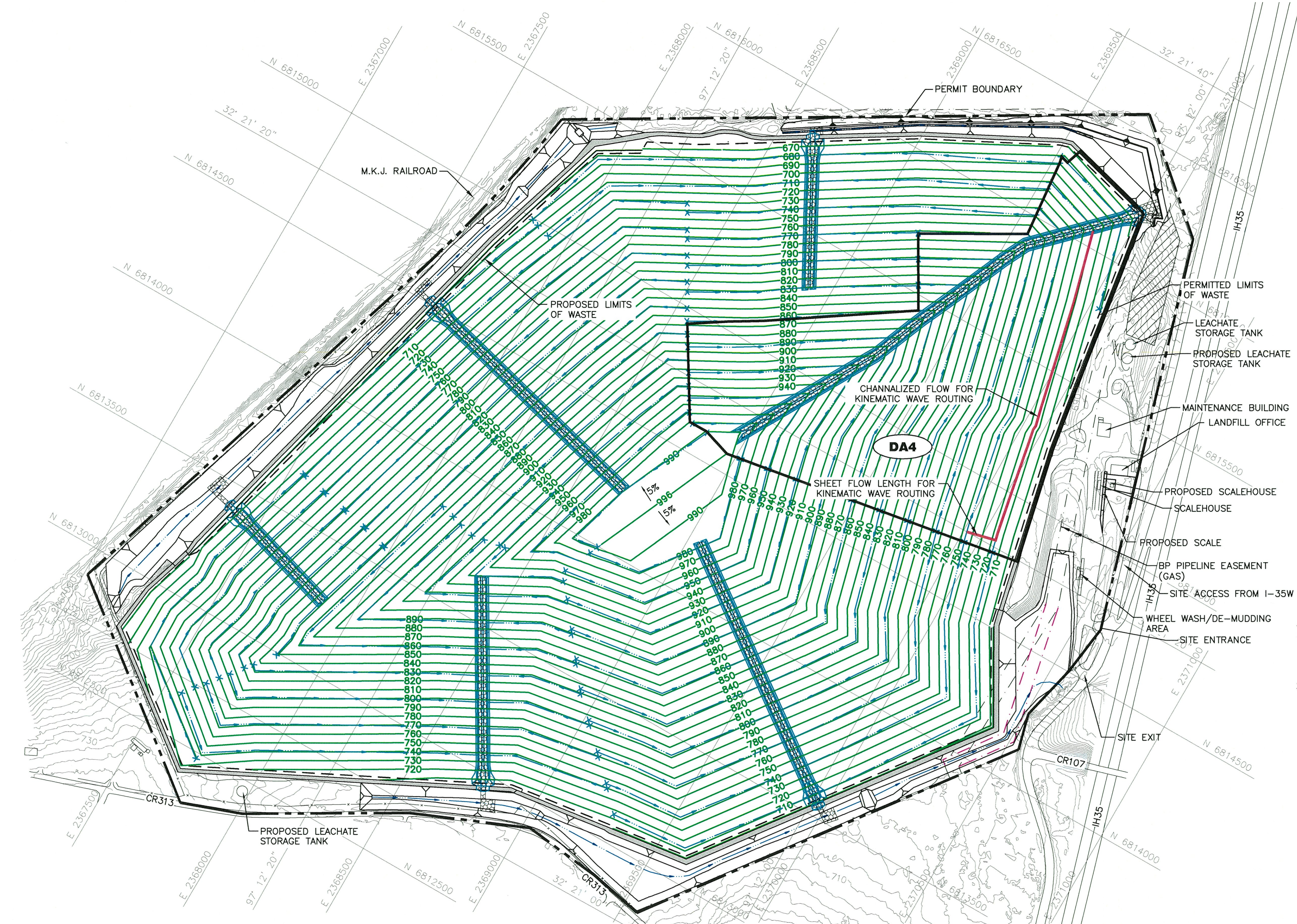
L=	120	ft	Typical overland flow (ft)
S=	0.25	ft/ft	Landfill slope (ft/ft)
N=	0.30		Manning's Coefficient

Percentage of the drainage area represented by this element is 100 percent

Kinematic Wave routing data for the swale:

L=	1338	ft	Typical swale length (ft)
S=	0.005	ft/ft	Swale bottom slope (ft/ft)
N=	0.03		Manning's Coefficient
Channel=	TRAP		Swale Type*

* A trapezoidal channel with no bottom width was used to simulate a triangular channel.



0 200 400
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMIT OF WASTE
- 750 EXISTING CONTOUR (SEE NOTE 1)
- N 6816000 STATE PLANE COORDINATE
- 32° 21' 20" GEODETIC COORDINATE
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 2)
- 800 PROPOSED FINAL COVER CONTOUR
- PROPOSED DRAINAGE CHUTE
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- DRAINAGE AREA BOUNDARY
- DA4 DRAINAGE AREA DESIGNATION
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

O:\0771\368\EXPANSION 2021\PART III\IIIF-A\IIIF-A-17-KINEMATIC WAVE PARAMETERS.dwg, rarrington, 1:2

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: CIIF-A-17 KINIMATIC WAVE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT
KINEMATIC WAVE PARAMETERS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-A-17

ESPEY 10-MINUTE METHOD PARAMETERS

TURKEY CREEK LANDFILL
0771-368-11-123
ESPEY 10 MINUTE SAMPLE CALCULATION

Snyder's Hydrograph Coefficients (Espey's 10 Minute Method)

Proposed Expansion Conditions

Area No.	Area (acres)	Max. Flow Length (L) (ft)	S (ft/ft)	I (%)	Manning "n"	Φ[1]	T_r[2] (min)	T_{lag}[3] (min)	T_{lag} (hr)	Area[4] (sq mi)	q_p[5] (cfs/sq mi)	C_p[6]
O1	180.49	6,381	0.0110	10	0.04	0.84	36.1	33.6	0.56	0.2820	716.3	0.63
O2	74.63	4,784	0.0115	5	0.04	0.86	39.3	36.8	0.61	0.1166	678.5	0.65
O3	69.25	3,820	0.0147	10	0.04	0.84	29.8	27.3	0.46	0.1082	912.5	0.65
O4	61.05	2,617	0.0172	5	0.04	0.86	30.9	28.4	0.47	0.0954	883.6	0.65
O5	6.34	1,135	0.0282	2	0.04	0.87	27.1	24.6	0.41	0.0099	1115.0	0.71
S1	1.14	671	0.0537	25	0.04	0.79	11.1	8.6	0.14	0.0018	3087.7	0.69
S2	0.99	61	0.0820	10	0.04	0.84	7.5	5.0	0.08	0.0015	4749.5	0.62
S3	1.71	100	0.0950	2	0.04	0.87	11.4	8.9	0.15	0.0027	2956.5	0.69
S4	6.49	1,184	0.0355	5	0.04	0.86	21.5	19.0	0.32	0.0101	1426.2	0.70
S5	1.93	732	0.0178	15	0.04	0.82	17.4	14.9	0.25	0.0030	1873.8	0.73
S6	8.14	922	0.0260	15	0.04	0.82	16.7	14.2	0.24	0.0127	1851.7	0.68
S7	2.40	783	0.0204	10	0.04	0.84	19.1	16.6	0.28	0.0038	1684.4	0.73

[1] Conveyance efficiency coefficient from Dodson & Associates Inc., *ProHec-1 Program Documentation*, 1995, pages 6-19 and 6-20.
[2] $T_r = 3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(\Phi^{1.57})$
[3] $T_{lag} = T_r - \Delta t/2$
[4] From area summary sheet
[5] $q_p = 31600(A^{-0.04})(T_r^{-1.07})$
[6] $C_p = 49.375(A^{-0.04})(T_r^{-1.07})(T_{lag})$

T_r = surface runoff to unit hydrograph peak (min)
L = distance along main channel from study point to watershed boundary (ft)
S = main channel slope (ft/ft)
I = impervious cover within the watershed (%)
T_{lag} = watershed lag time (min)
Δt = computation interval (minutes)
q_p = unit hydrograph peak discharge (cfs/sq mi)
C_p = Snyder's peaking coefficient

Snyder Unit Hydrograph uses lag time (T_{lag}) and peaking coefficient accounting for flood wave and watershed storage conditions.

Drainage area "S7" in the post-project condition is used in this example.

Estimated Watershed specific parameters

A =	2.40	acres	watershed area
L =	783.00	feet	maximun flow length with this watershed
S =	0.0204	feet/feet	watershed slope
I =	10	percent (%)	watershed imperviousness
n =	0.04		Manning's coefficient

Calculate Tr: time beginning of surface runoff to the unit hydrograph peak in minutes

$T_r = 3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(\Phi^{1.57})$

Estimate : conveyance efficiency coefficient

Φ = for 2 percent impervious cover and n = 0.06

$\Phi = 0.84$

$T_r = 3.1(783^{0.23})(0.0204^{-0.25})(10^{-0.18})(0.84^{1.57})$

$T_r = 19.1$ min

Calculate T_{lag}: watershed lag time

$T_{lag} = Tr - (\Delta t/2)$ — Δt is calculation interval, and 5 minutes is used in the HEC - 1 modeling in this project

$T_{lag} = 16.6$ minutes

$T_{lag} = 0.28$ hours

$A = A/640$

$A = 0.0038$ square miles

Calculate q_p: peak discharge of unit hydrograph per unit area (cfs/sq. mi).

$q_p = 31600(A^{-0.04})(T_r^{-1.07})$

$q_p = 31600(0.0038^{-0.04})(19.1^{-1.07})$

$q_p = 1684.4$ cfs/sq. mi

Calculate Peaking coefficient C_p:

$C_p = 49.375(A^{-0.04})(T_r^{-1.07})(T_{lag})$

$C_p = 49.375(0.0038^{-0.04})(19.1^{-1.07})(0.28)$

$C_p = 0.73$

compute the value of Snyder's peaking coefficient C_p for use in HEC-1 analyses. First, the watershed lag time T_L is determined by subtracting one-half of the computation interval from the time to rise ($T_L = T_r - \Delta t/2$). Then, C_p may be computed by substituting the known values of T_L and q_p into Snyder's equation for peak unit hydrograph flow rate and solving for C_p.

$$C_p = \frac{q_p \times T_L}{640} \qquad 6.30$$

Espey "10-Minute" Method for Estimating Snyder Parameters

In another study, Espey [1977] derived the following equation for computing the time from the beginning of surface runoff to the unit hydrograph peak:

$$T_r = 3.10\, L^{0.23} S^{-0.25} I^{-0.18} \Phi^{1.57} \qquad 6.31$$

in which:

T_r = time from beginning of surface runoff to unit hydrograph peak (minutes)

L = total distance along main channel from study point to watershed boundary (feet)

S = main channel slope between the reference point and a point 0.2L downstream from the upstream watershed boundary (feet per foot)

I = impervious cover within the watershed (percent)

Φ = description of conveyance efficiency of the watershed drainage system.

The conveyance efficiency coefficient Φ is determined using the relationships illustrated on Figure 6.12.

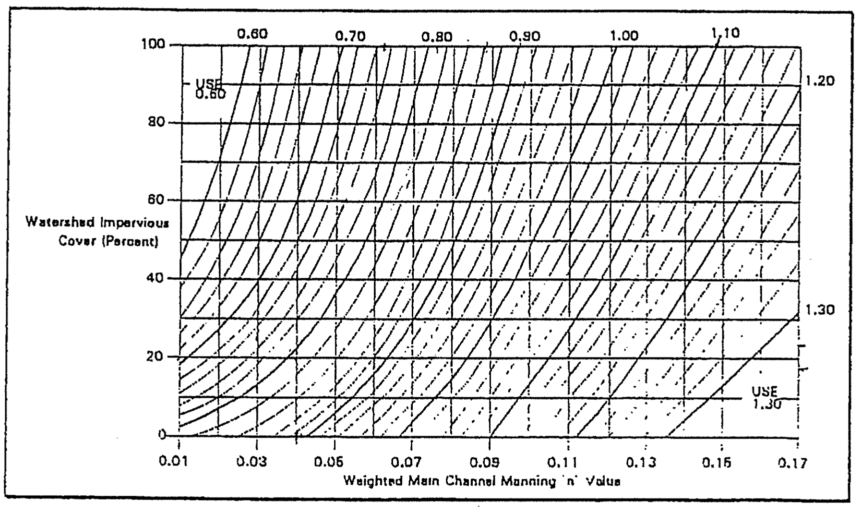


FIGURE 6.12 Determination of Conveyance Efficiency Coefficient Φ

This equation was derived from records for 41 watersheds in Texas, Tennessee, Mississippi, Pennsylvania, North Carolina, Colorado, Kentucky, and Indiana. The range in the watershed characteristics used to develop the equations for urban areas were:

Area : From 0.0128 square miles to 15.00 square miles

L : From 555 feet to 35,600 feet

S : From 0.0005 ft. per ft. to 0.0295 ft. per ft.

I : From 2% to 100%

Φ : From 0.60 to 1.30

Again, note that the time to rise T_r is not the same as the watershed lag time T_p. The difference between the two is that T_r is defined as the time from the beginning of effective rainfall to the peak of the unit hydrograph, while T_L is the time from the centroid of the effective rainfall to the peak of the unit hydrograph. For the purposes of HEC-1 analyses, however, T_L may be determined simply by subtracting one-half the computation time interval from the computed value of T_r (T_R - $\Delta t/2$).

The relationship developed by Espey to compute the peak flow rate of the unit hydrograph is as follows:

6.32 $$Q_u = 31600 \quad A^{0.96} T_r^{-1.07}$$

in which:

Q_u = unit hydrograph peak discharge (cfs)

A = drainage area (square miles)

T_r = time of rise from beginning of surface runoff to unit hydrograph peak (minutes)

Riverside County Method for Estimating Snyder Parameters

Three watershed lag equations have been derived for use in rural areas of Riverside County, California by the Riverside County Flood Control and Water Conservation District [Anonymous, 1963]. These equations differ slightly from those developed at the Tulsa District of the U.S. Army Corps of Engineers in that lag is defined as the time from the beginning of rainfall to the point on the unit hydrograph corresponding to one-half of the total runoff volume.

Each equation is applicable to a different topographic region:

6.33 $$T_L = 1.20\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Mountain Areas)

6.34 $$T_L = 0.72\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Foothill Areas)

6.35 $$T_L = 0.38\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Valley Areas)

in which:

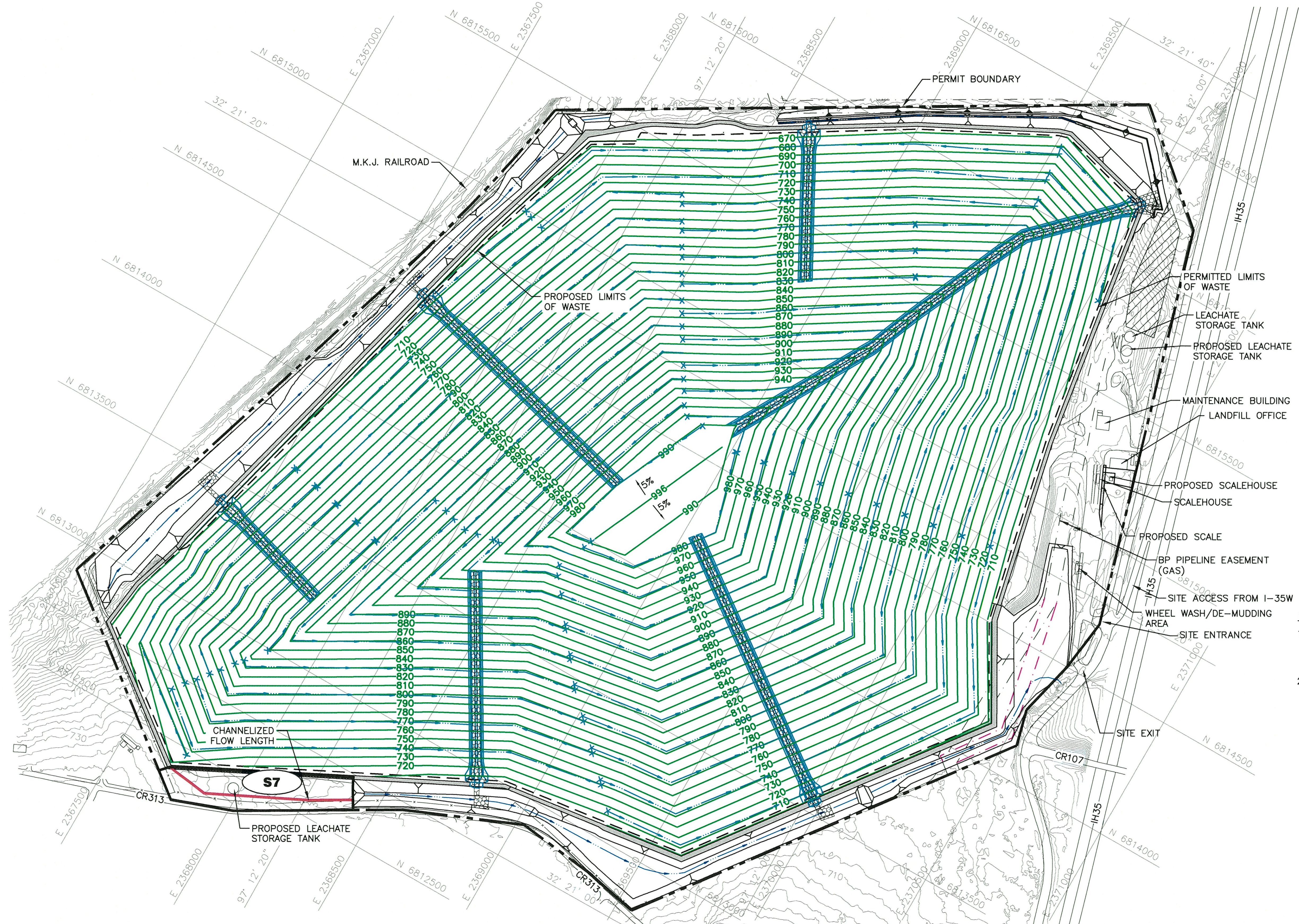
T_L = watershed lag in hours

L = watershed length in miles

L_{ca} = length to centroid in miles

S = watershed slope in feet per mile.

The sizes of the watersheds studied in developing these equations ranged from 2.3 square miles to 645 square miles.



LEGEND

PERMIT BOUNDARY	
LIMIT OF WASTE	
750	EXISTING CONTOUR (SEE NOTE 1)
N 6816000	STATE PLANE COORDINATE
32° 21' 20"	GEODETIC COORDINATE
	EASEMENT
	PROPOSED EASEMENT (SEE NOTE 2)
800	PROPOSED FINAL COVER CONTOUR
	PROPOSED DRAINAGE CHUTE
	DRAINAGE SWALE
	PROPOSED PERIMETER CHANNEL
	DRAINAGE AREA BOUNDARY
S7	DRAINAGE AREA DESIGNATION
	FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: CIIF-A-17 KINIMATIC WAVE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT EPSEY "10-MINUTE" METHOD PARAMETERS

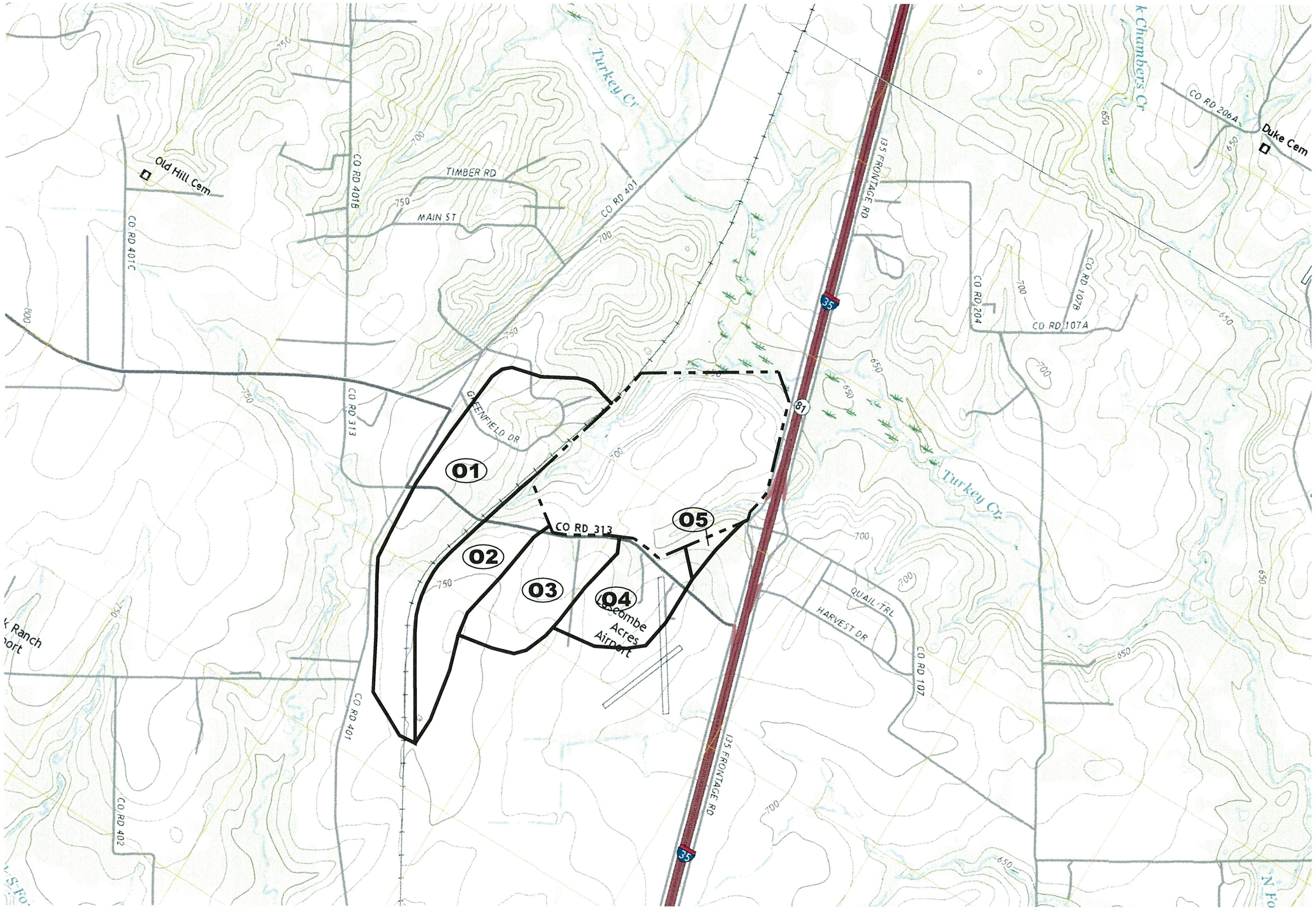
TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-A-23

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-A\IIIF-A-23 EPSEY METHOD.dwg, rarrington, 1:2

POST-DEVELOPMENT HEC-1 ANALYSIS
DRAINAGE AREAS



0 1000 2000

SCALE IN FEET

LEGEND

PERMIT BOUNDARY

DRAINAGE AREA BOUNDARY

O2 DRAINAGE AREA LABEL

DRAINAGE AREA NO.	AREA (ACRES)
O1	180.49
O2	74.62
O3	69.25
O4	61.05
O5	6.34
TOTAL	391.75

ALVARADO, TX 2019

GRANDVIEW, TX 2019

NOTES:

1. DRAINAGE AREA DELINEATION WITHIN THE PERMIT BOUNDARY IS INCLUDED ON DRAWING IIIF–A–26.
2. ALL TOPOGRAPHIC INFORMATION REPRODUCED FROM UNITED STATES GEOLOGICAL SURVEY 7 1/2 MINUTE QUADRANGLE SHEETS COMMERCE ALVARADO, TX; GRANDVIEW, TX.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-22-22

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-A\IIIF-A-25 OFFSITE DRAINAGE.dwg, rarrington, 1:2

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DATE: 02/2022
FILE: 0771-368-11
CAD: CIIF-A-25 OFFSITE DRAINAGE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR

TEXAS REGIONAL LANDFILL COMPANY, LP

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NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT OFFSITE DRAINGE AREA MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

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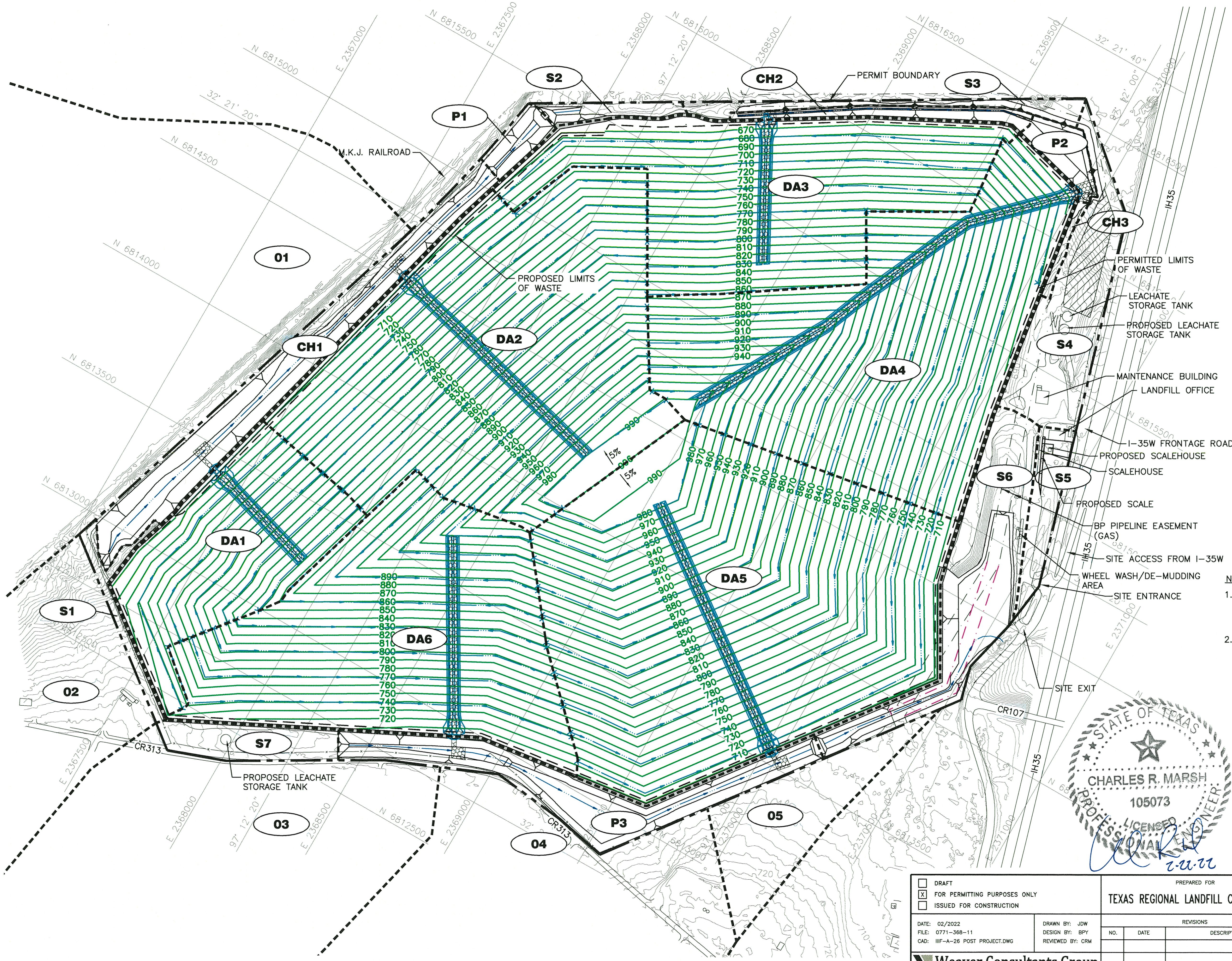
DRAWING IIIF–A–25



LEGEND

- PERMIT BOUNDARY
- LIMIT OF WASTE
- 750 EXISTING CONTOUR (SEE NOTE 1)
- N 6816000 STATE PLANE COORDINATE
- 32° 21' 20" GEODETIC COORDINATE
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 2)
- 800 PROPOSED FINAL COVER CONTOUR
- PROPOSED DRAINAGE CHUTE
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- DRAINAGE DIVIDE
- S7 DRAINAGE AREA DESIGNATION
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

DRAINAGE AREA NO.	AREA (ACRES)	DRAINAGE AREA NO.	AREA (ACRES)
DA1	12.96	P3	6.68
DA2	36.87	CH1	7.79
DA3	22.58	CH2	1.49
DA4	33.25	CH3	0.37
DA5	44.98	S1	1.14
DA6	27.53	S2	0.99
01	180.49	S3	1.71
02	74.63	S4	6.49
03	69.25	S5	1.93
04	61.05	S6	8.14
05	6.34	S7	2.40
P1	1.04		
P2	1.27		

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-A-26 POST PROJECT.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
POST PROJECT DRAINAGE

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-A-26

O:\0771\368\EXPANSION 2021\PART III\IIIF-A\IIIF-A-26 POST PROJECT DRNG.dwg, rarrington, 1:2

HEC-1 OUTPUT – POST-DEVELOPMENT
25-YEAR, 24-HOUR STORM EVENT

```
1****************************************               ****************************************
 *                                      *               *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *               *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *               *   HYDROLOGIC ENGINEERING CENTER      *
 *            VERSION 4.1               *               *        609 SECOND STREET             *
 *                                      *               *      DAVIS, CALIFORNIA 95616         *
 *  RUN DATE   13SEP21  TIME  09:37:08  *               *          (916) 756-1104              *
 *                                      *               *                                      *
 ****************************************               ****************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X       XXXXX   X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                              HEC-1 INPUT                                          PAGE  1

          LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                       *DIAGRAM
             1         ID  TURKEY CREEK LANDFILL
             2         ID  25-YEAR 24-HOUR STORM EVENT
             3         ID  PROPOSED SITE CONDITION
             4         ID  P:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-A\HEC
             5         IT       5       0    2400     432       0       0
             6         IO       3       0       0
                       *

             7         KK      O2
             8         KM  SUBAREA O2
             9         KO       0       0       0       7      21
            10         BA  0.1166
            11         PH                  0.85    1.69    3.07    3.88    4.38     5.3    6.27    7.33
            12         LS       0      84
            13         US    0.61    0.65
                       *

            14         KK    CLVT
            15         KM  CULVERT AT O2 DISCHARGE
            16         KO       0       0       0       7      21
            17         RS       1    ELEV  692.35
            18         SA       0  0.0233  0.0854   0.251  0.4773   0.701
            19         SE  692.35     694     696     698     700     702
            20         SL  693.35   9.621     0.7     0.5
            21         SS   696.5      30     2.6     1.5
                       *

            22         KK      S1
            23         KM  SUBAREA S1
            24         KO       0       0       0       7      21
            25         BA  0.0018
            26         LS       0      84
            27         US    0.14    0.69
                       *

            28         KK     DA1
            29         KM  DRAINAGE AREA DA1
            30         KO       0       0       0       7      21
            31         BA  0.0203
            32         LS       0      86
            33         UK     105    0.29     0.3     100
            34         RD   811.1   0.005    0.03            TRAP       0       2      NO
                       *

            35         KK   C/DA1
            36         KM  COMBINE HYDROGRAPHS
            37         KO       0       0       0       7      21
            38         HC       3
                       *
1                                              HEC-1 INPUT                                          PAGE  2

          LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            39         KK     CH1
            40         KM  SUBAREA CH1
            41         KO       0       0       0       7      21
            42         BA  0.0122
            43         LS       0      84
            44         UK      80    0.15     0.3     100
            45         RD    2273   0.005    0.04            TRAP      20     2.5     YES
                       *

            46         KK      O1
            47         KM  SUBAREA O1
```

```
 48          KO      0       0       0       7      21
 49          BA  0.282
 50          LS      0      84
 51          US   0.56    0.63
             *

 52          KK   CLVT
 53          KM  CULVERT AT O1 DISCHARGE
 54          KO      0       0       0       7      21
 55          RS      1    ELEV     680
 56          SA      0  0.0055  0.0211  0.0402   0.065   0.101    6.53
 57          SE    680     682     684     686     688     690     708
 58          SL  682.5   19.63     0.7     0.5
 59          SS    707     500     2.6     1.5
             *

 60          KK   C/O1
 61          KM  COMBINE HYDROGRAPHS
 62          KO      0       0       0       7      21
 63          HC      2
             *

 64          KK    DA2
 65          KM  DRAINAGE AREA DA2
 66          KO      0       0       0       7      21
 67          BA 0.0576
 68          LS      0      86
 69          UK    105    0.29     0.3     100
 70          RD   1120   0.005    0.03            TRAP       0       2      NO
             *

 71          KK  C/DA2
 72          KM  COMBINE HYDROGRAPHS
 73          KO      0       0       0       7      21
 74          HC      2
             *

 75          KK     P1
 76          KM  POND P1
 77          KO      0       0       0       7      21
 78          BA 0.0016
 79          LS      0     100
 80          UD      0
             *
```



```
LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 81          KK   C/P1
 82          KM  COMBINE HYDROGRAPHS
 83          KO      0       0       0       7      21
 84          HC      2
             *

 85          KK    RP1
 86          KM  ROUTE THROUGH P1
 87          KO      0       0       0       7      21
 88          RS      1    ELEV     659
 89          SA      0   0.321   0.399   0.482   0.569   0.661
 90          SE    659     662     664     666     668     670
 91          SL 660.25   47.72     0.8     0.5
 92          SS    665      26     2.6     1.5
             *

 93          KK     S2
 94          KM  SUBAREA S2
 95          KO      0       0       0       7      21
 96          BA 0.0015
 97          LS      0      84
 98          US   0.08    0.62
             *

 99          KK   C/NW
100          KM  DISCHARGE AT NW
101          KO      0       0       0       7      21
102          HC      2
             *

103          KK    DA3
104          KM  DRAINAGE AREA DA3
105          KO      0       0       0       7      21
106          BA 0.0353
107          LS      0      86
108          UK    105    0.29     0.3     100
109          RD   1184   0.005    0.03            TRAP       0       2      NO
             *

110          KK    CH2
111          KM  SUBAREA CH2
112          KO      0       0       0       7      21
113          BA 0.0023
114          LS      0      84
115          UK    100     0.4     0.3     100
116          RD   1238    0.01    0.03            TRAP       6       2     YES
             *

117          KK    DA4
118          KM  DRAINAGE AREA DA4
119          KO      0       0       0       7      21
120          BA  0.052
121          LS      0      86
122          UK    120    0.25     0.3     100
```

```
 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  123          RD    1338   0.005    0.03            TRAP       0       2      NO
               *

  124          KK     CH3
  125          KM   SUBAREA CH3
  126          KO       0       0       0       7      21
  127          BA   0.0006
  128          LS       0      84
  129          UK     137   0.204     0.3     100
  130          RD     505  0.0625    0.03            TRAP       6       2      NO
               *

  131          KK      P2
  132          KM   POND P2
  133          KO       0       0       0       7      21
  134          BA    0.002
  135          LS       0     100
  136          UD       0
               *

  137          KK    C/P2
  138          KM   COMBINE HYDROGRAPHS
  139          KO       0       0       0       7      21
  140          HC       4
               *

  141          KK     RP2
  142          KM   ROUTE THROUGH P2
  143          KO       0       0       0       7      21
  144          RS       1    ELEV     650
  145          SA       0    0.46    0.52    0.58    0.65    0.72    0.79    0.87     0.9    0.94
  146          SE     650     651     652     653     654     655     656     657     658     659
  147          SL     651   18.84     0.8     0.5
  148          SS   656.5      20     2.6     1.5
               *

  149          KK      S3
  150          KM   SUBAREA S3
  151          KO       0       0       0       7      21
  152          BA   0.0027
  153          LS       0      84
  154          US    0.15    0.69
               *

  155          KK      S4
  156          KM   SUBAREA S4
  157          KO       0       0       0       7      21
  158          BA   0.0101
  159          LS       0      84
  160          US    0.32    0.71
               *
```



```
 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  161          KK    C/NE
  162          KM   DISCHARGE AT NE
  163          KO       0       0       0       7      21
  164          HC       3
               *

  165          KK      O3
  166          KM   SUBAREA O3
  167          KO       0       0       0       7      21
  168          BA   0.1082
  169          LS       0      84
  170          US    0.46    0.65
               *

  171          KK      S7
  172          KM   SUBAREA S7
  173          KO       0       0       0       7      21
  174          BA   0.0038
  175          LS       0      84
  176          US    0.28    0.73
               *

  177          KK     DA6
  178          KM   DRAINAGE AREA DA6
  179          KO       0       0       0       7      21
  180          BA   0.0430
  181          LS       0      86
  182          UK     105    0.29     0.3     100
  183          RD  1203.8   0.005    0.03            TRAP       0       2      NO
               *

  184          KK   C/DA6
  185          KM   COMBINE HYDROGRAPHS
  186          KO       0       0       0       7      21
  187          HC       3
               *

  188          KK      O4
  189          KM   SUBAREA O4
  190          KO       0       0       0       7      21
  191          BA   0.0954
  192          LS       0      84
  193          US    0.47    0.65
               *
```

```
         194           KK    CLVT
         195           KM  CULVERT AT O4 DISCHARGE
         196           KO       0       0       0       7      21
         197           RS       1    ELEV  699.71
         198           SA       0 0.00689    0.02  0.1672   0.911
         199           SE  699.71     700     702     704     706
         200           SL  701.46   19.24     0.7     0.5
         201           SS   704.5      70     2.6     1.5
                       *
1                                                  HEC-1 INPUT                                         PAGE  6

        LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


         202           KK      P3
         203           KM  POND P3
         204           KO       0       0       0       7      21
         205           BA  0.0105
         206           LS       0     100
         207           UD       0
                       *

         208           KK    C/P3
         209           KM  COMBINE HYDROGRAPHS
         210           KO       0       0       0       7      21
         211           HC       3
                       *

         212           KK     DA5
         213           KM  DRAINAGE AREA DA5
         214           KO       0       0       0       7      21
         215           BA  0.0703
         216           LS       0      86
         217           UK     120    0.25     0.3     100
         218           RD    1358   0.005    0.03            TRAP       0       2      NO
                       *

         219           KK   C/DA5
         220           KM  COMBINE HYDROGRAPHS
         221           KO       0       0       0       7      21
         222           HC       2
                       *

         223           KK     RP3
         224           KM  ROUTE THROUGH P3
         225           KO       0       0       0       7      21
         226           RS       1    ELEV   692.5
         227           SA       0  2.2778   2.609   3.459    3.94
         228           SE   692.5     694     696     698     700
         229           SL  693.75  48.106     0.8     0.5
         230           SS     697      75     2.6     1.5
                       *

         231           KK      O5
         232           KM  SUBAREA O5
         233           KO       0       0       0       7      21
         234           BA  0.0099
         235           LS       0      84
         236           US    0.41    0.71
                       *

         237           KK    C/O5
         238           KM  COMBINE HYDROGRAPHS
         239           KO       0       0       0       7      21
         240           HC       2
                       *
1                                                  HEC-1 INPUT                                         PAGE  7

        LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


         241           KK      S6
         242           KM  SUBAREA S6
         243           KO       0       0       0       7      21
         244           BA  0.0127
         245           LS       0      84
         246           US    0.24    0.68
                       *

         247           KK      S5
         248           KM  SUBAREA S5
         249           KO       0       0       0       7      21
         250           BA  0.0030
         251           LS       0      84
         252           US    0.25    0.73
                       *

         253           KK    C/SE
         254           KM  DISCHARGE AT SE
         255           KO       0       0       0       7      21
         256           HC       3
                       *
         257           ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7           O2
                 V
                 V
   14          CLVT
```

```
              .
              .
 22           .          S1
              .           .
              .           .
 28           .           .         DA1
              .           .           .
              .           .           .
 35       C/DA1........................
              V
              V
 39         CH1 ***
              .
              .
 46           .          O1
              .           V
              .           V
 52           .        CLVT
              .           .
              .           .
 60        C/O1............
              .
              .
 64           .         DA2
              .           .
              .           .
 71       C/DA2............
              .
              .
 75           .          P1
              .           .
              .           .
 81        C/P1............
              V
              V
 85         RP1
              .
              .
 93           .          S2
              .           .
              .           .
 99        C/NW............
              .
              .
103           .         DA3
              .           V
              .           V
110           .         CH2 ***
              .           .
              .           .
117           .           .         DA4
              .           .           .
              .           .           .
124           .           .           .         CH3
              .           .           .           .
              .           .           .           .
131           .           .           .           .          P2
              .           .           .           .           .
              .           .           .           .           .
137           .        C/P2....................................
              .           V
              .           V
141           .         RP2
              .           .
              .           .
149           .           .          S3
              .           .           .
              .           .           .
155           .           .           .          S4
              .           .           .           .
              .           .           .           .
161           .        C/NE........................
              .           .
              .           .
165           .           .          O3
              .           .           .
              .           .           .
171           .           .           .          S7
              .           .           .           .
              .           .           .           .
177           .           .           .           .         DA6
              .           .           .           .           .
              .           .           .           .           .
184           .           .       C/DA6........................
              .           .           .
              .           .           .
188           .           .           .          O4
              .           .           .           V
              .           .           .           V
194           .           .           .        CLVT
              .           .           .           .
              .           .           .           .
202           .           .           .           .          P3
              .           .           .           .           .
              .           .           .           .           .
208           .           .        C/P3........................
              .           .           .
              .           .           .
212           .           .           .         DA5
              .           .           .           .
              .           .           .           .
219           .           .       C/DA5............
              .           .           V
              .           .           V
```

```
 223          .           .         RP3
              .           .           .
              .           .           .
 231          .           .           .          O5
              .           .           .           .
              .           .           .           .
 237          .           .         C/O5...........
              .           .           .
              .           .           .
 241          .           .           .          S6
              .           .           .           .
              .           .           .           .
 247          .           .           .           .          S5
              .           .           .           .           .
              .           .           .           .           .
 253          .           .         C/SE.......................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                             ***************************************
 *                                        *                            *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                            *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998                 *                            *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                  *                            *        609 SECOND STREET            *
 *                                        *                            *     DAVIS, CALIFORNIA 95616         *
 * RUN DATE   13SEP21  TIME  09:37:08     *                            *         (916) 756-1104              *
 *                                        *                            *                                     *
 *****************************************                             ***************************************


                         TURKEY CREEK LANDFILL
                         25-YEAR 24-HOUR STORM EVENT
                         PROPOSED SITE CONDITION
                         P:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-A\HEC

   6 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        432  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      3   0  ENDING DATE
                     NDTIME       1155  ENDING TIME
                      ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   35.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   7 KK     *       O2   *
            *            *
            **************
                         SUBAREA O2

   9 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                       IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

  10 BA         SUBBASIN CHARACTERISTICS
                      TAREA        .12  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =      .12

  12 LS         SCS LOSS RATE
                      STRTL        .38  INITIAL ABSTRACTION
                     CRVNBR      84.00  CURVE NUMBER
                      RTIMP        .00  PERCENT IMPERVIOUS AREA
```

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13 US         SNYDER UNITGRAPH
                        TP          .61  LAG
                        CP          .65  PEAKING COEFFICIENT

              SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                ***

                                                 UNIT HYDROGRAPH PARAMETERS
                                           CLARK   TC=    .71 HR,       R=    .52 HR
                                          SNYDER   TP=    .61 HR,      CP=    .65

                                                      UNIT HYDROGRAPH
                                                38 END-OF-PERIOD ORDINATES
                  4.        14.        28.        44.        60.        72.        79.        81.        76.        66.
                 56.        48.        41.        35.        30.        25.        21.        18.        16.        13.
                 11.        10.         8.         7.         6.         5.         4.         4.         3.         3.
                  2.         2.         2.         1.         1.         1.         1.         1.

        ***              ***              ***              ***              ***

                      HYDROGRAPH AT STATION       O2

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

 PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR       35.92-HR
+   (CFS)       (HR)
                           (CFS)
+     188.     12.67                   54.          17.          11.          11.
                        (INCHES)     4.339        5.428        5.428        5.428
                         (AC-FT)       27.          34.          34.          34.

                       CUMULATIVE AREA =      .12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

                **************
                *            *
14 KK           *     CLVT   *
                *            *
                **************
                              CULVERT AT O2 DISCHARGE

16 KO         OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE
                    IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                     IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


            HYDROGRAPH ROUTING DATA

17 RS         STORAGE ROUTING
                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       ELEV  TYPE OF INITIAL CONDITION
                   RSVRIC     692.35  INITIAL CONDITION
                        X        .00  WORKING R AND D COEFFICIENT

18 SA                AREA         .0         .0         .1         .3         .5         .7

19 SE         ELEVATION     692.35     694.00     696.00     698.00     700.00     702.00

20 SL         LOW-LEVEL OUTLET
                    ELEVL     693.35  ELEVATION AT CENTER OF OUTLET
                    CAREA       9.62  CROSS-SECTIONAL AREA
                     COQL        .70  COEFFICIENT
                     EXPL        .50  EXPONENT OF HEAD

21 SS         SPILLWAY
                     CREL     696.50  SPILLWAY CREST ELEVATION
                    SPWID      30.00  SPILLWAY WIDTH
                     COQW       2.60  WEIR COEFFICIENT
                     EXPW       1.50  EXPONENT OF HEAD

                                                                ***

                                                    COMPUTED STORAGE-ELEVATION DATA

            STORAGE         .00        .01        .12        .44       1.15       2.32
          ELEVATION      692.35     694.00     696.00     698.00     700.00     702.00

                                                    COMPUTED OUTFLOW-ELEVATION DATA

            OUTFLOW         .00        .00      68.39      71.31      74.49      77.97      81.78      85.99      90.66      95.86
          ELEVATION      692.35     693.35     694.95     695.09     695.25     695.43     695.64     695.88     696.17     696.50

            OUTFLOW      101.11     115.42     144.17     192.29     264.74     366.42     502.31     677.36     896.57    1164.95
          ELEVATION      696.62     696.83     697.13     697.53     698.03     698.63     699.32     700.12     701.01     702.00


                                                 COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

            STORAGE         .00        .00        .01        .05        .05        .06        .07        .09        .11        .12
            OUTFLOW         .00        .00      43.55      68.39      71.31      74.49      77.97      81.78      85.99      87.93
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```
        ELEVATION    692.35    693.35    694.00    694.95    695.09    695.25    695.43    695.64    695.88    696.00

          STORAGE       .13       .17       .18       .21       .26       .33       .44       .44       .61       .86
          OUTFLOW     90.66     95.86    101.11    115.42    144.17    192.29    259.77    264.74    366.42    502.31
        ELEVATION    696.17    696.50    696.62    696.83    697.13    697.53    698.00    698.03    698.63    699.32

          STORAGE      1.15      1.21      1.69      2.32
          OUTFLOW    650.02    677.36    896.57   1164.95
        ELEVATION    700.00    700.12    701.01    702.00

 *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO     1165.
                 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION     CLVT

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     35.92-HR
 +   (CFS)       (HR)
                          (CFS)
 +     187.     12.67                  54.          17.          11.          11.
                        (INCHES)     4.339        5.427        5.427        5.427
                         (AC-FT)       27.          34.          34.          34.

  PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR        24-HR        72-HR     35.92-HR
 +  (AC-FT)      (HR)
          0.    12.67                   0.           0.           0.           0.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR        24-HR        72-HR     35.92-HR
 +   (FEET)      (HR)
      697.49    12.67               694.58       693.71       693.44       693.44

                        CUMULATIVE AREA =      .12 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
   22 KK     *       S1   *
             *            *
             **************
                          SUBAREA S1

   24 KO          OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

   25 BA          SUBBASIN CHARACTERISTICS
                        TAREA          .00  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......    .............. TP-40 ..............    ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                    STORM AREA =      .00

   26 LS          SCS LOSS RATE
                        STRTL          .38  INITIAL ABSTRACTION
                       CRVNBR        84.00  CURVE NUMBER
                        RTIMP          .00  PERCENT IMPERVIOUS AREA

   27 US          SNYDER UNITGRAPH
                           TP          .14  LAG
                           CP          .69  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                ***

                                                          UNIT HYDROGRAPH PARAMETERS
                                                    CLARK   TC=    .17 HR,         R=    .09 HR
                                                   SNYDER   TP=    .14 HR,        CP=    .68

                                                               UNIT HYDROGRAPH
                                                          7 END-OF-PERIOD ORDINATES
                  2.         5.         4.         2.         1.         0.         0.

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION        S1

     TOTAL RAINFALL =      7.33, TOTAL LOSS =      1.88, TOTAL EXCESS =      5.45

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
```

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                                      6-HR       24-HR       72-HR    35.92-HR
+    (CFS)      (HR)
                            (CFS)
+       7.     12.17                     1.          0.          0.          0.
                          (INCHES)    4.364       5.438       5.438       5.438
                           (AC-FT)       0.          1.          1.          1.

                           CUMULATIVE AREA =      .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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            *            *
  28 KK     *      DA1   *
            *            *
            **************
                          DRAINAGE AREA DA1

  30 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

  31 BA          SUBBASIN CHARACTERISTICS
                       TAREA        .02  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ..............    ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =      .02

  32 LS          SCS LOSS RATE
                       STRTL        .33  INITIAL ABSTRACTION
                      CRVNBR      86.00  CURVE NUMBER
                       RTIMP        .00  PERCENT IMPERVIOUS AREA

                 KINEMATIC WAVE
  33 UK            OVERLAND-FLOW ELEMENT NO. 1
                           L       105.  OVERLAND FLOW LENGTH
                           S      .2900  SLOPE
                           N       .300  ROUGHNESS COEFFICIENT
                          PA      100.0  PERCENT OF SUBBASIN
                       DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
                 MUSKINGUM-CUNGE
  34 RD            MAIN CHANNEL
                           L       811.  CHANNEL LENGTH
                           S      .0050  SLOPE
                           N       .030  CHANNEL ROUGHNESS COEFFICIENT
                          CA        .02  CONTRIBUTING AREA
                       SHAPE       TRAP  CHANNEL SHAPE
                          WD        .00  BOTTOM WIDTH OR DIAMETER
                           Z       2.00  SIDE SLOPE
                      RUPSTQ         NO  ROUTE UPSTREAM HYDROGRAPH

                                                          ***
                               COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                      COMPUTATION TIME STEP
                   ELEMENT    ALPHA       M         DT        DX        PEAK    TIME TO    VOLUME    MAXIMUM
                                                                                  PEAK                CELERITY
                                                  (MIN)      (FT)      (CFS)     (MIN)      (IN)      (FPS)

                   PLANE1      2.67      1.67        .63     21.00     119.15    724.67      5.68        .71
                   MAIN        1.63      1.33       2.53    405.55     113.76    723.96      5.52       5.34

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .6153E+01 OUTFLOW= .5971E+01 BASIN STORAGE= .5042E-03 PERCENT ERROR=   2.9

                                      INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                   MAIN        1.63      1.33       5.00                105.64    725.00      5.52

       ***          ***           ***           ***           ***

                         HYDROGRAPH AT STATION       DA1

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    35.92-HR
+    (CFS)      (HR)
                            (CFS)
+     106.     12.08                    10.          3.          2.          2.
                          (INCHES)    4.502       5.518       5.518       5.518
                           (AC-FT)       5.          6.          6.          6.

                           CUMULATIVE AREA =      .02 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  35 KK    *    C/DA1   *
           *            *
           **************
                         COMBINE HYDROGRAPHS

  37 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE
                    IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                     IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


  38 HC        HYDROGRAPH COMBINATION
                    ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                  ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     C/DA1

  PEAK FLOW      TIME                        MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR     35.92-HR
+   (CFS)        (HR)
                              (CFS)
+      201.     12.67                   65.          20.          14.          14.
                            (INCHES)  4.357        5.441        5.441        5.441
                             (AC-FT)    32.          40.          40.          40.

                         CUMULATIVE AREA =      .14 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  39 KK    *      CH1   *
           *            *
           **************
                          SUBAREA CH1

  41 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE
                    IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                     IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

  42 BA        SUBBASIN CHARACTERISTICS
                    TAREA        .01  SUBBASIN AREA

               PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   .............. TP-40 ..............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                  STORM AREA =       .01

  43 LS        SCS LOSS RATE
                    STRTL        .38  INITIAL ABSTRACTION
                   CRVNBR      84.00  CURVE NUMBER
                    RTIMP        .00  PERCENT IMPERVIOUS AREA

               KINEMATIC WAVE
  44 UK          OVERLAND-FLOW ELEMENT NO. 1
                        L        80.  OVERLAND FLOW LENGTH
                        S      .1500  SLOPE
                        N       .300  ROUGHNESS COEFFICIENT
                       PA      100.0  PERCENT OF SUBBASIN
                    DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
               MUSKINGUM-CUNGE
  45 RD          MAIN CHANNEL
                        L      2273.  CHANNEL LENGTH
                        S      .0050  SLOPE
                        N       .040  CHANNEL ROUGHNESS COEFFICIENT
                       CA        .01  CONTRIBUTING AREA
                    SHAPE       TRAP  CHANNEL SHAPE
                       WD      20.00  BOTTOM WIDTH OR DIAMETER
                        Z       2.50  SIDE SLOPE
                   RUPSTQ        YES  ROUTE UPSTREAM HYDROGRAPH
```

```
                                              ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
              ELEMENT    ALPHA      M        DT        DX       PEAK     TIME TO    VOLUME    MAXIMUM
                                                                          PEAK                CELERITY
                                            (MIN)      (FT)     (CFS)     (MIN)      (IN)      (FPS)

              PLANE1      1.92     1.67       .67     16.00     69.38    724.79      5.45       .52
              MAIN         .50     1.49      5.00    757.67    205.36    765.00      5.44      4.48

CONTINUITY SUMMARY (AC-FT) - INFLOW= .4025E+02  EXCESS= .3548E+01 OUTFLOW= .4377E+02 BASIN STORAGE= .3948E-02 PERCENT ERROR=    .0

                                    INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

              MAIN         .50     1.49      5.00              205.36    765.00      5.44

      ***         ***          ***          ***           ***

                       HYDROGRAPH AT STATION       CH1

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                 6-HR        24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                         (CFS)
+     205.     12.75               71.          22.          15.          15.
                       (INCHES)  4.358        5.439        5.439        5.439
                        (AC-FT)    35.          44.          44.          44.

                       CUMULATIVE AREA =      .15 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  46 KK    *       O1   *
           *            *
           **************
                      SUBAREA O1

  48 KO         OUTPUT CONTROL VARIABLES
                      IPRNT            3  PRINT CONTROL
                      IPLOT            0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE
                      IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                       IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT         .083  TIME INTERVAL IN HOURS

            SUBBASIN RUNOFF DATA

  49 BA         SUBBASIN CHARACTERISTICS
                      TAREA          .28  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                             DEPTHS FOR    0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                               STORM AREA =      .28

  50 LS         SCS LOSS RATE
                      STRTL          .38  INITIAL ABSTRACTION
                     CRVNBR        84.00  CURVE NUMBER
                      RTIMP          .00  PERCENT IMPERVIOUS AREA

  51 US         SNYDER UNITGRAPH
                         TP          .56  LAG
                         CP          .63  PEAKING COEFFICIENT

                SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                              ***

                                          UNIT HYDROGRAPH PARAMETERS
                                    CLARK   TC=    .64 HR,        R=    .51 HR
                                   SNYDER   TP=    .56 HR,       CP=    .64

                                               UNIT HYDROGRAPH
                                          37 END-OF-PERIOD ORDINATES
              11.       41.       81.      126.      167.      195.      208.      200.      176.      149.
             126.      107.       91.       77.       65.       55.       47.       40.       34.       29.
              24.       21.       17.       15.       13.       11.        9.        8.        7.        6.
               5.        4.        3.        3.        2.        2.        2.

      ***         ***          ***          ***           ***

                       HYDROGRAPH AT STATION        O1

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45
```

```
  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                         (CFS)
+     466.     12.58                132.          41.          27.          27.
                       (INCHES)    4.339        5.427        5.427        5.427
                        (AC-FT)      65.          82.          82.          82.

                        CUMULATIVE AREA =       .28 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   52 KK    *     CLVT   *
            *            *
            **************
                          CULVERT AT O1 DISCHARGE

   54 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


                HYDROGRAPH ROUTING DATA

   55 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC      680.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

   56 SA               AREA          .0          .0          .0          .0          .1          .1         6.5

   57 SE          ELEVATION      680.00      682.00      684.00      686.00      688.00      690.00      708.00

   58 SL          LOW-LEVEL OUTLET
                        ELEVL      682.50  ELEVATION AT CENTER OF OUTLET
                        CAREA       19.63  CROSS-SECTIONAL AREA
                         COQL         .70  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

   59 SS          SPILLWAY
                         CREL      707.00  SPILLWAY CREST ELEVATION
                        SPWID      500.00  SPILLWAY WIDTH
                         COQW        2.60  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

                                                                ***

                                           COMPUTED STORAGE-ELEVATION DATA

              STORAGE        .00        .00        .03        .09        .19        .36      45.02
            ELEVATION     680.00     682.00     684.00     686.00     688.00     690.00     708.00

                                           COMPUTED OUTFLOW-ELEVATION DATA

              OUTFLOW        .00        .00     175.72     194.56     217.93     247.67     286.82     340.67     419.40     545.48
            ELEVATION     680.00     682.50     685.04     685.62     686.41     687.55     689.27     692.06     696.98     707.00

              OUTFLOW     547.11     557.08     583.02     632.66     713.59     833.50    1000.07    1221.06    1503.95    1856.50
            ELEVATION     707.01     707.04     707.09     707.16     707.25     707.36     707.49     707.64     707.81     708.00


                                       COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

              STORAGE        .00        .00        .01        .03        .06        .07        .09        .11        .17        .19
              OUTFLOW        .00        .00        .00     134.97     175.72     194.56     206.17     217.93     247.67     258.45
            ELEVATION     680.00     682.00     682.50     684.00     685.04     685.62     686.00     686.41     687.55     688.00

              STORAGE        .29        .36        .78       4.74      38.80      38.86      39.05      39.35      39.77      40.31
              OUTFLOW     286.82     301.80     340.67     419.40     545.48     547.11     557.08     583.02     632.66     713.59
            ELEVATION     689.27     690.00     692.06     696.98     707.00     707.01     707.04     707.09     707.16     707.25

              STORAGE      40.98      41.78      42.72      43.79      45.02
              OUTFLOW     833.50    1000.07    1221.06    1503.95    1856.50
            ELEVATION     707.36     707.49     707.64     707.81     708.00

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN          0. TO       287.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

       ***              ***              ***              ***              ***

                        HYDROGRAPH AT STATION      CLVT

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                         (CFS)
+     391.     12.83                132.          41.          27.          27.
                       (INCHES)    4.339        5.427        5.427        5.427
                        (AC-FT)      65.          82.          82.          82.
```

```
 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                    6-HR        24-HR       72-HR      35.92-HR
+  (AC-FT)      (HR)
        3.     12.83                  0.          0.          0.           0.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                    6-HR        24-HR       72-HR      35.92-HR
+   (FEET)      (HR)
    695.19     12.83              685.36      683.31      682.67       682.67

                          CUMULATIVE AREA =     .28 SQ MI
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            **************
            *            *
   60 KK    *      C/O1  *
            *            *
            **************
                          COMBINE HYDROGRAPHS

   62 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


   63 HC         HYDROGRAPH COMBINATION
                       ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      C/O1

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                    6-HR        24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                           (CFS)
+     595.     12.83                202.         63.         42.          42.
                        (INCHES)   4.346       5.431       5.431        5.431
                         (AC-FT)    100.        125.        125.         125.

                          CUMULATIVE AREA =     .43 SQ MI
```

*** ***

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            **************
            *            *
   64 KK    *       DA2  *
            *            *
            **************
                          DRAINAGE AREA DA2

   66 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

   67 BA         SUBBASIN CHARACTERISTICS
                       TAREA        .06  SUBBASIN AREA

                 PRECIPITATION DATA

   11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                      STORM AREA =       .06

   68 LS         SCS LOSS RATE
                       STRTL        .33  INITIAL ABSTRACTION
                      CRVNBR      86.00  CURVE NUMBER
                       RTIMP        .00  PERCENT IMPERVIOUS AREA

                 KINEMATIC WAVE
   69 UK           OVERLAND-FLOW ELEMENT NO. 1
                           L       105.  OVERLAND FLOW LENGTH
                           S      .2900  SLOPE
                           N       .300  ROUGHNESS COEFFICIENT
                          PA      100.0  PERCENT OF SUBBASIN
```

```
                    DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
              MUSKINGUM-CUNGE
   70 RD        MAIN CHANNEL
                        L       1120.  CHANNEL LENGTH
                        S       .0050  SLOPE
                        N        .030  CHANNEL ROUGHNESS COEFFICIENT
                       CA         .06  CONTRIBUTING AREA
                    SHAPE        TRAP  CHANNEL SHAPE
                       WD         .00  BOTTOM WIDTH OR DIAMETER
                        Z        2.00  SIDE SLOPE
                   RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                         ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
               ELEMENT     ALPHA        M         DT         DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                               PEAK                 CELERITY
                                                 (MIN)      (FT)      (CFS)    (MIN)       (IN)      (FPS)

               PLANE1       2.67      1.67        .63      21.00     337.95    724.66      5.68        .71
               MAIN         1.63      1.33       2.69     560.00     322.52    724.06      5.52       6.93

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1746E+02 OUTFLOW= .1694E+02 BASIN STORAGE= .8281E-03 PERCENT ERROR=   2.9

                                      INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


               MAIN         1.63      1.33       5.00                299.13    725.00      5.52

      ***            ***             ***             ***             ***

                          HYDROGRAPH AT STATION       DA2

     TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR      35.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +     299.     12.08                    28.          9.          6.           6.
                            (INCHES)   4.503       5.515       5.516       5.516
                             (AC-FT)     14.         17.         17.          17.

                          CUMULATIVE AREA =      .06 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   71 KK    *     C/DA2  *
            *            *
            **************
                           COMBINE HYDROGRAPHS

   73 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS

   74 HC          HYDROGRAPH COMBINATION
                        ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                         ***

      ***            ***             ***             ***             ***

                          HYDROGRAPH AT STATION     C/DA2

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR      35.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +     624.     12.83                   230.         72.         48.          48.
                            (INCHES)   4.359       5.441       5.441       5.441
                             (AC-FT)    114.        142.        142.         142.

                          CUMULATIVE AREA =      .49 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   75 KK    *        P1  *
            *            *
            **************
                           POND P1

   77 KO          OUTPUT CONTROL VARIABLES
```

```
                      IPRNT            3  PRINT CONTROL
                      IPLOT            0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE
                      IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                       IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT         .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

  78 BA           SUBBASIN CHARACTERISTICS
                      TAREA          .00  SUBBASIN AREA

                  PRECIPITATION DATA

  11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............    ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =       .00

  79 LS           SCS LOSS RATE
                      STRTL          .00  INITIAL ABSTRACTION
                     CRVNBR       100.00  CURVE NUMBER
                      RTIMP          .00  PERCENT IMPERVIOUS AREA

  80 UD           SCS DIMENSIONLESS UNITGRAPH
                       TLAG          .00  LAG

                                                                ***

                                                          UNIT HYDROGRAPH
                                                      5 END-OF-PERIOD ORDINATES
                  9.         3.         1.         0.         0.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION        P1

   TOTAL RAINFALL =     7.33, TOTAL LOSS =      .00, TOTAL EXCESS =     7.33

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                         6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                             (CFS)
+        9.     12.08                      1.            0.           0.           0.
                           (INCHES)     5.298         7.327        7.330        7.330
                            (AC-FT)        0.            1.           1.           1.

                       CUMULATIVE AREA =       .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  81 KK      *     C/P1   *
             *            *
             **************
                           COMBINE HYDROGRAPHS

  83 KO           OUTPUT CONTROL VARIABLES
                      IPRNT            3  PRINT CONTROL
                      IPLOT            0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE
                      IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                       IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT         .083  TIME INTERVAL IN HOURS


  84 HC           HYDROGRAPH COMBINATION
                      ICOMP            2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      C/P1

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                         6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                             (CFS)
+      625.     12.83                    231.           72.          48.          48.
                           (INCHES)     4.362         5.446        5.447        5.447
                            (AC-FT)      114.          143.         143.         143.

                       CUMULATIVE AREA =       .49 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
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          *            *
 85 KK    *       RP1  *
          *            *
          **************
                        ROUTE THROUGH P1

 87 KO         OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


             HYDROGRAPH ROUTING DATA

 88 RS         STORAGE ROUTING
                     NSTPS          1  NUMBER OF SUBREACHES
                      ITYP       ELEV  TYPE OF INITIAL CONDITION
                    RSVRIC     659.00  INITIAL CONDITION
                         X        .00 WORKING R AND D COEFFICIENT

 89 SA                AREA         .0         .3         .4         .5         .6         .7

 90 SE         ELEVATION     659.00     662.00     664.00     666.00     668.00     670.00

 91 SL         LOW-LEVEL OUTLET
                     ELEVL     660.25  ELEVATION AT CENTER OF OUTLET
                     CAREA      47.72  CROSS-SECTIONAL AREA
                      COQL        .80  COEFFICIENT
                      EXPL        .50  EXPONENT OF HEAD

 92 SS         SPILLWAY
                      CREL     665.00  SPILLWAY CREST ELEVATION
                     SPWID      26.00  SPILLWAY WIDTH
                      COQW       2.60  WEIR COEFFICIENT
                      EXPW       1.50  EXPONENT OF HEAD

                                                         ***

                                                 COMPUTED STORAGE-ELEVATION DATA

           STORAGE        .00        .32       1.04       1.92       2.97       4.20
         ELEVATION     659.00     662.00     664.00     666.00     668.00     670.00

                                                 COMPUTED OUTFLOW-ELEVATION DATA

           OUTFLOW        .00        .00     567.63     580.01     592.93     606.45     620.59     635.41     650.96     667.29
         ELEVATION     659.00     660.25     663.69     663.84     664.00     664.17     664.36     664.56     664.77     665.00

           OUTFLOW     756.99     802.23     859.65     930.55    1016.20    1117.92    1237.02    1374.80    1532.62    1711.81
         ELEVATION     665.72     666.00     666.34     666.72     667.14     667.62     668.14     668.71     669.33     670.00


                                             COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

           STORAGE        .00        .02        .32        .92        .98       1.04       1.11       1.19       1.27       1.36
           OUTFLOW        .00        .00     405.03     567.63     580.01     592.90     606.45     620.59     635.41     650.96
         ELEVATION     659.00     660.25     662.00     663.69     663.84     664.00     664.17     664.36     664.56     664.77

           STORAGE       1.46       1.78       1.92       2.08       2.28       2.50       2.76       2.97       3.05       3.39
           OUTFLOW     667.29     756.99     801.77     859.65     930.55    1016.20    1117.92    1203.61    1237.02    1374.80
         ELEVATION     665.00     665.72     666.00     666.34     666.72     667.14     667.62     668.00     668.14     668.71

           STORAGE       3.77       4.20
           OUTFLOW    1532.62    1711.81
         ELEVATION     669.33     670.00

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO      1712.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION       RP1

   PEAK FLOW      TIME                         MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR       72-HR      35.92-HR
 +   (CFS)        (HR)
                               (CFS)
 +     622.      12.83                    231.         72.         48.         48.
                            (INCHES)     4.362       5.446       5.446       5.446
                             (AC-FT)      114.        143.        143.        143.

  PEAK STORAGE    TIME                        MAXIMUM AVERAGE STORAGE
                                          6-HR        24-HR       72-HR      35.92-HR
 +  (AC-FT)       (HR)
          1.     12.83                      0.          0.          0.          0.

   PEAK STAGE     TIME                         MAXIMUM AVERAGE STAGE
                                          6-HR        24-HR       72-HR      35.92-HR
 +   (FEET)       (HR)
     664.38      12.83                  661.48      660.62      660.43      660.43

                          CUMULATIVE AREA =      .49 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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          **************
          *            *
   93 KK  *        S2  *
          *            *
          **************
                        SUBAREA S2

   95 KO       OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

   96 BA       SUBBASIN CHARACTERISTICS
                     TAREA        .00  SUBBASIN AREA

               PRECIPITATION DATA

   11 PH                         DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                             STORM AREA =      .00

   97 LS       SCS LOSS RATE
                     STRTL        .38  INITIAL ABSTRACTION
                    CRVNBR      84.00  CURVE NUMBER
                     RTIMP        .00  PERCENT IMPERVIOUS AREA

   98 US       SNYDER UNITGRAPH
                        TP        .08  LAG
                        CP        .62  PEAKING COEFFICIENT

               SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                          ***

                                                UNIT HYDROGRAPH PARAMETERS
                                             CLARK   TC=    .12 HR,       R=   .04 HR
                                            SNYDER   TP=    .08 HR,      CP=   .58

                                                     UNIT HYDROGRAPH
                                                 3 END-OF-PERIOD ORDINATES
               4.         6.         1.

       ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION        S2

     TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                               (CFS)
+        6.    12.17                      1.          0.          0.           0.
                            (INCHES)   4.377       5.454       5.454        5.454
                             (AC-FT)      0.          0.          0.           0.

                            CUMULATIVE AREA =     .00 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


          **************
          *            *
   99 KK  *      C/NW  *
          *            *
          **************
                        DISCHARGE AT NW

  101 KO       OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


  102 HC       HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

       ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION      C/NW

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
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                                   6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                         (CFS)
+    623.      12.83                232.          72.         48.          48.
                       (INCHES)    4.362        5.446       5.446        5.446
                        (AC-FT)     115.         143.        143.         143.

                        CUMULATIVE AREA =     .49 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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            *            *
  103 KK    *      DA3   *
            *            *
            **************
                          DRAINAGE AREA DA3

  105 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

  106 BA          SUBBASIN CHARACTERISTICS
                        TAREA        .04  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                DEPTHS FOR    0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                                     STORM AREA =      .04

  107 LS          SCS LOSS RATE
                        STRTL        .33  INITIAL ABSTRACTION
                       CRVNBR      86.00  CURVE NUMBER
                        RTIMP        .00  PERCENT IMPERVIOUS AREA

                  KINEMATIC WAVE
  108 UK            OVERLAND-FLOW ELEMENT NO. 1
                            L       105.  OVERLAND FLOW LENGTH
                            S      .2900  SLOPE
                            N       .300  ROUGHNESS COEFFICIENT
                           PA      100.0  PERCENT OF SUBBASIN
                        DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
                  MUSKINGUM-CUNGE
  109 RD            MAIN CHANNEL
                            L      1184.  CHANNEL LENGTH
                            S      .0050  SLOPE
                            N       .030  CHANNEL ROUGHNESS COEFFICIENT
                           CA        .04  CONTRIBUTING AREA
                        SHAPE       TRAP  CHANNEL SHAPE
                           WD        .00  BOTTOM WIDTH OR DIAMETER
                            Z       2.00  SIDE SLOPE
                       RUPSTQ         NO  ROUTE UPSTREAM HYDROGRAPH

                                                       ***
                                 COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                        COMPUTATION TIME STEP
                     ELEMENT    ALPHA       M          DT         DX        PEAK    TIME TO     VOLUME     MAXIMUM
                                                                                     PEAK                  CELERITY
                                                      (MIN)      (FT)       (CFS)    (MIN)       (IN)       (FPS)

                     PLANE1      2.67      1.67        .63      21.00     207.15    724.66       5.68        .71
                     MAIN        1.63      1.33       3.22     592.00     193.34    723.85       5.49       6.13

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1070E+02 OUTFLOW= .1033E+02 BASIN STORAGE= .7565E-03 PERCENT ERROR=    3.4

                                          INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                     MAIN        1.63      1.33       5.00                177.68    725.00       5.47

       ***          ***          ***           ***            ***

                         HYDROGRAPH AT STATION       DA3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

  PEAK FLOW      TIME                                MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                         (CFS)
+    178.      12.08                 17.           5.          3.           3.
                       (INCHES)    4.463        5.470       5.470        5.470
                        (AC-FT)       8.          10.         10.          10.

                        CUMULATIVE AREA =     .04 SQ MI
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 110 KK       *      CH2   *
              *            *
              **************
                           SUBAREA CH2

 112 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                       IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

 113 BA          SUBBASIN CHARACTERISTICS
                      TAREA        .00  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                    DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                        STORM AREA =       .00

 114 LS          SCS LOSS RATE
                      STRTL        .38  INITIAL ABSTRACTION
                     CRVNBR      84.00  CURVE NUMBER
                      RTIMP        .00  PERCENT IMPERVIOUS AREA

                 KINEMATIC WAVE
 115 UK            OVERLAND-FLOW ELEMENT NO. 1
                          L       100.  OVERLAND FLOW LENGTH
                          S      .4000  SLOPE
                          N       .300  ROUGHNESS COEFFICIENT
                         PA      100.0  PERCENT OF SUBBASIN
                      DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
                 MUSKINGUM-CUNGE
 116 RD            MAIN CHANNEL
                          L      1238.  CHANNEL LENGTH
                          S      .0100  SLOPE
                          N       .030  CHANNEL ROUGHNESS COEFFICIENT
                         CA        .00  CONTRIBUTING AREA
                      SHAPE       TRAP  CHANNEL SHAPE
                         WD       6.00  BOTTOM WIDTH OR DIAMETER
                          Z       2.00  SIDE SLOPE
                     RUPSTQ        YES  ROUTE UPSTREAM HYDROGRAPH

                                                         ***
                                 COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                        COMPUTATION TIME STEP
                   ELEMENT    ALPHA       M         DT         DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                                  PEAK                CELERITY
                                                  (MIN)       (FT)      (CFS)     (MIN)       (IN)      (FPS)

                  PLANE1       3.14      1.67        .45      20.00      13.18    725.00       5.45        .76
                  MAIN         1.69      1.40       2.73     619.00     170.62    726.88       5.46       7.55

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1030E+02  EXCESS= .6690E+00 OUTFLOW= .1094E+02 BASIN STORAGE= .7532E-03 PERCENT ERROR=    .2

                                          INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                  MAIN          1.69      1.40       5.00                157.30    725.00       5.46

     ***            ***            ***            ***            ***

                          HYDROGRAPH AT STATION       CH2

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                      6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                           (CFS)
+    157.      12.08                    18.           6.           4.           4.
                        (INCHES)     4.452        5.457        5.457        5.457
                         (AC-FT)        9.          11.          11.          11.

                         CUMULATIVE AREA =      .04 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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           *            *
 117 KK    *      DA4   *
           *            *
           **************
                         DRAINAGE AREA DA4

 119 KO         OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                       IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS


              SUBBASIN RUNOFF DATA

 120 BA         SUBBASIN CHARACTERISTICS
                      TAREA         .05  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                              STORM AREA =       .05

 121 LS         SCS LOSS RATE
                      STRTL         .33  INITIAL ABSTRACTION
                     CRVNBR       86.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
 122 UK          OVERLAND-FLOW ELEMENT NO. 1
                          L        120.  OVERLAND FLOW LENGTH
                          S       .2500  SLOPE
                          N        .300  ROUGHNESS COEFFICIENT
                         PA       100.0  PERCENT OF SUBBASIN
                      DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
                MUSKINGUM-CUNGE
 123 RD          MAIN CHANNEL
                          L       1338.  CHANNEL LENGTH
                          S       .0050  SLOPE
                          N        .030  CHANNEL ROUGHNESS COEFFICIENT
                         CA         .05  CONTRIBUTING AREA
                      SHAPE        TRAP  CHANNEL SHAPE
                         WD         .00  BOTTOM WIDTH OR DIAMETER
                          Z        2.00  SIDE SLOPE
                     RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                          ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
                 ELEMENT    ALPHA       M        DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                              PEAK                CELERITY
                                                (MIN)     (FT)      (CFS)    (MIN)       (IN)      (FPS)

                 PLANE1      2.48     1.67       .64     24.00     303.67    724.94      5.68        .71
                 MAIN        1.63     1.33      3.30    669.00     253.48    722.91      5.49       6.76

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1576E+02 OUTFLOW= .1522E+02 BASIN STORAGE= .1023E-02 PERCENT ERROR=    3.4


                                      INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                 MAIN        1.63     1.33      5.00               252.98    725.00      5.46

      ***          ***          ***          ***          ***

                        HYDROGRAPH AT STATION       DA4

     TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

   PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR         24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     253.     12.08                 25.           8.           5.           5.
                          (INCHES)  4.457        5.463        5.463        5.463
                           (AC-FT)    12.          15.          15.          15.

                         CUMULATIVE AREA =      .05 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
 124 KK    *      CH3   *
           *            *
           **************
                         SUBAREA CH3

 126 KO         OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
```

```
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


            SUBBASIN RUNOFF DATA

 127 BA       SUBBASIN CHARACTERISTICS
                     TAREA        .00  SUBBASIN AREA

              PRECIPITATION DATA

  11 PH                            DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                  STORM AREA =      .00

 128 LS       SCS LOSS RATE
                    STRTL         .38  INITIAL ABSTRACTION
                   CRVNBR       84.00  CURVE NUMBER
                    RTIMP         .00  PERCENT IMPERVIOUS AREA

              KINEMATIC WAVE
 129 UK         OVERLAND-FLOW ELEMENT NO. 1
                        L        137.  OVERLAND FLOW LENGTH
                        S       .2040  SLOPE
                        N        .300  ROUGHNESS COEFFICIENT
                       PA       100.0  PERCENT OF SUBBASIN
                    DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
              MUSKINGUM-CUNGE
 130 RD         MAIN CHANNEL
                        L        505.  CHANNEL LENGTH
                        S       .0625  SLOPE
                        N        .030  CHANNEL ROUGHNESS COEFFICIENT
                       CA         .00  CONTRIBUTING AREA
                    SHAPE        TRAP  CHANNEL SHAPE
                       WD        6.00  BOTTOM WIDTH OR DIAMETER
                        Z        2.00  SIDE SLOPE
                   RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                              ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
               ELEMENT     ALPHA       M          DT         DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                              PEAK                  CELERITY
                                                 (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)

               PLANE1       2.24      1.67        .82      27.40      3.32    724.79      5.45        .69
               MAIN         4.23      1.40       1.86     252.50      3.21    725.27      5.29       4.53

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1745E+00 OUTFLOW= .1694E+00 BASIN STORAGE= .1702E-03 PERCENT ERROR=   2.9


                                        INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


               MAIN         4.23      1.40       5.00                 3.18    725.00      5.31

      ***           ***           ***           ***           ***

                        HYDROGRAPH AT STATION       CH3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                        (CFS)
 +       3.     12.08                0.           0.           0.           0.
                      (INCHES)   4.358        5.309        5.309        5.309
                       (AC-FT)      0.           0.           0.           0.

                      CUMULATIVE AREA =      .00 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


         **************
         *            *
 131 KK  *       P2   *
         *            *
         **************
                    POND P2

 133 KO       OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS
```

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            SUBBASIN RUNOFF DATA

 134 BA          SUBBASIN CHARACTERISTICS
                       TAREA        .00  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ..............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                        STORM AREA =      .00

 135 LS          SCS LOSS RATE
                       STRTL        .00  INITIAL ABSTRACTION
                      CRVNBR     100.00  CURVE NUMBER
                       RTIMP        .00  PERCENT IMPERVIOUS AREA

 136 UD          SCS DIMENSIONLESS UNITGRAPH
                        TLAG        .00  LAG

                                                             ***

                                                        UNIT HYDROGRAPH
                                                    5 END-OF-PERIOD ORDINATES
            12.         3.         1.         0.         0.

     ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION        P2

   TOTAL RAINFALL =    7.33, TOTAL LOSS =     .00, TOTAL EXCESS =    7.33

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+       12.     12.08                    1.          0.          0.           0.
                        (INCHES)      5.298       7.327       7.330        7.330
                         (AC-FT)         1.          1.          1.           1.

                       CUMULATIVE AREA =      .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 137 KK     *     C/P2   *
            *            *
            **************
                          COMBINE HYDROGRAPHS

 139 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS

 140 HC          HYDROGRAPH COMBINATION
                       ICOMP          4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                             ***

     ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION      C/P2

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+      425.     12.08                   44.         14.          9.           9.
                        (INCHES)      4.471       5.496       5.500        5.500
                         (AC-FT)        22.         27.         27.          27.

                       CUMULATIVE AREA =      .09 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
 141 KK     *      RP2   *
            *            *
            **************
                          ROUTE THROUGH P2

 143 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
```

QSCAL	0.	HYDROGRAPH PLOT SCALE
IPNCH	7	PUNCH COMPUTED HYDROGRAPH
IOUT	21	SAVE HYDROGRAPH ON THIS UNIT
ISAV1	1	FIRST ORDINATE PUNCHED OR SAVED
ISAV2	432	LAST ORDINATE PUNCHED OR SAVED
TIMINT	.083	TIME INTERVAL IN HOURS

HYDROGRAPH ROUTING DATA

144 RS STORAGE ROUTING

NSTPS	1	NUMBER OF SUBREACHES
ITYP	ELEV	TYPE OF INITIAL CONDITION
RSVRIC	650.00	INITIAL CONDITION
X	.00	WORKING R AND D COEFFICIENT

145 SA	AREA	.0	.5	.5	.6	.6	.7	.8	.9	.9	.9
146 SE	ELEVATION	650.00	651.00	652.00	653.00	654.00	655.00	656.00	657.00	658.00	659.00

147 SL LOW-LEVEL OUTLET

ELEVL	651.00	ELEVATION AT CENTER OF OUTLET
CAREA	18.84	CROSS-SECTIONAL AREA
COQL	.80	COEFFICIENT
EXPL	.50	EXPONENT OF HEAD

148 SS SPILLWAY

CREL	656.50	SPILLWAY CREST ELEVATION
SPWID	20.00	SPILLWAY WIDTH
COQW	2.60	WEIR COEFFICIENT
EXPW	1.50	EXPONENT OF HEAD

***

COMPUTED STORAGE-ELEVATION DATA

STORAGE	.00	.15	.64	1.19	1.81	2.49	3.25	4.08	4.96	5.88
ELEVATION	650.00	651.00	652.00	653.00	654.00	655.00	656.00	657.00	658.00	659.00

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	.00	.00	182.76	192.53	203.41	215.59	229.32	244.92	262.79	283.48
ELEVATION	650.00	651.00	653.29	653.54	653.83	654.18	654.60	655.11	655.73	656.50
OUTFLOW	293.69	302.21	314.31	330.55	351.52	377.80	409.95	448.57	494.20	547.44
ELEVATION	656.71	656.84	657.00	657.19	657.41	657.67	657.95	658.27	658.62	659.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.15	.64	1.19	1.36	1.51	1.70	1.81	1.93	2.21
OUTFLOW	.00	.00	120.88	170.95	182.76	192.53	203.41	209.37	215.59	229.32
ELEVATION	650.00	651.00	652.00	653.00	653.29	653.54	653.83	654.00	654.18	654.60
STORAGE	2.49	2.57	3.03	3.25	3.65	3.83	3.94	4.07	4.24	4.44
OUTFLOW	241.75	244.92	262.79	270.29	283.48	293.69	302.21	314.31	330.55	351.52
ELEVATION	655.00	655.11	655.73	656.00	656.50	656.71	656.84	657.00	657.19	657.41
STORAGE	4.66	4.92	4.96	5.21	5.53	5.88				
OUTFLOW	377.80	409.95	415.34	448.57	494.20	547.44				
ELEVATION	657.67	657.95	658.00	658.27	658.62	659.00				

*** *** *** *** ***

HYDROGRAPH AT STATION RP2

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	35.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 260.	12.17		44.	14.	9.	9.
		(INCHES)	4.471	5.469	5.469	5.469
		(AC-FT)	22.	27.	27.	27.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	35.92-HR
+ (AC-FT)	(HR)				
3.	12.17	0.	0.	0.	0.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	35.92-HR
+ (FEET)	(HR)				
655.64	12.17	651.51	651.15	650.96	650.96

CUMULATIVE AREA = .09 SQ MI

*** ***

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          **************
          *            *
149 KK    *       S3   *
          *            *
          **************
                 SUBAREA S3
```

151 KO OUTPUT CONTROL VARIABLES

IPRNT 3 PRINT CONTROL

```
                 IPLOT            0  PLOT CONTROL
                 QSCAL           0.  HYDROGRAPH PLOT SCALE
                 IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                  IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                 ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                 ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                TIMINT         .083  TIME INTERVAL IN HOURS

            SUBBASIN RUNOFF DATA

 152 BA       SUBBASIN CHARACTERISTICS
                 TAREA          .00  SUBBASIN AREA

              PRECIPITATION DATA

  11 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                 STORM AREA =       .00

 153 LS       SCS LOSS RATE
                 STRTL          .38  INITIAL ABSTRACTION
                CRVNBR        84.00  CURVE NUMBER
                 RTIMP          .00  PERCENT IMPERVIOUS AREA

 154 US       SNYDER UNITGRAPH
                    TP          .15  LAG
                    CP          .69  PEAKING COEFFICIENT

              SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                             ***

                                                   UNIT HYDROGRAPH PARAMETERS
                                             CLARK   TC=    .21 HR,        R=   .07 HR
                                            SNYDER   TP=    .15 HR,       CP=   .68

                                                        UNIT HYDROGRAPH
                                                    6 END-OF-PERIOD ORDINATES
              3.         7.         7.         3.         1.         0.

     ***              ***              ***              ***              ***

                        HYDROGRAPH AT STATION       S3

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =     5.45

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                               (CFS)
+        10.    12.17                      1.           0.           0.           0.
                             (INCHES)   4.358        5.431        5.431        5.431
                              (AC-FT)      1.           1.           1.           1.

                          CUMULATIVE AREA =      .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


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           *            *
 155 KK    *       S4   *
           *            *
           **************
                          SUBAREA S4

 157 KO       OUTPUT CONTROL VARIABLES
                IPRNT             3  PRINT CONTROL
                 IPLOT            0  PLOT CONTROL
                 QSCAL           0.  HYDROGRAPH PLOT SCALE
                 IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                  IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                 ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                 ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                TIMINT         .083  TIME INTERVAL IN HOURS

            SUBBASIN RUNOFF DATA

 158 BA       SUBBASIN CHARACTERISTICS
                 TAREA          .01  SUBBASIN AREA

              PRECIPITATION DATA

  11 PH                              DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                 STORM AREA =       .01

 159 LS       SCS LOSS RATE
                 STRTL          .38  INITIAL ABSTRACTION
                CRVNBR        84.00  CURVE NUMBER
                 RTIMP          .00  PERCENT IMPERVIOUS AREA

 160 US       SNYDER UNITGRAPH
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                         TP          .32  LAG
                         CP          .71  PEAKING COEFFICIENT

                    SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                             ***

                                                           UNIT HYDROGRAPH PARAMETERS
                                                     CLARK   TC=    .39 HR,        R=   .22 HR
                                                    SNYDER   TP=    .32 HR,       CP=   .71

                                                                UNIT HYDROGRAPH
                                                           17 END-OF-PERIOD ORDINATES
                    2.         6.        11.        14.        14.        10.         7.         5.         3.         2.
                    1.         1.         1.         0.         0.         0.         0.

         ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       S4

     TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                          (CFS)
+      25.     12.33                  5.           1.           1.           1.
                        (INCHES)   4.358        5.434        5.434        5.434
                         (AC-FT)      2.           3.           3.           3.

                         CUMULATIVE AREA =       .01 SQ MI


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             *            *
  161 KK     *      C/NE  *
             *            *
             **************
                         DISCHARGE AT NE

  163 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


  164 HC          HYDROGRAPH COMBINATION
                        ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                             ***

         ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     C/NE

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                    6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                          (CFS)
+     289.     12.25                 50.          15.          10.          10.
                        (INCHES)   4.456        5.464        5.465        5.465
                         (AC-FT)     25.          31.          31.          31.

                         CUMULATIVE AREA =       .11 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

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             *            *
  165 KK     *        O3  *
             *            *
             **************
                         SUBAREA O3

  167 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


                  SUBBASIN RUNOFF DATA

  168 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .11  SUBBASIN AREA
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                  PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                    STORM AREA =       .11

 169 LS           SCS LOSS RATE
                        STRTL          .38  INITIAL ABSTRACTION
                       CRVNBR        84.00  CURVE NUMBER
                        RTIMP          .00  PERCENT IMPERVIOUS AREA

 170 US           SNYDER UNITGRAPH
                           TP          .46  LAG
                           CP          .65  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                 ***

                                                  UNIT HYDROGRAPH PARAMETERS
                                            CLARK   TC=    .54 HR,         R=   .39 HR
                                           SNYDER   TP=    .46 HR,        CP=   .66

                                                       UNIT HYDROGRAPH
                                                  29 END-OF-PERIOD ORDINATES
                     7.        25.        49.        73.        91.        99.        92.        77.        62.        50.
                    41.        33.        27.        21.        17.        14.        11.         9.         7.         6.
                     5.         4.         3.         3.         2.         2.         1.         1.         1.

       ***            ***              ***              ***              ***

                         HYDROGRAPH AT STATION        O3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR      35.92-HR
+    (CFS)        (HR)
                               (CFS)
+     206.       12.50                     51.          16.          11.          11.
                            (INCHES)     4.348        5.429        5.429        5.429
                             (AC-FT)       25.          31.          31.          31.

                         CUMULATIVE AREA =       .11 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

               **************
               *            *
 171 KK        *       S7   *
               *            *
               **************
                          SUBAREA S7

 173 KO           OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                       QSCAL            0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

 174 BA           SUBBASIN CHARACTERISTICS
                        TAREA          .00  SUBBASIN AREA

                  PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                    STORM AREA =       .00

 175 LS           SCS LOSS RATE
                        STRTL          .38  INITIAL ABSTRACTION
                       CRVNBR        84.00  CURVE NUMBER
                        RTIMP          .00  PERCENT IMPERVIOUS AREA

 176 US           SNYDER UNITGRAPH
                           TP          .28  LAG
                           CP          .73  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                 ***

                                                  UNIT HYDROGRAPH PARAMETERS
                                            CLARK   TC=    .36 HR,         R=   .18 HR
                                           SNYDER   TP=    .28 HR,        CP=   .73

                                                       UNIT HYDROGRAPH
```

```
                                    14 END-OF-PERIOD ORDINATES
          1.        3.        5.        6.        5.        3.        2.        1.        1.        0.
          0.        0.        0.        0.

    ***         ***         ***         ***         ***

                 HYDROGRAPH AT STATION       S7

  TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                         (CFS)
+      10.     12.33                2.          1.          0.          0.
                       (INCHES)   4.358       5.432       5.432       5.432
                        (AC-FT)      1.          1.          1.          1.

                     CUMULATIVE AREA =     .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  177 KK    *       DA6  *
            *            *
            **************
                     DRAINAGE AREA DA6

  179 KO         OUTPUT CONTROL VARIABLES
                      IPRNT            3  PRINT CONTROL
                      IPLOT            0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE
                      IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                      IOUT            21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT         .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

  180 BA         SUBBASIN CHARACTERISTICS
                      TAREA          .04  SUBBASIN AREA

                 PRECIPITATION DATA

   11 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   .............. TP-40 ..............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                               STORM AREA =       .04

  181 LS         SCS LOSS RATE
                      STRTL          .33  INITIAL ABSTRACTION
                     CRVNBR        86.00  CURVE NUMBER
                      RTIMP          .00  PERCENT IMPERVIOUS AREA

                 KINEMATIC WAVE
  182 UK           OVERLAND-FLOW ELEMENT NO. 1
                          L         105.  OVERLAND FLOW LENGTH
                          S        .2900  SLOPE
                          N         .300  ROUGHNESS COEFFICIENT
                         PA        100.0  PERCENT OF SUBBASIN
                      DXMIN            5  MINIMUM NUMBER OF DX INTERVALS
                 MUSKINGUM-CUNGE
  183 RD           MAIN CHANNEL
                          L        1204.  CHANNEL LENGTH
                          S        .0050  SLOPE
                          N         .030  CHANNEL ROUGHNESS COEFFICIENT
                         CA          .04  CONTRIBUTING AREA
                      SHAPE         TRAP  CHANNEL SHAPE
                         WD          .00  BOTTOM WIDTH OR DIAMETER
                          Z         2.00  SIDE SLOPE
                     RUPSTQ           NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
                   ELEMENT   ALPHA      M        DT        DX       PEAK    TIME TO    VOLUME    MAXIMUM
                                                                             PEAK                CELERITY
                                               (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)

                  PLANE1      2.67     1.67      .63      21.00    252.32   724.66      5.68       .71
                  MAIN        1.63     1.33     3.11     601.90    236.93   725.36      5.51      6.44

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1303E+02 OUTFLOW= .1264E+02 BASIN STORAGE= .8100E-03 PERCENT ERROR=   3.0

                                INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                  MAIN        1.63     1.33     5.00               232.74   725.00      5.55

    ***         ***         ***         ***         ***

                 HYDROGRAPH AT STATION      DA6
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    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.65, TOTAL EXCESS =    5.68

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+    233.      12.08                  21.           6.           4.           4.
                        (INCHES)    4.537        5.545        5.545        5.545
                         (AC-FT)      10.          13.          13.          13.

                        CUMULATIVE AREA =     .04 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  184 KK    *     C/DA6  *
            *            *
            **************
                          COMBINE HYDROGRAPHS

  186 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


  187 HC         HYDROGRAPH COMBINATION
                       ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                     ***

     ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION    C/DA6

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+    315.      12.08                  73.          23.          15.          15.
                        (INCHES)    4.396        5.461        5.461        5.461
                         (AC-FT)      36.          45.          45.          45.

                        CUMULATIVE AREA =     .16 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  188 KK    *        O4  *
            *            *
            **************
                          SUBAREA O4

  190 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS

               SUBBASIN RUNOFF DATA

  191 BA         SUBBASIN CHARACTERISTICS
                       TAREA        .10  SUBBASIN AREA

                 PRECIPITATION DATA

   11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                  STORM AREA =      .10

  192 LS         SCS LOSS RATE
                      STRTL         .38  INITIAL ABSTRACTION
                     CRVNBR       84.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

  193 US         SNYDER UNITGRAPH
                         TP         .47  LAG
                         CP         .65  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED
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                                                    ***

                                         UNIT HYDROGRAPH PARAMETERS
                                   CLARK   TC=   .54 HR,        R=   .40 HR
                                  SNYDER   TP=   .47 HR,       CP=   .65

                                              UNIT HYDROGRAPH
                                         30 END-OF-PERIOD ORDINATES
              6.        21.        42.        63.        79.        85.        80.        68.        55.        45.
             36.        30.        24.        20.        16.        13.        11.         9.         7.         6.
              5.         4.         3.         2.         2.         2.         1.         1.         1.         1.

      ***             ***              ***              ***              ***

                           HYDROGRAPH AT STATION        O4

     TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR      35.92-HR
+   (CFS)        (HR)
                              (CFS)
+     179.      12.50                   45.          14.          9.           9.
                           (INCHES)    4.348       5.430       5.430        5.430
                            (AC-FT)      22.          28.         28.          28.

                           CUMULATIVE AREA =      .10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  194 KK      *     CLVT   *
              *            *
              **************
                           CULVERT AT O4 DISCHARGE

  196 KO           OUTPUT CONTROL VARIABLES
                         IPRNT           3  PRINT CONTROL
                         IPLOT           0  PLOT CONTROL
                         QSCAL          0.  HYDROGRAPH PLOT SCALE
                         IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                          IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                         ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                         ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                        TIMINT        .083  TIME INTERVAL IN HOURS


                HYDROGRAPH ROUTING DATA

  197 RS           STORAGE ROUTING
                         NSTPS           1  NUMBER OF SUBREACHES
                          ITYP        ELEV  TYPE OF INITIAL CONDITION
                        RSVRIC      699.71  INITIAL CONDITION
                             X         .00 WORKING R AND D COEFFICIENT

  198 SA                  AREA          .0         .0         .0         .2         .9

  199 SE           ELEVATION      699.71     700.00     702.00     704.00     706.00

  200 SL           LOW-LEVEL OUTLET
                         ELEVL      701.46  ELEVATION AT CENTER OF OUTLET
                         CAREA       19.24  CROSS-SECTIONAL AREA
                          COQL         .70  COEFFICIENT
                          EXPL         .50  EXPONENT OF HEAD

  201 SS           SPILLWAY
                          CREL      704.50  SPILLWAY CREST ELEVATION
                         SPWID       70.00  SPILLWAY WIDTH
                          COQW        2.60  WEIR COEFFICIENT
                          EXPW        1.50  EXPONENT OF HEAD
                                                    ***

                                             COMPUTED STORAGE-ELEVATION DATA

          STORAGE         .00        .00        .03        .19       1.17
        ELEVATION      699.71     700.00     702.00     704.00     706.00

                                             COMPUTED OUTFLOW-ELEVATION DATA

          OUTFLOW         .00        .00     159.64     163.19     166.90     170.79     174.86     179.13     183.61     188.33
        ELEVATION      699.71     701.46     703.64     703.74     703.85     703.96     704.08     704.21     704.35     704.50

          OUTFLOW      191.94     198.68     210.65     229.35     256.24     292.77     340.40     400.61     474.80     564.50
        ELEVATION      704.55     704.61     704.70     704.81     704.95     705.11     705.29     705.51     705.74     706.00


                                         COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE         .00        .00        .02        .03        .14        .15        .17        .18        .19        .20
          OUTFLOW         .00        .00        .00      79.37     159.64     163.19     166.90     170.79     172.14     174.86
        ELEVATION      699.71     700.00     701.46     702.00     703.64     703.74     703.85     703.96     704.00     704.08

          STORAGE         .23        .26        .30        .32        .34        .37        .41        .47        .55        .65
          OUTFLOW      179.13     183.61     188.33     191.94     198.68     210.65     229.35     256.24     292.77     340.40
        ELEVATION      704.21     704.35     704.50     704.55     704.61     704.70     704.81     704.95     705.11     705.29

          STORAGE         .78        .95       1.17
          OUTFLOW      400.61     474.80     564.50
```

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          ELEVATION     705.51    705.74    706.00

 *** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO      565.
                 THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                 THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

     ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION     CLVT

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                          (CFS)
+    176.      12.58                  45.         14.          9.          9.
                        (INCHES)    4.348       5.427       5.427       5.427
                         (AC-FT)      22.         28.         28.         28.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR        24-HR       72-HR      35.92-HR
+ (AC-FT)       (HR)
        0.     12.58                   0.          0.          0.          0.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR        24-HR       72-HR      35.92-HR
+   (FEET)      (HR)
    704.12     12.58               701.90      701.59      701.27      701.27

                         CUMULATIVE AREA =      .10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  202 KK      *       P3   *
              *            *
              **************
                          POND P3

  204 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

  205 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .01  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......  ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =       .01

  206 LS          SCS LOSS RATE
                        STRTL         .00  INITIAL ABSTRACTION
                       CRVNBR      100.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

  207 UD          SCS DIMENSIONLESS UNITGRAPH
                         TLAG         .00  LAG

                                                                 ***

                                                           UNIT HYDROGRAPH
                                                       5 END-OF-PERIOD ORDINATES
                60.        17.        3.        1.         0.

     ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION       P3

     TOTAL RAINFALL =     7.33, TOTAL LOSS =      .00, TOTAL EXCESS =     7.33

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                          (CFS)
+      61.     12.08                   6.          2.          1.          1.
                        (INCHES)    5.298       7.327       7.330       7.330
                         (AC-FT)       3.          4.          4.          4.

                         CUMULATIVE AREA =      .01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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            **************
            *            *
 208 KK     *     C/P3   *
            *            *
            **************
                          COMBINE HYDROGRAPHS

 210 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


 211 HC          HYDROGRAPH COMBINATION
                       ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                         ***

     ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      C/P3

 PEAK FLOW      TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR         24-HR        72-HR      35.92-HR
+   (CFS)       (HR)
                          (CFS)
+      442.     12.08                    124.          39.          26.          26.
                        (INCHES)        4.408        5.519        5.524        5.524
                         (AC-FT)          61.          77.          77.          77.

                        CUMULATIVE AREA =       .26 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 212 KK     *      DA5   *
            *            *
            **************
                          DRAINAGE AREA DA5

 214 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

 215 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .07  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ..............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =       .07

 216 LS          SCS LOSS RATE
                       STRTL         .33  INITIAL ABSTRACTION
                      CRVNBR       86.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

                 KINEMATIC WAVE
 217 UK            OVERLAND-FLOW ELEMENT NO. 1
                           L        120.  OVERLAND FLOW LENGTH
                           S       .2500  SLOPE
                           N        .300  ROUGHNESS COEFFICIENT
                          PA       100.0  PERCENT OF SUBBASIN
                       DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
                 MUSKINGUM-CUNGE
 218 RD            MAIN CHANNEL
                           L       1358.  CHANNEL LENGTH
                           S       .0050  SLOPE
                           N        .030  CHANNEL ROUGHNESS COEFFICIENT
                          CA         .07  CONTRIBUTING AREA
                       SHAPE        TRAP  CHANNEL SHAPE
                          WD         .00  BOTTOM WIDTH OR DIAMETER
                           Z        2.00  SIDE SLOPE
                      RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                                         ***
                                   COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                          COMPUTATION TIME STEP
                    ELEMENT     ALPHA       M         DT         DX       PEAK     TIME TO      VOLUME     MAXIMUM
                                                                                     PEAK                 CELERITY
                                                     (MIN)       (FT)     (CFS)      (MIN)        (IN)       (FPS)
```

```
                  PLANE1        2.48       1.67        .64     24.00    410.47    724.94      5.68       .71
                  MAIN          1.63       1.33       3.11    679.00    369.20    723.65      5.49      7.29

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .2131E+02 OUTFLOW= .2059E+02 BASIN STORAGE= .1164E-02 PERCENT ERROR=   3.3

                                            INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                  MAIN          1.63       1.33       5.00              346.98    725.00      5.47

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       DA5

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR     35.92-HR
 +   (CFS)        (HR)
                                (CFS)
 +     347.      12.08                    34.          10.          7.           7.
                              (INCHES)  4.457        5.465       5.466        5.466
                               (AC-FT)    17.          20.         20.          20.

                           CUMULATIVE AREA =       .07 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
   219 KK    *     C/DA5  *
             *            *
             **************
                            COMBINE HYDROGRAPHS

   221 KO         OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS

   222 HC         HYDROGRAPH COMBINATION
                        ICOMP            2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION     C/DA5

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR     35.92-HR
 +   (CFS)        (HR)
                                (CFS)
 +     789.      12.08                   157.          49.         33.          33.
                              (INCHES)  4.417        5.507       5.512        5.512
                               (AC-FT)    78.          97.         97.          97.

                           CUMULATIVE AREA =       .33 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
   223 KK    *       RP3  *
             *            *
             **************
                            ROUTE THROUGH P3

   225 KO         OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS

                HYDROGRAPH ROUTING DATA

   226 RS         STORAGE ROUTING
                        NSTPS            1  NUMBER OF SUBREACHES
                         ITYP         ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       692.50  INITIAL CONDITION
                            X          .00 WORKING R AND D COEFFICIENT
```

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227 SA            AREA          .0      2.3      2.6      3.5      3.9

228 SE       ELEVATION    692.50   694.00   696.00   698.00   700.00

229 SL       LOW-LEVEL OUTLET
                  ELEVL      693.75  ELEVATION AT CENTER OF OUTLET
                  CAREA       48.11  CROSS-SECTIONAL AREA
                   COQL         .80  COEFFICIENT
                   EXPL         .50  EXPONENT OF HEAD

230 SS       SPILLWAY
                   CREL      697.00  SPILLWAY CREST ELEVATION
                  SPWID       75.00  SPILLWAY WIDTH
                   COQW        2.60  WEIR COEFFICIENT
                   EXPW        1.50  EXPONENT OF HEAD

                                                             ***

                                              COMPUTED STORAGE-ELEVATION DATA

          STORAGE       .00      1.14      6.02     12.07     19.46
        ELEVATION    692.50    694.00    696.00    698.00    700.00

                                              COMPUTED OUTFLOW-ELEVATION DATA

          OUTFLOW       .00       .00    560.77    560.15    559.52    558.90    558.28    557.66    557.04    556.42
        ELEVATION    692.50    693.75    697.05    697.04    697.04    697.03    697.02    697.01    697.01    697.00

          OUTFLOW    588.74    622.72    673.82    745.33    840.46    962.52   1114.70   1300.29   1522.58   1784.87
        ELEVATION    697.19    697.34    697.52    697.75    698.02    698.34    698.69    699.09    699.52    700.00

                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE       .00       .66      1.14      6.02      8.99      9.42      9.88     10.48     11.23     12.07
          OUTFLOW       .00       .00    154.32    462.97    563.02    588.74    622.72    673.82    745.33    831.29
        ELEVATION    692.50    693.75    694.00    696.00    697.05    697.19    697.34    697.52    697.75    698.00

          STORAGE     12.16     13.25     14.51     15.96     17.61     19.46
          OUTFLOW    840.46    962.52   1114.70   1300.29   1522.58   1784.87
        ELEVATION    698.02    698.34    698.69    699.09    699.52    700.00

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO      154.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION       RP3

 PEAK FLOW      TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR         24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                           (CFS)
+     495.     12.25                 157.           49.          33.          33.
                        (INCHES)    4.417         5.474        5.474        5.474
                         (AC-FT)      78.           97.          97.          97.

PEAK STORAGE    TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR         24-HR        72-HR     35.92-HR
+  (AC-FT)      (HR)
        7.     12.25                   2.            1.           1.           1.

 PEAK STAGE     TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR         24-HR        72-HR     35.92-HR
+   (FEET)      (HR)
    696.34     12.25               694.32        693.91       693.68       693.68

                        CUMULATIVE AREA =      .33 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
231 KK      *       O5   *
            *            *
            **************
                        SUBAREA O5

233 KO       OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE
                  IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                   IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                  ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                  ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                 TIMINT       .083  TIME INTERVAL IN HOURS

          SUBBASIN RUNOFF DATA

234 BA       SUBBASIN CHARACTERISTICS
                  TAREA        .01  SUBBASIN AREA

             PRECIPITATION DATA

 11 PH                            DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
             ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
             5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
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```
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                       STORM AREA =      .01

   235 LS         SCS LOSS RATE
                        STRTL          .38  INITIAL ABSTRACTION
                       CRVNBR        84.00  CURVE NUMBER
                        RTIMP          .00  PERCENT IMPERVIOUS AREA

   236 US         SNYDER UNITGRAPH
                           TP          .41  LAG
                           CP          .71  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                    ***

                                                         UNIT HYDROGRAPH PARAMETERS
                                                   CLARK   TC=    .49 HR,       R=   .28 HR
                                                  SNYDER   TP=    .41 HR,      CP=   .71

                                                               UNIT HYDROGRAPH
                                                         22 END-OF-PERIOD ORDINATES
                  1.         3.         7.         9.        11.        11.         9.         7.         5.         4.
                  3.         2.         1.         1.         1.         1.         0.         0.         0.         0.
                  0.         0.

      ***              ***               ***               ***               ***

                                HYDROGRAPH AT STATION       O5

      TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

   PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                               (CFS)
 +       22.     12.42                    5.           1.           1.           1.
                             (INCHES)  4.355        5.433        5.433        5.433
                              (AC-FT)     2.           3.           3.           3.

                               CUMULATIVE AREA =      .01 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   237 KK     *      C/O5  *
              *            *
              **************
                                 COMBINE HYDROGRAPHS

   239 KO         OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS


   240 HC         HYDROGRAPH COMBINATION
                        ICOMP            2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                    ***

      ***              ***               ***               ***               ***

                                HYDROGRAPH AT STATION     C/O5

   PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                               (CFS)
 +      513.     12.42                  162.          50.          34.          34.
                             (INCHES)  4.415        5.473        5.473        5.473
                              (AC-FT)    80.         100.         100.         100.

                               CUMULATIVE AREA =      .34 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   241 KK     *        S6  *
              *            *
              **************
                                 SUBAREA S6

   243 KO         OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
```

```
                IOUT        21  SAVE HYDROGRAPH ON THIS UNIT
               ISAV1         1  FIRST ORDINATE PUNCHED OR SAVED
               ISAV2       432  LAST ORDINATE PUNCHED OR SAVED
              TIMINT      .083  TIME INTERVAL IN HOURS

          SUBBASIN RUNOFF DATA

 244 BA     SUBBASIN CHARACTERISTICS
               TAREA       .01  SUBBASIN AREA

            PRECIPITATION DATA

  11 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......  ............... TP-40 ..............  ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                             STORM AREA =      .01

 245 LS     SCS LOSS RATE
               STRTL       .38  INITIAL ABSTRACTION
              CRVNBR     84.00  CURVE NUMBER
               RTIMP       .00  PERCENT IMPERVIOUS AREA

 246 US     SNYDER UNITGRAPH
                  TP       .24  LAG
                  CP       .68  PEAKING COEFFICIENT

            SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                        ***

                                               UNIT HYDROGRAPH PARAMETERS
                                         CLARK   TC=   .31 HR,       R=   .16 HR
                                        SNYDER   TP=   .24 HR,      CP=   .68

                                                    UNIT HYDROGRAPH
                                               12 END-OF-PERIOD ORDINATES
            4.        14.        22.        22.        15.         9.         5.         3.         2.         1.
            1.         0.

     ***            ***             ***             ***             ***

                 HYDROGRAPH AT STATION       S6

   TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR        72-HR      35.92-HR
+   (CFS)      (HR)
                          (CFS)
+      36.    12.25                  6.          2.           1.           1.
                      (INCHES)    4.355       5.428        5.428        5.428
                       (AC-FT)       3.          4.           4.           4.

                 CUMULATIVE AREA =      .01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

         **************
         *            *
 247 KK  *       S5   *
         *            *
         **************
                  SUBAREA S5

 249 KO     OUTPUT CONTROL VARIABLES
               IPRNT         3  PRINT CONTROL
               IPLOT         0  PLOT CONTROL
               QSCAL        0.  HYDROGRAPH PLOT SCALE
               IPNCH         7  PUNCH COMPUTED HYDROGRAPH
                IOUT        21  SAVE HYDROGRAPH ON THIS UNIT
               ISAV1         1  FIRST ORDINATE PUNCHED OR SAVED
               ISAV2       432  LAST ORDINATE PUNCHED OR SAVED
              TIMINT      .083  TIME INTERVAL IN HOURS

          SUBBASIN RUNOFF DATA

 250 BA     SUBBASIN CHARACTERISTICS
               TAREA       .00  SUBBASIN AREA

            PRECIPITATION DATA

  11 PH                       DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......  ............... TP-40 ..............  ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
              .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                             STORM AREA =      .00

 251 LS     SCS LOSS RATE
               STRTL       .38  INITIAL ABSTRACTION
              CRVNBR     84.00  CURVE NUMBER
               RTIMP       .00  PERCENT IMPERVIOUS AREA

 252 US     SNYDER UNITGRAPH
                  TP       .25  LAG
                  CP       .73  PEAKING COEFFICIENT
```

```
               SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                              ***

                                                                 UNIT HYDROGRAPH PARAMETERS
                                                           CLARK   TC=   .33 HR,        R=   .14 HR
                                                          SNYDER   TP=   .25 HR,       CP=   .73

                                                                      UNIT HYDROGRAPH
                                                                 11 END-OF-PERIOD ORDINATES
               1.         3.         5.         5.         4.         2.         1.         1.         0.         0.
               0.

    ***             ***              ***              ***              ***

                       HYDROGRAPH AT STATION       S5

  TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR         24-HR        72-HR      35.92-HR
+   (CFS)        (HR)
                          (CFS)
+       9.     12.33                         1.           0.           0.           0.
                       (INCHES)      4.355        5.428        5.428        5.428
                        (AC-FT)         1.           1.           1.           1.

                       CUMULATIVE AREA =       .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
 253 KK      *     C/SE   *
             *            *
             **************
                        DISCHARGE AT SE

 255 KO           OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                       IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


 256 HC           HYDROGRAPH COMBINATION
                      ICOMP          3  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                              ***

    ***             ***              ***              ***              ***

                       HYDROGRAPH AT STATION     C/SE

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR         24-HR        72-HR      35.92-HR
+   (CFS)        (HR)
                          (CFS)
+     558.     12.33                       169.          52.          35.          35.
                       (INCHES)      4.412        5.471        5.471        5.471
                        (AC-FT)        84.         104.         104.         104.

                       CUMULATIVE AREA =       .36 SQ MI

1
                                                                   RUNOFF SUMMARY
                                                            FLOW IN CUBIC FEET PER SECOND
                                                         TIME IN HOURS,  AREA IN SQUARE MILES

                                                  PEAK   TIME OF       AVERAGE FLOW FOR MAXIMUM PERIOD         BASIN     MAXIMUM     TIME OF
           OPERATION        STATION               FLOW     PEAK                                                AREA       STAGE    MAX STAGE
+                                                                    6-HOUR       24-HOUR       72-HOUR

           HYDROGRAPH AT
+                                O2               188.    12.67          54.          17.          11.           .12

           ROUTED TO
+                              CLVT               187.    12.67          54.          17.          11.           .12
+                                                                                                                       697.49       12.67

           HYDROGRAPH AT
+                                S1                 7.    12.17           1.           0.           0.           .00

           HYDROGRAPH AT
+                               DA1               106.    12.08          10.           3.           2.           .02

           3 COMBINED AT
+                             C/DA1               201.    12.67          65.          20.          14.           .14

           HYDROGRAPH AT
+                               CH1               205.    12.75          71.          22.          15.           .15

           HYDROGRAPH AT
+                                O1               466.    12.58         132.          41.          27.           .28
```

+	ROUTED TO	CLVT	391.	12.83	132.	41.	27.	.28	695.19	12.83
+	2 COMBINED AT	C/O1	595.	12.83	202.	63.	42.	.43		
+	HYDROGRAPH AT	DA2	299.	12.08	28.	9.	6.	.06		
+	2 COMBINED AT	C/DA2	624.	12.83	230.	72.	48.	.49		
+	HYDROGRAPH AT	P1	9.	12.08	1.	0.	0.	.00		
+	2 COMBINED AT	C/P1	625.	12.83	231.	72.	48.	.49		
+	ROUTED TO	RP1	622.	12.83	231.	72.	48.	.49	664.38	12.83
+	HYDROGRAPH AT	S2	6.	12.17	1.	0.	0.	.00		
+	2 COMBINED AT	C/NW	623.	12.83	232.	72.	48.	.49		
+	HYDROGRAPH AT	DA3	178.	12.08	17.	5.	3.	.04		
+	HYDROGRAPH AT	CH2	157.	12.08	18.	6.	4.	.04		
+	HYDROGRAPH AT	DA4	253.	12.08	25.	8.	5.	.05		
+	HYDROGRAPH AT	CH3	3.	12.08	0.	0.	0.	.00		
+	HYDROGRAPH AT	P2	12.	12.08	1.	0.	0.	.00		
+	4 COMBINED AT	C/P2	425.	12.08	44.	14.	9.	.09		
+	ROUTED TO	RP2	260.	12.17	44.	14.	9.	.09	655.64	12.17
+	HYDROGRAPH AT	S3	10.	12.17	1.	0.	0.	.00		
+	HYDROGRAPH AT	S4	25.	12.33	5.	1.	1.	.01		
+	3 COMBINED AT	C/NE	289.	12.25	50.	15.	10.	.11		
+	HYDROGRAPH AT	O3	206.	12.50	51.	16.	11.	.11		
+	HYDROGRAPH AT	S7	10.	12.33	2.	1.	0.	.00		
+	HYDROGRAPH AT	DA6	233.	12.08	21.	6.	4.	.04		
+	3 COMBINED AT	C/DA6	315.	12.08	73.	23.	15.	.16		
+	HYDROGRAPH AT	O4	179.	12.50	45.	14.	9.	.10		
+	ROUTED TO	CLVT	176.	12.58	45.	14.	9.	.10	704.12	12.58
+	HYDROGRAPH AT	P3	61.	12.08	6.	2.	1.	.01		
+	3 COMBINED AT	C/P3	442.	12.08	124.	39.	26.	.26		
+	HYDROGRAPH AT	DA5	347.	12.08	34.	10.	7.	.07		
+	2 COMBINED AT	C/DA5	789.	12.08	157.	49.	33.	.33		
+	ROUTED TO	RP3	495.	12.25	157.	49.	33.	.33	696.34	12.25
+	HYDROGRAPH AT	O5	22.	12.42	5.	1.	1.	.01		
+	2 COMBINED AT	C/O5	513.	12.42	162.	50.	34.	.34		
+	HYDROGRAPH AT	S6	36.	12.25	6.	2.	1.	.01		

```
      HYDROGRAPH AT
+                          S5          9.   12.33          1.          0.          0.        .00

      3 COMBINED AT
+                        C/SE        558.   12.33        169.         52.         35.        .36
1
                                    SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                       (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                      INTERPOLATED TO
                                                                   COMPUTATION INTERVAL
        ISTAQ    ELEMENT       DT       PEAK    TIME TO    VOLUME       DT      PEAK    TIME TO      VOLUME
                                                  PEAK                                    PEAK

                              (MIN)     (CFS)     (MIN)     (IN)      (MIN)     (CFS)     (MIN)       (IN)

          DA1  MANE          2.53    113.76    723.96      5.52      5.00    105.64    725.00        5.52

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .6153E+01 OUTFLOW= .5971E+01 BASIN STORAGE= .5042E-03 PERCENT ERROR=   2.9

          CH1  MANE          5.00    205.36    765.00      5.44      5.00    205.36    765.00        5.44

CONTINUITY SUMMARY (AC-FT) - INFLOW= .4025E+02 EXCESS= .3548E+01 OUTFLOW= .4377E+02 BASIN STORAGE= .3948E-02 PERCENT ERROR=    .0

          DA2  MANE          2.69    322.52    724.06      5.52      5.00    299.13    725.00        5.52

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1746E+02 OUTFLOW= .1694E+02 BASIN STORAGE= .8281E-03 PERCENT ERROR=   2.9

          DA3  MANE          3.22    193.34    723.85      5.49      5.00    177.68    725.00        5.47

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1070E+02 OUTFLOW= .1033E+02 BASIN STORAGE= .7565E-03 PERCENT ERROR=   3.4

          CH2  MANE          2.73    170.62    726.88      5.46      5.00    157.30    725.00        5.46

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1030E+02 EXCESS= .6690E+00 OUTFLOW= .1094E+02 BASIN STORAGE= .7532E-03 PERCENT ERROR=    .2

          DA4  MANE          3.30    253.48    722.91      5.49      5.00    252.98    725.00        5.46

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1576E+02 OUTFLOW= .1522E+02 BASIN STORAGE= .1023E-02 PERCENT ERROR=   3.4

          CH3  MANE          1.86      3.21    725.27      5.29      5.00      3.18    725.00        5.31

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1745E+00 OUTFLOW= .1694E+00 BASIN STORAGE= .1702E-03 PERCENT ERROR=   2.9

          DA6  MANE          3.11    236.93    725.36      5.51      5.00    232.74    725.00        5.55

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1303E+02 OUTFLOW= .1264E+02 BASIN STORAGE= .8100E-03 PERCENT ERROR=   3.0

          DA5  MANE          3.11    369.20    723.65      5.49      5.00    346.98    725.00        5.47

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .2131E+02 OUTFLOW= .2059E+02 BASIN STORAGE= .1164E-02 PERCENT ERROR=   3.3


*** NORMAL END OF HEC-1 ***
```

VOLUME CALCULATIONS

EXCESS RAINFALL VOLUME CALCULATION

The volume generated by the site and the surrounding properties is calculated for the 25-year storm event. A summary of the design information that is included in this Appendix and related appendices are listed below.

- Excess rainfall and drainage areas used in the volume calculations were taken from the HEC-1 analysis located on pages IIIF-A-27 through IIIF-A-65.
- Post-development condition volume information is summarized on pages IIIF-A-68 through IIIF-A-69.

Prep By: BPY
Date: 2/22/2022

TURKEY CREEK LANDFILL
0771-368-11-123
EXCESS RAINFALL
VOLUME CALCULATIONS

Chkd By: CRM
Date:2/22/2022

Required: Determine the volume generated by the site and offsite areas using the excess rainfall calculated in the HEC-1 analysis of the post-development condition.

Method: 1. Use the excessive rainfall data generated by the HEC-1 analysis to determine the volume produced by the site for the post-development condition.

1. Post-development Condition

1. a. Total Flow to Unnamed Tributary of Turkey Creek **northeast** of permit boundary (DCP1)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA3	**0.0353**	**5.68**	**22.58**	**10.7**
DA4	**0.0520**	**5.68**	**33.25**	**15.7**
S3	**0.0027**	**5.45**	**1.71**	**0.8**
S4	**0.0101**	**5.45**	**6.49**	**2.9**
CH2	**0.0023**	**5.45**	**1.49**	**0.7**
CH5	**0.0006**	**5.45**	**0.37**	**0.2**
P2	**0.0020**	**7.33**	**1.27**	**0.8**

DCP1 Volume = 31.8 ac-ft

1. b. Total volume of flow for areas discharging to the **north** (DCP2)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA1	**0.0203**	**5.68**	**12.96**	**6.1**
DA2	**0.0576**	**5.68**	**36.87**	**17.5**
O1	**0.2820**	**5.45**	**180.49**	**82.0**
O2	**0.1166**	**5.45**	**74.63**	**33.9**
S1	**0.0018**	**5.45**	**1.14**	**0.5**
S2	**0.0015**	**5.45**	**0.99**	**0.4**
CH1	**0.0122**	**5.45**	**7.79**	**3.5**

DCP2 Volume = 144.0 ac-ft

Prep By: BPY
Date: 2/22/2022

TURKEY CREEK LANDFILL
0771-368-11-123
EXCESS RAINFALL
VOLUME CALCULATIONS

Chkd By: CRM
Date:2/22/2022

1. c. Total flow to Turkey Creek from southeast corner (DCP3)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA5	**0.0703**	**5.68**	**44.98**	**21.3**
DA6	**0.0430**	**5.68**	**27.53**	**13.0**
O3	**0.1082**	**5.45**	**69.25**	**31.5**
O4	**0.0954**	**5.45**	**61.05**	**27.7**
O5	**0.0099**	**5.45**	**6.34**	**2.9**
S5	**0.0030**	**5.45**	**1.93**	**0.9**
S6	**0.0127**	**5.45**	**8.14**	**3.7**
S7	**0.0038**	**5.45**	**2.40**	**1.1**
P3	**0.0104**	**7.33**	**6.68**	**4.1**

DCP3 Volume = 106.1 ac-ft

VELOCITY CALCULATIONS

TURKEY CREEK LANDFILL
0771-368-11-123
VELOCITY CALCULATIONS
PROPOSED EXPANSION CONDITION

Required: Determine the flow velocities entering and exiting the permit boundary using HYDROCALC HYDRAULICS (Version 2.0, 1996-2010) for the flows calculated for the 25-year and 25- year storm event in the HEC-1 analysis.

Method:

1. Use the flow data generated by the HEC-1 analysis to determine velocity of runoff entering the landfill permit boundary.
2. Use the flow data generated by the HEC-1 analysis to determine velocity of runoff exiting the landfill permit boundary.

1. Flow Velocity entering the landfill permit boundary

O1

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 466 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	466	0.0110	0.03	2.00	2.00	15.00	2.72	8.38

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O2 (Sta. A-4740)

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 188 cfs

Storm Year	Flow Rate (cfs)	Flow Vel. (fps)
25	188	0.37

Note: Velocites were obtained from HEC-RAS anaysis starting on page IIIF-B-3.

O3

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 206 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	206	0.0182	0.03	2.00	4.00	20.00	1.25	6.95

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O4 (Sta. B-2680)

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 179 cfs

Storm Year	Flow Rate (cfs)	Flow Vel. (fps)
25	179	0.61

Note: Velocites were obtained from HEC-RAS anaysis starting on page IIIF-B-3.

O5

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 22 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	22	0.0282	0.03	100.00	40.00	100.00	0.11	1.84

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

2.
Flow Velocity exiting the landfill permit boundary

DCP1

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

$Q_{25} =$ 289 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	289	0.013	0.03	2.50	2.50	17.00	1.83	7.31

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

DCP2 (Sta. A-1500)

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

$Q_{25} =$ 623 cfs

Storm Year	Flow Rate (cfs)	Flow Vel. (fps)
25	623	3.35

Note: Velocites were obtained from HEC-RAS anaysis starting on page IIIF-B-3.

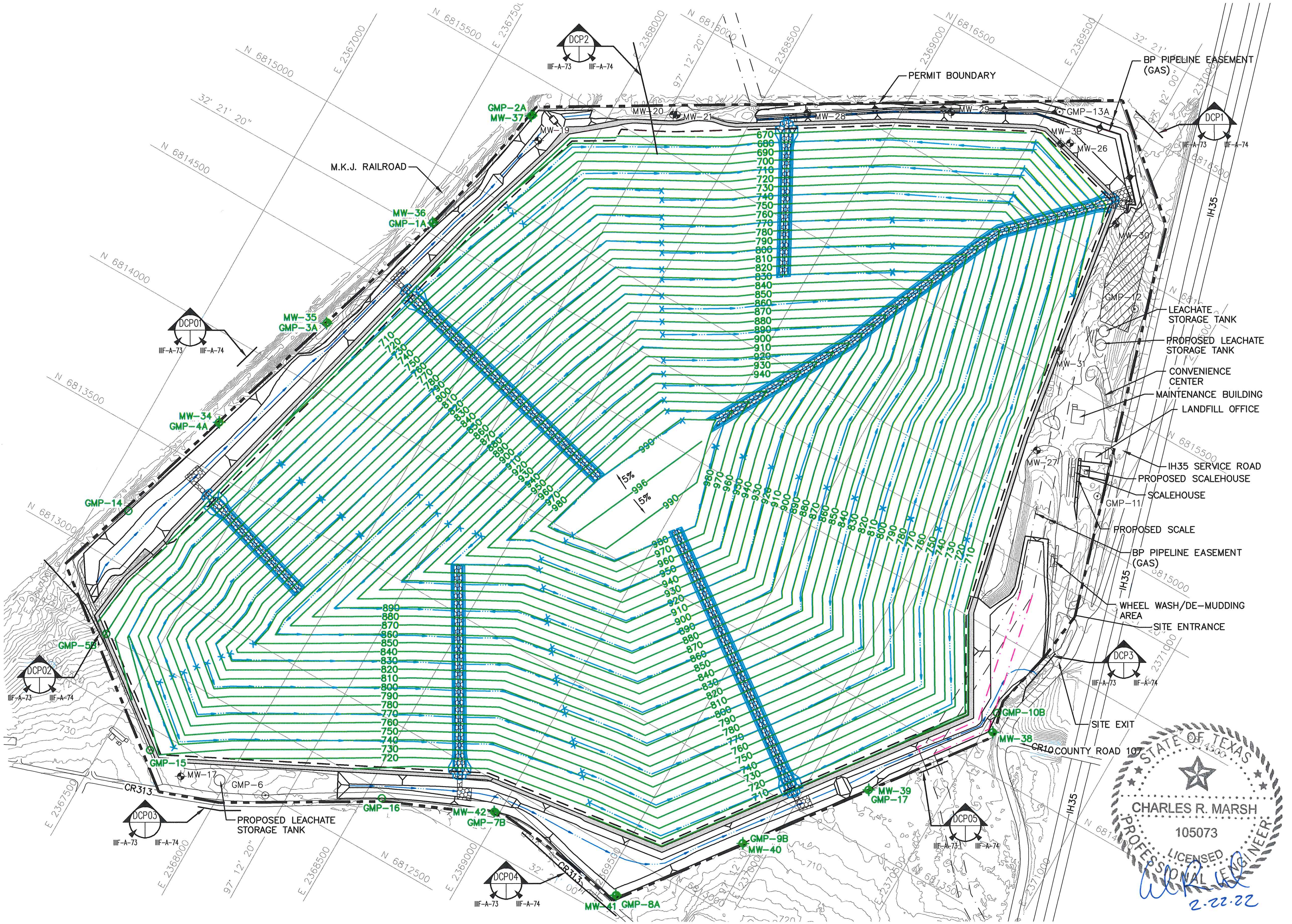
DCP3 (Sta. B-520)

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

$Q_{25} =$ 564 cfs

Storm Year	Flow Rate (cfs)	Flow Vel. (fps)
25	564	1.45

Note: Velocites were obtained from HEC-RAS anaysis starting on page IIIF-B-3.



LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 EXISTING CONTOUR
- N 6816000 STATE PLANE COORDINATE
- 32° 21' 20" GEODETIC COORDINATE
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 4)
- 800 FINAL COVER CONTOUR
- LIMIT OF CLASS 1 WASTE DISPOSAL AREA
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- GABIONS
- MW-7 EXISTING GROUNDWATER MONITORING WELL
- GMP-12 EXISTING GAS MONITORING PROBE
- MW-37 PROPOSED GROUNDWATER MONITORING WELL
- GMP-17 PROPOSED GAS MONITORING PROBE
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.
3. MAXIMUM FINAL COVER ELEVATION IS 996.0 FT-MSL. MAXIMUM TOP OF WASTE ELEVATION IS 992.5 FT-MSL.
4. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-A-73 POST DRAINAGE.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS		
NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT
POST DEVELOPMENT DRAINAGE

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-A-73

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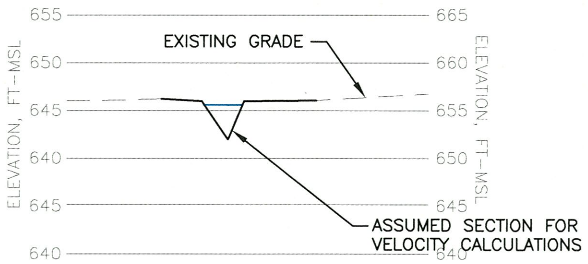
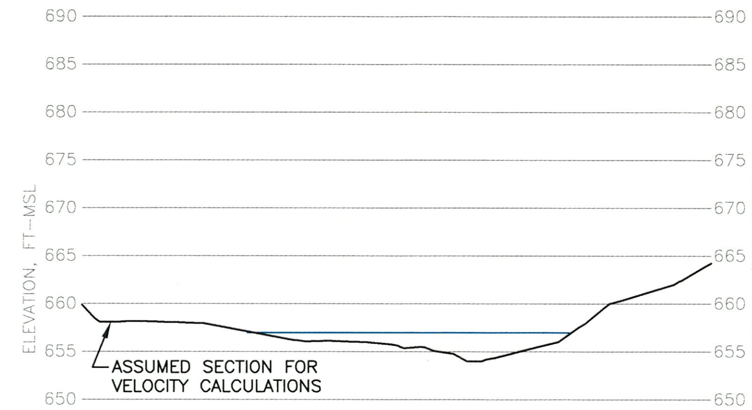


DISCHARGE POINT 1 (DCP1, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 2 (DCP2, IIIF-A-73, IIIF-A-74)

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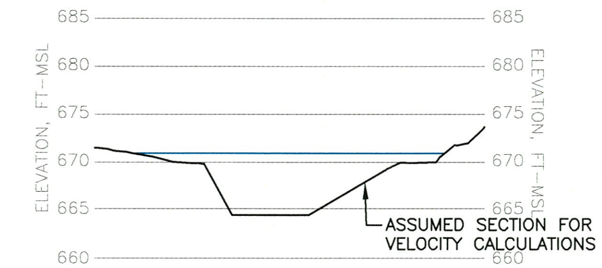
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 3 (DCP3, IIIF-A-73, IIIF-A-74)

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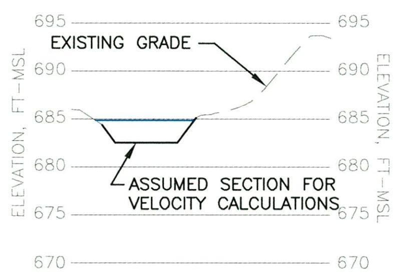
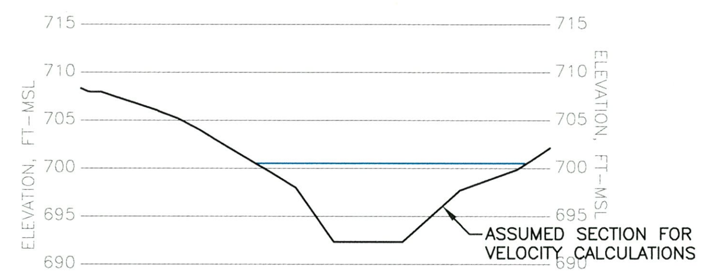
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



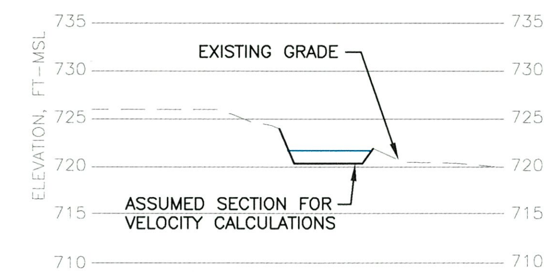
DISCHARGE POINT 01 (DCP01, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



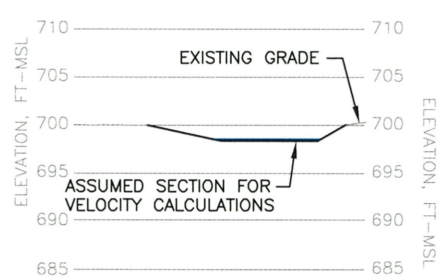
DISCHARGE POINT 02 (DCP02, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



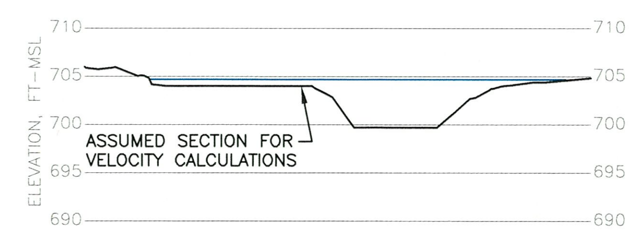
DISCHARGE POINT 03 (DCP03, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 05 (DCP05, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 04 (DCP04, IIIF-A-73, IIIF-A-74)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-A-69-DISCHARGE POINT SEC.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT UPDATED PERMITTED DISCHARGE POINT VELOCITY CALCULATIONS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-A-74

O:\0771\368\EXPANSION 2021\PART III\IIF\IIIF-A\IIIF-A-74-DISCHARGE POINT SECTIONS.dwg, rarrington, 1:2

APPENDIX IIIF-B

PERIMETER CHANNEL, DETENTION POND, AND CULVERT DESIGN

Includes pages IIIF-B-1 through IIIF-B-53

STATE OF TEXAS
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CONTENTS

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PROFESSIONAL ENGINEER
2-22-22

PERIMETER CHANNEL DESIGN

Perimeter channels have been designed to contain stormwater runoff from the 25-year storm frequency. A summary of the design information that is included in this Appendix is listed below.

- Flow rates used for the perimeter channel design were taken from the HEC-1 analysis included in Appendix IIIF-A.
- Perimeter channel design system information is summarized on Drawing IIIF.4 in Appendix IIIF.
- Channel profiles are presented on Drawings IIIF.5 through IIIF.6 in Appendix IIIF.
- Hydraulic calculations are summarized on pages IIIF-B-2.
- Channel Erosion Control Design information is included on page IIIF-B-5.

TURKEY CREEK LANDFILL
0771-368-11-123
PROPOSED PERIMETER CHANNEL DESIGN

Channel	STA[2]	Flow Rate (cfs)	Flow Depth (ft)	Flow Vel. (fps)	Froude No.	Flow Area (sq.ft.)	Top width of Flow (ft)
CH1 (Stream A)	A-4350	201.0	0.19	13.27	5.360	15.15	79.43
	A-3850	201.0	1.59	3.13	0.460	64.15	44.41
	A-3365	595.0	3.40	2.46	0.250	241.98	79.64
	A-3150	595.0	2.91	8.72	1.010	68.26	29.28
	A-2800	624.0	2.22	11.54	1.480	54.07	28.75
	A-2300	624.0	1.53	13.03	1.950	47.89	34.40
	A-2200	625.0	0.77	17.10	3.510	36.55	49.54
	A-1950	625.0	10.74	0.88	0.060	706.30	92.79
	A-1750	622.0	2.75	8.95	1.010	69.49	43.51
	A-1500	632.0	2.97	3.40	0.510	185.96	132.81
CH4 (Stream B & Stream B West)	BW-1050	315.0	3.53	3.83	0.420	82.19	32.08
	BW-550	315.0	1.82	3.49	0.480	90.20	54.18
	BW-350	315.0	6.70	1.15	0.090	273.98	57.70
	BW-100	315.0	6.71	0.38	0.030	818.55	138.88
	B-2220	442.0	6.68	1.35	0.110	328.04	65.56
	B-1920	442.0	6.62	1.50	0.120	294.81	60.12
	B-1520	798.0	6.46	2.13	0.170	375.10	72.65
	B-1410	513.0	2.12	8.25	1.000	62.19	55.83
	B-1270	513.0	1.43	13.87	2.190	36.99	29.64
	B-820	513.0	2.40	8.08	1.020	63.50	32.81
	B-670	513.0	0.30	20.90	6.740	24.54	82.18
	B-520	558.0	6.42	1.45	0.120	422.34	129.65

Note:
1. Calculations were performed using HEC-RAS Computer Program developed by U.S. Corps of Engineers (Version 6.0.0). HEC-RAS Output files can be found on pages IIIF-B-3 through IIIF-B-36
2. Stream A in the HEC-RAS output file is equivalent to CH1. Stream B and Stream B West in the HEC-RAS output file is equivalent to CH4.

HEC-RAS HEC-RAS 6.0.0 May 2021
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
X     X  X        X    X      X   X    X    X        X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
```

****

PROJECT DATA
Project Title: Post-Project Model
Project File : Post-ProjectModel.prj
Run Date and Time: 11/4/2021 8:23:57 AM

Project in English units

****

PLAN DATA

Plan Title: Post-Project Condition Plan
Plan File : p:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-B\HEC-RAS\Post-ProjectModel.p01

Geometry Title: Post-Project
Geometry File : p:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-B\HEC-RAS\Post-ProjectModel.g02

Flow Title : 25-Year Flow
Flow File : p:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-B\HEC-RAS\Post-ProjectModel.f01

Plan Summary Information:

```
Number of:  Cross Sections =   36    Multiple Openings  =    0
            Culverts       =    7    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0
```

Computational Information

```
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001
```

Computation Options

```
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow
```

****

FLOW DATA

Flow Title: 25-Year Flow
Flow File : p:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-B\HEC-RAS\Post-ProjectModel.f01

Flow Data (cfs)

River	Reach	RS	PF 1
Stream A - Post	Stream A	5430	188
Stream A - Post	Stream A	4350	201
Stream A - Post	Stream A	3365	595
Stream A - Post	Stream A	2800	624
Stream A - Post	Stream A	2200	625
Stream A - Post	Stream A	1750	622
Stream A - Post	Stream A	1500	623
Stream B - Post	Stream B South	3310	179
Stream B - Post	Stream B	2220	442
Stream B - Post	Stream B	1520	798
Stream B - Post	Stream B	1410	513
Stream B - Post	Stream B	520	558
Stream B - Post	Stream B	420	558
Stream B - Post	Stream B	150	558
Stream B West	Stream B - West	1050	315

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Stream A - Post	Stream A	PF 1	Normal S = 0.0172	Known WS = 656.96
Stream B - Post	Stream B South	PF 1	Normal S = 0.0135	
Stream B - Post	Stream B	PF 1		Known WS = 662.17
Stream B West	Stream B - West	PF 1	Normal S = 0.0231	

****

GEOMETRY DATA

Geometry Title: Post-Project
Geometry File : p:\Solid waste\WC\Turkey Creek\Expansion 2021\Part III-SDP\App IIIF\IIIF-B\HEC-RAS\Post-ProjectModel.g02

Reach Connection Table

****

```
* River           Reach            *  Upstream Boundary  * Downstream Boundary *
*******************************************************************************
* Stream A - Post  Stream A         *                     *                     *
* Stream B - Post  Stream B South   *                     *   SB Node1          *
* Stream B - Post  Stream B         *   SB Node1          *                     *
* Stream B West    Stream B - West  *                     *   SB Node1          *
*******************************************************************************

JUNCTION INFORMATION

Name: SB Node1
Description:
Energy computation Method

    Length across Junction              Tributary
     River           Reach               River             Reach        Length   Angle
Stream B - Post  Stream B South   to Stream B - Post     Stream B        45.22       0
 Stream B West   Stream B - West  to Stream B - Post     Stream B            0       0

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A           RS: 5430

INPUT
Description:
Station Elevation Data    num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  734.01   86.13  731.14  120.33     730  158.79  727.52   174.4  726.69
  285.62  720.36  293.13  720.26  300.26  720.19  300.56  720.19     309  720.26
  321.43  720.42  387.64  723.79  422.88   725.4     455  727.24  502.97     730
  566.63  733.98

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04   86.13     .04     455     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         86.13     455           227.52     200  224.62             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*************************************************************************************
* E.G. Elev (ft)         *  721.46  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)          *    0.33  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)         *  721.14  * Reach Len. (ft)        *  227.52  *  200.00  *  224.62  *
* Crit W.S. (ft)         *  721.14  * Flow Area (sq ft)      *          *   40.95  *          *
* E.G. Slope (ft/ft)     *0.027473  * Area (sq ft)           *          *   40.95  *          *
* Q Total (cfs)          *  188.00  * Flow (cfs)             *          *  188.00  *          *
* Top Width (ft)         *   63.54  * Top Width (ft)         *          *   63.54  *          *
* Vel Total (ft/s)       *    4.59  * Avg. Vel. (ft/s)       *          *    4.59  *          *
* Max Chl Dpth (ft)      *    0.95  * Hydr. Depth (ft)       *          *    0.64  *          *
* Conv. Total (cfs)      *  1134.2  * Conv. (cfs)            *          *  1134.2  *          *
* Length Wtd. (ft)       *  200.00  * Wetted Per. (ft)       *          *   63.59  *          *
* Min Ch El (ft)         *  720.19  * Shear (lb/sq ft)       *          *    1.10  *          *
* Alpha                  *    1.00  * Stream Power (lb/ft s) *          *    5.07  *          *
* Frctn Loss (ft)        *    6.67  * Cum Volume (acre-ft)   *          *   10.70  *          *
* C & E Loss (ft)        *    0.03  * Cum SA (acres)         *          *    4.90  *          *
*************************************************************************************

Warning: The energy equation could not be balanced within the specified number of iterations.  The program used critical
         depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
         water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
         program defaulted to critical depth.

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A           RS: 5230

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  730.81   27.99     730   75.66   726.7  141.55  722.13  170.92     720
  225.25  716.36  273.72  712.79  275.51  712.77  275.52  712.77  278.66  712.88
  306.61  715.02  384.64     720  403.52  721.58   504.4     730

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04       0     .04   504.4     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0   504.4           374.73     300  286.75             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*************************************************************************************
* E.G. Elev (ft)         *  714.77  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)          *    0.61  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)         *  714.16  * Reach Len. (ft)        *  374.73  *  300.00  *  286.75  *
* Crit W.S. (ft)         *  714.30  * Flow Area (sq ft)      *          *   30.07  *          *
* E.G. Slope (ft/ft)     *0.041888  * Area (sq ft)           *          *   30.07  *          *
* Q Total (cfs)          *  188.00  * Flow (cfs)             *          *  188.00  *          *
* Top Width (ft)         *   40.23  * Top Width (ft)         *          *   40.23  *          *
* Vel Total (ft/s)       *    6.25  * Avg. Vel. (ft/s)       *          *    6.25  *          *
* Max Chl Dpth (ft)      *    1.39  * Hydr. Depth (ft)       *          *    0.75  *          *
```

Conv. Total (cfs)	918.6	Conv. (cfs)		918.6	
Length Wtd. (ft)	300.00	Wetted Per. (ft)		40.33	
Min Ch El (ft)	712.77	Shear (lb/sq ft)		1.95	
Alpha	1.00	Stream Power (lb/ft s)		12.19	
Frctn Loss (ft)	10.22	Cum Volume (acre-ft)		10.53	
C & E Loss (ft)	0.01	Cum SA (acres)		4.66	

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 4930

INPUT
Description:
Station Elevation Data num= 97

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	721.33	2.36	721.26	3.08	721.24	3.63	719.3	4.04	717.98
12.35	718	14.06	718	14.36	718.44	14.41	718.43	20.44	720.57
21.12	720.54	22.69	720.44	22.79	720.44	25.33	720.32	25.43	720.32
26.82	720.26	28.14	720.21	29.24	720.17	34.56	720.29	34.68	720.29
35.53	720.26	42.53	720	53.05	718.87	54.69	718.74	57.47	718.46
61.51	718	62.12	718	62.56	717.99	74.71	717.2	81.45	716.78
82.13	716.74	83.39	716.68	85.22	716.6	86.67	716.54	89.65	716.36
89.81	716.38	90.1	716.35	95.13	716	105.27	714.48	110.65	714
111.75	713.89	122.28	712	123.81	711.81	124.07	711.8	129.68	711.39
133.47	711.22	135.01	711.15	135.89	711.1	136.97	711.05	151.01	710
153.69	709.77	156.11	709.48	157.35	709.32	161.88	708.79	167.03	708
173.12	707.11	180.9	706	184.95	705.49	186.14	705.28	188.4	704.75
190.3	704.38	192.25	704	196.18	703.02	200.19	702	204.02	702
214.54	703.26	218.97	703.82	219.18	703.85	219.95	703.98	220.18	703.99
220.49	704	236.47	705.93	237.01	706	252.55	707.88	253.53	708
255.54	708.24	270.2	710	283.5	711.63	286.57	712	296.36	713.18
300.06	713.67	302.32	714	311.61	715.48	315.38	716	320.52	716.56
322.5	716.8	325.62	717.1	325.72	717.11	333.52	717.98	334.64	717.98
336.43	718	337.43	718.02	338.4	718.01	340.91	718.16	341.48	718.19
343.89	718.35	363.42	719.71						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	82.13	.04	325.62	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
82.13	325.62	366.75	360	359.65	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	704.54	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.66	Wt. n-Val.		0.040	
W.S. Elev (ft)	703.88	Reach Len. (ft)	366.75	360.00	359.65
Crit W.S. (ft)	703.96	Flow Area (sq ft)		28.81	
E.G. Slope (ft/ft)	0.028256	Area (sq ft)		28.81	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	26.61	Top Width (ft)		26.61	
Vel Total (ft/s)	6.53	Avg. Vel. (ft/s)		6.53	
Max Chl Dpth (ft)	1.88	Hydr. Depth (ft)		1.08	
Conv. Total (cfs)	1118.4	Conv. (cfs)		1118.4	
Length Wtd. (ft)	360.00	Wetted Per. (ft)		26.96	
Min Ch El (ft)	702.00	Shear (lb/sq ft)		1.88	
Alpha	1.00	Stream Power (lb/ft s)		12.30	
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)		10.33	
C & E Loss (ft)	0.17	Cum SA (acres)		4.43	

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 4570

INPUT
Description:
Station Elevation Data num= 93

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	715.15	3.45	715	5.19	715.36	5.29	714.84	6.54	715.29
8.08	716	17.17	716	17.68	715.94	30.76	714	33.07	713.84
54.89	712.06	55.65	712.06	56.55	712.05	65.23	712	67.85	711.5
68.28	711.45	68.71	711.42	69.38	711.41	72.08	710.97	73.5	711.06
81.68	710.34	88.72	710.23	92.05	710.03	93.91	710.03	100.39	710.02
102.2	710.02	105.26	710.01	106.86	710	107.92	710	109.43	710
133.72	708.42	137.27	708	138.86	707.98	139.64	707.98	141.09	707.97
141.91	707.96	142.32	707.96	143.01	707.95	162.19	706.38	165.84	706.08
166.36	706	166.62	705.96	166.65	705.95	166.72	705.95	167.01	705.93
168.11	705.82	174.5	705.19	177.71	704.8	183.92	704	190.24	703
196.96	702	208.85	700.25	210.59	700	210.89	699.95	217.11	699.02
223.65	698	239.53	692.35	239.69	692.35	240.41	692.35	267.93	692.35
291.92	697.72	315.32	699.85	316.45	700	318.07	700.26	322	700.91
328.56	702	333.23	702.9	338.6	704	348.43	705.71	350.13	706
352.7	706.46	360.53	708	372.61	709.6	373.46	709.69	375.79	710
377.54	710.24	378.65	710.36	381.37	710.62	389.82	711.52	396.45	712
401.59	712.42	402.76	712.46	406.84	712.71	414.64	713.1	416.01	713.21
418.57	713.32	421.67	713.47	429.48	714	432.17	714.39	433.85	714.56
435.08	714.59	436.8	714.71	440.49	715.09				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	107.92	.04	372.61	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
107.92	372.61	62.12	60	65.76	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	246.99	700	F
260.49	440.49	700	F

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	700.50	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.040	
W.S. Elev (ft)	700.49	Reach Len. (ft)	62.12	60.00	65.76
Crit W.S. (ft)	694.17	Flow Area (sq ft)		508.28	
E.G. Slope (ft/ft)	0.000014	Area (sq ft)		508.28	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	112.28	Top Width (ft)		112.28	
Vel Total (ft/s)	0.37	Avg. Vel. (ft/s)		0.37	
Max Chl Dpth (ft)	8.14	Hydr. Depth (ft)		4.53	
Conv. Total (cfs)	51093.0	Conv. (cfs)		51093.0	
Length Wtd. (ft)	60.00	Wetted Per. (ft)		114.19	
Min Ch El (ft)	692.35	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)		Cum Volume (acre-ft)		8.11	
C & E Loss (ft)		Cum SA (acres)		3.86	

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
Note: Hydraulic jump has occurred between this cross section and the previous upstream section.

CULVERT

RIVER: Stream A - Post
REACH: Stream A RS: 4550

INPUT
Description: Culvert A-1: Southwest Landfill Perimeter Road Crossing
Distance from Upstream XS = 18
Deck/Roadway Width = 12
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 11

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
210.59	700	700	210.89	700	699.95	217.11	700	699.02
223.65	700	698	239.53	700	692.35	239.69	700	692.35
240.41	700	692.35	267.93	700	692.35	291.92	700	697.72
315.32	700	699.85	316.45	700	700			

Upstream Bridge Cross Section Data
Station Elevation Data num= 93

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	715.15	3.45	715	5.19	715.36	5.29	714.84	6.54	715.29
8.08	716	17.17	716	17.68	715.94	30.76	714	33.07	713.84
54.89	712.06	55.65	712.06	56.55	712.05	65.23	712	67.85	711.5
68.28	711.45	68.71	711.42	69.38	711.41	72.08	710.97	73.5	711.06
81.68	710.34	88.72	710.23	92.05	710.03	93.91	710.03	100.39	710.02
102.2	710.02	105.26	710.01	106.86	710	107.92	710	109.43	710
133.72	708.42	137.27	708	138.86	707.98	139.64	707.98	141.09	707.97
141.91	707.96	142.32	707.96	143.01	707.95	162.19	706.38	165.84	706.08
166.36	706	166.62	705.96	166.65	705.95	166.72	705.95	167.01	705.93
168.11	705.82	174.5	705.19	177.71	704.8	183.92	704	190.24	703
196.96	702	208.85	700.25	210.59	700	210.89	699.95	217.11	699.02
223.65	698	239.53	692.35	239.69	692.35	240.41	692.35	267.93	692.35
291.92	697.72	315.32	699.85	316.45	700	318.07	700.26	322	700.91
328.56	702	333.23	702.9	338.6	704	348.43	705.71	350.13	706
352.7	706.46	360.53	708	372.61	709.6	373.46	709.69	375.79	710
377.54	710.24	378.65	710.36	381.37	710.62	389.82	711.52	396.45	712
401.59	712.42	402.76	712.46	406.84	712.71	414.64	713.1	416.01	713.21
418.57	713.32	421.67	713.47	429.48	714	432.17	714.39	433.85	714.56
435.08	714.59	436.8	714.71	440.49	715.09				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	107.92	.04	372.61	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
107.92	372.61	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	246.99	700	F
260.49	440.49	700	F

Downstream Deck/Roadway Coordinates
num= 55

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
151.01	700	700	151.18	700	699.99	151.28	700	699.99
151.38	700	699.98	152.06	700	699.96	153.27	700	699.88
154.13	700	699.87	159.99	700	698.85	163.22	700	698.36
166.05	700	698.09	166.34	700	698.05	167.07	700	698
168.73	700	697.99	169.2	700	697.98	169.87	700	697.98
170.64	700	697.97	174.87	700	697.97	179.4	700	697.98
180.31	700	697.98	181.18	700	697.97	189.93	700	697.97
191.84	700	697.82	193.56	700	697.76	193.88	700	697.74
195.4	700	697.59	201.93	700	696.88	204.89	700	696.63
210.06	700	696	213.57	700	694.92	213.63	700	694.91

216.73	700	694	216.89	700	693.97	219.33	700	693.2
223.55	700	691.6	233.28	700	691.6	235.1	700	692.66
238.53	700	694	243.29	700	695.65	244.2	700	695.93
244.43	700	696	244.7	700	696.08	245.66	700	696.31
248.5	700	696.94	249.82	700	697.17	251.62	700	697.43
253.17	700	697.65	255.05	700	697.93	256.29	700	697.92
256.85	700	697.95	258.25	700	698	261.37	700	698.41
266.78	700	699.06	269.24	700	699.28	270.12	700	699.25
273	700	700						

Downstream Bridge Cross Section Data
Station Elevation Data num= 126

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	716	6.63	716	13.05	714.56	15.47	714	18.32	713.17
22.65	712	23.83	711.98	24.77	711.98	28.85	711.94	29.26	711.93
30.84	711.93	39.77	711.37	41.37	711.29	43.31	711.2	44.42	711.14
60.17	710	60.29	709.99	65.5	709.69	65.89	709.67	71.68	709.38
72.16	709.37	80.21	709.01	91.38	708.43	99.05	708.03	100.77	708
105.23	707.43	106.44	707.32	110.61	706.9	112.7	706.68	114	706.56
114.51	706.53	123.03	706	127.08	705.31	130.82	704.8	131.68	704.63
134.62	704	141.68	702.34	143.22	702	149.28	700.4	151.01	700
151.18	699.99	151.28	699.99	151.38	699.98	152.06	699.96	153.27	699.88
154.13	699.87	159.99	698.85	163.22	698.36	166.05	698.09	166.34	698.05
167.07	698	168.73	697.99	169.2	697.98	169.87	697.98	170.64	697.97
174.87	697.97	179.4	697.98	180.31	697.98	181.18	697.97	189.93	697.97
191.84	697.82	193.56	697.76	193.88	697.74	195.4	697.59	201.93	696.88
204.89	696.63	210.06	696	213.57	694.92	213.63	694.91	216.73	694
216.89	693.97	219.33	693.2	223.55	691.6	233.28	691.6	235.1	692.66
238.53	694	243.29	695.65	244.2	695.93	244.43	696	244.7	696.08
245.66	696.31	248.5	696.94	249.82	697.17	251.62	697.43	253.17	697.65
255.05	697.93	256.29	697.92	256.85	697.95	258.25	698	261.37	698.41
266.78	699.06	269.24	699.28	270.12	699.25	273	700	273.77	700.07
278.14	700.44	279.79	700.61	292.96	702	295.01	702.46	299.99	703.41
302.6	704	306.66	704.58	316.41	706	322.67	706.96	330.36	708
333.07	708.51	335.18	708.93	340.33	710	341.78	710.32	342.62	710.46
345.87	711.09	347.31	711.32	349.48	711.74	350.27	711.81	352.44	711.9
352.94	711.98	353.3	711.97	354.88	711.95	355.31	711.96	356.77	712
357.14	712.06	357.25	712.07	357.47	712.1	358.22	712.25	365.86	714
366.99	714.43								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	123.03	.04	335.18	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
123.03	335.18	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	221.67	700	F
235.17	366.99	700	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Circular	3.5	3.5

FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
18	14.3	.024	.024	0	.5	1

Upstream Elevation = 692.35
Centerline Station = 253.73
Downstream Elevation = 691.6
Centerline Station = 228.42

CULVERT OUTPUT Profile #PF 1 Culv Group: Culvert #1

Q Culv Group (cfs)	103.08	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	10.71
Q Barrel (cfs)	103.08	Culv Vel DS (ft/s)	17.85
E.G. US. (ft)	700.50	Culv Inv El Up (ft)	692.35
W.S. US. (ft)	700.49	Culv Inv El Dn (ft)	691.60
E.G. DS (ft)	694.46	Culv Frctn Ls (ft)	1.02
W.S. DS (ft)	693.55	Culv Exit Loss (ft)	4.12
Delta EG (ft)	6.04	Culv Entr Loss (ft)	0.89
Delta WS (ft)	6.94	Q Weir (cfs)	84.92
E.G. IC (ft)	700.50	Weir Sta Lft (ft)	207.49
E.G. OC (ft)	698.50	Weir Sta Rgt (ft)	319.22
Culvert Control	Inlet	Weir Submerg	0.00
Culv WS Inlet (ft)	695.85	Weir Max Depth (ft)	0.45
Culv WS Outlet (ft)	693.63	Weir Avg Depth (ft)	0.44
Culv Nml Depth (ft)	2.42	Weir Flow Area (sq ft)	48.98
Culv Crt Depth (ft)	3.10	Min El Weir Flow (ft)	700.01

Warning: The flow through the culvert is supercritical. However, since there is flow over the road (weir flow), the program cannot determine if the downstream cross section should be subcritical or supercritical. The program used the downstream subcritical answer, even though it may not be valid.
Warning: During the supercritical analysis, the program could not converge on a supercritical answer in the downstream cross section. The program used the solution with the least error.
Note: The flow in the culvert is entirely supercritical.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 4510

INPUT
Description:
Station Elevation Data num= 126

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	716	6.63	716	13.05	714.56	15.47	714	18.32	713.17
22.65	712	23.83	711.98	24.77	711.98	28.85	711.94	29.26	711.93
30.84	711.93	39.77	711.37	41.37	711.29	43.31	711.2	44.42	711.14
60.17	710	60.29	709.99	65.5	709.69	65.89	709.67	71.68	709.38
72.16	709.37	80.21	709.01	91.38	708.43	99.05	708.03	100.77	708
105.23	707.43	106.44	707.32	110.61	706.9	112.7	706.68	114	706.56
114.51	706.53	123.03	706	127.08	705.31	130.82	704.8	131.68	704.63
134.62	704	141.68	702.34	143.22	702	149.28	700.4	151.01	700
151.18	699.99	151.28	699.99	151.38	699.98	152.06	699.96	153.27	699.88
154.13	699.87	159.99	698.85	163.22	698.36	166.05	698.09	166.34	698.05
167.07	698	168.73	697.99	169.2	697.98	169.87	697.98	170.64	697.97
174.87	697.97	179.4	697.98	180.31	697.98	181.18	697.97	189.93	697.97
191.84	697.82	193.56	697.76	193.88	697.74	195.4	697.59	201.93	696.88
204.89	696.63	210.06	696	213.57	694.92	213.63	694.91	216.73	694
216.89	693.97	219.33	693.2	223.55	691.6	233.28	691.6	235.1	692.66
238.53	694	243.29	695.65	244.2	695.93	244.43	696	244.7	696.08
245.66	696.31	248.5	696.94	249.82	697.17	251.62	697.43	253.17	697.65
255.05	697.93	256.29	697.92	256.85	697.95	258.25	698	261.37	698.41
266.78	699.06	269.24	699.28	270.12	699.25	273	700	273.77	700.07
278.14	700.44	279.79	700.61	292.96	702	295.01	702.46	299.99	703.41
302.6	704	306.66	704.58	316.41	706	322.67	706.96	330.36	708
333.07	708.51	335.18	708.93	340.33	710	341.78	710.32	342.62	710.46
345.87	711.09	347.31	711.32	349.48	711.74	350.27	711.81	352.44	711.9
352.94	711.98	353.3	711.97	354.88	711.95	355.31	711.96	356.77	712
357.14	712.06	357.25	712.07	357.47	712.1	358.22	712.25	365.86	714
366.99	714.43								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	123.03	.04	335.18	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
123.03	335.18	153.85	160	164.58	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	221.67	700	F
235.17	366.99	700	F

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	694.46	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.91	Wt. n-Val.		0.040	
W.S. Elev (ft)	693.55	Reach Len. (ft)	153.85	160.00	164.58
Crit W.S. (ft)	693.55	Flow Area (sq ft)		24.60	
E.G. Slope (ft/ft)	0.019822	Area (sq ft)		27.59	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	19.15	Top Width (ft)		19.15	
Vel Total (ft/s)	7.64	Avg. Vel. (ft/s)		7.64	
Max Chl Dpth (ft)	1.95	Hydr. Depth (ft)		1.82	
Conv. Total (cfs)	1335.3	Conv. (cfs)		1335.3	
Length Wtd. (ft)	160.00	Wetted Per. (ft)		13.92	
Min Ch El (ft)	691.60	Shear (lb/sq ft)		2.19	
Alpha	1.00	Stream Power (lb/ft s)		16.71	
Frctn Loss (ft)	10.46	Cum Volume (acre-ft)		7.86	
C & E Loss (ft)	0.18	Cum SA (acres)		3.77	

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 4350

INPUT
Description:
Station Elevation Data num= 39

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	714.01	1.43	714	9.14	713.01	17.2	712	24.17	710.28
25.42	710	25.94	709.8	28.71	709.66	30.07	709.55	32.73	709.34
45.44	708	46.81	707.99	48.29	707.99	55.39	707.36	57.11	707.24
69.24	706.19	69.8	705.96	92.08	697.05	132.5	680.88	210.97	680.88
225.85	686.83	226.55	687.12	233.45	689.87	234.05	690.66	234.52	690.74
235.15	692.33	235.24	692.55	236.77	692.89	240.8	693.96	242.08	693.98
242.18	693.98	242.43	694	243.4	694.22	246.4	696	248.22	697.1
249.81	698	252.72	699.67	253.43	700	265.41	701.09		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	69.8	.04	253.43	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
69.8	253.43	504.26	500	496.65	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	683.82	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.74	Wt. n-Val.		0.040	
W.S. Elev (ft)	681.07	Reach Len. (ft)	504.26	500.00	496.65
Crit W.S. (ft)	681.47	Flow Area (sq ft)		15.13	
E.G. Slope (ft/ft)	*1.169402	Area (sq ft)		15.13	
Q Total (cfs)	201.00	Flow (cfs)		201.00	
Top Width (ft)	79.43	Top Width (ft)		79.43	
Vel Total (ft/s)	13.29	Avg. Vel. (ft/s)		13.29	
Max Chl Dpth (ft)	0.19	Hydr. Depth (ft)		0.19	
Conv. Total (cfs)	185.9	Conv. (cfs)		185.9	
Length Wtd. (ft)	500.00	Wetted Per. (ft)		79.50	
Min Ch El (ft)	680.88	Shear (lb/sq ft)		13.89	
Alpha	1.00	Stream Power (lb/ft s)		184.58	
Frctn Loss (ft)	1.94	Cum Volume (acre-ft)		7.78	
C & E Loss (ft)	0.01	Cum SA (acres)		3.59	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 3850

INPUT
Description:
Station Elevation Data num= 38

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	710	2.32	710	11.48	708.67	15.2	708.17	15.81	708.11
16.45	708.06	16.5	708.06	16.66	708	17.01	707.9	17.07	707.87
17.17	707.83	17.58	707.68	24.06	706	24.95	705.99	27.52	705.99
28.21	706	28.93	706	32.82	706.06	34.82	706.06	35.68	706.07
38.76	706.04	41.92	706.01	42.27	706	42.88	706	44.51	705.91
44.84	705.89	47.08	705.73	67.36	704.19	69.5	704.03	69.55	704.03
69.73	704.05	70	704.06	120.73	683.77	134.21	678.38	170.68	678.38
196.19	688.58	225.03	700.12	246.74	700.12				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	67.36	.04	225.03	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
67.36	225.03	477.96	485	486.99	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	680.12	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.15	Wt. n-Val.		0.040	
W.S. Elev (ft)	679.97	Reach Len. (ft)	477.96	485.00	486.99
Crit W.S. (ft)	679.34	Flow Area (sq ft)		64.15	
E.G. Slope (ft/ft)	*0.004435	Area (sq ft)		64.15	
Q Total (cfs)	201.00	Flow (cfs)		201.00	
Top Width (ft)	44.41	Top Width (ft)		44.41	
Vel Total (ft/s)	3.13	Avg. Vel. (ft/s)		3.13	
Max Chl Dpth (ft)	1.59	Hydr. Depth (ft)		1.44	
Conv. Total (cfs)	3018.1	Conv. (cfs)		3018.1	
Length Wtd. (ft)	485.00	Wetted Per. (ft)		45.02	
Min Ch El (ft)	678.38	Shear (lb/sq ft)		0.39	
Alpha	1.00	Stream Power (lb/ft s)		1.24	
Frctn Loss (ft)	0.65	Cum Volume (acre-ft)		7.33	
C & E Loss (ft)	0.02	Cum SA (acres)		2.88	

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Hydraulic jump has occurred between this cross section and the previous upstream section.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 3365

INPUT
Description:
Station Elevation Data num= 56

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	704.35	.51	704.35	8.79	704.05	10.81	704	11.94	703.46
15.13	702	17.93	700.65	19.23	700.04	19.31	700	19.38	699.95
19.49	699.89	22.4	698	23.73	697.12	24.19	696.68	25.28	696
26.39	695.44	28.55	694	31.49	692.04	31.56	692	32.65	691.32
34.77	690	34.98	689.86	37.91	688	38.28	687.76	41.04	686
42.16	685.26	44.22	684	46.19	682.88	47.77	682	48.83	681.56
51.34	680.62	53.02	680.49	53.74	680.35	54.18	680.3	54.45	680.28
58.65	680.31	60.02	680.28	60.16	680.26	60.29	680.25	64.96	682.91
65.34	683.2	66.71	684.22	66.87	684.15	68.41	683.49	69.01	683.24
77.24	679.73	80.23	678.53	86.59	675.96	86.69	675.96	97.9	675.95
115.51	675.95	149.34	675.96	164.01	681.83	195.91	694.59	195.96	694.59

```
  222.17  694.58

Manning's n Values         num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
***************************************************
       0      .04    66.87      .04   195.96      .04

Bank Sta: Left    Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
         66.87  195.96               227.58      215    211.6              .1        .3

CROSS SECTION OUTPUT  Profile #PF 1
****************************************************************************************************
* E.G. Elev (ft)           *   679.45  * Element                   *  Left OB *  Channel * Right OB *
* Vel Head (ft)            *     0.09  * Wt. n-Val.                *          *    0.040 *          *
* W.S. Elev (ft)           *   679.35  * Reach Len. (ft)           *   227.58 *   215.00 *   211.60 *
* Crit W.S. (ft)           *           * Flow Area (sq ft)         *          *   241.98 *          *
* E.G. Slope (ft/ft)       *0.001018   * Area (sq ft)              *          *   241.98 *          *
* Q Total (cfs)            *   595.00  * Flow (cfs)                *          *   595.00 *          *
* Top Width (ft)           *    79.64  * Top Width (ft)            *          *    79.64 *          *
* Vel Total (ft/s)         *     2.46  * Avg. Vel. (ft/s)          *          *     2.46 *          *
* Max Chl Dpth (ft)        *     3.40  * Hydr. Depth (ft)          *          *     3.04 *          *
* Conv. Total (cfs)        *  18652.4  * Conv. (cfs)               *          *  18652.4 *          *
* Length Wtd. (ft)         *   215.00  * Wetted Per. (ft)          *          *    80.95 *          *
* Min Ch El (ft)           *   675.95  * Shear (lb/sq ft)          *          *     0.19 *          *
* Alpha                    *     1.00  * Stream Power (lb/ft s)    *          *     0.47 *          *
* Frctn Loss (ft)          *     0.41  * Cum Volume (acre-ft)      *          *     5.62 *          *
* C & E Loss (ft)          *     0.11  * Cum SA (acres)            *          *     2.19 *          *
****************************************************************************************************

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A             RS: 3150

INPUT
Description:
Station Elevation Data     num=        53
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
******************************************************************************************
       0   703.22     5.67   702.59      6.8   702.52     8.26      702    12.06   700.15
   12.38      700    15.75    698.4    16.58      698    19.45   696.57    20.65      696
    22.9   694.62    23.94      694    25.32   693.19    27.34      692    28.39   691.37
   30.06   690.61    31.51      690    36.36   688.25    37.14      688    38.08      688
   42.92   687.98       44   687.98    49.42      688    51.68      688     52.9   688.01
    57.4   688.01    62.31   688.02    66.89   688.02    67.21   688.03    71.07   688.02
   72.48   688.02    74.36   688.01    80.02      688    82.81   687.71    84.49   687.52
   88.65   687.01    88.95   686.99    89.29   686.96    89.69   686.92    89.92    686.9
   91.08   686.77    91.32   686.75    91.93    686.7    99.87   685.81    100.4   685.75
  102.94   685.47   106.01   683.42   118.88   674.84   136.54   674.84   148.15   679.49
  169.77   688.14   179.88   692.19   207.01   692.19

Manning's n Values         num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
***************************************************
       0      .02    100.4      .02   179.88      .02

Bank Sta: Left    Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
         100.4  179.88               349.69      350   350.87              .1        .3

CROSS SECTION OUTPUT  Profile #PF 1
****************************************************************************************************
* E.G. Elev (ft)           *   678.93  * Element                   *  Left OB *  Channel * Right OB *
* Vel Head (ft)            *     1.18  * Wt. n-Val.                *          *    0.020 *          *
* W.S. Elev (ft)           *   677.75  * Reach Len. (ft)           *   349.69 *   350.00 *   350.87 *
* Crit W.S. (ft)           *   677.75  * Flow Area (sq ft)         *          *    68.26 *          *
* E.G. Slope (ft/ft)       *0.004748   * Area (sq ft)              *          *    68.26 *          *
* Q Total (cfs)            *   595.00  * Flow (cfs)                *          *   595.00 *          *
* Top Width (ft)           *    29.28  * Top Width (ft)            *          *    29.28 *          *
* Vel Total (ft/s)         *     8.72  * Avg. Vel. (ft/s)          *          *     8.72 *          *
* Max Chl Dpth (ft)        *     2.91  * Hydr. Depth (ft)          *          *     2.33 *          *
* Conv. Total (cfs)        *   8635.2  * Conv. (cfs)               *          *   8635.2 *          *
* Length Wtd. (ft)         *   350.00  * Wetted Per. (ft)          *          *    30.73 *          *
* Min Ch El (ft)           *   674.84  * Shear (lb/sq ft)          *          *     0.66 *          *
* Alpha                    *     1.00  * Stream Power (lb/ft s)    *          *     5.74 *          *
* Frctn Loss (ft)          *     1.51  * Cum Volume (acre-ft)      *          *     4.86 *          *
* C & E Loss (ft)          *     0.09  * Cum SA (acres)            *          *     1.92 *          *
****************************************************************************************************

Warning: The energy equation could not be balanced within the specified number of iterations.  The program used critical
         depth for the water surface and continued on with the calculations.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
         water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
         program defaulted to critical depth.

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A             RS: 2800

INPUT
Description:
Station Elevation Data     num=        41
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
```

0	700.25	.17	700.24	1.25	700.21	3.97	700.14	8.63	700
13.59	698.58	15.49	698	20.96	696.04	21.06	696.01	21.09	696
22.51	696.04	22.62	696.04	24.29	696.09	25.58	696.08	26.24	696.08
27.8	696.06	29.7	696.07	34.27	696.04	35.98	696.01	36.56	696.01
37.64	696	37.78	696	37.9	695.97	50.3	694	60.67	692.14
61.41	692	65.69	691.46	67.6	691.26	73.02	690.83	75.99	690.65
76.67	690.6	77.53	690.02	80.1	688.32	82.92	686.44	83.71	685.91
102.99	673.05	122.85	673.05	144.66	681.78	160.63	688.16	160.72	688.2
185.49	688.2								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.012	77.53	.012	160.63	.012

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
77.53	160.63	502.05	500	497.75	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	677.34	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.07	Wt. n-Val.		0.012	
W.S. Elev (ft)	675.27	Reach Len. (ft)	502.05	500.00	497.75
Crit W.S. (ft)	675.87	Flow Area (sq ft)		54.07	
E.G. Slope (ft/ft)	0.003934	Area (sq ft)		54.07	
Q Total (cfs)	624.00	Flow (cfs)		624.00	
Top Width (ft)	28.75	Top Width (ft)		28.75	
Vel Total (ft/s)	11.54	Avg. Vel. (ft/s)		11.54	
Max Chl Dpth (ft)	2.22	Hydr. Depth (ft)		1.88	
Conv. Total (cfs)	9948.5	Conv. (cfs)		9948.5	
Length Wtd. (ft)	500.00	Wetted Per. (ft)		29.86	
Min Ch El (ft)	673.05	Shear (lb/sq ft)		0.44	
Alpha	1.00	Stream Power (lb/ft s)		5.13	
Frctn Loss (ft)	2.62	Cum Volume (acre-ft)		4.36	
C & E Loss (ft)	0.06	Cum SA (acres)		1.69	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 2300

INPUT
Description:
Station Elevation Data num= 51

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	694.05	.17	694.05	3.91	694.11	4.37	694.1	8.52	694.06
11.76	694	16.99	692.58	19.16	692	21.33	691.38	24.03	690.55
25.72	690	26.97	689.59	28.2	689.26	32.13	688.05	32.29	688.05
33.04	688.04	34.47	688.02	36.08	688.01	37.04	688.01	37.91	688
44.66	687.08	52.19	686.17	52.86	686.1	53.81	686	72.22	684.06
73.61	684	76.71	683.99	81.26	683.99	81.78	684	82.81	684.33
82.95	684.36	83.38	684.45	83.47	684.48	83.56	684.51	88.29	685.48
90.67	683.95	98.62	678.82	98.96	678.6	99.28	678.4	99.56	678.22
100.35	677.7	101.1	677.22	104.36	675.12	105.49	674.39	105.68	674.27
111.54	670.49	139.75	670.49	142.09	671.43	160.74	678.89	160.82	678.92
188.89	678.92								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.012	90.67	.012	160.74	.012

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
90.67	160.74	103.77	100	99.16	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	674.66	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.64	Wt. n-Val.		0.012	
W.S. Elev (ft)	672.02	Reach Len. (ft)	103.77	100.00	99.16
Crit W.S. (ft)	672.82	Flow Area (sq ft)		47.89	
E.G. Slope (ft/ft)	0.007329	Area (sq ft)		47.89	
Q Total (cfs)	624.00	Flow (cfs)		624.00	
Top Width (ft)	34.40	Top Width (ft)		34.40	
Vel Total (ft/s)	13.03	Avg. Vel. (ft/s)		13.03	
Max Chl Dpth (ft)	1.53	Hydr. Depth (ft)		1.39	
Conv. Total (cfs)	7289.0	Conv. (cfs)		7289.0	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		35.14	
Min Ch El (ft)	670.49	Shear (lb/sq ft)		0.62	
Alpha	1.00	Stream Power (lb/ft s)		8.12	
Frctn Loss (ft)	1.30	Cum Volume (acre-ft)		3.78	
C & E Loss (ft)	0.19	Cum SA (acres)		1.32	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 2200

```
INPUT
Description:
Station Elevation Data    num=      34
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
*******************************************************************************
       0   692.13     .48   692.14    7.77   692.05    9.86   692.03   10.86   692.02
   12.23      692   13.51   691.53   18.16      690   21.37   688.41   22.48      688
   23.94   687.52   29.67      686   31.15   685.87      33   685.73   40.81   685.03
   47.59   684.46   52.08   684.04   53.05   684.02   53.37      684   55.04   683.72
   55.83   683.54   64.71   681.59   66.04    681.3   79.17    676.1    83.4   674.43
    83.9   674.23   84.56   673.97   85.18   673.73     100   667.86  145.68   667.86
  153.45   670.96   168.6   677.02  168.65   677.04  194.91   677.04

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
*************************************************
       0     .012   64.71     .012   168.6     .012

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
         64.71   168.6           247.27      250  249.74              .1         .3

CROSS SECTION OUTPUT  Profile #PF 1
*******************************************************************************************
* E.G. Elev (ft)          *   673.17  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *     4.54  * Wt. n-Val.              *          *    0.012 *          *
* W.S. Elev (ft)          *   668.63  * Reach Len. (ft)         *   247.27 *   250.00 *   249.74 *
* Crit W.S. (ft)          *   669.59  * Flow Area (sq ft)       *          *    36.55 *          *
* E.G. Slope (ft/ft)      *0.028831   * Area (sq ft)            *          *    36.55 *          *
* Q Total (cfs)           *   625.00  * Flow (cfs)              *          *   625.00 *          *
* Top Width (ft)          *    49.54  * Top Width (ft)          *          *    49.54 *          *
* Vel Total (ft/s)        *    17.10  * Avg. Vel. (ft/s)        *          *    17.10 *          *
* Max Chl Dpth (ft)       *     0.77  * Hydr. Depth (ft)        *          *     0.74 *          *
* Conv. Total (cfs)       *   3680.9  * Conv. (cfs)             *          *   3680.9 *          *
* Length Wtd. (ft)        *   250.00  * Wetted Per. (ft)        *          *    49.84 *          *
* Min Ch El (ft)          *   667.86  * Shear (lb/sq ft)        *          *     1.32 *          *
* Alpha                   *     1.00  * Stream Power (lb/ft s)  *          *    22.57 *          *
* Frctn Loss (ft)         *     0.03  * Cum Volume (acre-ft)    *          *     3.68 *          *
* C & E Loss (ft)         *     0.24  * Cum SA (acres)          *          *     1.23 *          *
*******************************************************************************************

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A              RS: 1950

INPUT
Description:
Station Elevation Data    num=      38
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
*******************************************************************************
       0      690     .25      690     .48   689.96    1.63   689.75    1.93    689.7
   11.24      688   14.87   686.82   16.21   686.35   17.91      686    20.1   685.28
    23.9      684   26.32   683.23   27.39   682.95   29.15   682.52   31.74      682
   33.63   681.63   37.15   680.91   38.38   680.56   40.36      680    41.1   679.79
   41.57   679.65    45.9      678   47.39   677.48   51.32      676   56.07   675.01
   62.81      674   64.39   674.23   65.44   674.24   66.19   673.95   88.03    665.3
   94.59   662.71  111.52      656  150.27      656  175.55   666.09   190.1    671.9
  191.38   672.41  215.54    672.3  222.87    672.3

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
*************************************************
       0      .04   66.19      .04   190.1      .04

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
         66.19   190.1           189.26      200   170.1              .1         .3
Ineffective Flow      num=       2
  Sta L   Sta R    Elev  Permanent
      0  116.64     665         F
 145.15  222.87     665         F

CROSS SECTION OUTPUT  Profile #PF 1
*******************************************************************************************
* E.G. Elev (ft)          *   666.75  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *     0.01  * Wt. n-Val.              *          *    0.040 *          *
* W.S. Elev (ft)          *   666.74  * Reach Len. (ft)         *   189.26 *   200.00 *   170.10 *
* Crit W.S. (ft)          *   658.46  * Flow Area (sq ft)       *          *   706.30 *          *
* E.G. Slope (ft/ft)      *0.000040   * Area (sq ft)            *          *   706.30 *          *
* Q Total (cfs)           *   625.00  * Flow (cfs)              *          *   625.00 *          *
* Top Width (ft)          *    92.79  * Top Width (ft)          *          *    92.79 *          *
* Vel Total (ft/s)        *     0.88  * Avg. Vel. (ft/s)        *          *     0.88 *          *
* Max Chl Dpth (ft)       *    10.74  * Hydr. Depth (ft)        *          *     7.61 *          *
* Conv. Total (cfs)       *  98637.6  * Conv. (cfs)             *          *  98637.6 *          *
* Length Wtd. (ft)        *   200.00  * Wetted Per. (ft)        *          *    96.90 *          *
* Min Ch El (ft)          *   656.00  * Shear (lb/sq ft)        *          *     0.02 *          *
* Alpha                   *     1.00  * Stream Power (lb/ft s)  *          *     0.02 *          *
* Frctn Loss (ft)         *           * Cum Volume (acre-ft)    *          *     1.55 *          *
* C & E Loss (ft)         *           * Cum SA (acres)          *          *     0.82 *          *
*******************************************************************************************

Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.
Note:    Hydraulic jump has occurred between this cross section and the previous upstream section.

CULVERT
```

RIVER: Stream A - Post
REACH: Stream A RS: 1800

INPUT
Description: Stream A - Proposed Detention Pond
Distance from Upstream XS = 55
Deck/Roadway Width = 24
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 11

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
65.44	674.24	656	88.03	670	656	94.59	670	656
111.52	670	656	112.895	670	656	117.895	665	656
143.895	665	656	148.895	670	656	150.27	670	656
175.55	670	656	191.38	672.41	656			

Upstream Bridge Cross Section Data
Station Elevation Data num= 38

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	690	.25	690	.48	689.96	1.63	689.75	1.93	689.7
11.24	688	14.87	686.82	16.21	686.35	17.91	686	20.1	685.28
23.9	684	26.32	683.23	27.39	682.95	29.15	682.52	31.74	682
33.63	681.63	37.15	680.91	38.38	680.56	40.36	680	41.1	679.79
41.57	679.65	45.9	678	47.39	677.48	51.32	676	56.07	675.01
62.81	674	64.39	674.23	65.44	674.24	66.19	673.95	88.03	665.3
94.59	662.71	111.52	656	150.27	656	175.55	666.09	190.1	671.9
191.38	672.41	215.54	672.3	222.87	672.3				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	66.19	.04	190.1	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
66.19	190.1	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	116.64	665	F
145.15	222.87	665	F

Downstream Deck/Roadway Coordinates
num= 38

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
35.17	670.58	656	35.89	670	656	35.99	670	656
38.01	670	656	38.2	670	656	51.85	670	656
72.76	670	656	74.94	670	656	75.57	670	656
77.59	670	656	81.56	670	656	84.09	670	656
86.79	670	656	89.24	670	656	107.73	670	656
108.77	670	656	112.8	670	656	121.82	670	656
127.36	670	656	129.93	670	656	133.17	670	656
134.61	670	656	137.26	670	656	142.41	670	656
144.05	670	656	149.05	665	656	152.44	665	656
152.87	665	656	170.44	665	656	171.05	665	656
176.05	670	656	180	670	656	180.5	670	656
192.65	670	656	201.15	670	656	201.44	670	656
209.89	670	656	235.65	670	656			

Downstream Bridge Cross Section Data
Station Elevation Data num= 51

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	670.5	9.2	671.22	13.63	671.57	15	671.65	18.95	671.74
21.85	671.75	22.99	671.68	31.39	671.15	31.89	671.11	32.29	671.05
33.4	670.88	35.17	670.58	35.89	670.46	35.99	670.02	38.01	670
38.2	670	51.85	669.21	72.76	668	74.94	667.98	75.57	667.97
77.59	667.97	81.56	667.71	84.09	667.6	86.79	667.46	89.24	667.34
92.07	667.16	107.73	666.16	108.77	666.09	112.8	666	121.82	665.16
127.36	664.58	129.93	664.32	133.17	664	134.61	663.94	137.26	663.91
142.41	661.46	144.05	659.42	147.21	658.52	152.44	657.04	152.87	656.86
170.44	656.79	172.71	656.78	180	656.78	180.5	656.98	192.65	661.43
201.15	665.26	201.44	665.39	209.89	669.22	215.51	669.35	235.65	669.79
257.17	669.79								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	92.07	.04	215.51	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
92.07	215.51	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	145.75	665	F
174.25	257.17	665	F

Upstream Embankment side slope = 3 horiz. to 1.0 vertical
Downstream Embankment side slope = 3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Circular	4.5	4.5

FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 2 - Mitered to conform to slope
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist Length Top n Bottom n Depth Blocked Entrance Loss Coef Exit Loss Coef

37	63	.024	.024	0	.5	1

Number of Barrels = 3
Upstream Elevation = 659
Centerline Stations

Sta.	Sta.	Sta.
123.895	130.895	137.895

Downstream Elevation = 658
Centerline Stations

Sta.	Sta.	Sta.
153	160	167

CULVERT OUTPUT Profile #PF 1 Culv Group: Culvert #1

Q Culv Group (cfs)	461.29	Culv Full Len (ft)	
# Barrels	3	Culv Vel US (ft/s)	9.67
Q Barrel (cfs)	153.76	Culv Vel DS (ft/s)	12.19
E.G. US. (ft)	666.75	Culv Inv El Up (ft)	659.00
W.S. US. (ft)	666.74	Culv Inv El Dn (ft)	658.00
E.G. DS (ft)	660.78	Culv Frctn Ls (ft)	2.39
W.S. DS (ft)	659.53	Culv Exit Loss (ft)	2.86
Delta EG (ft)	5.98	Culv Entr Loss (ft)	0.73
Delta WS (ft)	7.21	Q Weir (cfs)	163.71
E.G. IC (ft)	666.75	Weir Sta Lft (ft)	116.15
E.G. OC (ft)	665.51	Weir Sta Rgt (ft)	145.64
Culvert Control	Inlet	Weir Submerg	0.00
Culv WS Inlet (ft)	663.50	Weir Max Depth (ft)	1.75
Culv WS Outlet (ft)	661.33	Weir Avg Depth (ft)	1.64
Culv Nml Depth (ft)	4.50	Weir Flow Area (sq ft)	48.52
Culv Crt Depth (ft)	3.63	Min El Weir Flow (ft)	665.01

Warning: The flow through the culvert is supercritical. However, since there is flow over the road (weir flow), the program cannot determine if the downstream cross section should be subcritical or supercritical. The program used the downstream subcritical answer, even though it may not be valid.
Warning: During the supercritical analysis, the program could not converge on a supercritical answer in the downstream cross section. The program used the solution with the least error.
Note: The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height of the culvert.
Note: The flow in the culvert is entirely supercritical.

CROSS SECTION

RIVER: Stream A - Post
REACH: Stream A RS: 1750

INPUT
Description:
Station Elevation Data num= 51

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	670.5	9.2	671.22	13.63	671.57	15	671.65	18.95	671.74
21.85	671.75	22.99	671.68	31.39	671.15	31.89	671.11	32.29	671.05
33.4	670.88	35.17	670.58	35.89	670.46	35.99	670.02	38.01	670
38.2	670	51.85	669.21	72.76	668	74.94	667.98	75.57	667.97
77.59	667.97	81.56	667.71	84.09	667.6	86.79	667.46	89.24	667.34
92.07	667.16	107.73	666.16	108.77	666.09	112.8	666	121.82	665.16
127.36	664.58	129.93	664.32	133.17	664	134.61	663.94	137.26	663.91
142.41	661.46	144.05	659.42	147.21	658.52	152.44	657.04	152.87	656.86
170.44	656.79	172.71	656.78	180	656.78	180.5	656.98	192.65	661.43
201.15	665.26	201.44	665.39	209.89	669.22	215.51	669.35	235.65	669.79
257.17	669.79								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	92.07	.04	215.51	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
92.07	215.51	300.57	249.77	254.53	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	145.75	665	F
174.25	257.17	665	F

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	660.78	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.24	Wt. n-Val.		0.040	
W.S. Elev (ft)	659.53	Reach Len. (ft)	300.57	249.77	254.53
Crit W.S. (ft)	659.53	Flow Area (sq ft)		69.49	
E.G. Slope (ft/ft)	0.017937	Area (sq ft)		96.15	
Q Total (cfs)	622.00	Flow (cfs)		622.00	
Top Width (ft)	43.51	Top Width (ft)		43.51	
Vel Total (ft/s)	8.95	Avg. Vel. (ft/s)		8.95	
Max Chl Dpth (ft)	2.75	Hydr. Depth (ft)		2.44	
Conv. Total (cfs)	4644.2	Conv. (cfs)		4644.2	
Length Wtd. (ft)	249.77	Wetted Per. (ft)		28.80	
Min Ch El (ft)	656.78	Shear (lb/sq ft)		2.70	
Alpha	1.00	Stream Power (lb/ft s)		24.19	
Frctn Loss (ft)	2.20	Cum Volume (acre-ft)		0.81	
C & E Loss (ft)	0.32	Cum SA (acres)		0.51	

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

```
        program defaulted to critical depth.
Note:   Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.

CROSS SECTION


RIVER: Stream A - Post
REACH: Stream A            RS: 1500

INPUT
Description:
Station Elevation Data    num=       85
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0     664    8.35  664.37   33.27   663.8   43.11  662.45   64.85  661.32
   69.42  659.56   74.12  657.75   78.02  657.81   83.51  659.87   83.88  659.88
   89.25  658.47   91.32  658.09   95.96   658.1   98.91   658.1  101.42  658.13
  103.04  658.14  106.17  658.14  106.56  658.15  109.26  658.15  117.42  658.08
     119  658.06  121.79  658.05  126.72  658.01  127.34     658  129.31  657.99
  129.59  657.98  129.89  657.98  131.38  657.97  134.41  657.96  161.72  656.62
  168.68  656.31  170.09  656.27  171.33  656.22   171.6  656.22  172.48  656.19
  173.09  656.17  177.08  656.05  186.48  656.12  196.45  656.03  198.01  656.03
  202.22     656  212.32  655.75  213.65  655.71  213.94   655.7  215.01  655.66
  216.09  655.55  216.59   655.5  218.03  655.35  224.83  655.49  226.53  655.45
  230.58  655.06   230.8  655.04  238.72  654.75  244.28     654  244.86  653.99
  247.87  653.99   250.2     654  252.65  654.23  252.76  654.23  255.83  654.34
  271.73  655.36  281.97     656  282.18     656  290.71  657.51  293.73     658
  293.88  658.03   301.1  659.52   303.5     660  308.75  660.34  330.31     662
  332.33  662.29  333.49  662.43  343.97     664  346.53  664.35  361.86     666
  365.33  666.91  368.68     668  372.95  669.01  377.11     670   379.3     670
  405.17  677.25  414.99     680   422.7  682.16  450.69     690  452.12   690.4

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04  131.38     .04   303.5     .04

Bank Sta: Left    Right    Lengths: Left Channel    Right     Coeff Contr.   Expan.
        131.38    303.5             1500     1500    1500              .1        .3

CROSS SECTION OUTPUT  Profile #PF 1
************************************************************************************************
* E.G. Elev (ft)          *   657.13  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *     0.17  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)          *   656.96  * Reach Len. (ft)        *          *          *          *
* Crit W.S. (ft)          *   656.35  * Flow Area (sq ft)      *          *  185.96  *          *
* E.G. Slope (ft/ft)      *0.005207   * Area (sq ft)           *          *  185.96  *          *
* Q Total (cfs)           *   623.00  * Flow (cfs)             *          *  623.00  *          *
* Top Width (ft)          *   132.81  * Top Width (ft)         *          *  132.81  *          *
* Vel Total (ft/s)        *     3.35  * Avg. Vel. (ft/s)       *          *    3.35  *          *
* Max Chl Dpth (ft)       *     2.97  * Hydr. Depth (ft)       *          *    1.40  *          *
* Conv. Total (cfs)       *   8633.9  * Conv. (cfs)            *          *  8633.9  *          *
* Length Wtd. (ft)        *           * Wetted Per. (ft)       *          *  133.08  *          *
* Min Ch El (ft)          *   653.99  * Shear (lb/sq ft)       *          *    0.45  *          *
* Alpha                   *     1.00  * Stream Power (lb/ft s) *          *    1.52  *          *
* Frctn Loss (ft)         *           * Cum Volume (acre-ft)   *          *          *          *
* C & E Loss (ft)         *           * Cum SA (acres)         *          *          *          *
************************************************************************************************

Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B South      RS: 3310

INPUT
Description:
Station Elevation Data    num=       11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  724.32   41.42  723.57   239.3     720  262.76  719.18   346.4  716.19
  429.51  713.21  436.27  713.01  510.31  715.34   534.4  716.09  651.84     720
  807.46  723.45

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04   239.3     .04  651.84     .04

Bank Sta: Left    Right    Lengths: Left Channel    Right     Coeff Contr.   Expan.
         239.3   651.84           309.88      300  295.42              .1        .3

CROSS SECTION OUTPUT  Profile #PF 1
************************************************************************************************
* E.G. Elev (ft)          *   714.56  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *     0.13  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)          *   714.43  * Reach Len. (ft)        *  309.88  *  300.00  *  295.42  *
* Crit W.S. (ft)          *   714.16  * Flow Area (sq ft)      *          *   62.10  *          *
* E.G. Slope (ft/ft)      *0.009327   * Area (sq ft)           *          *   62.10  *          *
* Q Total (cfs)           *   179.00  * Flow (cfs)             *          *  179.00  *          *
* Top Width (ft)          *    86.17  * Top Width (ft)         *          *   86.17  *          *
* Vel Total (ft/s)        *     2.88  * Avg. Vel. (ft/s)       *          *    2.88  *          *
* Max Chl Dpth (ft)       *     1.42  * Hydr. Depth (ft)       *          *    0.72  *          *
* Conv. Total (cfs)       *   1853.5  * Conv. (cfs)            *          *  1853.5  *          *
* Length Wtd. (ft)        *   300.00  * Wetted Per. (ft)       *          *   86.22  *          *
* Min Ch El (ft)          *   713.01  * Shear (lb/sq ft)       *          *    0.42  *          *
* Alpha                   *     1.00  * Stream Power (lb/ft s) *          *    1.21  *          *
* Frctn Loss (ft)         *     4.53  * Cum Volume (acre-ft)   *    0.26  *    2.05  *    0.04  *
* C & E Loss (ft)         *     0.02  * Cum SA (acres)         *    0.44  *    1.22  *    0.14  *
************************************************************************************************

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
```

1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B South RS: 3010

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	721	78.92	720	163.81	716.97	318.35	710.93	342.1	710
383.76	708.76	389.07	708.64	391.78	708.59	391.8	708.59	393.59	708.62
396.89	708.73	427.38	710	455.02	711.06	516.62	713.43	686.75	720
770.77	722.06	789.96	722.53						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	318.35	.04	455.02	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
318.35	455.02	516.47	370	381.52	.1	.3

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	710.01	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.30	Wt. n-Val.		0.040	
W.S. Elev (ft)	709.71	Reach Len. (ft)	516.47	370.00	381.52
Crit W.S. (ft)	709.71	Flow Area (sq ft)		40.60	
E.G. Slope (ft/ft)	0.028438	Area (sq ft)		40.60	
Q Total (cfs)	179.00	Flow (cfs)		179.00	
Top Width (ft)	68.71	Top Width (ft)		68.71	
Vel Total (ft/s)	4.41	Avg. Vel. (ft/s)		4.41	
Max Chl Dpth (ft)	1.12	Hydr. Depth (ft)		0.59	
Conv. Total (cfs)	1061.5	Conv. (cfs)		1061.5	
Length Wtd. (ft)	373.66	Wetted Per. (ft)		68.75	
Min Ch El (ft)	708.59	Shear (lb/sq ft)		1.05	
Alpha	1.00	Stream Power (lb/ft s)		4.62	
Frctn Loss (ft)	0.07	Cum Volume (acre-ft)	0.26	1.70	0.04
C & E Loss (ft)	0.09	Cum SA (acres)	0.44	0.69	0.14

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B South RS: 2630

INPUT
Description:
Station Elevation Data num= 94

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	706	6.35	706	16.51	706.18	16.71	706.18	18.38	706.16
19.06	706.16	19.34	706.18	19.81	706.17	20.05	706.17	22.6	706.14
24.52	706.14	24.8	706.17	26.05	706.17	27.15	706.16	31.77	706.16
34.83	706.14	47.87	706.1	55.94	706.07	58.54	706.06	60.17	706.05
78.51	706.01	79.02	706.01	80.09	706	82.63	706	84.1	705.99
87.37	705.99	87.63	706	89.01	706	89.59	705.99	90.88	705.99
94.84	705.96	100.11	705.96	102.65	705.95	104.2	705.95	119.87	705.96
121.12	705.95	121.41	705.95	123.99	705.97	124.24	705.97	126.97	706
130.26	706	130.96	705.89	130.99	705.89	135.95	705.73	140.88	705.88
141.06	705.88	143.18	705.98	143.23	705.97	143.29	705.97	143.34	705.96
143.4	705.95	151.36	705.14	152.24	705.06	153.64	705.1	154.87	705.08
156.85	704.84	157.98	704.19	158	704.19	164.18	704	224.54	704
225.85	703.77	226.41	703.72	230.62	703.17	232.89	702.87	242.17	699.71
276.56	699.71	290.28	702.71	292.46	702.81	298.25	703.61	298.92	703.73
299.13	703.73	299.67	703.75	303.61	704	307.66	704.12	316.68	704.4
316.91	704.41	321.22	704.41	321.58	704.42	391.2	705.99	395.31	705.99
396.1	706	399.68	705.99	400.05	705.99	405.93	706	418.79	706
419.88	706.05	456.82	707.96	457.69	707.97	458.62	707.98	462.26	708
462.32	708.01	463.96	708.01	489.58	709.14	497.03	709.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	224.54	.04	303.61	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
224.54	303.61	46.23	45	43.18	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	250.4	704.5	F
268.36	497.03	704.5	F

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	704.67	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.	0.040	0.040	0.040

W.S. Elev (ft)	704.67	Reach Len. (ft)	46.23	45.00	43.18
Crit W.S. (ft)	701.17	Flow Area (sq ft)	44.10	276.86	8.78
E.G. Slope (ft/ft)	0.000052	Area (sq ft)	44.10	276.86	8.78
Q Total (cfs)	179.00	Flow (cfs)	8.87	169.08	1.06
Top Width (ft)	175.45	Top Width (ft)	67.39	79.07	28.99
Vel Total (ft/s)	0.54	Avg. Vel. (ft/s)	0.20	0.61	0.12
Max Chl Dpth (ft)	4.96	Hydr. Depth (ft)	0.65	3.50	0.30
Conv. Total (cfs)	24897.1	Conv. (cfs)	1233.2	23516.7	147.2
Length Wtd. (ft)	45.00	Wetted Per. (ft)	67.52	80.07	29.00
Min Ch El (ft)	699.71	Shear (lb/sq ft)	0.00	0.01	0.00
Alpha	1.20	Stream Power (lb/ft s)	0.00	0.01	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)		0.35	
C & E Loss (ft)		Cum SA (acres)	0.04	0.06	0.01

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CULVERT

RIVER: Stream B - Post
REACH: Stream B South RS: 2610

INPUT
Description: Stream B - County Road 313 Crossing
Distance from Upstream XS = 15
Deck/Roadway Width = 25
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 24

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
156.85	704.84	704.84	157.98	704.5	704.19	158	704.5	704.19
164.18	704.5	704	224.54	704.5	704	225.85	704.5	703.77
226.41	704.5	703.72	230.62	704.5	703.17	232.89	704.5	702.87
242.17	704.5	699.71	276.56	704.5	699.71	290.28	704.5	702.71
292.46	704.5	702.81	298.25	704.5	703.61	298.92	704.5	703.73
299.13	704.5	703.73	299.67	704.5	703.75	303.61	704.5	704
307.66	704.5	704.12	316.68	704.5	704.4	316.91	704.5	704.41
321.22	704.5	704.41	321.58	704.5	704.42	391.2	705.99	705.99

Upstream Bridge Cross Section Data
Station Elevation Data num= 94

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	706	6.35	706	16.51	706.18	16.71	706.18	18.38	706.16
19.06	706.16	19.34	706.18	19.81	706.17	20.05	706.17	22.6	706.14
24.52	706.14	24.8	706.17	26.05	706.17	27.15	706.16	31.77	706.16
34.83	706.14	47.87	706.1	55.94	706.07	58.54	706.06	60.17	706.05
78.51	706.01	79.02	706.01	80.09	706	82.63	706	84.1	705.99
87.37	705.99	87.63	706	89.01	706	89.59	705.99	90.88	705.99
94.84	705.96	100.11	705.96	102.65	705.95	104.2	705.95	119.87	705.96
121.12	705.95	121.41	705.95	123.99	705.97	124.24	705.97	126.97	706
130.26	706	130.96	705.89	130.99	705.89	135.95	705.73	140.88	705.88
141.06	705.88	143.18	705.98	143.23	705.97	143.29	705.97	143.34	705.96
143.4	705.95	151.36	705.14	152.24	705.06	153.64	705.1	154.87	705.08
156.85	704.84	157.98	704.19	158	704.19	164.18	704	224.54	704
225.85	703.77	226.41	703.72	230.62	703.17	232.89	702.87	242.17	699.71
276.56	699.71	290.28	702.71	292.46	702.81	298.25	703.61	298.92	703.73
299.13	703.73	299.67	703.75	303.61	704	307.66	704.12	316.68	704.4
316.91	704.41	321.22	704.41	321.58	704.42	391.2	705.99	395.31	705.99
396.1	706	399.68	705.99	400.05	705.99	405.93	706	418.79	706
419.88	706.05	456.82	707.96	457.69	707.97	458.62	707.98	462.26	708
462.32	708.01	463.96	708.01	489.58	709.14	497.03	709.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	224.54	.04	303.61	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
224.54	303.61	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	250.4	704.5	F
268.36	497.03	704.5	F

Downstream Deck/Roadway Coordinates
num= 5

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
148	704.83	704.83	175.11	704.5	699.74	197.91	704.5	699.74
217.48	704.5	703.93	220.79	704.54	704.54			

Downstream Bridge Cross Section Data
Station Elevation Data num= 91

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	705.99	1.38	705.99	6.19	706	46.04	706	49.03	706.01
50.17	706	52.7	706	53.62	705.99	54.86	706	69.12	706
69.5	705.99	69.98	706	70.14	706	70.43	705.99	70.82	705.97
71.61	705.98	72.27	705.95	72.87	705.96	73.73	705.94	74.06	705.93
74.66	705.9	75.2	705.91	75.74	705.9	76.24	705.89	76.78	705.87
77.28	705.87	78.54	705.84	78.87	705.83	79.44	705.8	79.95	705.81
84.22	705.69	84.61	705.65	87.21	705.61	94.75	705.51	99.42	705.37
99.6	705.37	99.82	705.36	110.37	705.17	111.16	705.19	111.76	705.2
112.72	705.22	115.18	705.27	117.72	705.33	118.09	705.34	123.91	705.1
132.14	705.08	136.52	705.05	137.23	705.04	145.65	704.97	146.3	704.92
148	704.83	175.11	699.74	197.91	699.74	217.48	703.93	220.79	704.54
227.92	704.57	228.79	704.58	231.93	704.61	233.32	704.62	240.8	704.67
244.24	704.7	245.57	704.72	249.06	704.76	249.44	704.76	251.17	704.78
251.25	704.78	260.49	704.64	261.56	704.64	262.31	704.63	263.01	704.63
265.55	704.55	269.98	704.51	272.47	704.43	280.82	704.43	289.58	705.54
289.93	705.54	298.53	705.58	299.37	705.58	299.84	705.59	308.24	705.77

```
  310.9  705.79  312.48  705.81  313.54  705.82  315.18  705.86  317.96  705.88
 323.76  705.96  326.96  705.94  331.52  705.98  332.25  705.96  332.91  705.99
 340.85  706.21

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04  145.65     .04  220.79     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
        145.65  220.79            .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0  177.51   704.5       F
  195.51  340.85   704.5       F

Upstream Embankment side slope             =       0 horiz. to 1.0 vertical
Downstream Embankment side slope           =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  2

Culvert Name     Shape      Rise    Span
Culvert #1      Circular     3.5     3.5
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 1 - Headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 15      25     .024     .024         0                     .5                 1
Upstream   Elevation =  699.71
           Centerline Station =  257.15
Downstream Elevation =  699.71
           Centerline Station =  184.26

Culvert Name     Shape      Rise    Span
Culvert #2      Circular     3.5     3.5
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 1 - Headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 15      25     .024     .024         0                     .5                 1
Upstream   Elevation =  699.84
           Centerline Station =  261.61
Downstream Elevation =  699.84
           Centerline Station =  188.76

CULVERT OUTPUT  Profile #PF 1  Culv Group:  Culvert #1
*************************************************************************
* Q Culv Group (cfs)      *   74.40  * Culv Full Len (ft)     *    3.84  *
* # Barrels               *       1  * Culv Vel US (ft/s)     *    7.73  *
* Q Barrel (cfs)          *   74.40  * Culv Vel DS (ft/s)     *    9.34  *
* E.G. US. (ft)           *  704.67  * Culv Inv El Up (ft)    *  699.71  *
* W.S. US. (ft)           *  704.67  * Culv Inv El Dn (ft)    *  699.71  *
* E.G. DS (ft)            *  701.92  * Culv Frctn Ls (ft)     *    0.44  *
* W.S. DS (ft)            *  701.19  * Culv Exit Loss (ft)    *    1.85  *
* Delta EG (ft)           *    2.75  * Culv Entr Loss (ft)    *    0.46  *
* Delta WS (ft)           *    3.48  * Q Weir (cfs)           *   32.33  *
* E.G. IC (ft)            *  704.39  * Weir Sta Lft (ft)      *  157.39  *
* E.G. OC (ft)            *  704.68  * Weir Sta Rgt (ft)      *  329.86  *
* Culvert Control         *  Outlet  * Weir Submerg           *    0.00  *
* Culv WS Inlet (ft)      *  703.21  * Weir Max Depth (ft)    *    0.18  *
* Culv WS Outlet (ft)     *  702.41  * Weir Avg Depth (ft)    *    0.17  *
* Culv Nml Depth (ft)     *          * Weir Flow Area (sq ft) *   29.77  *
* Culv Crt Depth (ft)     *    2.70  * Min El Weir Flow (ft)  *  704.51  *
*************************************************************************

CULVERT OUTPUT  Profile #PF 1  Culv Group:  Culvert #2
*************************************************************************
* Q Culv Group (cfs)      *   72.27  * Culv Full Len (ft)     *    0.96  *
* # Barrels               *       1  * Culv Vel US (ft/s)     *    7.51  *
* Q Barrel (cfs)          *   72.27  * Culv Vel DS (ft/s)     *    9.20  *
* E.G. US. (ft)           *  704.67  * Culv Inv El Up (ft)    *  699.84  *
* W.S. US. (ft)           *  704.67  * Culv Inv El Dn (ft)    *  699.84  *
* E.G. DS (ft)            *  701.92  * Culv Frctn Ls (ft)     *    0.42  *
* W.S. DS (ft)            *  701.19  * Culv Exit Loss (ft)    *    1.90  *
* Delta EG (ft)           *    2.75  * Culv Entr Loss (ft)    *    0.44  *
* Delta WS (ft)           *    3.48  * Q Weir (cfs)           *   32.33  *
* E.G. IC (ft)            *  704.39  * Weir Sta Lft (ft)      *  157.39  *
* E.G. OC (ft)            *  704.67  * Weir Sta Rgt (ft)      *  329.86  *
* Culvert Control         *  Outlet  * Weir Submerg           *    0.00  *
* Culv WS Inlet (ft)      *  703.34  * Weir Max Depth (ft)    *    0.18  *
* Culv WS Outlet (ft)     *  702.50  * Weir Avg Depth (ft)    *    0.17  *
* Culv Nml Depth (ft)     *          * Weir Flow Area (sq ft) *   29.77  *
* Culv Crt Depth (ft)     *    2.66  * Min El Weir Flow (ft)  *  704.51  *
*************************************************************************

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B South      RS: 2585

INPUT
Description:
Station Elevation Data     num=       91
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
*************************************************************************************
       0   705.99    1.38   705.99    6.19      706   46.04      706   49.03   706.01
   50.17      706    52.7      706   53.62   705.99   54.86      706   69.12      706
    69.5   705.99   69.98      706   70.14      706   70.43   705.99   70.82   705.97
```

```
   71.61  705.98    72.27  705.95    72.87  705.96    73.73  705.94    74.06  705.93
   74.66   705.9     75.2  705.91    75.74   705.9    76.24  705.89    76.78  705.87
   77.28  705.87    78.54  705.84    78.87  705.83    79.44   705.8    79.95  705.81
   84.22  705.69    84.61  705.65    87.21  705.61    94.75  705.51    99.42  705.37
    99.6  705.37    99.82  705.36   110.37  705.17   111.16  705.19   111.76   705.2
  112.72  705.22   115.18  705.27   117.72  705.33   118.09  705.34   123.91   705.1
  132.14  705.08   136.52  705.05   137.23  705.04   145.65  704.97    146.3  704.92
     148  704.83   175.11  699.74   197.91  699.74   217.48  703.93   220.79  704.54
  227.92  704.57   228.79  704.58   231.93  704.61   233.32  704.62    240.8  704.67
  244.24   704.7   245.57  704.72   249.06  704.76   249.44  704.76   251.17  704.78
  251.25  704.78   260.49  704.64   261.56  704.64   262.31  704.63   263.01  704.63
  265.55  704.55   269.98  704.51   272.47  704.43   280.82  704.43   289.58  705.54
  289.93  705.54   298.53  705.58   299.37  705.58   299.84  705.59   308.24  705.77
   310.9  705.79   312.48  705.81   313.54  705.82   315.18  705.86   317.96  705.88
  323.76  705.96   326.96  705.94   331.52  705.98   332.25  705.96   332.91  705.99
  340.85  706.21

Manning's n Values         num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
*************************************************
       0     .04   145.65     .04   220.79     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        145.65  220.79             97.84      110  136.17            .1        .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev  Permanent
       0  177.51   704.5      F
  195.51  340.85   704.5      F

CROSS SECTION OUTPUT  Profile #PF 1
*******************************************************************************************
* E.G. Elev (ft)          *  701.92  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.73  * Wt. n-Val.              *          *    0.040 *          *
* W.S. Elev (ft)          *  701.19  * Reach Len. (ft)         *    45.22 *    45.22 *    45.22 *
* Crit W.S. (ft)          *  701.19  * Flow Area (sq ft)       *          *    26.07 *          *
* E.G. Slope (ft/ft)      *0.020843  * Area (sq ft)            *          *    43.51 *          *
* Q Total (cfs)           *  179.00  * Flow (cfs)              *          *   179.00 *          *
* Top Width (ft)          *   37.28  * Top Width (ft)          *          *    37.28 *          *
* Vel Total (ft/s)        *    6.87  * Avg. Vel. (ft/s)        *          *     6.87 *          *
* Max Chl Dpth (ft)       *    1.45  * Hydr. Depth (ft)        *          *     1.45 *          *
* Conv. Total (cfs)       *  1239.8  * Conv. (cfs)             *          *   1239.8 *          *
* Length Wtd. (ft)        *   45.22  * Wetted Per. (ft)        *          *    18.00 *          *
* Min Ch El (ft)          *  699.74  * Shear (lb/sq ft)        *          *     1.88 *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s)  *          *    12.94 *          *
* Frctn Loss (ft)         *    0.01  * Cum Volume (acre-ft)    *          *     0.19 *          *
* C & E Loss (ft)         *    0.21  * Cum SA (acres)          *          *          *          *
*******************************************************************************************

Warning: The energy equation could not be balanced within the specified number of iterations.  The program used critical
           depth for the water surface and continued on with the calculations.
Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
         water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
         program defaulted to critical depth.
Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B            RS: 2220

INPUT
Description:
Station Elevation Data     num=       15
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
********************************************************************************
       0  702.89     9.51  702.89    10.59  702.44    19.14  698.93    35.95     692
   68.61     692    70.41  692.72    85.88  698.91    95.07  702.59   103.58  706.01
  103.66  706.01   104.12  706.07   111.16  706.89   115.84  707.43   117.66  707.64

Manning's n Values         num=        3
     Sta   n Val      Sta   n Val      Sta   n Val
*************************************************
       0     .04     9.51     .04   103.66     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          9.51  103.66            294.85      300  298.89            .1        .3

CROSS SECTION OUTPUT  Profile #PF 1
*******************************************************************************************
* E.G. Elev (ft)          *  698.71  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.03  * Wt. n-Val.              *          *    0.040 *          *
* W.S. Elev (ft)          *  698.68  * Reach Len. (ft)         *   294.85 *   300.00 *   298.89 *
* Crit W.S. (ft)          *  693.70  * Flow Area (sq ft)       *          *   328.04 *          *
* E.G. Slope (ft/ft)      *0.000162  * Area (sq ft)            *          *   328.04 *          *
* Q Total (cfs)           *  442.00  * Flow (cfs)              *          *   442.00 *          *
* Top Width (ft)          *   65.56  * Top Width (ft)          *          *    65.56 *          *
* Vel Total (ft/s)        *    1.35  * Avg. Vel. (ft/s)        *          *     1.35 *          *
* Max Chl Dpth (ft)       *    6.68  * Hydr. Depth (ft)        *          *     5.00 *          *
* Conv. Total (cfs)       * 34734.0  * Conv. (cfs)             *          *  34734.0 *          *
* Length Wtd. (ft)        *  300.00  * Wetted Per. (ft)        *          *    68.17 *          *
* Min Ch El (ft)          *  692.00  * Shear (lb/sq ft)        *          *     0.05 *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s)  *          *     0.07 *          *
* Frctn Loss (ft)         *    0.05  * Cum Volume (acre-ft)    *     0.71 *     9.16 *     1.29 *
* C & E Loss (ft)         *    0.00  * Cum SA (acres)          *     1.51 *     2.65 *     1.57 *
*******************************************************************************************

CROSS SECTION
```

```
RIVER: Stream B - Post
REACH: Stream B          RS: 1920

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  702.55    8.09  702.54    8.87  702.19   30.98  692.15   31.32     692
   60.29     692  100.39  708.02  100.73  708.16  101.64  708.53  103.62   709.7
  104.05     710  109.01     710  114.47  709.97  115.25  709.97

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************
       0     .04    8.09     .04  100.73     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          8.09  100.73             400.37     400  399.56             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)         *  698.65  * Element                * Left OB *  Channel * Right OB *
* Vel Head (ft)          *    0.03  * Wt. n-Val.             *         *   0.040  *          *
* W.S. Elev (ft)         *  698.62  * Reach Len. (ft)        * 400.37  *  400.00  *  399.56  *
* Crit W.S. (ft)         *          * Flow Area (sq ft)      *         *  294.81  *          *
* E.G. Slope (ft/ft)     *0.000207  * Area (sq ft)           *         *  294.81  *          *
* Q Total (cfs)          *  442.00  * Flow (cfs)             *         *  442.00  *          *
* Top Width (ft)         *   60.12  * Top Width (ft)         *         *   60.12  *          *
* Vel Total (ft/s)       *    1.50  * Avg. Vel. (ft/s)       *         *    1.50  *          *
* Max Chl Dpth (ft)      *    6.62  * Hydr. Depth (ft)       *         *    4.90  *          *
* Conv. Total (cfs)      * 30696.8  * Conv. (cfs)            *         * 30696.8  *          *
* Length Wtd. (ft)       *  400.00  * Wetted Per. (ft)       *         *   62.82  *          *
* Min Ch El (ft)         *  692.00  * Shear (lb/sq ft)       *         *    0.06  *          *
* Alpha                  *    1.00  * Stream Power (lb/ft s) *         *    0.09  *          *
* Frctn Loss (ft)        *    0.12  * Cum Volume (acre-ft)   *   0.71  *    7.01  *    1.29  *
* C & E Loss (ft)        *    0.00  * Cum SA (acres)         *   1.51  *    2.22  *    1.57  *
*********************************************************************************************

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B          RS: 1520

INPUT
Description:
Station Elevation Data    num=      15
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  702.07   14.15  702.07   14.31  701.94   16.13  700.43   16.43  700.46
   22.42  697.74   33.67     692   77.35     692   82.62  694.11  106.96  703.85
   107.7  704.14  114.72  705.11  117.69  705.44  120.99  705.87  121.27  705.87

Manning's n Values          num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************
       0     .04   14.15     .04  106.96     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         14.15  106.96             109.76     110  109.65             .1       .3
Ineffective Flow      num=       2
   Sta L   Sta R    Elev  Permanent
       0   39.19     697       F
   68.69  121.27     697       F

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)         *  698.53  * Element                * Left OB *  Channel * Right OB *
* Vel Head (ft)          *    0.07  * Wt. n-Val.             *         *   0.040  *          *
* W.S. Elev (ft)         *  698.46  * Reach Len. (ft)        * 109.76  *  110.00  *  109.65  *
* Crit W.S. (ft)         *  694.84  * Flow Area (sq ft)      *         *  375.10  *          *
* E.G. Slope (ft/ft)     *0.000386  * Area (sq ft)           *         *  375.10  *          *
* Q Total (cfs)          *  798.00  * Flow (cfs)             *         *  798.00  *          *
* Top Width (ft)         *   72.65  * Top Width (ft)         *         *   72.65  *          *
* Vel Total (ft/s)       *    2.13  * Avg. Vel. (ft/s)       *         *    2.13  *          *
* Max Chl Dpth (ft)      *    6.46  * Hydr. Depth (ft)       *         *    5.16  *          *
* Conv. Total (cfs)      * 40597.3  * Conv. (cfs)            *         * 40597.3  *          *
* Length Wtd. (ft)       *  110.00  * Wetted Per. (ft)       *         *   75.43  *          *
* Min Ch El (ft)         *  692.00  * Shear (lb/sq ft)       *         *    0.12  *          *
* Alpha                  *    1.00  * Stream Power (lb/ft s) *         *    0.26  *          *
* Frctn Loss (ft)        *          * Cum Volume (acre-ft)   *   0.71  *    3.94  *    1.29  *
* C & E Loss (ft)        *          * Cum SA (acres)         *   1.51  *    1.61  *    1.57  *
*********************************************************************************************

Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.

CULVERT


RIVER: Stream B - Post
REACH: Stream B          RS: 1475

INPUT
Description: Stream B - Proposed Detention Pond
Distance from Upstream XS =       45
Deck/Roadway Width        =       35
Weir Coefficient          =      2.6
Upstream  Deck/Roadway Coordinates
   num=       5
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
****************************************************************************
   22.42     697     697   33.67     697     692   77.35     697     692
   82.62     697  694.11  106.96     697     697
```

```
Upstream Bridge Cross Section Data
Station Elevation Data    num=      15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
*********************************************************************************
       0   702.07    14.15   702.07    14.31   701.94    16.13   700.43    16.43   700.46
   22.42   697.74    33.67      692    77.35      692    82.62   694.11   106.96   703.85
   107.7   704.14   114.72   705.11   117.69   705.44   120.99   705.87   121.27   705.87

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
************************************************
       0      .04    14.15      .04   106.96      .04

Bank Sta: Left    Right    Coeff Contr.   Expan.
         14.15   106.96             .1       .3
Ineffective Flow     num=       2
   Sta L    Sta R    Elev  Permanent
       0    39.19     697       F
   68.69   121.27     697       F

Downstream  Deck/Roadway Coordinates
    num=       7
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
*************************************************************************
    12.1     697     697    20.37     697  693.97    25.13     697  691.64
   39.89     697  691.65    47.52     697  691.65    71.38     697  691.66
   92.89     697     697

Downstream Bridge Cross Section Data
Station Elevation Data    num=      17
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
*********************************************************************************
       0   701.65     5.73    701.6     5.75   701.58    10.03   698.75     12.1   697.46
   20.37   693.97    25.13   691.64    39.89   691.65    47.52   691.65    71.38   691.66
   92.89   700.26    98.94   702.69    99.28   702.82   104.87   703.13   106.56   703.21
  114.32   703.25   119.78   703.29

Manning's n Values         num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
************************************************
       0     .012     5.75     .012    98.94     .012

Bank Sta: Left    Right    Coeff Contr.   Expan.
          5.75    98.94             .1       .3
Ineffective Flow     num=       2
   Sta L    Sta R    Elev  Permanent
       0    33.51     697       F
   63.01   119.78     697       F

Upstream Embankment side slope             =       3 horiz. to 1.0 vertical
Downstream Embankment side slope           =       3 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins        =
Energy head used in spillway design        =
Spillway height used in design             =
Weir crest shape                           = Broad Crested

Number of Culverts =  1

Culvert Name      Shape      Rise    Span
Culvert #1      Circular      3.5     3.5
FHWA Chart # 1 - Concrete Pipe Culvert
FHWA Scale # 1 - Square edge entrance with headwall
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
                 30      65     .013     .013        0                  .5                 1
Number of Barrels =  5
Upstream  Elevation =  692.5
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
  45.935  49.935  53.935  57.935  61.935
Downstream Elevation =  692
Centerline Stations
    Sta.    Sta.    Sta.    Sta.    Sta.
   40.26   44.26   48.26   52.26   56.26

CULVERT OUTPUT  Profile #PF 1  Culv Group:  Culvert #1
**************************************************************************
* Q Culv Group (cfs)      *  463.68  * Culv Full Len (ft)      *          *
* # Barrels               *       5  * Culv Vel US (ft/s)      *    9.64  *
* Q Barrel (cfs)          *   92.74  * Culv Vel DS (ft/s)      *   12.65  *
* E.G. US. (ft)           *  698.53  * Culv Inv El Up (ft)     *  692.50  *
* W.S. US. (ft)           *  698.46  * Culv Inv El Dn (ft)     *  692.00  *
* E.G. DS (ft)            *  694.82  * Culv Frctn Ls (ft)      *    0.83  *
* W.S. DS (ft)            *  693.76  * Culv Exit Loss (ft)     *    2.16  *
* Delta EG (ft)           *    3.71  * Culv Entr Loss (ft)     *    0.72  *
* Delta WS (ft)           *    4.70  * Q Weir (cfs)            *  334.32  *
* E.G. IC (ft)            *  698.53  * Weir Sta Lft (ft)       *   20.70  *
* E.G. OC (ft)            *  698.08  * Weir Sta Rgt (ft)       *   93.65  *
* Culvert Control         *   Inlet  * Weir Submerg            *    0.00  *
* Culv WS Inlet (ft)      *  696.00  * Weir Max Depth (ft)     *    1.52  *
* Culv WS Outlet (ft)     *  694.49  * Weir Avg Depth (ft)     *    1.45  *
* Culv Nml Depth (ft)     *    3.06  * Weir Flow Area (sq ft)  *  105.63  *
* Culv Crt Depth (ft)     *    2.98  * Min El Weir Flow (ft)   *  697.01  *
**************************************************************************

Warning: The flow through the culvert is supercritical.  However, since there is flow over the road (weir flow), the program
         cannot determine if the downstream cross section should be subcritical or supercritical.  The program used the
         downstream subcritical answer, even though it may not be valid.
Note:    The flow in the culvert is entirely supercritical.

CROSS SECTION
```

```
RIVER: Stream B - Post
REACH: Stream B          RS: 1410

INPUT
Description:
Station Elevation Data    num=      17
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  701.65    5.73   701.6    5.75  701.58   10.03  698.75    12.1  697.46
   20.37  693.97   25.13  691.64   39.89  691.65   47.52  691.65   71.38  691.66
   92.89  700.26   98.94  702.69   99.28  702.82  104.87  703.13  106.56  703.21
  114.32  703.25  119.78  703.29

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0    .012    5.75    .012   98.94    .012

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          5.75   98.94            139.22     140  141.54             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0   33.51     697       F
   63.01  119.78     697       F

CROSS SECTION OUTPUT  Profile #PF 1
**********************************************************************************************
* E.G. Elev (ft)           *   694.82  * Element                  *  Left OB *  Channel * Right OB *
* Vel Head (ft)            *     1.06  * Wt. n-Val.               *          *   0.012  *          *
* W.S. Elev (ft)           *   693.76  * Reach Len. (ft)          *  139.22  *  140.00  *  141.54  *
* Crit W.S. (ft)           *   693.76  * Flow Area (sq ft)        *          *   62.19  *          *
* E.G. Slope (ft/ft)       *0.001642  * Area (sq ft)             *          *  107.61  *          *
* Q Total (cfs)            *   513.00  * Flow (cfs)               *          *  513.00  *          *
* Top Width (ft)           *    55.83  * Top Width (ft)           *          *   55.83  *          *
* Vel Total (ft/s)         *     8.25  * Avg. Vel. (ft/s)         *          *    8.25  *          *
* Max Chl Dpth (ft)        *     2.12  * Hydr. Depth (ft)         *          *    2.11  *          *
* Conv. Total (cfs)        *  12661.1  * Conv. (cfs)              *          * 12661.1  *          *
* Length Wtd. (ft)         *   140.00  * Wetted Per. (ft)         *          *   29.50  *          *
* Min Ch El (ft)           *   691.64  * Shear (lb/sq ft)         *          *    0.22  *          *
* Alpha                    *     1.00  * Stream Power (lb/ft s)   *          *    1.78  *          *
* Frctn Loss (ft)          *     0.46  * Cum Volume (acre-ft)     *    0.71  *    3.43  *    1.29  *
* C & E Loss (ft)          *     0.19  * Cum SA (acres)           *    1.51  *    1.45  *    1.57  *
**********************************************************************************************

Warning: The energy equation could not be balanced within the specified number of iterations.  The program used critical
         depth for the water surface and continued on with the calculations.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
         water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
         program defaulted to critical depth.
Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B          RS: 1270

INPUT
Description:
Station Elevation Data    num=      19
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  700.34    8.12  700.19   11.67  698.48   30.97  689.75   42.66  689.77
   51.11  689.78   53.88  689.78    80.1  700.01   81.28  700.47   82.75  701.05
   83.51  701.07   83.76  701.07    84.1  701.08   85.02   701.1   85.74  701.12
   87.52  701.16   90.77  701.22   91.57  701.24   93.36  701.27

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0    .012    8.12    .012   82.75    .012

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          8.12   82.75             417.1     450  465.86             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
**********************************************************************************************
* E.G. Elev (ft)           *   694.16  * Element                  *  Left OB *  Channel * Right OB *
* Vel Head (ft)            *     2.99  * Wt. n-Val.               *          *   0.012  *          *
* W.S. Elev (ft)           *   691.18  * Reach Len. (ft)          *  417.10  *  450.00  *  465.86  *
* Crit W.S. (ft)           *   692.06  * Flow Area (sq ft)        *          *   36.99  *          *
* E.G. Slope (ft/ft)       *0.009577  * Area (sq ft)             *          *   36.99  *          *
* Q Total (cfs)            *   513.00  * Flow (cfs)               *          *  513.00  *          *
* Top Width (ft)           *    29.64  * Top Width (ft)           *          *   29.64  *          *
* Vel Total (ft/s)         *    13.87  * Avg. Vel. (ft/s)         *          *   13.87  *          *
* Max Chl Dpth (ft)        *     1.43  * Hydr. Depth (ft)         *          *    1.25  *          *
* Conv. Total (cfs)        *   5242.0  * Conv. (cfs)              *          *  5242.0  *          *
* Length Wtd. (ft)         *   450.00  * Wetted Per. (ft)         *          *   30.21  *          *
* Min Ch El (ft)           *   689.75  * Shear (lb/sq ft)         *          *    0.73  *          *
* Alpha                    *     1.00  * Stream Power (lb/ft s)   *          *   10.15  *          *
* Frctn Loss (ft)          *     6.06  * Cum Volume (acre-ft)     *    0.71  *    3.20  *    1.29  *
* C & E Loss (ft)          *     0.59  * Cum SA (acres)           *    1.51  *    1.31  *    1.57  *
**********************************************************************************************

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.
Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, water surface was used.

CROSS SECTION
```

```
RIVER: Stream B - Post
REACH: Stream B            RS: 820

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  696.73    1.91     696   13.26  691.63   32.85   684.1   43.49  684.12
   47.15  684.14   53.68  684.17   72.01   691.6   82.21  695.72   82.27  695.75
   82.74  695.61   87.94  695.29   95.26  694.96

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04    1.91     .04   82.21     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          1.91   82.21           493.97     150  138.84             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
***********************************************************************************************
* E.G. Elev (ft)         *  687.51  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)          *    1.01  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)         *  686.50  * Reach Len. (ft)        *  493.97  *  150.00  *  138.84  *
* Crit W.S. (ft)         *  686.52  * Flow Area (sq ft)      *          *   63.50  *          *
* E.G. Slope (ft/ft)     *0.020329  * Area (sq ft)           *          *   63.50  *          *
* Q Total (cfs)          *  513.00  * Flow (cfs)             *          *  513.00  *          *
* Top Width (ft)         *   32.81  * Top Width (ft)         *          *   32.81  *          *
* Vel Total (ft/s)       *    8.08  * Avg. Vel. (ft/s)       *          *    8.08  *          *
* Max Chl Dpth (ft)      *    2.40  * Hydr. Depth (ft)       *          *    1.94  *          *
* Conv. Total (cfs)      *  3598.0  * Conv. (cfs)            *          *  3598.0  *          *
* Length Wtd. (ft)       *  150.00  * Wetted Per. (ft)       *          *   33.70  *          *
* Min Ch El (ft)         *  684.10  * Shear (lb/sq ft)       *          *    2.39  *          *
* Alpha                  *    1.00  * Stream Power (lb/ft s) *          *   19.32  *          *
* Frctn Loss (ft)        *    9.84  * Cum Volume (acre-ft)   *    0.71  *    2.68  *    1.29  *
* C & E Loss (ft)        *    0.58  * Cum SA (acres)         *    1.51  *    0.99  *    1.57  *
***********************************************************************************************

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.

CROSS SECTION


RIVER: Stream B - Post
REACH: Stream B            RS: 670

INPUT
Description:
Station Elevation Data    num=      43
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0     696   27.31  685.08      65     670  145.63     670  160.15  675.53
  160.86   675.8  160.91   675.8  173.52  675.93  173.68  675.94  175.25     676
  180.61     676  181.18  676.03  181.26  676.03  181.29  676.04  182.88  676.39
  186.86     678   188.8   678.8  191.09  679.73  191.46  679.85  191.79     680
  194.91  681.24   196.1   681.6     197     682  197.97  682.28  198.26  682.35
  200.75   682.8  203.06  682.74  203.68  682.65  204.84  682.38  205.26  682.38
  206.53  682.56  207.34  682.59  208.48  682.71  210.21  682.91  212.96  683.28
  214.95  683.52  215.53  683.61  217.59  683.64  222.48  683.95  224.57  683.93
   226.9  683.95   228.8     684  228.96  684.01

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04       0     .04  160.86     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
             0  160.86          1836.03     150   60.93             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
***********************************************************************************************
* E.G. Elev (ft)         *  677.09  * Element                *  Left OB *  Channel * Right OB *
* Vel Head (ft)          *    6.79  * Wt. n-Val.             *          *   0.040  *          *
* W.S. Elev (ft)         *  670.30  * Reach Len. (ft)        * 1836.03  *  150.00  *   60.93  *
* Crit W.S. (ft)         *  671.06  * Flow Area (sq ft)      *          *   24.54  *          *
* E.G. Slope (ft/ft)     *1.588547  * Area (sq ft)           *          *   24.54  *          *
* Q Total (cfs)          *  513.00  * Flow (cfs)             *          *  513.00  *          *
* Top Width (ft)         *   82.18  * Top Width (ft)         *          *   82.18  *          *
* Vel Total (ft/s)       *   20.90  * Avg. Vel. (ft/s)       *          *   20.90  *          *
* Max Chl Dpth (ft)      *    0.30  * Hydr. Depth (ft)       *          *    0.30  *          *
* Conv. Total (cfs)      *   407.0  * Conv. (cfs)            *          *   407.0  *          *
* Length Wtd. (ft)       *  153.08  * Wetted Per. (ft)       *          *   82.29  *          *
* Min Ch El (ft)         *  670.00  * Shear (lb/sq ft)       *          *   29.58  *          *
* Alpha                  *    1.00  * Stream Power (lb/ft s) *          *  618.26  *          *
* Frctn Loss (ft)        *    0.01  * Cum Volume (acre-ft)   *    0.71  *    2.53  *    1.29  *
* C & E Loss (ft)        *    0.15  * Cum SA (acres)         *    1.51  *    0.79  *    1.57  *
***********************************************************************************************

Warning: The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross
         sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.
Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.

CROSS SECTION
```

RIVER: Stream B - Post
REACH: Stream B RS: 520

INPUT
Description:
Station Elevation Data num= 67

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	671.49	.8	671.5	2.52	671.47	4.57	671.4	5.56	671.35
7.96	671.21	13.54	671.05	14.51	670.99	15.66	670.94	16.74	670.88
21.11	670.69	23.67	670.58	32.41	670.03	33.35	670.02	34.45	670.01
34.75	670	36.67	669.96	40.35	669.9	42.82	669.89	43.57	669.86
44.76	669.84	44.87	669.84	45.24	669.83	56.81	664.51	88.63	664.51
120.37	669.14	120.73	669.17	121.41	669.31	127.18	669.95	128.82	669.95
130.14	669.93	131.23	669.94	133.88	669.94	134.84	669.95	136.99	669.95
140.03	669.98	142.08	670	143.76	670.6	144.29	670.65	149.64	671.79
150.91	671.77	155.32	672	160.41	673.2	161.89	673.59	163.27	674
164.57	674.57	166.38	675.28	168.57	676	172.07	677.04	175.03	677.92
175.21	677.97	175.29	678	175.56	678.03	175.72	678.06	180.52	678.7
188.04	680	188.07	680	188.49	680.01	188.84	680.02	189.59	680.03
190.14	680.05	190.47	680.06	191.41	680.08	192.03	680.09	193.86	680.1
206.48	681.21	210.92	681.58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	43.57	.013	120.37	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
43.57	120.37	130.31	100	163.8	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	60.72	670	F
84.72	210.92	670	F

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	670.96	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.	0.040	0.013	0.040
W.S. Elev (ft)	670.93	Reach Len. (ft)	130.31	100.00	163.80
Crit W.S. (ft)	667.07	Flow Area (sq ft)	17.72	379.51	25.11
E.G. Slope (ft/ft)	0.000020	Area (sq ft)	17.72	379.51	25.11
Q Total (cfs)	558.00	Flow (cfs)	2.17	551.72	4.11
Top Width (ft)	129.65	Top Width (ft)	27.64	76.80	25.21
Vel Total (ft/s)	1.32	Avg. Vel. (ft/s)	0.12	1.45	0.16
Max Chl Dpth (ft)	6.42	Hydr. Depth (ft)	0.64	4.94	1.00
Conv. Total (cfs)	125652.8	Conv. (cfs)	489.3	124238.1	925.4
Length Wtd. (ft)	100.00	Wetted Per. (ft)	27.67	78.30	25.40
Min Ch El (ft)	664.51	Shear (lb/sq ft)	0.00	0.01	0.00
Alpha	1.20	Stream Power (lb/ft s)	0.00	0.01	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)	0.34	1.83	1.27
C & E Loss (ft)		Cum SA (acres)	0.93	0.52	1.55

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
Note: Hydraulic jump has occurred between this cross section and the previous upstream section.

CULVERT

RIVER: Stream B - Post
REACH: Stream B RS: 500

INPUT
Description: Stream B - Access Road West Crossing
Distance from Upstream XS = 20
Deck/Roadway Width = 65
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	670	650	210.92	670	650

Upstream Bridge Cross Section Data
Station Elevation Data num= 67

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	671.49	.8	671.5	2.52	671.47	4.57	671.4	5.56	671.35
7.96	671.21	13.54	671.05	14.51	670.99	15.66	670.94	16.74	670.88
21.11	670.69	23.67	670.58	32.41	670.03	33.35	670.02	34.45	670.01
34.75	670	36.67	669.96	40.35	669.9	42.82	669.89	43.57	669.86
44.76	669.84	44.87	669.84	45.24	669.83	56.81	664.51	88.63	664.51
120.37	669.14	120.73	669.17	121.41	669.31	127.18	669.95	128.82	669.95
130.14	669.93	131.23	669.94	133.88	669.94	134.84	669.95	136.99	669.95
140.03	669.98	142.08	670	143.76	670.6	144.29	670.65	149.64	671.79
150.91	671.77	155.32	672	160.41	673.2	161.89	673.59	163.27	674
164.57	674.57	166.38	675.28	168.57	676	172.07	677.04	175.03	677.92
175.21	677.97	175.29	678	175.56	678.03	175.72	678.06	180.52	678.7
188.04	680	188.07	680	188.49	680.01	188.84	680.02	189.59	680.03
190.14	680.05	190.47	680.06	191.41	680.08	192.03	680.09	193.86	680.1
206.48	681.21	210.92	681.58						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	43.57	.013	120.37	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
43.57	120.37	.1	.3

Ineffective Flow num= 2

Sta L Sta R Elev Permanent

0	60.72	670	F
84.72	210.92	670	F

Downstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	670	650	538.2	670	650

Downstream Bridge Cross Section Data
Station Elevation Data num= 125

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	673.66	3.42	673.54	20.44	673.24	22.1	673.34	23.84	673.07
24.24	673.09	24.66	673.12	25.52	673.01	27.03	672.9	28.28	672.8
32.1	672.57	38.83	672.1	39	672.09	39.17	672.06	41.29	672
48.63	671.98	48.95	671.98	53.75	671.58	60.51	671.49	60.68	671.46
61.1	671.39	64.26	671.24	66.94	670.88	69.79	670.59	70.44	670.56
72.84	670.35	74.01	670.31	79.69	670	185.69	670	191.08	670.01
213.85	670.01	217.33	670	239.21	670	241.11	669.38	244.2	668.38
244.7	668	245	664.48	268.02	664.48	268.17	666	273.49	667.2
276.98	667.99	277.01	667.99	277.06	668	277.08	668	278.98	668.23
280.58	668.37	283.82	668.4	284.19	668.42	284.97	668.4	289.15	668.54
290.59	668.53	294.31	668.34	295.95	668.25	298.02	668.21	298.4	668.19
308.43	668.2	309.89	668.19	313.04	668.25	317.96	668.47	319.42	668.47
324.51	668.36	327.05	668.35	329.17	668.35	329.86	668.36	338.72	668.58
341.75	668.62	347.77	668.64	354.02	668.79	358.01	668.86	363.86	668.88
367.44	669	369	669.03	370	669.04	372.63	669.13	376.51	669.27
393.5	669.25	396.43	669.27	398.51	669.32	400.24	669.32	402.79	669.31
404.26	669.33	406.79	669.32	409.36	669.35	411.58	669.42	417.75	669.43
422.71	669.47	424.32	669.51	429.77	669.72	435.56	669.99	436.02	670
436.1	670	437.19	670.12	442.35	670.58	445.99	670.8	447.05	670.88
459.42	672	462.76	672.47	472.79	674	476.37	674.8	479.72	675.58
481.56	676	483.37	676.6	486.68	677.92	486.91	678	489.89	678.78
493.21	680	497.61	681.6	498.6	682	500.19	682.61	503.92	684
504.85	684.3	508.92	686	513.32	687.4	513.88	687.6	514.18	687.68
515.1	688	515.96	688.31	516.41	688.44	517.86	688.95	521.07	690
526.77	691.8	527.49	692	528.47	692.33	533.7	694	538.2	694

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	239.21	.013	283.82	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
239.21	283.82	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	244.51	670	F
268.51	538.2	670	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Box	5	14

FHWA Chart # 8 - flared wingwalls
FHWA Scale # 1 - Wingwall flared 30 to 75 deg.
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
20	65	.013	.013	0	.5	1

Upstream Elevation = 664.51
Centerline Station = 71.92
Downstream Elevation = 664.48
Centerline Station = 256.51

CULVERT OUTPUT Profile #PF 1 Culv Group: Culvert #1

Q Culv Group (cfs)	275.59	Culv Full Len (ft)	65.00
# Barrels	1	Culv Vel US (ft/s)	3.94
Q Barrel (cfs)	275.59	Culv Vel DS (ft/s)	3.94
E.G. US. (ft)	670.96	Culv Inv El Up (ft)	664.51
W.S. US. (ft)	670.93	Culv Inv El Dn (ft)	664.48
E.G. DS (ft)	670.62	Culv Frctn Ls (ft)	0.03
W.S. DS (ft)	670.56	Culv Exit Loss (ft)	0.18
Delta EG (ft)	0.33	Culv Entr Loss (ft)	0.12
Delta WS (ft)	0.36	Q Weir (cfs)	282.41
E.G. IC (ft)	670.54	Weir Sta Lft (ft)	15.33
E.G. OC (ft)	670.96	Weir Sta Rgt (ft)	145.72
Culvert Control	Outlet	Weir Submerg	0.57
Culv WS Inlet (ft)	669.51	Weir Max Depth (ft)	0.95
Culv WS Outlet (ft)	669.48	Weir Avg Depth (ft)	0.87
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	113.40
Culv Crt Depth (ft)	2.29	Min El Weir Flow (ft)	670.01

Warning: During the culvert inlet control computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B RS: 420

INPUT
Description:

Station Elevation Data num= 125

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	673.66	3.42	673.54	20.44	673.24	22.1	673.34	23.84	673.07
24.24	673.09	24.66	673.12	25.52	673.01	27.03	672.9	28.28	672.8
32.1	672.57	38.83	672.1	39	672.09	39.17	672.06	41.29	672
48.63	671.98	48.95	671.98	53.75	671.58	60.51	671.49	60.68	671.46
61.1	671.39	64.26	671.24	66.94	670.88	69.79	670.59	70.44	670.56
72.84	670.35	74.01	670.31	79.69	670	185.69	670	191.08	670.01
213.85	670.01	217.33	670	239.21	670	241.11	669.38	244.2	668.38
244.7	668	245	664.48	268.02	664.48	268.17	666	273.49	667.2
276.98	667.99	277.01	667.99	277.06	668	277.08	668	278.98	668.23
280.58	668.37	283.82	668.4	284.19	668.42	284.97	668.4	289.15	668.54
290.59	668.53	294.31	668.34	295.95	668.25	298.02	668.21	298.4	668.19
308.43	668.2	309.89	668.19	313.04	668.25	317.96	668.47	319.42	668.47
324.51	668.36	327.05	668.35	329.17	668.35	329.86	668.36	338.72	668.58
341.75	668.62	347.77	668.64	354.02	668.79	358.01	668.86	363.86	668.88
367.44	669	369	669.03	370	669.04	372.63	669.13	376.51	669.27
393.5	669.25	396.43	669.27	398.51	669.32	400.24	669.32	402.79	669.31
404.26	669.33	406.79	669.32	409.36	669.35	411.58	669.42	417.75	669.43
422.71	669.47	424.32	669.51	429.77	669.72	435.56	669.99	436.02	670
436.1	670	437.19	670.12	442.35	670.58	445.99	670.8	447.05	670.88
459.42	672	462.76	672.47	472.79	674	476.37	674.8	479.72	675.58
481.56	676	483.37	676.6	486.68	677.92	486.91	678	489.89	678.78
493.21	680	497.61	681.6	498.6	682	500.19	682.61	503.92	684
504.85	684.3	508.92	686	513.32	687.4	513.88	687.6	514.18	687.68
515.1	688	515.96	688.31	516.41	688.44	517.86	688.95	521.07	690
526.77	691.8	527.49	692	528.47	692.33	533.7	694	538.2	694

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	239.21	.013	283.82	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
239.21	283.82	91.69	90	89.44	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	244.51	670	F
268.51	538.2	670	F

CROSS SECTION OUTPUT Profile #PF 1

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	670.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.06	Wt. n-Val.	0.040	0.013	0.040
W.S. Elev (ft)	670.56	Reach Len. (ft)	91.69	90.00	89.44
Crit W.S. (ft)	667.09	Flow Area (sq ft)	92.28	197.17	256.24
E.G. Slope (ft/ft)	0.000060	Area (sq ft)	92.28	197.17	256.24
Q Total (cfs)	558.00	Flow (cfs)	17.82	438.21	101.98
Top Width (ft)	371.76	Top Width (ft)	168.82	44.61	158.33
Vel Total (ft/s)	1.02	Avg. Vel. (ft/s)	0.19	2.22	0.40
Max Chl Dpth (ft)	6.08	Hydr. Depth (ft)	0.55	4.42	1.62
Conv. Total (cfs)	71776.6	Conv. (cfs)	2291.6	56367.5	13117.4
Length Wtd. (ft)	89.90	Wetted Per. (ft)	168.84	49.85	158.40
Min Ch El (ft)	664.48	Shear (lb/sq ft)	0.00	0.01	0.01
Alpha	3.74	Stream Power (lb/ft s)	0.00	0.03	0.00
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)	0.34	1.28	1.27
C & E Loss (ft)	0.02	Cum SA (acres)	0.64	0.38	1.20

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B RS: 330

INPUT
Description:
Station Elevation Data num= 116

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	673.28	12.91	672.76	15.25	672.76	27.32	672.31	31.55	672.14
41.05	671.79	41.48	671.78	41.49	671.78	75.57	670.77	77.76	670.77
85.26	670.76	91.76	670.76	139.39	669.61	139.57	669.61	140.69	669.57
154.41	669.46	173.63	669.4	182.39	669.32	189.87	669.53	197.23	669.38
201.57	668.65	216.84	667.57	227.48	667.39	230.66	667.32	238.58	667.34
245.92	666.9	245.95	666.9	246.13	666.91	251.3	663.08	275.71	663.08
280.05	666.5	294.25	666.35	319.25	664.92	328.32	664.72	328.37	664.72
332.58	664.66	336.04	664.66	336.49	664.65	339.19	664.65	346.63	664.55
362.74	665.62	372.86	666.26	372.88	666.27	381.57	666.18	387.88	666.13
391.09	666.08	394.25	666.03	398.49	666.01	399.74	666	399.75	666
407.71	666.11	414.99	666.18	416.86	666.2	418.7	666.21	420.76	666.22
423.05	666.24	423.98	666.24	424.72	666.25	426.34	666.29	428.6	666.35
432.2	666.41	434.99	666.45	435.24	666.46	435.56	666.46	439.35	666.64
448.45	667.1	450.05	667.2	452.08	667.29	455.8	667.46	460.65	667.68
464.87	667.88	467.36	668	468.49	668	474.03	668.36	480.07	668.74
485.59	669.15	487.39	669.27	488.74	669.36	489.8	669.43	490.65	669.48
496.93	669.9	498.23	669.99	498.49	670	498.72	670	498.88	670.01
499.82	670.14	501.02	670.3	505.11	670.87	507.15	671.15	511.86	671.82
512.43	671.9	513.1	672	513.57	672.16	517.73	673.38	519.42	673.88
519.82	674	519.9	674.03	520.15	674.12	525.14	676	528.95	677.23
531.25	678	533.29	678.89	535.72	680	535.84	680.03	541.91	682
544.57	683.01	546.96	684	547.85	684.37	552.36	686	556.09	687.22
558.38	688	562.84	689.91	563.07	690	563.2	690.05	569.51	692
575.06	694								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	246.13	.013	280.05	.04

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
246.13	280.05	177.72	180	183.81	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	248.5	670.27	F
277.5	575.06	670.24	F

CROSS SECTION OUTPUT Profile #PF 1

E.G. Elev (ft)	670.61	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.	0.040	0.013	0.040
W.S. Elev (ft)	670.60	Reach Len. (ft)	177.72	180.00	183.81
Crit W.S. (ft)	665.49	Flow Area (sq ft)	227.02	237.60	916.65
E.G. Slope (ft/ft)	0.000008	Area (sq ft)	227.02	237.60	916.65
Q Total (cfs)	558.00	Flow (cfs)	32.40	273.79	251.81
Top Width (ft)	404.57	Top Width (ft)	147.55	33.92	223.09
Vel Total (ft/s)	0.40	Avg. Vel. (ft/s)	0.14	1.15	0.27
Max Chl Dpth (ft)	7.52	Hydr. Depth (ft)	1.54	7.00	4.11
Conv. Total (cfs)	193430.2	Conv. (cfs)	11232.7	94909.4	87288.2
Length Wtd. (ft)	180.00	Wetted Per. (ft)	147.69	36.37	223.34
Min Ch El (ft)	663.08	Shear (lb/sq ft)	0.00	0.00	0.00
Alpha	4.21	Stream Power (lb/ft s)	0.00	0.00	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)	0.00	0.83	0.07
C & E Loss (ft)		Cum SA (acres)	0.30	0.30	0.81

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CULVERT

RIVER: Stream B - Post
REACH: Stream B RS: 315

INPUT
Description: Stream B - IH-35W Crossing
Distance from Upstream XS = 15
Deck/Roadway Width = 155
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	671.4	650	265	670.2	650	575.06	671	650

Upstream Bridge Cross Section Data
Station Elevation Data num= 116

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	673.28	12.91	672.76	15.25	672.76	27.32	672.31	31.55	672.14
41.05	671.79	41.48	671.78	41.49	671.78	75.57	670.77	77.76	670.77
85.26	670.76	91.76	670.76	139.39	669.61	139.57	669.61	140.69	669.57
154.41	669.46	173.63	669.4	182.39	669.32	189.87	669.53	197.23	669.38
201.57	668.65	216.84	667.57	227.48	667.39	230.66	667.32	238.58	667.34
245.92	666.9	245.95	666.9	246.13	666.91	251.3	663.08	275.71	663.08
280.05	666.5	294.25	666.35	319.25	664.92	328.32	664.72	328.37	664.72
332.58	664.66	336.04	664.66	336.49	664.65	339.19	664.65	346.63	664.55
362.74	665.62	372.86	666.26	372.88	666.27	381.57	666.18	387.88	666.13
391.09	666.08	394.25	666.03	398.49	666.01	399.74	666	399.75	666
407.71	666.11	414.99	666.18	416.86	666.2	418.7	666.21	420.76	666.22
423.05	666.24	423.98	666.24	424.72	666.25	426.34	666.29	428.6	666.35
432.2	666.41	434.99	666.45	435.24	666.46	435.56	666.46	439.35	666.64
448.45	667.1	450.05	667.2	452.08	667.29	455.8	667.46	460.65	667.68
464.87	667.88	467.36	668	468.49	668	474.03	668.36	480.07	668.74
485.59	669.15	487.39	669.27	488.74	669.36	489.8	669.43	490.65	669.48
496.93	669.9	498.23	669.99	498.49	670	498.72	670	498.88	670.01
499.82	670.14	501.02	670.3	505.11	670.87	507.15	671.15	511.86	671.82
512.43	671.9	513.1	672	513.57	672.16	517.73	673.38	519.42	673.88
519.82	674	519.9	674.03	520.15	674.12	525.14	676	528.95	677.23
531.25	678	533.29	678.89	535.72	680	535.84	680.03	541.91	682
544.57	683.01	546.96	684	547.85	684.37	552.36	686	556.09	687.22
558.38	688	562.84	689.91	563.07	690	563.2	690.05	569.51	692
575.06	694								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	246.13	.013	280.05	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
246.13	280.05	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	248.5	670.27	F
277.5	575.06	670.24	F

Downstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	671.4	650	535	670.2	650	899.7	671	650

Downstream Bridge Cross Section Data
Station Elevation Data num= 150

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	674.98	9.26	674.27	12.71	674.17	17.53	673.75	28.16	673.78
28.21	673.78	41.98	673.57	82.67	672.34	107.61	671.58	111.01	671.57
112	671.57	120.36	671.55	122.43	671.56	129.45	671.56	146.16	671.19
179.33	670.95	218.23	671.47	218.77	671.48	221.37	671.43	294.41	670.78
315.88	670.44	369.44	669.6	370.29	669.59	371.06	669.57	453.66	667.99
460.48	667.55	471.2	666.99	479.95	666.53	481.45	666.3	484.43	666.3
485.71	666.29	487.54	666.29	489.07	666.28	490.14	666.25	491.09	666.25

500.55	666.39	508.33	666.13	510.79	666	515.07	665.65	515.7	665.55
517.28	665.4	523.63	664.89	524.19	664.84	528.59	662.21	548.44	662.21
552	664.96	553.52	665.08	556.08	664.97	557.88	664.91	560.99	664.89
563.86	664.72	572.63	664.03	572.83	664.01	573.03	664	581.75	663.5
582.42	663.48	584.1	663.5	589.68	663.31	591.64	663.18	594.85	663.01
596.01	662.98	596.67	663.02	600.22	662.9	602.09	663.07	604.97	662.97
605.62	663.02	606.21	663.07	611.05	663.69	614.28	663.68	616.51	663.66
620.32	663.65	626.93	663.59	632.34	663.66	643.24	663.76	645.78	663.78
647.82	663.79	652.38	663.84	654.39	663.87	660.96	663.91	662.11	663.92
664.19	663.95	665.9	663.96	666.01	663.96	668.11	664	672.86	664.19
673.86	664.23	674.54	664.28	675.59	664.36	687.51	664.84	687.87	664.86
689	664.91	693.49	665.07	696.82	665.16	700.39	665.32	706.57	665.72
708.23	665.8	710.53	666	725.04	666.54	731.01	666.66	734.92	666.8
741.26	667.08	747.11	667.22	749.43	667.34	750.91	667.37	754.01	667.39
756.24	667.48	756.8	667.5	762.74	667.71	765.66	667.85	766.04	667.86
768.84	667.99	770.3	668	770.42	668	771.12	668.02	771.26	668.03
777.43	668.35	782.25	668.59	789.79	668.98	794.19	669.18	796.5	669.29
797.66	669.34	806.61	669.88	807.88	669.96	809.8	670	809.83	670
809.88	670.01	810.06	670.03	825.16	671.85	825.8	671.92	826.45	672
833.79	673.28	837.69	674	844.16	675.59	846.16	676	852.37	677.55
854.34	678	857.1	678.64	863.26	680	870.02	681.66	870.94	681.86
871.57	682	872.3	682.2	878.9	684	884.6	685.74	885.44	686
886.11	686.21	892.39	688	895.73	688.98	897.57	689.33	899.7	690

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	523.63	.013	552	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
523.63	552	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	523.52	670.23	F
553.52	899.7	670.24	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Box	5	6

FHWA Chart # 8 - flared wingwalls
FHWA Scale # 1 - Wingwall flared 30 to 75 deg.
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
15	155	.013	.013	2	.5	1

Number of Barrels = 3
Upstream Elevation = 663.08
Centerline Stations

Sta.	Sta.	Sta.
256.5	263.5	270.5

Downstream Elevation = 662.21
Centerline Stations

Sta.	Sta.	Sta.
531.52	538.52	545.52

CULVERT OUTPUT Profile #PF 1 Culv Group: Culvert #1

Q Culv Group (cfs)	498.28	Culv Full Len (ft)	
# Barrels	3	Culv Vel US (ft/s)	9.23
Q Barrel (cfs)	166.09	Culv Vel DS (ft/s)	11.43
E.G. US. (ft)	670.61	Culv Inv El Up (ft)	663.08
W.S. US. (ft)	670.60	Culv Inv El Dn (ft)	662.21
E.G. DS (ft)	666.08	Culv Frctn Ls (ft)	1.28
W.S. DS (ft)	664.93	Culv Exit Loss (ft)	2.59
Delta EG (ft)	4.53	Culv Entr Loss (ft)	0.66
Delta WS (ft)	5.67	Q Weir (cfs)	59.72
E.G. IC (ft)	670.61	Weir Sta Lft (ft)	174.76
E.G. OC (ft)	670.12	Weir Sta Rgt (ft)	423.40
Culvert Control	Inlet	Weir Submerg	0.00
Culv WS Inlet (ft)	668.08	Weir Max Depth (ft)	0.41
Culv WS Outlet (ft)	666.63	Weir Avg Depth (ft)	0.20
Culv Nml Depth (ft)	2.60	Weir Flow Area (sq ft)	50.81
Culv Crt Depth (ft)	2.88	Min El Weir Flow (ft)	670.21

Warning: The flow through the culvert is supercritical. However, since there is flow over the road (weir flow), the program cannot determine if the downstream cross section should be subcritical or supercritical. The program used the downstream subcritical answer, even though it may not be valid.
Warning: During the supercritical analysis, the program could not converge on a supercritical answer in the downstream cross section. The program used the solution with the least error.
Warning: During the culvert outlet control computations, the program could not balance the culvert/weir flow. The reported outlet energy grade answer may not be valid.
Note: The flow in the culvert is entirely supercritical.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B RS: 150

INPUT
Description:
Station Elevation Data num= 150

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	674.98	9.26	674.27	12.71	674.17	17.53	673.75	28.16	673.78

28.21	673.78	41.98	673.57	82.67	672.34	107.61	671.58	111.01	671.57
112	671.57	120.36	671.55	122.43	671.56	129.45	671.56	146.16	671.19
179.33	670.95	218.23	671.47	218.77	671.48	221.37	671.43	294.41	670.78
315.88	670.44	369.44	669.6	370.29	669.59	371.06	669.57	453.66	667.99
460.48	667.55	471.2	666.99	479.95	666.53	481.45	666.3	484.43	666.3
485.71	666.29	487.54	666.29	489.07	666.28	490.14	666.25	491.09	666.25
500.55	666.39	508.33	666.13	510.79	666	515.07	665.65	515.7	665.55
517.28	665.4	523.63	664.89	524.19	664.84	528.59	662.21	548.44	662.21
552	664.96	553.52	665.08	556.08	664.97	557.88	664.91	560.99	664.89
563.86	664.72	572.63	664.03	572.83	664.01	573.03	664	581.75	663.5
582.42	663.48	584.1	663.5	589.68	663.31	591.64	663.18	594.85	663.01
596.01	662.98	596.67	663.02	600.22	662.9	602.09	663.07	604.97	662.97
605.62	663.02	606.21	663.07	611.05	663.69	614.28	663.68	616.51	663.66
620.32	663.65	626.93	663.59	632.34	663.66	643.24	663.76	645.78	663.78
647.82	663.79	652.38	663.84	654.39	663.87	660.96	663.91	662.11	663.92
664.19	663.95	665.9	663.96	666.01	663.96	668.11	664	672.86	664.19
673.86	664.23	674.54	664.28	675.59	664.36	687.51	664.84	687.87	664.86
689	664.91	693.49	665.07	696.82	665.16	700.39	665.32	706.57	665.72
708.23	665.8	710.53	666	725.04	666.54	731.01	666.66	734.92	666.8
741.26	667.08	747.11	667.22	749.43	667.34	750.91	667.37	754.01	667.39
756.24	667.48	756.8	667.5	762.74	667.71	765.66	667.85	766.04	667.86
768.84	667.99	770.3	668	770.42	668	771.12	668.02	771.26	668.03
777.43	668.35	782.25	668.59	789.79	668.98	794.19	669.18	796.5	669.29
797.66	669.34	806.61	669.88	807.88	669.96	809.8	670	809.83	670
809.88	670.01	810.06	670.03	825.16	671.85	825.8	671.92	826.45	672
833.79	673.28	837.69	674	844.16	675.59	846.16	676	852.37	677.55
854.34	678	857.1	678.64	863.26	680	870.02	681.66	870.94	681.86
871.57	682	872.3	682.2	878.9	684	884.6	685.74	885.44	686
886.11	686.21	892.39	688	895.73	688.98	897.57	689.33	899.7	690

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	523.63	.013	552	.04

```
Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.   Expan.
       523.63     552              39.8      40   41.13              .1        .3
Ineffective Flow      num=       2
   Sta L    Sta R    Elev  Permanent
       0  523.52  670.23       F
  553.52   899.7  670.24       F
```

CROSS SECTION OUTPUT Profile #PF 1

```
*********************************************************************************************
* E.G. Elev (ft)          *   666.08  * Element                  *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *     1.15  * Wt. n-Val.               *   0.040  *   0.013  *          *
* W.S. Elev (ft)          *   664.93  * Reach Len. (ft)          *   39.80  *   40.00  *    41.13 *
* Crit W.S. (ft)          *   664.93  * Flow Area (sq ft)        *    0.00  *   64.92  *          *
* E.G. Slope (ft/ft)      *0.002018   * Area (sq ft)             *    0.01  *   64.92  *   143.11 *
* Q Total (cfs)           *   558.00  * Flow (cfs)               *    0.00  *  558.00  *          *
* Top Width (ft)          *   160.92  * Top Width (ft)           *    0.46  *   28.33  *   132.13 *
* Vel Total (ft/s)        *     8.59  * Avg. Vel. (ft/s)         *    0.17  *    8.59  *          *
* Max Chl Dpth (ft)       *     2.72  * Hydr. Depth (ft)         *    0.03  *    2.29  *          *
* Conv. Total (cfs)       *  12420.0  * Conv. (cfs)              *     0.0  * 12420.0  *          *
* Length Wtd. (ft)        *    40.00  * Wetted Per. (ft)         *    0.11  *   29.98  *          *
* Min Ch El (ft)          *   662.21  * Shear (lb/sq ft)         *    0.00  *    0.27  *          *
* Alpha                   *     1.00  * Stream Power (lb/ft s)   *    0.00  *    2.35  *          *
* Frctn Loss (ft)         *     0.14  * Cum Volume (acre-ft)     *    0.00  *    0.10  *     0.07 *
* C & E Loss (ft)         *     0.14  * Cum SA (acres)           *    0.00  *    0.17  *     0.06 *
*********************************************************************************************
```

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: Divided flow computed for this cross-section.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B RS: 110

INPUT
Description:
Station Elevation Data num= 154

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	672.65	9.4	672.41	18.52	672.23	26.46	672.1	44.54	671.61
46.03	671.61	51.99	671.62	64.9	671.59	71.74	671.57	73.69	671.57
141.32	670.04	143.37	669.99	146.98	669.92	147.58	669.91	147.81	669.9
162.97	669.59	167.96	669.57	176.37	669.56	182.07	669.56	200.55	669.55
235.25	668.3	250.44	667.76	252.54	667.69	257.63	667.57	272.44	667.54
314.76	666	330.9	665.87	339.65	665.57	346.88	665.56	349.28	665.56
355.04	665.54	406.78	665.45	418.36	665.92	420.44	665.87	420.8	665.86
421.02	665.86	422.37	665.82	423.76	665.79	423.92	665.77	424.11	665.76
436.15	665.57	436.42	665.53	438.82	665.1	439.54	665	445.49	664
446.35	663.73	448.86	662.93	450.52	662.45	451.58	661.59	476.07	661.59
478.09	662.81	479.26	663.22	482.51	663.85	483.17	664	487.2	664.76
490.18	665.09	492.77	665.02	494.43	665.1	499.47	665.11	502.1	665.16
504.4	665.18	507.8	665.13	511.51	665.02	518.74	665.29	525.97	665.3
526.65	665.33	529.33	665.3	531.32	665.4	538.3	665.3	543.09	665.44
548.42	665.42	552.49	665.44	557.05	665.51	559.15	665.54	564.8	665.61
571.15	665.73	573.85	665.78	578	665.83	579.85	665.84	580.37	665.84
587.96	665.99	589.31	665.99	591.11	665.98	598.62	666	598.69	666
605.14	666.36	609.94	666.57	612.14	666.63	614.92	666.72	619.74	666.92
621.29	666.99	628.51	667.32	631.12	667.46	632.88	667.54	634.76	667.63
636.4	667.69	646.68	668	647.75	668.1	648.05	668.1	654.32	668.71
655.81	668.75	660.3	668.97	668.19	669.33	669.44	669.4	670.92	669.43
673.72	669.58	675.34	669.67	680.82	669.75	687.23	669.95	687.3	669.96
688.17	670	698.79	670.9	699.67	670.91	701.78	671	704.22	671.2
706.95	671.04	709.14	670.96	710.54	670.95	712.8	670.97	716.36	671.1

721.56	671.17	723.35	671.22	724.93	671.27	733.07	671.65	739.35	671.98
740.37	671.99	741.89	671.99	743.07	672	750.76	672	751.67	672.07
752.63	672.15	753.08	672.19	766.9	673.35	769.63	673.55	773.41	673.86
774.44	674	781.21	675.59	782.91	676	783.71	676.11	789.25	676.8
795.43	677.65	797.64	678	798.52	678.16	809.7	680	818.35	681.93
818.66	682	819.06	682.09	824.34	683.36	827.63	684	829.93	684.59
832.1	685.19	835.29	686	840.17	687.01	845.36	688		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	436.42	.013	490.18	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
436.42	490.18	97.45	110	118.12	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	450.33	669	F
477.63	845.36	669	F

CROSS SECTION OUTPUT Profile #PF 1

			Left OB	Channel	Right OB
E.G. Elev (ft)	665.80	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.57	Wt. n-Val.		0.013	
W.S. Elev (ft)	663.23	Reach Len. (ft)	97.45	110.00	118.12
Crit W.S. (ft)	663.99	Flow Area (sq ft)		43.43	
E.G. Slope (ft/ft)	0.006995	Area (sq ft)		44.84	
Q Total (cfs)	558.00	Flow (cfs)		558.00	
Top Width (ft)	31.40	Top Width (ft)		31.40	
Vel Total (ft/s)	12.85	Avg. Vel. (ft/s)		12.85	
Max Chl Dpth (ft)	1.64	Hydr. Depth (ft)		1.59	
Conv. Total (cfs)	6671.9	Conv. (cfs)		6671.9	
Length Wtd. (ft)	110.00	Wetted Per. (ft)		27.88	
Min Ch El (ft)	661.59	Shear (lb/sq ft)		0.68	
Alpha	1.00	Stream Power (lb/ft s)		8.74	
Frctn Loss (ft)		Cum Volume (acre-ft)		0.05	
C & E Loss (ft)		Cum SA (acres)		0.14	

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CULVERT

RIVER: Stream B - Post
REACH: Stream B RS: 100

INPUT
Description: Stream B - Access Road East Crossing
Distance from Upstream XS = 10
Deck/Roadway Width = 65
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	669	650	845.36	669	650

Upstream Bridge Cross Section Data
Station Elevation Data num= 154

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	672.65	9.4	672.41	18.52	672.23	26.46	672.1	44.54	671.61
46.03	671.61	51.99	671.62	64.9	671.59	71.74	671.57	73.69	671.57
141.32	670.04	143.37	669.99	146.98	669.92	147.58	669.91	147.81	669.9
162.97	669.59	167.96	669.57	176.37	669.56	182.07	669.56	200.55	669.55
235.25	668.3	250.44	667.76	252.54	667.69	257.63	667.57	272.44	667.54
314.76	666	330.9	665.87	339.65	665.57	346.88	665.56	349.28	665.56
355.04	665.54	406.78	665.45	418.36	665.92	420.44	665.87	420.8	665.86
421.02	665.86	422.37	665.82	423.76	665.79	423.92	665.77	424.11	665.76
436.15	665.57	436.42	665.53	438.82	665.1	439.54	665	445.49	664
446.35	663.73	448.86	662.93	450.52	662.45	451.58	661.59	476.07	661.59
478.09	662.81	479.26	663.22	482.51	663.85	483.17	664	487.2	664.76
490.18	665.09	492.77	665.02	494.43	665.1	499.47	665.11	502.1	665.16
504.4	665.18	507.8	665.13	511.51	665.02	518.74	665.29	525.97	665.3
526.65	665.33	529.33	665.3	531.32	665.4	538.3	665.3	543.09	665.44
548.42	665.42	552.49	665.44	557.05	665.51	559.15	665.54	564.8	665.61
571.15	665.73	573.85	665.78	578	665.83	579.85	665.84	580.37	665.84
587.96	665.99	589.31	665.99	591.11	665.98	598.62	666	598.69	666
605.14	666.36	609.94	666.57	612.14	666.63	614.92	666.72	619.74	666.92
621.29	666.99	628.51	667.32	631.12	667.46	632.88	667.54	634.76	667.63
636.4	667.69	646.68	668	647.75	668.1	648.05	668.1	654.32	668.71
655.81	668.75	660.3	668.97	668.19	669.33	669.44	669.4	670.92	669.43
673.72	669.58	675.34	669.67	680.82	669.75	687.23	669.95	687.3	669.96
688.17	670	698.79	670.9	699.67	670.91	701.78	671	704.22	671.2
706.95	671.04	709.14	670.96	710.54	670.95	712.8	670.97	716.36	671.1
721.56	671.17	723.35	671.22	724.93	671.27	733.07	671.65	739.35	671.98
740.37	671.99	741.89	671.99	743.07	672	750.76	672	751.67	672.07
752.63	672.15	753.08	672.19	766.9	673.35	769.63	673.55	773.41	673.86
774.44	674	781.21	675.59	782.91	676	783.71	676.11	789.25	676.8
795.43	677.65	797.64	678	798.52	678.16	809.7	680	818.35	681.93
818.66	682	819.06	682.09	824.34	683.36	827.63	684	829.93	684.59
832.1	685.19	835.29	686	840.17	687.01	845.36	688		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	436.42	.013	490.18	.04

Bank Sta: Left Right Coeff Contr. Expan.

436.42	490.18	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	450.33	669	F
477.63	845.36	669	F

Downstream Deck/Roadway Coordinates
num= 2

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	669	650	425.04	669	650

Downstream Bridge Cross Section Data
Station Elevation Data num= 48

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	670.41	36.69	669.76	41.29	669.57	43.66	669.46	46.27	669.42
56.99	668.88	86.83	668.58	117.24	667.98	130.83	667.6	173.94	667.58
178.07	667.59	179.45	667.59	184.45	667.57	197.28	666.75	230.61	666.54
234.51	666.42	243.11	665.86	246.97	665.57	247.19	665.53	251.87	664.57
256.46	663.67	256.84	663.57	295.22	657.45	314.22	657.45	342.69	662
342.98	662.01	351.72	662.62	357.75	663.03	361.52	663.27	370.1	664
376.22	664.66	376.7	664.68	377.22	664.72	389.96	665.79	390.3	665.79
395.57	665.99	395.87	666	401.04	667.01	402.87	667.42	406.07	667.94
406.53	667.94	408.12	668	413.1	668.71	417.45	669.82	417.64	669.87
418.25	670	424.09	671.64	425.04	672				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	230.61	.013	425.04	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
230.61	425.04	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	291.22	669	F
318.22	425.04	669	F

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .98
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Box	4	5

FHWA Chart # 8 - flared wingwalls
FHWA Scale # 1 - Wingwall flared 30 to 75 deg.
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
10	65	.013	.013	0	.5	1

Number of Barrels = 3
Upstream Elevation = 661.59
Centerline Stations

Sta.	Sta.	Sta.
457.83	463.83	470.13

Downstream Elevation = 657.45
Centerline Stations

Sta.	Sta.	Sta.
298.72	304.72	310.72

CULVERT OUTPUT Profile #PF 1 Culv Group: Culvert #1

Q Culv Group (cfs)	558.00	Culv Full Len (ft)	65.00
# Barrels	3	Culv Vel US (ft/s)	9.30
Q Barrel (cfs)	186.00	Culv Vel DS (ft/s)	9.30
E.G. US. (ft)	665.80	Culv Inv El Up (ft)	661.59
W.S. US. (ft)	663.23	Culv Inv El Dn (ft)	657.45
E.G. DS (ft)	662.48	Culv Frctn Ls (ft)	3.42
W.S. DS (ft)	662.17	Culv Exit Loss (ft)	1.03
Delta EG (ft)	3.32	Culv Entr Loss (ft)	0.67
Delta WS (ft)	1.06	Q Weir (cfs)	
E.G. IC (ft)	667.90	Weir Sta Lft (ft)	
E.G. OC (ft)	664.56	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	665.59	Weir Max Depth (ft)	
Culv WS Outlet (ft)	661.45	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	1.39	Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.50	Min El Weir Flow (ft)	669.01

Warning: During subcritical analysis, the water surface upstream of culvert went to critical depth.
Note: During the supercritical calculations a hydraulic jump occurred inside of the culvert.
Note: During the supercritical calculations a hydraulic jump occurred at the inlet of (going into) the culvert.
Note: The culvert inlet is submerged and the culvert flows full over part or all of its length. Therefore, the culvert inlet equations are not valid and the supercritical result has been discarded. The outlet answer will be used.

CROSS SECTION

RIVER: Stream B - Post
REACH: Stream B RS: 0

INPUT
Description:
Station Elevation Data num= 48

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	670.41	36.69	669.76	41.29	669.57	43.66	669.46	46.27	669.42

```
   56.99  668.88   86.83  668.58  117.24  667.98  130.83   667.6  173.94  667.58
  178.07  667.59  179.45  667.59  184.45  667.57  197.28  666.75  230.61  666.54
  234.51  666.42  243.11  665.86  246.97  665.57  247.19  665.53  251.87  664.57
  256.46  663.67  256.84  663.57  295.22  657.45  314.22  657.45  342.69     662
  342.98  662.01  351.72  662.62  357.75  663.03  361.52  663.27   370.1     664
  376.22  664.66   376.7  664.68  377.22  664.72  389.96  665.79   390.3  665.79
  395.57  665.99  395.87     666  401.04  667.01  402.87  667.42  406.07  667.94
  406.53  667.94  408.12     668   413.1  668.71  417.45  669.82  417.64  669.87
  418.25     670  424.09  671.64  425.04     672

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04  230.61    .013  425.04     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
        230.61  425.04             .1       .3
Ineffective Flow      num=        2
   Sta L   Sta R    Elev  Permanent
       0  291.22     669       F
  318.22  425.04     669       F

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)          *  662.48  * Element                * Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.31  * Wt. n-Val.             *         *   0.013  *          *
* W.S. Elev (ft)          *  662.17  * Reach Len. (ft)        *         *          *          *
* Crit W.S. (ft)          *  659.91  * Flow Area (sq ft)      *         *  124.89  *          *
* E.G. Slope (ft/ft)      *0.000199  * Area (sq ft)           *         *  229.37  *          *
* Q Total (cfs)           *  558.00  * Flow (cfs)             *         *  558.00  *          *
* Top Width (ft)          *   79.65  * Top Width (ft)         *         *   79.65  *          *
* Vel Total (ft/s)        *    4.47  * Avg. Vel. (ft/s)       *         *    4.47  *          *
* Max Chl Dpth (ft)       *    4.72  * Hydr. Depth (ft)       *         *    4.63  *          *
* Conv. Total (cfs)       * 39528.4  * Conv. (cfs)            *         * 39528.4  *          *
* Length Wtd. (ft)        *          * Wetted Per. (ft)       *         *   27.10  *          *
* Min Ch El (ft)          *  657.45  * Shear (lb/sq ft)       *         *    0.06  *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s) *         *    0.26  *          *
* Frctn Loss (ft)         *          * Cum Volume (acre-ft)   *         *          *          *
* C & E Loss (ft)         *          * Cum SA (acres)         *         *          *          *
*********************************************************************************************

Note:    Multiple critical depths were found at this location.  The critical depth with the lowest, valid, energy was used.

CROSS SECTION


RIVER: Stream B West
REACH: Stream B - West     RS: 1050

INPUT
Description:
Station Elevation Data     num=       25
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  713.92     .79  713.97    1.22     714    1.71     714    1.94  714.03
    5.65  714.58   10.29  715.52   10.71  715.35   15.95  713.25   56.28  697.12
   56.57     697   71.05     697  106.18  711.12   113.3  713.98  114.07  713.98
  114.27  713.98  117.28  713.99  120.67     714  122.85  714.02  123.03  714.02
  123.57  714.01  124.91  714.01  126.73     714  130.78  713.99  137.27  713.99

Manning's n Values         num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
************************************************
       0     .04   10.29     .04  114.07     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         10.29  114.07             500.8     500  493.01            .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)          *  700.76  * Element                * Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.23  * Wt. n-Val.             *         *   0.040  *          *
* W.S. Elev (ft)          *  700.53  * Reach Len. (ft)        *  500.80 *  500.00  *  493.01  *
* Crit W.S. (ft)          *  699.14  * Flow Area (sq ft)      *         *   82.19  *          *
* E.G. Slope (ft/ft)      *0.003209  * Area (sq ft)           *         *   82.19  *          *
* Q Total (cfs)           *  315.00  * Flow (cfs)             *         *  315.00  *          *
* Top Width (ft)          *   32.08  * Top Width (ft)         *         *   32.08  *          *
* Vel Total (ft/s)        *    3.83  * Avg. Vel. (ft/s)       *         *    3.83  *          *
* Max Chl Dpth (ft)       *    3.53  * Hydr. Depth (ft)       *         *    2.56  *          *
* Conv. Total (cfs)       *  5560.3  * Conv. (cfs)            *         *  5560.3  *          *
* Length Wtd. (ft)        *  500.00  * Wetted Per. (ft)       *         *   33.45  *          *
* Min Ch El (ft)          *  697.00  * Shear (lb/sq ft)       *         *    0.49  *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s) *         *    1.89  *          *
* Frctn Loss (ft)         *    1.90  * Cum Volume (acre-ft)   *         *    4.96  *          *
* C & E Loss (ft)         *    0.01  * Cum SA (acres)         *         *    1.32  *          *
*********************************************************************************************

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
         the need for additional cross sections.

CROSS SECTION


RIVER: Stream B West
REACH: Stream B - West     RS: 550

INPUT
Description:
Station Elevation Data     num=       19
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
********************************************************************************
       0  709.92    2.81   709.9    11.9  709.35   11.94  709.38   12.07  709.46
   12.09  709.79   18.72   707.1   44.41  696.84   82.08  696.84    89.5  696.85
   117.6  708.06  120.83  709.34  121.55  709.63   121.8   709.6  131.72  708.11
```

```
  141.01  708.04  146.84     708  148.63  707.99  153.13  707.99

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************
       0     .04   12.09     .04  121.55     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         12.09  121.55            214.14     200  171.74             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)          *  698.85  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.19  * Wt. n-Val.              *          *    0.040 *          *
* W.S. Elev (ft)          *  698.66  * Reach Len. (ft)         *   214.14 *   200.00 *   171.74 *
* Crit W.S. (ft)          *          * Flow Area (sq ft)       *          *    90.20 *          *
* E.G. Slope (ft/ft)      *0.004555  * Area (sq ft)            *          *    90.20 *          *
* Q Total (cfs)           *  315.00  * Flow (cfs)              *          *   315.00 *          *
* Top Width (ft)          *   54.18  * Top Width (ft)          *          *    54.18 *          *
* Vel Total (ft/s)        *    3.49  * Avg. Vel. (ft/s)        *          *     3.49 *          *
* Max Chl Dpth (ft)       *    1.82  * Hydr. Depth (ft)        *          *     1.66 *          *
* Conv. Total (cfs)       *  4667.3  * Conv. (cfs)             *          *   4667.3 *          *
* Length Wtd. (ft)        *  200.00  * Wetted Per. (ft)        *          *    54.87 *          *
* Min Ch El (ft)          *  696.84  * Shear (lb/sq ft)        *          *     0.47 *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s)  *          *     1.63 *          *
* Frctn Loss (ft)         *    0.07  * Cum Volume (acre-ft)    *          *     3.97 *          *
* C & E Loss (ft)         *    0.05  * Cum SA (acres)          *          *     0.82 *          *
*********************************************************************************************

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Stream B West
REACH: Stream B - West    RS: 350

INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  706.05    4.78  706.05    8.07  706.04    8.16  706.01   37.75  694.15
   43.13     692   67.18     692   93.03  702.24    97.4  703.95  103.21  706.24
  107.69     708  107.78     708  108.88     708   110.1  708.01  110.88  708.01
     114     708  121.15     708  131.21  707.55  139.04  707.23  140.23   707.2
  140.57  707.21   140.7  707.21

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************
       0     .04    8.16     .04  107.78     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          8.16  107.78            254.15     250  248.78             .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
* E.G. Elev (ft)          *  698.72  * Element                 *  Left OB *  Channel * Right OB *
* Vel Head (ft)           *    0.02  * Wt. n-Val.              *          *    0.040 *          *
* W.S. Elev (ft)          *  698.70  * Reach Len. (ft)         *   254.15 *   250.00 *   248.78 *
* Crit W.S. (ft)          *          * Flow Area (sq ft)       *          *   273.98 *          *
* E.G. Slope (ft/ft)      *0.000127  * Area (sq ft)            *          *   273.98 *          *
* Q Total (cfs)           *  315.00  * Flow (cfs)              *          *   315.00 *          *
* Top Width (ft)          *   57.70  * Top Width (ft)          *          *    57.70 *          *
* Vel Total (ft/s)        *    1.15  * Avg. Vel. (ft/s)        *          *     1.15 *          *
* Max Chl Dpth (ft)       *    6.70  * Hydr. Depth (ft)        *          *     4.75 *          *
* Conv. Total (cfs)       * 27928.6  * Conv. (cfs)             *          *  27928.6 *          *
* Length Wtd. (ft)        *  250.00  * Wetted Per. (ft)        *          *    60.28 *          *
* Min Ch El (ft)          *  692.00  * Shear (lb/sq ft)        *          *     0.04 *          *
* Alpha                   *    1.00  * Stream Power (lb/ft s)  *          *     0.04 *          *
* Frctn Loss (ft)         *    0.01  * Cum Volume (acre-ft)    *          *     3.14 *          *
* C & E Loss (ft)         *    0.01  * Cum SA (acres)          *          *     0.56 *          *
*********************************************************************************************

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than
         1.4.  This may indicate the need for additional cross sections.

CROSS SECTION


RIVER: Stream B West
REACH: Stream B - West    RS: 100

INPUT
Description:
Station Elevation Data    num=      14
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*******************************************************************************
       0  703.94    8.04  703.94    9.02  703.54   16.29  700.64   37.93     692
  143.09     692  152.15  695.59   168.9  702.24  169.33  702.41  172.97  703.86
  177.04  705.47  188.93  704.12  189.89     704  196.11     704

Manning's n Values         num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************
       0     .04    8.04     .04  177.04     .04

Bank Sta: Left   Right    Coeff Contr.   Expan.
          8.04  177.04           .1       .3

CROSS SECTION OUTPUT  Profile #PF 1
*********************************************************************************************
```

E.G. Elev (ft)	698.71	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.		0.040	
W.S. Elev (ft)	698.71	Reach Len. (ft)	0.00	0.00	0.00
Crit W.S. (ft)		Flow Area (sq ft)		818.55	
E.G. Slope (ft/ft)	0.000010	Area (sq ft)		818.55	
Q Total (cfs)	315.00	Flow (cfs)		315.00	
Top Width (ft)	138.88	Top Width (ft)		138.88	
Vel Total (ft/s)	0.38	Avg. Vel. (ft/s)		0.38	
Max Chl Dpth (ft)	6.71	Hydr. Depth (ft)		5.89	
Conv. Total (cfs)	98011.7	Conv. (cfs)		98011.7	
Length Wtd. (ft)	0.00	Wetted Per. (ft)		141.45	
Min Ch El (ft)	692.00	Shear (lb/sq ft)		0.00	
Alpha	1.00	Stream Power (lb/ft s)		0.00	
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)			
C & E Loss (ft)	0.00	Cum SA (acres)			

SUMMARY OF MANNING'S N VALUES

River:Stream A - Post

Reach	River Sta.	n1	n2	n3
Stream A	5430	.04	.04	.04
Stream A	5230	.04	.04	.04
Stream A	4930	.04	.04	.04
Stream A	4570	.04	.04	.04
Stream A	4550	Culvert		
Stream A	4510	.04	.04	.04
Stream A	4350	.04	.04	.04
Stream A	3850	.04	.04	.04
Stream A	3365	.04	.04	.04
Stream A	3150	.02	.02	.02
Stream A	2800	.012	.012	.012
Stream A	2300	.012	.012	.012
Stream A	2200	.012	.012	.012
Stream A	1950	.04	.04	.04
Stream A	1800	Culvert		
Stream A	1750	.04	.04	.04
Stream A	1500	.04	.04	.04

River:Stream B - Post

Reach	River Sta.	n1	n2	n3
Stream B South	3310	.04	.04	.04
Stream B South	3010	.04	.04	.04
Stream B South	2630	.04	.04	.04
Stream B South	2610	Culvert		
Stream B South	2585	.04	.04	.04
Stream B	2220	.04	.04	.04
Stream B	1920	.04	.04	.04
Stream B	1520	.04	.04	.04
Stream B	1475	Culvert		
Stream B	1410	.012	.012	.012
Stream B	1270	.012	.012	.012
Stream B	820	.04	.04	.04
Stream B	670	.04	.04	.04
Stream B	520	.04	.013	.04
Stream B	500	Culvert		
Stream B	420	.04	.013	.04
Stream B	330	.04	.013	.04
Stream B	315	Culvert		
Stream B	150	.04	.013	.04
Stream B	110	.04	.013	.04
Stream B	100	Culvert		
Stream B	0	.04	.013	.04

River:Stream B West

Reach	River Sta.	n1	n2	n3
Stream B - West	1050	.04	.04	.04
Stream B - West	550	.04	.04	.04
Stream B - West	350	.04	.04	.04
Stream B - West	100	.04	.04	.04

SUMMARY OF REACH LENGTHS

River: Stream A - Post

Reach	River Sta.	Left	Channel	Right
Stream A	5430	227.52	200	224.62
Stream A	5230	374.73	300	286.75
Stream A	4930	366.75	360	359.65
Stream A	4570	62.12	60	65.76
Stream A	4550	Culvert		
Stream A	4510	153.85	160	164.58
Stream A	4350	504.26	500	496.65
Stream A	3850	477.96	485	486.99
Stream A	3365	227.58	215	211.6
Stream A	3150	349.69	350	350.87
Stream A	2800	502.05	500	497.75
Stream A	2300	103.77	100	99.16
Stream A	2200	247.27	250	249.74
Stream A	1950	189.26	200	170.1

Reach	River Sta.	Left	Channel	Right
Stream A	1800	Culvert		
Stream A	1750	300.57	249.77	254.53
Stream A	1500	1500	1500	1500

River: Stream B - Post

Reach	River Sta.	Left	Channel	Right
Stream B South	3310	309.88	300	295.42
Stream B South	3010	516.47	370	381.52
Stream B South	2630	46.23	45	43.18
Stream B South	2610	Culvert		
Stream B South	2585	97.84	110	136.17
Stream B	2220	294.85	300	298.89
Stream B	1920	400.37	400	399.56
Stream B	1520	109.76	110	109.65
Stream B	1475	Culvert		
Stream B	1410	139.22	140	141.54
Stream B	1270	417.1	450	465.86
Stream B	820	493.97	150	138.84
Stream B	670	1836.03	150	60.93
Stream B	520	130.31	100	163.8
Stream B	500	Culvert		
Stream B	420	91.69	90	89.44
Stream B	330	177.72	180	183.81
Stream B	315	Culvert		
Stream B	150	39.8	40	41.13
Stream B	110	97.45	110	118.12
Stream B	100	Culvert		
Stream B	0			

River: Stream B West

Reach	River Sta.	Left	Channel	Right
Stream B - West	1050	500.8	500	493.01
Stream B - West	550	214.14	200	171.74
Stream B - West	350	254.15	250	248.78
Stream B - West	100			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Stream A - Post

Reach	River Sta.	Contr.	Expan.
Stream A	5430	.1	.3
Stream A	5230	.1	.3
Stream A	4930	.1	.3
Stream A	4570	.1	.3
Stream A	4550	Culvert	
Stream A	4510	.1	.3
Stream A	4350	.1	.3
Stream A	3850	.1	.3
Stream A	3365	.1	.3
Stream A	3150	.1	.3
Stream A	2800	.1	.3
Stream A	2300	.1	.3
Stream A	2200	.1	.3
Stream A	1950	.1	.3
Stream A	1800	Culvert	
Stream A	1750	.1	.3
Stream A	1500	.1	.3

River: Stream B - Post

Reach	River Sta.	Contr.	Expan.
Stream B South	3310	.1	.3
Stream B South	3010	.1	.3
Stream B South	2630	.1	.3
Stream B South	2610	Culvert	
Stream B South	2585	.1	.3
Stream B	2220	.1	.3
Stream B	1920	.1	.3
Stream B	1520	.1	.3
Stream B	1475	Culvert	
Stream B	1410	.1	.3
Stream B	1270	.1	.3
Stream B	820	.1	.3
Stream B	670	.1	.3
Stream B	520	.1	.3
Stream B	500	Culvert	
Stream B	420	.1	.3
Stream B	330	.1	.3
Stream B	315	Culvert	
Stream B	150	.1	.3
Stream B	110	.1	.3
Stream B	100	Culvert	
Stream B	0	.1	.3

River: Stream B West

Reach	River Sta.	Contr.	Expan.
Stream B - West	1050	.1	.3
Stream B - West	550	.1	.3

Stream B - West	350	.1	.3
Stream B - West	100	.1	.3

Profile Output Table - Standard Table 1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Stream B West	Stream B - West	1050	PF 1	315.00	697.00	700.53	699.14	700.76	0.003209	3.83	82.19	32.08	0.42
Stream B West	Stream B - West	550	PF 1	315.00	696.84	698.66		698.85	0.004555	3.49	90.20	54.18	0.48
Stream B West	Stream B - West	350	PF 1	315.00	692.00	698.70		698.72	0.000127	1.15	273.98	57.70	0.09
Stream B West	Stream B - West	100	PF 1	315.00	692.00	698.71		698.71	0.000010	0.38	818.55	138.88	0.03
Stream B - Post	Stream B South	3310	PF 1	179.00	713.01	714.43	714.16	714.56	0.009327	2.88	62.10	86.17	0.60
Stream B - Post	Stream B South	3010	PF 1	179.00	708.59	709.71	709.71	710.01	0.028438	4.41	40.60	68.71	1.01
Stream B - Post	Stream B South	2630	PF 1	179.00	699.71	704.67	701.17	704.67	0.000052	0.61	329.74	175.45	0.06
Stream B - Post	Stream B South	2610		Culvert									
Stream B - Post	Stream B South	2585	PF 1	179.00	699.74	701.19	701.19	701.92	0.020843	6.87	26.07	37.28	1.01
Stream B - Post	Stream B	2220	PF 1	442.00	692.00	698.68	693.70	698.71	0.000162	1.35	328.04	65.56	0.11
Stream B - Post	Stream B	1920	PF 1	442.00	692.00	698.62		698.65	0.000207	1.50	294.81	60.12	0.12
Stream B - Post	Stream B	1520	PF 1	798.00	692.00	698.46	694.84	698.53	0.000386	2.13	375.10	72.65	0.17
Stream B - Post	Stream B	1475		Culvert									
Stream B - Post	Stream B	1410	PF 1	513.00	691.64	693.76	693.76	694.82	0.001642	8.25	62.19	55.83	1.00
Stream B - Post	Stream B	1270	PF 1	513.00	689.75	691.18	692.06	694.16	0.009577	13.87	36.99	29.64	2.19
Stream B - Post	Stream B	820	PF 1	513.00	684.10	686.50	686.52	687.51	0.020329	8.08	63.50	32.81	1.02
Stream B - Post	Stream B	670	PF 1	513.00	670.00	670.30	671.06	677.09	1.588547	20.90	24.54	82.18	6.74
Stream B - Post	Stream B	520	PF 1	558.00	664.51	670.93	667.07	670.96	0.000020	1.45	422.34	129.65	0.12
Stream B - Post	Stream B	500		Culvert									
Stream B - Post	Stream B	420	PF 1	558.00	664.48	670.56	667.09	670.62	0.000060	2.22	545.70	371.76	0.19
Stream B - Post	Stream B	330	PF 1	558.00	663.08	670.60	665.49	670.61	0.000008	1.15	1381.27	404.57	0.08
Stream B - Post	Stream B	315		Culvert									
Stream B - Post	Stream B	150	PF 1	558.00	662.21	664.93	664.93	666.08	0.002018	8.59	64.93	160.92	1.00
Stream B - Post	Stream B	110	PF 1	558.00	661.59	663.23	663.99	665.80	0.006995	12.85	43.43	31.40	1.80
Stream B - Post	Stream B	100		Culvert									
Stream B - Post	Stream B	0	PF 1	558.00	657.45	662.17	659.91	662.48	0.000199	4.47	124.89	79.65	0.37
Stream A - Post	Stream A	5430	PF 1	188.00	720.19	721.14	721.14	721.46	0.027473	4.59	40.95	63.54	1.01
Stream A - Post	Stream A	5230	PF 1	188.00	712.77	714.16	714.30	714.77	0.041888	6.25	30.07	40.23	1.27
Stream A - Post	Stream A	4930	PF 1	188.00	702.00	703.88	703.96	704.54	0.028256	6.53	28.81	26.61	1.11
Stream A - Post	Stream A	4570	PF 1	188.00	692.35	700.49	694.17	700.50	0.000014	0.37	508.28	112.28	0.03
Stream A - Post	Stream A	4550		Culvert									
Stream A - Post	Stream A	4510	PF 1	188.00	691.60	693.55	693.55	694.46	0.019822	7.64	24.60	19.15	1.00
Stream A - Post	Stream A	4350	PF 1	201.00	680.88	681.07	681.47	683.82	1.169402	13.29	15.13	79.43	5.37
Stream A - Post	Stream A	3850	PF 1	201.00	678.38	679.97	679.34	680.12	0.004435	3.13	64.15	44.41	0.46
Stream A - Post	Stream A	3365	PF 1	595.00	675.95	679.35		679.45	0.001018	2.46	241.98	79.64	0.25
Stream A - Post	Stream A	3150	PF 1	595.00	674.84	677.75	677.75	678.93	0.004748	8.72	68.26	29.28	1.01
Stream A - Post	Stream A	2800	PF 1	624.00	673.05	675.27	675.87	677.34	0.003934	11.54	54.07	28.75	1.48
Stream A - Post	Stream A	2300	PF 1	624.00	670.49	672.02	672.82	674.66	0.007329	13.03	47.89	34.40	1.95
Stream A - Post	Stream A	2200	PF 1	625.00	667.86	668.63	669.59	673.17	0.028831	17.10	36.55	49.54	3.51
Stream A - Post	Stream A	1950	PF 1	625.00	656.00	666.74	658.46	666.75	0.000040	0.88	706.30	92.79	0.06
Stream A - Post	Stream A	1800		Culvert									
Stream A - Post	Stream A	1750	PF 1	622.00	656.78	659.53	659.53	660.78	0.017937	8.95	69.49	43.51	1.01
Stream A - Post	Stream A	1500	PF 1	623.00	653.99	656.96	656.35	657.13	0.005207	3.35	185.96	132.81	0.50

Profile Output Table - Culvert Only

River	Reach	River Sta		Profile	E.G. US. (ft)	W.S. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Min El Weir Flow (ft)	Q Culv Group (cfs)	Q Weir (cfs)	Delta WS (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
Stream B - Post	Stream B South	2610	Culvert #1	PF 1	704.67	704.67	704.39	704.68	704.51	74.40	32.33	3.48	7.73	9.34
Stream B - Post	Stream B South	2610	Culvert #2	PF 1	704.67	704.67	704.39	704.67	704.51	72.27	32.33	3.48	7.51	9.20
Stream B - Post	Stream B	1475	Culvert #1	PF 1	698.53	698.46	698.53	698.08	697.01	463.68	334.32	4.70	9.64	12.65
Stream B - Post	Stream B	500	Culvert #1	PF 1	670.96	670.93	670.54	670.96	670.01	275.59	282.41	0.36	3.94	3.94
Stream B - Post	Stream B	315	Culvert #1	PF 1	670.61	670.60	670.61	670.12	670.21	498.28	59.72	5.67	9.23	11.43
Stream B - Post	Stream B	100	Culvert #1	PF 1	665.80	663.23	667.90	664.56	669.01	558.00		1.06	9.30	9.30
Stream A - Post	Stream A	4550	Culvert #1	PF 1	700.50	700.49	700.50	698.50	700.01	103.08	84.92	6.94	10.71	17.85
Stream A - Post	Stream A	1800	Culvert #1	PF 1	666.75	666.74	666.75	665.51	665.01	461.29	163.71	7.21	9.67	12.19

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
PROPOSED PERIMETER CHANNEL DESIGN

Channel	Station		Flow Rate (cfs)	Bottom Slope (ft/ft)	Bottom Width (ft)	Side Slope (ft/ft)		Normal Depth (ft)	Flow Vel. (fps)	Froude No.	Vel. Head (ft)	Energy Head (ft)	Flow Area (sq.ft.)	Top width of Flow (ft)
						Right	Left							
CH2	0+00	0+62.45	157.0	0.048	6	2	2	1.52	11.39	1.881	2.02	3.54	13.78	12.09
	0+62.45	1+28.53	157.0	0.009	6	2	2	2.35	6.23	0.858	0.60	2.96	25.21	15.42
	1+28.53	6+96.81	157.0	0.010	6	2	2	2.29	6.47	0.902	0.65	2.94	27.27	15.17
	6+96.81	12+39.06	157.0	0.010	6	2	2	2.29	6.47	0.899	0.65	2.94	27.27	15.17
CH3	0+00.00	5+05.88	3.0	0.063	0	3	3	0.47	4.58	1.669	0.33	0.79	0.66	2.80

Note:
1. Calculations were performed using the HYDROCALC Computer Program developed by Dodson and Associates (Version 2.0, 1996-2010).
2. n = 0.03 (Manning Coefficient) is used for the calculations.

TURKEY CREEK LANDFILL
0771-368-11-123
PROPOSED PERIMETER CHANNEL DESIGN
HYDRAULIC ANALYSIS

Example Calculation: Calculate the 25-year normal depth for Channel 2 between stations 0+00.00 and 0+62.45.

List of Symbols:

Q_d = peak flow rate for channel, cfs - obtained from HEC-1 Analysis (Appendix IIIF-A)
R = hydraulic radius, ft
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = bottom width of channel, ft
z = z-ratio (ratio of run to rise for channel sideslope)
A_f = flow area, sf
g = gravitational acceleration = 32.2 ft/s^2
T = top width of flow, ft
d = normal depth of channel, ft

The program uses an iterative process to calculate the normal depth of the channel to satisfy Manning's Equation

$$Q = \frac{1.486}{n} A R^{0.67} S^{0.5}$$

Design Inputs:

Q_d =	157	cfs
S =	0.048	ft/ft
b =	6	ft
z =	2	(H) : 1 (V)
n =	0.03	

Step 1 - Based on the geometry of the channel cross-section, solve for R and A_f

$$R = \frac{bd + zd^2}{b + 2d(z^2 + 1)^{0.5}}$$

$$A_f = bd + zd^2$$

assume: d = 1.52 ft

R = 1.074 ft

A_f = 13.78 sf

solve for Q: Q = 157

if Q is not equal to Q_d, select a new d and repeat calculations

Step 2 - solve for velocity, T, Froude number, velocity head, and energy head

Q = VA => V = Q/A

V = 11.39 ft/s

T = b + 2(z x d)

T = 12.09 ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

F_r = 1.881

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 2.02 ft

Energy Head = water elevation + velocity head

Energy Head = 3.54 ft

CHANNEL EROSION CONTROL DESIGN

Channel erosion controls have been designed for flow velocities resulted from the 25-year frequency flow rates. As shown on pages IIIF-B-2 and IIIF-B-38, velocities in the perimeter channels range from 0.38 ft/s to 20.90 ft/s. The channel lining needed to protect against erosive velocities is shown on Drawings IIIF.5 and IIIF.6 in Appendix IIIF. All channels and drainage features will be inspected and maintained in accordance with the Site Operating Plan.

The following was used to select the type of channel lining material.

- Vegetation – used in all areas where velocities are less than 4 ft/s for channels.
- Turf reinforcement matting – used in channels for velocities between 4 ft/s and 13 ft/s. Please refer to page IIIF-B-6 for more information.
- 2-foot-thick Gabions – used at chute discharges in channels, areas in channels where flow velocities exceed 13 ft/s, and detention ponds (see Appendix IIIF-C – Final Cover Erosion Control Structure Design).

Channel lining details are presented on Drawings IIIF.7 in Appendix IIIF.

North American Green
14649 Highway 41 North
Evansville, IN 47725
800-772-2040
FAX: 812-867-0247
www.nagreen.com

Material and Performance Specification Sheet

A tensar Company

C350 Turf Reinforcement Mat

The composite turf reinforcement mat (C-TRM) shall be a machine-produced mat of 100% coconut fiber matrix incorporated into a permanent three-dimensional turf reinforcement matting. The matrix shall be evenly distributed across the entire width of the matting and stitch bonded between a super heavy duty UV stabilized nettings with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings, an ultra heavy UV stabilized, dramatically corrugated (crimped) intermediate netting with 0.5 x 0.5 inch (1.27 x 1.27 cm) openings, and covered by an super heavy duty UV stabilized nettings with 0.50 x 0.50 inch (1.27 x 1.27 cm) openings. The middle corrugated netting shall form prominent closely spaced ridges across the entire width of the mat. The three nettings shall be stitched together on 1.50 inch (3.81cm) centers with UV stabilized polypropylene thread to form a permanent three-dimensional turf reinforcement matting.

The C350 shall meet requirements established by the Erosion Control Technology Council (ECTC) Specification and the US Department of Transportation, Federal Highway Administration's (FHWA) *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-03 Section 713.18 as a Type 5A, B, and C Permanent Turf Reinforcement Mat.*

Installation staple patterns shall be clearly marked on the turf reinforcement matting with environmentally safe paint. All mats shall be manufactured with a colored thread stitched along both outer edges (approximately 2-5 inches [5-12.5 cm] from the edge) as an overlap guide for adjacent mats.

Material Content		
Matrix	100% Coconut fibers	0.50 lbs/yd^2 (0.27 kg/m^2)
Nettings	Top and Bottom, UV stabilized Polypropylene	8 lb/1000 ft^2 (3.91 kg/100 m^2)
	Middle, corrugated UV stabilized Polypropylene	24 lb/1000 ft^2 (11.7 kg/100 m^2)
Thread	Polypropylene, UV stabilized	

C350 is available in the following roll sizes:

Width	6.5 ft (2.0 m)
Length	55.5 ft (16.9 m)
Weight ± 10%	37 lbs (16.8 kg)
Area	40.0 yd^2 (33.4 m^2)

Index Value Properties:

Property	Test Method	Typical	Net Only
Thickness	ASTM D6525	0.67 in (17.0 mm)	0.51 in
Resiliency	ASTM 6524	90%	---
Density	ASTM D792	0.53 oz/in^3	---
Mass/Unit Area	ASTM 6566	12.57 oz/yd^2 (426 g/m^2)	---
Porosity	ECTC Guidelines	99%	---
Stiffness	ASTM D1388	3.83 oz-in	---
Light Penetration	ECTC Guidelines	9.0%	---
UV Stability	ASTM D4355/ 1000 hr	86%	86%
Tensile Strength MD	ASTM D6818	625 lbs/ft (9.12 kN/m)	698 lbs/ft
Elongation MD	ASTM D6818	22%	30%
Tensile Strength TD	ASTM D6818	768 lbs/ft (11.21 kN/m)	710 lbs/ft
Elongation TD	ASTM D6818	15%	20%

Bench Scale Testing* (NTPEP):

Test Method	Parameters	Results
ECTC Method 2 Rainfall	50 mm (2 in)/hr for 30 min	SLR** = 18.32
	100mm (4 in)/hr for 30 min	SLR** = 19.65
	150 mm (6 in)/hr for 30 min	SLR** = 20.48
ECTC Method 3 Shear Resistance	**Shear at 0.50 inch soil loss**	**7.5 lbs/ft^2**
ECTC Method 4 Germination	Top Soil, Fescue, 21 day incubation	243% improvement of biomass

* Bench Scale tests should not be used for design purposes

** Soil Loss Ratio = Soil loss with Bare Soil/Soil Loss with RECP (soil loss is based on regression analysis)

Performance Design Values:

Maximum Permissible Shear Stress		
	Short Duration	Long Duration
Phase 1 Unvegetated	3.2 lbs/ft^2 (153 Pa)	3.0 lbs/ft^2 (144 Pa)
Phase 2 Partially Veg.	10.0 lbs/ft^2 (480 Pa)	10.0 lbs/ft^2 (480 Pa)
Phase 3 Fully Veg.	12.0 lbs/ft^2 (576 Pa)	10.0 lbs/ft^2 (480 Pa)
Velocity Unveg	10.5 ft/s (3.2 m/s)	
Velocity Veg.	20 ft/s (6.0 m/s)	

Slope Design Data: C Factors			
	Slope Gradients (S)		
Slope Length (L)	≤ 3:1	3:1 – 2:1	≥ 2:1
≤ 20 ft (6 m)	0.0005	0.015	0.043
20-50 ft	0.018	0.031	0.050
≥ 50 ft (15.2 m)	0.035	0.047	0.057

Roughness Coefficients- Unveg.	
Flow Depth	Manning's n
≤ 0.50 ft (0.15 m)	0.041
0.50 – 2.0 ft	0.040 – 0.013
≥ 2.0 ft (0.60 m)	0.012

Product Participant of: QDOR Performance Verified

Updated 3/09

DETENTION POND DESIGN

Detention ponds have been analyzed by using HEC-1, storage routing method. The input parameters for the model are presented in Appendix IIIF-A. A summary of HEC-1 results are presented on page IIIF-B-44. As can be seen on the table, during the 25-year storm event, none of the ponds flow over their spillways.

Downstream sides of the low-water outlets will be designed with either rock riprap or gabions as shown on pages IIIF-B-45 and IIIF-B-46.

TURKEY CREEK LANDFILL
0771-368-11-123
DETENTION POND DESIGN

Purpose: Demonstrate that the detention pond outlet structure designs are adequate to convey runoff from the various subbasins to their discharge points.

Method:
1. Use the 25-year, 24-hour flow rates and water surface elevations for the drainage areas that will discharge to each detention pond from the HEC-1 analysis (see Appendix IIIF-A).
2. Use the Weir Equation to calculate the flow rate over the spillways as appropriate.

Solution:

	P1	P2	P3
Bottom ELEV, ft[1]	659.0	650.0	692.5
Spillway ELEV, ft	665.0	656.5	697.0
Spillway Length, ft	26	20	75
Top of Road/Berm, ft	670.00	657.00	702.00
Discharge Pipe Downstream Invert ELEV, ft	658.00	649.25	692.00
Peak Inflow Q_{25}, cfs	625	425	789
Peak Outflow Q_{25}, cfs	622	260	495
Peak Stage in Pond Q_{25}, ft	664.38	655.64	696.34
Est. Flow (Q_{25}) over Spillway, cfs	--	--	--

Note:
1) Details of the pond outlet structures are presented on Drawing IIIF.13 through Drawing IIIF.15
2) The flow over the spillway is estimated using the formula $Q = CLH^{3/2}$ where $C = 2.64$, L is the length of the spillway in feet, and H is the head on the spillway in feet. The flow over the spillway conservatively assumes no flow through the low water outlet.

Required: Determine the minimum length and median diameter of riprap required at the detention pond outlet structures and creek culverts to control erosion in the detention pond outlet channels.

Reference:

1. Haan, Barfield, and Hayes, *Design Hydrology and Sedimentology for Small Catchments*, 1994.
2. Dodson's and Associates, Inc., *ProHec-1 Plus Program Documentation,* 1995.
3. Freeman, Gary E., J. Craig Fischenich, Gabion for Streambank Erosion Control, 2000. EMRRP Technical Notes Collection (ERDC TN-EMRRP-SR-22), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Solution: The riprap will be designed for the 25-year flow rates at the detention pond outlet structures and culverts. The flow at the outlet structures and culverts can be divided into two categories:

1. Flow over the Spillway/Road

As shown on page IIIF-B-43, both the Ponds P1, P2 and P3 are not expected to have flow over the spillway during the 25-year event. Erosion protection calculations for the drainage structures will be based on flow through low water outlets/culverts only.

Flow Structure Spillway Topslope	25-Year Flow Rate (cfs)	25-Year Velocity (ft/s)	25-Year Flow Depth (ft)	25-Year Foude Number	25-Year Velocity Head (ft)	25-Year Energy Head (ft)	25-Year Flow Area (sq. ft.)	25-Year Top Width (ft)
P1	--	--	--	--	--	--	--	--
P2	--	--	--	--	--	--	--	--
P3	--	--	--	--	--	--	--	--

Flow Structure Spillway Sideslope	25-Year Flow Rate (cfs)	25-Year Velocity (ft/s)	25-Year Flow Depth (ft)	25-Year Foude Number	25-Year Velocity Head (ft)	25-Year Energy Head (ft)	25-Year Flow Area (sq. ft.)	25-Year Top Width (ft)
P1	--	--	--	--	--	--	--	--
P2	--	--	--	--	--	--	--	--
P3	--	--	--	--	--	--	--	--

2. Flow through the Low Water Outlet

The flow rate through the low water outlet (LWO) is summarized below.

Flow Structure	Pond Bottom Elev (ft-msl)	LWO Invert Elev. Upstream (ft-msl)	LWO Invert Elev. Downstream (ft-msl)	LWO Diameter (in)	25-Year Flow Rate[2] (cfs)	25-Year Outlet Velocity[1] (ft/s)
P1	659.00	659.00	658.00	3-54	207.33	13.04
P2	650.00	650.00	649.25	2-42	130.00	13.51
P3	692.00	692.50	692.00	5-42	99.00	11.10

[1] Velocities through the low water outlet for P1 and Culvert1 were calculated using the HYDROCALC HYDRAULICS FOR WINDOWS program developed by Dodson and Associates (Version 2.01, 1996-2010).

[2] The flowrates for all low water outlets are the peak discharges for the respective areas as calculated by HEC-1 since the spillway crest is not overtopped in the 25-year event. The total 25-year flowrate discharging
from P1" is 662 cfs / 3 pipes = 207.33 cfs per pipe,
from P2" is 260 cfs / 2 pipes = 130 cfs per pipe, and
from P3" is 495 cfs / 5 pipes = 99 cfs per pipe.

The velocity through the low water outlet is larger than the velocity over the spillway, when there is a low water outlet present. The flowrate through the low water outlet is used to design the riprap apron.

The nomograph used for design of the length of the riprap and the median diameter are shown on page IIIF-B-46 (Figure 5.24 and 5.25).

The minimum riprap length and diameter for each outlet is summarized below. Riprap was not designed for culvert as they discharge into channels or ponds. The length of the riprap is increased by 20 percent to provide for a conservative design.

Pond	Riprap Design Flowrate (cfs)	Pipe Diameter (in)	Riprap Length (ft)	Length L x 1.2 (ft)	Rock Diameter (ft)
P1	207.3	3-54	40	48	1.20
P2	130.0	2-42	32	38	1.10
P3	99.0	5-42	31	37	0.40

Apron width required for the ponds (e.g., width of erosion protection in outlet channel) are:
W_{req}=LWO diameter + 0.4*(RipRap Length)

Pond	W_{req} (ft)	$W_{provided}$ (ft)
P1	19.5	20.0
P2	15.8	16.0
P3	15.4	16.0

The median diameter of riprap is intended to determine the minimum diameter of the riprap that will be used. As an alternative, 2-foot thick gabions with a d_{50} of 6-inches can be used.

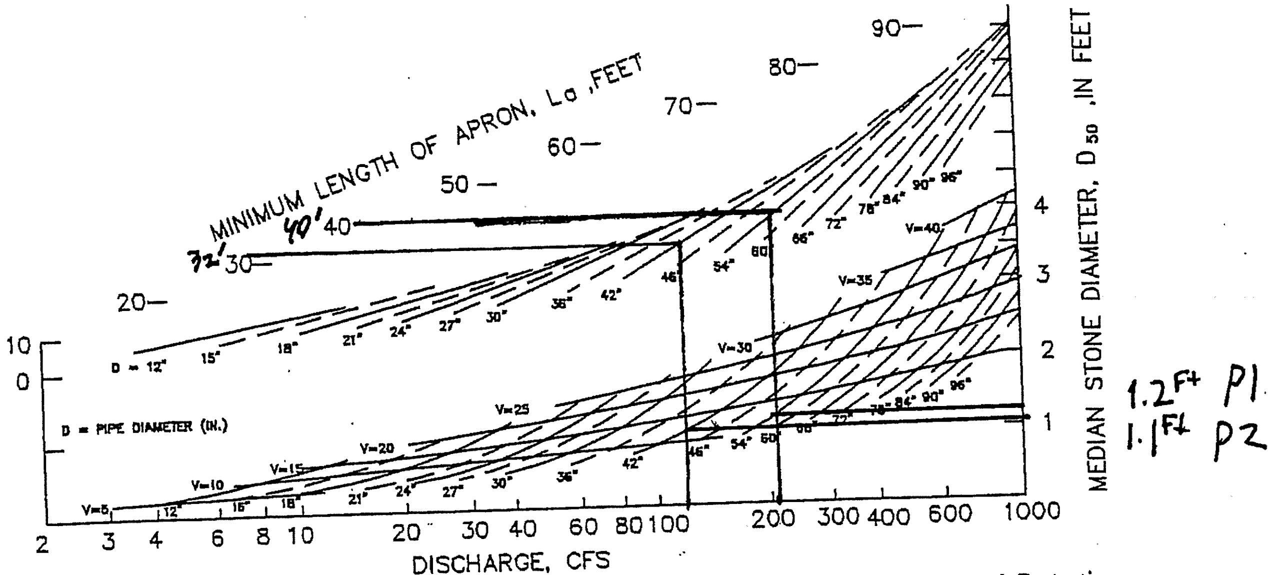


Figure 5.24 Design of outlet protection—minimum tailwater condition, $T_w < 0.5D$ (Environmental Protection Agency, 1976).

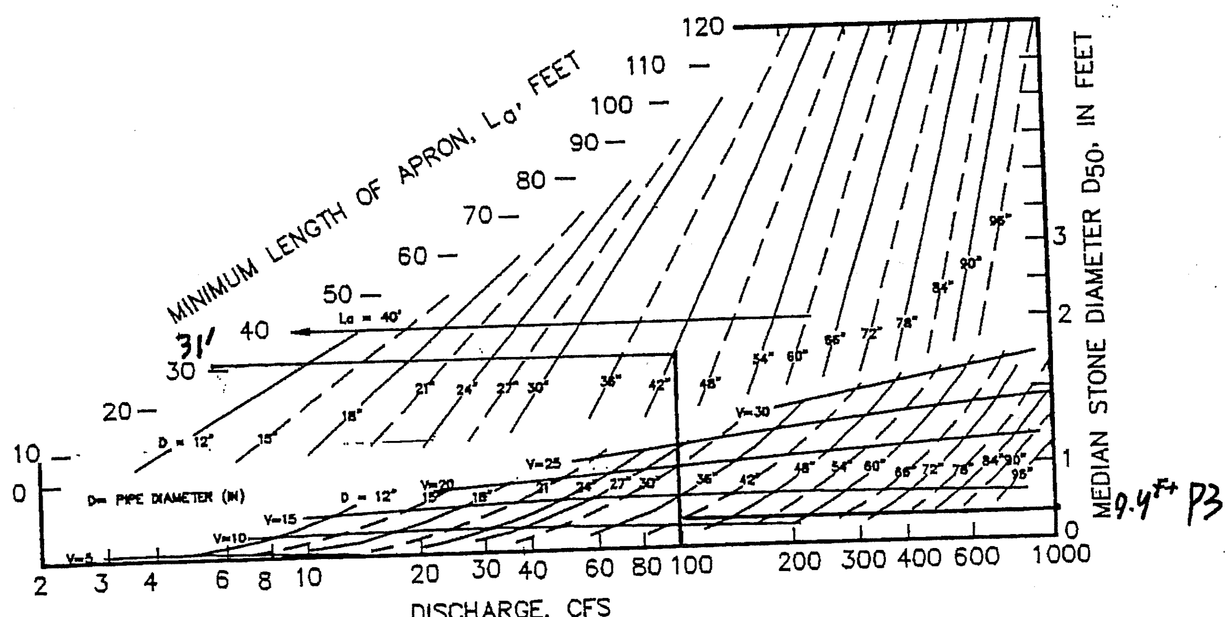


Figure 5.25 Design of outlet protection—maximum tailwater condition, $T_w \geq 0.5D$ (Environmental Protection Agency, 1976).

into the riser 3 ft below its top, what discharge will pass through the four holes with the water level at 1, 2, 4, and 8 ft above the riser? (c) What is the total discharge through the pipe? (d) How might the orifices be sized to provide better stormwater control? (e) Explain whether you would expect two rows (each consisting of four holes) of 8-in.-diameter holes to provide better results? Assume that one row is 2 ft below the riser invert and the other row is 4 ft below the riser invert.

(5.6) A gravel roadway is constructed in a low-lying area such that the roadway is frequently overtopped as a result of severe storms. The roadway is 40 ft wide, and its elevation is 36 ft. (a) If the water level upstream of the roadway is 2 ft above the crest of the roadway, what is the discharge across the roadway? (b) If the roadway is paved, what upstream depth would be required to carry the same flow? (c) Would paving reduce flooding problems?

CULVERT DESIGN

Prep by: BPY
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
CULVERT DESIGN

Chkd By: CRM
Date: 11/15/2021

Required: Design culverts to convey the flow.

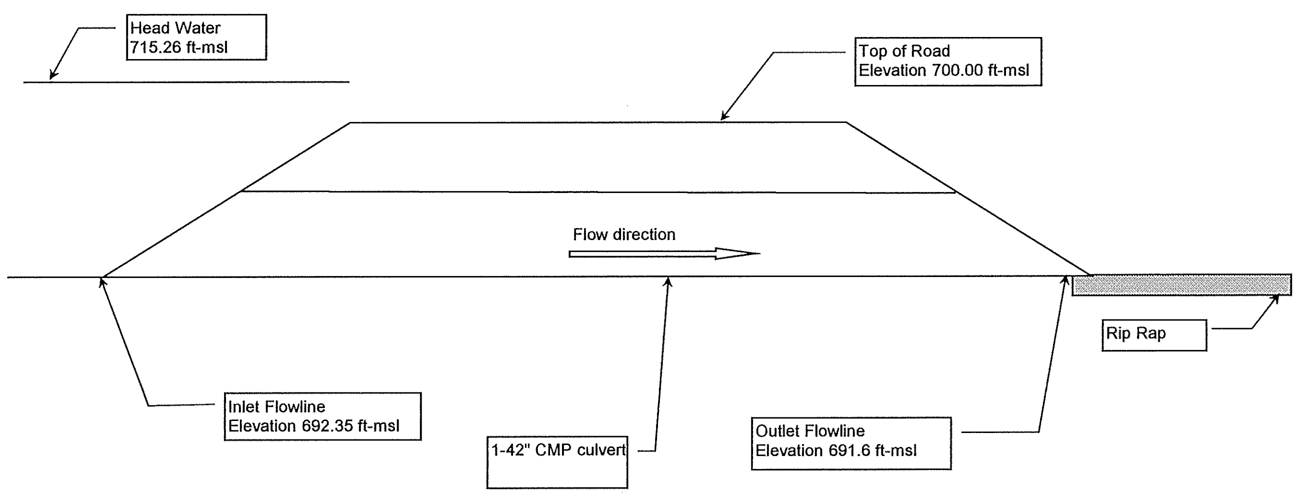
Method: Use HYDROCALC Hydraulics for Windows computer program to determine number and size of the culverts.
Use total 25-year frequency storm event flow estimated by HEC-1 included in Appendix IIIF-A.

For existing 42" CMP culvert existing O2, Culvert "1"

Total Flow=	188	cfs
No. of Culverts=	1	
Culvert Span=	--	inches
Culvert Rise=	--	inches
Culvert Diameter=	42	inches

Culvert ID	Culvert Span (ft)	Culvert Span (ft)	FHWA Chart Number	FHWA Scale Number	Culvert Diameter (ft)	Manning's Coefficient	Entrance Loss Coefficient	Culvert Length (ft)	Downstream Invert Elevation (ft msl)	Upstream Invert Elevation (ft msl)	Flow Rate (cfs)	Tailwater Depth[2] (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1	--	--	2	3	3.5	0.024	0.5	14.30	691.60	692.35	188.00	1.95	22.91	7.41	3.50	3.45	3.50	19.54

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.0, 1996-2010).
2. Tailwater depth is assumed to be the 25-year, 24-hour storm water surface elevation in CH1 or Stream A in HEC-RAS Cross secction A-4510 (693.55 ft-msl).

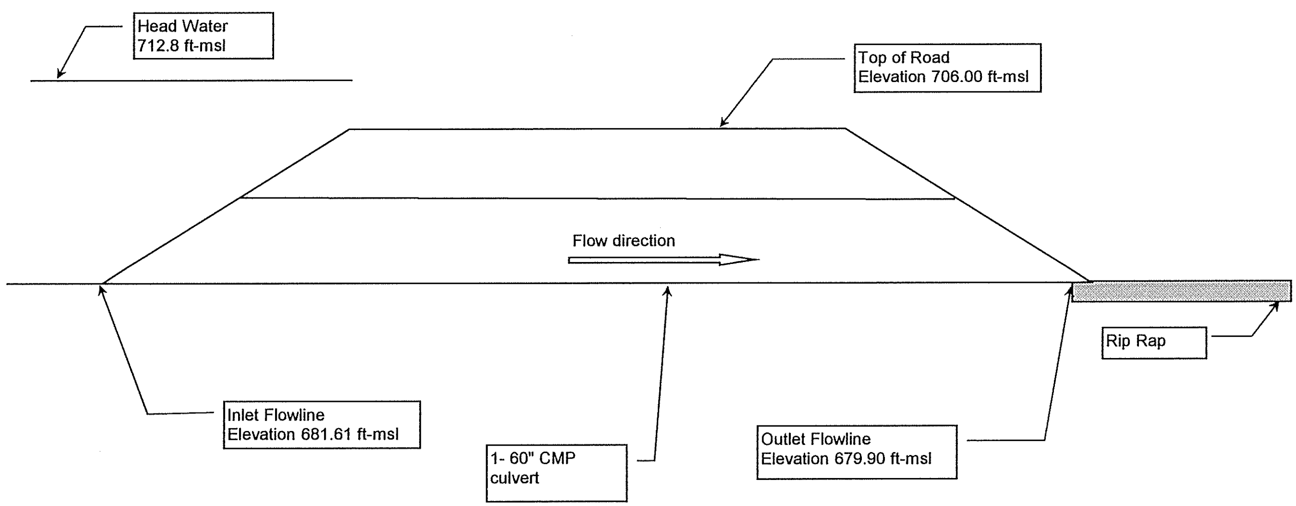


For existing 60" CMP culvert existing O1, Culvert "2"

Total Flow=	446 cfs
No. of Culverts=	1
Culvert Span=	-- inches
Culvert Rise=	-- inches
Culvert Diameter=	60 inches

Culvert ID	Culvert Span	Culvert Span (ft)	FHWA Chart Number	FHWA Scale Number	Culvert Diameter (ft)	Manning's Coefficient	Entrance Loss Coefficient	Culvert Length (ft)	Downstream Invert Elevation (ft msl)	Upstream Invert Elevation (ft msl)	Flow Rate (cfs)	Tailwater Depth[2] (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
2	--	--	2	3	5	0.024	0.5	100.00	679.90	681.61	446.00	0.00	31.19	17.27	5.00	4.93	5.00	22.71

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.0, 1996-2010).
2. Tailwater depth is assumed to be the 25-year, 24-hour storm water surface elevation in CH1 or Stream A in HEC-RAS Cross secction A-3365 (679.35 ft-msl).



Prep by: BPY
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
CULVERT DESIGN

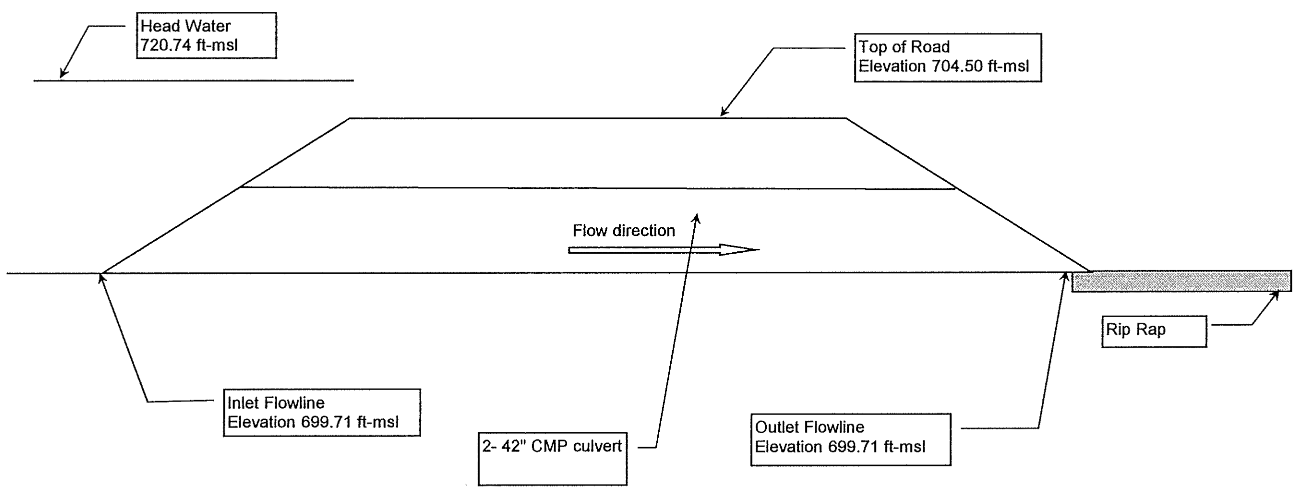
Chkd By: CRM
Date: 11/15/2021

For existing 42" CMP culvert existing O4, Culvert "3"

Total Flow= 179 cfs
No. of Culverts= 2
Culvert Span= -- inches
Culvert Rise= -- inches
Culvert Diameter= 42 inches

Culvert ID	Culvert Span	Culvert Span (ft)	FHWA Chart Number	FHWA Scale Number	Culvert Diameter (ft)	Manning's Coefficient	Entrance Loss Coefficient	Culvert Length (ft)	Downstream Invert Elevation (ft msl)	Upstream Invert Elevation (ft msl)	Flow Rate (cfs)	Tailwater Depth[2] (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
3	--	--	2	3	3.5	0.024	0.5	25.10	699.71	699.71	89.50	1.48	21.03	8.87	3.50	3.44	3.50	18.60

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.0, 1996-2010).
2. Tailwater depth is assumed to be the 25-year, 24-hour storm water surface elevation in CH4 or Stream B in HEC-RAS Cross secction B-2585 (701.19 ft-msl).



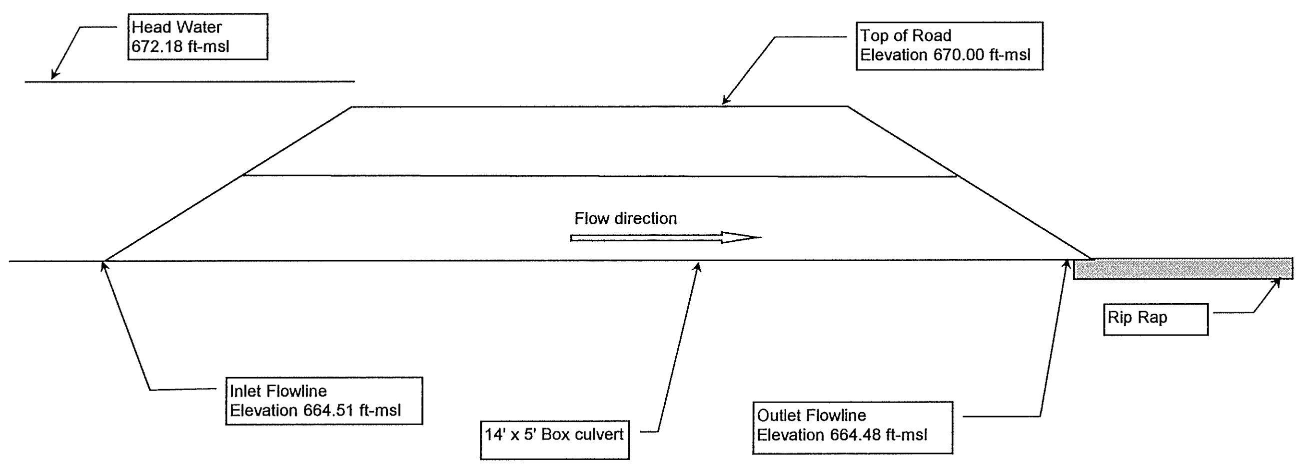
TURKEY CREEK LANDFILL
0771-368-11-123
CULVERT DESIGN

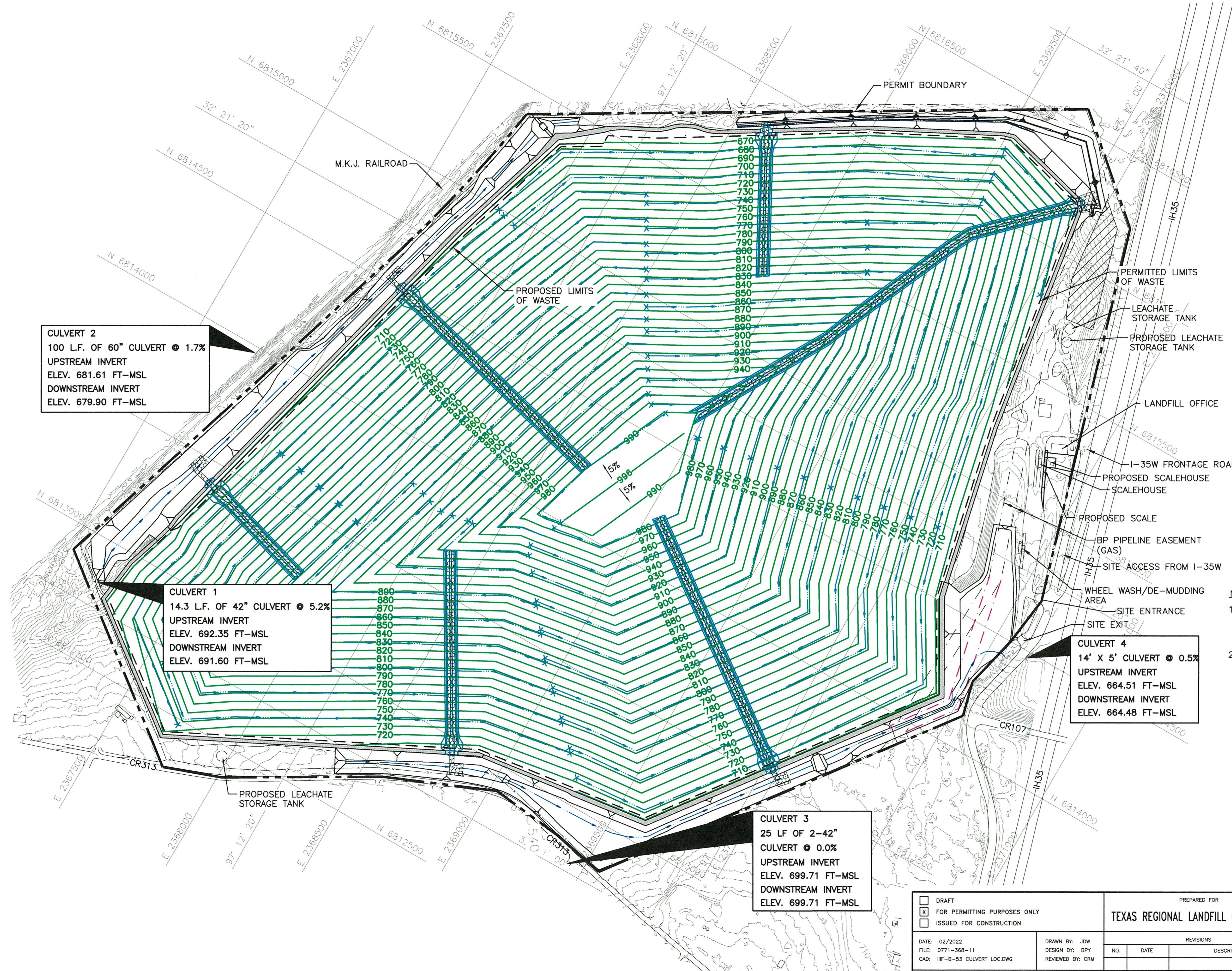
For exsting culvert at downstream of "S5", Culvert "4"

Total Flow= 558 cfs
No. of Culverts= 1
Culvert Span= 168 inches
Culvert Rise= 60 inches
Culvert Diameter= -- inches

Culvert ID	Culvert Span (ft)	Culvert Rise (ft)	FHWA Chart Number	FHWA Scale Number	Culvert Diameter (ft)	Manning's Coefficient	Entrance Loss Coefficient	Culvert Length (ft)	Downstream Invert Elevation (ft msl)	Upstream Invert Elevation (ft msl)	Flow Rate (cfs)	Tailwater Depth[2] (ft)	Headwater Inlet Control (ft)	Headwater Outlet Control (ft)	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
4	14	5	8	1	-	0.013	0.5	66.00	664.48	664.51	558.00	6.08	6.11	7.67	5.00	3.67	5.00	7.97

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.0, 1996-2010).
2. Tailwater depth is assumed to be the 25-year, 24-hour storm water surface elevation in CH4 or Stream B in HEC-RAS Cross secction B-420 (670.56 ft-msl).





LEGEND

- PERMIT BOUNDARY
- LIMIT OF WASTE
- 750 — EXISTING CONTOUR (SEE NOTE 1)
- N 6816000 — STATE PLANE COORDINATE
- 32° 21' 20" — GEODETIC COORDINATE
- EASEMENT
- PROPOSED EASEMENT (SEE NOTE 2)
- 800 — PROPOSED FINAL COVER CONTOUR
- PROPOSED DRAINAGE CHUTE
- DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- FUTURE LFGTE FACILITY LOCATION

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. THE PROPOSED EASEMENT SHOWN IS FOR VISUAL PURPOSES ONLY. THE ACTUAL LOCATION WILL BE DETERMINED AT A LATER DATE IN COORDINATION WITH THE EASEMENT HOLDER.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
1-22-22

☐ DRAFT	PREPARED FOR
☒ FOR PERMITTING PURPOSES ONLY	TEXAS REGIONAL LANDFILL COMPANY, LP
☐ ISSUED FOR CONSTRUCTION	

DATE: 02/2022 | DRAWN BY: JDW
FILE: 0771-368-11 | DESIGN BY: BPY
CAD: IIIF-B-53 CULVERT LOC.DWG | REVIEWED BY: CRM

REVISIONS		
NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT CULVERT LOCATIONS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-B-53

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-B\IIIF-B-53-CULVERT LOCATION.dwg, rarrington, 1:2

APPENDIX IIIF-C

FINAL COVER EROSION CONTROL STRUCTURE DESIGN

Includes pages IIIF-C-1 through IIIF-C-23

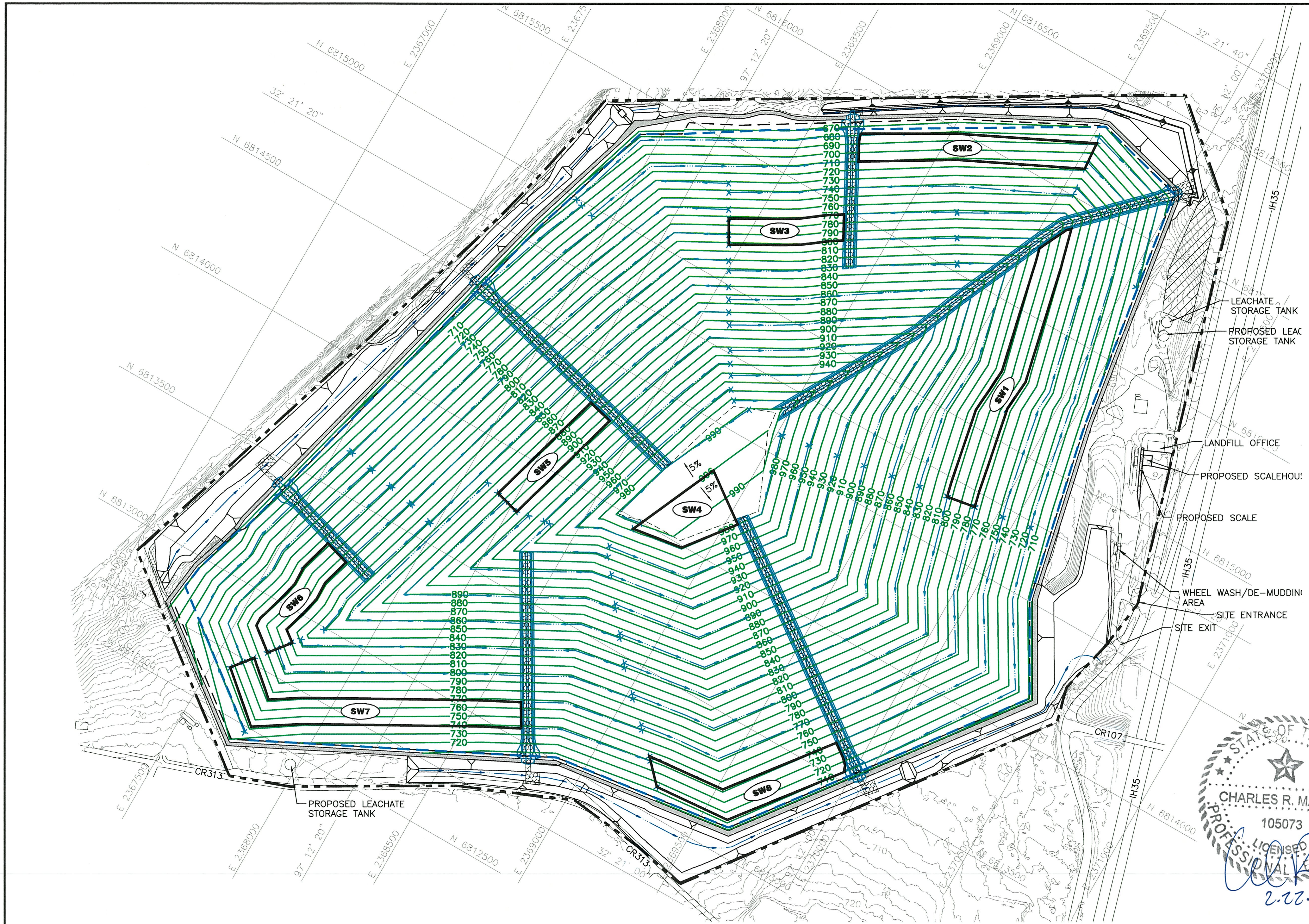
STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

CONTENTS

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

DRAINAGE SWALE DESIGN

- The drainage swale layout is shown on Drawing IIIF.1 – Drainage Structure Plan. A swale detail is provided on Drawing IIIF.7 – Drainage Details.
- Typical Swale Design Summary:
  - Typical swale drainage areas analyzed are shown on sheet IIIF-C-2.
  - Hydraulic calculations are summarized on page IIIF-C-5.
  - Maximum normal depth is 1.49 feet (Drainage Area S7).
  - Maximum flow velocity is 2.76 fps (Drainage Area S7).
  - Vegetation will be established on the swales to protect against erosion.
  - Typical swale drainage areas were selected such that all slope conditions (3.5% and 4.0%) are included in this analysis. Additionally, swales with large individual drainage areas and short and long swale lengths are included in this analysis.



LEGEND

- PROPERTY BOUNDARY
- LIMITS OF WASTE
- N 6816000 — STATE PLANE GRID
- 32° 21' 20" — GEODETIC COORDINATE
- 730 — EXISTING CONTOUR
- 810 — PROPOSED FINAL COVER CONTOUR
- PROPOSED DRAINAGE CHUTE
- PROPOSED DRAINAGE SWALE
- PROPOSED PERIMETER CHANNEL
- DRAINAGE DIVIDE
- SW2 — SWALE DRAINAGE AREA DESIGNATION
- FUTURE LFGTE FACILITY LOCATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 03-07-2018. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.

TYPICAL SWALE DRAINAGE AREA DESIGNATION	AREA (ACRES)
SW1	2.81
SW2	2.28
SW3	1.11
SW4	1.47
SW5	1.25
SW6	1.18
SW7	3.03
SW8	2.13

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DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-C-2-TYP. SWALE AREAS.DWG

DRAWN BY: JDW
DESIGN BY: BPY
REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT SWALE DRAINAGE AREAS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF-C-2

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-C\IIIF-C-2 Swale Areas.dwg, rarrington, 1:2

Required: Analyze swales to determine the adequacy of the swale design.

Method:

1. Determine the 25-year, 24-hour flow rates for the swale drainage areas by the Rational Method.

Reference:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, 3rd Edition, September 2019.
2. NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0: Texas (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, 2018)

Solution:

1. Determine the 25-year intensity flow rates.

$$Q = CIA$$

Where:
C= 0.7 (runoff coefficient, Ref 1.)
I = intensity in/hr
A= drainage area, ac

$$I = \frac{b}{(t_c + d)^e}$$

b = 83.01
d = 10.65
e = 0.775

From Ref. 2, for Johnson County 25-year storm event

t_c is assumed to be 10 min.

I = 7.95 in/hr

Swale	Area[1] (ac)	Flow Rate (cfs)
S1	2.81	15.6
S2	2.28	12.7
S3	1.11	6.2
S4	1.47	8.2
S5	1.25	7.0
S6	1.18	6.6
S7	3.03	16.9
S8	2.13	11.9

[1] The total drainage area was conservatively assumed to be contributing to the swale at the analysis point.

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Texas Department of Transportation

Based on "National Oceanic and Atmospheric Administration's (NOAA) Atlas 14
Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas" (Perica et al. 2018)

Parameter Selection

1. Select Units
   English
2. Select Methodology
   Annual Maximum Series (AMS)
3. Select County
   JOHNSON
4. Select County Zone
   Zone-1
5. Select Time of Concentration (t_c)
   10 Minute

Coefficient	Design Annual Exceedance Probability (Design Annual Recurrence Interval)						
	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)	0.2% (500-year)
e	0.7853	0.7799	0.7772	0.7746	0.7732	0.7717	0.7666
b	45.0947	58.5103	68.8917	83.0120	94.0156	105.4618	133.5994
d (min)	10.3117	10.3756	10.4692	10.6482	10.8145	11.0321	11.6620
Intensity (inches/hour)	4.24	5.57	6.59	7.95	8.99	10.05	12.64

Note: Johnson County has 1 rainfall zone.

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
SWALE ANALYSIS

Swale	Flow Rate (cfs)	Bottom Slope (ft/ft)	n-value	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude No.	Velocity Head (ft)	Energy Head (ft)	Flow Area (sq. ft.)	Top Width of Flow (ft)
S1	15.6	0.005	0.03	4.0	2.0	0	1.40	2.65	0.559	0.11	1.51	5.88	8.40
S2	12.7	0.005	0.03	3.5	2.0	0	1.34	2.56	0.552	0.10	1.44	4.95	7.38
S3	6.2	0.005	0.03	3.5	2.0	0	1.03	2.14	0.528	0.07	1.10	2.89	5.64
S4	8.2	0.005	0.03	20.0	2.0	0	1.14	2.31	0.539	0.08	1.22	3.56	6.25
S5	7.0	0.005	0.03	3.5	2.0	0	0.67	1.68	0.511	0.04	0.71	4.89	14.68
S6	6.6	0.005	0.03	3.5	2.0	0	1.05	2.18	0.529	0.07	1.12	3.03	5.78
S7	16.9	0.005	0.03	3.5	2.0	0	1.49	2.76	0.563	0.12	1.61	6.12	8.21
S8	11.9	0.005	0.03	4.0	2.0	0	1.26	2.48	0.550	0.10	1.36	4.80	7.59

Note: Calculations were performed using the HYDROCALC HYDRAULICS program developed by Dodson and Associates (Version 2.01, 1996-2010).

Maximum flow depth is 1.49 ft < 2.0 ft (swale height).

Design is okay.

Example Calculation: Calculate the normal depth for the swale for drainage area SW1 (See IIIF-C-2)

List of Symbols

Q_d = design flow rate for channel, cfs
R = hydraulic radius, ft
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = bottom width of channel, ft
z_r = z-ratio (ratio of run to rise for channel sideslope) for right side slope of swale
z_l = z-ratio (ratio of run to rise for channel sideslope) for left side slope of swale
A_f = flow area, sf
g = gravitational acceleration = 32.2 ft/s^2
T = top width of flow, ft
d = normal depth of swale, ft

The program uses an iterative process to calculate the normal depth of the swale to satisfy Manning's Equation

$$Q = \frac{1.486}{n} A R^{0.67} S^{0.5}$$

Design Inputs:

Q_d =	15.6	cfs	(From page IIIF-C-3)
S =	0.005	ft/ft	
b =	0	ft	
z_r =	4	(H) : 1 (V)	
z_l =	2	(H) : 1 (V)	
n =	0.03		

Step 1 - Based on the geometry of the swale cross-section, solve for R and A_f

$$R = \frac{bd + 1/2d^2(z_r + z_l)}{b + d((z_l^2 + 1)^{0.5} + (z_r^2 + 1)^{0.5})}$$

$$A_f = bd + 1/2d^2(z_r + z_l)$$

assume: d = 1.40 ft

R = 0.66 ft

A_f = 5.88 sf

solve for Q: $Q =$ 15.6

if Q is not equal to Q_d, select a new d and repeat calculations

Step 2 - solve for velocity, T, Froude number, velocity head, and energy head

$Q = VA \Rightarrow \quad V = Q/A$

$V =$ 2.65 ft/s

$T = b + d(z_l + z_r)$

$T =$ 8.40 ft

$$F_r = \frac{V}{(gA/T`)^{0.5}}$$

$F_r =$ 0.570

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 0.11 ft

Energy Head = water elevation + velocity head

Energy Head = 1.51 ft

DRAINAGE LETDOWN (OR CHUTE) DESIGN

Chute Design

The letdown structures are designed using gabions as a liner. Bedding for the gabions will be prepared subgrade soil overlain by 8 oz/sy geotextile (refer to Drawing IIIF.9). The gabions or FML are placed along the entire chute to protect the chute bottom and the final cover from erosion due to potential erosive velocities. Tumbling flow concrete energy dissipators will be placed at the bottom end of the letdown structure to dissipate excess energy present in the water as it travels down the two and three percent slopes in the low-water crossings over the perimeter road.

The following design information is included in this Appendix:

- Flow rates used in the chutes are presented in Appendix IIIF-A – HEC-1 computer program output file.
- Hydraulic calculations are summarized on pages IIIF-C-9 and IIIF-C-10, and the calculation procedure is provided on pages IIIF-C-11 and IIIF-C-12.
- Chute layouts and drainage areas are shown on Sheet IIIF-C-13.
- The chute energy dissipater sizing calculation procedure is provided on pages IIIF-C-14 through IIIF-C-18.
- FML Anchor Trench Design calculations are provided on Pageedes IIIF-C-19 through IIF-C-23
- Additional stormwater details are included on Drawings IIIF.7 through IIIF.12.

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
CHUTE ANALYSIS
NORMAL DEPTH CALCULATIONS FOR
GABION LINED CHUTES

Drainage Area	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
SIDESLOPE AREAS													
LD1	106	0.29	0.04	4.0	4.0	8.0	0.72	13.60	3.183	2.87	3.59	7.79	13.74
LD2	299	0.29	0.04	4.0	4.0	8.0	1.25	18.45	3.425	5.29	6.54	16.21	17.98
LD3	178	0.29	0.04	4.0	4.0	8.0	0.95	15.89	3.306	3.92	4.87	11.20	15.60
LD4	253	0.13	0.04	4.0	4.0	8.0	1.41	13.19	2.331	2.70	4.11	19.18	19.26
LD5	347	0.25	0.04	4.0	4.0	8.0	1.40	18.24	3.229	5.17	6.57	19.03	19.19
LD6	233	0.29	0.04	4.0	4.0	8.0	1.10	17.18	3.367	4.59	5.68	13.56	16.76

Drainage Area	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
LOW WATER CROSSING (2%) AREAS													
LD1	106	0.02	0.04	8.0	8.0	12.0	1.24	5.06	0.911	0.40	1.63	20.97	20.90
LD2	299	0.02	0.04	8.0	8.0	34.0	1.32	5.77	0.944	0.52	1.84	51.78	44.55
LD3	178	0.02	0.04	8.0	8.0	20.0	1.29	5.47	0.930	0..46	1.76	32.57	30.35
LD4	253	0.02	0.04	8.0	8.0	28.0	1.33	5.72	0.941	0.51	1.84	44.26	38.63
LD5	347	0.02	0.04	8.0	8.0	38.0	1.35	5.91	0.950	0.54	1.90	58.73	48.82
LD6	233	0.02	0.04	8.0	8.0	28.0	1.27	5.56	0.935	0.48	1.75	41.91	38.14

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
CHUTE ANALYSIS
NORMAL DEPTH CALCULATIONS FOR
FML LINED CHUTES

Drainage Area	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
SIDESLOPE AREAS													
LD1	106	0.29	0.01	2.0	2.0	8.0	0.34	36.24	11.421	20.41	20.74	2.93	9.35
LD2	299	0.29	0.01	2.0	2.0	8.0	0.62	55.22	12.455	42.38	43.00	5.73	10.48
LD3	178	0.29	0.01	2.0	2.0	8.0	0.46	43.67	11.957	29.64	30.10	4.08	9.83
LD4	253	0.13	0.01	2.0	2.0	8.0	0.71	38.00	8.544	22.44	23.15	6.66	10.83
LD5	347	0.25	0.01	2.0	2.0	8.0	0.70	52.50	11.838	42.84	43.54	6.61	10.81
LD6	233	0.29	0.01	2.0	2.0	8.0	0.56	45.89	11.482	32.72	33.28	5.08	10.23

Drainage Area	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
LOW WATER CROSSING (2%) AREAS													
LD1	106	0.02	0.04	8.0	8.0	12.0	1.24	5.06	0.911	0.40	1.63	20.97	20.90
LD2	299	0.02	0.04	8.0	8.0	34.0	1.32	5.77	0.944	0.52	1.84	51.78	44.55
LD3	178	0.02	0.04	8.0	8.0	20.0	1.29	5.47	0.930	0..46	1.76	32.57	30.35
LD4	253	0.02	0.04	8.0	8.0	28.0	1.33	5.72	0.941	0.51	1.84	44.26	38.63
LD5	347	0.02	0.04	8.0	8.0	38.0	1.35	5.91	0.950	0.54	1.90	58.73	48.82
LD6	233	0.02	0.04	8.0	8.0	28.0	1.27	5.56	0.935	0.48	1.75	41.91	38.14

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

Example Calculation: Calculate the normal depth for the chute for the 25% slope portion of drainage area LD1.

List of Symbols

Q_d = design flow rate for channel, cfs
R = hydraulic radius, ft
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = bottom width of channel, ft
z = z-ratio (ratio of run to rise for channel sideslope)
A_f = flow area, sf
g = gravitational acceleration = 32.2 ft/s^2
T = top width of flow, ft
d = normal depth of chute, ft

The program uses an iterative process to calculate the normal depth of the chute to satisfy Manning's Equation

$$Q = \frac{1.486}{n} A R^{0.67} S^{0.5}$$

Design Inputs:

Q_d =	106	cfs (from HEC-1 analysis, Appendix IIIF-A)
S =	0.290	ft/ft
b =	8	ft
z =	4	(H) : 1 (V)
n =	0.04	

Step 1 - Based on the geometry of the chute cross-section, solve for R and A_f

$$R = \frac{bd + zd^2}{b + 2d(z^2 + 1)^{0.5}}$$

$$A_f = bd + zd^2$$

assume: d = 0.720 ft

R = 0.562 ft

A_f = 7.79 sf

solve for Q: Q = 106 cfs

if Q is not equal to Q_d, select a new d and repeat calculations

Step 2 - solve for velocity, T, Froude number, velocity head, and energy head

$Q = VA \Rightarrow \quad V = Q/A$

$V = 13.60$ ft/s

$T = b + 2(z \times d)$

$T = 13.74$ ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

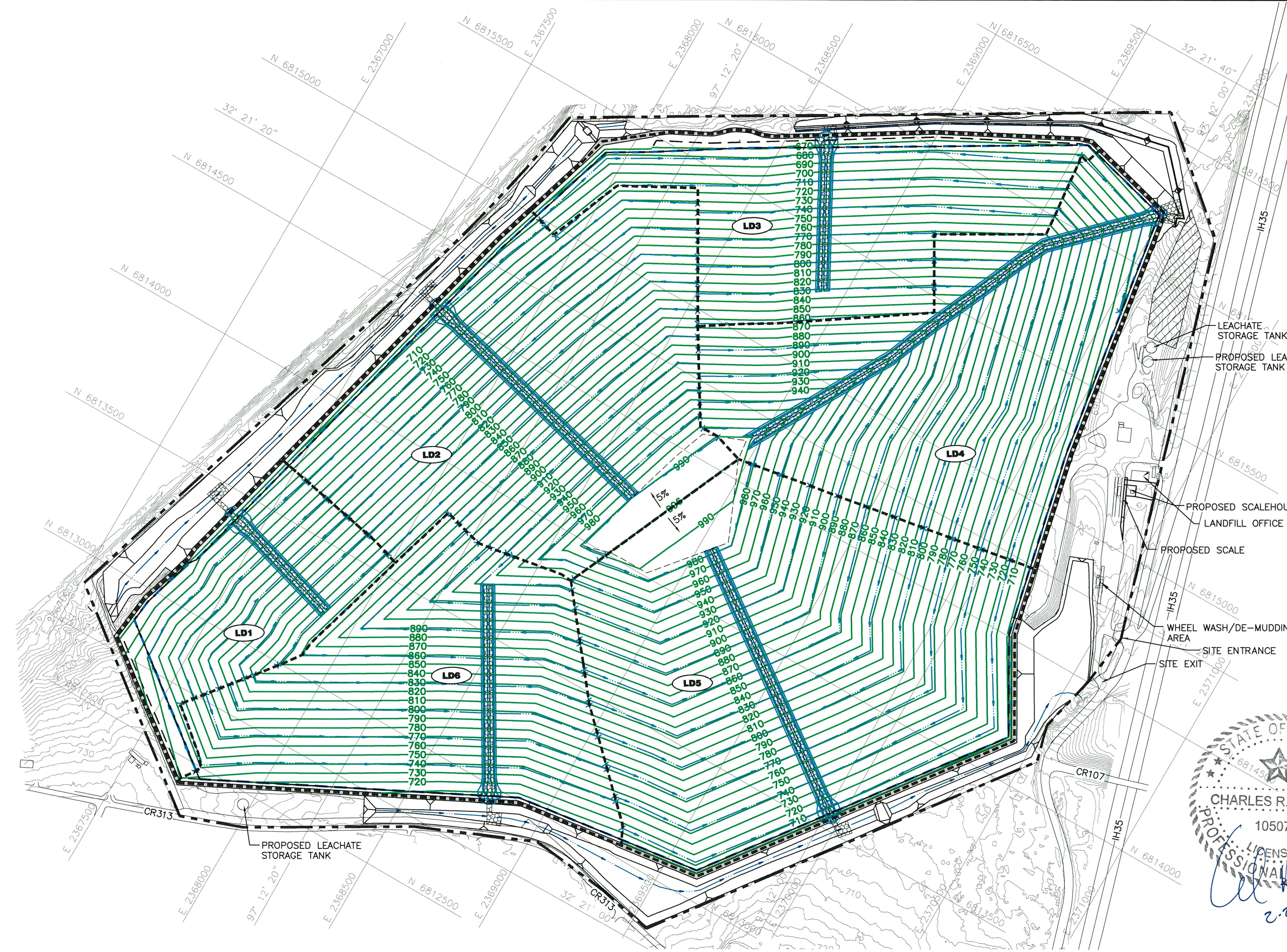
$F_r = 3.183$

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 2.87 ft

Energy Head = water elevation + velocity head

Energy Head = 3.59 ft



0 200 400
SCALE IN FEET

LEGEND

PROPERTY BOUNDARY
LIMITS OF WASTE
DRAINAGE DIVIDE
730 EXISTING CONTOUR
810 PROPOSED FINAL COVER CONTOUR
N 6816000 STATE PLANE GRID
DRAINAGE LETDOWN
DRAINAGE SWALE
PROPOSED PERIMETER CHANNEL
LD2 DRAINAGE AREA DESIGNATION
FUTURE LFGTE FACILITY LOCATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 03-07-2018. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO DRAWING IIIF-A-25 FOR COMPLETE OFFSITE DRAINAGE AREA DELINEATIONS.

DRAINAGE AREA NO.	AREA (ACRES)
LD1	12.96
LD2	36.87
LD3	22.58
LD4	33.25
LD5	44.98
LD6	27.53

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
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DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-D-7-TYP. SLOPE LENGTHS.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS		
NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT LETDOWN STRUCTURE DRAINAGE AREAS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF-C-13

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-C\IIIF-C-13-LETDOWN STRUCTURE.dwg, rarrington, 1:2

Required:

Determine the hydraulic properties for the grouted ripraps as energy letdown structures (chutes).

Method:

1. Calculate the design flow rate of the chute section.
2. Estimate the normal and flow velocity from Hydrocalc using calculated design flow rate.
3. Calculate the critical depth and critical flow velocity.
4. Calculate the height of the roughness element and spacing between the rows of the roughness elements.
5. Calculate the total length of roughness elements.

References:

1. Henry M. Morris, *Hydraulic Dissipation in Steep, Rough Channels*, Bulletin19, Research Division, Virginia Polytechnic Institute, 1968.
2. "Open Channel Hydraulics" by V.T. Chow.
3. "Hydraulic Design of Energy Dissipators for Culverts and Channels", FHWA Hydraulics Engineering Circular Number 14, Third Edition.
4. "Hydraulic Considerations for Corrugated Plastic Pipes" Plastic Pipe Institute.
5. "Reclamation Managing Water in the West" Erosion and Sedimentation Manual. US Department of the Interior Bureau of Reclamation, November 2006.
6. Fort Bend County, Texas, Drainage District "Drainage Criteria Manual", 2nd Revision, February, 2011. Interim Atlas 14 Drainage Criteria Manual and Minimum Slab Elevation Criteria December, 2019.

Solution:

The design of energy dissipators for the 28.6 percent sideslope is based on tumbling flow in the chute. Tumbling flow consists of a series of hydraulic jumps on overfalls that maintain the critical velocity in the chute.

1. For Chute LF1 (For the Upper Portion of a FML Chute):

1.A Design flow rates for energy dissipation.

According to the definition of the unit flow rate,

q = Q/b

Where:
Q = Design flow rate for channel, cfs
b = Bottom width of chute, ft
q = Unit flowrate, cfs/ft of chute width

Q = 106 cfs
b = 8 ft

q = 13.25 cfs/ft

1.B. Estimate the normal depth and flow velocity from Hydrocalc using the design flow rate and appropriate Manning's coefficient.

Where:
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = Width of the channel, ft
z = z-ratio (ratio of run to rise for channel sideslope) for side slope
d = Normal Depth of the channel
v = Flow Velocity in the channel

Q = 106 cfs
n = 0.01
S = 0.286 ft/ft
z = 2 ft/ft
D = 8 ft

From Hydrocalc

d = 0.34 ft
v = 36.24 ft/sec

1.C For Chute LF1 (For the Lower Portion of the Chute):

Design flow rates for energy dissipation.

According to the definition of the unit flow rate,

$q = Q/b$

Where:
- Q = Design flow rate for channel, cfs
- b = Bottom width of chute, ft
- q = Unit flowrate, cfs/ft of chute width

Q = 106 cfs
b = 18 ft

q = 5.89 cfs/ft

2. Estimate the normal and flow velocity due to the roughness elements from Hydrocalc using flow rate and appropriately adjusted Manning's coefficient.

The roughness coefficient can be calculated from Equation 5-12 from Reference 2

$n = (n_0+n_1+n_2+n_3+n_4)\, m_5$ (Equation 5-12, Reference 2)

Where:	n_0	basic n value for straight, uniform, smooth channel based on material = 0.013	(Reference 2, Page 111, Table 5-6)
	n_1	value added for surface irregularities = 0.01	(Reference 2, Page 109, Table 5-5)
	n_2	value added for variation in channel cross section= 0.0	(Reference 2, Page 109, Table 5-5)
	n_3	value added for obstructions = 0.015	(Reference 2, Page 109, Table 5-5)
	n_4	value added for vegetation and flow conditions = 0.001	(Reference 2, Page 109, Table 5-5)
	m_5	correction factor for meandering of channel =1.0	(Reference 2, Page 109, Table 5-5)

n = (0.013+0.01+0.0+0.015+0.001)*1.0
n = 0.039

Therefore:
Q = 106 cfs
n = 0.039
S = 0.286 ft/ft
z = 4 ft/ft
b = 18 ft

From Hydrocalc

d = 0.46 ft
v = 11.50 ft/sec

3. Calculate the critical depth and critical flow velocity.

$Y_c = (q2/g)^{1/3}$ (Reference 3, Equation 7.1)

$V_c = (gq)^{1/3}$ (Reference 3)

Where:
- Y_c = Critical depth, ft
- q = Unit flowrate, cfs/ft of channel width
- g = Acceleration due to gravity = 32.2 ft/s^2
- V_c = Critical velocity, ft/s

q = 5.89 cfs

Y_c = 1.03 ft
V_c = 5.75 ft/s

4. Calculate the height of the roughness element and spacing between the rows of the roughness elements.

$h = Y_c/((3-3.7S)^\wedge(2/3))$ (Reference 3, Equation 7.2)

Where:
Y_c = Critical depth, ft
S = Channel slope, ft/ft
h = Element height, ft

S = 0.286 ft/ft

h = 0.66 ft
h = 7.9 in

$h_{provided}$ = 12.0 in

$h_{provided} > h$, so the design is adequate.

5. Calculate the total length of roughness elements.

L = 8.5*h (Reference 3)

Where:
L = Spacing between the roughness elements, ft
h = Element height, ft
L_{Total} = Total length of roughened section, ft

L = 6.09 ft

The spacing and height of the roughness elements are designed based on 5 rows of roughness elements. (Reference 3)

$L_{total\ (recommended)}$ = L5

$L_{total\ (recommended)}$ = 30.5

$L_{total(provided)}$ = 40.00 ft

$L_{total(provided)} > L_{total\ (recommended)}$, so the design is adequate.

The following table summarizes the calculations for gabion chutes.

Upper Portion of Chutes

Chute	[1]Q	W_{Design}	q	n-value	Bottom Slope	Side Slope	Normal Depth	Flow Velocity
	(cfs)	(ft)	(cfs/ft)		(ft/ft)	(ft/ft)	(ft)	(ft/sec)
LD1	106	8	13.25	0.04	0.286	4	0.72	13.60
LD2	299	8	37.38	0.04	0.286	4	1.25	18.45
LD3	178	8	22.25	0.04	0.286	4	0.95	15.89
LD4	253	8	31.63	0.04	0.130	4	1.41	13.19
LD5	347	8	43.38	0.04	0.250	4	1.40	18.24
LD6	233	8	29.13	0.04	0.286	4	1.10	17.18

Lower Portion of Chutes

Chute	[1]Q	W_{Design}	q	n-value	Bottom Slope	Side Slope	Normal Depth	Flow Velocity	Y_c	V_c	h	L (=9.25h)	h_{Design}	[2]L_{Total} (Recommended)	$W_{Provided}$	$h_{Provided}$	L_{Total} (Provided)
	(cfs)	(ft)	(cfs/ft)		(ft/ft)	(ft/ft)	(ft)	(ft/sec)	(ft)	(fps)	(ft)	(ft)	(in)	(ft)	(ft)	(in)	(ft)
LF1	106	12	8.83	0.055	0.286	4	0.71	10.14	1.34	6.58	0.86	8.0	10.3	39.8	12	12.0	40.0
LF2	299	34	8.79	0.055	0.286	4	0.73	11.11	1.34	6.57	0.86	7.9	10.3	39.7	34	12.0	40.0
LF3	178	20	8.90	0.055	0.286	4	0.72	10.73	1.35	6.59	0.86	8.0	10.4	40.0	20	12.0	40.0
LF4	253	28	9.04	0.055	0.130	4	0.93	8.58	1.36	6.63	0.73	6.8	8.8	34.0	28	12.0	40.0
LF5	347	38	9.13	0.055	0.250	4	0.78	10.86	1.37	6.65	0.84	7.8	10.1	38.9	38	12.0	40.0
LF6	233	28	8.32	0.055	0.286	4	0.70	10.76	1.29	6.45	0.83	7.7	9.9	38.3	28	12.0	40.0

1. The flowrates were reproduced from Appendix IIIF-A.
2. Total length of the roughened section was calculated based on FHWA recommendation of 5 rows of roughened elements.

The following table summarizes the calculations for FML chutes.

Upper Portion of Chutes

Chute	[1]Q	W_{Design}	q	n-value	Bottom Slope	Side Slope	Normal Depth	Flow Velocity
	(cfs)	(ft)	(cfs/ft)		(ft/ft)	(ft/ft)	(ft)	(ft/sec)
LD1	106	8	13.25	0.01	0.286	2	0.34	36.24
LD2	299	8	37.38	0.01	0.286	2	0.62	55.22
LD3	178	8	22.25	0.01	0.286	2	0.46	43.67
LD4	253	8	31.63	0.01	0.130	2	0.71	38.00
LD5	347	8	43.38	0.01	0.250	2	0.70	52.50
LD6	233	8	29.13	0.01	0.286	2	0.56	45.89

Lower Portion of Chutes

Chute	[1]Q	W_{Design}	q	n-value	Bottom Slope	Side Slope	Normal Depth	Flow Velocity	Y_c	V_c	h	L (=9.25h)	h_{Design}	[2]L_{Total} (Recommended)	$W_{Provided}$	$h_{Provided}$	L_{Total} (Provided)
	(cfs)	(ft)	(cfs/ft)		(ft/ft)	(ft/ft)	(ft)	(ft/sec)	(ft)	(fps)	(ft)	(ft)	(in)	(ft)	(ft)	(in)	(ft)
LF1	106	12	8.83	0.055	0.286	4	0.71	10.14	1.34	6.58	0.86	8.0	10.3	39.8	12	12.0	40.0
LF2	299	34	8.79	0.055	0.286	4	0.73	11.11	1.34	6.57	0.86	7.9	10.3	39.7	34	12.0	40.0
LF3	178	20	8.90	0.055	0.286	4	0.72	10.73	1.35	6.59	0.86	8.0	10.4	40.0	20	12.0	40.0
LF4	253	28	9.04	0.055	0.130	4	0.93	8.58	1.36	6.63	0.73	6.8	8.8	34.0	28	12.0	40.0
LF5	347	38	9.13	0.055	0.250	4	0.78	10.86	1.37	6.65	0.84	7.8	10.1	38.9	38	12.0	40.0
LF6	233	28	8.32	0.055	0.286	4	0.70	10.76	1.29	6.45	0.83	7.7	9.9	38.3	28	12.0	40.0

1. The flowrates were reproduced from Appendix IIIF-A.
2. Total length of the roughened section was calculated based on FHWA recommendation of 5 rows of roughened elements.

Required:

Provide topslope and sideslope anchor trench design for a geomembrane-lined letdown structure (or chute).

Method:

1. Design anchor trench spacing and depths.
2. Design upstream end anchor trench.

Assumptions:

1. The geomembrane-lined chute will transition to its maximum width for the energy dissipater design where maximum total flow for chute is expected to occur.
2. Proposed chutes will convey runoff from the following chute drainage area:

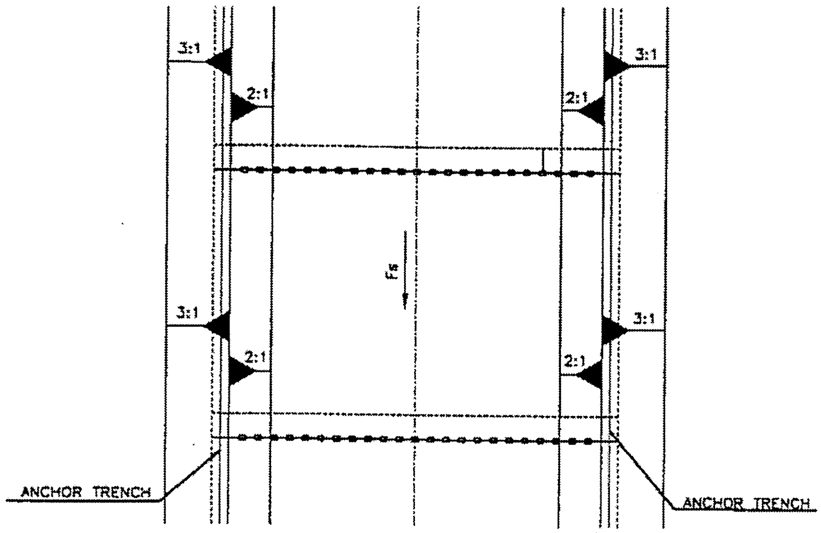
Proposed Chute	Chute Drainage Areas	25-year Total Flow (cfs)[1]
1	LD1	128
2	LD2	302
3	LD3	174
4	LD4	302
5	LD5	83
6	LD6	140

[1] From HEC-1 Analysis, Appendix IIIF-A

References:

1. Gamelsky, S.G., *Innovations in Stormwater Management for Landfill Closure* Technical Paper
2. Koerner, R.M., *Designing with Geosynthetics*, 5th Edition, Prentice-Hall, Inc, 2005.
3. Morris, H.M., *Hydraulics of Energy Dissipators in Steep Rough Channels*, Bulletin 19, Research Division, Virginia Polytechnic Institute, Blacksburg, Virginia.

Design anchor trench spacing and depths.



Shear force pulling on geomembrane due to water:

The shear force acting on the geomembrane per square foot of water in the chute:

$T = \gamma_w \times D \times S$ where: γ_w = unit weight of water (lb/cf)
D = maximum water depth (ft)
S = hydraulic gradient (ft/ft)

Shear force acting on the geomembrane per foot of anchor trench:

$F_{s1} = T \times P$

where:
P = wetted perimeter of the chute = $(W + 2 \times (a^2+D^2)^{1/2})$
a = h x D = horizontal distance from bottom of chute to the depth submerged on the sideslopes
h = Slope of sidewalls = 2 (H) : 1 (V)
W = Minimum bottom width of flow = 8 ft

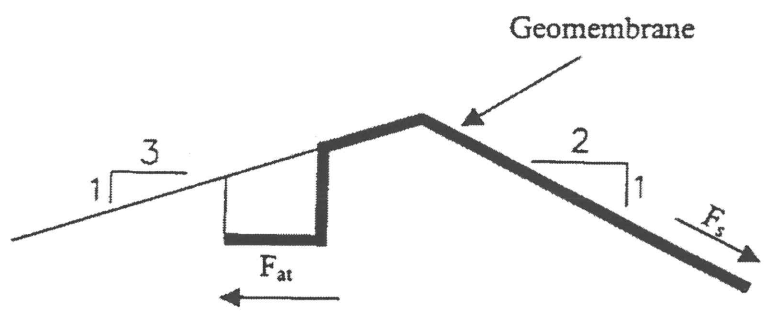
Conservatively, the maximum calculated water depth in the chutes will be used to verify the design. Thus, the water depth in the narrowest part of the chute with the highest depth will be used.

Letdown	Maximum Water Depth (ft)[1]	Hydraulic Gradient (ft/ft)	T (lb/sf)	a (ft)	F_{s1} (lb/ft)
LD1	0.34	0.286	6.07	0.68	58
LD2	0.62	0.286	11.06	1.24	119
LD3	0.46	0.286	8.21	0.92	83
LD4	0.71	0.13	5.76	1.42	64
LD5	0.70	0.25	10.92	1.40	122
LD6	0.56	0.286	9.99	1.12	105

[1] See design depths on page IIIF-C-9 and IIIF-C-10

Pullout Resistance from Edges, F_{at1} [1]

Assuming pullout only opposed by trench (conservative assumption)



$$F_{at} = 2[\{K_o\gamma(D/2)\}\{\tan\zeta\}\{D\} + \{\gamma D\}\{\tan\zeta\}\{w\}] \quad \text{(Ref 3)}$$

where:
- ζ = interface friction angle
- K_o = 1 - sin ζ
- γ = unit weight of soil (lb/cf)
- D = depth of anchor trench (ft)
- w = bottom width of anchor trench (ft)

soil friction angle =	33	degrees
soil/geomembrane friction angle =	18.2	degrees
unit weight =	112	lb/ft^3
depth of anchor trench =	1	ft
bottom width of anchor trench =	1	ft

[1]See detail D10 - Anchor Trench Type 2 on Drawing IIIF.9 for dimensions.

K_o = 0.46

F_{at1} =	179	lb/ft width on one side

Factor of Safety = $2F_{at1}/F_{s1}$ =	$\frac{357}{122}$	FS =	2.9

3. Upstream End Anchor Trench Design

Shear force pulling on geomembrane due to water:

$F_{s2} = T \times A$

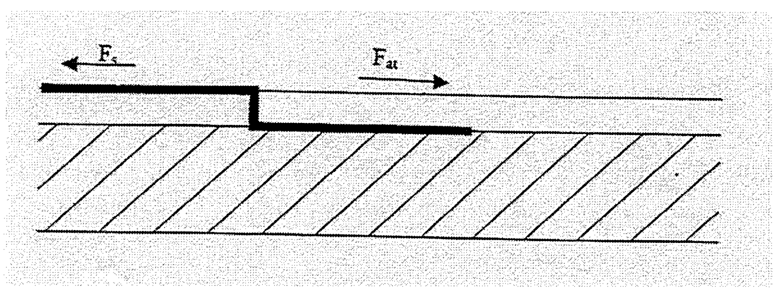
where: T = Maximum shear force acting on the geomembrane per square foot of water in the chute (lb/sf)
A = area of geomembrane at the top of the chute (ft^2)

Area of geomembrane at top of chute = 116 ft x 17 ft = 1,972 sf

Conservatively, use the maximum shear force per square foot calculated in Part 2

F_{s2} =	21,820	lbs

Pullout resistance of upstream end, F_{at2} [2]



$F_{at} = 2[\{K_o\gamma(D/2)\}\{\tan\zeta\}\{D\} + \{\gamma D\}\{\tan\zeta\}\{w\}]$ (Ref 3)

where: ζ = interface friction angle
K_o = 1 - sin ζ
γ = unit weight of soil (lb/cf)
D = depth of anchor trench (ft)
w = bottom width of anchor trench (ft)

friction angle =	18.2	degrees
anchor trench soil unit weight =	112	lb/ft^3
depth of anchor trench =	0.5	ft
bottom width of anchor trench =	3	ft

K_o = 0.69

F_{at2}= 117 lb/ft width

Total End Anchor Length (L_T) [4] = 150 ft

F_{pr} = Pullout Resistance (End) = $F_{at2} \times L_T$ =	17,520	lbs

Factor of Safety = F_{pr}/F_{s2} =	$\frac{17,520}{21,820}$	FS =	0.8

Summary of Results

Side Anchor Trench Pullout resistance:

FS = $\frac{2F_{AT2}}{F_{S1}}$ ==> FS = 2.9

Upstream End Anchor Trench Pullout resistance:

FS = $\frac{F_{pr}}{F_{s2}}$ ==> FS = 0.8

As it is stated on page 557 of Reference 3, the typical factors of safety for the proposed anchor trenches are between 0.7 to 5.0. Therefore, the design is acceptable.

APPENDIX IIIF-D

EROSION LAYER EVALUATION

Includes pages IIIF-D-1 through IIIF-D-37

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PROFESSIONAL ENGINEER

2.22.22

EROSION LAYER EVALUATION

This appendix presents the supporting documentation for evaluation of the thickness of the erosion layer for the final cover system at the Turkey Creek Landfill. The evaluation is based on the premise of adding excess soil to increase the time required before maintenance is needed as recommended in the EPA Solid Waste Disposal Facility Criteria Technical Manual (EPA 530-R-93-017, November 1993). The design procedure is as follows:

1. Minimum thickness of the erosion layer at the end of the 30-year postclosure period is evaluated based on the depth of frost penetration or 6 inches, whichever is greater. For Johnson County, the approximate depth of frost penetration is approximately 6 inches (see IIIF-D-10). Therefore, the minimum erosion layer thickness is 6 inches.
2. Soil loss is calculated using the Universal Soil Loss Equation (USLE) by following SCS procedures. The soil loss is adjusted by a safety factor of 2 and is then converted to a thickness. The thickness of the soil loss over a 30-year postclosure period is added to the minimum thickness of the erosion layer (from Step 1) to yield an initial thickness to be placed at closure of the site. According to the USLE, the typical 5 percent topslope and 28.6 percent side slope require a minimum of 6.082 inches and 7.041 inches, respectively, for the erosion layer. These USLE requirements include the 6-inch minimum required by regulations. Conservatively, a 12-inch erosion layer is proposed over final cover. These calculations begin on page IIIF-D-3.
3. Stormwater flows over the final cover system by (1) sheet flow over the topslope and sideslopes and (2) channelized flow in the drainage berms (or swales). As discussed in Section 2.2 and Appendix IIIF-C, flow also occurs in the letdown structures. The letdown structures are lined with gabions or FML to prevent erosion given that the velocities in the letdowns are over 5 ft/sec.

   Sheet flow velocities for the topslope and sideslope cases for a 25-year storm event are calculated to be less than permissible nonerosive velocities. A permissible nonerosive velocity is defined as 5.0 ft/sec or less. Calculated sheet flow velocities range from 0.23 to 0.40 ft/sec for topslope and sideslope cases. The supporting calculations are presented on pages IIIF-D-20 through IIIF-D-28.

   Channelized flow for drainage swales is also calculated to be less than permissible nonerosive velocities. Calculated channelized flow velocities range from 2.14 to 2.83 ft/sec for the drainage swales. The supporting calculations are presented on pages IIIF-C-3 through IIIF-C-7.

4. Vegetation for the site will be native and introduced grasses with root depths of 6 inches to 8 inches. The erosion layer shall also include a mixture of Bermuda, vetch, rye, wheat grass, wild flowers, and flowering plants. The seeding is specified on the attached pages IIIF-D-29 through IIIF-D-37. The seeding included on pages IIIF-D-29 through IIIF-D-37 is specified by TxDOT for temporary and permanent erosion control for Johnson County, Texas (Fort Worth District).

5. Native and introduced grasses will be hydroseeded with fertilizer on the disked (parallel to contours) erosion layer upon final grading. Temporary cold weather vegetation will be established if needed. Irrigation will be employed for 6 to 8 weeks or until vegetation is well established. Erosion control measures such as silt fences and straw bales will be used to minimize erosion until the vegetation is established. Areas that experience erosion or do not readily vegetate after hydroseeding will be reseeded until vegetation is established or the soil will be replaced with soil that will support the grasses.

6. Slope stability information is included in Appendix IIIE.

Required: Determine expected soil loss and minimum thickness for the erosion layer.

Method: Expected soil loss is calculated using the Universal Soil Loss Equation. Minimum erosion layer thickness is determined by adding the minimum thickness allowed by TCEQ to the expected soil loss.

References:

1. SCS National Engineering Handbook, Chapter 3 - Erosion.
2. TNRCC, *Use of the USLE in Final Cover/Configuration Design*, 1993.
3. United States Department of Agriculture, National Resource Conservation Service, Web Soil Survey for Johnson County, Texas (http://websoilsurvey.nrcs.usda.gov).
4. United States Environmental Protection Agency, *Solid Waste Disposal Facility Criteria Technical Manual*, 1993.

Solution:

1. Soil Loss Equation: $A=RKL_SCP$

Where:

A= Soil loss (tons/ac/yr)
R= Rainfall factor
K= Soil erodibility factor
L_S= Slope length/slope gradient factor
C= Plant cover or cropping management factor
P= Erosion practice factor

The rainfall factor, R, represents the average intensity for the maximum intensity, 30 minute storms over a 22 year period of record compiled by the SCS. Using Figure 1 (Ref 2), Average Annual Values of the R Factor, the R factor for Johnson County is:

R = 290

The soil erodibility factor, K, factor represents the resistance of a soil surface to erosion as a function of the soil's physical and chemical properties. Assume an organic matter content of 2% to determine the K factor. The site top soil will consist of sandy clay with high organic content. Clean compost as a soil amendment may be added to final cover top soil as necessary to protect against erosion. Therefore, the following is a K value for the site.

K = 0.25

The slope length/slope gradient factor, L_s, represents the erosion of the soil due to both slope length and degree of slope. The slopes of interest are the typical side slope and top slope conditions.
See sheet IIIF-D-7 for the locations of the slopes analyzed.

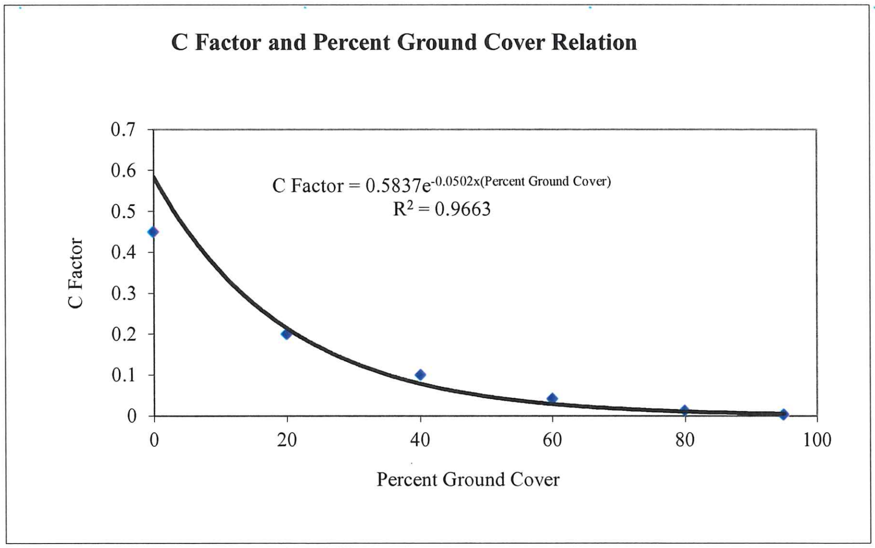
Case 1.	Typical Top Slope			Case 2.	Longest Top Slope		
	slope =	5	%		slope =	5	%
	length =	119	ft		length =	249	ft
Case 3.	Typical Side Slope			Case 4.	Typical Side Slope		
		28.6	%			25	%
		105	ft			120	ft
Case 5.	Longest Side Slope (28.6%)			Case 6.	Longest Side Slope (25%)		
		28.6	%			25	%
		130	ft			145	ft

Using the above information and Figure 2 (Ref 2, p.9), the L_s factors are determined.

Case	Slope (%)	Slope Length (ft)	L_s
1. Typical Top Slope	5	119	0.59
2. Longest Top Slope	5	249	0.85
3. Typical Side Slope	28.6	105	7.50
4. Typical Side Slope	25	120	6.50
5. Longest Side Slope (28.6%)	28.6	130	8.10
6. Longest Side Slope (25%)	25	145	7.00

The plant cover or cropping management factor, C, represents the percentage of soil loss that would occur if the surface were partially protected by some combination of cover and management practices. C Factor for Permanent Pasture, Range, and Idle Land with No Appreciable Canopy has the following relation with percent ground cover (GC) (from Ref 2, p.7) .

% GC	C Factor
0	0.45
20	0.2
40	0.1
60	0.042
80	0.013
95	0.003



C Factor= $0.5837e^{(-0.0502x90)}$
C Factor= 0.0064 (for 90% ground cover)

The erosion control practice factor, P, measures the effect of control practices that reduce the erosion potential of the runoff by influencing drainage patterns, runoff concentration , and runoff velocity. Contouring for this site will be done only to establish vegetation.

P = 1.00

2. Soil loss calculations

Slope Condition	R	K	L_s	C	P	A (tons/ac/yr)
1. Typical Top Slope 5% slope 119 ft length	290	0.25	0.59	0.0064	1.00	0.27
2. Longest Top Slope 5% slope 249 ft length	290	0.25	0.85	0.0064	1.00	0.39
3. Typical Side Slope 28.6% slope 120 ft length	290	0.25	7.50	0.0064	1.00	3.46
4. Typical Side Slope 25.0% slope 120 ft length	290	0.25	6.50	0.0064	1.00	3.00
5. Longest Side Slope 28.6% slope 130 feet length	290	0.25	8.10	0.0064	1.00	3.74
6. Longest Side Slope 25% slope 140 feet length	290	0.25	7.00	0.0064	1.00	3.23

Note: Erosion layer will be maintained to provide 90% ground cover.

3. Erosion layer thickness calculations:

$$T_{el} = 6in + \frac{AYF(2000lb/ton)(12in/ft)}{w(43{,}560sf/ac)}$$

Where:

T_{el} = Erosion layer thickness
A = Soil loss (ton/ac/yr)
Y = Postclosure period (yr)
F = Factor of Safety
w = Specific weight of soil (pcf)

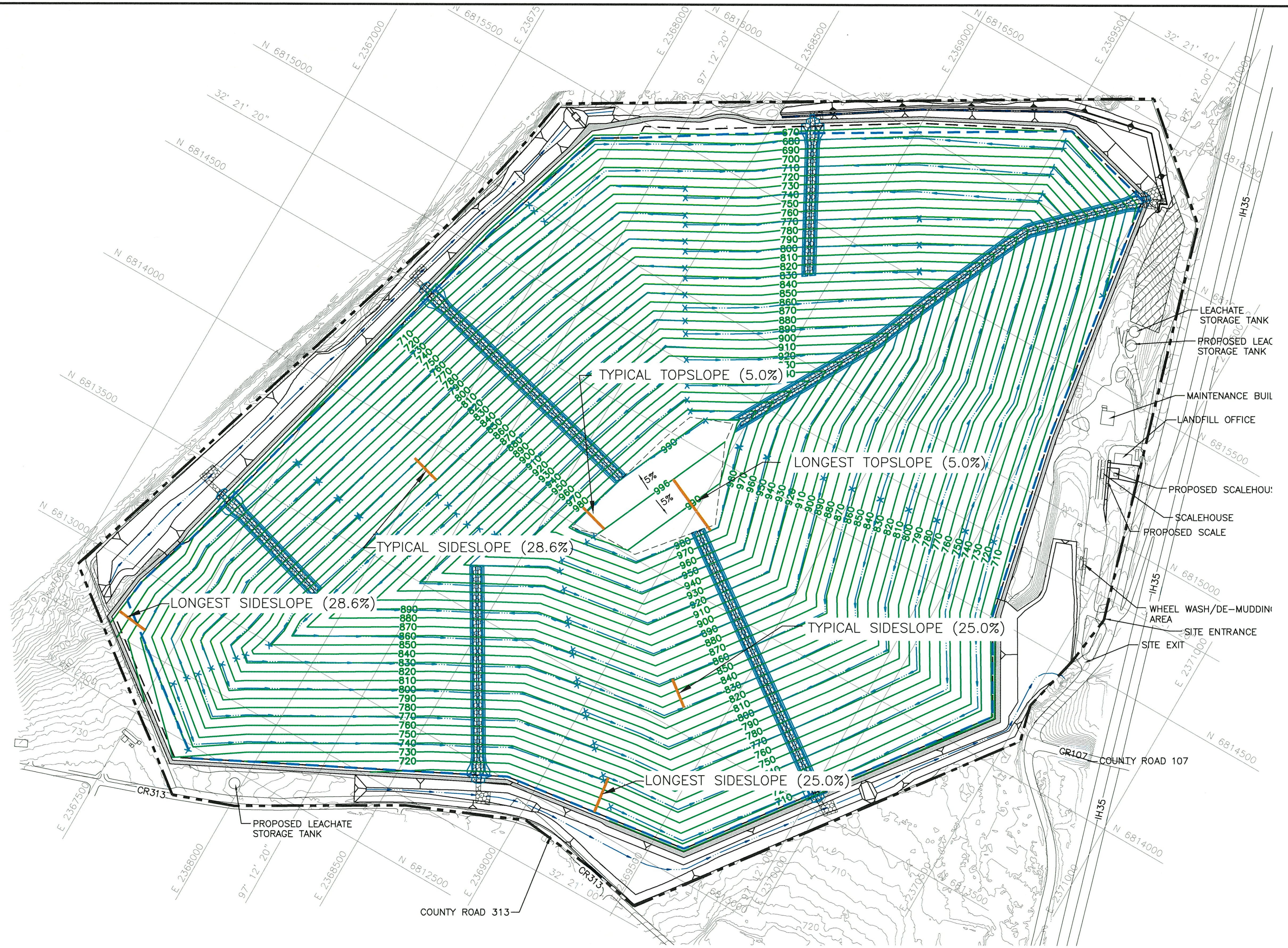
Y = 30 yr
F = 2
w = 110 pcf

1. Typical Top Slope Thickness:		
T_{el}, Required thickness[1] =	6.082	in
Total estimated soil loss =	0.082	in
Minimum Specified thickness =	12.000	in
2. Longest Top Slope Thickness:		
T_{el}, Required thickness[1] =	6.118	in
Total estimated soil loss =	0.118	in
Minimum Specified thickness =	12.000	in
3. Typical Sideslope Thickness:		
T_{el}, Required thickness[1] =	7.041	in
Total estimated soil loss =	1.041	in
Minimum Specified thickness =	12.000	in
4. Typical Sideslope Thickness:		
T_{el}, Required thickness[1] =	6.902	in
Total estimated soil loss =	0.902	in
Minimum Specified thickness =	12.000	in
5. Longest Sideslope Thickness (28.6%):		
T_{el}, Required thickness[1] =	7.124	in
Total estimated soil loss =	1.124	in
Minimum Specified thickness =	12.000	in
6. Longest Sideslope Thickness (25%):		
T_{el}, Required thickness[1] =	6.971	in
Total estimated soil loss =	0.971	in
Minimum Specified thickness =	12.000	in

Note: [1]Required thicknesses include 6 inch minimum required and estimated soil loss.

4. Summary:

Calculated erosion losses are shown in Step 2 above.
The erosion layer will be a minimum of 12 inches thick.
As shown above, this is a conservative design considering the maximum expected soil loss for a 30 year period is 1.17 inches.



LEGEND

	PROPERTY BOUNDARY
	LIMITS OF WASTE
730	EXISTING CONTOUR
810	PROPOSED FINAL COVER CONTOUR
N 6816000	STATE PLANE GRID
32° 21' 20"	GEODETIC COORDINATE
	DRAINAGE LETDOWN
	DRAINAGE SWALE
	PROPOSED PERIMETER CHANNEL
	FUTURE LFGTE FACILITY LOCATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 03-07-2018. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-22-22

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-D\IIIF-D-7 Typical Slope Lengths.dwg, rarrington, 1:2

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PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

DATE: 02/2022	DRAWN BY: JDW
FILE: 0771-368-11	DESIGN BY: BPY
CAD: IIIF-D-7-TYP. SLOPE LENGTHS.DWG	REVIEWED BY: CRM

REVISIONS

NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

EROSION LAYER EVALUATION TYPICAL SLOPE LENGTHS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF-D-7

SOIL LOSS ESTIMATE SUMMARY TABLE

Case	Slope (%)	Length (ft)	L_s	Percent Ground Cover	C Factor	A (tons/ac/yr)
Top Slope	5	119	0.59	60	0.042	1.8
Top Slope	5	119	0.59	70	0.017	0.7
Top Slope	5	119	0.59	80	0.013	0.6
Top Slope	5	119	0.59	90	0.0064	0.3
Top Slope	5	249	0.85	60	0.042	2.6
Top Slope	5	249	0.85	70	0.017	1.0
Top Slope	5	249	0.85	80	0.013	0.8
Top Slope	5	249	0.85	90	0.0064	0.4
Side Slope	28.6	120	7.50	60	0.042	22.8
Side Slope	28.6	120	7.50	70	0.017	9.2
Side Slope	28.6	120	7.50	80	0.013	7.1
Side Slope	28.6	120	7.50	90	0.0064	3.5
Side Slope	25	120	6.50	60	0.042	19.8
Side Slope	25	120	6.50	70	0.017	8.0
Side Slope	25	120	6.50	80	0.013	6.1
Side Slope	25	120	6.50	90	0.0064	3.0
Side Slope	28.6	151	8.10	60	0.042	24.7
Side Slope	28.6	151	8.10	70	0.017	10.0
Side Slope	28.6	151	8.10	80	0.013	7.6
Side Slope	28.6	151	8.10	90	0.0064	3.8
Side Slope	25	151	7.00	60	0.042	21.3
Side Slope	25	151	7.00	70	0.017	8.6
Side Slope	25	151	7.00	80	0.013	6.6
Side Slope	25	151	7.00	90	0.0064	3.2

Solid Waste Disposal Facility Criteria

Technical Manual

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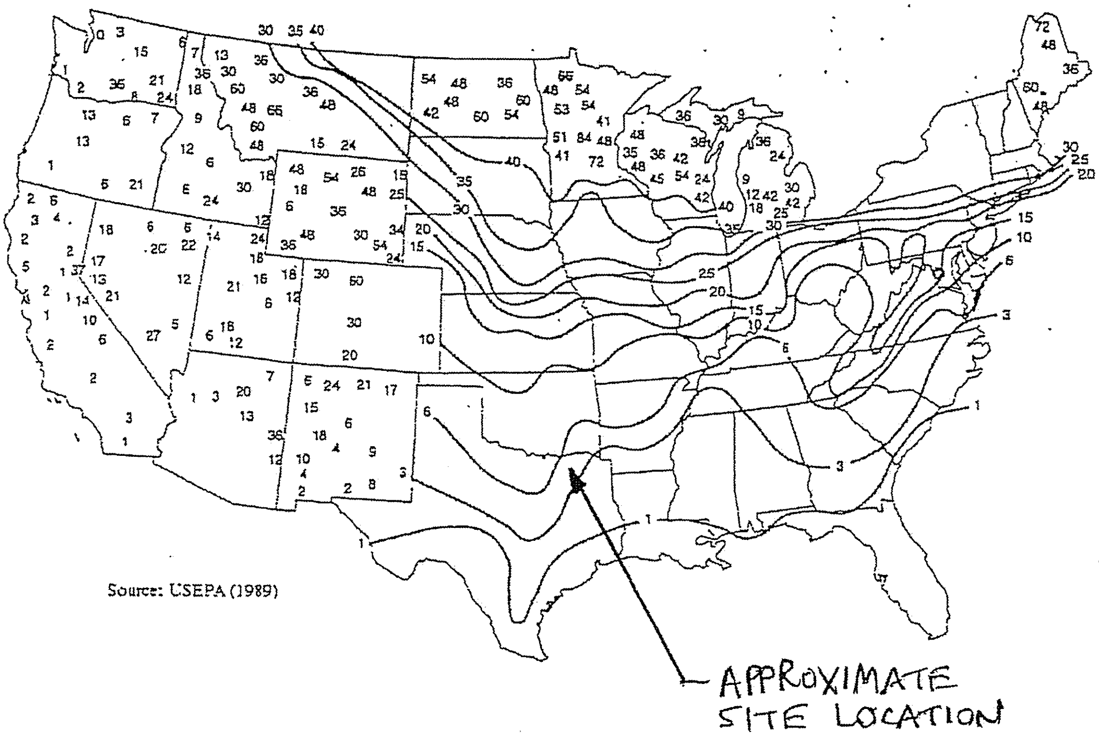
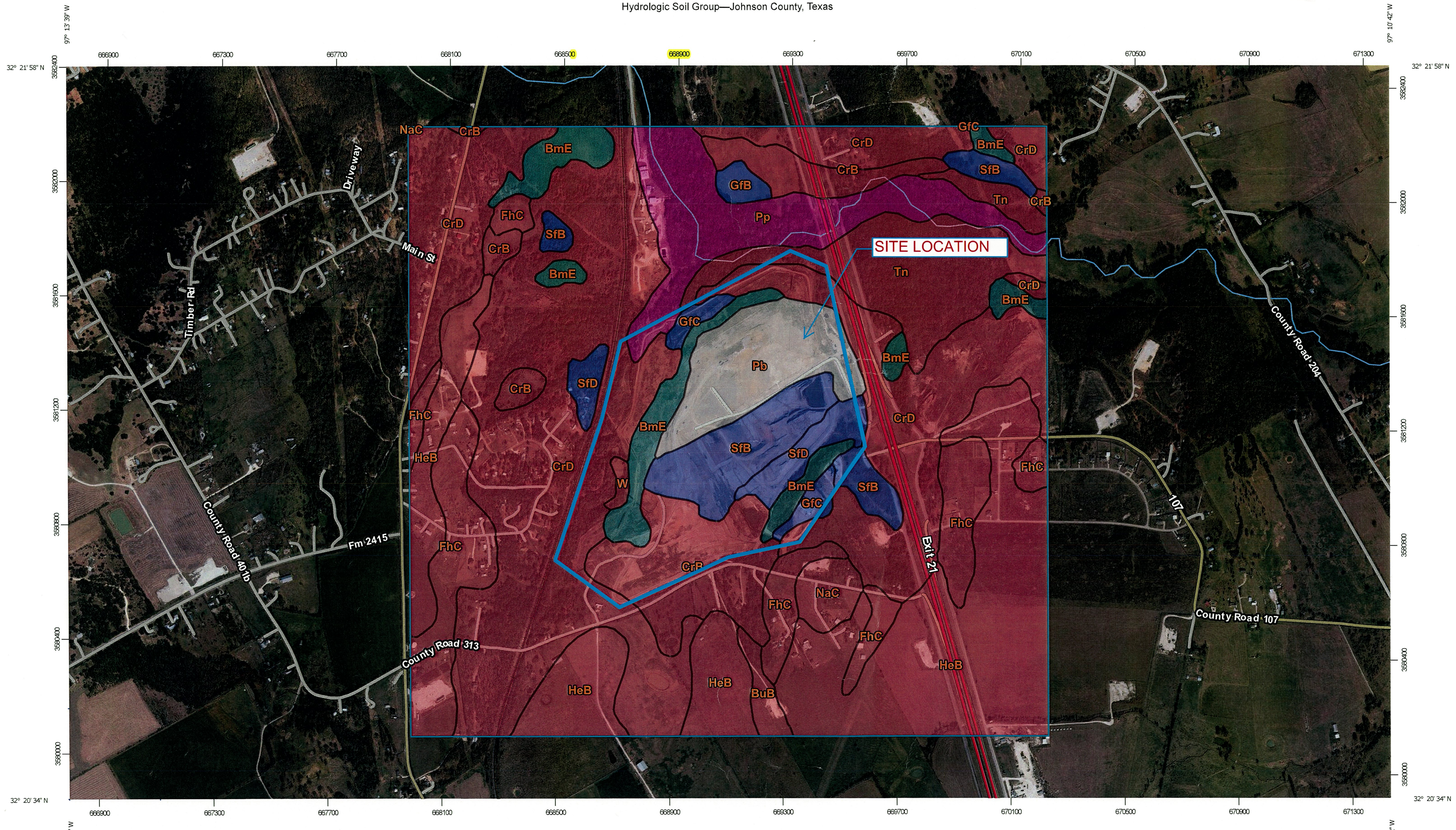


Figure 6-4
Regional Depth of Frost Penetration in Inches



Map Scale: 1:12,500 if printed on B landscape (17" x 11") sheet.

N

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

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 Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Johnson County, Texas
Survey Area Data: Version 15, Sep 14, 2018

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

Date(s) aerial images were photographed: Nov 27, 2014—Mar 19, 2017

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
BmE	Birome-Rayex complex, 5 to 20 percent slopes	C	50.9	4.3%
BuB	Burleson clay, 1 to 3 percent slopes	D	7.2	0.6%
CrB	Crosstell fine sandy loam, 1 to 3 percent slopes	D	85.8	7.3%
CrD	Crosstell fine sandy loam, 3 to 8 percent slopes	D	433.7	36.7%
FhC	Ferris-Heiden complex, 2 to 5 percent slopes	D	91.4	7.7%
GfB	Gasil fine sandy loam, 1 to 3 percent slopes	B	5.0	0.4%
GfC	Gasil fine sandy loam, 3 to 8 percent slopes	B	9.2	0.8%
HeB	Heiden clay, 1 to 3 percent slopes	D	216.3	18.3%
NaC	Navo clay loam, 2 to 5 percent slopes	D	11.9	1.0%
Pb	Pits, 0 to 45 percent slopes		49.6	4.2%
Pp	Pulexas fine sandy loam, frequently flooded	A	74.9	6.3%
SfB	Silstid loamy fine sand, 1 to 3 percent slopes	B	52.7	4.5%
SfD	Silstid loamy fine sand, 3 to 8 percent slopes	B	19.6	1.7%
Tn	Tinn clay, 0 to 1 percent slopes, frequently flooded	D	72.3	6.1%
W	Water	D	2.3	0.2%
Totals for Area of Interest			**1,182.6**	**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

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

USE OF THE UNIVERSAL SOIL LOSS EQUATION IN FINAL COVER/CONFIGURATION DESIGN

PROCEDURAL HANDBOOK

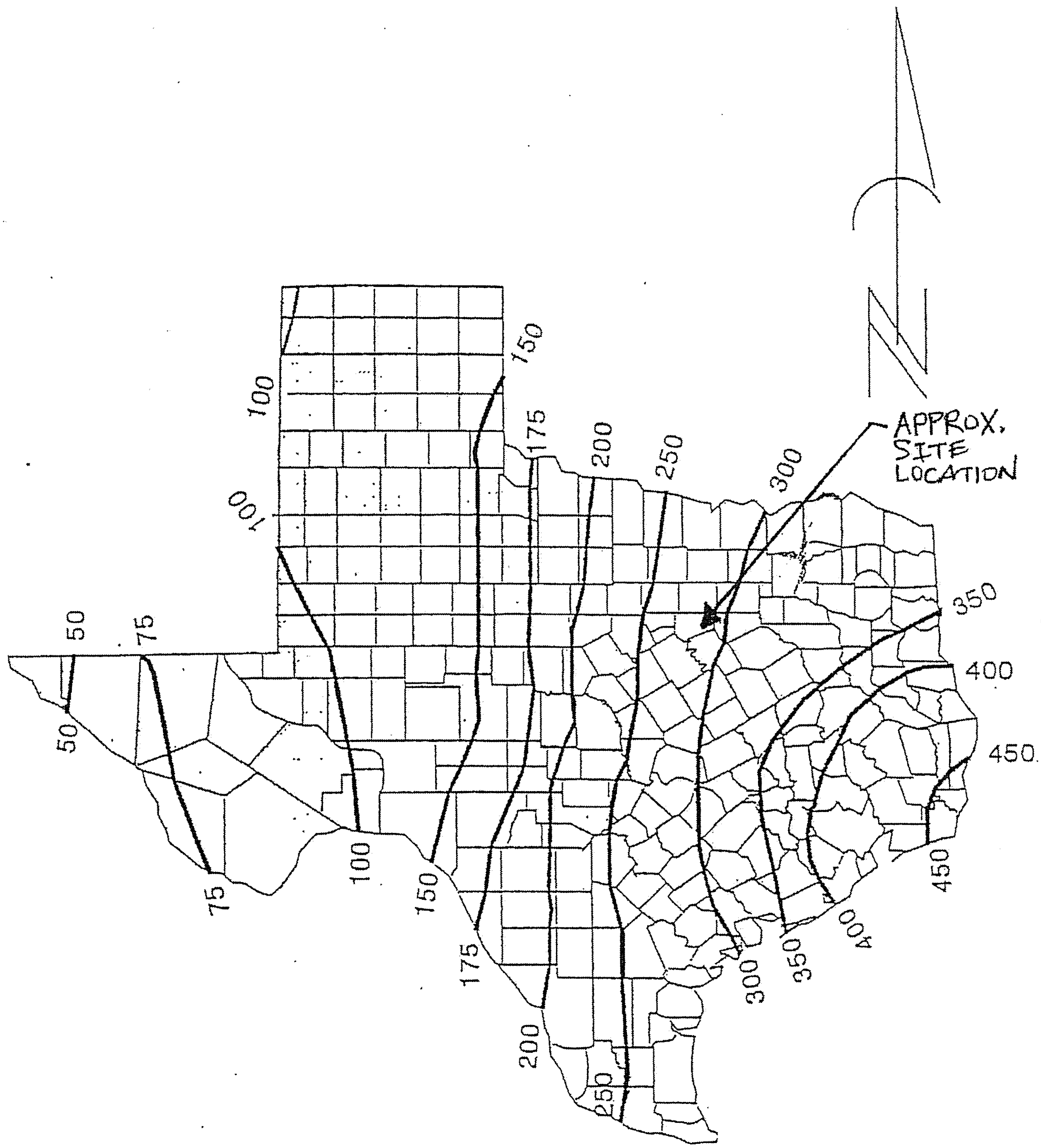
PERMITS SECTION
MUNICIPAL SOLID WASTE DIVISION

OCTOBER 1993

Table 1 Approximate Values of Factor K for USDA Textural Classes

Texture Class	Organic Matter Content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine Sand	0.16	0.14	0.10
Very Fine Sand	0.42	0.36	0.28
Loamy Sand	0.12	0.10	0.08
Loamy Fine Sand	0.24	0.20	0.16
Loamy Very Fine Sand	0.44	0.38	0.30
Sandy Loam	0.27	0.24	0.19
Fine Sandy Loam	0.35	0.30	0.24
Very Fine Sandy Loam	0.47	0.41	0.33
Loam	0.38	0.32	0.29
Silt Loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy Clay Loam	0.27	0.25	0.21
Clay Loam	0.28	0.25	0.21
Silty Clay Loam	0.37	0.32	0.26
Sandy Clay	0.14	0.13	0.12
Silty Clay	0.25	0.23	0.19
Clay	0.13 - 0.29 K = 0.25		

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.



W.H. Wischmeier, SEA, 1976

FIGURE 1. - AVERAGE ANNUAL VALUES OF THE RAINFALL EROSION INDEX

tion and developmental areas can be obtained from table 5 if good judgment is exercised in comparing the surface conditions with those of agricultural conditions specified in lines of the table. Time intervals analogous to cropstage periods will be defined to begin and end with successive construction or management activities that appreciably change the surface conditions. The procedure is then similar to that described for cropland.

Establishing vegetation on the denuded areas as quickly as possible is highly important. A good sod has a **C** value of 0.01 or less (table 5-B), but such a low **C** value can be obtained quickly only by laying sod on the area, at a substantial cost. When grass or small grain is started from seed, the probable soil loss for the period while cover is developing can be computed by the procedure outlined for estimating cropstage-period soil losses. If the seeding is on topsoil, without a mulch, the soil loss ratios given in line 141 of table 5 are appropriate for cropstage **C** values. If the seeding is on a desurfaced area, where residual effects of prior vegetation are no longer significant, the ratios for periods SB, 1 and 2 are 1.0, 0.75 and 0.50, respectively, and line 141 applies for cropstage 3. When the seedbed is protected by a mulch, the pertinent mulch factor from the upper curve of figure 6 or table 9 is applicable until good canopy cover is attained. The combined effects of vegetative mulch and low-growing canopy are given in figure 7. When grass is established in small grain, it can usually be evaluated as established meadow about 2 mo after the grain is cut.

C Values for Pasture, Range, and Idle Land

Factor **C** for a specific combination of cover conditions on these types of land may be obtained from table 10 (57). The cover characteristics that must be appraised before consulting this table are defined in the table and its footnotes. Cropstage periods and **EI** monthly distribution data are generally not necessary where perennial vegetation has become established and there is no mechanical disturbance of the soil.

Available soil loss data from undisturbed land were not sufficient to derive table 10 by direct comparison of measured soil loss rates, as was done for development of table 5. However, analyses of the assembled erosion data showed that the research information on values of **C** can be extended to completely different situations by combining subfactors that evaluate three separate and distinct, but interrelated, zones of influence: (a) vegetative cover in direct contact with the soil surface, (b) canopy cover, and (c) residual and tillage effects.

Subfactors for various percentages of surface cover by mulch are given by the upper curve of

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy: Type and height[2]	Vegetative canopy: Percent cover[3]	Type[4]	Percent ground cover: 0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

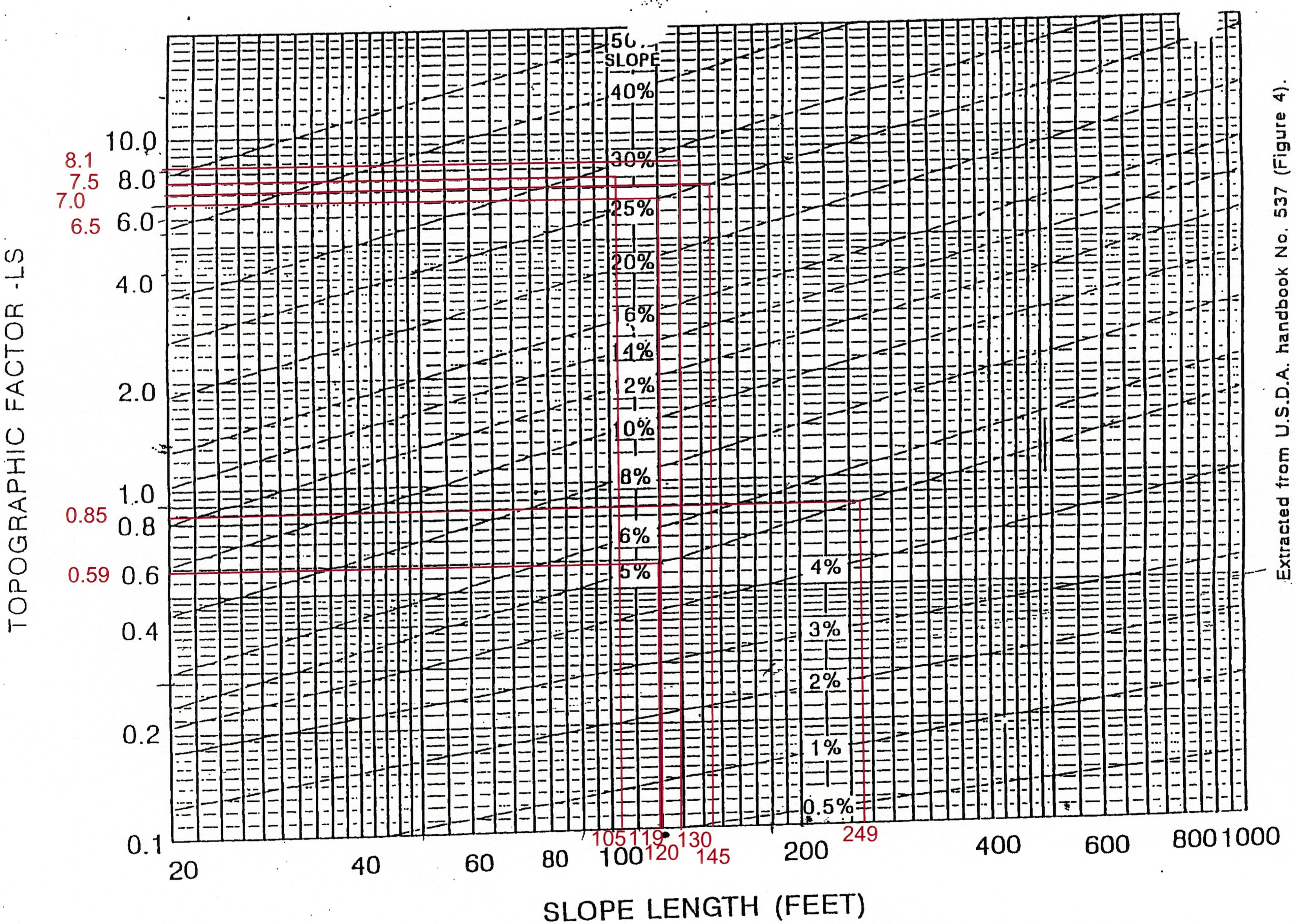


FIGURE 2.- Slope effect chart (topographic factor, LS). LS = (λ/72.6)''' 65.41 sin² ()=4.56 sin ()+ 0.065) whereλ= slope lenght in feet ;()=angle of slope; and m = 0.2 for gradients <1 percent, 0.3 for 1 to 3 slopes; 0.4 for 3.5 to 4.5 percent slopes, and 0.5 for slopes of 5 percent or steeper.

Required:

Determine the sheet flow velocity for the final cover system design and compare to the permissible non-erodible flow velocity.

Method:

1. Determine the flow using the Rational Method.
2. Calculate flow depth using Kinematic Wave procedures.
3. Compute flow velocity and compare to permissible non-erodibility velocity.

References:

1. Raudkivi, A.J., *Hydrology - An Advanced Introduction to Hydrological Processes and Modeling*, 1979.
2. NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0: Texas
3. United States Soil Conservation Service, *TR-55 Hydrology for Small Watersheds*, December 1989.

Solution:

Use the typical case scenarios from the USLE calculation to determine the expected sheet flow velocity.

Case 1. Typical top slope

slope =	0.05	ft/ft
length =	119	ft

Case 2. Longest top slope

slope =	0.05	ft/ft
length =	249	ft

Case 3. Typical side slope

slope =	0.286	ft/ft
length =	105	ft

Case 4. Typical side slope

slope =	0.25	ft/ft
length =	120	ft

Case 5. Longest Side Slope (28.6%)

slope =	0.286	ft/ft
length =	130	ft

Case 6. Longest Side Slope (25%)

slope =	0.25	ft/ft
length =	150	ft

Time of Concentration:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{2,24})^{0.5} S^{0.4}}$$

Where:

t_c = time of concentration (hr)
n = Manning's roughness coefficient
L = slope length
$P_{2,24}$ = 2-year, 24-hour rainfall depth (in)
S = slope (ft/ft)

USDA

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Chapter 3 Time of Concentration and Travel Time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[eq. 3-1]}$$

where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \ldots T_{t_m} \qquad \text{[eq. 3-2]}$$

where:

T_c = time of concentration (hr)
m = number of flow segments

Determine $P_{2,24}$:

$P_{2,24}$ = 3.98 in (ref 2)

Calculate t_c:

Case 1:

n =	0.24	
L =	119	
$P_{2,24}$ =	4.0	
S =	0.05	
t_c =	0.17	hr
	10.19	min

Case 2:

n =	0.24	
L =	249	
$P_{2,24}$ =	4.0	
S =	0.05	
t_c =	0.31	hr
	18.40	min

Case 3:

n =	0.24	
L =	105	
$P_{2,24}$ =	4.0	
S =	0.286	
t_c =	0.08	hr
	4.59	min

Case 4:

n =	0.24	
L =	120	
$P_{2,24}$ =	4.0	
S =	0.25	
t_c =	0.09	hr
	4.59	min

Case 5:

n =	0.24	
L =	130	
$P_{2,24}$ =	4.0	
S =	0.286	
t_c =	0.09	hr
	5.45	min

Case 6:

n =	0.24	
L =	150	
$P_{2,24}$ =	4.0	
S =	0.25	
t_c =	0.11	hr
	6.44	min

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 bank-full elevation.

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on "National Oceanic and Atmospheric Administration's (NOAA) Atlas 14
Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas" (Perica et al. 2018)

Parameter Selection

1. Select Units
   English
2. Select Methodology
   Annual Maximum Series (AMS)
3. Select County
   JOHNSON
4. Select County Zone
   Zone-1
5. Select Time of Concentration (t_c)
   10 Minute

Coefficient	Design Annual Exceedance Probability (Design Annual Recurrence Interval)						
	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)	0.2% (500-year)
e	0.7853	0.7799	0.7772	0.7746	0.7732	0.7717	0.7666
b	45.0947	58.5103	68.8917	83.0120	94.0156	105.4618	133.5994
d (min)	10.3117	10.3756	10.4692	10.6482	10.8145	11.0321	11.6620
Intensity (inches/hour)	4.24	5.57	6.59	7.95	8.99	10.05	12.64

Note: Johnson County has 1 rainfall zone.

Calculate the design 25-year frequency for each condition:

$Q = CiA$

Where:
Q = flow rate (cfs)
C = runoff coefficient
i = rainfall intensity (in/hr)
A = drainage area (ac)

$i = b/(t_c+d)^e$

Where:
i = rainfall intensity (in/hr)
b = constant for Johnson County = 83.01
d = constant for Johnson County = 10.65
e = constant for Johnson County = 0.775
t_c = time of concentration (min)

For a unit width of final cover, the flow lengths shown on sheet IIIF-D-7 for each case is used.

A=[Length (ft) x Width (ft)] / 43560 sq. ft/acre = A in acres

Case 1:

C =	0.7	
t_c =	10.19	min
i =	7.90	in/hr
Length:	119.00	ft
A	0.0027	ac
Q =	0.015	cfs

Case 2:

C =	0.7	
t_c =	18.40	min
i =	6.11	in/hr
Length:	249.00	ft
A	0.0057	ac
Q =	0.024	cfs

Case 3:

C =	0.7	
t_c =	4.59	min
i =	10.07	in/hr
Length:	105.00	ft
A	0.0024	ac
Q =	0.017	cfs

Case 4:

C =	0.7	
t_c =	4.59	min
i =	10.07	in/hr
Length:	120.00	ft
A	0.0028	ac
Q =	0.017	cfs

Case 5:

C =	0.7	
t_c =	5.45	min
i =	9.65	in/hr
Length:	130.00	ft
A	0.0030	ac
Q =	0.020	cfs

Case 6:

C =	0.7	
t_c =	6.44	min
i =	9.65	in/hr
Length:	150.00	ft
A	0.0034	ac
Q =	0.023	cfs

Approximate depth of flow:

Using Manning's Equation

$$V = (1.49/n)\ y^{0.67}\ S^{0.5}$$

$Q = VA \quad => \quad V = Q/A$

$A = y \times 1$ (assuming unit width of flow)

substituting for V

$$Q/y = (1.49/n)\ y^{0.67}\ S^{0.5}$$

$$Q = (1.49/n)\ y^{1.67}\ S^{0.5}$$

solve for y

$$y = (Qn/1.49\ S^{0.5})^{1/1.67}$$

$$y = (Qn/1.49S^{0.5})^{0.6}$$

Case 1:

Q =	0.015	cfs
n =	0.24	
S =	0.05	ft/ft
y =	0.066	ft

Case 2:

Q =	0.024	cfs
n =	0.24	
S =	0.05	ft/ft
y =	0.089	ft

Case 3:

Q =	0.017	cfs
n =	0.24	
S =	0.286	ft/ft
y =	0.042	ft

Case 4:

Q =	0.017	cfs
n =	0.24	
S =	0.25	ft/ft
y =	0.044	ft

Case 5:

Q =	0.020	cfs
n =	0.24	
S =	0.286	ft/ft
y =	0.047	ft

Case 6:

Q =	0.023	cfs
n =	0.24	
S =	0.25	ft/ft
y =	0.053	ft

Determine sheet flow velocity:

V = Q/A (assume unit flow width for the flow area, A)

Case 1:

Q =	0.015	cfs
A =	0.066	sf
V =	0.23	ft/s

Case 2:

Q =	0.024	cfs
A =	0.089	sf
V =	0.28	ft/s

Case 3:

Q =	0.017	cfs
A =	0.042	sf
V =	0.40	ft/s

Case 4:

Q =	0.017	cfs
A =	0.044	sf
V =	0.39	ft/s

Case 5:

Q =	0.020	cfs
A =	0.047	sf
V =	0.43	ft/s

Case 6:

Q =	0.023	cfs
A =	0.053	sf
V =	0.44	ft/s

Permissible non-erodible velocity is 5.0 ft/s. Therefore, expected sheet flow velocity is acceptable on the final cover system top and side slopes.

Texas Department of Transportation

Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Adopted by the
Texas Department of Transportation

November 1, 2014

Item 164
Seeding for Erosion Control

1. DESCRIPTION

Provide and install temporary or permanent seeding for erosion control as shown on the plans or as directed.

2. MATERIALS

2.1. **Seed.** Provide seed from the previous season's crop meeting the requirements of the Texas Seed Law, including the testing and labeling for pure live seed (PLS = Purity × Germination). Furnish seed of the designated species, in labeled unopened bags or containers to the Engineer before planting. Use within 12 mo. from the date of the analysis. When Buffalograss is specified, use seed that is treated with KNO_3 (potassium nitrate) to overcome dormancy.

Use Tables 1–4 to determine the appropriate seed mix and rates as specified on the plans. If a plant species is not available by the producers, the other plant species in the recommended seed mixture will be increased proportionally by the PLS/acre of the missing plant species.

Table 1
Permanent Rural Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
1 (Paris) Feb. 1–May 15	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	3.2	Bermudagrass	1.5
	Bermudagrass	1.8	Bahiagrass (Pensacola)	6.0
	Little Bluestem (Native)	1.7	Sand Lovegrass	0.6
	Illinois Bundleflower	1.0	Weeping Lovegrass (Ermelo)	0.8
			Partridge Pea	1.0
2 (Ft. Worth) Feb. 1–May 15	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Slender Grama (Dilley)	1.0
	Little Bluestem (OK Select)	0.8	Sand Lovegrass (Mason)	0.2
	Purple Prairie Clover (Cuero)	0.6	Sand Dropseed (Borden County)	0.2
	Engelmann Daisy (Eldorado)	0.75	Partridge Pea (Comanche)	0.6
	Illinois Bundleflower	1.3	Little Bluestem (OK Select)	0.8
	Awnless Bushsunflower (Plateau)	0.2	Englemann Daisy (Eldorado)	0.75
			Purple Prairie Clover	0.3
3 (Wichita Falls) Feb. 1–May 15	Green Sprangletop (Van Horn)	0.6	Green Sprangletop (Van Horn)	1.0
	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Little Bluestem (OK Select)	0.8	Sand Dropseed (Borden County)	0.2
	Blue Grama (Hachita)	0.4	Partridge Pea (Comanche)	0.6
	Western Wheatgrass (Barton)	1.2	Little Bluestem (OK Select)	0.8
	Galleta Grass (Viva)	0.6	Englemann Daisy (Eldorado)	0.75
	Engelmann Daisy (Eldorado)	0.75	Purple Prairie Clover (Cuero)	0.3
	Awnless Bushsunflower (Plateau)	0.2		
4 (Amarillo) Feb. 15–May 15	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	3.6	Weeping Lovegrass (Ermelo)	0.8
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	1.0
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
	Illinois Bundleflower	1.0	Sand Bluestem	1.8
			Purple Prairie Clover	0.5

Table 1 (continued)
Permanent Rural Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
5 (Lubbock)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 15–May 15	Sideoats Grama (El Reno)	3.6	Weeping Lovegrass (Ermelo)	0.8
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	1.0
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
	Illinois Bundleflower	1.0	Sand Bluestem	1.8
			Purple Prairie Clover	0.5
6 (Odessa)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (South Texas)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Blue Grama (Hachita)	0.4	Blue Grama (Hachita)	0.4
	Galleta Grass (Viva)	0.6	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Pink Pappusgrass (Maverick)	0.6	Sand Dropseed (Borden County)	0.2
	Alkali Sacaton (Saltalk)	0.2	Indian Ricegrass (Rim Rock)	1.6
	Plains Bristlegrass (Catarina Blend)	0.2	Sand Bluestem (Cottle County)	1.2
	False Rhodes Grass (Kinney)	0.1	Little Bluestem (Pastura)	0.8
	Whiplash Pappusgrass (Webb)	0.6	Purple Prairie Clover (Cuero)	0.3
	Arizona Cottontop (La Salle)	0.2		
7 (San Angelo)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 1	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Little Bluestem (OK Select)	0.4	Sand Dropseed (Borden County)	0.2
	Blue Grama (Hachita)	0.4	Sand Bluestem (Cottle County)	1.2
	Western Wheatgrass (Barton)	1.2	Partridge Pea (Comanche)	0.6
	Galleta Grass (Viva)	0.6	Little Bluestem (OK Select)	0.8
	Engelmann Daisy (Eldorado)	0.75	Englemann Daisy (Eldorado)	0.75
	Illinois Bundleflower (Sabine)	1.0	Purple Prairie Clover (Cuero)	0.3
8 (Abilene)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Little Bluestem (OK Select)	0.4	Sand Dropseed (Borden County)	0.2
	Blue Grama (Hachita)	0.4	Sand Bluestem (Cottle County)	1.2
	Western Wheatgrass (Barton)	1.2	Partridge Pea (Comanche)	0.6
	Galleta Grass (Viva)	0.6	Little Bluestem (OK Select)	0.8
	Engelmann Daisy (Eldorado)	0.75	Englemann Daisy (Eldorado)	0.75
	Illinois Bundleflower (Sabine)	1.0	Purple Prairie Clover (Cuero)	0.3
9 (Waco)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Slender Grama (Dilley)	1.0
	Little Bluestem (OK Select)	0.8	Sand Lovegrass (Mason)	0.2
	Purple Prairie Clover (Cuero)	0.6	Sand Dropseed (Borden County)	0.2
	Engelmann Daisy (Eldorado)	0.75	Partridge Pea (Comanche)	0.6
	Illinois Bundleflower	1.3	Little Bluestem (OK Select)	0.8
	Awnless Bushsunflower (Plateau)	0.2	Englemann Daisy (Eldorado)	0.75
			Purple Prairie Clover	0.3
10 (Tyler)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	1.8	Bermudagrass	1.8
	Bahiagrass (Pensacola)	9.0	Bahiagrass (Pensacola)	9.0
	Sideoats Grama (Haskell)	2.7	Weeping Lovegrass (Ermelo)	0.5
	Illinois Bundleflower	1.0	Sand Lovegrass	0.5
			Lance-Leaf Coreopsis	1.0
11 (Lufkin)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	1.8	Bermudagrass	2.1
	Bahiagrass (Pensacola)	9.0	Bahiagrass (Pensacola)	9.0
	Sideoats Grama (Haskell)	2.7	Sand Lovegrass	0.5
	Illinois Bundleflower	1.0	Lance-Leaf Coreopsis	1.0

Table 1 (continued)
Permanent Rural Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
12 (Houston)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Bermudagrass	2.1	Bermudagrass	2.4
	Sideoats Grama (Haskell)	3.2	Bahiagrass (Pensacola)	10.5
	Little Bluestem (Native)	1.4	Weeping Lovegrass (Ermelo)	1.0
	Illinois Bundleflower	1.0	Lance-Leaf Coreopsis	1.0
13 (Yoakum)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Jan. 15–May 15	Sideoats Grama (South Texas)	1.0	Hooded Windmillgrass (Mariah)	0.4
	Texas Grama (Atascosa)	1.5	Slender Grama (Dilley)	1.0
	Slender Grama (Dilley)	1.0	Hairy Grama (Chaparral)	0.8
	Shortspike Windmillgrass (Welder)	0.3	Shortspike Windmillgrass (Welder)	0.2
	Halls Panicum (Oso)	0.2	Purple Prairie Clover (Cuero)	0.6
	Plains Bristlegrass (Catarina Blend)	0.2	Partridge Pea (Comanche)	0.6
	Canada Wildrye (Lavaca)	2.0	Englemann Daisy (Eldorado)	1.0
	Illinois Bundleflower (Sabine)	1.3		
	Purple Prairie Clover (Cuero)	0.6		
14 (Austin)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (South Texas)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Slender Grama (Dilley)	1.0
	Little Bluestem (OK Select)	0.8	Sand Lovegrass (Mason)	0.2
	Purple Prairie Clover (Cuero)	0.6	Sand Dropseed (Borden County)	0.2
	Engelmann Daisy (Eldorado)	0.75	Partridge Pea (Comanche)	0.6
	Illinois Bundleflower (Sabine)	1.3	Little Bluestem (OK Select)	0.8
	Awnless Bushsunflower (Plateau)	0.2	Englemann Daisy (Eldorado)	0.75
			Purple Prairie Clover	0.3
15 (San Antonio)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 1	Sideoats Grama (South Texas)	1.0	Slender Grama (Dilley)	2.0
	Texas Grama (Atascosa)	1.0	Hairy Grama (Chaparral)	0.6
	Slender Grama (Dilley)	1.0	Shortspike Windmillgrass (Welder)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Pink Pappusgrass (Maverick)	0.6
	Pink Pappusgrass (Maverick)	0.6	Plains Bristlegrass (Catarina Blend)	0.2
	Halls Panicum (Oso)	0.2	Hooded Windmillgrass (Mariah)	0.3
	Plains Bristlegrass (Catarina Blend)	0.2	Multi-flowered False Rhoades Grass	0.1
	False Rhodes Grass (Kinney)	0.1	(Hidalgo)	0.2
	Hooded Windmillgrass (Mariah)	0.2	Arizona Cottontop (La Salle)	
	Arizona Cottontop (La Salle)	0.2		
16 (Corpus Christi)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Jan. 1–May 1	Sideoats Grama (South Texas)	1.0	Slender Grama (Dilley)	2.0
	Texas Grama (Atascosa)	1.0	Hairy Grama (Chaparral)	0.6
	Slender Grama (Dilley)	1.0	Shortspike Windmillgrass (Welder)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Pink Pappusgrass (Maverick)	0.6
	Pink Pappusgrass (Maverick)	0.6	Plains Bristlegrass (Catarina Blend)	0.2
	Halls Panicum (Oso)	0.2	Hooded Windmillgrass (Mariah)	0.3
	Plains Bristlegrass (Catarina Blend)	0.2	Multi-flowered False Rhodes Grass	0.1
	False Rhodes Grass (Kinney)	0.1	(Hidalgo)	0.2
	Hooded Windmillgrass (Mariah)	0.2	Arizona Cottontop (La Salle)	
	Arizona Cottontop (La Salle)	0.2		
17 (Bryan)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	1.5	Bermudagrass	1.5
	Sideoats Grama (Haskell)	3.6	Bahiagrass (Pensacola)	7.5
	Little Bluestem (Native)	1.7	Weeping Lovegrass (Ermelo)	0.6
	Illinois Bundleflower	1.0	Sand Lovegrass	0.6
			Lance-Leaf Coreopsis	1.0

Permanent Rural Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
18 (Dallas)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Slender Grama (Dilley)	1.0
	Little Bluestem (OK Select)	0.8	Sand Lovegrass (Mason)	0.2
	Purple Prairie Clover (Cuero)	0.6	Sand Dropseed (Borden County)	0.2
	Engelmann Daisy (Eldorado)	0.75	Partridge Pea (Comanche)	0.6
	Illinois Bundleflower	1.3	Little Bluestem (OK Select)	0.8
	Awnless Bushsunflower (Plateau)	0.2	Englemann Daisy (Eldorado)	0.75
			Purple Prairie Clover	0.3
19 (Atlanta)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	2.1
	Sideoats Grama (Haskell)	4.5	Bahiagrass (Pensacola)	7.5
	Illinois Bundleflower	1.0	Sand Lovegrass	0.6
			Lance-Leaf Coreopsis	1.0
20 (Beaumont)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Bermudagrass	2.7	Bermudagrass	2.1
	Sideoats Grama (Haskell)	4.1	Bahiagrass (Pensacola)	7.5
	Illinois Bundleflower	1.0	Sand Lovegrass	0.6
			Lance-Leaf Coreopsis	1.0
21 (Pharr)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Jan. 15–May 15	Sideoats Grama (South Texas)	1.0	Slender Grama (Dilley)	2.0
	Texas Grama (Atascosa)	1.0	Hairy Grama (Chaparral)	0.6
	Slender Grama (Dilley)	1.0	Shortspike Windmillgrass (Welder)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Pink Pappusgrass (Maverick)	0.6
	Pink Pappusgrass (Maverick)	0.6	Plains Bristlegrass (Catarina Blend)	0.2
	Halls Panicum (Oso)	0.2	Hooded Windmillgrass (Mariah)	0.3
	Plains Bristlegrass (Catarina Blend)	0.2	Multi-flowered False Rhoades Grass	0.1
	False Rhodes Grass (Kinney)	0.1	(Hidalgo)	0.2
	Hooded Windmillgrass (Mariah)	0.2	Arizona Cottontop (La Salle)	
	Arizona Cottontop (La Salle)	0.2		
22 (Laredo)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Jan. 15–May 1	Sideoats Grama (South Texas)	1.0	Slender Grama (Dilley)	2.0
	Texas Grama (Atascosa)	1.0	Hairy Grama (Chaparral)	0.6
	Slender Grama (Dilley)	1.0	Shortspike Windmillgrass (Welder)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Pink Pappusgrass (Maverick)	0.6
	Pink Pappusgrass (Maverick)	0.6	Plains Bristlegrass (Catarina Blend)	0.2
	Halls Panicum (Oso)	0.2	Hooded Windmillgrass (Mariah)	0.3
	Plains Bristlegrass (Catarina Blend)	0.2	Multi-flowered False Rhoades Grass	0.1
	False Rhodes Grass (Kinney)	0.1	(Hidalgo)	0.2
	Hooded Windmillgrass (Mariah)	0.2	Arizona Cottontop (La Salle)	
	Arizona Cottontop (La Salle)	0.2		
23 (Brownwood)	Green Sprangletop (Van Horn)	0.6	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (Haskell)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Texas Grama (Atascosa)	1.0	Shortspike Windmillgrass (Welder)	0.2
	Hairy Grama (Chaparral)	0.4	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Little Bluestem (OK Select)	0.8	Sand Dropseed (Borden County)	0.2
	Blue Grama (Hachita)	0.4	Partridge Pea (Comanche)	0.6
	Western Wheatgrass (Barton)	1.2	Little Bluestem (OK Select)	0.8
	Galleta Grass (Viva)	0.6	Englemann Daisy (Eldorado)	0.75
	Engelmann Daisy (Eldorado)	0.75	Purple Prairie Clover (Cuero)	0.3
	Awnless Bushsunflower (Plateau)	0.2		

Table 1 (continued)
Permanent Rural Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
24 (El Paso)	Green Sprangletop (Van Horn)	1.0	Green Sprangletop (Van Horn)	1.0
Feb. 1–May 15	Sideoats Grama (South Texas)	1.0	Hooded Windmillgrass (Mariah)	0.2
	Blue Grama (Hachita)	0.4	Blue Grama (Hachita)	0.4
	Galleta Grass (Viva)	0.6	Hairy Grama (Chaparral)	0.4
	Shortspike Windmillgrass (Welder)	0.2	Sand Lovegrass (Mason)	0.2
	Pink Pappusgrass (Maverick)	0.6	Sand Dropseed (Borden County)	0.2
	Alkali Sacaton (Saltalk)	0.2	Indian Ricegrass (Rim Rock)	1.6
	Plains Bristlegrass (Catarina Blend)	0.2	Sand Bluestem (Cottle County)	1.2
	False Rhodes Grass (Kinney)	0.1	Little Bluestem (Pastura)	0.8
	Whiplash Pappusgrass (Webb)	0.6	Purple Prairie Clover (Cuero)	0.3
	Arizona Cottontop (La Salle)	0.2		
25 (Childress)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (El Reno)	2.7	Weeping Lovegrass (Ermelo)	1.2
	Blue Grama (Hachita)	0.9	Sand Dropseed (Borden Co.)	0.5
	Western Wheatgrass	2.1	Sand Lovegrass	0.8
	Galleta	1.6	Purple Prairie Clover	0.5
	Illinois Bundleflower	1.0		

Table 2
Permanent Urban Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
1 (Paris)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
2 (Ft. Worth)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	3.6
	Bermudagrass	2.4	Bermudagrass	2.1
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
3 (Wichita Falls)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (El Reno)	4.5	Sideoats Grama (El Reno)	3.6
	Bermudagrass	1.8	Bermudagrass	1.8
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
4 (Amarillo)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 15–May 15	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	2.7
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	0.9
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
			Buffalograss (Texoka)	1.6
5 (Lubbock)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 15–May 15	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	2.7
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	0.9
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
			Buffalograss (Texoka)	1.6
6 (Odessa)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (Haskell)	3.6	Sideoats Grama (Haskell)	2.7
	Blue Grama (Hachita)	1.2	Sand Dropseed (Borden Co.)	0.4
	Buffalograss (Texoka)	1.6	Blue Grama (Hachita)	0.9
			Buffalograss (Texoka)	1.6
7 (San Angelo)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 1	Sideoats Grama (Haskell)	7.2	Sideoats Grama (Haskell)	3.2
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
			Blue Grama (Hachita)	0.9
			Buffalograss (Texoka)	1.6
8 (Abilene)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (Haskell)	3.6	Sand Dropseed (Borden Co.)	0.3
	Blue Grama (Hachita)	1.2	Sideoats Grama (Haskell)	3.6
	Buffalograss (Texoka)	1.6	Blue Grama (Hachita)	0.8
			Buffalograss (Texoka)	1.6

Table 2 (continued)

Permanent Urban Seed Mix

District and Planting Dates	Clay Soils Species and Rates (lb. PLS/acre)		Sandy Soils Species and Rates (lb. PLS/acre)	
9 (Waco)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	1.8	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Sideoats Grama (Haskell)	4.5	Sand Dropseed (Borden Co.)	0.4
10 (Tyler)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
11 (Lufkin)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
12 (Houston)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Sideoats Grama (Haskell)	4.5	Bermudagrass	5.4
	Bermudagrass	2.4		
13 (Yoakum)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Sideoats Grama (South Texas)	4.5	Bermudagrass	5.4
	Bermudagrass	2.4		
14 (Austin)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	4.8
	Sideoats Grama (South Texas)	3.6	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
15 (San Antonio)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 1	Sideoats Grama (South Texas)	3.6	Bermudagrass	4.8
	Bermudagrass	2.4	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
16 (Corpus Christi)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 1–May 1	Sideoats Grama (South Texas)	3.6	Bermudagrass	4.8
	Bermudagrass	2.4	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
17 (Bryan)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
18 (Dallas)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (El Reno)	3.6	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Bermudagrass	2.4	Sand Dropseed (Borden Co.)	0.4
19 (Atlanta)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
20 (Beaumont)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
21 (Pharr)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 15	Sideoats Grama (South Texas)	3.6	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Bermudagrass	2.4	Sand Dropseed (Borden Co.)	0.4
22 (Laredo)	Green Sprangletop	0.3	Green Sprangletop	0.3
Jan. 15–May 1	Sideoats Grama (South Texas)	4.5	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Bermudagrass	1.8	Sand Dropseed	0.4
23 (Brownwood)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (Haskell)	3.6	Buffalograss (Texoka)	1.6
	Bermudagrass	1.2	Bermudagrass	3.6
	Blue Grama (Hachita)	0.9	Sand Dropseed (Borden Co.)	0.4
24 (El Paso)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (South Texas)	3.6	Buffalograss (Texoka)	1.6
	Blue Grama (Hachita)	1.2	Sand Dropseed (Borden Co.)	0.4
	Buffalograss (Texoka)	1.6	Blue Grama (Hachita)	1.8
25 (Childress)	Green Sprangletop	0.3	Green Sprangletop	0.3
Feb. 1–May 15	Sideoats Grama (El Reno)	3.6	Sand Dropseed (Borden Co.)	0.4
	Blue Grama (Hachita)	1.2	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	1.8

Table 3
Temporary Cool Season Seeding

Districts	Dates	Seed Mix and Rates (lb. PLS/acre)
Paris (1), Amarillo (4), Lubbock (5), Dallas (18)	September 1–November 30	Tall Fescue 4.5 Western Wheatgrass 5.6 Wheat (Red, Winter) 34
Odessa (6), San Angelo (7), El Paso (24)	September 1–November 30	Western Wheatgrass 8.4 Wheat (Red, Winter) 50
Waco (9), Tyler (10), Lufkin (11), Austin (14), San Antonio (15), Bryan (17), Atlanta (19)	September 1–November 30	Tall Fescue 4.5 Oats 24 Wheat 34
Houston (12), Yoakum (13), Corpus Christi (16), Beaumont (20), Pharr (21), Laredo (22)	September 1–November 30	Oats 72
Ft. Worth (2), Wichita Falls (3), Abilene (8), Brownwood (23), Childress (25)	September 1–November 30	Tall Fescue 4.5 Western Wheatgrass 5.6 Cereal Rye 34

Table 4
Temporary Warm Season Seeding

Districts	Dates	Seed Mix and Rates (lb. PLS/acre)
All	May 1–August 31	Foxtail Millet 34

2.2. **Fertilizer.** Use fertilizer in conformance with Article 166.2., "Materials."

2.3. **Vegetative Watering.** Use water that is clean and free of industrial wastes and other substances harmful to the growth of vegetation.

2.4. **Mulch.**

2.4.1. **Straw or Hay Mulch.** Use straw or hay mulch in conformance with Section 162.2.5., "Mulch."

2.4.2. **Cellulose Fiber Mulch.** Use only cellulose fiber mulches that are on the Approved Products List, *Erosion Control Approved Products*. (http://www.txdot.gov/business/resources/erosion-control.html) Submit one full set of manufacturer's literature for the selected material. Keep mulch dry until applied. Do not use molded or rotted material.

2.5. **Tacking Methods.** Use a tacking agent applied in accordance with the manufacturer's recommendations or a crimping method on all straw or hay mulch operations. Use tacking agents as approved or as specified on the plans.

3. CONSTRUCTION

Cultivate the area to a depth of 4 in. before placing the seed unless otherwise directed. Use approved equipment to vertically track the seedbed as shown on the plans or as directed. Cultivate the seedbed to a depth of 4 in. or mow the area before placement of the permanent seed when performing permanent seeding after an established temporary seeding. Plant the seed specified and mulch, if required, after the area has been completed to lines and grades as shown on the plans.

3.1. **Broadcast Seeding.** Distribute the seed or seed mixture uniformly over the areas shown on the plans using hand or mechanical distribution or hydro-seeding on top of the soil unless otherwise directed. Apply the mixture to the area to be seeded within 30 min. of placement of components in the equipment when seed and water are to be distributed as a slurry during hydro-seeding. Roll the planted area with a light roller or other suitable equipment. Roll sloped areas along the contour of the slopes.

3.2. **Straw or Hay Mulch Seeding.** Plant seed according to Section 164.3.1., "Broadcast Seeding." Apply straw or hay mulch uniformly over the seeded area immediately after planting the seed or seed mixture. Apply straw mulch at 2 to 2.5 tons per acre. Apply hay mulch at 1.5 to 2 tons per acre. Use a tacking method over the mulched area.

3.3. **Cellulose Fiber Mulch Seeding**. Plant seed in accordance with Section 164.3.1., "Broadcast Seeding." Apply cellulose fiber mulch uniformly over the seeded area immediately after planting the seed or seed mixture at the following rates.

- Sandy soils with slopes of 3:1 or less—2,500 lb. per acre.
- Sandy soils with slopes greater than 3:1—3,000 lb. per acre.
- Clay soils with slopes of 3:1 or less—2,000 lb. per acre.
- Clay soils with slopes greater than 3:1—2,300 lb. per acre.

Cellulose fiber mulch rates are based on dry weight of mulch per acre. Mix cellulose fiber mulch and water to make a slurry and apply uniformly over the seeded area using suitable equipment.

3.4. **Drill Seeding.** Plant seed or seed mixture uniformly over the area shown on the plans at a depth of 1/4 to 1/3 in. using a pasture or rangeland type drill unless otherwise directed. Plant seed along the contour of the slopes.

3.5. **Straw or Hay Mulching.** Apply straw or hay mulch uniformly over the area as shown on the plans. Apply straw mulch at 2 to 2.5 tons per acre. Apply hay mulch at 1.5 to 2 tons per acre. Use a tacking method over the mulched area.

Apply fertilizer in conformance with Article 166.3., "Construction." Seed and fertilizer may be distributed simultaneously during "Broadcast Seeding" operations, provided each component is applied at the specified rate. Apply half of the required fertilizer during the temporary seeding operation and the other half during the permanent seeding operation when temporary and permanent seeding are both specified for the same area.

Water the seeded areas at the rates and frequencies as shown on the plans or as directed.

4. MEASUREMENT

This Item will be measured by the square yard or by the acre.

5. PAYMENT

The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Broadcast Seeding (Perm)" of the rural or urban seed mixture and sandy or clay soil specified, "Broadcast Seeding (Temp)" of warm or cool season specified, "Straw or Hay Mulch Seeding (Perm)" of the rural or urban seed mixture and sandy or clay soil specified, "Straw or Hay Mulch Seeding (Temp)" of warm or cool season specified, "Cellulose Fiber Mulch Seeding (Perm)" of the rural or urban seed mixture and sandy or clay soil specified, "Cellulose Fiber Mulch Seeding (Temp)" of warm or cool season specified, "Drill Seeding (Perm)" of the rural or urban seed mixture and sandy or clay soil specified, "Drill Seeding (Temp)" of warm or cool season specified, and "Straw or Hay Mulching." This price is full compensation for furnishing materials, including water for hydro-seeding and hydro-mulching operations, mowing, labor, equipment, tools, supplies, and incidentals. Fertilizer will not be paid for directly but will be subsidiary to this Item. Water for irrigating the seeded area, when specified, will be paid for under Item 168, "Vegetative Watering."

APPENDIX IIIF-E

PERMITTED LANDFILL CONDITION
HYDROLOGIC CALCULATIONS

Includes pages IIIF-E-1 through IIIF-E-69

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER

2-22-22

CONTENTS

STATE OF TEXAS
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2.22.22

HYPOTHETICAL STORM DATA

Hypothetical Storm Data

Precipitation data taken from NOAA Atlas 14 rainfall data.

Time	5 min	15 min	60 min	2 hr	3 hr	6 hr	12 hr	24 hr
25-Year Event	0.85	1.69	3.07	3.88	4.38	5.30	6.27	7.33

NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0: Texas (*U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, 2018*) was used to identify precipitation values for storm durations ranging from 5 minutes to 24 hours.

PRECIPITATION LOSS DATA

Required: Determine the SCS curve numbers for both on-site and off-site drainage areas for use in the HEC-1 analysis.

References:

1. Dodson's and Associates, Inc., *ProHec-1 Plus Program Documentation*, 1995.
2. United States Department of Agriculture, National Resource Conservation Service, Web Soil Survey for Johnson County, Texas (http://websoilsurvey.nrcs.usda.gov).
3. The Hydrologic Evaluation of Landfill Performance (HELP) Model - Engineering Documentation for version 3. EPA/600/R-94/168b, September 1994.

Note: Approximate non landfill areas within the permit boundary on SCS map (page IIIF-E-5).

Solution: Based on the soil survey information found in Ref. 2, hydrologic group D soils predominate the soils within the permit boundary drainage area (see pages IIIF-E-5 through IIIF-E-8).

The curve number for the offsite drainage areas around the site, large non-landfill drainage basins within the permit boundary, and drainage channels (O1, O2, O3, O4, O5, S1, S2, S3, S4, S5, S6, S7,CH1, CH2, CH3, CH4, and CH5) was calculated using the table on Page IIIF- assuming pasture land in fair conditions. The majority of the area is undeveloped and assumed to compare to the off-site and on-site subasins near the site.

Use:	CN = 84

The final cover system was assumed to be in place and the erosion layer will control precipitation loss. A curve number that is corrected for the surface slope of the erosion layer may be computed first using the chart on page IIIF-E-11 to select an un-adjusted curve number. Calculate the adjusted curve number using equation 34 from Ref. 3 (see page IIIF-E-10).

$$CN_{II} = 100 - (100 - CN_{II\,o}) * (L^{*\,2} / S^{*}) \wedge (CN_{II\,o}^{-0.81})$$

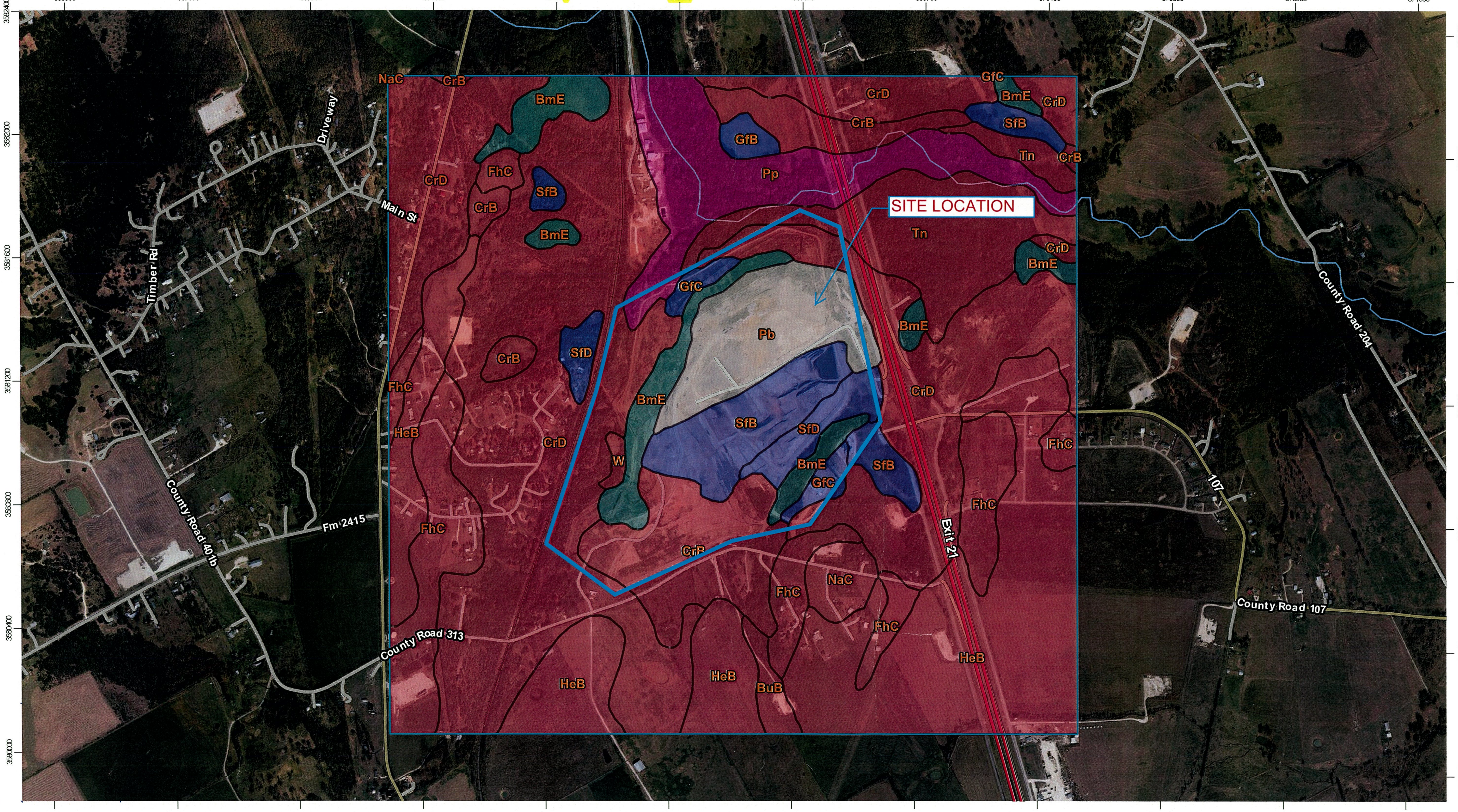
Use:	$CN_{II\,o} = 84$, $L^* = (500/500)$, $S^* = (.06/.04)$	for top dome surfaces
Use:	$CN_{II\,o} = 84$, $L^* = (120/500)$, $S^* = (.29/.04)$	for side slopes

Calculate:	CN = 85	for top dome surfaces
Calculate:	CN = 86	for side slopes

- Use curve number calculated for side slopes for the entire final cover area, inculding top dome areas, conservatively.

The pond areas are assumed to collect all precipitation for their areas:

Use:	CN = 100



Map Scale: 1:12,500 if printed on B landscape (17" x 11") sheet.

N

Meters: 0, 150, 300, 600, 900

Feet: 0, 500, 1000, 2000, 3000

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 Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Johnson County, Texas
Survey Area Data: Version 15, Sep 14, 2018

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

Date(s) aerial images were photographed: Nov 27, 2014—Mar 19, 2017

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
BmE	Birome-Rayex complex, 5 to 20 percent slopes	C	50.9	4.3%
BuB	Burleson clay, 1 to 3 percent slopes	D	7.2	0.6%
CrB	Crosstell fine sandy loam, 1 to 3 percent slopes	D	85.8	7.3%
CrD	Crosstell fine sandy loam, 3 to 8 percent slopes	D	433.7	36.7%
FhC	Ferris-Heiden complex, 2 to 5 percent slopes	D	91.4	7.7%
GfB	Gasil fine sandy loam, 1 to 3 percent slopes	B	5.0	0.4%
GfC	Gasil fine sandy loam, 3 to 8 percent slopes	B	9.2	0.8%
HeB	Heiden clay, 1 to 3 percent slopes	D	216.3	18.3%
NaC	Navo clay loam, 2 to 5 percent slopes	D	11.9	1.0%
Pb	Pits, 0 to 45 percent slopes		49.6	4.2%
Pp	Pulexas fine sandy loam, frequently flooded	A	74.9	6.3%
SfB	Silstid loamy fine sand, 1 to 3 percent slopes	B	52.7	4.5%
SfD	Silstid loamy fine sand, 3 to 8 percent slopes	B	19.6	1.7%
Tn	Tinn clay, 0 to 1 percent slopes, frequently flooded	D	72.3	6.1%
W	Water	D	2.3	0.2%
Totals for Area of Interest			**1,182.6**	**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

where

CN_{II_o} = AMC-II curve number for mild slope (unadjusted for slope)

C_O = regression constant for a given level of vegetation

C_1 = regression constant for a given level of vegetation

C_2 = regression constant for a given level of vegetation

IR = infiltration correlation parameter for given soil type

The relationship between CN_{II_o}, the vegetative cover and default soil texture is shown graphically in Figure 8. Table 7 gives values of C_0, C_1 *and* C_2 for the five types of vegetative cover built into the HELP program.

4.2.3 Adjustment of Curve Number for Surface Slope

A regression equation was developed to adjust the AMC-II curve number for surface slope conditions. The regression was developed based on kinematic wave theory where

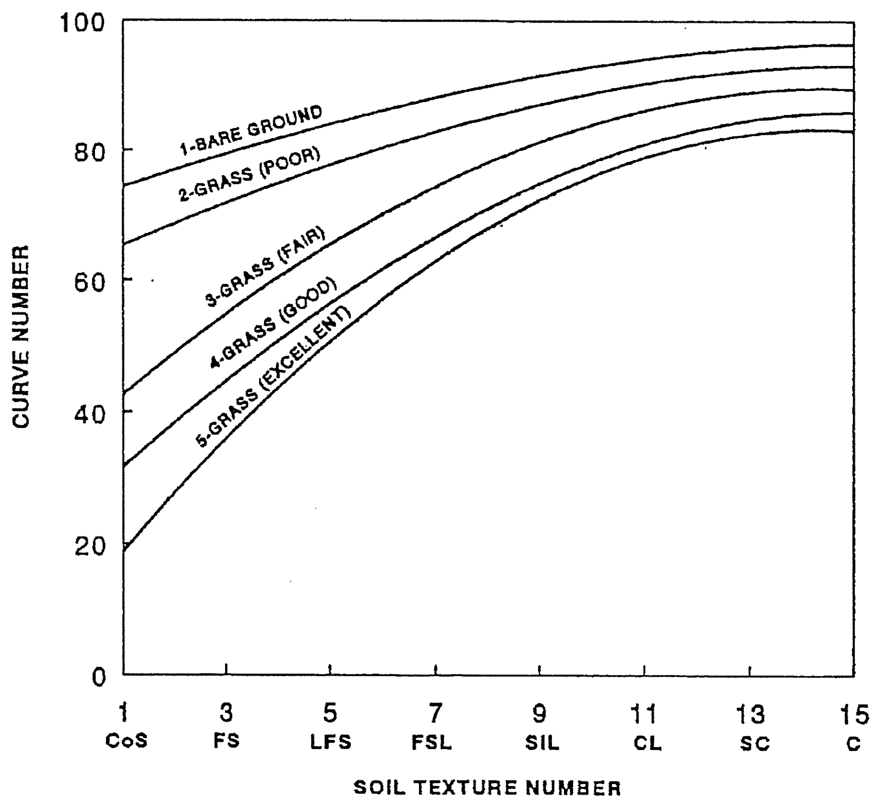


Figure 8. Relation between SCS Curve Number and Default Soil Texture Number for Various Levels of Vegetation

loam, and clayey loam as specified by saturated hydraulic conductivity, capillary drive, porosity, and maximum relative saturation, Two levels of vegetation were described--a good stand of grass (bluegrass sod) and a poor stand of grass (clipped range). Slopes of 0.04,0.10,0.20,0.35, and 0.50 ft/ft and slope lengths of 50, 100, 250, and 500 ft were used. Rainfalls of 1.1 inches, l-hour duration and 2nd quartile Huff distribution and of 3.8 inches, 6-hour duration and balanced distribution were modeled.

The resulting regression equation used for adjusting the AMC-II curve number computed for default soils and vegetation placed at mild slopes, CN_{II_o}, is:

$$CN_{II} = 100 - (100 - CN_{II_o}) \cdot \left(\frac{L^{*2}}{S^*} \right)^{CN_{II_o}^{-0.81}} \tag{34}$$

where

L^* = standardized dimensionless length, (L/500 ft)

S^* = standardized dimensionless slope, (S/0.04)

This same equation is used to adjust user-specified AMC-II curve numbers for surface slope conditions by substituting the user value for CN_{II_o} in Equation 34.

4.2.4 Adjustment of Curve Number for Frozen Soil

When the HELP program predicts frozen conditions to exist, the value of CN_{II} is increased, resulting in a higher calculated runoff. Knisel et al. (1985) found that this type of curve number adjustment in the CREAMS model resulted in improved predictions of annual runoff for several test watersheds. If the CN_{II} for unfrozen soil is less than or equal to 80, the CN_{II} for frozen soil conditions is set at 95. When the unfrozen soil CN_{II} is greater than 80, the CN_{II} is reset to be 98 on days when the program has determined the soil to be frozen. This adjustment results in an increase in CN_I and consequently a decrease in S_{mx} and S' (Equations 19, 26, and 30).

From Equations 19 and 21, it is apparent that as S' approaches zero, Q approaches P. In other words, as S' decreases, the calculated runoff becomes closer to being equal to the net rainfall which is most often, when frozen soil conditions exist, predominantly snowmelt. This will result in a decrease in infiltration under frozen soil conditions, which has been observed in numerous studies.

4.2.5 Summary of Daily Runoff Computation

The HELP model determines daily runoff by the following procedure:

TABLE 5.3 Values of SCS Curve Number for Rural Areas

Source: [McCuen, 1982]

Land Use Description	Hydrologic Soil Group A	B	C	D
Fallow:				
Straight Row	77	86	91	94
Row Crops:				
Straight Row, Poor Condition	72	81	88	91
Straight Row, Good Condition	67	78	85	89
Contoured, Poor Condition	70	79	84	88
Contoured, Good Condition	65	75	82	86
Contoured and Terraced, Poor Condition	66	74	80	82
Contoured and Terraced, Good Condition	62	71	78	81
Small Grain:				
Straight Row, Poor Condition	65	76	84	88
Straight Row, Good Condition	63	75	83	87
Contoured, Poor Condition	63	74	82	85
Contoured, Good Condition	61	73	81	84
Contoured and Terraced, Poor Condition	61	72	79	82
Contoured and Terraced, Good Condition	59	70	78	81
Close-Seeded Legumes or Rotation Meadow				
Straight Row, Poor Condition	66	77	85	89
Straight Row, Good Condition	58	72	81	85
Contoured, Poor Condition	64	75	83	85
Contoured, Good Condition	55	69	78	83
Contoured and Terraced, Poor Condition	63	73	80	83
Contoured and Terraced, Good Condition	51	67	76	80
Pasture or Range:				
Poor Condition	68	79	86	89
Fair Condition	49	69	79	84
Good Condition	39	61	74	80
Contoured, Poor Condition	47	67	81	88
Contoured, Fair Condition	25	59	75	83
Contoured, Good Condition	6	35	70	79
Meadow, Good Condition	30	58	71	78
Woods or Forest Land:				
Poor Condition	45	66	77	83
Fair Condition	36	60	73	79
Good Condition	25	55	70	77
Farmsteads:	59	74	82	86

Initial and Uniform Loss Rate

An initial loss in inches (*STRTL*) and a constant loss rate (*CNSTL*) in inches per hour are specified for this method. All rainfall is lost until the volume of initial loss is satisfied. After the initial loss is satisfied, rainfall is lost at the constant rate.

This section provides guidance in selecting the values used for the initial loss and uniform loss rate in two ways:

1. By consulting previous studies of actual rainfall events for a particular watershed or region.
2. By relating the parameters to the SCS Curve Number, which can be estimated using the information presented earlier in this chapter.

Previous studies by the U.S. Army Corps of Engineers or other public agencies may provide guidance on selecting appropriate values for the initial loss and uniform loss rate for a particular location. Tables 5.4 through 5.6 list the values of initial and

HYDROGRAPH DEVELOPMENT INFORATION

HYDROGRAPH DEVELOPMENT INFORMATION

Landfill Areas

Direct runoff methods, (i.e., kinematic wave) have been used for the majority of the landfill final cover areas. The kinematic wave method has been used to model the 4 percent topslope areas and 25 percent side slope areas before the flow is intercepted by the drainage swales. The kinematic wave method is a physically based method using slope, surface roughness, catchment lengths and areas. This method does not consider attenuation for flood wave; as a consequence, this method provides for a conservative analysis. The following typical parameters for the kinematic wave method have been developed for landfill areas.

Kinematic wave parameters for overland flow:

Slope: Varies from 0.04 to 0.25 ft/ft landfill slopes

N: 0.35 Manning's friction coefficient (based on using a value between dense grass (N = 0.24) and Bermuda grass (N = 0.41) listed in Soil Conservation Services TR-55)

L: Represents a typical distance between swales for overland flow for each drainage area. For example, as shown on Sheet IIIF-E-23, the swale spacing on 4H:1V sideslopes is 120 feet.

Percentage of drainage area represented by this element is 100 percent.

Kinematic Wave routing for channels:

- Channel length (ft): The length of the channel section.
- Channel slope (ft/ft): Varies from 0.0010 to 0.0574 (0.005 for swales).
- Channel roughness coefficient: 0.03 for grass lined channels and swales.
- Channel type: A trapezoidal channel was used with varying width and 3:1 side slopes ("V" ditch with varying side slopes for swales).

Non-Landfill Final Cover Areas

Hydrographs for the majority of non-landfill final cover areas within and near the permit boundary (e.g., pond areas) were developed using the Snyder unit hydrograph method. Espey "10-Minute" method has been used to estimate Snyder parameters. Snyder parameter estimations are provided on pages IIIF-E-18 through IIIF-E-23.

As discussed in Section 2 of Appendix IIIF, hydrographs for the areas outside of the permit boundary (O, O2, O3, O4, and O5), and larger areas inside the permit boundary (S1, S2, S3, S4, S5, S6, and S7) were developed using the Snyder unit hydrograph method. The percent imperviousness ranges from 2 percent to 12 percent, for the majority of the non-landfill no-site and off-site areas, which represents the majority of the watershed as undeveloped. Pond areas are assumed to be 100 percent impervious, and areas with significant channel surface or paved surfaces were assigned higher percentages of impervious area, as shown on IIIF-E-19.

Drainage Areas

The drainage areas used for this analysis are shown on Sheets IIIF-E-25 and IIIF-E-26. The routing scheme for the post-development condition is shown in the HEC-1 output file presented on pages IIIF-E-27 through IIIF-E-60.

DISTRIBUTED RUNOFF METHOD
KINEMATIC WAVE EXAMPLE

Drainage area "DA4" is used in this example (refer to Sheet IIIF-A-17 for location of drainage area).

Watershed Specific Parameters:

A =	36.24	acres	Watershed Area (acres)
A =	0.0566	sq-miles	Watershed Area (sq-miles)
CN=	86		SCS Curve Number (see sheet IIIF-A-4 for more information)

Kinematic Wave parameter for overland flow:

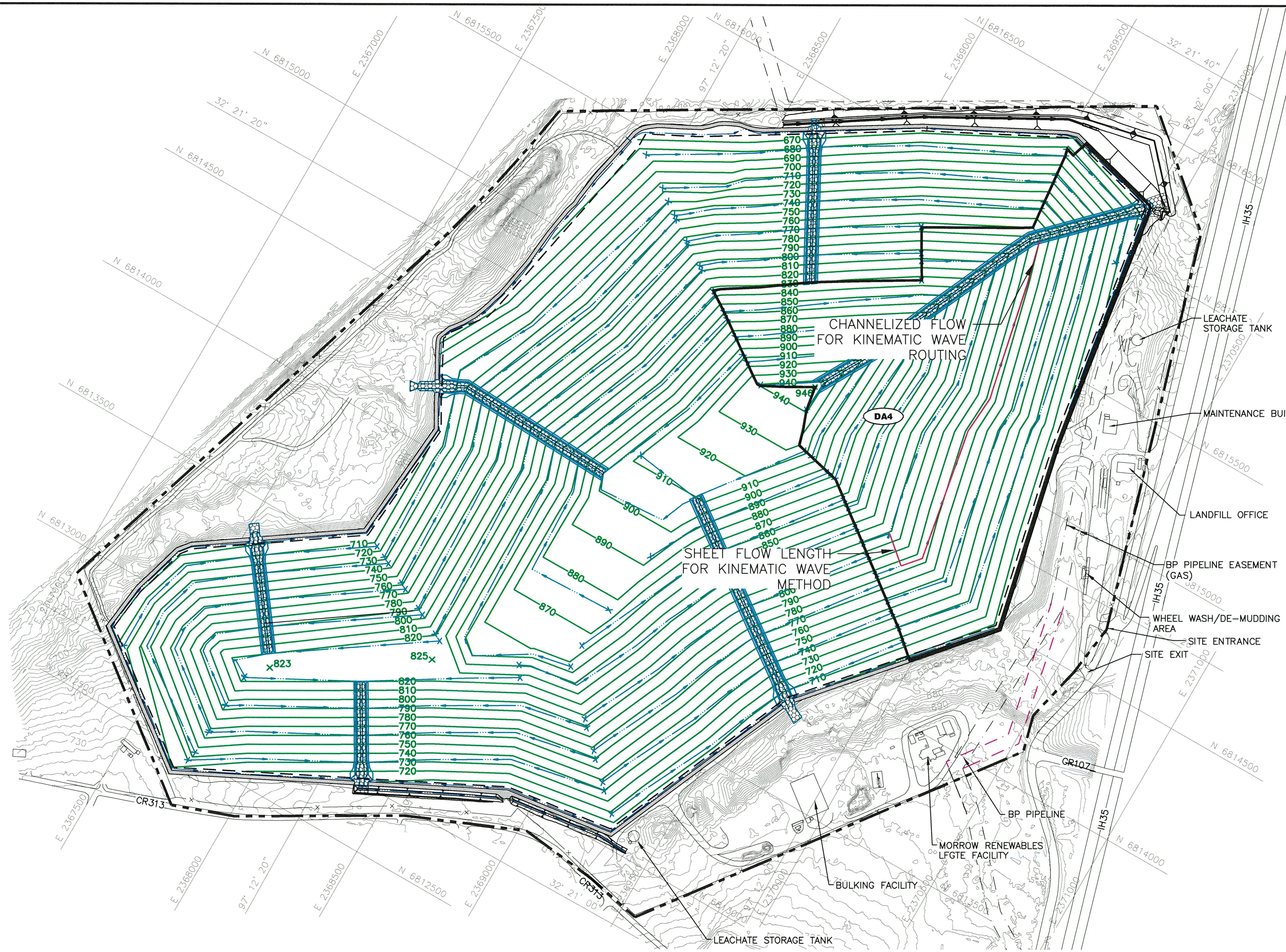
L=	135	ft	Typical overland flow (ft)
S=	0.29	ft/ft	Landfill slope (ft/ft)
N=	0.30		Manning's Coefficient

Percentage of the drainage area represented by this element is 100 percent

Kinematic Wave routing data for the swale:

L=	1520	ft	Typical swale length (ft)
S=	0.01	ft/ft	Swale bottom slope (ft/ft)
N=	0.03		Manning's Coefficient
Channel=	TRAP		Swale Type*

* A trapezoidal channel with no bottom width was used to simulate a triangular channel.



0 200 400
SCALE IN FEET

LEGEND

	PROPERTY BOUNDARY
	PERMITTED LIMITS OF WASTE
N 6816000	STATE PLANE GRID
32° 21' 20"	GEODETIC COORDINATE
730	EXISTING CONTOUR
810	PERMITTED FINAL COVER CONTOUR
	PERMITTED DRAINAGE CHUTE
	PERMITTED DRAINAGE SWALE
	DRAINAGE AREA BOUNDARY
DA4	DRAINAGE AREA DESIGNATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

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DATE: 02/2022
FILE: 0771-368-11
CAD: FIG IIIF-E-17 KINEMATIC WAVE.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

KINEMATIC WAVE PARAMETERS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF-E-17

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-E\IIIF-E-17_KINEMATIC WAVE PARAMETERS.dwg, rarrington, 1:2

ESPEY 10-MINUTE METHOD PARAMETERS

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
UNIT HYDROGRAPH DATA
PROPOSED EXPANSION CONDITION

Snyder's Hydrograph Coefficients (Espey's 10 Minute Method)

Proposed Expansion Conditions

Area No.	Area (acres)	Max. Flow Length (L) (ft)	S (ft/ft)	I (%)	Manning "n"	Φ[1]	T_r[2] (min)	T_{lag}[3] (min)	T_{lag} (hr)	Area[4] (sq mi)	q_p[5] (cfs/sq mi)	C_p[6]
O1	180.49	6,381	0.0110	10	0.04	0.84	36.1	33.6	0.56	0.2820	716.3	0.63
O2	74.63	4,784	0.0115	5	0.04	0.86	39.3	36.8	0.61	0.1166	678.5	0.65
O3	69.25	3,820	0.0147	10	0.04	0.84	29.8	27.3	0.46	0.1082	912.5	0.65
O4	61.05	2,617	0.0172	5	0.04	0.86	30.9	28.4	0.47	0.0954	883.6	0.65
O5	6.34	1,135	0.0282	2	0.04	0.87	27.1	24.6	0.41	0.0099	1115.0	0.71
S1	13.82	2,309	0.0225	25	0.04	0.79	18.4	15.9	0.26	0.0216	1634.4	0.68
S2	1.74	100	0.0950	2	0.04	0.87	11.4	8.9	0.15	0.0027	2954.4	0.69
S3	6.40	1,184	0.0355	5	0.04	0.86	21.5	19.0	0.32	0.0100	1426.7	0.71
S4	1.93	684	0.0190	5	0.04	0.86	22.1	19.6	0.33	0.0030	1449.8	0.74
S5	21.38	2,043	0.0225	15	0.04	0.82	20.8	18.3	0.30	0.0334	1409.0	0.67
S6	3.78	1,466	0.0164	2	0.04	0.87	32.9	30.4	0.51	0.0059	924.1	0.73
S7	4.10	630	0.0413	2	0.04	0.87	21.5	19.0	0.32	0.0064	1452.1	0.72

[1] Conveyance efficiency coefficient from Dodson & Associates Inc., *ProHec-1 Program Documentation*, 1995, pages 6-19 and 6-20.
[2] $T_r = 3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(\Phi^{1.57})$
[3] $T_{lag} = T_r - \Delta t/2$
[4] From area summary sheet
[5] $q_p = 31600(A^{-0.04})(T_r^{-1.07})$
[6] $C_p = 49.375(A^{-0.04})(T_r^{-1.07})(T_{lag})$

T_r = surface runoff to unit hydrograph peak (min)
L = distance along main channel from study point to watershed boundary (ft)
S = main channel slope (ft/ft)
I = impervious cover within the watershed (%)
T_{lag} = watershed lag time (min)
Δt= computation interval (minutes)
q_p = unit hydrograph peak discharge (cfs/sq mi)
C_p = Snyder's peaking coefficient

Snyder Unit Hydrograph uses lag time (T_{lag}) and peaking coefficient accounting for flood wave and watershed storage conditions.

Drainage area "S1" is used in this example.

Estimated Watershed specific parameters

A =	13.82	acres	watershed area
L =	2309	feet	maximun flow length with this watershed
S =	0.0225	feet/feet	watershed slope
I =	25	percent (%)	watershed imperviousness
n =	0.04		Manning's coefficient

Calculate Tr: time beginning of surface runoff to the unit hydrograph peak in minutes

$T_r = 3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(\Phi^{1.57})$

Estimate : conveyance efficiency coefficient
See figure 6.12 on page IIIF-A-18 for estimating
Φ = for 0.6 percent impervious cover and n = 0.01

$\Phi = 0.79$

$T_r = 3.1(2309^{0.23})(0.0225^{-0.25})(0.25^{-0.18})(0.79^{.57})$

$T_r = 18.4$ min

Calculate T_{lag}: watershed lag time

$T_{lag} = Tr - (\Delta t/2)$ — Δt is calculation interval, and 10 minutes is used in the HEC - HMS modeling in this project

$T_{lag} = 15.9$ minutes

$T_{lag} = 0.26$ hours

A= A/640

A= 0.0216 square miles

Calculate q_p: peak discharge of unit hydrograph per unit area (cfs/sq. mi).

$q_p = 31600(A^{-0.04})(T_r^{-1.07})$

$q_p = 31600(0.0216^{-0.04})(18.4^{-1.07})$

$q_p = 1634.4$ cfs/sq. mi

Calculate Peaking coefficient C_p:

$C_p = 49.375(A^{-0.04})(T_r^{-1.07})(T_{lag})$

$C_p = 49.375(0.0351^{-0.04})(29.6^{-1.07})(0.45)$

$C_p = 0.68$

compute the value of Snyder's peaking coefficient C_p for use in HEC-1 analyses. First, the watershed lag time T_L is determined by subtracting one-half of the computation interval from the time to rise ($T_L = T_r - \Delta t/2$). Then, C_p may be computed by substituting the known values of T_L and q_p into Snyder's equation for peak unit hydrograph flow rate and solving for C_p.

$$C_p = \frac{q_p \times T_L}{640} \qquad 6.30$$

Espey "10-Minute" Method for Estimating Snyder Parameters

In another study, Espey [1977] derived the following equation for computing the time from the beginning of surface runoff to the unit hydrograph peak:

$$T_r = 3.10\, L^{0.23} S^{-0.25} I^{-0.18} \Phi^{1.57} \qquad 6.31$$

in which:

T_r = time from beginning of surface runoff to unit hydrograph peak (minutes)

L = total distance along main channel from study point to watershed boundary (feet)

S = main channel slope between the reference point and a point 0.2L downstream from the upstream watershed boundary (feet per foot)

I = impervious cover within the watershed (percent)

Φ = description of conveyance efficiency of the watershed drainage system.

The conveyance efficiency coefficient Φ is determined using the relationships illustrated on Figure 6.12.

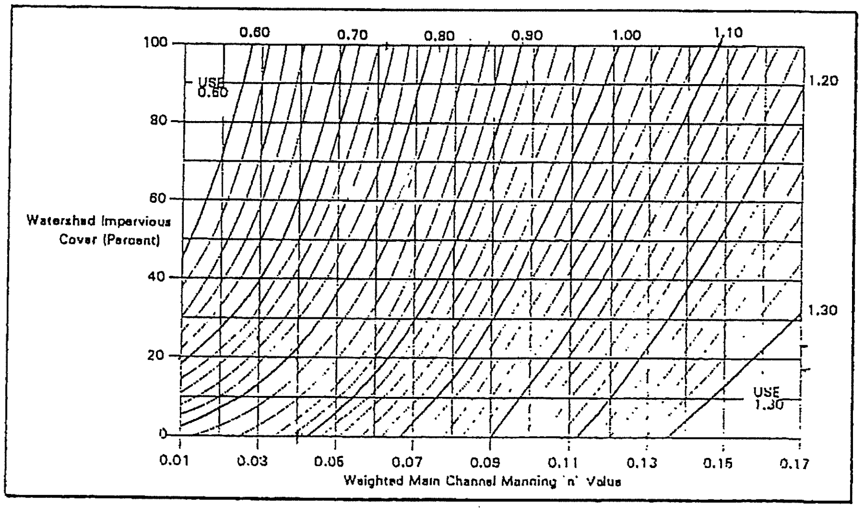


FIGURE 6.12 Determination of Conveyance Efficiency Coefficient Φ

This equation was derived from records for 41 watersheds in Texas, Tennessee, Mississippi, Pennsylvania, North Carolina, Colorado, Kentucky, and Indiana. The range in the watershed characteristics used to develop the equations for urban areas were:

Area : From 0.0128 square miles to 15.00 square miles

L : From 555 feet to 35,600 feet

S : From 0.0005 ft. per ft. to 0.0295 ft. per ft.

I: From 2% to 100%

Φ : From 0.60 to 1.30

Again, note that the time to rise T_r is not the same as the watershed lag time T_p. The difference between the two is that T_r is defined as the time from the beginning of effective rainfall to the peak of the unit hydrograph, while T_L is the time from the centroid of the effective rainfall to the peak of the unit hydrograph. For the purposes of HEC-1 analyses, however, T_L may be determined simply by subtracting one-half the computation time interval from the computed value of T_r (T_R - $\Delta t/2$).

The relationship developed by Espey to compute the peak flow rate of the unit hydrograph is as follows:

6.32 $$Q_u = 31600 \ A^{0.96} T_r^{-1.07}$$

in which:

Q_u = unit hydrograph peak discharge (cfs)

A = drainage area (square miles)

T_r = time of rise from beginning of surface runoff to unit hydrograph peak (minutes)

Riverside County Method for Estimating Snyder Parameters

Three watershed lag equations have been derived for use in rural areas of Riverside County, California by the Riverside County Flood Control and Water Conservation District [Anonymous, 1963]. These equations differ slightly from those developed at the Tulsa District of the U.S. Army Corps of Engineers in that lag is defined as the time from the beginning of rainfall to the point on the unit hydrograph corresponding to one-half of the total runoff volume.

Each equation is applicable to a different topographic region:

6.33 $$T_L = 1.20\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Mountain Areas)

6.34 $$T_L = 0.72\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Foothill Areas)

6.35 $$T_L = 0.38\left(\frac{L \times L_{ca}}{\sqrt{S}}\right)^{0.38}$$ (Valley Areas)

in which:

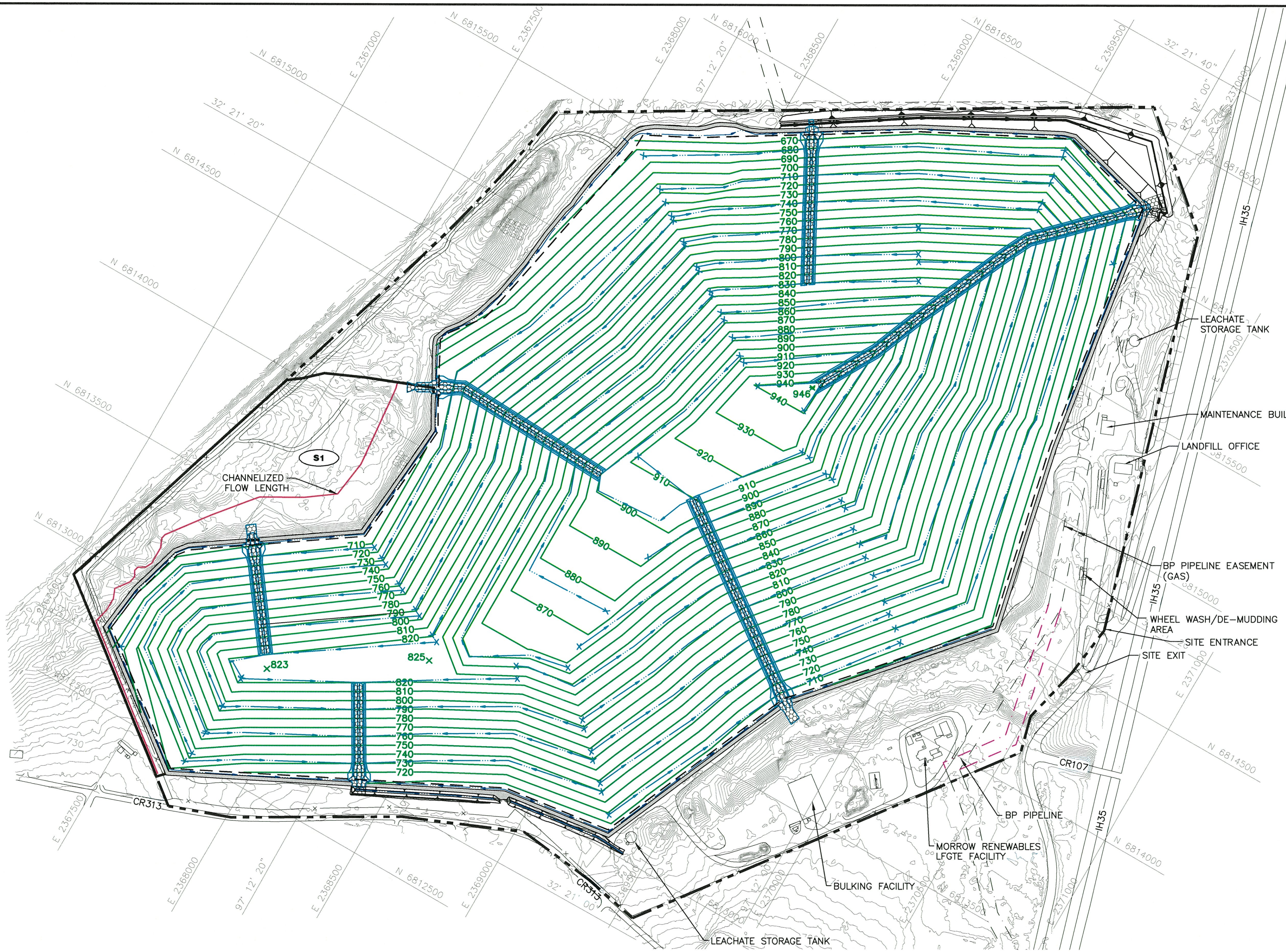
T_L = watershed lag in hours

L = watershed length in miles

L_{ca} = length to centroid in miles

S = watershed slope in feet per mile.

The sizes of the watersheds studied in developing these equations ranged from 2.3 square miles to 645 square miles.



LEGEND

	PROPERTY BOUNDARY
	PERMITTED LIMITS OF WASTE
N 6816000	STATE PLANE GRID
32° 21' 20"	GEODETIC COORDINATE
730	EXISTING CONTOUR
810	PERMITTED FINAL COVER CONTOUR
	PERMITTED DRAINAGE CHUTE
	PERMITTED DRAINAGE SWALE
	DRAINAGE AREA BOUNDARY
S1	DRAINAGE AREA DESIGNATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.

STATE OF TEXAS
CHARLES R. MARSH
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2-22-22

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DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

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EPSEY "10-MINUTE" METHOD PARAMETERS

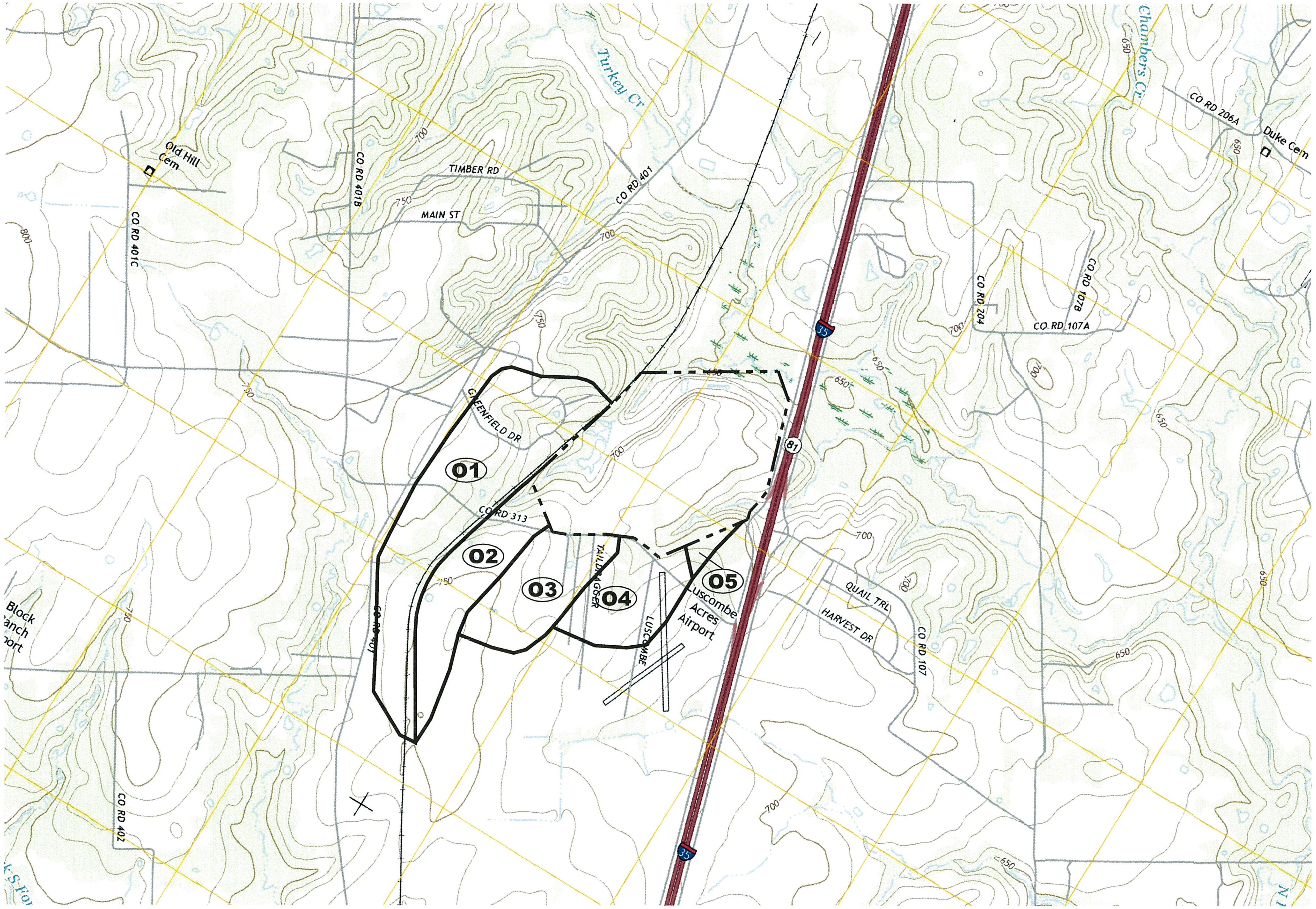
TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-E-23

O:\0771\368\EXPANSION 2021\PART III\IIIF-E\IIIF-E-23_ EPSEY METHOD.dwg, rfarrington, 1:2

PERMITTED LANDFILL HEC-1 ANALYSIS
DRAINAGE AREAS



SCALE IN FEET: 0, 1000, 2000

LEGEND

- PERMIT BOUNDARY
- DRAINAGE AREA BOUNDARY
- (02) DRAINAGE AREA LABEL

DRAINAGE AREA NO.	AREA (ACRES)
01	180.5
02	74.6
03	69.2
04	61.0
05	6.3
TOTAL	391.6

ROAD CLASSIFICATION

Expressway, Secondary Hwy, Ramp, Local Connector, Local Road, 4WD, Interstate Route, US Route, State Route

ALVARADO, TX 2016

GRANDVIEW, TX 2016

NOTES:

1. DRAINAGE AREA DELINEATION WITHIN THE PERMIT BOUNDARY IS INCLUDED ON DRAWING IIIF–E–26.
2. ALL TOPOGRAPHIC INFORMATION REPRODUCED FROM UNITED STATES GEOLOGICAL SURVEY 7 1/2 MINUTE QUADRANGLE SHEETS COMMERCE ALVARADO, TX; GRANDVIEW, TX.

STATE OF TEXAS — CHARLES R. MARSH — 105073 — LICENSED PROFESSIONAL ENGINEER

2.22.22

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DATE: 02/2022
FILE: 0771–368–11
CAD: IIIF–E–25–OFFSIDE DRAINAGE MAP.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
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MAJOR PERMIT AMENDMENT
OFFSITE DRAINAGE AREA MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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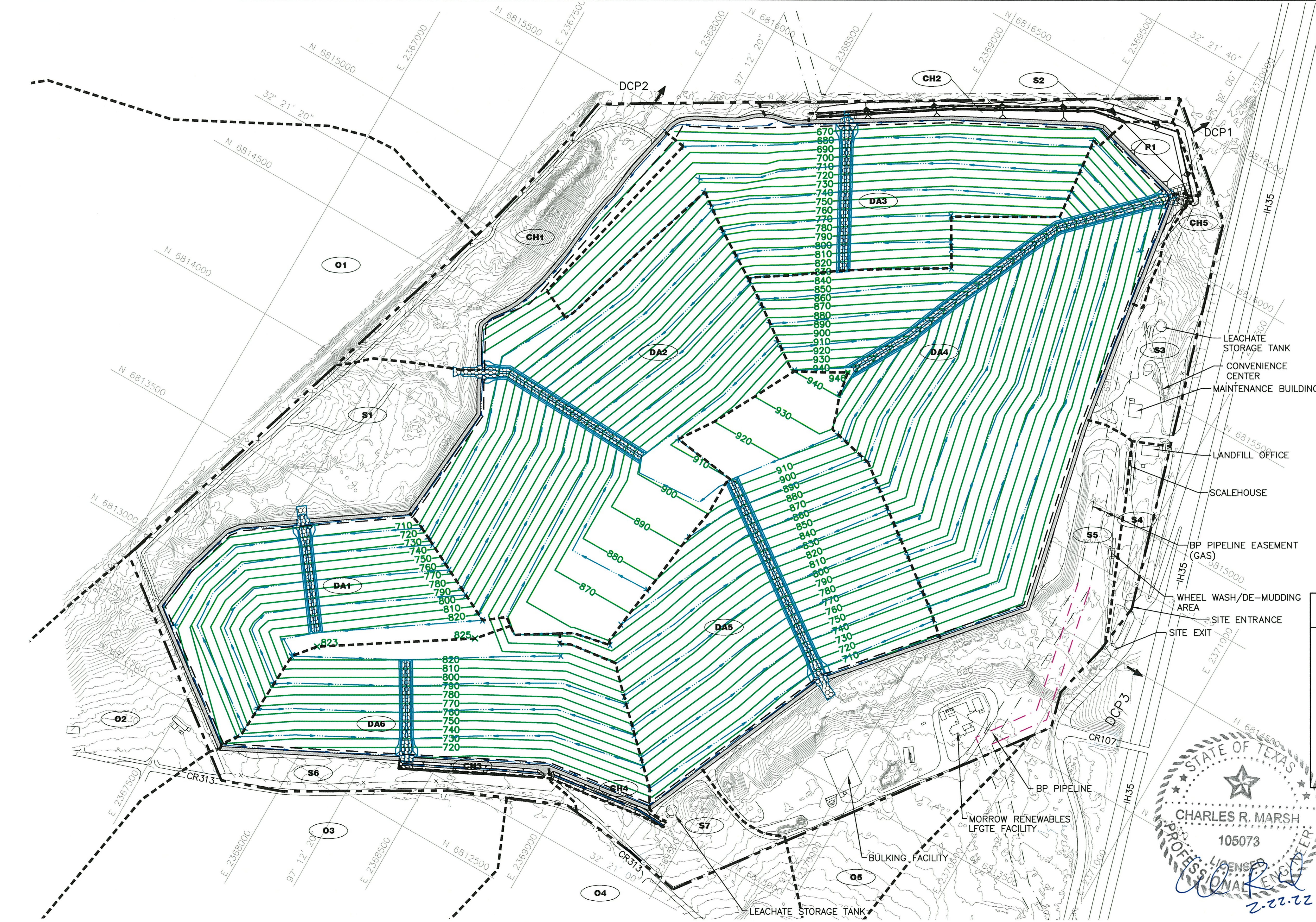
DRAWING IIIF–E–25



0 200 400
SCALE IN FEET

LEGEND

- PROPERTY BOUNDARY
- PERMITTED LIMITS OF WASTE
- DRAINAGE DIVIDE
- 730 EXISTING CONTOUR
- 800 PERMITTED FINAL COVER CONTOUR
- N 6816000 STATE PLANE GRID
- 32° 21' 20" GEODETIC COORDINATE
- DRAINAGE LETDOWN
- DRAINAGE SWALE
- DA2 DRAINAGE AREA DESIGNATION

NOTE:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO DRAWING IIIF-E-25 FOR COMPLETE OFFSITE DRAINAGE AREA DELINEATIONS.

DRAINAGE AREA NO.	AREA (ACRES)	DRAINAGE AREA NO.	AREA (ACRES)
DA1	14.85	CH1	10.30
DA2	35.46	CH2	1.47
DA3	21.31	CH3	0.51
DA4	36.22	CH4	0.45
DA5	27.65	CH5	0.45
DA6	16.51	S1	13.82
O1	180.49	S2	1.74
O2	74.63	S3	6.40
O3	69.25	S4	1.93
O4	61.05	S5	21.38
O5	6.31	S6	3.78
P1	1.34	S7	4.10

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DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-E-26-POST DEVOLPMENT DRAINAGE.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

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TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
PERMITTED LANDFILL DRAINAGE

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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DRAWING IIIF-E-26

HEC-1 OUTPUT – PERMITTED LANDFILL
25-YEAR, 24-HOUR STORM EVENT

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *   U.S. ARMY CORPS OF ENGINEERS      *
 *            JUN   1998                 *                                                   *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                 *                                                   *         609 SECOND STREET           *
 *                                       *                                                   *      DAVIS, CALIFORNIA 95616        *
 * RUN DATE   10JUL19  TIME  15:00:29    *                                                   *          (916) 756-1104             *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************


                                          X     X  XXXXXXX   XXXXX         X
                                          X     X  X        X     X       XX
                                          X     X  X        X              X
                                          XXXXXXX  XXXX     X       XXXXX  X
                                          X     X  X        X              X
                                          X     X  X        X     X        X
                                          X     X  XXXXXXX   XXXXX        XXX


            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                  HEC-1 INPUT                                                   PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                        *DIAGRAM
             1          ID  IESI TURKEY CREEK LANDFILL
             2          ID  25-YEAR 24-HOUR STORM EVENT
             3          ID  PROPOSED SITE CONDITION
             4          ID  P:\SW\IESI\TURKEY CREEK\EXPANSION_VERTICAL\SDP\APP IIIF\IIIF-A\HEC-1\TCPROPOSE
             5          IT       5       0    2400     432       0       0
             6          IO       3       0       0
                        *

             7          KK      O1
             8          KM  SUBAREA O1
             9          KO       0       0       0       7      21
            10          BA   0.282
            11          PH                    0.85    1.69    3.07    3.88    4.38     5.3    6.27    7.33
            12          LS       0      84
            13          US    0.56    0.63
                        *

            14          KK    CLVT
            15          KM  CULVERT AT O1 DISCHARGE
            16          KO       0       0       0       7      21
            17          RS       1    ELEV     680
            18          SA       0  0.0055  0.0211  0.0402   0.065   0.101    6.53
            19          SE     680     682     684     686     688     690     708
            20          SL   682.5   19.63     0.7     0.5
            21          SS     707     500     2.6     1.5
                        *

            22          KK      O2
            23          KM  SUBAREA O2
            24          KO       0       0       0       7      21
            25          BA  0.1166
            26          LS       0      84
            27          US    0.61    0.65
                        *

            28          KK     DA1
            29          KM  DRAINAGE AREA DA1
            30          KO       0       0       0       7      21
            31          BA  0.0232
            32          LS       0      86
            33          UK      86    0.29     0.3     100
            34          RD     953   0.005    0.03  0.0022    TRAP       0       2      NO
                        *

            35          KK   C/DA1
            36          KM  COMBINE UPSTREAM HYDROGRAPHS
            37          KO       0       0       0       7      21
            38          HC       2
                        *
1                                                  HEC-1 INPUT                                                   PAGE  2

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            39          KK     DA2
            40          KM  DRAINAGE AREA DA2
            41          KO       0       0       0       7      21
            42          BA  0.0554
            43          LS       0      86
            44          UK     383    0.06     0.3     100
            45          RD     955   0.005    0.03  0.0032    TRAP       0       2      NO
                        *

            46          KK      S1
            47          KM  SUBAREA S1
```

```
KO       0       0       0       7      21
BA  0.0216
LS       0      84
US    0.26    0.68
*

KK    C/S1
KM  COMBINE UPSTREAM HYDROGRAPHS
KO       0       0       0       7      21
HC       4
*

KK   NORTH
KM  REROUTE THROUGH SUBAREA CH1
KO       0       0       0       7      21
BA  0.0161
LS       0      84
UK     173  0.0867     0.3     100
RD    1145  0.0177     0.3            TRAP       0       5     YES
*

KK     DA3
KM  DRAINAGE AREA DA3
KO       0       0       0       7      21
BA  0.0333
LS       0      86
UK     105    0.29     0.3     100
RD    1431   0.005    0.03  0.0071    TRAP       0       2      NO
*

KK     CH2
KM  SUBAREA CH2
KO       0       0       0       7      21
BA  0.0023
LS       0      84
UK      29     0.4     0.3     100
RD    1238    0.01    0.03            TRAP       6       2     YES
*
1                                        HEC-1 INPUT                                                      PAGE  3

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK     DA4
KM  DRAINAGE AREA DA4
KO       0       0       0       7      21
BA  0.0566
LS       0      86
UK     105    0.29     0.3     100
RD    1266   0.005    0.03            TRAP       0       2      NO
*

KK     CH5
KM  CHANNEL CH5
KO       0       0       0       7      21
BA  0.0007
LS       0      84
UK     137   0.175     0.3     100
RD     505  0.0625    0.03            TRAP       0       3      NO
*

KK      P1
KM  POND P1
KO       0       0       0       7      21
BA  0.0021
LS       0     100
UD       0
*

KK    C/P1
KM  COMBINE HYDROGRAPHS
KO       0       0       0       7      21
HC       4
*

KK     RP1
KM  ROUTE THROUGH P1
KO       0       0       0       7      21
RS       1    ELEV   643.5
SA       0  0.3339  0.3903  0.4978  0.6141  0.7406  0.7953  0.8818  0.9494
SE   643.5   643.6     645   647.5     650   652.5   653.5     655   656.5
SL     645    7.07     0.8     0.5
SS   653.5      10     2.6     1.5
*

KK      S2
KM  SUBAREA S2
KO       0       0       0       7      21
BA  0.0027
LS       0      84
US    0.15    0.69
*
1                                        HEC-1 INPUT                                                      PAGE  4

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK      S3
KM  SUBAREA S3
KO       0       0       0       7      21
BA    0.01
LS       0      84
US    0.32    0.71
*
```

```
   121          KK    C/NENORTHEAST
   122          KM  DISCHARGE AT NE
   123          KO       0       0       0       7      21
   124          HC       3
                *

   125          KK      O3
   126          KM  SUBAREA O3
   127          KO       0       0       0       7      21
   128          BA  0.1082
   129          LS       0      84
   130          US    0.46    0.65
                *

   131          KK      S6
   132          KM  SUBAREA S6
   133          KO       0       0       0       7      21
   134          BA  0.0059
   135          LS       0      84
   136          US    0.51    0.73
                *

   137          KK    C/S6
   138          KM  COMBINE OFFSITE HYDROGRAPHS ENTERING S6
   139          KO       0       0       0       7      21
   140          HC       2
                *

   141          KK      O4
   142          KM  SUBAREA O4
   143          KO       0       0       0       7      21
   144          BA  0.0954
   145          LS       0      84
   146          US    0.47    0.65
                *

   147          KK      S7
   148          KM  SUBAREA S7
   149          KO       0       0       0       7      21
   150          BA  0.0064
   151          LS       0      84
   152          US    0.32    0.72
                *
1                                         HEC-1 INPUT                                       PAGE  5

  LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   153          KK     DA6
   154          KM  DRAINAGE AREA DA6
   155          KO       0       0       0       7      21
   156          BA   0.026
   157          LS       0      86
   158          UK     105    0.29     0.3     100
   159          RD     877   0.005    0.03  0.0037    TRAP       0       2      NO
                *

   160          KK     CH3
   161          KM  CHANNEL CH3
   162          KO       0       0       0       7      21
   163          BA  0.0008
   164          LS       0      84
   165          UK      45   0.116     0.3     100
   166          RD     545    0.01    0.03            TRAP       8       3     YES
                *

   167          KK     CH4
   168          KM  CHANNEL CH4
   169          KO       0       0       0       7      21
   170          BA  0.0007
   171          LS       0      84
   172          UK      54  0.0957     0.3     100
   173          RD     484    0.01    0.03            TRAP       8       3     YES
                *

   174          KK    C/S7
   175          KM  COMBINE HYDROGRAPHS AT S7
   176          KO       0       0       0       7      21
   177          HC       4
                *

   178          KK   CLVRT
   179          KM  CULVERT AT S6/S5
   180          KO       0       0       0       7      21
   181          RS       1  680.74
   182          SA       0   0.009   0.049  0.0805   0.134   0.334   0.693
   183          SE  680.74     682     684     686     690     694     698
   184          SL   682.9      45     0.7     0.5
   185          SS   697.9       9     2.6     1.5
                *

   186          KK     DA5
   187          KM  DRAINAGE AREA DA5
   188          KO       0       0       0       7      21
   189          BA  0.0432
   190          LS       0      86
   191          UK     120    0.25     0.3     100
   192          RD     835   0.005    0.03  0.0033    TRAP       0       2      NO
                *
1                                         HEC-1 INPUT                                       PAGE  6

  LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
            193           KK      S4
            194           KM  SUBAREA S4
            195           KO       0       0       0       7      21
            196           BA  0.003
            197           LS       0      84
            198           US    0.33    0.74
                          *

            199           KK      S5
            200           KM  SUBAREA S5
            201           KO       0       0       0       7      21
            202           BA  0.0334
            203           LS       0      84
            204           US     0.3    0.67
                          *

            205           KK      O5
            206           KM  SUBAREA O5
            207           KO       0       0       0       7      21
            208           BA  0.0099
            209           LS       0      84
            210           US    0.41    0.71
                          *

            211           KK    C/SESOUTHEAST
            212           KM  COMBINE HYDROGRAPHS AT SE
            213           KO       0       0       0       7      21
            214           HC       5
                          *
            215           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING            (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR          (<---) RETURN OF DIVERTED OR PUMPED FLOW

     7          O1
                 V
                 V
    14        CLVT
                 .
                 .
    22           .          O2
                 .           .
                 .           .
    28           .           .         DA1
                 .           .           .
                 .           .           .
    35           .        C/DA1............
                 .           .
                 .           .
    39           .           .         DA2
                 .           .           .
                 .           .           .
    46           .           .           .           S1
                 .           .           .            .
                 .           .           .            .
    52        C/S1....................................
                 V
                 V
    56       NORTH ***
                 .
                 .
    63           .         DA3
                 .           V
                 .           V
    70           .         CH2 ***
                 .           .
                 .           .
    77           .           .         DA4
                 .           .           .
                 .           .           .
    84           .           .           .         CH5
                 .           .           .            .
                 .           .           .            .
    91           .           .           .            .          P1
                 .           .           .            .           .
                 .           .           .            .           .
    97           .        C/P1....................................
                 .           V
                 .           V
   101           .         RP1
                 .           .
                 .           .
   109           .           .          S2
                 .           .           .
                 .           .           .
   115           .           .           .           S3
                 .           .           .            .
                 .           .           .            .
   121           .        C/NE........................
                 .           .
                 .           .
   125           .           .          O3
                 .           .           .
                 .           .           .
   131           .           .           .           S6
                 .           .           .            .
                 .           .           .            .
   137           .           .        C/S6............
                 .           .           .
                 .           .           .
```

```
 141          .          .          .        O4
              .          .          .         .
              .          .          .         .
 147          .          .          .         .          S7
              .          .          .         .           .
              .          .          .         .           .
 153          .          .          .         .           .          DA6
              .          .          .         .           .           V
              .          .          .         .           .           V
 160          .          .          .         .           .          CH3 ***
              .          .          .         .           .           V
              .          .          .         .           .           V
 167          .          .          .         .           .          CH4 ***
              .          .          .         .           .           .
              .          .          .         .           .           .
 174          .          .        C/S7.................................
              .          .          V
              .          .          V
 178          .          .        CLVRT
              .          .          .
              .          .          .
 186          .          .          .        DA5
              .          .          .         .
              .          .          .         .
 193          .          .          .         .          S4
              .          .          .         .           .
              .          .          .         .           .
 199          .          .          .         .           .           S5
              .          .          .         .           .           .
              .          .          .         .           .           .
 205          .          .          .         .           .           .          O5
              .          .          .         .           .           .           .
              .          .          .         .           .           .           .
 211          .          .        C/SE.........................................

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                    ***************************************
*                                        *                                                    *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                                    *   U.S. ARMY CORPS OF ENGINEERS      *
*             JUN   1998                 *                                                    *   HYDROLOGIC ENGINEERING CENTER     *
*           VERSION 4.1                  *                                                    *        609 SECOND STREET            *
*                                        *                                                    *     DAVIS, CALIFORNIA 95616         *
*  RUN DATE   10JUL19  TIME  15:00:29    *                                                    *         (916) 756-1104              *
*                                        *                                                    *                                     *
******************************************                                                    ***************************************


                      IESI TURKEY CREEK LANDFILL
                      25-YEAR 24-HOUR STORM EVENT
                      PROPOSED SITE CONDITION
                      P:\SW\IESI\TURKEY CREEK\EXPANSION_VERTICAL\SDP\APP IIIF\IIIF-A\HEC-1\TCPROPOSE

   6 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        432  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      3    0  ENDING DATE
                     NDTIME       1155  ENDING TIME
                      ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   35.92 HOURS

         ENGLISH UNITS
              DRAINAGE AREA          SQUARE MILES
              PRECIPITATION DEPTH    INCHES
              LENGTH, ELEVATION      FEET
              FLOW                   CUBIC FEET PER SECOND
              STORAGE VOLUME         ACRE-FEET
              SURFACE AREA           ACRES
              TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
   7 KK    *       O1   *
           *            *
           **************
                      SUBAREA O1

   9 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                       IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS
```

```
             SUBBASIN RUNOFF DATA

 10 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .28  SUBBASIN AREA

                PRECIPITATION DATA

 11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......     ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                                  STORM AREA =      .28

 12 LS          SCS LOSS RATE
                      STRTL         .38  INITIAL ABSTRACTION
                     CRVNBR       84.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 13 US          SNYDER UNITGRAPH
                         TP         .56  LAG
                         CP         .63  PEAKING COEFFICIENT

                SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                ***

                                                    UNIT HYDROGRAPH PARAMETERS
                                              CLARK   TC=   .64 HR,        R=   .51 HR
                                             SNYDER   TP=   .56 HR,       CP=   .64

                                                          UNIT HYDROGRAPH
                                                    37 END-OF-PERIOD ORDINATES
              11.        41.        81.       126.       167.       195.       208.       200.       176.       149.
             126.       107.        91.        77.        65.        55.        47.        40.        34.        29.
              24.        21.        17.        15.        13.        11.         9.         8.         7.         6.
               5.         4.         3.         3.         2.         2.         2.

      ***             ***             ***              ***              ***

                            HYDROGRAPH AT STATION        O1

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR        72-HR      35.92-HR
+   (CFS)        (HR)
                             (CFS)
+      466.     12.58                  132.          41.          27.          27.
                          (INCHES)    4.339        5.427        5.427        5.427
                           (AC-FT)      65.          82.          82.          82.

                       CUMULATIVE AREA =      .28 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 14 KK      *     CLVT   *
            *            *
            **************
                         CULVERT AT O1 DISCHARGE

 16 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                       IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS


             HYDROGRAPH ROUTING DATA

 17 RS          STORAGE ROUTING
                      NSTPS           1  NUMBER OF SUBREACHES
                       ITYP        ELEV  TYPE OF INITIAL CONDITION
                     RSVRIC      680.00  INITIAL CONDITION
                          X         .00 WORKING R AND D COEFFICIENT

 18 SA               AREA          .0         .0         .0         .0         .1         .1        6.5

 19 SE          ELEVATION      680.00     682.00     684.00     686.00     688.00     690.00     708.00

 20 SL          LOW-LEVEL OUTLET
                      ELEVL      682.50  ELEVATION AT CENTER OF OUTLET
                      CAREA       19.63  CROSS-SECTIONAL AREA
                       COQL         .70  COEFFICIENT
                       EXPL         .50  EXPONENT OF HEAD

 21 SS          SPILLWAY
                       CREL      707.00  SPILLWAY CREST ELEVATION
                      SPWID      500.00  SPILLWAY WIDTH
                       COQW        2.60  WEIR COEFFICIENT
                       EXPW        1.50  EXPONENT OF HEAD

                                                                ***
```

```
                                    COMPUTED STORAGE-ELEVATION DATA

      STORAGE        .00       .00       .03       .09       .19       .36     45.02
    ELEVATION     680.00    682.00    684.00    686.00    688.00    690.00    708.00

                                    COMPUTED OUTFLOW-ELEVATION DATA

      OUTFLOW        .00       .00    175.72    194.56    217.93    247.67    286.82    340.67    419.40    545.48
    ELEVATION     680.00    682.50    685.04    685.62    686.41    687.55    689.27    692.06    696.98    707.00

      OUTFLOW     547.11    557.08    583.02    632.66    713.59    833.50   1000.07   1221.06   1503.95   1856.50
    ELEVATION     707.01    707.04    707.09    707.16    707.25    707.36    707.49    707.64    707.81    708.00


                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

      STORAGE        .00       .00       .01       .03       .06       .07       .09       .11       .17       .19
      OUTFLOW        .00       .00       .00    134.97    175.72    194.56    206.17    217.93    247.67    258.45
    ELEVATION     680.00    682.00    682.50    684.00    685.04    685.62    686.00    686.41    687.55    688.00

      STORAGE        .29       .36       .78      4.74     38.80     38.86     39.05     39.35     39.77     40.31
      OUTFLOW     286.82    301.80    340.67    419.40    545.48    547.11    557.08    583.02    632.66    713.59
    ELEVATION     689.27    690.00    692.06    696.98    707.00    707.01    707.04    707.09    707.16    707.25

      STORAGE      40.98     41.78     42.72     43.79     45.02
      OUTFLOW     833.50   1000.07   1221.06   1503.95   1856.50
    ELEVATION     707.36    707.49    707.64    707.81    708.00

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO      287.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION    CLVT

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR         24-HR        72-HR       35.92-HR
+   (CFS)       (HR)
                             (CFS)
+     391.     12.83                   132.          41.          27.          27.
                          (INCHES)    4.339        5.427        5.427        5.427
                           (AC-FT)      65.          82.          82.          82.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                      6-HR         24-HR        72-HR       35.92-HR
+  (AC-FT)      (HR)
        3.     12.83                     0.           0.           0.           0.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                      6-HR         24-HR        72-HR       35.92-HR
+   (FEET)      (HR)
    695.19     12.83                 685.36       683.31       682.67       682.67

                       CUMULATIVE AREA =      .28 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   22 KK    *      O2    *
            *            *
            **************
                      SUBAREA O2

   24 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

   25 BA         SUBBASIN CHARACTERISTICS
                       TAREA         .12  SUBBASIN AREA

                 PRECIPITATION DATA

   11 PH                             DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                              STORM AREA =      .12

   26 LS         SCS LOSS RATE
                       STRTL         .38  INITIAL ABSTRACTION
                      CRVNBR       84.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

   27 US         SNYDER UNITGRAPH
                          TP         .61  LAG
                          CP         .65  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED
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                                                                              ***

                                                                    UNIT HYDROGRAPH PARAMETERS
                                                              CLARK   TC=   .71 HR,        R=   .52 HR
                                                             SNYDER   TP=   .61 HR,       CP=   .65

                                                                         UNIT HYDROGRAPH
                                                                    38 END-OF-PERIOD ORDINATES
                 4.        14.        28.        44.        60.        72.        79.        81.        76.        66.
                56.        48.        41.        35.        30.        25.        21.        18.        16.        13.
                11.        10.         8.         7.         6.         5.         4.         4.         3.         3.
                 2.         2.         2.         1.         1.         1.         1.         1.

        ***               ***               ***               ***               ***

                             HYDROGRAPH AT STATION       O2

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

   PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR       72-HR      35.92-HR
+   (CFS)       (HR)
                         (CFS)
+    188.      12.67                54.         17.         11.         11.
                       (INCHES)    4.339       5.428       5.428       5.428
                        (AC-FT)      27.         34.         34.         34.

                        CUMULATIVE AREA =     .12 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


              **************
              *            *
   28 KK      *      DA1   *
              *            *
              **************
                           DRAINAGE AREA DA1

   30 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

   31 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .02  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                          STORM AREA =      .02

   32 LS          SCS LOSS RATE
                       STRTL          .33  INITIAL ABSTRACTION
                      CRVNBR        86.00  CURVE NUMBER
                       RTIMP          .00  PERCENT IMPERVIOUS AREA

                  KINEMATIC WAVE
   33 UK            OVERLAND-FLOW ELEMENT NO. 1
                           L          86.  OVERLAND FLOW LENGTH
                           S        .2900  SLOPE
                           N         .300  ROUGHNESS COEFFICIENT
                          PA        100.0  PERCENT OF SUBBASIN
                       DXMIN            5  MINIMUM NUMBER OF DX INTERVALS
                  MUSKINGUM-CUNGE
   34 RD            MAIN CHANNEL
                           L         953.  CHANNEL LENGTH
                           S        .0050  SLOPE
                           N         .030  CHANNEL ROUGHNESS COEFFICIENT
                          CA          .02  CONTRIBUTING AREA
                       SHAPE         TRAP  CHANNEL SHAPE
                          WD          .00  BOTTOM WIDTH OR DIAMETER
                           Z         2.00  SIDE SLOPE
                      RUPSTQ           NO  ROUTE UPSTREAM HYDROGRAPH

                                                                              ***
                                                   COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                                          COMPUTATION TIME STEP
                     ELEMENT     ALPHA       M          DT          DX         PEAK     TIME TO      VOLUME     MAXIMUM
                                                                                         PEAK                   CELERITY
                                                       (MIN)       (FT)       (CFS)     (MIN)        (IN)        (FPS)

                    PLANE1        2.67      1.67        .54       17.20      136.80     724.76       5.68         .66
                    MAIN          1.63      1.33       2.87      476.50      124.82     723.24       5.49        5.53

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .7032E+01 OUTFLOW= .6789E+01 BASIN STORAGE= .5766E-03 PERCENT ERROR=   3.4
```

```
                         INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                MAIN         1.63      1.33      5.00            117.02    725.00      5.46

     ***           ***          ***          ***           ***

                         HYDROGRAPH AT STATION      DA1

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.65, TOTAL EXCESS =    5.68

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR      72-HR     35.92-HR
+   (CFS)       (HR)
                         (CFS)
+    117.      12.08               11.          3.         2.          2.
                      (INCHES)    4.447       5.457      5.457       5.457
                       (AC-FT)       6.          7.         7.          7.

                     CUMULATIVE AREA =     .02 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   35 KK    *    C/DA1   *
            *            *
            **************
                         COMBINE UPSTREAM HYDROGRAPHS

   37 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS

   38 HC          HYDROGRAPH COMBINATION
                        ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE
                                                                   ***

     ***           ***          ***          ***           ***

                         HYDROGRAPH AT STATION    C/DA1

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                  6-HR        24-HR      72-HR     35.92-HR
+   (CFS)       (HR)
                         (CFS)
+    201.      12.67               65.         20.        14.         14.
                      (INCHES)    4.351       5.433      5.433       5.433
                       (AC-FT)      32.         41.        41.         41.

                     CUMULATIVE AREA =     .14 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   39 KK    *      DA2   *
            *            *
            **************
                         DRAINAGE AREA DA2

   41 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS

                SUBBASIN RUNOFF DATA

   42 BA          SUBBASIN CHARACTERISTICS
                        TAREA        .06  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......  ............... TP-40 ...............  ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =      .06

   43 LS          SCS LOSS RATE
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                   STRTL        .33  INITIAL ABSTRACTION
                  CRVNBR      86.00  CURVE NUMBER
                   RTIMP        .00  PERCENT IMPERVIOUS AREA

              KINEMATIC WAVE
   44 UK        OVERLAND-FLOW ELEMENT NO. 1
                       L       383.  OVERLAND FLOW LENGTH
                       S      .0600  SLOPE
                       N       .300  ROUGHNESS COEFFICIENT
                      PA      100.0  PERCENT OF SUBBASIN
                   DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
              MUSKINGUM-CUNGE
   45 RD        MAIN CHANNEL
                       L       955.  CHANNEL LENGTH
                       S      .0050  SLOPE
                       N       .030  CHANNEL ROUGHNESS COEFFICIENT
                      CA        .06  CONTRIBUTING AREA
                   SHAPE       TRAP  CHANNEL SHAPE
                      WD        .00  BOTTOM WIDTH OR DIAMETER
                       Z       2.00  SIDE SLOPE
                  RUPSTQ         NO  ROUTE UPSTREAM HYDROGRAPH

                                                        ***
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
                 ELEMENT    ALPHA      M         DT        DX       PEAK    TIME TO    VOLUME    MAXIMUM
                                                                              PEAK               CELERITY
                                               (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)

                PLANE1        1.22      1.67      2.22     76.60    202.90    727.05      5.67       .60
                MAIN          1.63      1.33      2.60    477.50    198.37    729.26      5.57      6.11

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1679E+02 OUTFLOW= .1644E+02 BASIN STORAGE= .5735E-02 PERCENT ERROR=   2.0

                                        INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                MAIN          1.63      1.33      5.00              194.99    730.00      5.56

       ***            ***             ***             ***             ***

                        HYDROGRAPH AT STATION        DA2

     TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.65, TOTAL EXCESS =    5.68

   PEAK FLOW       TIME                         MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     35.92-HR
 +   (CFS)        (HR)
                             (CFS)
 +     195.      12.17                   27.          8.          6.          6.
                         (INCHES)       4.504       5.561       5.564       5.564
                          (AC-FT)         13.         16.         16.         16.

                       CUMULATIVE AREA =     .06 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
   46 KK      *      S1    *
              *            *
              **************
                          SUBAREA S1

   48 KO          OUTPUT CONTROL VARIABLES
                   IPRNT          3  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE
                   IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                    IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                   ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                   ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                  TIMINT       .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

   49 BA          SUBBASIN CHARACTERISTICS
                   TAREA        .02  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =       .02

   50 LS          SCS LOSS RATE
                   STRTL        .38  INITIAL ABSTRACTION
                  CRVNBR      84.00  CURVE NUMBER
                   RTIMP        .00  PERCENT IMPERVIOUS AREA

   51 US          SNYDER UNITGRAPH
                      TP        .26  LAG
                      CP        .68  PEAKING COEFFICIENT
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              SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                        ***

                                                           UNIT HYDROGRAPH PARAMETERS
                                                     CLARK   TC=   .33 HR,        R=   .19 HR
                                                    SNYDER   TP=   .26 HR,       CP=   .69

                                                                UNIT HYDROGRAPH
                                                           14 END-OF-PERIOD ORDINATES
              5.        19.        31.        35.        28.        18.        11.         7.         5.         3.
              2.         1.         1.         0.

      ***             ***             ***             ***             ***

                      HYDROGRAPH AT STATION        S1

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+      59.     12.33                   10.           3.           2.           2.
                        (INCHES)     4.353        5.427        5.427        5.427
                         (AC-FT)        5.           6.           6.           6.

                       CUMULATIVE AREA =      .02 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
   52 KK   *      C/S1  *
           *            *
           **************
                        COMBINE UPSTREAM HYDROGRAPHS

   54 KO          OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS

   55 HC          HYDROGRAPH COMBINATION
                        ICOMP            4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                        ***

      ***             ***             ***             ***             ***

                      HYDROGRAPH AT STATION      C/S1

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+     653.     12.58                  234.          73.          49.          49.
                        (INCHES)     4.360        5.443        5.444        5.444
                         (AC-FT)      116.         145.         145.         145.

                       CUMULATIVE AREA =      .50 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
   56 KK   *     NORTH  *
           *            *
           **************
                        REROUTE THROUGH SUBAREA CH1

   58 KO          OUTPUT CONTROL VARIABLES
                        IPRNT            3  PRINT CONTROL
                        IPLOT            0  PLOT CONTROL
                        QSCAL           0.  HYDROGRAPH PLOT SCALE
                        IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                         IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT         .083  TIME INTERVAL IN HOURS

                SUBBASIN RUNOFF DATA

   59 BA          SUBBASIN CHARACTERISTICS
                        TAREA          .02  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                             DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
```

```
                   ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                   5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                     .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                  STORM AREA =      .02

  60 LS            SCS LOSS RATE
                         STRTL        .38  INITIAL ABSTRACTION
                        CRVNBR      84.00  CURVE NUMBER
                         RTIMP        .00  PERCENT IMPERVIOUS AREA

                   KINEMATIC WAVE
  61 UK              OVERLAND-FLOW ELEMENT NO. 1
                             L       173.  OVERLAND FLOW LENGTH
                             S      .0867  SLOPE
                             N       .300  ROUGHNESS COEFFICIENT
                            PA      100.0  PERCENT OF SUBBASIN
                         DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
                   MUSKINGUM-CUNGE
  62 RD              MAIN CHANNEL
                             L      1145.  CHANNEL LENGTH
                             S      .0177  SLOPE
                             N       .300  CHANNEL ROUGHNESS COEFFICIENT
                            CA        .02  CONTRIBUTING AREA
                         SHAPE       TRAP  CHANNEL SHAPE
                            WD        .00  BOTTOM WIDTH OR DIAMETER
                             Z       5.00  SIDE SLOPE
                        RUPSTQ        YES  ROUTE UPSTREAM HYDROGRAPH

                                                          ***
                                    COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                           COMPUTATION TIME STEP
                     ELEMENT    ALPHA       M          DT        DX        PEAK    TIME TO     VOLUME    MAXIMUM
                                                                                     PEAK                CELERITY
                                                     (MIN)      (FT)      (CFS)     (MIN)       (IN)      (FPS)

                    PLANE1       1.46      1.67       1.15     34.60      79.20    725.20       5.45        .55
                    MAIN          .24      1.33       5.00    381.67     663.91    760.00       5.44       1.96

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1448E+03  EXCESS= .4683E+01 OUTFLOW= .1495E+03 BASIN STORAGE= .2834E-02 PERCENT ERROR=    .0

                                          INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                    MAIN          .24      1.33       5.00               663.91    760.00       5.44

      ***            ***            ***             ***             ***

                         HYDROGRAPH AT STATION    NORTH

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR     35.92-HR
+   (CFS)       (HR)
                           (CFS)
+     664.     12.67                  241.          75.          50.          50.
                        (INCHES)     4.358        5.442        5.443        5.443
                         (AC-FT)      120.         149.         149.         149.

                        CUMULATIVE AREA =     .51 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


              **************
              *            *
  63 KK       *      DA3   *
              *            *
              **************
                         DRAINAGE AREA DA3

  65 KO            OUTPUT CONTROL VARIABLES
                         IPRNT          3  PRINT CONTROL
                         IPLOT          0  PLOT CONTROL
                         QSCAL         0.  HYDROGRAPH PLOT SCALE
                         IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                          IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                         ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                         ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                        TIMINT       .083  TIME INTERVAL IN HOURS


                 SUBBASIN RUNOFF DATA

  66 BA            SUBBASIN CHARACTERISTICS
                         TAREA        .03  SUBBASIN AREA

                   PRECIPITATION DATA

  11 PH                                    DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                   ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                   5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                     .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                  STORM AREA =      .03

  67 LS            SCS LOSS RATE
                         STRTL        .33  INITIAL ABSTRACTION
```

```
                    CRVNBR       86.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
  68 UK           OVERLAND-FLOW ELEMENT NO. 1
                         L        105.  OVERLAND FLOW LENGTH
                         S       .2900  SLOPE
                         N        .300  ROUGHNESS COEFFICIENT
                        PA       100.0  PERCENT OF SUBBASIN
                     DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
                MUSKINGUM-CUNGE
  69 RD           MAIN CHANNEL
                         L       1431.  CHANNEL LENGTH
                         S       .0050  SLOPE
                         N        .030  CHANNEL ROUGHNESS COEFFICIENT
                        CA         .03  CONTRIBUTING AREA
                     SHAPE        TRAP  CHANNEL SHAPE
                        WD         .00  BOTTOM WIDTH OR DIAMETER
                         Z        2.00  SIDE SLOPE
                    RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                     ***
                                COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                       COMPUTATION TIME STEP
                   ELEMENT    ALPHA       M         DT        DX        PEAK    TIME TO     VOLUME    MAXIMUM
                                                                                 PEAK                 CELERITY
                                                  (MIN)      (FT)      (CFS)    (MIN)        (IN)      (FPS)

                   PLANE1       2.67     1.67       .63     21.00     195.42    724.66       5.68        .71
                   MAIN         1.63     1.33      3.95    715.50     166.19    725.96       5.50       6.04

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1009E+02 OUTFLOW= .9767E+01 BASIN STORAGE= .8725E-03 PERCENT ERROR=   3.2

                                      INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                   MAIN         1.63     1.33      5.00               162.39    725.00       5.49

      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION       DA3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

  PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
                                     6-HR         24-HR        72-HR      35.92-HR
+   (CFS)        (HR)
                           (CFS)
+     162.      12.08                  16.           5.           3.          3.
                         (INCHES)    4.485        5.487        5.488       5.488
                          (AC-FT)       8.          10.          10.         10.

                        CUMULATIVE AREA =      .03 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
  70 KK       *      CH2   *
              *            *
              **************
                         SUBAREA CH2

  72 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                      IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                       IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

  73 BA         SUBBASIN CHARACTERISTICS
                      TAREA        .00  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......    ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN     2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07     3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                                   STORM AREA =       .00

  74 LS         SCS LOSS RATE
                     STRTL         .38  INITIAL ABSTRACTION
                    CRVNBR       84.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
  75 UK           OVERLAND-FLOW ELEMENT NO. 1
                         L         29.  OVERLAND FLOW LENGTH
                         S       .4000  SLOPE
                         N        .300  ROUGHNESS COEFFICIENT
```

```
                    PA       100.0  PERCENT OF SUBBASIN
                 DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
            MUSKINGUM-CUNGE
  76 RD       MAIN CHANNEL
                     L       1238.  CHANNEL LENGTH
                     S       .0100  SLOPE
                     N        .030  CHANNEL ROUGHNESS COEFFICIENT
                    CA         .00  CONTRIBUTING AREA
                 SHAPE        TRAP  CHANNEL SHAPE
                    WD        6.00  BOTTOM WIDTH OR DIAMETER
                     Z        2.00  SIDE SLOPE
                RUPSTQ         YES  ROUTE UPSTREAM HYDROGRAPH

                                                                 ***
      MCUNGE FATAL ERROR - NUMBER OF ORDINATES FOR CONSTANT TIME STEP OVERLAND FLOW EXCEEDS ARRAY DIMENSIONS - REDUCE DURATION OF RUN
ON IT - RECORD
                              COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                     COMPUTATION TIME STEP
                ELEMENT   ALPHA      M        DT        DX       PEAK    TIME TO    VOLUME   MAXIMUM
                                                                          PEAK               CELERITY
                                            (MIN)      (FT)     (CFS)    (MIN)      (IN)     (FPS)

                PLANE1     3.14     1.67      .31      5.80     13.20    724.57     5.45       .47
                MAIN       1.69     1.40     2.79    619.00    155.25    726.68     9.62      7.38

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .9746E+01  EXCESS= .6690E+00 OUTFLOW= .1827E+02 BASIN STORAGE= .4582E-01 PERCENT ERROR= -75.8

                                       INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


                MAIN       1.69     1.40     5.00              148.69    725.00     9.62

      ***           ***          ***           ***          ***

                          HYDROGRAPH AT STATION      CH2

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR        24-HR      72-HR     35.92-HR
+   (CFS)       (HR)
                           (CFS)
+     149.     12.08                   17.          9.         6.           6.
                         (INCHES)   4.466       9.026      9.619        9.619
                          (AC-FT)      8.         17.        18.          18.

                        CUMULATIVE AREA =     .04 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  77 KK      *    DA4     *
             *            *
             **************
                          DRAINAGE AREA DA4

  79 KO         OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE
                     IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                      IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


              SUBBASIN RUNOFF DATA

  80 BA         SUBBASIN CHARACTERISTICS
                      TAREA        .06  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                   STORM AREA =      .06

  81 LS         SCS LOSS RATE
                     STRTL         .33  INITIAL ABSTRACTION
                    CRVNBR       86.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
  82 UK           OVERLAND-FLOW ELEMENT NO. 1
                         L        105.  OVERLAND FLOW LENGTH
                         S       .2900  SLOPE
                         N        .300  ROUGHNESS COEFFICIENT
                        PA       100.0  PERCENT OF SUBBASIN
                     DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
                MUSKINGUM-CUNGE
  83 RD           MAIN CHANNEL
                         L       1266.  CHANNEL LENGTH
                         S       .0050  SLOPE
```

```
                  N        .030  CHANNEL ROUGHNESS COEFFICIENT
                 CA         .06  CONTRIBUTING AREA
              SHAPE        TRAP  CHANNEL SHAPE
                 WD         .00  BOTTOM WIDTH OR DIAMETER
                  Z        2.00  SIDE SLOPE
             RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
                          COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                 COMPUTATION TIME STEP
          ELEMENT     ALPHA       M        DT        DX        PEAK    TIME TO     VOLUME    MAXIMUM
                                                                         PEAK                CELERITY
                                          (MIN)     (FT)      (CFS)     (MIN)       (IN)      (FPS)

         PLANE1        2.67      1.67       .63     21.00     332.10    724.66      5.68        .71
         MAIN          1.63      1.33      3.06    633.00     318.17    724.25      5.50       6.90

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1715E+02 OUTFLOW= .1661E+02 BASIN STORAGE= .8922E-03 PERCENT ERROR=   3.2

                                INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

         MAIN          1.63      1.33      5.00               296.69    725.00      5.50

      ***             ***             ***             ***             ***

                    HYDROGRAPH AT STATION       DA4

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.65, TOTAL EXCESS =    5.68

  PEAK FLOW      TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+     297.     12.08                 27.          8.          6.          6.
                       (INCHES)    4.495       5.503       5.503       5.503
                        (AC-FT)      14.         17.         17.         17.

                    CUMULATIVE AREA =     .06 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
  84 KK    *      CH5   *
           *            *
           **************
                   CHANNEL CH5

  86 KO        OUTPUT CONTROL VARIABLES
                  IPRNT          3  PRINT CONTROL
                  IPLOT          0  PLOT CONTROL
                  QSCAL         0.  HYDROGRAPH PLOT SCALE
                  IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                   IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                  ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                  ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                 TIMINT       .083  TIME INTERVAL IN HOURS

             SUBBASIN RUNOFF DATA

  87 BA        SUBBASIN CHARACTERISTICS
                  TAREA        .00  SUBBASIN AREA

               PRECIPITATION DATA

  11 PH                          DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
               ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
               5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                            STORM AREA =      .00

  88 LS        SCS LOSS RATE
                 STRTL         .38  INITIAL ABSTRACTION
                CRVNBR       84.00  CURVE NUMBER
                 RTIMP         .00  PERCENT IMPERVIOUS AREA

               KINEMATIC WAVE
  89 UK          OVERLAND-FLOW ELEMENT NO. 1
                      L       137.  OVERLAND FLOW LENGTH
                      S      .1750  SLOPE
                      N       .300  ROUGHNESS COEFFICIENT
                     PA      100.0  PERCENT OF SUBBASIN
                  DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
               MUSKINGUM-CUNGE
  90 RD          MAIN CHANNEL
                      L       505.  CHANNEL LENGTH
                      S      .0625  SLOPE
                      N       .030  CHANNEL ROUGHNESS COEFFICIENT
                     CA        .00  CONTRIBUTING AREA
                  SHAPE       TRAP  CHANNEL SHAPE
                     WD        .00  BOTTOM WIDTH OR DIAMETER
                      Z       3.00  SIDE SLOPE
                 RUPSTQ         NO  ROUTE UPSTREAM HYDROGRAPH

                                                    ***
```

```
                         COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                COMPUTATION TIME STEP
          ELEMENT    ALPHA      M         DT        DX        PEAK    TIME TO    VOLUME    MAXIMUM
                                                                        PEAK               CELERITY
                                         (MIN)     (FT)      (CFS)    (MIN)      (IN)      (FPS)

         PLANE1       2.08      1.67       .71     27.40      3.87    724.93      5.45       .65
         MAIN         5.24      1.33      1.54    252.50      3.75    724.41      5.36      5.45

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .2036E+00 OUTFLOW= .2000E+00 BASIN STORAGE= .1158E-03 PERCENT ERROR=   1.7

                               INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

         MAIN         5.24      1.33      5.00                3.64    725.00      5.36

     ***            ***            ***            ***            ***

                  HYDROGRAPH AT STATION         CH5

     TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                           (CFS)
 +       4.     12.08                 0.           0.           0.            0.
                         (INCHES)   4.364        5.360        5.360         5.360
                          (AC-FT)      0.           0.           0.            0.

                      CUMULATIVE AREA =       .00 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


              **************
              *            *
   91 KK      *        P1  *
              *            *
              **************
                        POND P1

   93 KO           OUTPUT CONTROL VARIABLES
                         IPRNT           3  PRINT CONTROL
                         IPLOT           0  PLOT CONTROL
                         QSCAL          0.  HYDROGRAPH PLOT SCALE
                         IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                          IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                         ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                         ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                        TIMINT        .083  TIME INTERVAL IN HOURS


                 SUBBASIN RUNOFF DATA

   94 BA           SUBBASIN CHARACTERISTICS
                         TAREA         .00  SUBBASIN AREA

                   PRECIPITATION DATA

   11 PH                                  DEPTHS FOR    0-PERCENT HYPOTHETICAL STORM
                   ..... HYDRO-35 ......   ............... TP-40 ..............   ........... TP-49 ..........
                   5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                     .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                    STORM AREA =       .00

   95 LS           SCS LOSS RATE
                         STRTL         .00  INITIAL ABSTRACTION
                        CRVNBR      100.00  CURVE NUMBER
                         RTIMP         .00  PERCENT IMPERVIOUS AREA

   96 UD           SCS DIMENSIONLESS UNITGRAPH
                          TLAG         .00  LAG

                                                              ***

                                                        UNIT HYDROGRAPH
                                                    5 END-OF-PERIOD ORDINATES
                12.         3.         1.         0.         0.

     ***            ***            ***            ***            ***

                  HYDROGRAPH AT STATION          P1

     TOTAL RAINFALL =     7.33, TOTAL LOSS =      .00, TOTAL EXCESS =     7.33

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)       (HR)
                           (CFS)
 +      12.     12.08                 1.           0.           0.            0.
                         (INCHES)   5.298        7.327        7.330         7.330
                          (AC-FT)      1.           1.           1.            1.

                      CUMULATIVE AREA =       .00 SQ MI
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   97 KK    *     C/P1   *
            *            *
            **************
                          COMBINE HYDROGRAPHS

   99 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS


  100 HC          HYDROGRAPH COMBINATION
                        ICOMP          4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                           ***

       ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION      C/P1

   PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
                                          6-HR        24-HR        72-HR      35.92-HR
 +   (CFS)        (HR)
                               (CFS)
 +      461.     12.08                      46.          17.          12.          12.
                            (INCHES)      4.499        6.674        7.085        7.085
                             (AC-FT)        23.          34.          36.          36.

                          CUMULATIVE AREA =      .09 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  101 KK    *      RP1   *
            *            *
            **************
                          ROUTE THROUGH P1

  103 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE
                        IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                         IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT       .083  TIME INTERVAL IN HOURS


               HYDROGRAPH ROUTING DATA

  104 RS          STORAGE ROUTING
                        NSTPS          1  NUMBER OF SUBREACHES
                         ITYP       ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     643.50  INITIAL CONDITION
                            X        .00 WORKING R AND D COEFFICIENT

  105 SA               AREA          .0         .3         .4         .5         .6         .7         .8         .9         .9

  106 SE          ELEVATION      643.50     643.60     645.00     647.50     650.00     652.50     653.50     655.00     656.50

  107 SL          LOW-LEVEL OUTLET
                        ELEVL     645.00  ELEVATION AT CENTER OF OUTLET
                        CAREA       7.07  CROSS-SECTIONAL AREA
                         COQL        .80  COEFFICIENT
                         EXPL        .50  EXPONENT OF HEAD

  108 SS          SPILLWAY
                         CREL     653.50  SPILLWAY CREST ELEVATION
                        SPWID      10.00  SPILLWAY WIDTH
                         COQW       2.60  WEIR COEFFICIENT
                         EXPW       1.50  EXPONENT OF HEAD

                                                                           ***

                                                     COMPUTED STORAGE-ELEVATION DATA

            STORAGE         .00        .01        .52       1.62       3.01       4.70       5.47       6.73       8.10
          ELEVATION      643.50     643.60     645.00     647.50     650.00     652.50     653.50     655.00     656.50

                                                     COMPUTED OUTFLOW-ELEVATION DATA

            OUTFLOW         .00        .00      55.33      60.34      66.36      73.70      82.87      94.65     110.34     132.25
          ELEVATION      643.50     645.00     646.49     646.77     647.14     647.64     648.34     649.35     650.92     653.50

            OUTFLOW      134.35     137.59     143.04     151.23     162.74     178.09     197.84     222.53     252.71     288.93
          ELEVATION      653.62     653.76     653.93     654.16     654.43     654.75     655.12     655.53     655.99     656.50
```

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.01	.52	1.14	1.27	1.45	1.62	1.70	2.06	2.63
OUTFLOW	.00	.00	.00	55.33	60.34	66.36	71.72	73.70	82.87	94.65
ELEVATION	643.50	643.60	645.00	646.49	646.77	647.14	647.50	647.64	648.34	649.35
STORAGE	3.01	3.60	4.70	5.47	5.57	5.68	5.82	6.01	6.24	6.51
OUTFLOW	101.43	110.34	124.23	132.25	134.35	137.59	143.04	151.23	162.74	178.09
ELEVATION	650.00	650.92	652.50	653.50	653.62	653.76	653.93	654.16	654.43	654.75
STORAGE	6.73	6.83	7.20	7.63	8.10					
OUTFLOW	191.21	197.84	222.53	252.71	288.93					
ELEVATION	655.00	655.12	655.53	655.99	656.50					

```
     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION      RP1

 PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                              (CFS)
+    185.      12.25                    46.          17.         12.          12.
                           (INCHES)   4.498        6.672       6.975        6.975
                            (AC-FT)     23.          34.         35.          35.

PEAK STORAGE    TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR        24-HR       72-HR     35.92-HR
+  (AC-FT)      (HR)
       7.      12.25                     2.           1.          1.           1.

 PEAK STAGE     TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR        24-HR       72-HR     35.92-HR
+   (FEET)      (HR)
   654.88      12.25                 647.04       645.67      645.19       645.19

                   CUMULATIVE AREA =      .09 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
 109 KK      *        S2  *
             *            *
             **************
                    SUBAREA S2

 111 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

 112 BA          SUBBASIN CHARACTERISTICS
                       TAREA        .00  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ..............   ........... TP-49 ..........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                STORM AREA =      .00

 113 LS          SCS LOSS RATE
                      STRTL         .38  INITIAL ABSTRACTION
                     CRVNBR       84.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 114 US          SNYDER UNITGRAPH
                         TP         .15  LAG
                         CP         .69  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                          ***

                                                 UNIT HYDROGRAPH PARAMETERS
                                            CLARK   TC=    .21 HR,        R=   .07 HR
                                           SNYDER   TP=    .15 HR,       CP=   .68

                                                      UNIT HYDROGRAPH
                                                  6 END-OF-PERIOD ORDINATES
                 3.        7.        7.        3.        1.        0.

     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION       S2

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45
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```
   PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR      35.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      10.     12.17                      1.          0.          0.            0.
                            (INCHES)     4.358       5.431       5.431         5.431
                             (AC-FT)       1.          1.          1.            1.

                             CUMULATIVE AREA =      .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   115 KK   *        S3  *
            *            *
            **************
                          SUBAREA S3

   117 KO        OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

   118 BA        SUBBASIN CHARACTERISTICS
                       TAREA        .01  SUBBASIN AREA

                 PRECIPITATION DATA

    11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......    ............... TP-40 ..............    ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                                     STORM AREA =      .01

   119 LS        SCS LOSS RATE
                      STRTL         .38  INITIAL ABSTRACTION
                     CRVNBR       84.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

   120 US        SNYDER UNITGRAPH
                         TP         .32  LAG
                         CP         .71  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                ***

                                                      UNIT HYDROGRAPH PARAMETERS
                                                   CLARK   TC=    .39 HR,        R=   .22 HR
                                                  SNYDER   TP=    .32 HR,       CP=   .71

                                                           UNIT HYDROGRAPH
                                                      17 END-OF-PERIOD ORDINATES
                 2.          6.         11.         14.         13.         10.          7.          5.          3.          2.
                 1.          1.          1.          0.          0.          0.          0.

       ***            ***            ***            ***            ***

                         HYDROGRAPH AT STATION         S3

      TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

   PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR      35.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      25.     12.33                      5.          1.          1.            1.
                            (INCHES)     4.358       5.434       5.434         5.434
                             (AC-FT)       2.          3.          3.            3.

                             CUMULATIVE AREA =      .01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   121 KK   *      C/NE  *     NORTHEAST
            *            *
            **************
                          DISCHARGE AT NE

   123 KO        OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
```

```
                    IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                   ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                   ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                  TIMINT        .083  TIME INTERVAL IN HOURS


 124 HC          HYDROGRAPH COMBINATION
                   ICOMP           3  NUMBER OF HYDROGRAPHS TO COMBINE

                                                         ***

     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     C/NE

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     35.92-HR
+   (CFS)      (HR)
                     (CFS)
+    216.     12.25                52.         19.         13.          13.
                  (INCHES)       4.481       6.504       6.793        6.793
                   (AC-FT)         26.         37.         39.          39.

                    CUMULATIVE AREA =     .11 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

           **************
           *            *
 125 KK    *       O3   *
           *            *
           **************
                     SUBAREA O3

 127 KO          OUTPUT CONTROL VARIABLES
                   IPRNT           3  PRINT CONTROL
                   IPLOT           0  PLOT CONTROL
                   QSCAL          0.  HYDROGRAPH PLOT SCALE
                   IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                    IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                   ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                   ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                  TIMINT        .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

 128 BA          SUBBASIN CHARACTERISTICS
                   TAREA         .11  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                               DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......    ............... TP-40 ...............     ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =       .11

 129 LS          SCS LOSS RATE
                  STRTL         .38  INITIAL ABSTRACTION
                 CRVNBR       84.00  CURVE NUMBER
                  RTIMP         .00  PERCENT IMPERVIOUS AREA

 130 US          SNYDER UNITGRAPH
                     TP         .46  LAG
                     CP         .65  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                         ***

                                                     UNIT HYDROGRAPH PARAMETERS
                                                CLARK   TC=    .54 HR,        R=    .39 HR
                                               SNYDER   TP=    .46 HR,       CP=    .66

                                                          UNIT HYDROGRAPH
                                                     29 END-OF-PERIOD ORDINATES
                 7.         25.         49.         73.         91.         99.         92.         77.         62.         50.
                41.         33.         27.         21.         17.         14.         11.          9.          7.          6.
                 5.          4.          3.          3.          2.          2.          1.          1.          1.

     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION        O3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     35.92-HR
+   (CFS)      (HR)
                     (CFS)
+    206.     12.50                51.         16.         11.          11.
                  (INCHES)       4.348       5.429       5.429        5.429
                   (AC-FT)         25.         31.         31.          31.

                    CUMULATIVE AREA =     .11 SQ MI
```

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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  131 KK    *       S6   *
            *            *
            **************
                          SUBAREA S6

  133 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

  134 BA         SUBBASIN CHARACTERISTICS
                       TAREA         .01  SUBBASIN AREA

                 PRECIPITATION DATA

   11 PH                            DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                 ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                 5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                   .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                             STORM AREA =       .01

  135 LS         SCS LOSS RATE
                       STRTL         .38  INITIAL ABSTRACTION
                      CRVNBR       84.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

  136 US         SNYDER UNITGRAPH
                          TP         .51  LAG
                          CP         .73  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                        ***

                                                   UNIT HYDROGRAPH PARAMETERS
                                              CLARK   TC=   .62 HR,       R=   .32 HR
                                             SNYDER   TP=   .51 HR,      CP=   .72

                                                        UNIT HYDROGRAPH
                                                   25 END-OF-PERIOD ORDINATES
                 0.        1.        3.        4.        5.        5.        5.        5.        4.        3.
                 2.        2.        1.        1.        1.        1.        0.        0.        0.        0.
                 0.        0.        0.        0.        0.

       ***            ***            ***            ***            ***

                          HYDROGRAPH AT STATION        S6

     TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW      TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR     35.92-HR
+   (CFS)        (HR)
                             (CFS)
+       12.     12.58                      3.           1.           1.           1.
                          (INCHES)      4.350        5.429        5.429        5.429
                           (AC-FT)         1.           2.           2.           2.

                         CUMULATIVE AREA =      .01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  137 KK    *     C/S6   *
            *            *
            **************
                          COMBINE OFFSITE HYDROGRAPHS ENTERING S6

  139 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


  140 HC         HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                        ***
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      ***             ***             ***             ***             ***

                           HYDROGRAPH AT STATION     C/S6

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     35.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     217.     12.50                    53.          17.         11.          11.
                           (INCHES)    4.348        5.429       5.429        5.429
                            (AC-FT)      26.          33.         33.          33.

                          CUMULATIVE AREA =      .11 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   141 KK   *        O4  *
            *            *
            **************
                          SUBAREA O4

   143 KO         OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

   144 BA         SUBBASIN CHARACTERISTICS
                        TAREA         .10  SUBBASIN AREA

                  PRECIPITATION DATA

    11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............    ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =       .10

   145 LS         SCS LOSS RATE
                        STRTL         .38  INITIAL ABSTRACTION
                       CRVNBR       84.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

   146 US         SNYDER UNITGRAPH
                           TP         .47  LAG
                           CP         .65  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                             ***

                                                           UNIT HYDROGRAPH PARAMETERS
                                                     CLARK   TC=    .54 HR,        R=    .40 HR
                                                    SNYDER   TP=    .47 HR,       CP=    .65

                                                                UNIT HYDROGRAPH
                                                          30 END-OF-PERIOD ORDINATES
                     6.        21.        42.        63.        79.        85.        80.        68.        55.        45.
                    36.        30.        24.        20.        16.        13.        11.         9.         7.         6.
                     5.         4.         3.         2.         2.         2.         1.         1.         1.         1.

      ***             ***             ***             ***             ***

                           HYDROGRAPH AT STATION        O4

      TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =     5.45

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     35.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     179.     12.50                    45.          14.          9.           9.
                           (INCHES)    4.348        5.430       5.430        5.430
                            (AC-FT)      22.          28.         28.          28.

                          CUMULATIVE AREA =      .10 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
   147 KK   *        S7  *
            *            *
            **************
                          SUBAREA S7
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149 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                       IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

150 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .01  SUBBASIN AREA

                PRECIPITATION DATA

 11 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =      .01

151 LS          SCS LOSS RATE
                      STRTL         .38  INITIAL ABSTRACTION
                     CRVNBR       84.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

152 US          SNYDER UNITGRAPH
                         TP         .32  LAG
                         CP         .72  PEAKING COEFFICIENT

                SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                 ***

                                                      UNIT HYDROGRAPH PARAMETERS
                                                   CLARK   TC=    .40 HR,        R=    .21 HR
                                                  SNYDER   TP=    .32 HR,       CP=    .71

                                                            UNIT HYDROGRAPH
                                                      16 END-OF-PERIOD ORDINATES
                1.         4.         7.         9.         9.         7.         4.         3.         2.         1.
                1.         1.         0.         0.         0.         0.

      ***             ***             ***             ***             ***

                       HYDROGRAPH AT STATION        S7

   TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR         24-HR         72-HR       35.92-HR
+   (CFS)       (HR)
                          (CFS)
+       16.     12.33                    3.            1.            1.            1.
                        (INCHES)      4.354         5.429         5.429          5.429
                         (AC-FT)         1.            2.            2.             2.

                      CUMULATIVE AREA =      .01 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
153 KK     *      DA6   *
           *            *
           **************
                        DRAINAGE AREA DA6

155 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                       IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

156 BA          SUBBASIN CHARACTERISTICS
                      TAREA         .03  SUBBASIN AREA

                PRECIPITATION DATA

 11 PH                                  DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                  .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =      .03

157 LS          SCS LOSS RATE
                      STRTL         .33  INITIAL ABSTRACTION
                     CRVNBR       86.00  CURVE NUMBER
```

```
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

                  KINEMATIC WAVE
 158 UK             OVERLAND-FLOW ELEMENT NO. 1
                            L        105.  OVERLAND FLOW LENGTH
                            S       .2900  SLOPE
                            N        .300  ROUGHNESS COEFFICIENT
                           PA       100.0  PERCENT OF SUBBASIN
                        DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
                  MUSKINGUM-CUNGE
 159 RD             MAIN CHANNEL
                            L        877.  CHANNEL LENGTH
                            S       .0050  SLOPE
                            N        .030  CHANNEL ROUGHNESS COEFFICIENT
                           CA         .03  CONTRIBUTING AREA
                        SHAPE        TRAP  CHANNEL SHAPE
                           WD         .00  BOTTOM WIDTH OR DIAMETER
                            Z        2.00  SIDE SLOPE
                       RUPSTQ          NO  ROUTE UPSTREAM HYDROGRAPH

                                                         ***
                                  COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                         COMPUTATION TIME STEP
                    ELEMENT    ALPHA       M        DT        DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                                  PEAK                 CELERITY
                                                   (MIN)      (FT)     (CFS)    (MIN)       (IN)      (FPS)

                   PLANE1       2.67      1.67       .63     21.00    152.58    724.66      5.68        .71
                   MAIN         1.63      1.33      2.57    438.50    141.88    725.49      5.50       5.68

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .7880E+01 OUTFLOW= .7632E+01 BASIN STORAGE= .5604E-03 PERCENT ERROR=   3.1

                                          INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                   MAIN         1.63      1.33      5.00              139.92    725.00      5.50

     ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION       DA6

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

  PEAK FLOW      TIME                               MAXIMUM AVERAGE FLOW
                                          6-HR         24-HR       72-HR      35.92-HR
+   (CFS)         (HR)
                                (CFS)
+      140.      12.08                    13.            4.          3.             3.
                             (INCHES)    4.484        5.499       5.499          5.499
                              (AC-FT)       6.            8.          8.             8.

                         CUMULATIVE AREA =      .03 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
 160 KK       *      CH3   *
              *            *
              **************
                            CHANNEL CH3

 162 KO           OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS

                 SUBBASIN RUNOFF DATA

 163 BA           SUBBASIN CHARACTERISTICS
                        TAREA         .00  SUBBASIN AREA

                  PRECIPITATION DATA

  11 PH                                 DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ..............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                      STORM AREA =       .00

 164 LS           SCS LOSS RATE
                        STRTL         .38  INITIAL ABSTRACTION
                       CRVNBR       84.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

                  KINEMATIC WAVE
 165 UK             OVERLAND-FLOW ELEMENT NO. 1
                            L         45.  OVERLAND FLOW LENGTH
                            S       .1160  SLOPE
                            N        .300  ROUGHNESS COEFFICIENT
                           PA       100.0  PERCENT OF SUBBASIN
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              DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
          MUSKINGUM-CUNGE
166 RD      MAIN CHANNEL
                  L        545.  CHANNEL LENGTH
                  S      .0100  SLOPE
                  N       .030  CHANNEL ROUGHNESS COEFFICIENT
                 CA        .00  CONTRIBUTING AREA
              SHAPE       TRAP  CHANNEL SHAPE
                 WD       8.00  BOTTOM WIDTH OR DIAMETER
                  Z       3.00  SIDE SLOPE
             RUPSTQ        YES  ROUTE UPSTREAM HYDROGRAPH

                                                  ***
                         COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                COMPUTATION TIME STEP
            ELEMENT    ALPHA      M        DT       DX       PEAK    TIME TO     VOLUME    MAXIMUM
                                                                      PEAK                 CELERITY
                                          (MIN)     (FT)     (CFS)    (MIN)       (IN)      (FPS)

            PLANE1      1.69     1.67      .57      9.00      4.59    725.00      5.45       .39
            MAIN        1.50     1.40     1.43    272.50    134.66    725.77      5.49      6.37

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7625E+01  EXCESS= .2327E+00 OUTFLOW= .7848E+01 BASIN STORAGE= .3526E-03 PERCENT ERROR=    .1

                              INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


            MAIN        1.50     1.40     5.00              128.51    725.00      5.50

     ***           ***           ***           ***           ***

                 HYDROGRAPH AT STATION       CH3

    TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.88, TOTAL EXCESS =     5.45

  PEAK FLOW      TIME                   MAXIMUM AVERAGE FLOW
                               6-HR        24-HR        72-HR     35.92-HR
+   (CFS)        (HR)
                       (CFS)
+     129.      12.08            13.          4.           3.           3.
                   (INCHES)    4.483       5.497        5.497        5.497
                    (AC-FT)       6.          8.           8.           8.

                 CUMULATIVE AREA =      .03 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


         **************
         *            *
167 KK   *      CH4   *
         *            *
         **************
                CHANNEL CH4

169 KO      OUTPUT CONTROL VARIABLES
                IPRNT          3  PRINT CONTROL
                IPLOT          0  PLOT CONTROL
                QSCAL         0.  HYDROGRAPH PLOT SCALE
                IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                 IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
               TIMINT       .083  TIME INTERVAL IN HOURS


          SUBBASIN RUNOFF DATA

170 BA      SUBBASIN CHARACTERISTICS
                TAREA        .00  SUBBASIN AREA

            PRECIPITATION DATA

 11 PH                               DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
            ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
            5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR    2-DAY   4-DAY   7-DAY  10-DAY
              .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33      .00     .00     .00     .00

                                                STORM AREA =       .00

171 LS      SCS LOSS RATE
                STRTL        .38  INITIAL ABSTRACTION
               CRVNBR      84.00  CURVE NUMBER
                RTIMP        .00  PERCENT IMPERVIOUS AREA

            KINEMATIC WAVE
172 UK        OVERLAND-FLOW ELEMENT NO. 1
                    L        54.  OVERLAND FLOW LENGTH
                    S      .0957  SLOPE
                    N       .300  ROUGHNESS COEFFICIENT
                   PA      100.0  PERCENT OF SUBBASIN
                DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
            MUSKINGUM-CUNGE
173 RD        MAIN CHANNEL
                    L       484.  CHANNEL LENGTH
                    S      .0100  SLOPE
                    N       .030  CHANNEL ROUGHNESS COEFFICIENT
                   CA        .00  CONTRIBUTING AREA
                SHAPE       TRAP  CHANNEL SHAPE
```

```
              WD        8.00  BOTTOM WIDTH OR DIAMETER
               Z        3.00  SIDE SLOPE
          RUPSTQ         YES  ROUTE UPSTREAM HYDROGRAPH

                                             ***
                            COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                   COMPUTATION TIME STEP
        ELEMENT    ALPHA      M       DT        DX       PEAK    TIME TO    VOLUME    MAXIMUM
                                                                  PEAK                CELERITY
                                    (MIN)      (FT)      (CFS)    (MIN)      (IN)      (FPS)

        PLANE1      1.54     1.67      .53     10.80      4.00    724.87     5.45       .38
        MAIN        1.50     1.40     1.30    242.00    127.76    726.32     5.49      6.22

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7857E+01  EXCESS= .2036E+00 OUTFLOW= .8057E+01 BASIN STORAGE= .3186E-03 PERCENT ERROR=    .0

                                  INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


        MAIN        1.50     1.40     5.00              120.13    725.00     5.50

     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION      CH4

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                    MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+     120.     12.08                13.          4.          3.          3.
                       (INCHES)   4.491       5.503       5.504       5.504
                        (AC-FT)      7.          8.          8.          8.

                       CUMULATIVE AREA =     .03 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
  174 KK     *     C/S7   *
             *            *
             **************
                          COMBINE HYDROGRAPHS AT S7

  176 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS


  177 HC          HYDROGRAPH COMBINATION
                       ICOMP          4  NUMBER OF HYDROGRAPHS TO COMBINE

                                             ***

     ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     C/S7

  PEAK FLOW     TIME                    MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                          (CFS)
+     435.     12.50               114.         36.         24.         24.
                       (INCHES)   4.362       5.438       5.438       5.438
                        (AC-FT)     57.         71.         71.         71.

                       CUMULATIVE AREA =     .24 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
  178 KK     *    CLVRT   *
             *            *
             **************
                          CULVERT AT S6/S5

  180 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE
                       IPNCH          7  PUNCH COMPUTED HYDROGRAPH
                        IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS
```

```
            HYDROGRAPH ROUTING DATA

 181 RS        STORAGE ROUTING
                     NSTPS           1  NUMBER OF SUBREACHES
                      ITYP        0.74  TYPE OF INITIAL CONDITION
                    RSVRIC         .00  INITIAL CONDITION
                         X         .00 WORKING R AND D COEFFICIENT

 182 SA             AREA          .0        .0        .0        .1        .1        .3        .7

 183 SE        ELEVATION      680.74    682.00    684.00    686.00    690.00    694.00    698.00

 184 SL        LOW-LEVEL OUTLET
                     ELEVL      682.90  ELEVATION AT CENTER OF OUTLET
                     CAREA       45.00  CROSS-SECTIONAL AREA
                      COQL         .70  COEFFICIENT
                      EXPL         .50  EXPONENT OF HEAD

 185 SS        SPILLWAY
                      CREL      697.90  SPILLWAY CREST ELEVATION
                     SPWID        9.00  SPILLWAY WIDTH
                      COQW        2.60  WEIR COEFFICIENT
                      EXPW        1.50  EXPONENT OF HEAD

                                                              ***

                                                    COMPUTED STORAGE-ELEVATION DATA

          STORAGE        .00       .00       .06       .18       .61      1.52      3.53
        ELEVATION     680.74    682.00    684.00    686.00    690.00    694.00    698.00

                                                    COMPUTED OUTFLOW-ELEVATION DATA

          OUTFLOW        .00       .00    484.50    522.15    566.15    618.26    680.92    757.72    854.05    978.43
        ELEVATION     680.74    682.90    686.58    687.17    687.92    688.89    690.16    691.90    694.33    697.90

          OUTFLOW    1017.99   1011.70   1006.07   1001.06    996.65    992.80    989.48    986.67    984.33    982.43
        ELEVATION     698.65    698.55    698.46    698.37    698.29    698.22    698.15    698.09    698.04    698.00


                                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE        .00       .00       .02       .06       .18       .23       .29       .36       .47       .61
          OUTFLOW        .00       .00       .00    264.96    444.80    484.50    522.15    566.15    618.26    673.15
        ELEVATION     680.74    682.00    682.90    684.00    686.00    686.58    687.17    687.92    688.89    690.00

          STORAGE        .63       .94      1.52      1.63      3.46      3.53      4.00
          OUTFLOW     680.92    757.72    841.68    854.05    978.43    982.43   1017.99
        ELEVATION     690.16    691.90    694.00    694.33    697.90    698.00    698.65

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO      681.
               THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
               THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

      ***             ***             ***             ***             ***

                    HYDROGRAPH AT STATION    CLVRT

  PEAK FLOW      TIME                              MAXIMUM AVERAGE FLOW
                                       6-HR         24-HR         72-HR      35.92-HR
+   (CFS)        (HR)
                             (CFS)
+      435.     12.50                   114.           36.           24.           24.
                         (INCHES)      4.362         5.437         5.437         5.437
                          (AC-FT)        57.           71.           71.           71.

 PEAK STORAGE    TIME                            MAXIMUM AVERAGE STORAGE
                                       6-HR         24-HR         72-HR      35.92-HR
+  (AC-FT)       (HR)
          0.    12.50                     0.            0.            0.            0.

  PEAK STAGE     TIME                              MAXIMUM AVERAGE STAGE
                                       6-HR         24-HR         72-HR      35.92-HR
+   (FEET)       (HR)
     685.89     12.50                 683.47        683.07        682.70        682.70

                    CUMULATIVE AREA =      .24 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
 186 KK      *       DA5  *
             *            *
             **************
                             DRAINAGE AREA DA5

 188 KO        OUTPUT CONTROL VARIABLES
                     IPRNT           3  PRINT CONTROL
                     IPLOT           0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE
                     IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                      IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                     ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                     ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT        .083  TIME INTERVAL IN HOURS
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              SUBBASIN RUNOFF DATA

 189 BA         SUBBASIN CHARACTERISTICS
                      TAREA          .04  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                               DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                 .85    1.69    3.07     3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                STORM AREA =      .04

 190 LS         SCS LOSS RATE
                      STRTL          .33  INITIAL ABSTRACTION
                     CRVNBR        86.00  CURVE NUMBER
                      RTIMP          .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
 191 UK           OVERLAND-FLOW ELEMENT NO. 1
                          L         120.  OVERLAND FLOW LENGTH
                          S        .2500  SLOPE
                          N         .300  ROUGHNESS COEFFICIENT
                         PA        100.0  PERCENT OF SUBBASIN
                      DXMIN            5  MINIMUM NUMBER OF DX INTERVALS
                MUSKINGUM-CUNGE
 192 RD           MAIN CHANNEL
                          L         835.  CHANNEL LENGTH
                          S        .0050  SLOPE
                          N         .030  CHANNEL ROUGHNESS COEFFICIENT
                         CA          .04  CONTRIBUTING AREA
                      SHAPE         TRAP  CHANNEL SHAPE
                         WD          .00  BOTTOM WIDTH OR DIAMETER
                          Z         2.00  SIDE SLOPE
                     RUPSTQ           NO  ROUTE UPSTREAM HYDROGRAPH

                                                                  ***
                                    COMPUTED MUSKINGUM-CUNGE PARAMETERS
                                           COMPUTATION TIME STEP
                   ELEMENT    ALPHA       M        DT        DX        PEAK     TIME TO     VOLUME     MAXIMUM
                                                                                  PEAK                  CELERITY
                                                  (MIN)      (FT)      (CFS)     (MIN)       (IN)       (FPS)

                  PLANE1       2.48      1.67       .64     24.00     252.30     724.94      5.68        .71
                  MAIN         1.63      1.33      2.16    417.50     240.79     725.14      5.53       6.45

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1309E+02 OUTFLOW= .1274E+02 BASIN STORAGE= .7125E-03 PERCENT ERROR=   2.7

                                          INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

                  MAIN         1.63      1.33      5.00               239.05     725.00      5.56

      ***             ***            ***             ***             ***

                         HYDROGRAPH AT STATION        DA5

     TOTAL RAINFALL =     7.33, TOTAL LOSS =     1.65, TOTAL EXCESS =     5.68

   PEAK FLOW      TIME                           MAXIMUM AVERAGE FLOW
                                         6-HR         24-HR         72-HR      35.92-HR
 +    (CFS)       (HR)
                               (CFS)
 +      239.      12.08                   21.            6.            4.            4.
                             (INCHES)    4.538         5.560         5.560         5.560
                              (AC-FT)      10.           13.           13.           13.

                          CUMULATIVE AREA =      .04 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
 193 KK      *        S4  *
             *            *
             **************
                          SUBAREA S4

 195 KO         OUTPUT CONTROL VARIABLES
                      IPRNT            3  PRINT CONTROL
                      IPLOT            0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE
                      IPNCH            7  PUNCH COMPUTED HYDROGRAPH
                       IOUT           21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1            1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2          432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT         .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

 196 BA         SUBBASIN CHARACTERISTICS
                      TAREA          .00  SUBBASIN AREA

                PRECIPITATION DATA

  11 PH                               DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
```

```
              ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =      .00

 197 LS          SCS LOSS RATE
                       STRTL         .38  INITIAL ABSTRACTION
                      CRVNBR       84.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

 198 US          SNYDER UNITGRAPH
                          TP         .33  LAG
                          CP         .74  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                             ***

                                                UNIT HYDROGRAPH PARAMETERS
                                          CLARK   TC=    .42 HR,        R=   .19 HR
                                         SNYDER   TP=    .33 HR,       CP=   .73

                                                     UNIT HYDROGRAPH
                                                15 END-OF-PERIOD ORDINATES
                 1.         2.         3.         4.         4.         3.         2.         1.         1.         1.
                 0.         0.         0.         0.         0.

     ***            ***              ***              ***              ***

                     HYDROGRAPH AT STATION        S4

   TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR        72-HR     35.92-HR

+   (CFS)       (HR)
                          (CFS)
+       8.     12.33                     1.          0.           0.           0.
                        (INCHES)     4.356       5.431        5.431        5.431
                         (AC-FT)        1.          1.           1.           1.

                    CUMULATIVE AREA =      .00 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 199 KK     *        S5  *
            *            *
            **************
                    SUBAREA S5

 201 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS


               SUBBASIN RUNOFF DATA

 202 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .03  SUBBASIN AREA

                 PRECIPITATION DATA

  11 PH                                DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
              ..... HYDRO-35 ......    ............... TP-40 ...............    ........... TP-49 ...........
              5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =      .03

 203 LS          SCS LOSS RATE
                       STRTL         .38  INITIAL ABSTRACTION
                      CRVNBR       84.00  CURVE NUMBER
                       RTIMP         .00  PERCENT IMPERVIOUS AREA

 204 US          SNYDER UNITGRAPH
                          TP         .30  LAG
                          CP         .67  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                             ***

                                                UNIT HYDROGRAPH PARAMETERS
                                          CLARK   TC=    .35 HR,        R=   .24 HR
                                         SNYDER   TP=    .30 HR,       CP=   .67

                                                     UNIT HYDROGRAPH
                                                18 END-OF-PERIOD ORDINATES
                 6.        22.        39.        47.        42.        30.        21.        15.        11.         8.
                 5.         4.         3.         2.         1.         1.         1.         0.
```

```
      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       S5

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                             (CFS)
+      83.     12.33                    16.          5.          3.           3.
                           (INCHES)    4.355       5.430       5.430        5.430
                            (AC-FT)       8.         10.         10.          10.

                       CUMULATIVE AREA =     .03 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  205 KK    *        O5  *
            *            *
            **************
                           SUBAREA O5

  207 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
                        IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                         IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                        ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                        ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                       TIMINT        .083  TIME INTERVAL IN HOURS


                SUBBASIN RUNOFF DATA

  208 BA          SUBBASIN CHARACTERISTICS
                        TAREA         .01  SUBBASIN AREA

                  PRECIPITATION DATA

   11 PH                               DEPTHS FOR   0-PERCENT HYPOTHETICAL STORM
                  ..... HYDRO-35 ......   ............... TP-40 ...............   ........... TP-49 ...........
                  5-MIN  15-MIN  60-MIN    2-HR    3-HR    6-HR   12-HR   24-HR   2-DAY   4-DAY   7-DAY  10-DAY
                    .85    1.69    3.07    3.88    4.38    5.30    6.27    7.33     .00     .00     .00     .00

                                                     STORM AREA =      .01

  209 LS          SCS LOSS RATE
                        STRTL         .38  INITIAL ABSTRACTION
                       CRVNBR       84.00  CURVE NUMBER
                        RTIMP         .00  PERCENT IMPERVIOUS AREA

  210 US          SNYDER UNITGRAPH
                           TP         .41  LAG
                           CP         .71  PEAKING COEFFICIENT

                  SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                                 ***

                                                       UNIT HYDROGRAPH PARAMETERS
                                                  CLARK   TC=    .49 HR,         R=   .28 HR
                                                 SNYDER   TP=    .41 HR,        CP=   .71

                                                             UNIT HYDROGRAPH
                                                       22 END-OF-PERIOD ORDINATES
                     1.        3.        7.        9.       11.       11.        9.        7.        5.        4.
                     3.        2.        1.        1.        1.        1.        0.        0.        0.        0.
                     0.        0.

      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION       O5

    TOTAL RAINFALL =    7.33, TOTAL LOSS =    1.88, TOTAL EXCESS =    5.45

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     35.92-HR
+   (CFS)       (HR)
                             (CFS)
+      22.     12.42                     5.          1.          1.           1.
                           (INCHES)    4.355       5.433       5.433        5.433
                            (AC-FT)       2.          3.          3.           3.

                       CUMULATIVE AREA =     .01 SQ MI


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

            **************
            *            *
  211 KK    *       C/SE *    SOUTHEAST
            *            *
            **************
```

COMBINE HYDROGRAPHS AT SE

```
213 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           3  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
                      IPNCH           7  PUNCH COMPUTED HYDROGRAPH
                       IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                      ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                      ISAV2         432  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS


213 HC          HYDROGRAPH COMBINATION
                      ICOMP           5  NUMBER OF HYDROGRAPHS TO COMBINE
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***

***   ***   ***   ***   ***

HYDROGRAPH AT STATION C/SE

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
				6-HR	24-HR	72-HR	35.92-HR
+	(CFS)	(HR)					
			(CFS)				
+	571.	12.42		157.	49.	33.	33.
			(INCHES)	4.382	5.452	5.452	5.452
			(AC-FT)	78.	97.	97.	97.

CUMULATIVE AREA = .33 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	O1	466.	12.58	132.	41.	27.	.28		
+	ROUTED TO	CLVT	391.	12.83	132.	41.	27.	.28		
+									695.19	12.83
+	HYDROGRAPH AT	O2	188.	12.67	54.	17.	11.	.12		
+	HYDROGRAPH AT	DA1	117.	12.08	11.	3.	2.	.02		
+	2 COMBINED AT	C/DA1	201.	12.67	65.	20.	14.	.14		
+	HYDROGRAPH AT	DA2	195.	12.17	27.	8.	6.	.06		
+	HYDROGRAPH AT	S1	59.	12.33	10.	3.	2.	.02		
+	4 COMBINED AT	C/S1	653.	12.58	234.	73.	49.	.50		
+	HYDROGRAPH AT	NORTH	664.	12.67	241.	75.	50.	.51		
+	HYDROGRAPH AT	DA3	162.	12.08	16.	5.	3.	.03		
+	HYDROGRAPH AT	CH2	149.	12.08	17.	9.	6.	.04		
+	HYDROGRAPH AT	DA4	297.	12.08	27.	8.	6.	.06		
+	HYDROGRAPH AT	CH5	4.	12.08	0.	0.	0.	.00		
+	HYDROGRAPH AT	P1	12.	12.08	1.	0.	0.	.00		
+	4 COMBINED AT	C/P1	461.	12.08	46.	17.	12.	.09		
+	ROUTED TO	RP1	185.	12.25	46.	17.	12.	.09		
+									654.88	12.25
+	HYDROGRAPH AT	S2	10.	12.17	1.	0.	0.	.00		
+	HYDROGRAPH AT	S3	25.	12.33	5.	1.	1.	.01		
+	3 COMBINED AT	C/NE	216.	12.25	52.	19.	13.	.11		
+	HYDROGRAPH AT	O3	206.	12.50	51.	16.	11.	.11		
	HYDROGRAPH AT									

```
+                          S6         12.   12.58          3.          1.          1.        .01

           2 COMBINED AT
+                        C/S6        217.   12.50         53.         17.         11.        .11

           HYDROGRAPH AT
+                          O4        179.   12.50         45.         14.          9.        .10

           HYDROGRAPH AT
+                          S7         16.   12.33          3.          1.          1.        .01

           HYDROGRAPH AT
+                         DA6        140.   12.08         13.          4.          3.        .03

           HYDROGRAPH AT
+                         CH3        129.   12.08         13.          4.          3.        .03

           HYDROGRAPH AT
+                         CH4        120.   12.08         13.          4.          3.        .03

           4 COMBINED AT
+                        C/S7        435.   12.50        114.         36.         24.        .24

           ROUTED TO
+                       CLVRT        435.   12.50        114.         36.         24.        .24
+                                                                                                   685.89       12.50

           HYDROGRAPH AT
+                         DA5        239.   12.08         21.          6.          4.        .04

           HYDROGRAPH AT
+                          S4          8.   12.33          1.          0.          0.        .00

           HYDROGRAPH AT
+                          S5         83.   12.33         16.          5.          3.        .03

           HYDROGRAPH AT
+                          O5         22.   12.42          5.          1.          1.        .01

           5 COMBINED AT
+                        C/SE        571.   12.42        157.         49.         33.        .33
1
                                         SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                            (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                            INTERPOLATED TO
                                                                         COMPUTATION INTERVAL
             ISTAQ     ELEMENT      DT       PEAK     TIME TO      VOLUME        DT        PEAK     TIME TO      VOLUME
                                                        PEAK                                         PEAK

                                  (MIN)     (CFS)      (MIN)        (IN)      (MIN)      (CFS)      (MIN)        (IN)

                 DA1   MANE        2.87    124.82     723.24        5.49       5.00     117.02     725.00        5.46

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .7032E+01 OUTFLOW= .6789E+01 BASIN STORAGE= .5766E-03 PERCENT ERROR=   3.4

                 DA2   MANE        2.60    198.37     729.26        5.57       5.00     194.99     730.00        5.56

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1679E+02 OUTFLOW= .1644E+02 BASIN STORAGE= .5735E-02 PERCENT ERROR=   2.0

               NORTH   MANE        5.00    663.91     760.00        5.44       5.00     663.91     760.00        5.44

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1448E+03 EXCESS= .4683E+01 OUTFLOW= .1495E+03 BASIN STORAGE= .2834E-02 PERCENT ERROR=    .0

                 DA3   MANE        3.95    166.19     725.96        5.50       5.00     162.39     725.00        5.49

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1009E+02 OUTFLOW= .9767E+01 BASIN STORAGE= .8725E-03 PERCENT ERROR=   3.2

                 CH2   MANE        2.79    155.25     726.68        9.62       5.00     148.69     725.00        9.62

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .9746E+01 EXCESS= .6690E+00 OUTFLOW= .1827E+02 BASIN STORAGE= .4582E-01 PERCENT ERROR= -75.8

                 DA4   MANE        3.06    318.17     724.25        5.50       5.00     296.69     725.00        5.50

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1715E+02 OUTFLOW= .1661E+02 BASIN STORAGE= .8922E-03 PERCENT ERROR=   3.2

                 CH5   MANE        1.54      3.75     724.41        5.36       5.00       3.64     725.00        5.36

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .2036E+00 OUTFLOW= .2000E+00 BASIN STORAGE= .1158E-03 PERCENT ERROR=   1.7

                 DA6   MANE        2.57    141.88     725.49        5.50       5.00     139.92     725.00        5.50

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .7880E+01 OUTFLOW= .7632E+01 BASIN STORAGE= .5604E-03 PERCENT ERROR=   3.1

                 CH3   MANE        1.43    134.66     725.77        5.49       5.00     128.51     725.00        5.50

 CONTINUITY SUMMARY (AC-FT) - INFLOW= .7625E+01 EXCESS= .2327E+00 OUTFLOW= .7848E+01 BASIN STORAGE= .3526E-03 PERCENT ERROR=    .1
```

```
             CH4  MANE         1.30    127.76    726.32      5.49      5.00    120.13    725.00          5.50

CONTINUITY SUMMARY (AC-FT) - INFLOW= .7857E+01 EXCESS= .2036E+00 OUTFLOW= .8057E+01 BASIN STORAGE= .3186E-03 PERCENT ERROR=    .0

             DA5  MANE         2.16    240.79    725.14      5.53      5.00    239.05    725.00          5.56

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1309E+02 OUTFLOW= .1274E+02 BASIN STORAGE= .7125E-03 PERCENT ERROR=   2.7


*** NORMAL END OF HEC-1 ***
```

VOLUME CALCULATIONS

EXCESS RAINFALL VOLUME CALCULATION

The volume generated by the site and the surrounding properties is calculated for the 25-year storm event. A summary of the design information that is included in this Appendix and related appendices are listed below.

- Excess rainfall and drainage areas used in the volume calculations were taken from the HEC-1 analysis located on pages IIIF-E-24 through IIIF-E-60.
- Permitted landfill condition volume information is summarized on pages IIIF-E-63 through IIIF-E-64.

TURKEY CREEK LANDFILL
0771-368-11-123
EXCESS RAINFALL
VOLUME CALCULATIONS

Required: Determine the volume generated by the site and offsite areas using the excess rainfall calculated in the HEC-1 analysis of the post-development site conditions.

Method: 1. Use the excessive rainfall data generated by the HEC-1 analysis (see Appendix IIIF-E) to determine the volume produced by the site for the post-development conditions.

1. Post-development Conditions

1. a. Total Flow to Unnamed Tributary of Turkey Creek **northeast** of permit boundary (DCP1)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA3	**0.0333**	**5.68**	**21.31**	**10.1**
DA4	**0.0566**	**5.68**	**36.22**	**17.1**
S2	**0.0027**	**5.45**	**1.74**	**0.8**
S3	**0.0100**	**5.45**	**6.40**	**2.9**
CH2	**0.0023**	**5.45**	**1.47**	**0.7**
CH5	**0.0007**	**5.45**	**0.45**	**0.2**
P1	**0.0021**	**7.33**	**1.34**	**0.8**

Total Volume of flow discharging from northeast of the Permit Boundary (refer to Figure 4.4 in the Drainage Report for the location) = 32.6 ac-ft

1. b. Total volume of flow for areas discharging to the **north** (DCP2)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA1	**0.0232**	**5.68**	**14.83**	**7.0**
DA2	**0.0554**	**5.45**	**35.46**	**16.1**
O1	**0.2820**	**5.45**	**180.49**	**82.0**
O2	**0.1166**	**5.45**	**74.63**	**33.9**
S1	**0.0216**	**5.45**	**13.82**	**6.3**
CH1	**0.0161**	**5.45**	**10.30**	**4.7**

Total Volume of flow discharging from north of the Permit Boundary (refer to Figure 4.4 in the Drainage Report for the location) = 149.9 ac-ft

1. c. Total flow to Turkey Creek from southeast corner (DCP3)

Area No.	Area (sq mi)	Total Excess Rainfall (in)	Area (ac)	Volume (ac-ft)
DA5	**0.0432**	**5.68**	**27.65**	**13.1**
DA6	**0.0260**	**5.68**	**16.51**	**7.8**
O3	**0.1082**	**5.45**	**69.25**	**31.5**
O4	**0.0954**	**5.45**	**61.05**	**27.7**
O5	**0.0099**	**5.45**	**6.34**	**2.9**
S4	**0.0030**	**5.45**	**1.93**	**0.9**
S5	**0.0334**	**5.45**	**21.38**	**9.7**
S6	**0.0059**	**5.45**	**3.78**	**1.7**
S7	**0.0064**	**5.45**	**4.10**	**1.9**
CH3	**0.0008**	**5.45**	**0.51**	**0.2**
CH4	**0.0007**	**5.45**	**0.45**	**0.2**

Total Volume of flow discharging from southeast of the Permit Boundary (refer to Figure 4.4 in the Drainage Report for the location) = 97.6 ac-ft

VELOCITY CALCULATIONS

TURKEY CREEK LANDFILL
0771-368-11-123
VELOCITY CALCULATIONS
EXISTING EXPANSION CONDITION

Required: Determine the flow velocities entering and exiting the permit boundary using HYDROCALC HYDRAULICS (Version 2.0, 1996-2010) for the flows calculated for the 25-year and 25- year storm event in the HEC-1 analysis.

Method:
1. Use the flow data generated by the HEC-1 analysis to determine velocity of runoff entering the landfill permit boundary.
2. Use the flow data generated by the HEC-1 analysis to determine velocity of runoff exiting the landfill permit boundary.

1. Flow Velocity entering the landfill permit boundary

O1

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 466 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	466	0.0110	0.03	2.00	2.00	15.00	2.72	8.38

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O2

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 188 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	188	0.0115	0.03	2.00	2.00	30.00	1.09	5.34

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O3

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 206 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	206	0.0182	0.03	2.00	4.00	20.00	1.33	6.47

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O4

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 179 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	179	0.0172	0.03	50.00	50.00	15.00	0.82	3.93

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

O5

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 22 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	22	0.0282	0.03	100.00	40.00	100.00	0.11	1.84

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)

2.

Flow Velocity exiting the landfill permit boundary

DCP1

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 297 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	297	0.013	0.03	2.50	2.50	17.00	1.86	7.37

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

DCP2

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 664 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	664	0.018	0.03	5.00	5.00	0.00	3.68	9.83

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

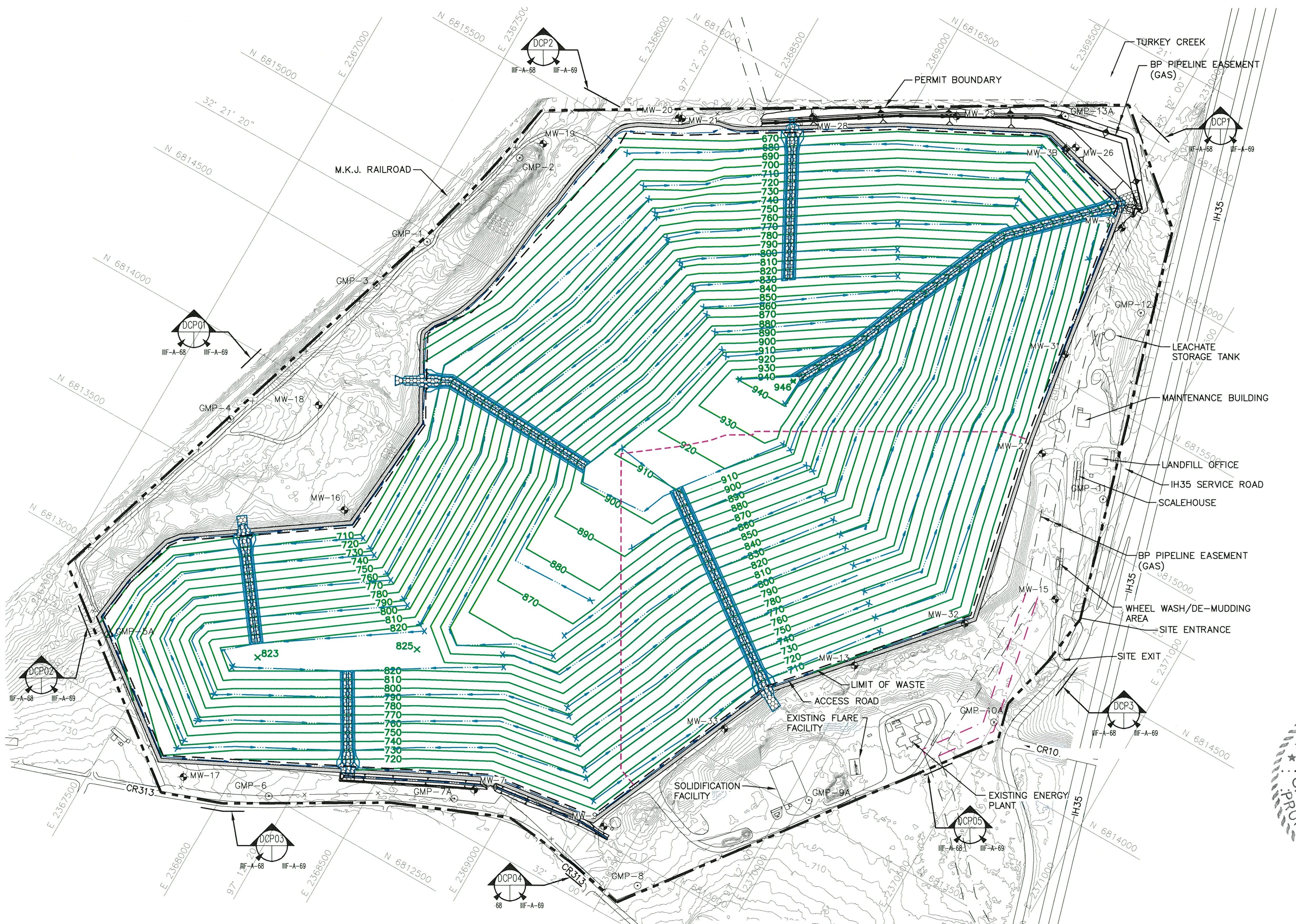
DCP3

- Flows were obtained from the HEC-1 files included in this Appendix and are summarized below.

Q_{25} = 564 cfs

Storm Year	Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
25	564	0.065	0.03	2.00	2.00	28	1.31	14.11

Note: Calculations were performed using the HYDROCALC HYDRAULICS for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010)



LEGEND

— · —	PERMIT BOUNDARY
— — —	PERMITTED LIMITS OF WASTE
750	EXISTING CONTOUR
N 6816000	STATE PLANE COORDINATE
32° 21' 20"	GEODETIC COORDINATE
— · — · —	EASEMENT
800	FINAL COVER CONTOUR
- - -	LIMIT OF CLASS 1 WASTE DISPOSAL AREA
	DRAINAGE LETDOWN
	DRAINAGE SWALE
	GABIONS
MW-7	EXISTING GROUNDWATER MONITORING WELL
GMP-12	EXISTING GAS MONITORING PROBE

NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021. THE GRID SYSTEM IS TIED TO THE TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE NAD 1983.
2. REFER TO APPENDIX IIIF-SURFACE WATER DRAINAGE PLAN FOR DRAINAGE DESIGN INFORMATION.
3. MAXIMUM FINAL COVER ELEVATION IS 946.0 FT-MSL. MAXIMUM TOP OF WASTE ELEVATION IS 942.5 FT-MSL.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED
PROFESSIONAL ENGINEER
2-22-22

O:\0771\368\EXPANSION 2021\PART III\IIIF-E\IIIF-E-68_PERMITTED LANDFILL DRAINAGE.dwg, rarrington, 1:2

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-E-68-POST DEV DRAINAGE.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

MAJOR PERMIT AMENDMENT
PERMITTED LANDFILL DRAINAGE

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

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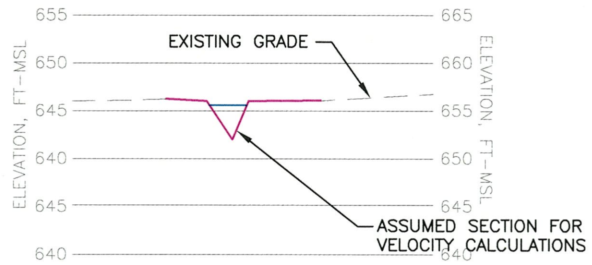
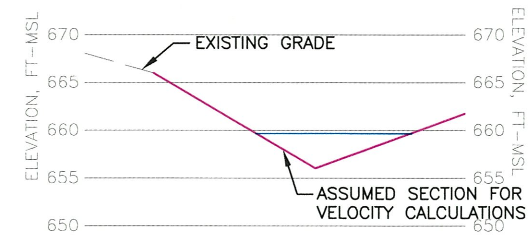
DRAWING IIIF-E-68



DISCHARGE POINT 1 (DCP1, IIIF-A-68, IIIF-A-69)

0 40 80
SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)



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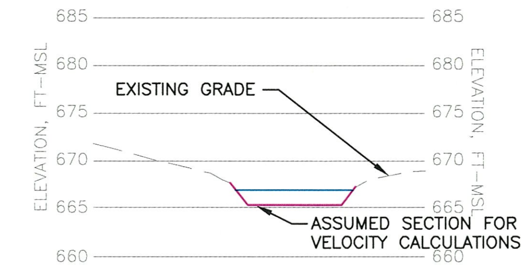
SCALE IN FEET (VERTICAL)



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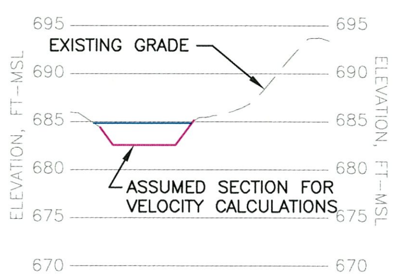
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 01 (DCP01, IIIF-A-68, IIIF-A-69)

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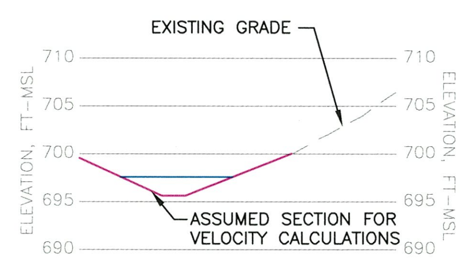
SCALE IN FEET (VERTICAL)



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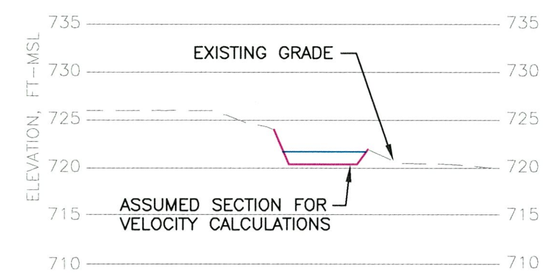
SCALE IN FEET (VERTICAL)



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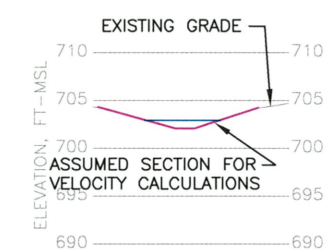
SCALE IN FEET (VERTICAL)



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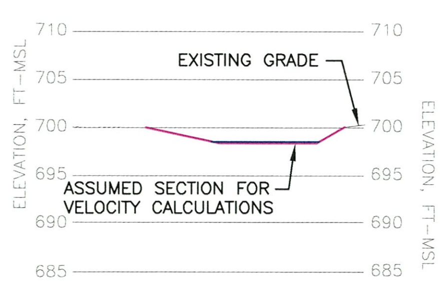
SCALE IN FEET (VERTICAL)



DISCHARGE POINT 05 (DCP05, IIIF-A-68, IIIF-A-69)

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SCALE IN FEET (HORIZONTAL)
0 10 20
SCALE IN FEET (VERTICAL)

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☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-E-69-DISCHARGE POINT SEC.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

MAJOR PERMIT AMENDMENT
UPDATED PERMITTED DISCHARGE POINT VELOCITY CALCULATIONS

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING IIIF-E-69

APPENDIX IIIF-F

EROSION CONTROL PLAN FOR ALL PHASES OF LANDFILL OPERATION

Includes pages IIIF-F-1 through IIIF-F-15

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2-22-22

CONTENTS

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EROSION CONTROL PLAN FOR ALL PHASES OF LANDFILL OPERATION

1.0 Introduction

The purpose of this appendix is to provide an Erosion Control Plan (ECP) to meet the requirements of Title 30 Texas Administrative Code (TAC) Chapter §330.305(d), which are listed below.

> *"The landfill design must provide effective erosional stability to top dome surfaces and external embankment side slopes during all phases of landfill operation, closure, and post-closure care in accordance with the following.*
>
> *(1) Estimated peak velocities for top surfaces and external embankment slopes should be less than the permissible non-erodible velocities under similar conditions.*
>
> *(2) The top surfaces and external embankment slopes of municipal solid waste landfill units must be designed to minimize erosion and soil loss through the use of appropriate side slopes, vegetation, and other structural and nonstructural controls, as necessary. Soil erosion loss (tons/acre) for the top surfaces and external embankment slopes may be calculated using the Soil Conservation Service of the United States Department of Agriculture's Universal Soil Loss Equation, in which case the potential soil loss should not exceed the permissible soil loss for comparable soil-slope lengths and soil-cover conditions."*

This ECP has also been developed to meet the requirements of the Texas Commission on Environmental Quality (TCEQ) guidance document titled, "Guidance for Addressing Erosional Stability During All Phases of Landfill Operation." As noted in the above guidance document, landfill cover phases are defined as daily cover, intermediate cover, and final cover. Top dome surfaces and external embankment side slopes are:

- Those above grade slopes that directly drain to the site perimeter stormwater management system (i.e., areas where the stormwater directly flows to a perimeter channel or detention pond designed in accordance with Title 30 TAC §330.63(c), §330.303, and §330.305);
- Above grade slopes that have received intermediate or final cover; and
- Above grade slopes that have either reached their permitted elevation, or will subsequently remain inactive for longer than 180 days. For example, after an above grade slope has reached the permitted elevation and

intermediate cover has been placed, the structural erosion control features (e.g., drainage swales, letdown structures, and/or sedimentation ponds) will be in-place 180 days after intermediate cover has been placed.

Slopes which drain to ongoing waste placement areas, pre-excavated areas, areas that have received only daily cover, and areas under construction which have not received waste are not considered external side slopes.

The ECP for daily cover areas and top dome surfaces and external side slopes that drain directly to the site perimeter stormwater management system, have received intermediate cover, and either reached their permitted configuration or will remain inactive for longer than 180 days are addressed in the following sections. Erosion control measures for final cover areas are addressed in the currently TCEQ-approved Site Development Plan (SDP).

Inspection, maintenance, and recordkeeping requirements are included in the Site Operating Plan (SOP). The word "temporary" is used throughout the ECP to describe any erosion control feature that is not a permanent erosion control feature that is included in the approved Site Development Plan. Additionally, "temporary" is defined as the time between construction of intermediate cover and the construction of final cover. Temporary erosion controls are those controls which may be installed or constructed within 180 days from when the intermediate cover is constructed and in place until permanent controls are constructed for the final cover.

2.0 Erosion Control Plan for Top Dome Surfaces and External Side Slopes with Intermediate Cover

Erosion control for above grade top dome surfaces and external embankment side slopes that drain directly to the site perimeter stormwater management system, have received intermediate cover, and either reached their permitted configuration or may remain inactive for longer than 180 days will be managed using a system of nonstructural and structural erosion and sediment controls to meet rule requirements for the intermediate cover phase of landfill construction.

The structural controls may consist of a combination of vegetation, temporary add-on swales, and letdown structures. These structural controls will be configured in a manner that will result in a net soil loss of 50 tons/acre/year or less from the external slope area. As shown on Sheet IIIF-F-10, stormwater runoff will be collected in swales and conveyed to drainage letdown structures down the 28.6 and 25 percent slopes to the perimeter drainage system. The primary goal will be to establish the vegetative cover percentage and swale spacing distance indicated in the swale design summary table on Sheet IIIF-F-11 on all external top dome surfaces and external embankment slopes. These criteria will result in a net soil loss of 50 tons/acres/year or less for each drainage swale and letdown combination specified on Sheets IIIF-F-10 and IIIF-F-11 (refer to Section 2.1 for additional information).

Mulch, woodchips, compost or straw/hay may be used as a layer placed over the intermediate cover to protect the exposed soil surface from erosive forces and conserve soil moisture until vegetation can be established. The mulch, woodchips, compost or straw/hay may be used to stabilize recently graded or seeded areas. If needed, the mulch, woodchips, compost or straw/hay will be spread evenly over a recently seeded area and tracked into the surface to protect the soil from erosion and moisture loss, and provide additional erosional stability to the intermediate cover surface during the establishment of vegetation. These materials are not required for the establishment of vegetation on the intermediate cover unless they are needed to provide additional erosional stability to the intermediate cover surface. These materials will vary in thickness but the mulch, woodchips, compost or straw/hay will be placed so as not to inhibit the growth of vegetation. In the event that the indicated vegetative ground cover required for a specific swale spacing distance is not obtained within 180 days after intermediate cover is placed on a top dome or external side slope, mulch, woodchips, compost or straw/hay may be used as a secondary measure to limit soil loss to 50 tons/acre/year or less until vegetation is established. In the above referenced cases, other erosion protection measures will only be used upon prior written authorization by TCEQ (e.g., permit modification). Stormwater discharge from the site must comply with the current TPDES for the site. The discharge locations for the site are identified in Appendix IIIF as a part of the final drainage design and cannot be revised based on this ECP. Design and use of temporary erosion control measures cannot result in offsite discharge exceeding the peak flow rates, volumes, or velocities listed in Table 4-1 of Appendix IIIF.

As an alternative to mulch, wood chips, compost, or straw/hay, a detention/ sedimentation pond may be used as a secondary measure to limit the discharge of eroded soil loss to 50 tons/acre/year or less (refer to Section 2.2 for additional information) if the required percent vegetation goal is not obtained within 180 days after intermediate cover is placed on the top dome or external side slopes. In this case, the detention/sedimentation pond will remain in place until the specified percent vegetation goal is met (e.g., 60 percent vegetation on the external embankment slopes and top dome surfaces).

2.1 Drainage Swale and Letdown Structure Requirements

Sheet IIIF-F-10 shows a typical layout for erosion control structures, including temporary add-on swales and drainage letdowns. Sheet IIIF-F-11 provides a swale design summary, which includes spacing and vegetative cover requirements for the swales. Supporting calculations for the specifications listed on Sheet IIIF-F-11 are provided in Appendix IIIF-F-1 – Temporary Add-on Swale Design. Appendix IIIF-F-1 also includes a demonstration to show that sheet flow velocities for the grass established surfaces for all swale spacings are less than 5 ft/sec and sheet flow velocity for "nearly bare ground" is less than 3.5 ft/sec (consistent with Title 30 TAC §330.305(d)(1)).

Letdown structures will be located and constructed in a manner that minimizes erosion loss. The letdowns are designed to convey runoff from the 25-year frequency storm event (refer to Appendix IIIF-F-2 – Temporary Letdown Design for more information). Sheet IIIF-F-12 shows letdown details and the letdown design summary. As shown on Sheet IIIF-F-12, the letdowns will consist of either a lined open channel structure or a pipe letdown. The type, size, and number of letdowns will be determined based on the size of the drainage area using the design information specified on Sheet IIIF-F-12. As noted on Sheet IIIF-F-12, the use of pipe letdowns will be limited to 1 inlet per letdown.

As noted on Sheet IIIF-F-10, the acceptable soil loss is determined for each acre on the top dome surfaces and external embankment side slopes. The soil loss for top dome surfaces and external embankment side slopes will vary depending on swale spacing and percent vegetative cover (refer to Sheet IIIF-F-11 for soil loss estimates). If certain percent vegetation cover is not achieved, a sediment control pond will be temporarily used for sediment capture to reduce the discharge of eroded soil from the external slopes to a rate that is equal to or less than 50 tons/acre/year. The swale spacing as shown on Sheet IIIF-F-11 for top dome and side slope surfaces is based on the limiting soil loss of 50 tons/acres/year. If a vegetative coverage and swale spacing configuration results in a soil loss greater than 50 tons/acre/year, the following procedure will be used to verify that an acceptable intermediate cover thickness is maintained.

- Intermediate cover areas will be inspected to detect erosion gullies and vegetation loss.
- After identifying the areas requiring additional soil, these areas will be replenished with additional soil and graded to provide uniform surfaces prior to reseeding.
- Any damaged concentrated flow drainage structures such as swales will be repaired to eliminate uncontrolled concentrated flow.

Temporary open channel letdowns will be inspected for erosion/hollowing through and under the lining materials (e.g., gabions, grouted riprap, and turf reinforcement) and repaired as necessary to ensure the letdown is functioning as designed. Numerous erosion control structures have been installed at the site that conform to the requirements of this ECP, and these structures will remain in place and continue to serve as erosion control measures until they are decommissioned.

As stated previously, the primary goal is to obtain the required vegetation coverage percentage for each condition (e.g., swale spacing).

2.2 Sedimentation Pond Design

As noted on Sheets IIIF-F-10 and IIIF-F-11, if vegetative cover for any surface is maintained at or above the percentages given for swale spacing distances, the estimated soil loss is less than 50 tons/acre/year. In the event that certain percent ground cover that limits the soil loss to 50 tons/acre/year is not achieved and soil loss is temporarily greater than 50 tons/acre/year, a sedimentation pond will be used along with other structural and non-structural BMPs approved as part of this plan to limit the discharge of eroded soil. Sheet IIIF-F-13 provides a procedure for determining the required pond size. Supporting calculations for the procedure listed on Sheet IIIF-F-13 are included in Appendix IIIF-F-3 – Sediment Control Pond Design. If a sediment control pond is used to limit the off-site discharge of eroded soil to 50 tons/acre/year or less from the external slope area, a demonstration noting how the pond was sized will be documented and maintained in the Site Operating Record. This document will also include a statement that notes how the temporary sedimentation pond, the pond outlet, and any related perimeter channels were constructed consistent with the requirements of the Site Development Plan. Sheet IIIF-F-14 shows the different options for typical pond outlet structures.

The sedimentation pond option is a secondary erosion control option, similar to mulch, wood chips, compost, or straw/hay, and will only be used if the required percent vegetation specification is not met. If the sedimentation pond option is implemented, the swales and letdowns specified will remain in-place. The sedimentation pond option simply allows for the control of sediment while vegetation is being established.

For example, if intermediate cover is placed over a 20-acre external side slope area that is at the permitted elevation on December 31, then the operator will install swales and letdowns on the 20-acre slope consistent with the design and specifications listed in Section 2.1. The operator then has 180 days (which for this example would be June 29) to obtain the required vegetation coverage on the 20-acre area. If in early June it becomes apparent that the percent vegetation will be less than the required coverage on June 29, then the operator may install a sedimentation pond downstream of the 20-acre area, consistent with the requirements shown on Sheet IIIF-F-13. Consistent with Section II.D of the TCEQ guidance document titled, "Guidance for Addressing Erosional Stability During All Phases of Landfill Operation," the sedimentation pond will remain in-place so that the net annual soil loss from the 20-acre area that could leave the facility boundary is less than 50 tons/acre/year until the required percent vegetation specification is met.

If a sedimentation pond is used as a source to maintain a soil loss equal to or less than 50 tons/acre/year, the following procedure will be used to verify that an acceptable intermediate cover thickness is maintained.

- Intermediate cover areas will be inspected to detect erosion gullies and vegetation loss.
- After identifying the areas requiring additional soil, these areas will be replenished with additional soil and graded to provide uniform surfaces prior to reseeding.
- Any damaged concentrated flow drainage structures such as swales will be repaired to eliminate uncontrolled concentrated flow.

As stated previously, the primary goal is to obtain the specified vegetation coverage percentage on top dome surfaces and external embankments. The sedimentation pond will only be used until the specified vegetation coverage percentage is obtained. The sedimentation pond may only be used for a period of 12 months after the 180-day period has expired (e.g., 12 months after the June 29th date used in the above example). Once the required vegetation percentage is achieved, then the sedimentation pond will no longer be needed (but may remain in-place as an additional BMP until the site reaches the permitted final configuration). If the percent vegetation does not meet the required specification within the 12-month period, then additional erosion control measures will be implemented. These measures will include: (1) adjusting the swale spacing, (2) applying mulch, wood chips, compost, or straw/hay, or similar TCEQ approved materials, or (3) the submittal of a permit modification to revise this erosion control plan to provide additional erosion protection measures that will allow the site to meet the goals of this plan.

2.3 Other Erosion Control BMPs

Other best management practices (BMPs) used in conjunction with the above erosion control measures are listed below.

- Check Dams – These structures will be used in channels to slow down flow velocities and improve sediment capture.
- Silt Fences – These structures will be used in capturing sediment transported by sheet flow and for diversion of flow for controlling sediment discharge.
- Compost Filter Berms – These structures may be used in capturing sediment transported by sheet flow and for diversion of flow for controlling sediment discharge.
- Erosion Booms – These structures may be used in capturing sediment and for diversion of flow for controlling sediment discharge.

These erosion control measures will be used on slopes to help control erosion loss. Rock check dams will be used in the detention/sedimentation pond. Refer to Sheet IIIF-F-15 for details of typical BMPs.

Nonstructural controls that will be used at the site to minimize erosion loss include: plans and designs to minimize disruption of the natural features, drainage, topography, and vegetative cover features; phased development to minimize the area of bare soil exposed at any given time; plans to disturb only the smallest area necessary to perform current activities; scheduling of construction activities during the time of year with the least erosion potential; and specific plans for the stabilization of exposed surfaces in a timely manner. Other BMPs will only be utilized upon prior written authorization (e.g., permit modification) by TCEQ.

2.4 Schedule and Recordkeeping Requirements

After an external side slope or top dome surface reaches the final permitted grade or will remain inactive for longer than 180 days, the structural erosion control features and letdown structures will be in place within 180 days from when intermediate cover is placed. During this 180 day period, the structural erosion control structures will be constructed and vegetation established. Structural erosion control measures consist of drainage swales, letdown structures, and detention ponds.

At the end of this 180-day period, the cover log will be updated to document the external side slope and top dome surface area, the structural controls that were installed, and a demonstration showing how the structural controls meet the 50 tons/acre/year or less soil loss requirement (e.g., percent vegetation coverage, swale spacing, and letdowns installed). Inspection requirements and schedules are listed in the SOP for all drainage features, including intermediate cover areas. If the required percent vegetation coverage is not achieved within the 180-day period, secondary erosion control measures such as mulch, wood chips or compost will be used to limit the soil loss to the 50 tons/acre/year or less. Other erosion protection measures will only be utilized upon prior written authorization (e.g., permit modification) by TCEQ. In addition, a detention/sedimentation pond may also be used until the required vegetation coverage is achieved. Any secondary measure used will be documented in the Site Operating Record at the end of the 180-day period to document compliance with this plan. In addition, the date the required vegetation cover is achieved and the date that the secondary measure is no longer needed will also be documented in the Site Operating Record. The dates and locations of installation of erosion and sediment control will also be documented in the Site Operating Record. Inspection requirements and schedules are listed in the SOP for all drainage features, including intermediate cover areas. Inspection and maintenance of the erosion and sediment control structures of the top dome surfaces and external embankment side slopes will follow the same schedule and methods as described in Section 4.24 of the facility's SOP.

For example, as stated in Section 4.18.3 of the current Site Operating Plan (SOP), intermediate cover areas are inspected weekly and within 72 hours of a rainfall event of 0.5 inches or more, or as soon as the areas are accessible, for proper placement, thickness, erosion, and compaction. Additionally, Section 4.23 of the SOP also requires inspections of perimeter channels and ponds to ensure they are functioning as designed (e.g., excess sediment removed, outlet structures intact, and erosion control measures intact, etc.) on a weekly basis and after a rainfall event of 0.5 inches or more, or as soon as the areas are accessible.

During the inspection of structural controls (e.g., vegetation over intermediate cover areas), if significant soil loss is identified in a given intermediate cover area, impacted areas will be replenished with additional soil. Prior to application of temporary erosion controls and seeding, the area will be graded to eliminate preferential path ways or any other uneven surface due to settlement to prevent concentrated flow over the intermediate cover areas. Soil for replenishment of cover areas will be borrowed from sedimentation ponds or any other soil source. If sediment collected from wet retention pond(s) (e.g., Pond NP or temporary sedimentation ponds) is used for erosion layer replenishment, it will be stockpiled outside the ponds to dry out prior to being used for intermediate cover layer replenishment. Soil borrowed from other soil sources may be used as intermediate cover layer and erosion layer replenishment soil.

2.5 Construction Activities on Top Dome Surfaces and External Side Slopes with Intermediate Cover

Occasionally, top dome surfaces and external side slopes that have been stabilized through the use of swales, letdown structures, and compliance with the minimum required vegetation cover specification will be disturbed due to various construction activities such as the installation or repair of a landfill gas system, regrading of an area due to ponded water caused by uneven waste settlement, the repair of erosion rills, or damage due to an extreme storm event or natural disaster. Each of these events will be documented in the Site Operating Record. Recorded information will include the date of construction, approximate area disturbed, and the date re-seeding of the disturbed area occurred. In accordance with Title 30 TAC §330.165(g), previously stabilized surfaces will be repaired within 5 days of detection of the disturbance of these surfaces.

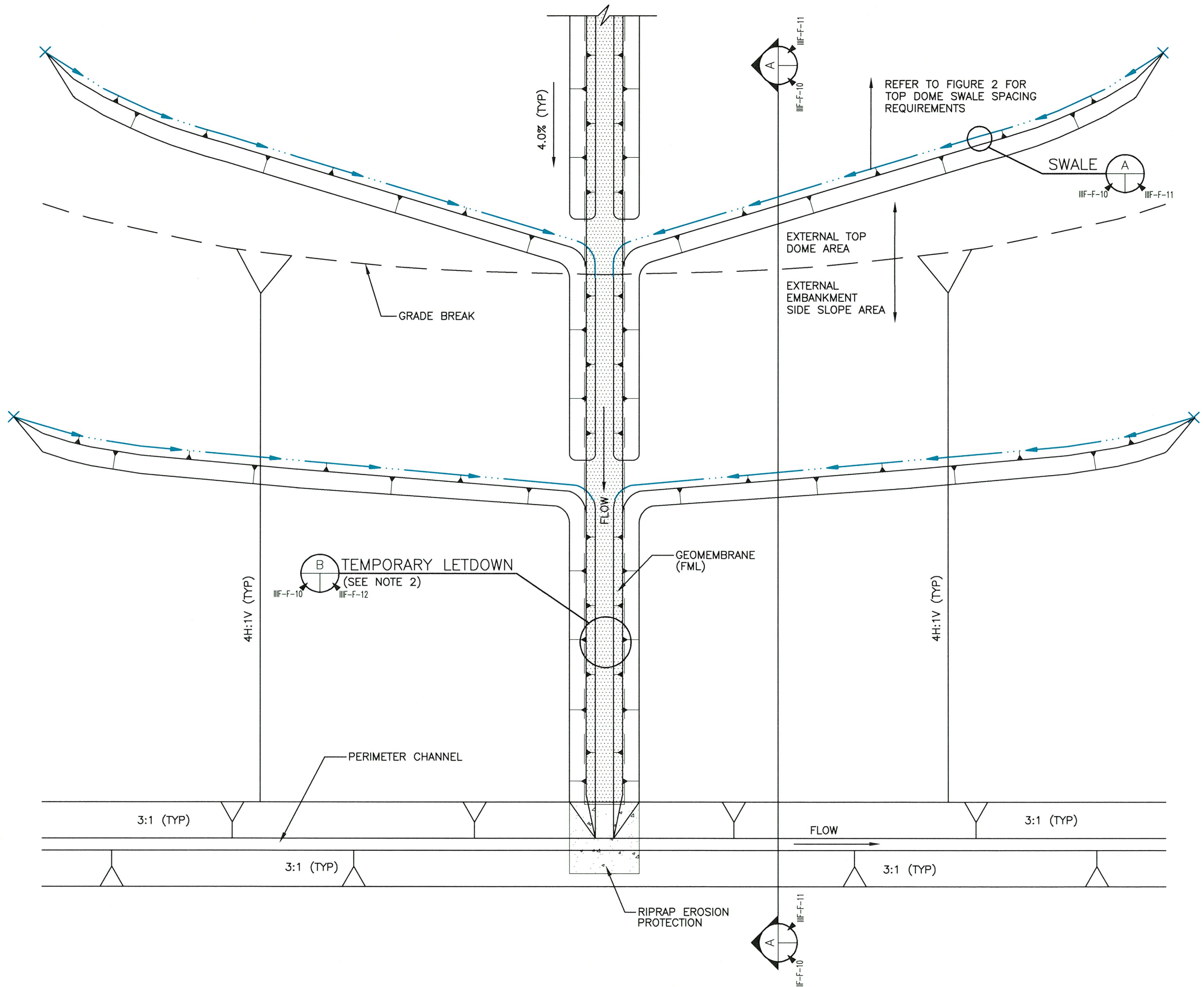
3.0 Erosion Control Plan for Daily Cover Areas and Intermediate Cover Areas for Non-External Side Slopes

BMPs will be employed to control erosion. BMPs will include the use of temporary rock riprap, silt fences, straw bales, check dams, interceptor swales and berms, temporary and permanent seeding and sodding, surface roughening, matting and mulching, sediment traps, and surface wetting for dust control.

Examples of erosion and sedimentation control features that will be used during the phased development of the site are shown in Appendix IIIA-A of the Site Development Plan. The following provides general guidelines of how the erosion control features will minimize sediment discharge from the site.

- As noted in the SOP, vegetation will be established on above-grade intermediate cover areas that remain inactive. The temporary vegetative cover will minimize erosion potential.
- Typically, uncontaminated stormwater runoff from the site will be channeled through the perimeter channel system to detention ponds before being discharged from the site. Sediment that collects in the channels and detention ponds will be removed consistent with the stormwater system maintenance plan presented in Section 2.3 of Appendix IIIF.
- Erosion will be controlled by vegetation in drainage structures with flow velocities less than or equal to 5 ft/sec. For drainage structures with flow velocities greater than 5 ft/sec, rock riprap or gabions will be used for surface reinforcement. Other erosion protection measures will only be utilized upon prior written authorization (e.g., permit modification) by TCEQ.

Typical erosion control features are shown on Sheet IIIF-F-15. Inspection items and schedules are listed in the SOP for all drainage features, daily cover, and intermediate cover areas.



LEGEND

- DRAINAGE SWALE FLOWLINE
- LETDOWN
- GEOMEMBRANE LINING WITHIN LETDOWN (SEE NOTE 2)
- RIPRAP EROSION PROTECTION

NOTES:

1. THE ACCEPTABLE SOIL LOSS IS LESS THAN OR EQUAL TO 50 TONS/ACRE/YEAR. THE SOIL LOSS FOR TOP DOME SURFACES AND EXISTING EXTERNAL EMBANKMENT SIDE SLOPES WILL VARY DEPENDING ON SWALE SPACING AND PERCENT VEGETATIVE COVER (REFER TO SHEET IIIF-F-11 FOR SOIL LOSS ESTIMATES).
2. TEMPORARY LETDOWN IS SHOWN AS AN OPEN CHANNEL WITH A GEOMEMBRANE LINER. AS NOTED ON SHEET IIIF-F-12, OTHER CHANNEL LININGS MAY BE USED (e.g., GABIONS, GROUT, GROUTED CONCRETE RIPRAP, AND TURF REINFORCEMENT MAT). IN ADDITION, PIPE LETDOWNS MAY ALSO BE USED. HOWEVER, IF PIPE LETDOWNS ARE USED THEY WILL BE LIMITED TO 1-INLET AS SHOWN ON SHEET IIIF-F-12.

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REVIEWED BY: CRM

PREPARED FOR
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REVISIONS

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EROSION CONTROL PLAN
TYPICAL EROSION CONTROL STRUCTURE LAYOUT

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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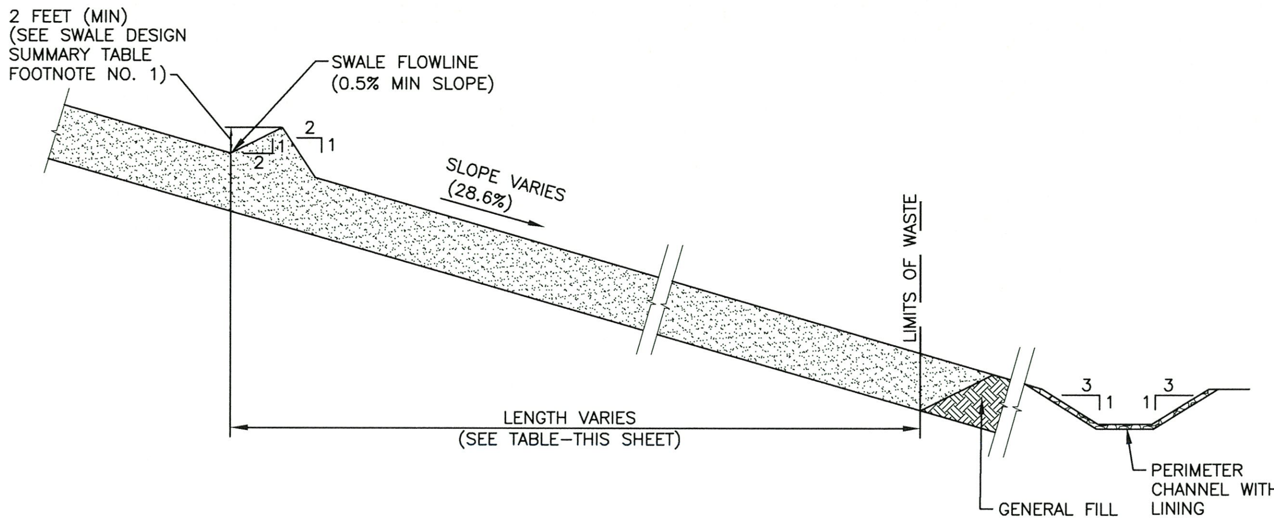
SHEET IIIF-F-10



A — IIIF-F-10 / IIIF-F-11

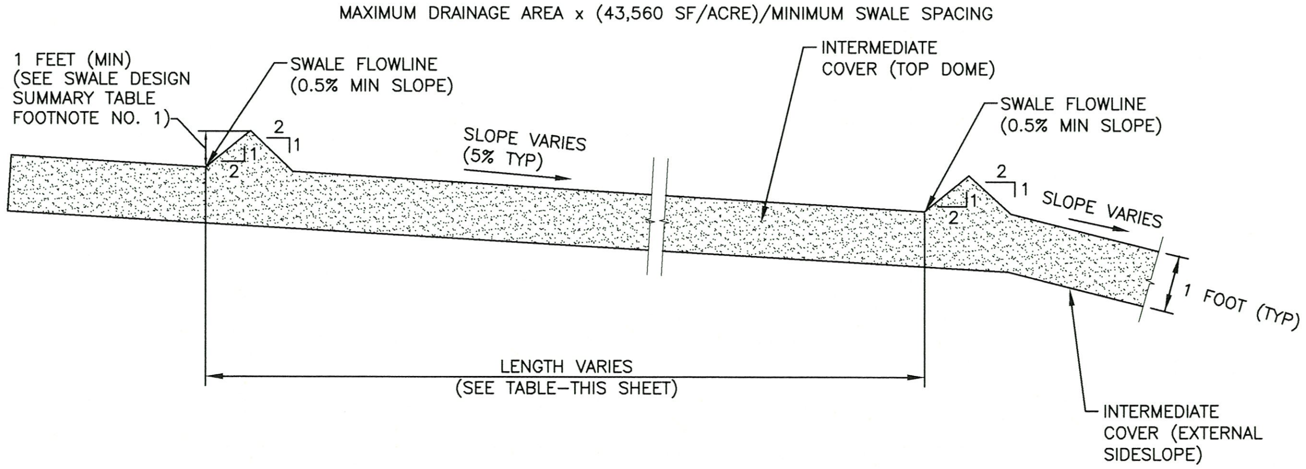
SIDE SLOPE DRAINAGE SWALE

SWALE DRAINAGE AREA SUMMARY			
CONDITION (SWALE HEIGHT)	MAXIMUM DRAINAGE AREA (ACRES)	MINIMUM SWALE SPACING[1] (FEET)	MAXIMUM SWALE LENGTH[2] (FEET)
TOP SLOPE (2 FT SWALE, 5%)	27.5	200	5,984
TOP SLOPE (1.5 FT SWALE, 5%)	12.8	200	2,781
TOP SLOPE (1 FT SWALE, 5%)	4.3	200	943
SIDE SLOPE (2 FT SWALE, 28.6%)	6.6	105	2,757
SIDE SLOPE (2 FT SWALE, 25%)	7.3	120	2,640

[1] THE MINIMUM SWALE SPACING IS USED TO DETAIN THE MAXIMUM SWALE LENGTH GIVEN THAT THE AREA IS FIXED. MINIMUM SWALE SPACING IS OBTAINED FROM THE CALCULATIONS PROVIDED ON PAGE IIIF-F-1-10.

[2] MAXIMUM SWALE LENGTH CALCULATED USING THE FOLLOWING EQUATION:

MAXIMUM DRAINAGE AREA x (43,560 SF/ACRE)/MINIMUM SWALE SPACING



A — IIIF-F-10 / IIIF-F-11

TOP DOME SURFACE DRAINAGE SWALE

SWALE DESIGN SUMMARY[1]

TOP SLOPE (5%)			
VEGETATIVE COVER PERCENTAGE	DISTANCE BETWEEN SWALES[3] (FT)	ESTIMATED SOIL LOSS (TONS/ACRE/YEAR)	ADDITIONAL SEDIMENT CAPTURE REQUIRED[2]
60	200	2.3	NO
70	200	0.9	NO
80	200	0.7	NO
90	200	0.3	NO
60	500	4.0	NO
70	500	1.6	NO
80	500	1.2	NO
90	500	0.6	NO
60	700	4.6	NO
70	700	1.8	NO
80	700	1.4	NO
90	700	0.7	NO

SIDE SLOPE (28.6%)			
VEGETATIVE COVER PERCENTAGE	DISTANCE BETWEEN SWALES (FT)	ESTIMATED SOIL LOSS (TONS/ACRE/YEAR)	ADDITIONAL SEDIMENT CAPTURE REQUIRED[2]
60	105	25.3	NO
70	105	10.2	NO
80	105	7.8	NO
90	105	3.9	NO
60	200	31.1	NO
70	200	12.6	NO
80	200	9.6	NO
90	200	4.7	NO
60	300	32.3	NO
70	300	13.1	NO
80	300	10.0	NO
90	300	4.9	NO

SIDE SLOPE (25.0%)			
VEGETATIVE COVER PERCENTAGE	DISTANCE BETWEEN SWALES (FT)	ESTIMATED SOIL LOSS (TONS/ACRE/YEAR)	ADDITIONAL SEDIMENT CAPTURE REQUIRED[2]
60	120	19.8	NO
70	120	8.0	NO
80	120	6.1	NO
90	120	3.0	NO
60	200	24.1	NO
70	200	9.7	NO
80	200	7.4	NO
90	200	3.7	NO
60	300	31.1	NO
70	300	12.6	NO
80	300	9.6	NO
90	300	4.7	NO

[1] REFER TO APPENDIX IIIF-F-1 FOR SUPPORTING CALCULATIONS.

[2] IF SITE SPECIFIC CONDITIONS YIELD A MAXIMUM HORIZONTAL DISTANCE BETWEEN THE TOE OF THE SLOPE AND GRADE BREAK OF LESS THAN 120 FEET FOR SIDE SLOPES AND A DISTANCE OF 200 FEET FROM THE GRADE BREAK TO THE PEAK OF THE TOP SLOPES, ESTABLISHMENT OF 60% VEGETATION WILL BE SUFFICIENT MEANS OF EROSION CONTROL WITHOUT THE ADDITION OF TEMPORARY SWALES AND LETDOWNS GIVEN THAT THE TOTAL SOIL LOSS FOR THE SIDE SLOPE IS LESS THAN 50 TONS/ACRE/YEAR AND THE TOP SLOPE IS LESS THAN 50 TONS/ACRE/YEAR.

[3] NUMBERS INDICATE THE MAXIMUM SWALE SPACING FOR A GIVEN VEGETATIVE COVER PERCENTAGE.

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NO.	DATE	DESCRIPTION

EROSION CONTROL PLAN
SWALE DESIGN SUMMARY

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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SHEET IIIF-F-11

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OPEN CHANNEL GEOMEMBRANE LETDOWN DESIGN SUMMARY

DESIGN IS APPLICABLE FOR A DRAINAGE AREA UP TO 30.0 ACRES (TOP DECK AND SIDE SLOPE).

28.6% SLOPE
MAXIMUM FLOW DEPTH = 0.44 FT.
BOTTOM WIDTH = 8 FT.

25.0% SLOPE
MAXIMUM FLOW DEPTH = 0.46 FT.
BOTTOM WIDTH = 8 FT.

5% SLOPE
MAXIMUM FLOW DEPTH = 0.73 FT.
BOTTOM WIDTH = 8 FT.

OPEN CHANNEL GABION AND ROCK RIPRAP LETDOWN DESIGN SUMMARY

DESIGN IS APPLICABLE FOR A DRAINAGE AREA UP TO 30.0 ACRES (SIDE SLOPE AND TOP DECK).

28.6% SLOPE
MAXIMUM FLOW DEPTH = 0.99 FT.
BOTTOM WIDTH = 8 FT.

25.0% SLOPE
MAXIMUM FLOW DEPTH = 1.02 FT.
BOTTOM WIDTH = 8 FT.

5% SLOPE
MAXIMUM FLOW DEPTH = 1.60 FT.
BOTTOM WIDTH = 8 FT.

OPEN CHANNEL GROUTED RIPRAP LETDOWN DESIGN SUMMARY

DESIGN IS APPLICABLE FOR A DRAINAGE AREA UP TO 30.0 ACRES (TOP DECK AND SIDE SLOPE) AND 5% TOP DECK.

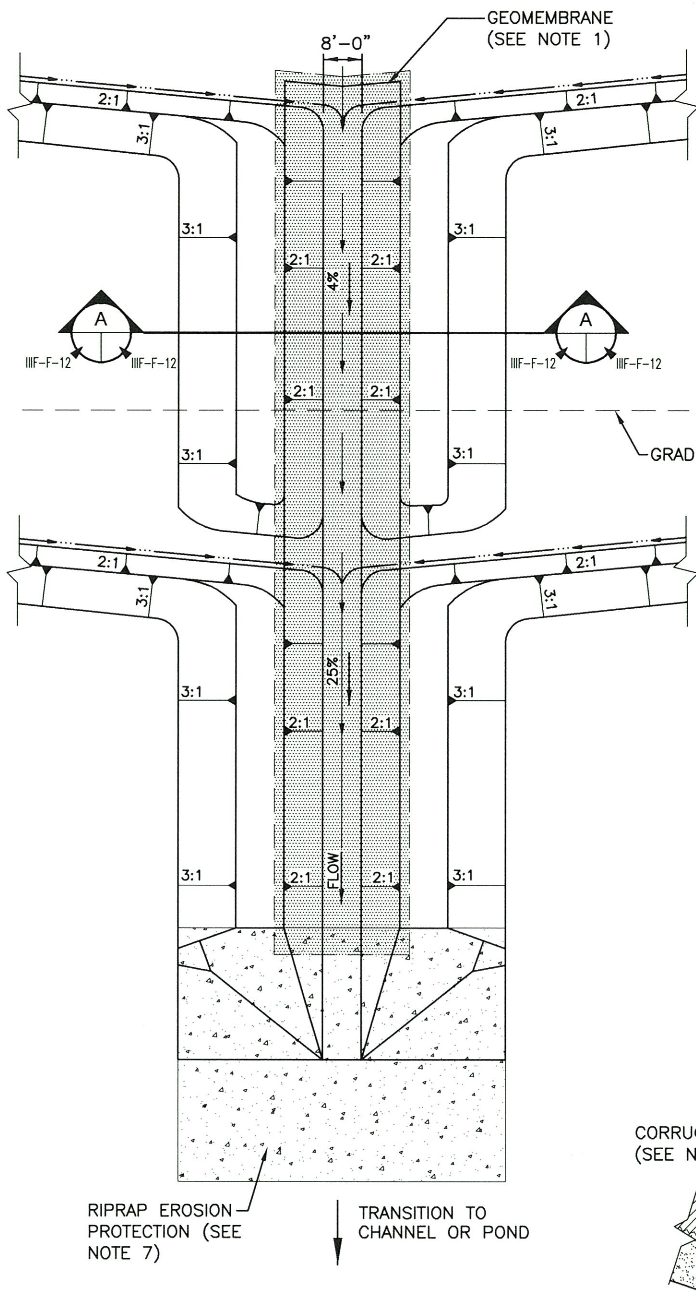
28.6% SLOPE
MAXIMUM FLOW DEPTH = 0.84 FT.
BOTTOM WIDTH = 8 FT.

25.0% SLOPE
MAXIMUM FLOW DEPTH = 0.87 FT.
BOTTOM WIDTH = 8 FT.

5% SLOPE
MAXIMUM FLOW DEPTH = 1.37 FT.
BOTTOM WIDTH = 8 FT.

OPEN CHANNEL TURF REINFORCEMENT LETDOWN DESIGN SUMMARY

SEE GROUTED RIPRAP LETDOWN DESIGN.



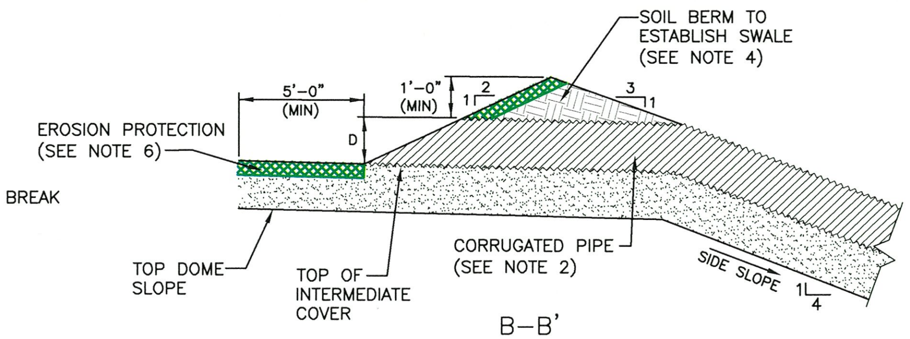
TEMPORARY OPEN CHANNEL LETDOWN (B, IIIF-F-10 / IIIF-F-12)

0 20 40
SCALE IN FEET

28.6% PIPE LETDOWN DESIGN SUMMARY*
(USE OF PIPE LETDOWN IS LIMITED TO 1-INLET)

DRAINAGE AREA (ACRE)	DESIGN FLOW RATE (CFS)	REQUIRED PIPE DIAMETER (FT)
5.2	28.9	2
9.3	52.0	3

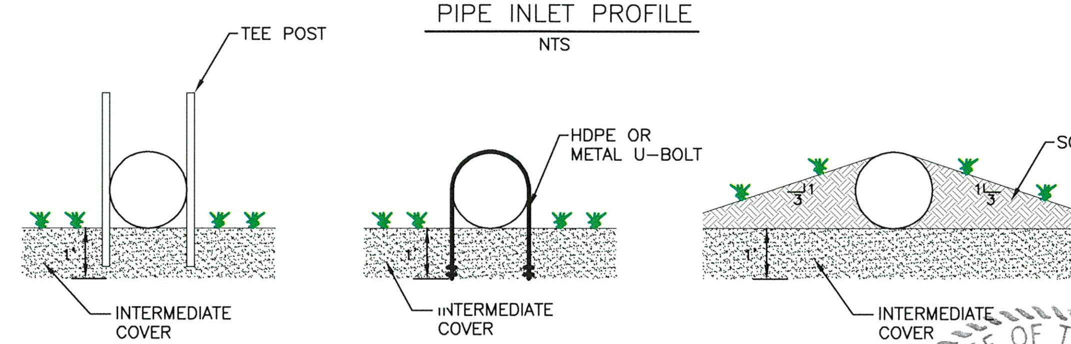
*SEE NOTE 4



B-B'

PIPE INLET PROFILE

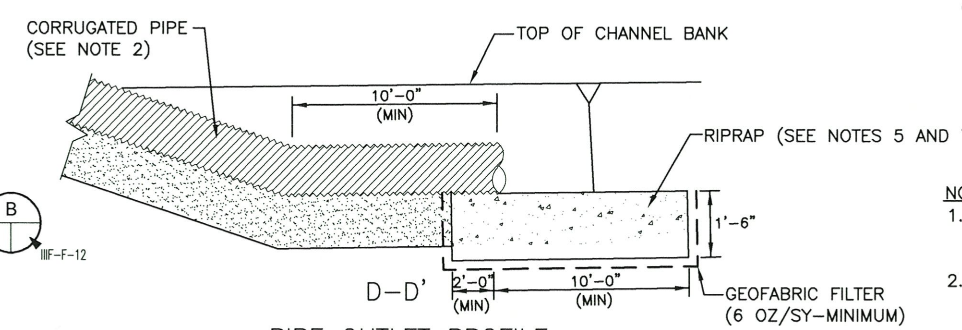
NTS



C-C'

ANCHORING DETAILS

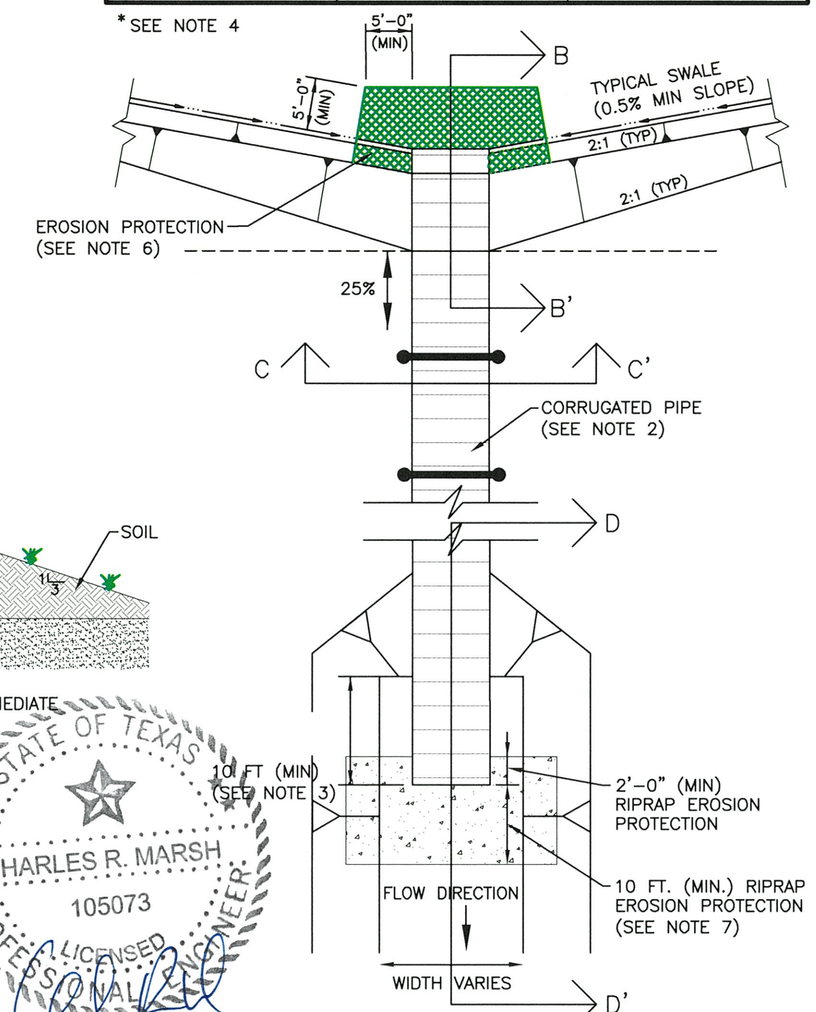
NTS



D-D'

PIPE OUTLET PROFILE
(SEE NOTE 3)

NTS



TEMPORARY PIPE LETDOWN

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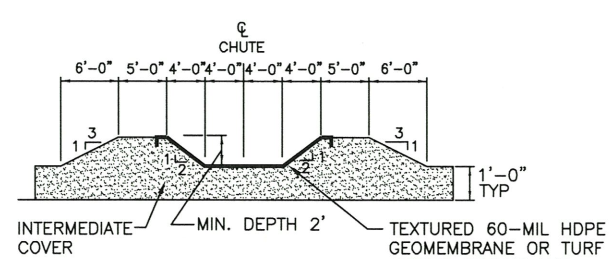
6-22-22

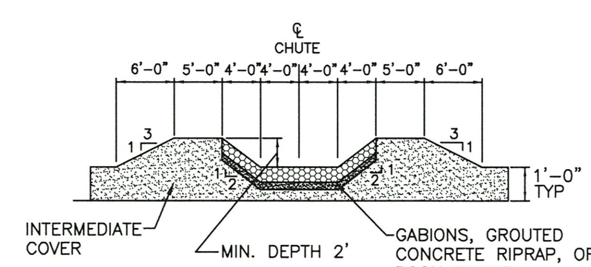
NOTES:

1. 60 MIL HDPE GEOMEMBRANE TEXTURED BOTH SIDES WILL BE USED FOR GEOMEMBRANE LETDOWN LINING. AS AN ALTERNATIVE, TEMPORARY LETDOWN CAN BE LINED WITH GABIONS, GROUTED CONCRETE RIPRAP, TURF REINFORCEMENT MAT, OR ROCK RIPRAP.
2. PIPE DRAINAGE LETDOWN WILL BE ANCHORED BY USING SOIL BERM AT THE INLET LOCATED WITHIN THE SWALE. ADDITIONAL ANCHORING ON THE SIDE SLOPE MAY BE PROVIDED USING SOIL, HDPE OR METAL U-BOLTS, T-POSTS OR EQUIVALENT MATERIALS.
3. PIPE WILL BE EXTENDED INTO THE CHANNEL TO MINIMIZE EROSION.
4. PIPE LETDOWNS WILL BE LIMITED TO 1 INLET PER LETDOWN. SOIL BERMS AROUND THE PIPE INLET WILL BE EXTENDED A MINIMUM 1-FOOT ABOVE THE LETDOWN PIPE INLET. REFER TO PAGE IIIF-F-2-24 FOR HYDRAULIC ANALYSIS.
5. RIPRAP APRON DESIGN IS PROVIDED ON PAGES IIIF-F-2-36 AND 37. D_{50} FOR RIPRAP 8-INCHES IS MINIMUM.
6. RIPRAP, GROUT, GROUTED RIPRAP, GABIONS, GEOMEMBRANE, EXISTING VEGETATION OR TURF REINFORCEMENT MAY BE USED FOR EROSION PROTECTION.
7. OTHER EROSION PROTECTION (e.g., RIPRAP, GROUT, GROUTED RIPRAP, GABIONS OR TURF REINFORCEMENT) MAY BE USED AT TEMPORARY LETDOWN OUTFALLS.
8. REFER TO PAGE IIIF-F-2-37 FOR EROSION PROTECTION DESIGN. IF LETDOWN DISCHARGES TO A POND, 10 FEET OF RIPRAP WILL BE SUFFICIENT.



A1 (IIIF-F-12 / IIIF-F-12) TEMPORARY GEOMEMBRANE OR TURF REINFORCEMENT LETDOWN OPTION

0 10 20
SCALE IN FEET



A2 (IIIF-F-12 / IIIF-F-12) TEMPORARY GABION LETDOWN OPTION

0 10 20
SCALE IN FEET

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REVISIONS

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EROSION CONTROL PLAN
LETDOWN DESIGN SUMMARY

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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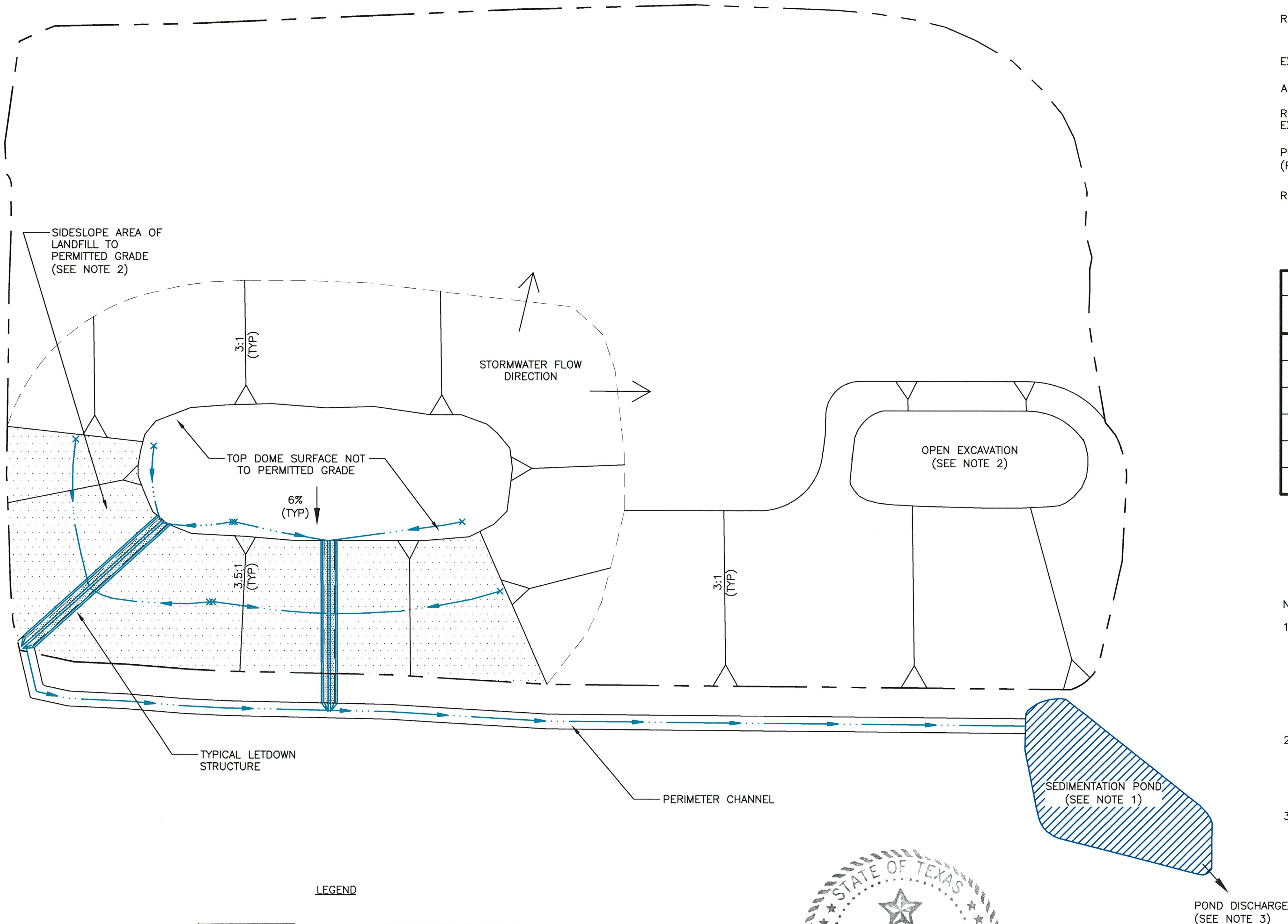

LEGEND

EXTERNAL SIDE SLOPE TO PERMITTED GRADE

LETDOWN

DRAINAGE SWALE

STORMWATER FLOW DIRECTION

EXAMPLE CALCULATION

REQUIRED POND SIZE = EXTERNAL EMBANKMENT AREA (ACRES) X POND AREA REQUIRED/UNIT DRAINAGE AREA FACTOR

EXTERNAL EMBANKMENT AREA DRAINING TO POND = 20 ACRES

ADDITIONAL UPLAND AREA DRAINING TO POND = 0 ACRES (SEE NOTE 1)

REQUIRED SEDIMENT REMOVAL FROM EXTERNAL SIDE SLOPE AREA = 80 TONS/ACRE/YEAR TO 50 TONS/ACRE/YEAR

POND AREA REQUIRED/UNIT DRAINAGE AREA FACTOR (FROM TABLE BELOW) = 0.060

REQUIRED POND SIZE = 20 ACRES X 0.060 = 1.20 ACRES

SIZE OF POND REQUIRED[1]

REQUIRED SEDIMENT REMOVAL (TONS/ACRE/YEAR)	POND AREA REQUIRED/ UNIT DRAINAGE AREA FACTOR	EFFICIENCY OF POND (DYNAMIC AND QUIESCENT)
60 TO 50	0.025	13.3%
70 TO 50	0.040	25.5%
80 TO 50	0.060	34.0%
90 TO 50	0.075	41.5%
100 TO 50	0.110	46.4%
200 TO 50	0.300	71.2%

[1] REFER TO APPENDIX IIIF-F-3 FOR MORE INFORMATION. THE POND DESIGN AND DEMONSTRATION ARE PROVIDED TO ENSURE THAT SEDIMENT DISCHARGE FROM THE SITE WILL BE PREVENTED DURING INITIAL ESTABLISHMENT OF VEGETATION OVER THE SIDE SLOPES AND TOP DOME SURFACES.

NOTES:

1. EXAMPLE POND CONFIGURATION IS SHOWN. A DEMONSTRATION WILL BE INCLUDED IN THE SITE OPERATING RECORD TO SHOW THAT THE POND HAS THE CAPABILITY TO CAPTURE SEDIMENT SUCH THAT DISCHARGE IS LESS THAN OR EQUAL TO 50 TONS/ACRE/YEAR FROM THE EXTERNAL SIDE SLOPE AND TOP DOME AREA. THE DEMONSTRATION WILL ACCOUNT FOR THE ADDITIONAL SEDIMENT CREATED BY THE UPLAND AREA THAT FLOWS TO THE POND. FOR DEMONSTRATION PURPOSES, THE POND DEPTH WILL BE AN AVERAGE OF 4 FEET. OVERALL SEDIMENT DISCHARGE FROM THE SITE MUST COMPLY WITH THE CURRENT TPDES PERMIT FOR THE SITE.
2. EXCAVATED FUTURE CELL AREAS OR SOIL BORROW AREAS CAN ALSO BE USED AS SEDIMENTATION PONDS. IF THESE AREAS ARE USED FOR PONDS, A DEMONSTRATION NOTING THAT THE EXCAVATED FUTURE CELL AREA OR SOIL BORROW AREA HAS MORE CAPACITY THAN THE VOLUME PRODUCED BY THE 25-YEAR, 24-HOUR STORM WILL BE DOCUMENTED AND MAINTAINED IN THE SITE OPERATING RECORD.
3. AS STATED IN SECTION 2.2, A STATEMENT WILL BE ADDED TO THE SITE OPERATING RECORD EACH TIME A SEDIMENTATION POND IS INSTALLED TO NOTE HOW THE TEMPORARY SEDIMENTATION POND AND THE POND OUTLET WERE CONSTRUCTED CONSISTENT WITH THE REQUIREMENTS OF THE SITE DEVELOPMENT PLAN.

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NO.	DATE	DESCRIPTION

EROSION CONTROL PLAN
SEDIMENT CONTROL POND PLAN

TURKEY CREEK LANDFILL
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SHEET IIIF-F-13

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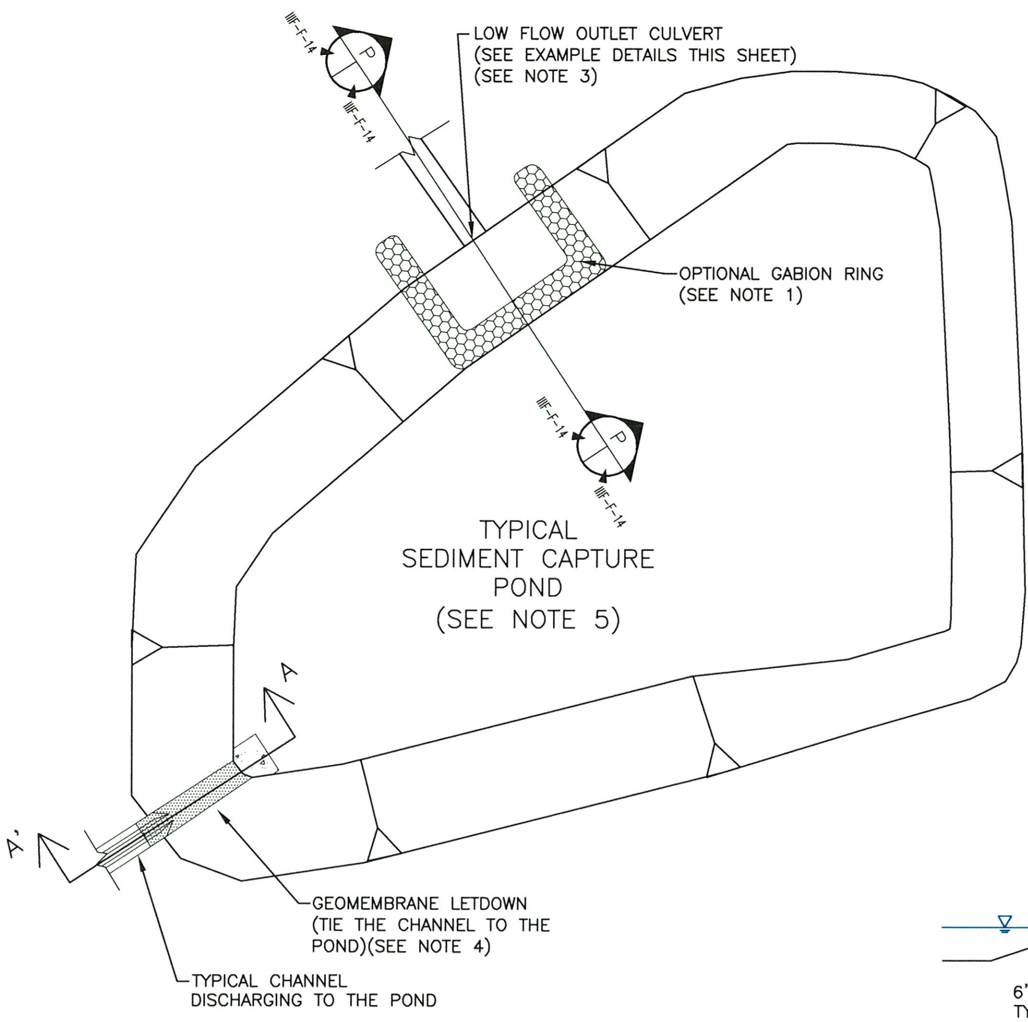
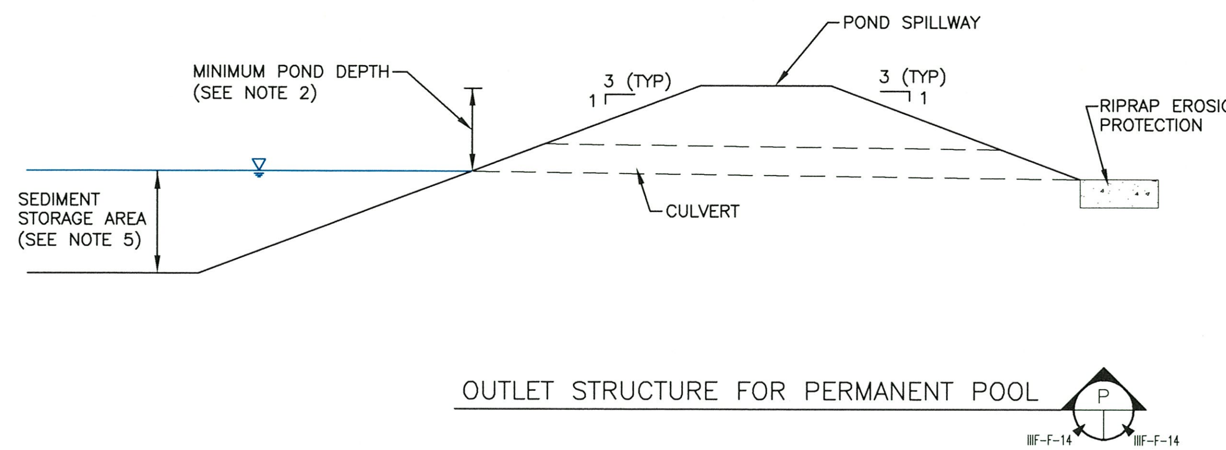
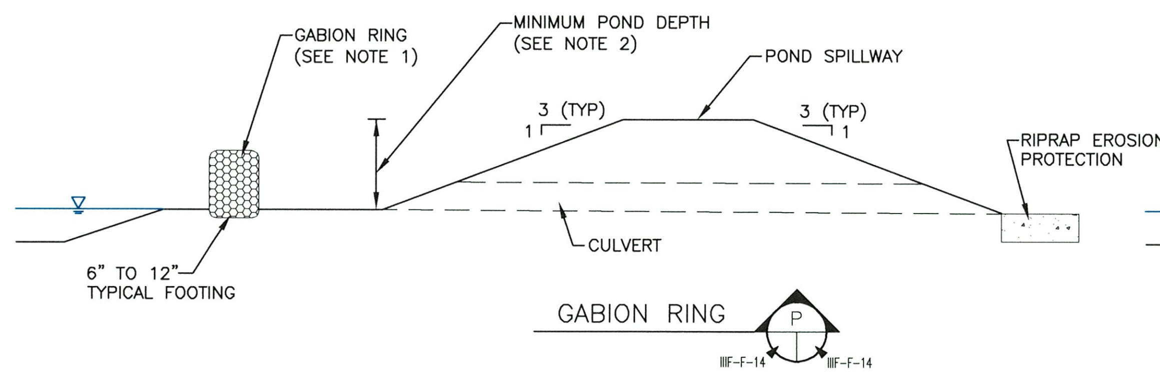
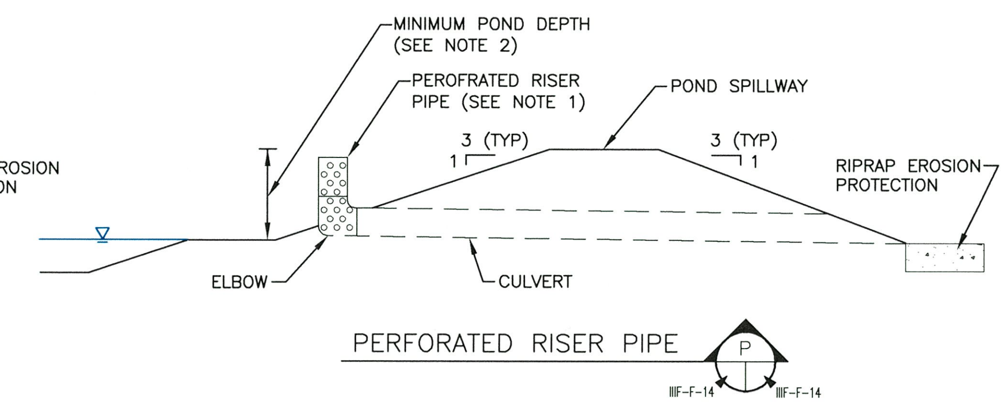




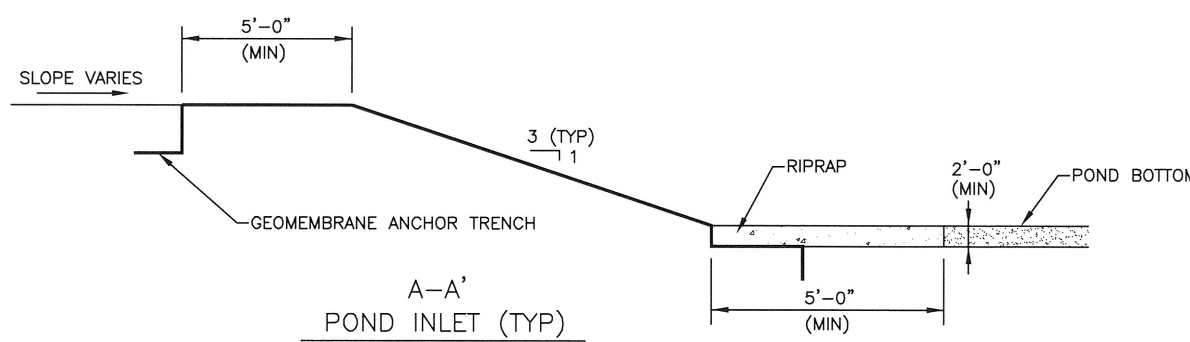




OPTIONS FOR DRY PONDS

NOTES:

1. AS AN OPTION TO THE GABION RING, A PERFORATED RISER PIPE (SHOWN ON THIS SHEET) MAY ALSO BE USED, AS WELL AS A ROCK CHECK DAM.
2. MINIMUM POND DEPTH IS 4 FEET BETWEEN THE LOW FLOW OUTLET FLOW LINE AND POND SPILLWAY ELEVATION.
3. IF THE POND IS INSTALLED WITHOUT A LOW FLOW OUTLET, THEN SEE NOTE 2 ON SHEET IIIF-F-13.
4. VEGETATIVE SURFACING, GROUTED RIPRAP, RIPRAP, GABIONS, OR TURF REINFORCEMENT MAY BE USED TO ENSURE THE STABILITY OF THE POND INLET.
5. POND BOTTOM AREAS WILL BE EXCAVATED BELOW THE LOW FLOW OUTLET FLOW LINE ELEVATION TO PROVIDE SEDIMENT STORAGE. SEDIMENT ACCUMULATED IN POND WILL BE REMOVED AS NEEDED TO ENSURE SEDIMENT STORAGE CAPACITY BELOW THE FLOWLINE ELEVATION OF LOW FLOW OUTLET (REFER TO SECTION 2.4 FOR ADDITIONAL INFORMATION REGARDING SEDIMENT REMOVAL).



A–A'
POND INLET (TYP)
NTS

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EROSION CONTROL PLAN TYPICAL POND OUTLET STRUCTURES

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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SHEET IIIF-F-14

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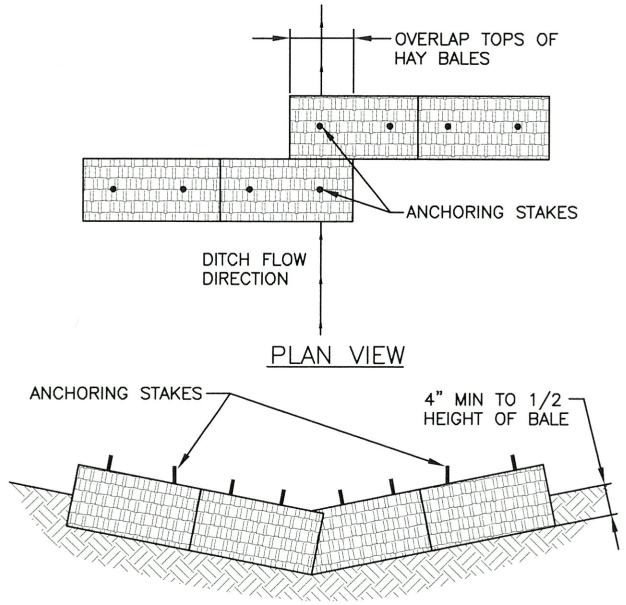
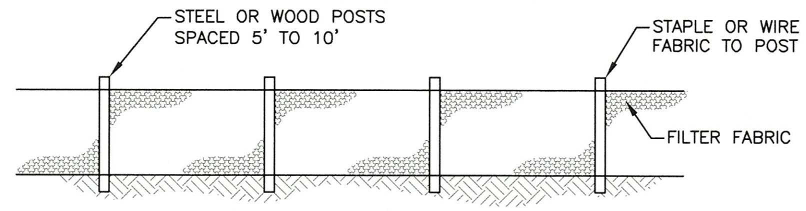


PROFILE VIEW

BALED HAY FOR EROSION CONTROL

NTS

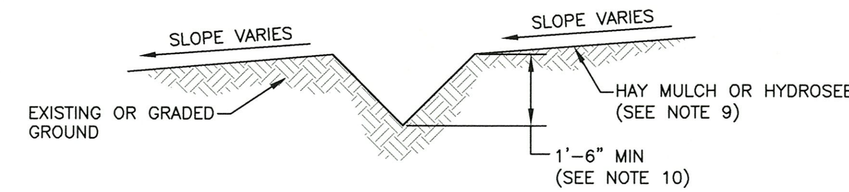
(SEE NOTE 1)



TEMPORARY SEDIMENT CONTROL FENCE

NTS

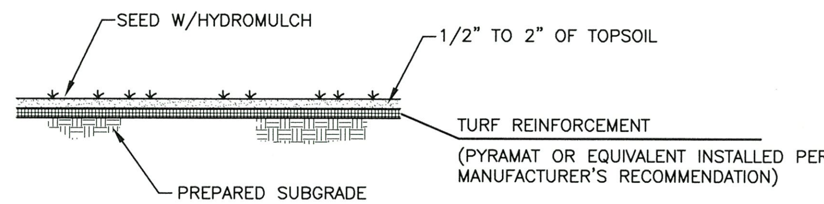
(SEE NOTE 3)



TEMPORARY DIVERSION CHANNEL

NTS

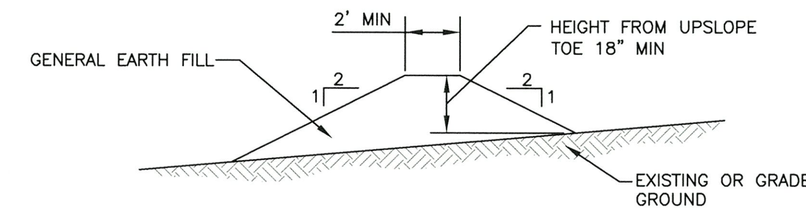
(SEE NOTE 6)



TURF REINFORCEMENT

NTS

(SEE NOTE 4)

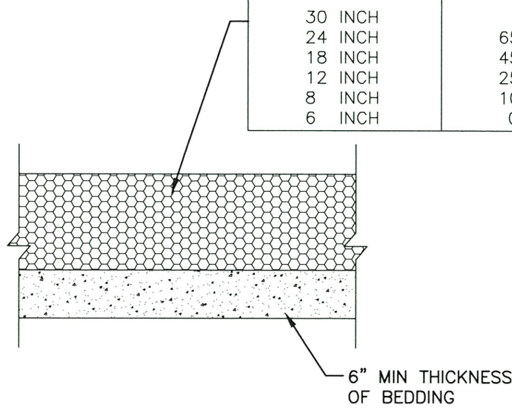


TEMPORARY DIVERSION BERM

NTS

(SEE NOTE 7)

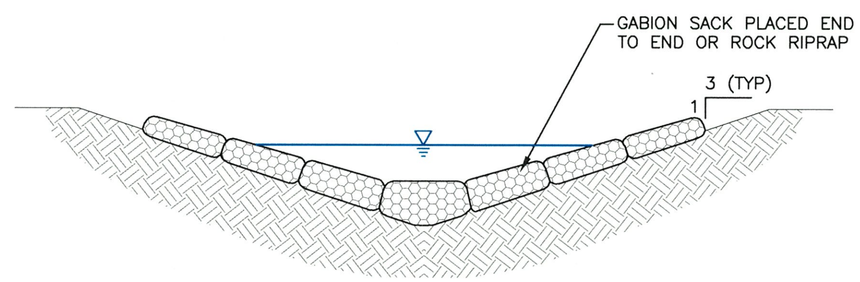
24" THICKNESS OF RIPRAP	
SIEVE SIZE SQUARE MESH	PERCENT PASSING
30 INCH	100
24 INCH	65–100
18 INCH	45–75
12 INCH	25–50
8 INCH	10–30
6 INCH	0–15



ROCK RIPRAP

NTS

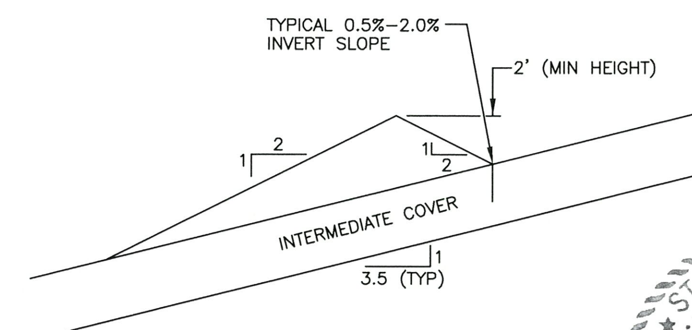
(SEE NOTE 2)



ROCK CHECK DAM

NTS

(SEE NOTE 5)



SWALE

NTS

(SEE NOTE 8)

NOTES:

1. BALED HAY MAY BE USED IN NEWLY ESTABLISHED COVER AREAS OR DISTURBED/REGRADED SURFACES TO MAINTAIN SHEET FLOW UNTIL VEGETATION IS ESTABLISHED.
2. ROCK RIPRAP MAY BE USED IN AREAS WHERE CONCENTRATED FLOW WITH HIGH VELOCITIES MAY OCCUR (e.g., CULVERT INLETS/OUTLETS).
3. A TEMPORARY SEDIMENT CONTROL FENCE MAY BE USED IN CAPTURING SEDIMENT TRANSPORTED BY SHEET FLOW AND FOR DIVERSION OF FLOW FOR CONTROLLING SEDIMENT DISCHARGE.
4. TURF REINFORCEMENT MAY BE USED ON NEWLY ESTABLISHED SURFACES SUCH AS INTERMEDIATE COVER AND IN CHANNELS WHERE MODERATELY HIGH FLOW VELOCITIES ARE EXPECTED.
5. A ROCK CHECK DAM MAY BE USED IN CHANNELS TO SLOW DOWN FLOW VELOCITIES AND IMPROVE SEDIMENT CAPTURE.
6. A TEMPORARY DIVERSION CHANNEL MAY BE USED FOR SHORTENING SHEET FLOW DISTANCES IN UNDEVELOPED AREAS OR IN LARGER CHANNELS TO PROVIDE MEANDERING AND SLOWER FLOW VELOCITIES TO PREVENT IN-CHANNEL EROSION.
7. A TEMPORARY DIVERSION BERM MAY BE USED IN AREAS TO DIVERT FLOW FROM ENTERING STEEP SLOPED AREAS (e.g., TOP OF EXCAVATION) AND TO REDUCE SHEET FLOW LENGTHS.
8. A SWALE MAY BE USED IN AREAS TO DIVERT FLOW FROM ENTERING STEEP SLOPED AREAS (e.g., TOP OF EXCAVATION) AND TO REDUCE SHEET FLOW LENGTHS.
9. HAY MULCH AND HYDROSEED MAY ALSO BE USED FOR NEWLY ESTABLISHED SURFACES TO PROMOTE VEGETATION ESTABLISHMENT AND PREVENT EROSION.
10. THE VALUE SHOWN IS AT THE TIME OF CHANNEL INSTALLATION; CHANNEL WIDTH AND DEPTH MAY VARY.

☐ DRAFT
☒ FOR PERMITTING PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 02/2022
FILE: 0771-368-11
CAD: IIIF-F-15-TYPICAL BMPS.DWG

DRAWN BY: RAA
DESIGN BY: BPY
REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS		
NO.	DATE	DESCRIPTION

EROSION CONTROL PLAN
TYPICAL BMPs

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

SHEET IIIF-F-15

O:\0771\368\EXPANSION 2021\PART III\IIIF\IIIF-F\IIIF-F-15-TYPICAL BMPs.dwg, rarrington, 1:2

APPENDIX IIIF-F-1

TEMPORARY ADD-ON SWALE DESIGN

Includes pages IIIF-F-1-1 through IIIF-F-1-12

STATE OF TEXAS
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105073
LICENSED
PROFESSIONAL ENGINEER

2-22-22

SWALE DESIGN

This appendix includes the expected soil loss calculations for various swale spacing intervals on the side slopes and top dome surfaces. An example calculation is provided on pages IIIF-F-1-2 through IIIF-F-1-4 for a vegetative cover of 60 percent. For the results of various percent vegetative covers and swale spacing intervals, refer to the table on page IIIF-F-1-5 and to Sheet IIIF-F-10 – Swale Design Summary. If the required percent vegetation coverage is not achieved within the 180-day period, secondary erosion control measures such as mulch, wood chips, compost or straw/hay will be used to limit the soil loss to 50 tons/acre/year or less. In addition, a detention/sedimentation pond may also be used until the required vegetation coverage is achieved. Any secondary measure used will be documented in the Site Operating Record at the end of the 180-day period to document compliance with this plan. In addition, the date the required percent vegetation coverage is achieved and the secondary measure is no longer needed will also be documented in the Site Operating Record.

Also included in this appendix are the sheet flow velocities for all swale spacing intervals on the side slopes and top dome surfaces. As noted in these calculations (pages IIIF-F-1-6 through IIIF-F-1-8), all velocities are acceptable.

Additionally, this appendix includes a calculation for the maximum drainage area that each swale can drain, as well as the maximum swale length. These calculations are included on pages IIIF-F-1-9 through IIIF-F-1-12.

Required: Determine the required spacing of the drainage swales for different percentages of vegetative cover for top dome surfaces and external embankment side slopes.

Method:

1. Estimate soil loss per acre based on percent ground cover and swale spacing for top dome surface and external side slope.
2. Summary.

Notes:

1. The following example calculation procedure has been developed for 60 percent ground cover.
2. The table on page IIIF-F-1-5 includes the results of the following procedure for 60, 70, 80, and 90 percent ground cover and various swale spacings. The results are also summarized on Figure 2 in Appendix IIIF-F.

References:

1. SCS National Engineering Handbook, Chapter 3 - Erosion.
2. TNRCC, *Use of the USLE in Final Cover/Configuration Design*, 1993.
3. United States Environmental Protection Agency, *Solid Waste Disposal Facility Criteria Technical Manual*, 1993.

Solution:

1. Estimate soil loss per acre based on percent ground cover and swale spacing for top dome surface and external side slope.

Soil Loss Equation: $A=RKL_SCP$

Where:

$A=$ Soil loss (tons/ac/yr)
$R=$ Rainfall factor
$K=$ Soil erodibility factor
$L_S=$ Slope length/slope gradient factor
$C=$ Plant cover or cropping management factor
$P=$ Erosion practice factor

The rainfall factor, R, represents the average intensity for the maximum intensity, 30 minute storms over a 22 year period of record compiled by the SCS. Using Figure 1 (Ref 2), Average Annual Values of the R Factor, the R factor for Johnson County is:

R = 290

The soil erodibility factor, K, factor represents the resistance of a soil surface to erosion as a function of the soil's physical and chemical properties. Assume an organic matter content of 2% to determine the K factor. The intermediate soil will consist of soils comparable to sandy clay. Additionally, compost will be added to intermediate soil as necessary to protect against erosion. Therefore, the following is a conservative K value for the site (Table 1 on page 6, Ref. 2).

K = 0.25

The slope length/slope gradient factor, L_s, represents the erosion of the soil due to both slope length and degree of slope.

Case 1. Top Slope
slope = 5 %
length = 200 ft

Case 2. Top Slope
slope = 5 %
length = 500 ft

Case 3. Top Slope
slope = 5 %
length = 700 ft

Case 4. Side Slope (28.6%)
slope = 28.6 %
length = 105 ft

Case 5. Side Slope (28.6%)
slope = 28.6 %
length = 200 ft

Case 6. Side Slope (28.6%)
slope = 28.6 %
length = 300 ft

Case 7. Side Slope (25.0%)
slope = 25 %
length = 120 ft

Case 8. Side Slope (25.0%)
slope = 25 %
length = 200 ft

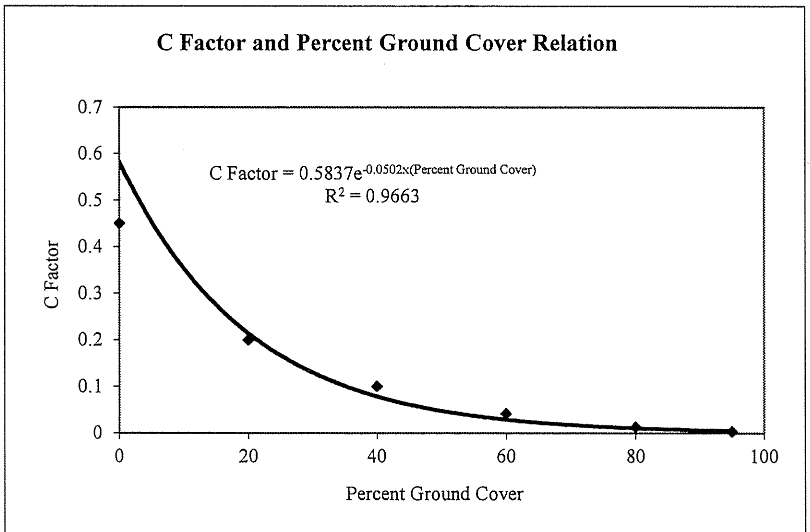
Case 9. Side Slope (25.0%)
slope = 25 %
length = 300 ft

Using the above information and Figure 2 (Ref 2, p.9), the L_s factors are determined.

Case	Slope (%)	Slope Length (ft)	L_s
1. Top Slope	5	200	0.75
2. Top Slope	5	500	1.30
3.Top Slope	5	700	1.50
4.Side Slope (28.6%)	28.6	105	8.30
5.Side Slope (28.6%)	28.6	200	10.20
6.Side Slope (28.6%)	28.6	300	10.60
7.Side Slope (25.0%)	25	120	6.50
8.Side Slope (25.0%)	25	200	7.90
9.Side Slope (25.0%)	25	300	10.20

The plant cover or cropping management factor, C, represents the percentage of soil loss that would occur if the surface were partially protected by some combination of cover and management practices. C Factor for Permanent Pasture, Range, and Idle Land with No Appreciable Canopy has the following relation with percent ground cover (GC) (from Ref 2, p.7) .

% GC	C Factor:
0	0.45
20	0.20
40	0.10
60	0.042
80	0.013
95	0.003



C Factor= $0.5837e^{(-0.0502x60)}$
C Factor= 0.0420

The erosion control practice factor, P, measures the effect of control practices that reduce the erosion potential of the runoff by influencing drainage patterns, runoff concentration , and runoff velocity. Contouring for this site will be done only to establish vegetation.

P = 1.00

Slope Condition	R	K	L_s	C	P	A (tons/ac/yr)
1. Top Slope 5% slope 200 ft length	290	0.25	0.75	0.0420	1.0	2.3
2. Top Slope 5% slope 500 ft length	290	0.25	1.30	0.0420	1.0	4.0
3. Top Slope 5% slope 700 ft length	290	0.25	1.50	0.0420	1.0	4.6
4. Side Slope 28.6% slope 120 ft length	290	0.25	8.30	0.0420	1.0	25.3
5. Side Slope 28.6% slope 200 ft length	290	0.25	10.20	0.0420	1.0	31.1
6. Side Slope 28.6% slope 300 ft length	290	0.25	10.60	0.0420	1.0	32.3
7. Side Slope 25% slope 120 ft length	290	0.25	6.50	0.0420	1.0	19.8
8. Side Slope 25% slope 200 ft length	290	0.25	7.90	0.0420	1.0	24.1
9. Side Slope 25% slope 300 ft length	290	0.25	10.20	0.0420	1.0	31.1

2. Summary

For a summary of soil loss rates for various percentages of ground cover, see Figure 2 in Appendix IIIF-F and page IIIF-F-1-5.

SOIL LOSS ESTIMATE SUMMARY TABLE

Case	Slope (%)	Length (ft)	L_s	Percent Ground Cover	C Factor	A (tons/ac/yr)
Top Slope	5	200	0.75	60	0.042	2.3
Top Slope	5	200	0.75	70	0.017	0.9
Top Slope	5	200	0.75	80	0.013	0.7
Top Slope	5	200	0.75	90	0.0064	0.3
Top Slope	5	500	1.30	60	0.042	4.0
Top Slope	5	500	1.30	70	0.017	1.6
Top Slope	5	500	1.30	80	0.013	1.2
Top Slope	5	500	1.30	90	0.0064	0.6
Top Slope	5	700	1.50	60	0.042	4.6
Top Slope	5	700	1.50	70	0.017	1.8
Top Slope	5	700	1.50	80	0.013	1.4
Top Slope	5	700	1.50	90	0.0064	0.7
Side Slope	28.6	105	8.30	60	0.042	25.3
Side Slope	28.6	105	8.30	70	0.017	10.2
Side Slope	28.6	105	8.30	80	0.013	7.8
Side Slope	28.6	105	8.30	90	0.0064	3.9
Side Slope	28.6	200	10.20	60	0.042	31.1
Side Slope	28.6	200	10.20	70	0.017	12.6
Side Slope	28.6	200	10.20	80	0.013	9.6
Side Slope	28.6	200	10.20	90	0.0064	4.7
Side Slope	28.6	300	10.60	60	0.042	32.3
Side Slope	28.6	300	10.60	70	0.017	13.1
Side Slope	28.6	300	10.60	80	0.013	10.0
Side Slope	28.6	300	10.60	90	0.0064	4.9
Side Slope	25	120	6.50	60	0.042	19.8
Side Slope	25	120	6.50	70	0.017	8.0
Side Slope	25	120	6.50	80	0.013	6.1
Side Slope	25	120	6.50	90	0.0064	3.0
Side Slope	25	200	7.90	60	0.042	24.1
Side Slope	25	200	7.90	70	0.017	9.7
Side Slope	25	200	7.90	80	0.013	7.4
Side Slope	25	200	7.90	90	0.0064	3.7
Side Slope	25	300	10.20	60	0.042	31.1
Side Slope	25	300	10.20	70	0.017	12.6
Side Slope	25	300	10.20	80	0.013	9.6
Side Slope	25	300	10.20	90	0.0064	4.7

Required: Determine the sheet flow velocity for the top dome surfaces and external embankment side slopes and compare to the permissible non-erodible flow velocity.

Method:

1. Determine the peak velocities for the cases listed on page IIIF-F-1-2.
2. Compare to permissible velocities.
3. Conclusion.

References:

1. National Engineering Handbook, Section 4, Hydrology. *Chapter 15 - Travel Time, Time of Concentration and Lag.*

Solution: Use the typical case scenarios from the USLE calculation to determine the expected peak sheet flow velocity.

Case		slope (%)	length (ft)
Case 1.	Top Slope	5	200
Case 2.	Top Slope	5	500
Case 3.	Top Slope	5	700
Case 4.	Top Slope	28.6	105
Case 5.	Side Slope	28.6	200
Case 6.	Side Slope	28.6	300
Case 5.	Side Slope	25	120
Case 6.	Side Slope	25	200
Case 5.	Side Slope	25	300

1. Determine the peak velocities for the cases listed on page IIIF-F-1-2.

Cultivated Straight Row (Overland Flow)

From Figure 15.2 (page 15-8 in Ref. 1), determine the velocities for all cases.

Case	V (ft/s)
Case 1.	2.0
Case 2.	2.0
Case 3.	2.0
Case 4.	4.9
Case 5.	4.9
Case 6.	4.9
Case 7.	4.5
Case 8.	4.5
Case 9.	4.5

Note: Figure 15.2 is reproduced on page IIIF-F-1-8.

2. Compare to permissible velocities.

Summary of Velocities

	Condition	Equivalent Percent Ground Coverage	Peak Velocity (ft/s)	Permissible Velocity[1] (ft/s)
Cultivated Straight Row	5%, 200 ft	>60%	2.0	5.0
	5%, 500 ft	>60%	2.0	5.0
	5%, 700 ft	>60%	2.0	5.0
	28.6%, 120 ft	>60%	4.9	5.0
	28.6%, 200 ft	>60%	4.9	5.0
	28.6%, 300 ft	>60%	4.9	5.0
	25%, 120 ft	>60%	4.5	5.0
	25%, 200 ft	>60%	4.5	5.0
	25%, 300 ft	>60%	4.5	5.0

1 Permissible velocity information is from USACE EM 1110-0-1418, Chapter 5 - Evaluation of Stability.

3. Conclusion.
The peak velocities for each case are listed in the above summary table. As shown peak velocities are below permissible velocities for the conditions analyzed. After 180 days, at least 60 percent vegetation will be established in order to maintain permissible non-erodible velocities.

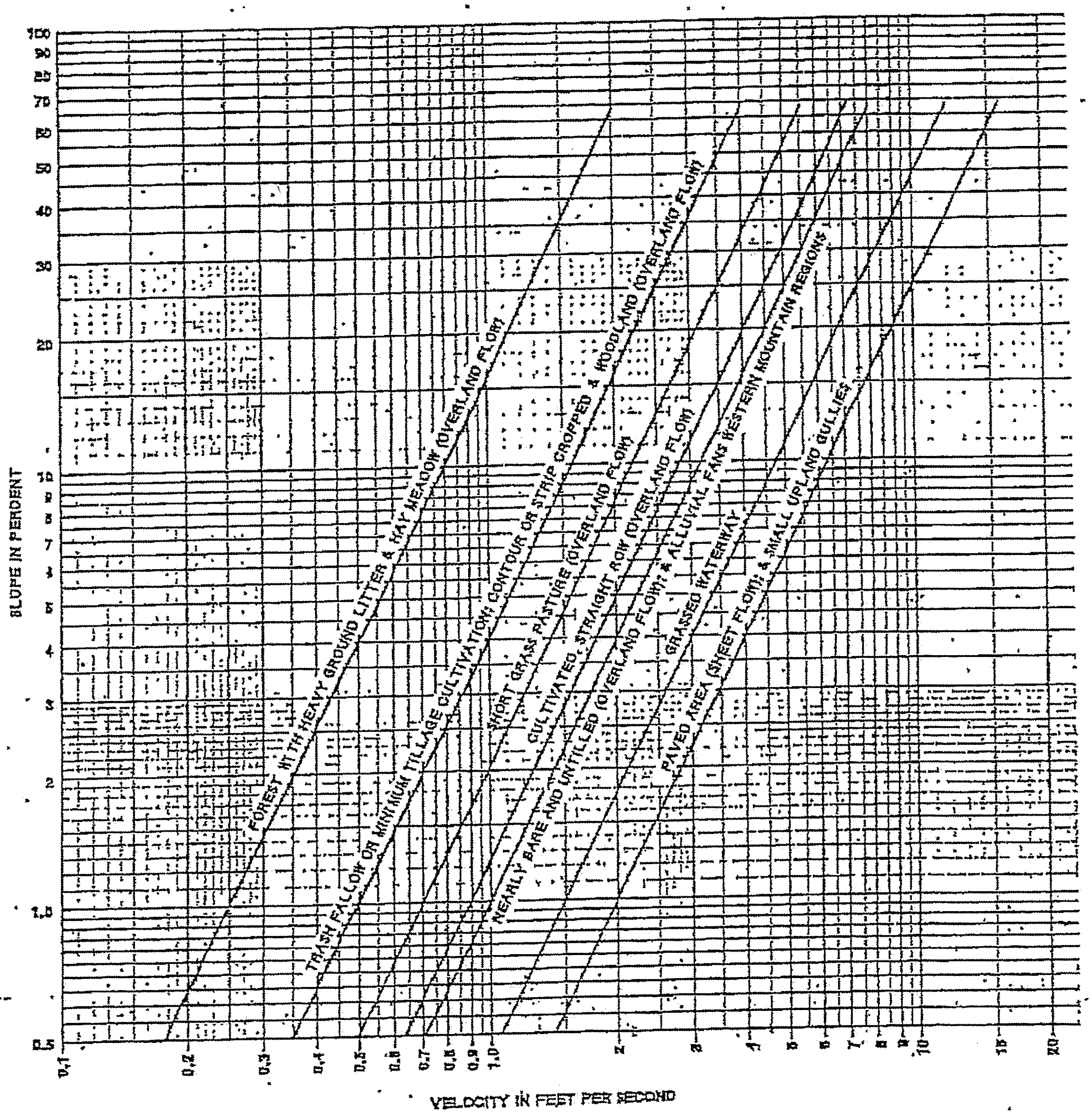


Figure 15.2.—Velocities for upland method of estimating T_c

Required: Analyze swales to determine the adequacy of the swale design.

Method:

1. Determine the 25-year, 24-hour flow rates for a maximum swale drainage area for top slopes and side slopes using the Rational Method.
2. Determine maximum swale length that corresponds to the maximum swale drainage area.

Reference:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, September 2019.

Solution:

1. Determine the 25-year, 24-hour flow rates for a maximum swale drainage area for top slopes and side slopes using the Rational Method.

$$Q = CIA$$

Where:

C= 0.7 (runoff coefficient, Ref 1.)
I = intensity, in/hr
A= drainage area, ac

$$I = \frac{b}{(t_c + d)^e}$$

b = 83.01
d = 10.65
e = 0.775

From Ref. 1, for Johnson County 25-year storm event

t_c is assumed to be 10 min.

I = 7.95 in/hr

For Top Slope (5%):

Maximum Drainage Area (2 ft swale) = 27.5 acres
Maximum Drainage Area (1.5 ft swale) = 12.8 acres
Maximum Drainage Area (1 ft swale) = 4.3 acres

Flow Rate (2 ft swale) =	153.0	cfs
Flow Rate (1.5 ft swale) =	71.1	cfs
Flow Rate (1 ft swale) =	24.1	cfs

For Side Slope (28.6 %):

Maximum Drainage Area = 6.6 acres

Flow Rate (2 ft swale) =	37.0	cfs

For Side Slope (25 %):

Maximum Drainage Area = 7.3 acres

Flow Rate (2 ft swale) =	40.5	cfs

2. Determine maximum swale length that corresponds to the maximum swale drainage area.

Condition (swale height)	Maximum Drainage Area (acres)	Minimum Swale Spacing[1] (ft)	Maximum Swale Length[2] (ft)
Top Slope (2 ft swale)	27.5	200	5,984
Top Slope (1.5 ft swale)	12.8	200	2,781
Top Slope (1 ft swale)	4.3	200	943
Side Slope (2 ft swale - 28.6%)	6.6	105	2,757
Side Slope (2 ft swale - 25%)	7.3	120	2,640

[1] Minimum swale spacing is taken from calculations provided on page IIIF-F-1-2.

[2] Maximum swale length calculated using the following equation:

Maximum Drainage Area x (43,560 sf/acre) / Minimum Swale Spacing

Prep By: BPY
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
SWALE ANALYSIS

Chkd By: CRM
Date: 11/15/2021

Flow Rate (cfs)	Bottom Slope (ft/ft)	n-value	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude No.	Velocity Head (ft)	Energy Head (ft)	Flow Area (sq. ft.)	Top Width of Flow (ft)
2 ft Top Slope Swale												
153.0	0.005	0.03	2	20	0	2.00	3.48	0.613	0.19	2.19	43.98	43.99
1.5 ft Top Slope Swale												
71.1	0.005	0.03	2	20	0	1.50	2.87	0.584	0.13	1.63	24.76	33.01
1 ft Top Slope Swale												
24.1	0.005	0.03	2	20	0	1.00	2.19	0.546	0.07	1.07	11.00	22.00
2 ft Side Slope Swale												
37.0	0.005	0.03	2	3.5	0	2.00	3.36	0.592	0.18	2.18	11.02	11.01
2 ft Side Slope Swale												
40.5	0.005	0.03	2	4	0	2.00	3.37	0.595	0.18	2.18	12.00	12.00

Note: Calculations were performed using the HYDROCALC HYDRAULICS program developed by Dodson and Associates (Version 2.01, 1996-2010).

Maximum flow depth is less than temporary swale height.

Design is acceptable.

Example Calculation: Calculate the normal depth for the swale for the maximum size top slope drainage area.

List of Symbols

Q_d = design flow rate for channel, cfs
R = hydraulic radius, ft
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = bottom width of channel, ft
z_r = z-ratio (ratio of run to rise for channel sideslope) for right side slope of swale
z_l = z-ratio (ratio of run to rise for channel sideslope) for left side slope of swale
A_f = flow area, sf
g = gravitational acceleration = 32.2 ft/s^2
T = top width of flow, ft
d = normal depth of swale, ft

The program uses an iterative process to calculate the normal depth of the swale to satisfy Manning's Equation

$$Q = \frac{1.486}{n} A R^{0.67} S^{0.5}$$

Design Inputs:

Q_d =	153.0	cfs
S =	0.005	ft/ft
b =	0	ft
z_r =	20	(H) : 1 (V)
z_l =	2	(H) : 1 (V)
n =	0.03	

Step 1 - Based on the geometry of the swale cross-section, solve for R and A_f

$$R = \frac{bd + 1/2d^2(z_r + z_l)}{b + d((z_l^2 + 1)^{0.5} + (z_r^2 + 1))}$$

$$A_f = bd + 1/2d^2(z_r + z_l)$$

assume: d = 2.00 ft

R = 0.989 ft

A_f = 43.98 sf

solve for Q: $Q = 153.0$

if Q is not equal to Q_d, select a new d and repeat calculations

Step 2 - solve for velocity, T, Froude number, velocity head, and energy head

$Q = VA \Rightarrow \quad V = Q/A$

$V = 3.48$ ft/s

$T = b + d(z_l + z_r)$

$T = 43.99$ ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

$F_r = 0.613$

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 0.19 ft

Energy Head = water elevation + velocity head

Energy Head = 2.19 ft

APPENDIX IIIF-F-2

TEMPORARY LETDOWN DESIGN

Includes pages IIIF-F-2-1 through IIIF-F-2-37

STATE OF TEXAS
CHARLES R. MARSH
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2-22-22

LETDOWN (OR CHUTE) DESIGN

The temporary letdown structure options include open channel flow letdowns and pipe letdowns. Open channel flow letdowns will be lined with either geomembrane, turf reinforcement mat, gabions, grouted concrete riprap, or rock riprap. The pipe letdowns are typically corrugated plastic pipe. Both types of letdowns will have an energy dissipator structure at the bottom of the letdown. Typical letdown details are shown on Sheet IIIF-F-12 – Letdown Design Summary.

This appendix includes a demonstration to show that the letdown structure sizes shown on Sheet IIIF-F-12 will contain the peak flow rate produced by the 25-year storm event. The geomembrane-lined and gabion-lined chutes (as well as turf reinforcement, rock riprap, and grouted riprap-lined chutes) were analyzed for peak flow rates generated from drainage areas ranging from 5 acres to 30 acres. This analysis (pages IIIF-F-2-2 through IIIF-F-2-8) is summarized on Sheet IIIF-F-12 and shows the maximum drainage areas that the 2-foot-deep chutes (8 feet minimum bottom width) are adequate to handle (i.e., the maximum flow depth calculated is less than 2.00 feet).

Also included in this appendix is an analysis for the 24-inch- and 36-inch-diameter temporary pipe letdowns for 25 percent slopes. The maximum flow that these pipes were capable of conveying was determined, and from this design flow rate a maximum drainage area size was calculated. The drainage area corresponds to the area that could drain to the pipe at each inlet. As noted on Sheet IIIF-F-12, the use of pipe letdowns will be limited to 1 inlet per letdown. The design summary for geomembrane-lined letdowns and pipe letdowns is provided on Sheet IIIF-F-12.

Required: Analyze chutes to determine chute sizes for drainage areas that range from 1.81 acres to 32.4 acres.

Method:

1. Determine the 25-year, 24-hour flow rates for various sizes of chute drainage areas using the Rational Method.

Reference:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, September 2019.

Solution:

1. Determine the 25-year intensity flow rates.

$$Q = CIA$$

Where:

C= 0.7 (runoff coefficient, Ref 1.)
I = intensity, in/hr
A= drainage area, ac

$$I = \frac{b}{(t_c + d)^e}$$

b = 83.01
d = 10.65
e = 0.775

From Ref. 1, for Johnson County 25-year storm event

t_c is assumed to be 10 min.

I = 7.95 in/hr

Area (ac)	Flow (cfs)
5.00	27.8
10.0	55.7
15.0	83.5
20.0	111.4
25.0	139.2
30.0	167.1

2. Demonstrate that the normal depth of flow for the maximum 25-year flow rate will be contained within the chute.

Please refer to Page 3 for chute hydraulic analysis output.

Prep By: BPY
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
EROSION CONTROL STRUCTURE DESIGN
GEOMEMBRANE-LINED CHUTE

Chkd By: CRM
Date: 11/15/2021

Uniform flow design for the geomembrane-lined chutes on 5% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.05	0.01	2	2	8	0.26	12.77	4.585	2.54	2.79	2.18	9.02
55.7	0.05	0.01	2	2	8	0.39	16.48	4.883	4.22	4.61	3.38	9.54
83.5	0.05	0.01	2	2	8	0.49	19.01	5.046	5.62	6.10	4.39	9.96
111.4	0.05	0.01	2	2	8	0.58	21.00	5.162	6.85	7.43	5.31	10.32
139.2	0.05	0.01	2	2	8	0.66	22.64	5.251	7.97	8.63	6.15	10.64
167.1	0.05	0.01	2	2	8	0.73	24.06	5.324	9.00	9.73	6.94	10.93

Uniform flow design for the geomembrane-lined chutes on 25% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.25	0.01	2	2	8	0.16	21.20	9.590	6.99	7.14	1.31	8.63
55.7	0.25	0.01	2	2	8	0.24	27.42	10.152	11.69	11.93	2.03	8.96
83.5	0.25	0.01	2	2	8	0.30	31.83	10.521	15.75	16.05	2.62	9.22
111.4	0.25	0.01	2	2	8	0.36	35.34	10.786	19.41	19.77	3.15	9.45
139.2	0.25	0.01	2	2	8	0.41	38.34	11.019	22.85	23.26	3.63	9.65
167.1	0.25	0.01	2	2	8	0.46	40.89	11.183	25.99	26.44	4.09	9.83

Uniform flow design for the geomembrane-lined chutes on 28.6% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.286	0.01	2	2	8	0.15	22.11	10.195	7.59	7.75	1.26	8.61
55.7	0.286	0.01	2	2	8	0.23	28.61	10.794	12.72	12.95	1.95	8.92
83.5	0.286	0.01	2	2	8	0.29	33.22	11.187	17.15	17.44	2.51	9.17
111.4	0.286	0.01	2	2	8	0.35	36.90	11.470	21.15	21.50	3.02	9.39
139.2	0.286	0.01	2	2	8	0.40	40.04	11.720	24.92	25.31	3.48	9.58
167.1	0.286	0.01	2	2	8	0.44	42.72	11.896	28.36	28.80	3.91	9.76

Conclusions: Maximum normal depth is 0.73 feet. Chute design depth is 2.0 feet; therefore, design is acceptable.

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).

TURKEY CREEK LANDFILL
0771-368-11-123
EROSION CONTROL STRUCTURE DESIGN
GABION, TURF REINFORCEMENT MAT, ROCK RIPRAP, OR CONCRETE GROUTED RIPRAP-LINED CHUTE

Chute flow design for the gabion and rock riprap-lined chutes on 5% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.05	0.04	2	2	8	0.58	5.25	1.920	0.43	1.01	5.30	10.31
55.7	0.05	0.04	2	2	8	0.87	6.61	1.360	0.68	1.54	8.42	11.46
83.5	0.05	0.04	2	2	8	1.09	7.52	1.400	0.88	1.97	11.10	12.36
111.4	0.05	0.04	2	2	8	1.28	8.23	1.428	1.05	2.33	13.54	13.13
139.2	0.05	0.04	2	2	8	1.45	8.80	1.450	1.20	2.65	15.82	13.80
167.1	0.05	0.04	2	2	8	1.60	9.30	1.467	1.34	2.95	17.98	14.42

Chute flow design for the gabion and rock riprap-lined chutes on 25% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.25	0.04	2	2	8	0.36	8.83	2.696	1.21	1.57	3.15	9.44
55.7	0.25	0.04	2	2	8	0.54	11.30	2.860	1.98	2.53	4.93	10.17
83.5	0.25	0.04	2	2	8	0.69	12.96	2.951	2.61	3.30	6.44	10.75
111.4	0.25	0.04	2	2	8	0.81	14.26	3.015	3.16	3.97	7.81	11.25
139.2	0.25	0.04	2	2	8	0.92	15.34	3.069	3.66	4.58	9.08	11.69
167.1	0.25	0.04	2	2	8	1.02	16.24	3.104	4.10	5.12	10.29	12.10

Chute flow design for the gabion and rock riprap-lined chutes on 28.6% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.286	0.04	2	2	8	0.35	9.22	2.867	1.32	1.67	3.02	9.39
55.7	0.286	0.04	2	2	8	0.52	11.81	3.043	2.17	2.69	4.72	10.09
83.5	0.286	0.04	2	2	8	0.66	13.55	3.140	2.85	3.52	6.16	10.64
111.4	0.286	0.04	2	2	8	0.78	14.92	3.209	3.46	4.24	7.47	11.12
139.2	0.286	0.04	2	2	8	0.89	16.04	3.262	4.00	4.89	8.68	11.55
167.1	0.286	0.04	2	2	8	0.99	17.01	3.306	4.50	5.48	9.82	11.94

TURKEY CREEK LANDFILL
0771-368-11-123
EROSION CONTROL STRUCTURE DESIGN
GABION, TURF REINFORCEMENT MAT, ROCK RIPRAP, OR CONCRETE GROUTED RIPRAP-LINED CHUTE

Conclusions: Maximum acceptable normal depth is 1.60 feet. Chute design depth is 2.0 feet; therefore, 30 acres is the maximum allowable drainage area for a gabion or rock rip-rap lined chute on a 5% slope.
Maximum velocity is 42.72 fps. As noted in footnote No. 2 below, the lining material will be selected so that the permissible velocity is not exceeded for erosion control.

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).
2. Permissible velocities are listed below, and lining material will be selected so that these are not exceeded.

Description	Permissible Velocity (fps)
Turf Reinforcement Mat (based on Pyramat or equivalent. Refer to Sheet **IIIF-F-2-21**.)	25
Rock Riprap (based on Sheet **IIIF-F-2-22** and a D_{50} of 12 inches. (If other riprap is used, it will meet the D_{50} requirements listed on Sheet **IIIF-F-2-22**.)	9
Gabion/Concrete Grouted Riprap (based on **Sheet IIIF-F-2-23** and a D_{50} of 0.62 ft. If other gabion is used, it will meet the D_{50} requirements listed on Sheet **IIIF-F-2-23**. (The permissible velocity for concrete grouted riprap will actually be greater than 21 fps because it is classified as a rigid channel lining material.)	21

TURKEY CREEK LANDFILL
0771-368-11-123
EROSION CONTROL STRUCTURE DESIGN
GABION, TURF REINFORCEMENT MAT, ROCK RIPRAP, OR CONCRETE GROUTED RIPRAP-LINED CHUTE

Chute flow design for the concrete grouted riprap and turf reinforcement-lined chutes on 5% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.05	0.03	2	2	8	0.49	6.33	1.682	0.62	1.11	4.39	9.96
55.7	0.05	0.03	2	2	8	0.73	8.02	1.775	1.00	1.73	6.94	10.93
83.5	0.05	0.03	2	2	8	0.93	9.16	1.830	1.30	2.23	9.11	11.70
111.4	0.05	0.03	2	2	8	1.09	10.03	1.866	1.56	2.65	11.10	12.36
139.2	0.05	0.03	2	2	8	1.24	10.75	1.895	1.80	3.03	12.95	12.95
167.1	0.05	0.03	2	2	8	1.37	11.37	1.919	2.01	3.38	14.70	13.48

Chute flow design for the concrete grouted riprap and turf reinforcement-lined chutes on 25% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.25	0.03	2	2	8	0.30	10.61	3.507	1.75	2.05	2.62	9.22
55.7	0.25	0.03	2	2	8	0.46	13.63	3.728	2.89	3.35	4.09	9.83
83.5	0.25	0.03	2	2	8	0.58	15.68	3.849	3.82	4.40	5.33	10.32
111.4	0.25	0.03	2	2	8	0.69	17.28	3.935	4.64	5.33	6.45	10.75
139.2	0.25	0.03	2	2	8	0.78	18.61	4.001	5.38	6.16	7.48	11.13
167.1	0.25	0.03	2	2	8	0.87	19.75	4.055	6.06	6.93	8.46	11.48

Chute flow design for the concrete grouted riprap and turf reinforcement-lined chutes on 28.6% slope.

Flow Rate (cfs)	Bottom Slope (ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sf)	Flow Top Width (ft)
27.8	0.286	0.03	2	2	8	0.29	11.07	3.729	1.90	2.20	2.51	9.17
55.7	0.286	0.03	2	2	8	0.44	14.24	3.965	3.15	3.59	3.91	9.76
83.5	0.286	0.03	2	2	8	0.56	16.39	4.095	4.17	4.73	5.09	10.24
111.4	0.286	0.03	2	2	8	0.66	18.07	4.187	5.08	5.74	6.16	10.64
139.2	0.286	0.03	2	2	8	0.75	19.47	4.258	5.89	6.64	7.15	11.01
167.1	0.286	0.03	2	2	8	0.84	20.67	4.316	6.64	7.47	8.08	11.34

Prep By: BPY
Date: 11/15/2021

Chkd By: CRM
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
EROSION CONTROL STRUCTURE DESIGN
GABION, TURF REINFORCEMENT MAT, ROCK RIPRAP, OR CONCRETE GROUTED RIPRAP-LINED CHUTE

Conclusions: Maximum normal depth is 1.37 feet. Chute design depth is 2.0 feet; therefore, design is acceptable. Maximum velocity is 20.67 fps. As noted in footnote No. 2 below, the lining material will be selected so that the permissible velocity is not exceeded for erosion control.

1. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 2.01, 1996-2010).
2. Permissible velocities are listed below, and lining material will be selected so that these are not exceeded.

Description	Permissible Velocity (fps)
Turf Reinforcement Mat (based on Pyramat or equivalent. Refer to Sheet **IIIF-F-2-21**.)	25
Rock Riprap (based on Sheet **IIIF-F-2-22** and a D_{50} of 12 inches. If other riprap is used, it will meet the D_{50} requirements listed on Sheet **IIIF-F-2-22**.)	9
Gabion/Concrete Grouted Riprap (based on Sheet **IIIF-F-2-23** and a D_{50} of 0.62 ft. If other gabion is used, it will meet the D_{50} requirements listed on Sheet **IIIF-F-2-23**. The permissible velocity for concrete grouted riprap will actually be greater than 21 fps because it is classified as a rigid channel lining material.)	21

OPEN CHANNEL LETDOWN
RIPRAP EROSION PROTECTION DESIGN

Required: Design the riprap erosion protection at the downstream end of the open channel letdown.

Method: Use HEC-RAS to model the open channel geomembrane-lined letdown to determine the hydraulic characteristics of the hydraulic jump that will occur at the downstream end of the letdown. Based on the results, design the riprap erosion protection area.

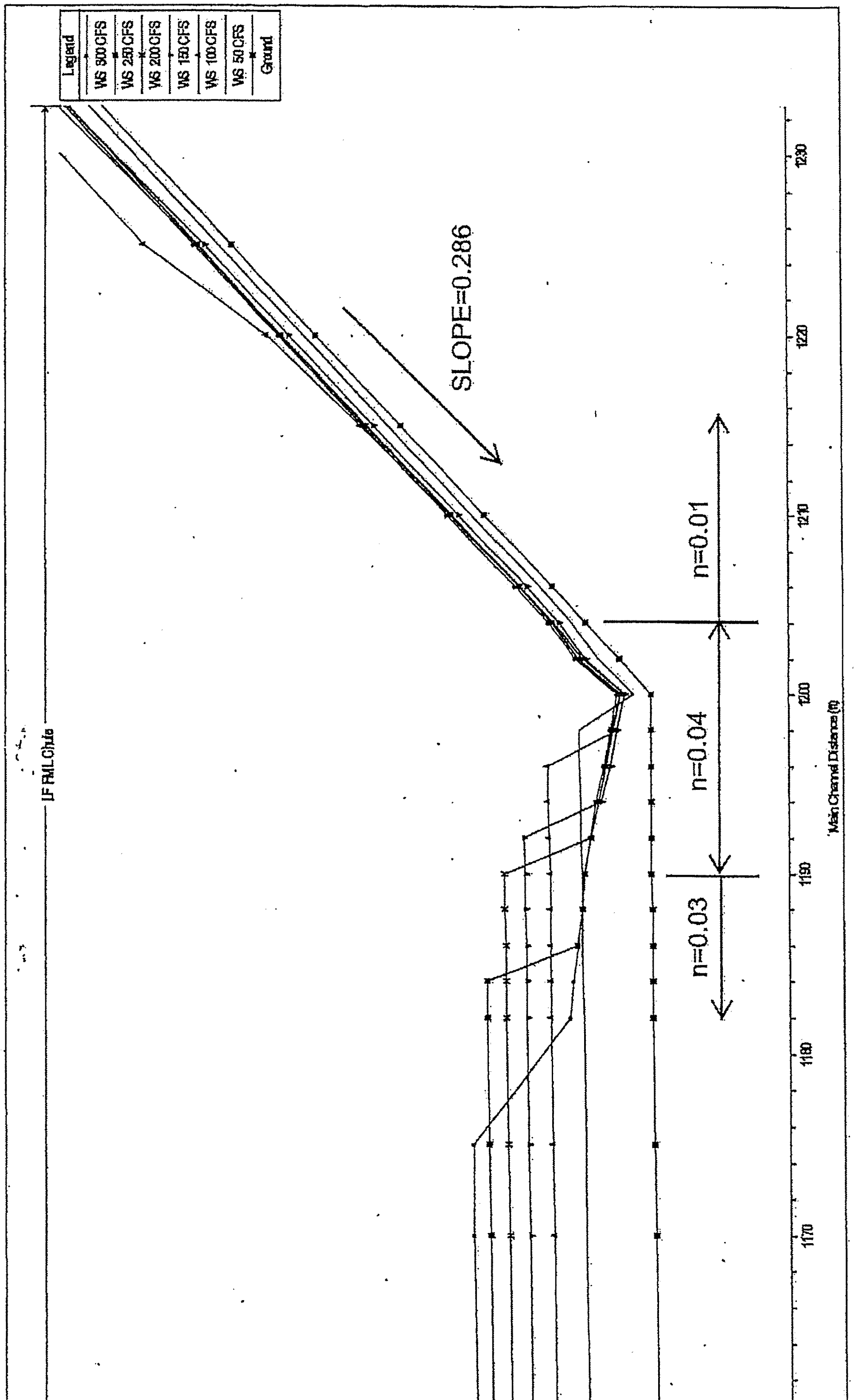
Note: This example calculation is shown for geomembrane-lined letdowns to conservatively estimate the length of riprap needed. As seen on pages IIIF-F-2-3 through IIIF-F-2-6, the geomembrane-lined letdowns have the highest velocities and represent the worst-case scenario. Therefore, this riprap design is applicable to all lined letdowns.

Solution: Page IIIF-F-2-9 shows the water surface profile for incremental flows up to 300 cfs for the geomembrane letdown into a channel, as modeled in HEC-RAS. The modeling output is presented on pages IIIF-F-2-10 through IIIF-F-2-20. The following table summarizes the erosion protection design for the various flows.

Flow (cfs)	Drainage Area* (ac)	Length of Hydraulic Jump (ft)	Specified Runout of Riprap (ft)
50	9	2	10
100	18	4	10
150	27	8	10
200	36	10	10
250	45	16	16
300	54	18	25

* Drainage areas are approximated based on the calculation methodology listed on page IIIF-F-2-2.

The values listed in the above table are specified riprap lengths for letdowns terminating into a perimeter channel. If the letdown terminates into a pond, 10 feet of riprap erosion control will be sufficient because the water in the pond will provide additional energy dissipation.



LF RML Chute
Legend
WS 300 CFS
WS 250 CFS
WS 200 CFS
WS 150 CFS
WS 100 CFS
WS 50 CFS
Ground
SLOPE=0.286
n=0.01
n=0.04
n=0.03
Elevation (ft)
Main Channel Distance (ft)
300
298
296
294
292
290
288
1160
1170
1180
1190
1200
1210
1220
1230

IIIF-F-2-9

HEC-RAS HEC-RAS 5.0.3 September 2016
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX   XXXX        XXXX     XX     XXXX
X     X  X       X    X       X   X   X  X   X
X     X  X       X            X   X  X    X  X
XXXXXXX  XXXX    X       XXX  XXXX   XXXXXX   XXXX
X     X  X       X            X  X   X    X       X
X     X  X       X    X       X   X  X    X       X
X     X  XXXXXX   XXXX        X    X X    X  XXXXX
```

PROJECT DATA
Project Title: Hydraulic Jump
Project File : HydraulicJump.prj
Run Date and Time: 1/23/2019 1:17:24 PM

Project in English units

PLAN DATA

Plan Title: Rio Grande Runup 0.3%
Plan File : p:\Solid waste\IESI\Turkey Creek\Expansion _Vertical\SDP\App III-F\App IIIF-F (from Maloy)\Hydraulic Jump HEC-RAS\HydraulicJump.p09

Geometry Title: Rio Grande FML CHUTE with 4' RUNUP .003
Geometry File : p:\Solid waste\IESI\Turkey Creek\Expansion _Vertical\SDP\App III-F\App IIIF-F (from Maloy)\Hydraulic Jump HEC-RAS\HydraulicJump.g08

Flow Title : Rio Grande FML CHUTE 0.3%
Flow File : p:\Solid waste\IESI\Turkey Creek\Expansion _Vertical\SDP\App III-F\App IIIF-F (from Maloy)\Hydraulic Jump HEC-RAS\HydraulicJump.f04

Plan Summary Information:

Number of:				
Cross Sections =	36		Multiple Openings =	0
Culverts =	0		Inline Structures =	0
Bridges =	0		Lateral Structures =	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: Rio Grande FML CHUTE 0.3%
Flow File : p:\Solid waste\IESI\Turkey Creek\Expansion _Vertical\SDP\App III-F\App IIIF-F (from Maloy)\Hydraulic Jump HEC-RAS\HydraulicJump.f04

Flow Data (cfs)

River	Reach	RS	50 CFS	100 CFS	150 CFS	200 CFS	250 CFS	300 CFS
LF	FML Chute	5000	50	100	150	200	250	300

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
LF	FML Chute	50 CFS	Normal S = 0.2857	Normal S = 0.003
LF	FML Chute	100 CFS	Normal S = 0.2857	Normal S = 0.003
LF	FML Chute	150 CFS	Normal S = 0.2857	Normal S = 0.003
LF	FML Chute	200 CFS	Normal S = 0.2857	Normal S = 0.003
LF	FML Chute	250 CFS	Normal S = 0.2857	Normal S = 0.003
LF	FML Chute	300 CFS	Normal S = 0.2857	Normal S = 0.003

GEOMETRY DATA

Geometry Title: Rio Grande FML CHUTE with 4' RUNUP .003
Geometry File : p:\Solid waste\IESI\Turkey Creek\Expansion _Vertical\SDP\App III-F\App IIIF-F (from Maloy)\Hydraulic Jump HEC-RAS\HydraulicJump.g08

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 5000

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	528.79	20	518.79	28	518.79	48	528.79

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4900

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	500.19	20	490.19	28	490.19	48	500.19

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4800

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	471.59	20	461.59	28	461.59	48	471.59

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4700

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	442.99	20	432.99	28	432.99	48	442.99

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4600

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	414.39	20	404.39	28	404.39	48	414.39

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4500

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	385.79	20	375.79	28	375.79	48	385.79

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4400

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	357.19	20	347.19	28	347.19	48	357.19

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4300

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	328.59	20	318.59	28	318.59	48	328.59

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	75	75	75	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4225

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	307.14	20	297.14	28	297.14	48	307.14

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	5	5	5	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4220

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	305.71	20	295.71	28	295.71	48	305.71

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	5	5	5	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4215

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	304.29	20	294.29	28	294.29	48	304.29

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	5	5	5	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4210

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	302.86	20	292.86	28	292.86	48	302.86

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	4	4	4	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4206

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	301.71	20	291.71	28	291.71	48	301.71

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.01	0	.01	48	.01

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4204

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	301.14	20	291.14	28	291.14	48	301.14

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	48	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4202

INPUT

Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300.57	20	290.57	28	290.57	48	300.57

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	48	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	48	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4200

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300	30	290	42	290	72	300

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	72	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	72	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4198

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300	30	290	42	290	72	300

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	72	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	72	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4196

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300	30	290	42	290	72	300

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	72	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	72	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4194

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300	30	290	42	290	72	300

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	72	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	72	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4192

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	300	30	290	42	290	72	300

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	0	.04	72	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	72	2	2	2	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4190

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	310	60	290	72	290	132	310

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

```
      0      .03        0      .03       72      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0       72                 2        2       2               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4188

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 309.994       60 289.994       72 289.994       132 309.994

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                 2        2       2               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4186

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 309.988       60 289.988       72 289.988       132 309.988

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                 2        2       2               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4184

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 309.982       60 289.982       72 289.982       132 309.982

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                 2        2       2               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4182

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 309.976       60 289.976       72 289.976       132 309.976

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                 7        7       7               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4175

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0 309.955       60 289.955       72 289.955       132 309.955

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                 5        5       5               .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute           RS: 4170

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
       0  309.94       60  289.94       72  289.94       132  309.94

Manning's n Values          num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
       0     .03        0     .03      132     .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10               .1        .5

CROSS SECTION
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```
RIVER: LF
REACH: FML Chute          RS: 4160

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.91      60   289.91      72   289.91     132   309.91

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4150

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.88      60   289.88      72   289.88     132   309.88

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4140

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.85      60   289.85      72   289.85     132   309.85

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4130

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.82      60   289.82      72   289.82     132   309.82

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4120

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.79      60   289.79      72   289.79     132   309.79

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4110

INPUT
Description:
Station Elevation Data     num=       4
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
       0   309.76      60   289.76      72   289.76     132   309.76

Manning's n Values         num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
       0      .03       0      .03     132      .03

Bank Sta: Left    Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
             0      132                10       10      10                .1        .5

CROSS SECTION


RIVER: LF
REACH: FML Chute          RS: 4100

INPUT
Description:
Station Elevation Data     num=       4
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	309.73	60	289.73	72	289.73	132	309.73

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.03	0	.03	132	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	132	100	100	100	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 4000

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	309.43	60	289.43	72	289.43	132	309.43

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.03	0	.03	132	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
0	132	1000	1000	1000	.1	.5

CROSS SECTION

RIVER: LF
REACH: FML Chute RS: 3000

INPUT
Description:
Station Elevation Data num= 4

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	306.43	60	286.43	72	286.43	132	306.43

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.03	0	.03	132	.03

Bank Sta: Left	Right	Coeff Contr.	Expan.
0	132	.1	.5

SUMMARY OF MANNING'S N VALUES

River:LF

Reach	River Sta.	n1	n2	n3
FML Chute	5000	.01	.01	.01
FML Chute	4900	.01	.01	.01
FML Chute	4800	.01	.01	.01
FML Chute	4700	.01	.01	.01
FML Chute	4600	.01	.01	.01
FML Chute	4500	.01	.01	.01
FML Chute	4400	.01	.01	.01
FML Chute	4300	.01	.01	.01
FML Chute	4225	.01	.01	.01
FML Chute	4220	.01	.01	.01
FML Chute	4215	.01	.01	.01
FML Chute	4210	.01	.01	.01
FML Chute	4206	.01	.01	.01
FML Chute	4204	.04	.04	.04
FML Chute	4202	.04	.04	.04
FML Chute	4200	.04	.04	.04
FML Chute	4198	.04	.04	.04
FML Chute	4196	.04	.04	.04
FML Chute	4194	.04	.04	.04
FML Chute	4192	.04	.04	.04
FML Chute	4190	.03	.03	.03
FML Chute	4188	.03	.03	.03
FML Chute	4186	.03	.03	.03
FML Chute	4184	.03	.03	.03
FML Chute	4182	.03	.03	.03
FML Chute	4175	.03	.03	.03
FML Chute	4170	.03	.03	.03
FML Chute	4160	.03	.03	.03
FML Chute	4150	.03	.03	.03
FML Chute	4140	.03	.03	.03
FML Chute	4130	.03	.03	.03
FML Chute	4120	.03	.03	.03
FML Chute	4110	.03	.03	.03
FML Chute	4100	.03	.03	.03
FML Chute	4000	.03	.03	.03
FML Chute	3000	.03	.03	.03

SUMMARY OF REACH LENGTHS

River: LF

Reach	River Sta.	Left	Channel	Right
FML Chute	5000	100	100	100
FML Chute	4900	100	100	100
FML Chute	4800	100	100	100
FML Chute	4700	100	100	100
FML Chute	4600	100	100	100
FML Chute	4500	100	100	100
FML Chute	4400	100	100	100
FML Chute	4300	75	75	75
FML Chute	4225	5	5	5
FML Chute	4220	5	5	5
FML Chute	4215	5	5	5
FML Chute	4210	4	4	4
FML Chute	4206	2	2	2
FML Chute	4204	2	2	2
FML Chute	4202	2	2	2
FML Chute	4200	2	2	2
FML Chute	4198	2	2	2
FML Chute	4196	2	2	2
FML Chute	4194	2	2	2

FML Chute	4192	2	2	2
FML Chute	4190	2	2	2
FML Chute	4188	2	2	2
FML Chute	4186	2	2	2
FML Chute	4184	2	2	2
FML Chute	4182	7	7	7
FML Chute	4175	5	5	5
FML Chute	4170	10	10	10
FML Chute	4160	10	10	10
FML Chute	4150	10	10	10
FML Chute	4140	10	10	10
FML Chute	4130	10	10	10
FML Chute	4120	10	10	10
FML Chute	4110	10	10	10
FML Chute	4100	100	100	100
FML Chute	4000	1000	1000	1000
FML Chute	3000			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: LF

Reach	River Sta.	Contr.	Expan.
FML Chute	5000	.1	.5
FML Chute	4900	.1	.5
FML Chute	4800	.1	.5
FML Chute	4700	.1	.5
FML Chute	4600	.1	.5
FML Chute	4500	.1	.5
FML Chute	4400	.1	.5
FML Chute	4300	.1	.5
FML Chute	4225	.1	.5
FML Chute	4220	.1	.5
FML Chute	4215	.1	.5
FML Chute	4210	.1	.5
FML Chute	4206	.1	.5
FML Chute	4204	.1	.5
FML Chute	4202	.1	.5
FML Chute	4200	.1	.5
FML Chute	4198	.1	.5
FML Chute	4196	.1	.5
FML Chute	4194	.1	.5
FML Chute	4192	.1	.5
FML Chute	4190	.1	.5
FML Chute	4188	.1	.5
FML Chute	4186	.1	.5
FML Chute	4184	.1	.5
FML Chute	4182	.1	.5
FML Chute	4175	.1	.5
FML Chute	4170	.1	.5
FML Chute	4160	.1	.5
FML Chute	4150	.1	.5
FML Chute	4140	.1	.5
FML Chute	4130	.1	.5
FML Chute	4120	.1	.5
FML Chute	4110	.1	.5
FML Chute	4100	.1	.5
FML Chute	4000	.1	.5
FML Chute	3000	.1	.5

Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FML Chute	5000	50 CFS	50.00	518.79	519.01	519.77	530.72	0.286102	27.46	1.82	8.86	10.68
FML Chute	5000	100 CFS	100.00	518.79	519.12	520.27	538.67	0.286125	35.47	2.82	9.30	11.36
FML Chute	5000	150 CFS	150.00	518.79	519.20	520.66	545.37	0.286041	41.04	3.66	9.66	11.76
FML Chute	5000	200 CFS	200.00	518.79	519.28	521.00	551.33	0.286018	45.42	4.40	9.96	12.04
FML Chute	5000	250 CFS	250.00	518.79	519.35	521.29	556.76	0.285889	49.06	5.10	10.24	12.26
FML Chute	5000	300 CFS	300.00	518.79	519.41	521.56	561.79	0.285857	52.22	5.74	10.49	12.44
FML Chute	4900	50 CFS	50.00	490.19	490.41	491.17	502.12	0.285966	27.46	1.82	8.86	10.68
FML Chute	4900	100 CFS	100.00	490.19	491.67	491.67	492.26	0.001489	6.15	16.26	13.93	1.00
FML Chute	4900	150 CFS	150.00	490.19	492.06	492.06	492.79	0.001415	6.81	22.03	15.50	1.01
FML Chute	4900	200 CFS	200.00	490.19	492.40	492.40	493.23	0.001361	7.29	27.43	16.84	1.01
FML Chute	4900	250 CFS	250.00	490.19	492.69	492.69	493.61	0.001320	7.68	32.56	18.01	1.01
FML Chute	4900	300 CFS	300.00	490.19	490.81	492.96	533.20	0.285954	52.23	5.74	10.49	12.44
FML Chute	4800	50 CFS	50.00	461.59	461.81	462.57	473.52	0.285966	27.46	1.82	8.86	10.68
FML Chute	4800	100 CFS	100.00	461.59	463.07	463.07	463.66	0.001489	6.15	16.26	13.93	1.00
FML Chute	4800	150 CFS	150.00	461.59	463.46	463.46	464.19	0.001415	6.81	22.03	15.50	1.01
FML Chute	4800	200 CFS	200.00	461.59	462.11	463.80	490.05	0.231587	42.40	4.72	10.09	10.93
FML Chute	4800	250 CFS	250.00	461.59	462.22	464.09	490.43	0.186161	42.60	5.87	10.53	10.06
FML Chute	4800	300 CFS	300.00	461.59	464.36	464.36	465.35	0.001289	8.01	37.47	19.07	1.01
FML Chute	4700	50 CFS	50.00	432.99	433.21	433.97	444.92	0.285966	27.46	1.82	8.86	10.68
FML Chute	4700	100 CFS	100.00	432.99	434.47	434.47	435.06	0.001489	6.15	16.26	13.93	1.00
FML Chute	4700	150 CFS	150.00	432.99	434.86	434.86	435.59	0.001415	6.81	22.03	15.50	1.01
FML Chute	4700	200 CFS	200.00	432.99	435.20	435.20	436.03	0.001361	7.29	27.43	16.84	1.01
FML Chute	4700	250 CFS	250.00	432.99	433.57	435.49	468.18	0.253958	47.19	5.30	10.31	11.61
FML Chute	4700	300 CFS	300.00	432.99	433.73	435.76	462.18	0.156799	42.79	7.01	10.96	9.43
FML Chute	4600	50 CFS	50.00	404.39	404.61	405.37	416.32	0.285966	27.46	1.82	8.86	10.68
FML Chute	4600	100 CFS	100.00	404.39	405.87	405.87	406.46	0.001489	6.15	16.26	13.93	1.00
FML Chute	4600	150 CFS	150.00	404.39	406.26	406.26	406.99	0.001415	6.81	22.03	15.50	1.01
FML Chute	4600	200 CFS	200.00	404.39	404.91	406.60	432.85	0.231587	42.40	4.72	10.09	10.93
FML Chute	4600	250 CFS	250.00	404.39	404.95	406.89	441.52	0.276060	48.51	5.15	10.26	12.06
FML Chute	4600	300 CFS	300.00	404.39	405.05	407.16	442.29	0.235109	48.95	6.13	10.63	11.37
FML Chute	4500	50 CFS	50.00	375.79	376.01	376.77	387.72	0.285966	27.46	1.82	8.86	10.68
FML Chute	4500	100 CFS	100.00	375.79	377.27	377.27	377.86	0.001489	6.15	16.26	13.93	1.00
FML Chute	4500	150 CFS	150.00	375.79	377.66	377.66	378.39	0.001415	6.81	22.03	15.50	1.01
FML Chute	4500	200 CFS	200.00	375.79	378.00	378.00	378.83	0.001361	7.29	27.43	16.84	1.01
FML Chute	4500	250 CFS	250.00	375.79	378.29	378.29	379.21	0.001320	7.68	32.56	18.01	1.01
FML Chute	4500	300 CFS	300.00	375.79	376.42	378.56	416.93	0.266963	51.06	5.88	10.54	12.05
FML Chute	4400	50 CFS	50.00	347.19	347.41	348.17	359.12	0.285966	27.46	1.82	8.86	10.68
FML Chute	4400	100 CFS	100.00	347.19	348.67	348.67	349.26	0.001489	6.15	16.26	13.93	1.00
FML Chute	4400	150 CFS	150.00	347.19	349.06	349.06	349.79	0.001415	6.81	22.03	15.50	1.01
FML Chute	4400	200 CFS	200.00	347.19	347.71	349.40	375.65	0.231587	42.40	4.72	10.09	10.93
FML Chute	4400	250 CFS	250.00	347.19	347.82	349.69	376.03	0.186161	42.60	5.87	10.53	10.06
FML Chute	4400	300 CFS	300.00	347.19	347.82	349.96	389.53	0.279062	51.81	5.79	10.50	12.30
FML Chute	4300	50 CFS	50.00	318.59	318.81	319.57	330.52	0.285966	27.46	1.82	8.86	10.68
FML Chute	4300	100 CFS	100.00	318.59	320.07	320.07	320.66	0.001489	6.15	16.26	13.93	1.00

FML Chute	4300	150 CFS	150.00	318.59	320.46	320.46	321.19	0.001415	6.81	22.03	15.50	1.01
FML Chute	4300	200 CFS	200.00	318.59	320.80	320.80	321.63	0.001361	7.29	27.43	16.84	1.01
FML Chute	4300	250 CFS	250.00	318.59	319.17	321.09	353.78	0.253958	47.19	5.30	10.31	11.61
FML Chute	4300	300 CFS	300.00	318.59	321.36	321.36	322.35	0.001289	8.01	37.47	19.07	1.01
FML Chute	4225	50 CFS	50.00	297.14	297.36	298.12	309.07	0.285966	27.46	1.82	8.86	10.68
FML Chute	4225	100 CFS	100.00	297.14	298.62	298.62	299.21	0.001489	6.15	16.26	13.93	1.00
FML Chute	4225	150 CFS	150.00	297.14	297.60	299.01	318.78	0.206306	36.92	4.06	9.82	10.12
FML Chute	4225	200 CFS	200.00	297.14	297.73	299.35	319.22	0.155225	37.19	5.38	10.35	9.09
FML Chute	4225	250 CFS	250.00	297.14	297.71	299.64	333.92	0.272009	48.27	5.18	10.27	11.98
FML Chute	4225	300 CFS	300.00	297.14	297.97	299.91	319.94	0.106674	37.61	7.98	11.31	7.89
FML Chute	4220	50 CFS	50.00	295.71	295.93	296.69	307.64	0.286102	27.46	1.82	8.86	10.68
FML Chute	4220	100 CFS	100.00	295.71	296.53	297.19	299.00	0.012073	12.61	7.93	11.29	2.65
FML Chute	4220	150 CFS	150.00	295.71	296.16	297.58	317.70	0.211610	37.23	4.03	9.81	10.24
FML Chute	4220	200 CFS	200.00	295.71	296.29	297.92	318.37	0.161683	37.69	5.31	10.32	9.27
FML Chute	4220	250 CFS	250.00	295.71	296.30	298.21	329.73	0.240900	46.38	5.39	10.35	11.33
FML Chute	4220	300 CFS	300.00	295.71	296.52	298.48	319.31	0.112581	38.29	7.83	11.26	8.09
FML Chute	4215	50 CFS	50.00	294.29	294.51	295.27	306.22	0.285966	27.46	1.82	8.86	10.68
FML Chute	4215	100 CFS	100.00	294.29	294.97	295.77	298.79	0.023128	15.67	6.38	10.73	3.58
FML Chute	4215	150 CFS	150.00	294.29	294.74	296.16	316.60	0.216539	37.51	4.00	9.80	10.35
FML Chute	4215	200 CFS	200.00	294.29	294.86	296.50	317.48	0.167784	38.15	5.24	10.29	9.42
FML Chute	4215	250 CFS	250.00	294.29	294.88	296.79	328.50	0.243016	46.52	5.37	10.34	11.38
FML Chute	4215	300 CFS	300.00	294.29	295.09	297.06	318.65	0.118329	38.94	7.70	11.21	8.28
FML Chute	4210	50 CFS	50.00	292.86	293.08	293.84	304.79	0.285966	27.46	1.82	8.86	10.68
FML Chute	4210	100 CFS	100.00	292.86	293.46	294.34	298.52	0.035420	18.04	5.54	10.41	4.36
FML Chute	4210	150 CFS	150.00	292.86	293.31	294.73	315.48	0.221360	37.78	3.97	9.79	10.46
FML Chute	4210	200 CFS	200.00	292.86	293.43	295.07	316.58	0.173797	38.60	5.18	10.27	9.58
FML Chute	4210	250 CFS	250.00	292.86	293.44	295.36	327.26	0.245111	46.65	5.36	10.34	11.42
FML Chute	4210	300 CFS	300.00	292.86	293.65	295.63	317.97	0.124040	39.56	7.58	11.17	8.46
FML Chute	4206	50 CFS	50.00	291.71	291.93	292.69	303.65	0.286238	27.46	1.82	8.86	10.68
FML Chute	4206	100 CFS	100.00	291.71	292.27	293.19	298.26	0.045794	19.63	5.09	10.23	4.91
FML Chute	4206	150 CFS	150.00	291.71	292.15	293.58	314.57	0.225053	37.98	3.95	9.78	10.53
FML Chute	4206	200 CFS	200.00	291.71	292.27	293.92	315.83	0.178523	38.94	5.14	10.25	9.70
FML Chute	4206	250 CFS	250.00	291.71	292.29	294.21	326.26	0.246742	46.75	5.35	10.33	11.46
FML Chute	4206	300 CFS	300.00	291.71	292.49	294.48	317.41	0.128598	40.04	7.49	11.13	8.60
FML Chute	4204	50 CFS	50.00	291.14	291.37	292.12	301.42	3.581274	25.43	1.97	8.93	9.55
FML Chute	4204	100 CFS	100.00	291.14	291.69	292.62	297.98	0.790865	20.13	4.97	10.19	5.08
FML Chute	4204	150 CFS	150.00	291.14	291.60	293.01	312.86	3.319764	36.99	4.05	9.82	10.15
FML Chute	4204	200 CFS	200.00	291.14	291.71	293.35	314.58	2.730099	38.36	5.21	10.28	9.50
FML Chute	4204	250 CFS	250.00	291.14	291.73	293.64	324.32	3.707006	45.79	5.46	10.38	11.13
FML Chute	4204	300 CFS	300.00	291.14	291.93	293.91	316.67	2.037098	39.91	7.52	11.14	8.57
FML Chute	4202	50 CFS	50.00	290.57	290.91	291.55	295.26	0.951378	16.72	2.99	9.38	5.22
FML Chute	4202	100 CFS	100.00	290.57	291.19	292.05	295.95	0.516862	17.50	5.71	10.47	4.18
FML Chute	4202	150 CFS	150.00	290.57	291.13	292.44	304.39	1.606705	29.20	5.14	10.25	7.27
FML Chute	4202	200 CFS	200.00	290.57	291.24	292.78	306.98	1.549898	31.83	6.28	10.69	7.32
FML Chute	4202	250 CFS	250.00	290.57	291.27	293.07	313.79	2.120330	38.07	6.57	10.80	8.60
FML Chute	4202	300 CFS	300.00	290.57	291.45	293.34	310.52	1.383043	35.03	8.56	11.51	7.16
FML Chute	4200	50 CFS	50.00	290.00	290.31	290.76	292.81	0.628408	12.69	3.94	13.83	4.19
FML Chute	4200	100 CFS	100.00	290.00	290.47	291.17	294.45	0.593764	16.00	6.25	14.80	4.34
FML Chute	4200	150 CFS	150.00	290.00	290.47	291.48	299.27	1.299564	23.79	6.30	14.82	6.43
FML Chute	4200	200 CFS	200.00	290.00	290.54	291.75	301.81	1.393216	26.92	7.43	15.27	6.80
FML Chute	4200	250 CFS	250.00	290.00	290.57	291.99	306.52	1.873075	32.04	7.80	15.42	7.94
FML Chute	4200	300 CFS	300.00	290.00	290.69	292.21	305.69	1.411511	31.07	9.65	16.12	7.08
FML Chute	4198	50 CFS	50.00	290.00	291.26	290.76	291.36	0.004652	2.52	19.82	19.54	0.44
FML Chute	4198	100 CFS	100.00	290.00	290.60	291.17	292.85	0.247006	12.03	8.31	15.61	2.91
FML Chute	4198	150 CFS	150.00	290.00	290.59	291.48	295.80	0.581150	18.31	8.19	15.57	4.45
FML Chute	4198	200 CFS	200.00	290.00	290.66	291.75	297.85	0.701609	21.50	9.30	15.99	4.97
FML Chute	4198	250 CFS	250.00	290.00	290.69	291.99	301.12	0.981880	25.91	9.65	16.12	5.90
FML Chute	4198	300 CFS	300.00	290.00	290.80	292.21	301.33	0.828343	26.03	11.53	16.80	5.54
FML Chute	4196	50 CFS	50.00	290.00	291.25		291.35	0.004810	2.55	19.59	19.47	0.45
FML Chute	4196	100 CFS	100.00	290.00	291.81	291.17	291.97	0.004914	3.17	31.52	22.85	0.48
FML Chute	4196	150 CFS	150.00	290.00	290.72	291.48	294.08	0.298341	14.70	10.21	16.32	3.28
FML Chute	4196	200 CFS	200.00	290.00	290.78	291.75	295.68	0.394176	17.75	11.27	16.71	3.81
FML Chute	4196	250 CFS	250.00	290.00	290.80	291.99	298.07	0.569527	21.62	11.56	16.82	4.60
FML Chute	4196	300 CFS	300.00	290.00	290.91	292.21	298.64	0.521966	22.29	13.46	17.48	4.48
FML Chute	4194	50 CFS	50.00	290.00	291.23		291.34	0.004983	2.58	19.36	19.40	0.46
FML Chute	4194	100 CFS	100.00	290.00	291.80		291.96	0.005043	3.20	31.23	22.78	0.48
FML Chute	4194	150 CFS	150.00	290.00	290.86	291.48	293.09	0.162258	11.99	12.51	17.15	2.48
FML Chute	4194	200 CFS	200.00	290.00	290.91	291.75	294.37	0.234984	14.93	13.40	17.46	3.00
FML Chute	4194	250 CFS	250.00	290.00	290.92	291.99	296.19	0.353371	18.42	13.57	17.52	3.69
FML Chute	4194	300 CFS	300.00	290.00	291.03	292.21	296.86	0.344253	19.37	15.49	18.16	3.70
FML Chute	4192	50 CFS	50.00	290.00	291.22		291.33	0.005160	2.61	19.13	19.33	0.46
FML Chute	4192	100 CFS	100.00	290.00	291.78		291.95	0.005173	3.23	30.95	22.70	0.49
FML Chute	4192	150 CFS	150.00	290.00	292.21	291.48	292.42	0.005182	3.64	41.24	25.28	0.50
FML Chute	4192	200 CFS	200.00	290.00	291.05	291.75	293.52	0.143243	12.62	15.84	18.28	2.39
FML Chute	4192	250 CFS	250.00	290.00	291.04	291.99	294.96	0.227825	15.88	15.75	18.25	3.01
FML Chute	4192	300 CFS	300.00	290.00	291.15	292.21	295.62	0.233729	16.97	17.68	18.87	3.09
FML Chute	4190	50 CFS	50.00	290.00	291.21		291.32	0.002884	2.76	18.87	19.25	0.47
FML Chute	4190	100 CFS	100.00	290.00	291.77		291.94	0.002882	3.44	30.54	22.59	0.50
FML Chute	4190	150 CFS	150.00	290.00	292.19		292.41	0.002883	3.89	40.70	25.15	0.51
FML Chute	4190	200 CFS	200.00	290.00	292.55	291.77	292.80	0.002889	4.24	49.99	27.27	0.52
FML Chute	4190	250 CFS	250.00	290.00	291.15	292.01	294.33	0.085931	14.61	17.78	18.90	2.55
FML Chute	4190	300 CFS	300.00	290.00	291.25	292.23	294.97	0.091072	15.82	19.74	19.52	2.66
FML Chute	4188	50 CFS	50.00	289.99	291.20		291.31	0.002999	2.64	18.91	19.26	0.47
FML Chute	4188	100 CFS	100.00	289.99	291.76		291.93	0.003002	3.27	30.62	22.61	0.49
FML Chute	4188	150 CFS	150.00	289.99	292.19		292.40	0.003001	3.68	40.81	25.17	0.51
FML Chute	4188	200 CFS	200.00	289.99	292.54		292.79	0.003003	3.99	50.13	27.31	0.52
FML Chute	4188	250 CFS	250.00	289.99	291.20	291.99	293.95	0.076566	13.31	18.78	19.22	2.37
FML Chute	4188	300 CFS	300.00	289.99	291.29	292.21	294.57	0.083663	14.53	20.65	19.79	2.51
FML Chute	4186	50 CFS	50.00	289.99	291.20		291.31	0.003000	2.64	18.91	19.26	0.47
FML Chute	4186	100 CFS	100.00	289.99	291.76		291.92	0.003002	3.27	30.62	22.61	0.49
FML Chute	4186	150 CFS	150.00	289.99	292.18		292.39	0.003001	3.68	40.81	25.17	0.51
FML Chute	4186	200 CFS	200.00	289.99	292.54		292.79	0.003003	3.99	50.13	27.31	0.52
FML Chute	4186	250 CFS	250.00	289.99	291.28	291.98	293.58	0.058940	12.17	20.54	19.76	2.10
FML Chute	4186	300 CFS	300.00	289.99	291.37	292.20	294.19	0.067257	13.47	22.27	20.28	2.27
FML Chute	4184	50 CFS	50.00	289.98	291.19		291.30	0.003000	2.64	18.91	19.26	0.47
FML Chute	4184	100 CFS	100.00	289.98	291.75		291.92	0.003002	3.27	30.62	22.61	0.49
FML Chute	4184	150 CFS	150.00	289.98	292.18		292.39	0.003001	3.68	40.81	25.17	0.51
FML Chute	4184	200 CFS	200.00	289.98	292.53		292.78	0.003003	3.99	50.13	27.31	0.52
FML Chute	4184	250 CFS	250.00	289.98	292.84	291.98	293.12	0.003002	4.25	58.88	29.17	0.53
FML Chute	4184	300 CFS	300.00	289.98	291.45	292.19	293.86	0.053789	12.47	24.06	20.80	2.04
FML Chute	4182	50 CFS	50.00	289.98	291.19		291.29	0.003000	2.64	18.91	19.26	0.47
FML Chute	4182	100 CFS	100.00	289.98	291.75		291.91	0.003003	3.27	30.61	22.61	0.49
FML Chute	4182	150 CFS	150.00	289.98	292.17		292.38	0.003001	3.68	40.81	25.17	0.51
FML Chute	4182	200 CFS	200.00	289.98	292.53		292.77	0.003003	3.99	50.13	27.31	0.52

FML Chute	4182	250 CFS	250.00	289.98	292.84		293.12	0.003002	4.25	58.88	29.16	0.53
FML Chute	4182	300 CFS	300.00	289.98	293.11	292.19	293.42	0.003000	4.46	67.21	30.83	0.53
FML Chute	4175	50 CFS	50.00	289.96	291.16		291.27	0.003000	2.64	18.91	19.26	0.47
FML Chute	4175	100 CFS	100.00	289.96	291.72		291.89	0.003003	3.27	30.61	22.61	0.49
FML Chute	4175	150 CFS	150.00	289.96	292.15		292.36	0.003001	3.68	40.81	25.17	0.51
FML Chute	4175	200 CFS	200.00	289.96	292.51		292.75	0.003003	3.99	50.13	27.31	0.52
FML Chute	4175	250 CFS	250.00	289.96	292.82		293.10	0.003002	4.25	58.88	29.16	0.53
FML Chute	4175	300 CFS	300.00	289.96	293.09		293.40	0.003000	4.46	67.21	30.83	0.53
FML Chute	4170	50 CFS	50.00	289.94	291.15		291.26	0.003000	2.64	18.91	19.26	0.47
FML Chute	4170	100 CFS	100.00	289.94	291.71		291.87	0.003003	3.27	30.61	22.61	0.49
FML Chute	4170	150 CFS	150.00	289.94	292.14		292.35	0.003001	3.68	40.81	25.17	0.51
FML Chute	4170	200 CFS	200.00	289.94	292.49		292.74	0.003003	3.99	50.13	27.30	0.52
FML Chute	4170	250 CFS	250.00	289.94	292.80		293.08	0.003003	4.25	58.88	29.16	0.53
FML Chute	4170	300 CFS	300.00	289.94	293.08		293.39	0.003000	4.46	67.21	30.83	0.53
FML Chute	4160	50 CFS	50.00	289.91	291.12		291.23	0.003000	2.64	18.91	19.26	0.47
FML Chute	4160	100 CFS	100.00	289.91	291.68		291.84	0.003003	3.27	30.61	22.61	0.49
FML Chute	4160	150 CFS	150.00	289.91	292.11		292.32	0.003001	3.68	40.81	25.17	0.51
FML Chute	4160	200 CFS	200.00	289.91	292.46		292.71	0.003004	3.99	50.13	27.30	0.52
FML Chute	4160	250 CFS	250.00	289.91	292.77		293.05	0.003003	4.25	58.88	29.16	0.53
FML Chute	4160	300 CFS	300.00	289.91	293.05		293.36	0.003000	4.46	67.21	30.83	0.53
FML Chute	4150	50 CFS	50.00	289.88	291.09		291.20	0.003000	2.64	18.91	19.26	0.47
FML Chute	4150	100 CFS	100.00	289.88	291.65		291.81	0.003003	3.27	30.61	22.61	0.49
FML Chute	4150	150 CFS	150.00	289.88	292.08		292.29	0.003001	3.68	40.81	25.17	0.51
FML Chute	4150	200 CFS	200.00	289.88	292.43		292.68	0.003004	3.99	50.13	27.30	0.52
FML Chute	4150	250 CFS	250.00	289.88	292.74		293.02	0.003003	4.25	58.88	29.16	0.53
FML Chute	4150	300 CFS	300.00	289.88	293.02		293.33	0.003000	4.46	67.21	30.83	0.53
FML Chute	4140	50 CFS	50.00	289.85	291.06		291.17	0.003000	2.64	18.91	19.26	0.47
FML Chute	4140	100 CFS	100.00	289.85	291.62		291.78	0.003004	3.27	30.61	22.61	0.50
FML Chute	4140	150 CFS	150.00	289.85	292.05		292.26	0.003002	3.68	40.81	25.17	0.51
FML Chute	4140	200 CFS	200.00	289.85	292.40		292.65	0.003004	3.99	50.13	27.30	0.52
FML Chute	4140	250 CFS	250.00	289.85	292.71		292.99	0.003003	4.25	58.88	29.16	0.53
FML Chute	4140	300 CFS	300.00	289.85	292.99		293.30	0.003000	4.46	67.21	30.83	0.53
FML Chute	4130	50 CFS	50.00	289.82	291.03		291.14	0.003000	2.64	18.91	19.26	0.47
FML Chute	4130	100 CFS	100.00	289.82	291.59		291.75	0.003004	3.27	30.61	22.61	0.50
FML Chute	4130	150 CFS	150.00	289.82	292.02		292.23	0.003002	3.68	40.81	25.17	0.51
FML Chute	4130	200 CFS	200.00	289.82	292.37		292.62	0.003004	3.99	50.13	27.30	0.52
FML Chute	4130	250 CFS	250.00	289.82	292.68		292.96	0.003003	4.25	58.88	29.16	0.53
FML Chute	4130	300 CFS	300.00	289.82	292.96		293.27	0.003000	4.46	67.21	30.83	0.53
FML Chute	4120	50 CFS	50.00	289.79	291.00		291.11	0.003000	2.64	18.91	19.26	0.47
FML Chute	4120	100 CFS	100.00	289.79	291.56		291.72	0.003004	3.27	30.61	22.61	0.50
FML Chute	4120	150 CFS	150.00	289.79	291.99		292.20	0.003002	3.68	40.81	25.17	0.51
FML Chute	4120	200 CFS	200.00	289.79	292.34		292.59	0.003005	3.99	50.12	27.30	0.52
FML Chute	4120	250 CFS	250.00	289.79	292.65		292.93	0.003003	4.25	58.88	29.16	0.53
FML Chute	4120	300 CFS	300.00	289.79	292.93		293.24	0.003000	4.46	67.21	30.83	0.53
FML Chute	4110	50 CFS	50.00	289.76	290.97		291.08	0.003000	2.64	18.91	19.26	0.47
FML Chute	4110	100 CFS	100.00	289.76	291.53		291.69	0.003004	3.27	30.61	22.61	0.50
FML Chute	4110	150 CFS	150.00	289.76	291.96		292.17	0.003002	3.68	40.81	25.17	0.51
FML Chute	4110	200 CFS	200.00	289.76	292.31		292.56	0.003005	3.99	50.12	27.30	0.52
FML Chute	4110	250 CFS	250.00	289.76	292.62		292.90	0.003004	4.25	58.87	29.16	0.53
FML Chute	4110	300 CFS	300.00	289.76	292.90		293.21	0.003000	4.46	67.21	30.83	0.53
FML Chute	4100	50 CFS	50.00	289.73	290.94		291.05	0.003000	2.64	18.91	19.26	0.47
FML Chute	4100	100 CFS	100.00	289.73	291.50		291.66	0.003005	3.27	30.61	22.61	0.50
FML Chute	4100	150 CFS	150.00	289.73	291.93		292.14	0.003002	3.68	40.81	25.17	0.51
FML Chute	4100	200 CFS	200.00	289.73	292.28		292.53	0.003005	3.99	50.12	27.30	0.52
FML Chute	4100	250 CFS	250.00	289.73	292.59		292.87	0.003004	4.25	58.87	29.16	0.53
FML Chute	4100	300 CFS	300.00	289.73	292.87		293.18	0.003000	4.46	67.21	30.83	0.53
FML Chute	4000	50 CFS	50.00	289.43	290.64		290.75	0.002994	2.64	18.92	19.26	0.47
FML Chute	4000	100 CFS	100.00	289.43	291.20	290.60	291.36	0.003013	3.27	30.58	22.60	0.50
FML Chute	4000	150 CFS	150.00	289.43	291.62	290.91	291.84	0.003005	3.68	40.79	25.17	0.51
FML Chute	4000	200 CFS	200.00	289.43	291.98	291.18	292.23	0.003010	3.99	50.09	27.30	0.52
FML Chute	4000	250 CFS	250.00	289.43	292.29		292.57	0.003006	4.25	58.85	29.16	0.53
FML Chute	4000	300 CFS	300.00	289.43	292.57		292.88	0.003001	4.46	67.21	30.83	0.53
FML Chute	3000	50 CFS	50.00	286.43	287.64	287.19	287.75	0.003001	2.64	18.91	19.26	0.47
FML Chute	3000	100 CFS	100.00	286.43	288.20	287.60	288.36	0.003002	3.27	30.62	22.61	0.49
FML Chute	3000	150 CFS	150.00	286.43	288.63	287.91	288.84	0.003004	3.68	40.80	25.17	0.51
FML Chute	3000	200 CFS	200.00	286.43	288.98	288.18	289.23	0.003001	3.99	50.14	27.31	0.52
FML Chute	3000	250 CFS	250.00	286.43	289.29	288.42	289.57	0.003000	4.24	58.90	29.17	0.53
FML Chute	3000	300 CFS	300.00	286.43	289.57	288.64	289.88	0.003004	4.47	67.18	30.82	0.53

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PROPEX
GEOSYNTHETICS

Pyramat® Turf Reinforcement Mat

Technical Data Sheet

Roll Sizes - 8.5 ft x 90 ft, 85 sq yd (2.6m x 27.4m, 8.44 sq m)

PYRAMAT high performance turf reinforcement mat (HPTRM) is a three-dimensional, lofty, woven polypropylene geotextile that is available in green or tan which is specially designed for erosion control applications on steep slopes and vegetated waterways. The matrix is composed of polypropylene monofilament yarns featuring X3® technology woven into a uniform configuration of resilient pyramid-like projections. The material exhibits very high interlock and reinforcement capacity with both soil and root systems, demonstrates superior UV resistance, and enhances seedling emergence.

PYRAMAT conforms to the property values listed below[1] and is manufactured at a Propex facility having achieved ISO 9001:2000 certification. Propex performs Internal Manufacturing Quality Control (MQC) tests that have been accredited by the Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP).

PRODUCT TEST DATA		
Property	Test Method	MARV[2]
Physical		
Mass Per Unit Area	ASTM D-6566	13.5 oz sq yd (455 g sq m)
Thickness	ASTM D-6525	.4 in (10.2 mm)
Light Penetration (% Passing)	ASTM D-6567	10% (10%)
Color	Visual	Green, Tan
Mechanical		
Tensile Strength (Grab)	ASTM D-6818	4000 x 3000 lbs/ft (58.4 x 43.8 kN/m)
Elongation	ASTM D-6818	65% max (65% max)
Resiliency	ASTM D-6524	80% (80%)
Flexibility	ASTM D-6575	.534 in/lbs (615000 mg-cm) avg
Endurance		
UV Resistance @ 6000 hrs	ASTM D-4355	90% (90%)
Performance		
Velocity[3] (Vegetated)	Large Scale	25 ft/sec (7.6 m/sec)
Shear Stress[3] (Vegetated)	Large Scale	15 lbs sq ft (718 Pa)
Manning's "n"[4] (Unvegetated)	Calculated	.028 (.028)
Seedling Emergence	ECTC Draft Method #4	296% (296%)

NOTES:

1. The property values listed are effective 08/2006 and are subject to change without notice.
2. MARV indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.
3. Maximum permissible velocity and shear stress has been obtained through vegetated testing programs featuring specific soil types, vegetation classes, flow conditions, and failure criteria. These conditions may not be relevant to every project nor are they replicated by other manufacturers. Please contact Propex for further information.
4. Calculated at typical values from large-scale flexible channel lining test programs with a flow depth of 6 to 12 inches.

Distributed by:

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Phone: (607) 729-5111 (800) 659-5111 Fax: (607) 729-5158

www.ivifindustries.com

IVI-EC-3442-0407-C147

Type	Thickness m (ft)	Size mm	d_{50} m (ft)	velocity m/s (ft/sec)	velocity m/s (ft/sec)
Reno mattress	0.15 - 0.17	70 - 100	0.085	3.5	4.2
		70 - 150	0.110	4.2	4.5
	0.23 - 0.25	70 - 100	0.085	3.6	5.5
		70 - 150	0.120	4.5	6.1
	0.30	70 - 120	0.100	4.2	5.5
		100 - 150	0.125	5.0	6.4
Gabions	0.50 (1.64)	100 - 200	0.150 (0.49)	5.8 (19)	7.6 (25)
		120 - 250	0.190 (0.62)	6.4 (21)	8.0 (26)

Where the revetment has to be placed under water the thickness of the Reno mattress remains the same since it can be launched from a pontoon whereas rip rap has to be increased by 50% [12, 13, 49, 50, 51].

The big reduction in the revetment thickness, which is achieved using Reno mattress instead of rip rap, is of economic significance in protection projects in large rivers, given the same area of work, and, therefore, the quantity of material used.

2.2 Semi permeable and impermeable linings with sand asphalt mastic.

a) General characteristics of sand asphalt mastic grouted Reno mattress.

The combination of the stone filled Reno mattress and sand asphalt mastic has the characteristics of both gabion work and asphalt concrete. The addition of bituminous mastic to the Reno mattress produces a structure which combines the properties and performance of both materials. The mattress retains its flexibility, while the density of the filling is increased and therefore the efficiency of the protection. If all the voids between the stones in the layer are filled and the surface of the mattress covered, the lining will be completely impervious. The mastic also protects the wire mesh against corrosion and from abrasion by transported material.

The wire mesh reinforces the grouted stone layer and gives it strength in tension. Hence, the thickness of the combined structure can be considerably less than that of ordinary mastic grouted stone to withstand the same stresses. The resulting saving in bitumen and aggregate, and the increased flexibility due to the reduced thickness, have given rise to extensive use of this type of lining for protection in a variety of waterways.

b) Mix design of sand asphalt mastic.

To avoid excessive detail, only the fundamental data on mix design is given here. For fuller information, reference should be made to the specific publications listed in the bibliography [5, 6].

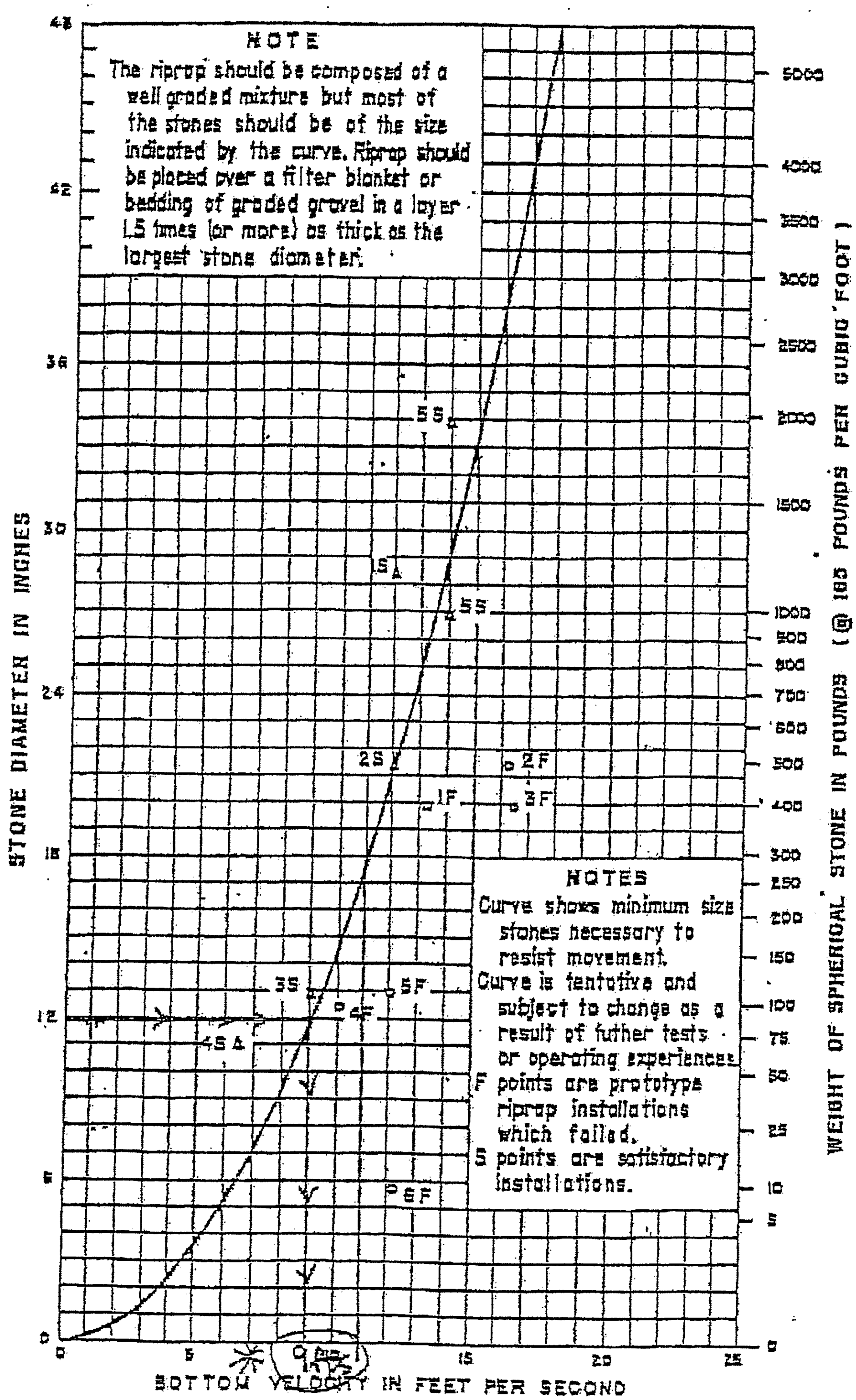


Figure 165.—Curve to determine maximum stone size in riprap mixture.

SOURCE: HYDRAULIC DESIGN OF STILLING BASINS AND ENERGY DISSIPATORS. US DEPT OF THE INTERIOR - BUREAU OF RECLAMATION, [illegible].

Required: Determine the maximum drainage area for 24-inch and 36-inch diameter letdown pipes using the BCAP computer program.

Method:
1. Determine the maximum flow for 24-inch and 36-inch diameter letdown pipes on the 28.6% side slope.
2. Determine the maximum drainage areas for the flows calculated in Step 1.

Reference:
1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, September 2019.

Note: The pipe letdown analysis has been performed using "Broken-Back" Culvert Analysis Program (BCAP) which is available from the Federal Highway Administration Web Page:

http://www.dor.state.ne.us/roadway-design/ [follow link to downloadable files and info]

The program was developed to analyze culverts with changing slopes.

Solution:
1. Determine the maximum flow for 24-inch and 36-inch diameter letdown pipes on the 28.6% side slope.

The following pages include the program outputs for the 24-in dia culvert and 36-in diameter culvert. Pages IIIF-F-2-26 and IIIF-F-2-31 include rating tables that show if the hydraulic jump occurs within the pipe or not [YES/NO]. The results also include pipe outlet velocity for each flow rate as well as the tailwater depth and velocity in the channel ("Tailwater Velocity").

The flow ratings are used to calculate the maximum allowable top dome drainage area for each pipe size analyzed (Step 2). The maximum flow rate that has hydraulic jump within the culvert is used for allowable drainage area calculations on page IIIF-F-2-35. The computer program does not have corrugated plastic pipe option; therefore, the corrugated metal pipe option has been used with a Manning's Coefficient of 0.024.

Results:

Q24 =	28.9	cfs	maximum allowable flow in 24-in-dia pipe
Q36 =	52.0	cfs	maximum allowable flow in 36-in-dia pipe

NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

PROJECT INFO	
Project:	TURKEY CREEK LANDFILL EXPANSION
Station or Location:	JOHNSON COUNTY, TEXAS
Date:	11 / 04 / 2021

DISCHARGE DATA	
Minimum:	1.00 cfs
Design Discharge:	25.00 cfs
Maximum:	32.00 cfs
Number of Barrels:	1

TAILWATER DATA	
Type:	Downstream
Channel Shape:	Trapezoid
Left Side Slope:	3 H:1V
Right Side Slope:	3 H:1V
Bottom Width:	10 ft
Bottom Slope:	0.005 ft/ft
Roughness Coefficient:	0.04

CULVERT DATA	
Type:	Circular Pipe
Pipe Diameter:	2 ft
Culvert Material:	Corr. Metal Pipe
Inlet Type:	Mitered to Conform to Slope
Roughness Coefficient:	0.024
Outlet Section Roughness Coeff.:	0.024
Inlet Section Slope:	0.06 ft/ft
Steep Section Slope:	0.2857 ft/ft
Outlet Section Slope:	0 ft/ft

CULVERT PROFILE DATA	
Type:	Double Broken-Back
Inlet Station:	100.00 ft
Inlet Elevation:	930.00 ft
Upper Break Station:	110.00 ft
Upper Break Elevation:	929.40 ft
Lower Break Station:	982.90 ft
Lower Break Elevation:	680.00 ft
Outlet Station:	1020.00 ft
Outlet Elevation:	680.00 ft

NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

Project: TURKEY CREEK LANDFILL EXPANSION
Station or Location: JOHNSON COUNTY, TEXAS
Date: 11/04/2021

Discharge cfs	Headwater Depth ft	Inlet Control Elevation ft	Break Control Elevation ft	Critical Depth ft	Outlet Depth ft	Outlet Velocity ft/s	Outlet Froude Number	Tailwater Depth ft	Tailwater Velocity ft/s	Hydraulic Jump
4.1	1.02	931.02	930.45	.71	.71	4.07	1.0	.33	1.13	YES
7.2	1.40	931.40	930.85	.95	.95	4.91	1.0	.45	1.41	YES
10.3	1.74	931.74	931.22	1.13	1.13	5.61	1.0	.55	1.61	YES
13.4	2.13	932.13	931.62	1.29	1.29	6.24	1.0	.65	1.73	YES
16.5	2.61	932.61	932.03	1.43	1.43	6.84	1.0	.73	1.85	YES
19.6	3.19	933.19	932.49	1.56	1.56	7.44	1.0	.79	2.01	YES
25.0	4.43	934.43	933.38	1.77	1.77	8.52	1.0	.91	2.16	YES
25.8	4.63	934.63	933.52	1.79	1.79	8.69	1.0	.93	2.17	YES
28.9	5.45	935.45	934.11	1.90	2.00	9.20	.9	.99	2.25	YES
32.0	6.48	936.48	934.80	2.00	2.00	10.19	1.0	1.05	2.32	NO

NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

PROJECT INFO

Project:	TURKEY CREEK LANDFILL EXPANSION
Station or Location:	JOHNSON COUNTY, TEXAS
Date:	11/04/2021

CULVERT DATA

Discharge:	25.0 cfs
Shape:	Circular
Material:	Corr. Metal Pipe
Size:	1-2.0 ft x 2.0 ft
Inlet Type:	Mitered to Conform to Slope

WATER SURFACE PROFILE

Inlet Depth:	2.00 ft
Inlet Velocity:	7.96 ft/s
Upper Break Depth:	1.77 ft
Upper Break Velocity:	8.52 ft/s
Lower Break Depth:	0.86 ft
Lower Break Velocity:	19.35 ft/s
Depth at End of Hydraulic Jump:	2.00 ft
Velocity at End of Hydraulic Jump:	7.96 ft/s
Depth at End of Hydraulic Jump:	0.91 ft
Velocity at End of Hydraulic Jump:	2.16 ft/s

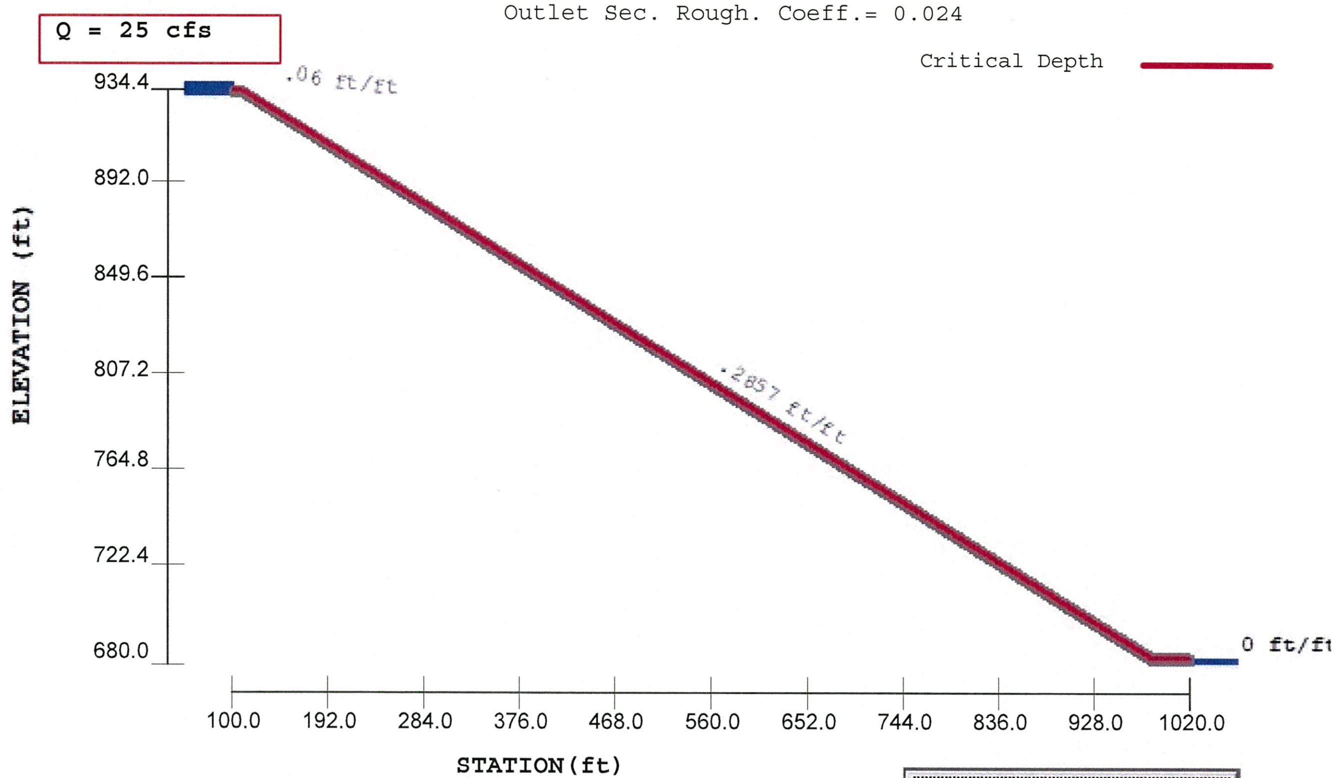
OUTPUT DATA

Head Water Depth:	4.43 ft
Inlet Control Elevation:	934.43 ft
Break Control Elevation:	933.38 ft
Critical Depth:	1.77 ft
Tailwater Depth:	0.91 ft
Hydraulic Jump?	YES
Jump Station:	1005.38 ft
Jump Length:	13.79 ft
Outlet Depth:	1.77 ft
Outlet Velocity:	8.52 ft/s
Outlet Froude No.:	1.0

Project: TURKEY CREEK LANDFILL EXPANSION **Location: JOHNSON COUNTY,**

Circle Pipe Culvert
Diameter=2 ft
Culvert Material: Corr. Metal Pipe

Inlet Type
Mitered to Conform to Slope
Rough. Coeff.= 0.024
Outlet Sec. Rough. Coeff.= 0.024



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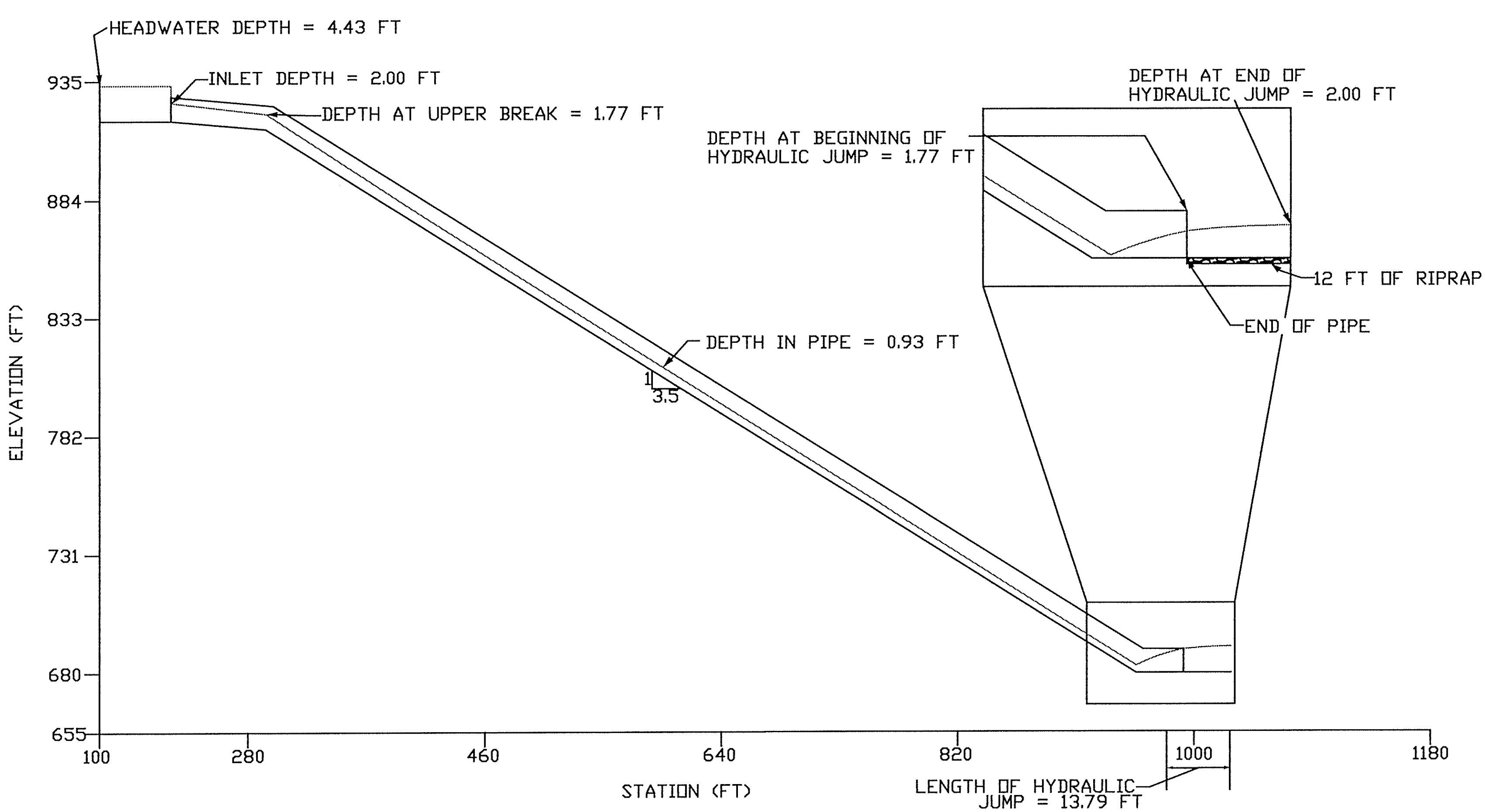
WATER SURFACE PROFILE



NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

PROJECT INFO

Project:	TURKEY CREEK LANDFILL EXPANSION
Station or Location:	JOHNSON COUNTY, TEXAS
Date:	11 / 04 / 2021

DISCHARGE DATA

Minimum:	10.00 cfs
Design Discharge:	25.00 cfs
Maximum:	80.00 cfs
Number of Barrels:	1

TAILWATER DATA

Type:	Downstream
Channel Shape:	Trapezoid
Left Side Slope:	3 H:1V
Right Side Slope:	3 H:1V
Bottom Width:	10 ft
Bottom Slope:	0.005 ft/ft
Roughness Coefficient:	0.04

CULVERT DATA

Type:	Circular Pipe
Pipe Diameter:	3 ft
Culvert Material:	Corr. Metal Pipe
Inlet Type:	Mitered to Conform to Slope
Roughness Coefficient:	0.024
Outlet Section Roughness Coeff.:	0.024
Inlet Section Slope:	0.06 ft/ft
Steep Section Slope:	0.2857 ft/ft
Outlet Section Slope:	0 ft/ft

CULVERT PROFILE DATA

Type:	Double Broken-Back
Inlet Station:	100.00 ft
Inlet Elevation:	930.00 ft
Upper Break Station:	110.00 ft
Upper Break Elevation:	929.40 ft
Lower Break Station:	982.90 ft
Lower Break Elevation:	680.00 ft
Outlet Station:	1040.00 ft
Outlet Elevation:	680.00 ft

NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

Project: TURKEY CREEK LANDFILL EXPANSION
Station or Location: JOHNSON COUNTY, TEXAS
Date: 11/04/2021

Discharge cfs	Headwater Depth ft	Inlet Control Elevation ft	Break Control Elevation ft	Critical Depth ft	Outlet Depth ft	Outlet Velocity ft/s	Outlet Froude Number	Tailwater Depth ft	Tailwater Velocity ft/s	Hydraulic Jump
17.0	1.93	931.93	931.39	1.32	1.32	5.70	1.0	.73	1.91	YES
25.0	2.41	932.41	931.91	1.59	1.59	6.55	1.0	.91	2.16	YES
31.0	2.78	932.78	932.28	1.78	1.78	7.11	1.0	1.03	2.30	YES
38.0	3.28	933.28	932.72	1.97	1.97	7.74	1.0	1.15	2.46	YES
45.0	3.87	933.87	933.21	2.14	2.14	8.34	1.0	1.27	2.57	YES
52.0	4.56	934.56	933.73	2.30	2.70	7.76	.7	1.37	2.69	YES
59.0	5.36	935.36	934.28	2.45	2.90	8.44	.7	1.47	2.79	NO
66.0	6.25	936.25	934.87	2.59	3.00	9.34	.7	1.55	2.91	NO
73.0	7.21	937.21	935.49	2.73	3.00	10.33	.8	1.65	2.96	NO
80.0	8.23	938.23	936.17	2.85	3.00	11.32	.9	1.73	3.04	NO

NEBRASKA DEPARTMENT OF ROADS
Broken-Back Culvert Analysis Program (BCAP)

PROJECT INFO	
Project:	TURKEY CREEK LANDFILL EXPANSION
Station or Location:	JOHNSON COUNTY, TEXAS
Date:	11/04/2021

CULVERT DATA	
Discharge:	25.0 cfs
Shape:	Circular
Material:	Corr. Metal Pipe
Size:	1-3.0 ft x 3.0 ft
Inlet Type:	Mitered to Conform to Slope

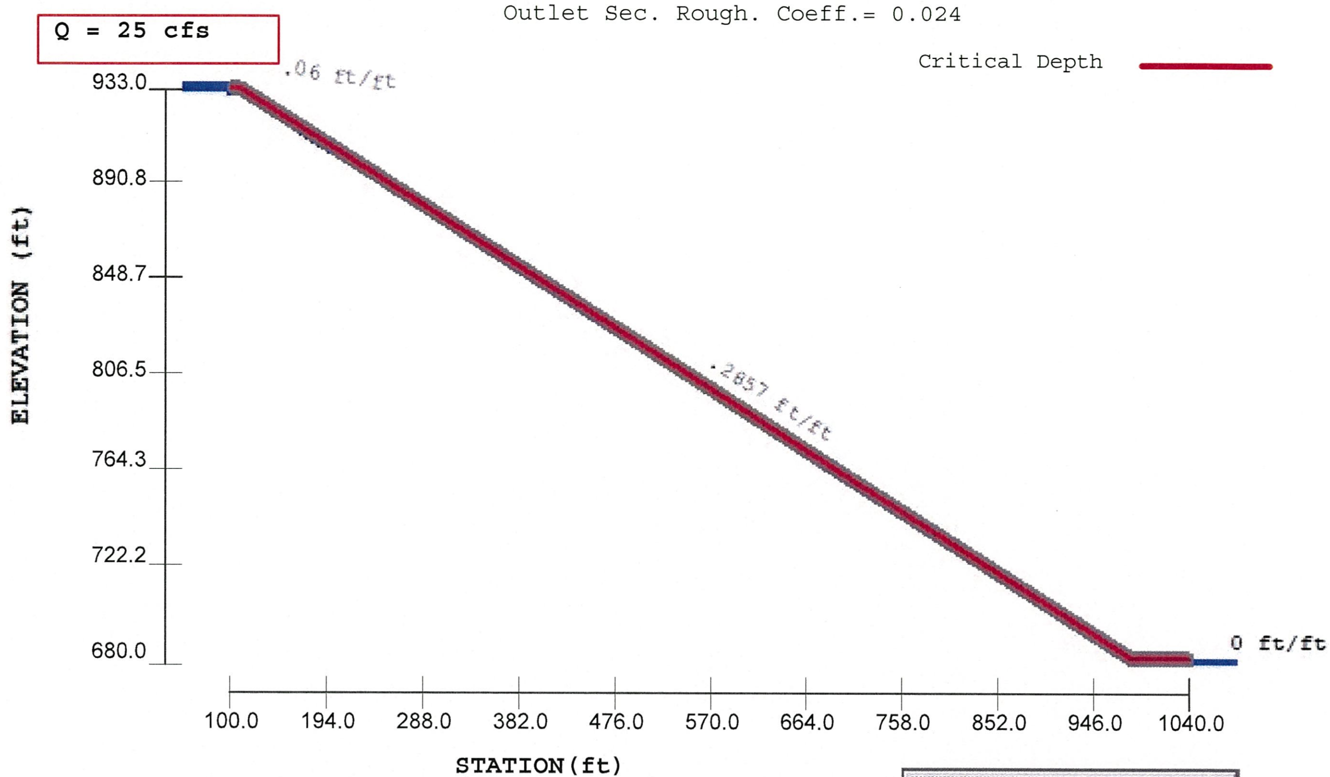
WATER SURFACE PROFILE	
Inlet Depth:	2.49 ft
Inlet Velocity:	3.98 ft/s
Upper Break Depth:	1.59 ft
Upper Break Velocity:	6.55 ft/s
Lower Break Depth:	0.72 ft
Lower Break Velocity:	19.16 ft/s
Depth at End of Hydraulic Jump:	2.08 ft
Velocity at End of Hydraulic Jump:	4.79 ft/s
Depth at End of Hydraulic Jump:	0.91 ft
Velocity at End of Hydraulic Jump:	2.16 ft/s

OUTPUT DATA	
Head Water Depth:	2.41 ft
Inlet Control Elevation:	932.41 ft
Break Control Elevation:	931.91 ft
Critical Depth:	1.59 ft
Tailwater Depth:	0.91 ft
Hydraulic Jump?	YES
Jump Station:	1016.11 ft
Jump Length:	12.46 ft
Outlet Depth:	1.59 ft
Outlet Velocity:	6.55 ft/s
Outlet Froude No.:	1.0

Project: TURKEY CREEK LANDFILL EXPANSION **Location: JOHNSON COUNTY.**

Circle Pipe Culvert
Diameter=3 ft
Culvert Material: Corr. Metal Pipe

Inlet Type
Mitered to Conform to Slope
Rough. Coeff.= 0.024
Outlet Sec. Rough. Coeff.= 0.024



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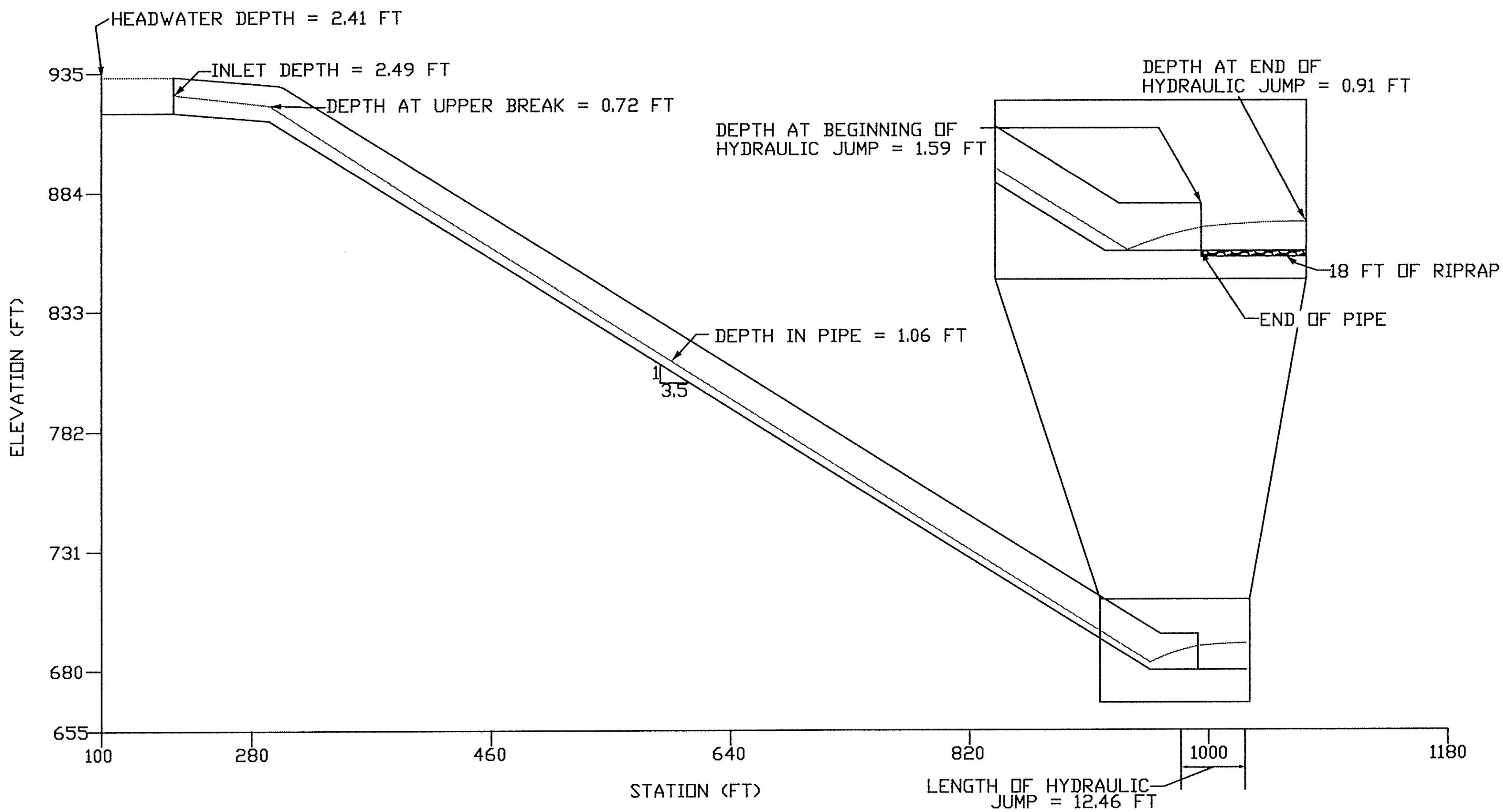
WATER SURFACE PROFILE



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2. Determine the maximum drainage areas for the flows calculated in Step 1.

$$Q = CIA$$

Where:

C= 0.7 (runoff coefficient, Ref 1.)
I = intensity, in/hr
A= drainage area, ac

$$I = \frac{b}{(t_c + d)^e}$$

b = 83.01 — From Ref. 1, for Johnson County
d = 10.65 — 25-year storm event
e = 0.775

t_c is assumed to be 10 min.

I = 7.95 in/hr

$$A = Q / (CI)$$

Pipe Diameter (in)	Flow (cfs)	Area (ac)
24	28.9	5.2
36	52.0	9.3

Conclusion:

The maximum allowable drainage area for a 24-inch diameter letdown pipe is 5.2 acres for each inlet and for a 36-inch diameter letdown pipe is 9.3 acres for each inlet. The minimum berm height is 3 feet for a 24-inch diameter pipe and 4 feet for 36-inch diameter pipe. (Figure 3 details indicate 1 foot berm above the pipe).

Required: Determine the Riprap size and Dimensions for 24-inch and 36-inch diameter letdown pipes using Riprap Apron Design provided by the Reference 1.

Method:

1. Determine the hydraulic conditions at the outlet of 24-inch and 36-inch diameter letdown pipes using the hydraulic design developed using the BCAP computer simulation.
2. Determine the riprap size and apron dimensions for each pipe letdown

Reference:

1. U.S. Department of Transportation - Federal Highway Administration. Hydraulic Engineering Circular No. 14, Third Edition. *Hydraulic Design of Energy Dissipators for Culverts and Channels*. Publication No. FHWA-NHI-06-086, July 2006.

Solution:

1. Determine the hydraulic parameters from pages IIIF-F-2-27 (pipe diameter 24-inches) and IIIF-F-2-32 (pipe diameter 36-inches):

Parameter	Symbol	24-inch Dia. Culvert	36-inch Dia. Culvert
Design flow rates, cfs	Q=	28.9	52.0
Pipe Diameters, ft	D=	2	3
Depth at the pipe outlet, ft	y_n=	1.77	1.59
Adjusted culvert rise, ft	D'=	1.77	2.39
Tailwater Depth[1], ft	TW=	0.91	0.91

[1]Tailwater depth is the pipe diameter when the calculated tailwater depth is higher per Reference 1.

$$D_{50} = 0.2 \times D \left[\frac{Q}{\sqrt{g} \times D^{2.5}} \right]^{4/3} \times \left[\frac{D}{TW} \right]$$ Eq. 10.4 (page 10-17 of Ref. 1)

$$D' = \frac{D \times y_n}{2}$$ Eq. 10.5 (page 10-17 of Ref. 1)

D_{50} = Riprap Size in feet

Riprap Classes and Apron Dimensions[1]

Class	D_{50} (in)	Apron Length[2] (ft)	Apron Depth (ft)
1	5	4xD	$3.5xD_{50}$
2	6	4xD	$3.3xD_{50}$
3	10	5xD	$2.4xD_{50}$
4	14	6xD	$2.2xD_{50}$
5	20	7xD	$2.0xD_{50}$
6	22	8xD	$2.0xD_{50}$

[1]This table has been reproduced from Table 10.1 included on page 10-18 of Reference 1.

[2]D is the culvert rise.

Design Parameter	24-inch Dia. Culvert	36-inch Dia. Culvert
D_{50}, calculated, inches =	9.2	11.7
D_{50}, selected, inches =	10	12
Apron Length, calculated, feet =	10	15
Apron Length, selected, feet =	12	18
Apron Depth, calculated, inches =	24.0	28.8
Apron Depth, selected, inches =	30	30

Conclusion:

Riprap sizes for pipe diameters of 24-inches and 36-inches are selected conservatively. The calculated apron length is increased to 10 feet in the design. The apron depth used is higher than the calculated apron depth. Therefore, the design of the pipe letdown outlet energy dissipator calculations are acceptable and channels at the pipe outlets will be stable.

APPENDIX IIIF-F-3

SEDIMENT CONTROL POND DESIGN

Includes pages IIIF-F-3-1 through IIIF-F-3-7

STATE OF TEXAS
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2-22-22

SEDIMENT CONTROL POND DESIGN

This appendix includes supporting information for the sedimentation pond sizing procedure presented on Sheet IIIF-F-13 (refer to Section 2.2 of the Erosion Control Plan for All Phases of Development). In the event that certain percent ground cover that limits the soil loss to 50/tons/acres/year is not achieved and soil loss is temporarily greater than 50 tons/acre/year, a sedimentation pond will be used along with other structural and non-structural BMPs approved as part of this plan to limit the discharge of eroded soil. The sedimentation pond option is a secondary erosion control option, similar to mulch, wood chips, compost, or straw/hay, and will only be used if the required percent vegetation specification is not met. If the sedimentation pond option is implemented, the swales and letdowns specified will remain in-place. The sedimentation pond option simply allows for the control of sediment while vegetation is being established. The pond design procedure has been developed for reducing discharge of eroded soil to less than the allowable amount for external side slopes (i.e., 50 tons/acre/year) if the required percent vegetation coverage is not obtained soil loss is greater than 50 tons/acre/year. The stormwater sedimentation pond design provided is for a 25-year frequency storm event. This provides for a conservative design because the efficiency of the pond will be higher for more frequent storms (e.g., one year frequency). The example calculation included on pages IIIF-F-3-2 through IIIF-F-3-6 demonstrates that a 0.5-acre detention pond is capable of reducing the discharge of 60 tons/acre/year of soil to less than 50 tons/acre/year of soil from the external slopes for a 20-acre area. A factor has been calculated that will be used to determine the required pond size for a specified external slope area. For a summary of the efficiencies of ponds for various required soil loss reduction amounts, refer to Sheet IIIF-F-13 – Sediment Control Pond Plan as well as the table on page IIIF-F-3-7.

Required:

Develop a procedure to size a sedimentation pond to reduce sediment discharge from the external embankment area to 50 tons/acre/year or less.

Method:

1. Determine the 25-year frequency peak flow rate upstream of the sediment control pond using the Rational Method.
2. Calculate the settling velocity of sediment particles using Stokes equation.
3. Calculate the fraction of sediment trapped under dynamic conditions.
4. Calculate the fraction of sediment trapped under quiescent conditions.
5. Calculate the total fraction of sediment trapped under combined conditions.
6. Verify that pond design is adequate to reduce given soil loss to 50 tons/acre/year or less.

Reference:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, 3rd Edition, September 2019.
2. NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 11, Version 2.0: Texas (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, 2018)
2. Chin, David. A. Water-Resources Engineering. Prentice Hall, Inc., 2000.
3. Haan, C.T., et al. Design Hydrology and Sedimentology for Small Catchments, 1994.
4. Cooperative Studies Section, Hydrologic Serices Division. U.S. Department of Commerce. *Technical Paper No. 40.*

Solution:

1. Determine the 25-year frequency peak flow rate upstream of the sediment control pond.

$$Q = CIA$$

Where:

C= 0.7 (runoff coefficient, Ref. 1)
I = intensity (in/hr)
A= upstream drainage area (ac)

Note: A runoff coefficient of 0.8 is used for all areas regardless of slope.

$$I = \frac{b}{(t_c + d)^e}$$

b = 83.01
d = 10.65
e = 0.775

From Ref. 2, for Johnnson County 25-year frequency storm event

t_c is assumed to be 10 min.

I = 7.95 in/hr

A = 20.0 acres

Q = 111.37 cfs

2. Calculate the settling velocity, V_s (ft/hr), of sediment particles using Stokes equation.

$$V_s = \frac{\alpha\,(\rho_s/\rho_w - 1)\,g\phi^2}{18v_w}$$ (Ref. 3)

Where:

α = factor that measures the effect of particle shape (assume spherical, $\alpha = 1$)
ρ_s = density of sediment particle (pcf)
ρ_w = density of ambient water (62.4 pcf)
g = gravity (32.2 ft/s^2)
ϕ = particle diameter (ft)
v_w = kinematic viscosity of the ambient water (ft^2/s)

α = 1
ρ_s = 165 pcf
v_w = 1.08E-05 ft^2/s

Particle Class[1]	Percent in Class	Particle Diameter[2] (ft)	Settling Velocity, V_s (ft/hr)
1	10	1.31E-05	0.17
2	20	1.97E-05	0.38
3	30	2.62E-05	0.68
4	20	3.28E-05	1.06
5	20	3.94E-05	1.52
Total	**100**		

[1] Particle class corresponds to particle diameter.

[2] Particle diameter ranges from 4μm to 12μm, which is typical for clay and silt particles.

3. Calculate the fraction of sediment trapped under dynamic conditions.

a. Determine the overflow rate.

$V_c = Q/A_p$ (EPA Pond Performance Model from Ref. 4)

Where:

V_c = overflow rate
A_p = area of sediment control pond (ac)

Q = 111.37 cfs (from Step 2)
A_p = 0.50 acre

V_c = 18.41 ft/hr

b. Determine the fraction of sediment removed.

$F = 1 - (1 + 1/\beta * V_s/V_c)^{-\beta}$ (Ref. 4)

Where:

F = single-storm trapping of sediment
β = turbulence or short-circuiting parameter reflecting non-ideal performance of pond (assume good performance, $\beta = 3$)

β = 3

$D_R = L_F\,[(1/CV_Q^2) / (1/CV_Q^2 - \ln(E_m/L_F))]^{(1/CVQ\text{^}2)+1}$ (Ref. 4)

Where:

D_R = long-term dynamic removal fraction for stormwater
L_F = removal ratio for very low flow rates
E_m = mean storm removal fraction
CV_Q = coefficient of variation of flows

L_F = 1
E_m = assume equals single-storm trapping, F
CV_Q = 1.74 (from Table 9B.1, p. 570, Ref. 4)

Table 1 - Summary for Dynamic Conditions

Particle Class	Percent in Class	Particle Diameter (ft)	Settling Velocity, V_s (ft/hr)	Single-storm Trapping, F	Fraction Removed Over All Storms, D_R	Fraction Captured Under Dynamic Conditions, E_D[1]
1	10	1.31E-05	0.17	0.009	0.027	0.27
2	20	1.97E-05	0.38	0.020	0.034	0.67
3	30	2.62E-05	0.68	0.036	0.041	1.22
4	20	3.28E-05	1.06	0.055	0.048	0.96
5	20	3.94E-05	1.52	0.078	0.056	1.12
Total	**100**					**4.3**

[1] E_D is the product of percent in class and D_R.

4. Calculate the fraction of sediment trapped under quiescent conditions.

$$RR = \frac{T_{IA} V_s A_Q}{V_R}$$ (Ref. 3)

$V_R = RA$

Where:

RR = removal ratio
T_{IA} = average time interval between storms (hr)
V_s = settling velocity (ft/hr) from Step 2
A_Q = average surface area under quiescent conditions (ft^2)
V_R = mean runoff volume (ft^3)
R = runoff depth for 25-year, 24-hour storm (ft)
A = upstream drainage area (ac)

A_Q = 21,780 ft^2 (assume equal to A_p)
T_{IA} = 108 hrs (from Table 9B.1, p. 570 of Ref. 4)
R = 0.61 ft (Ref. 5)
A = 20.0 ac (from Step 1)

V_R = 529,980 ft^3

Table 2 - Summary for Quiescent Conditions

Particle Class	Percent in Class	Settling Velocity, V_s (ft/hr)	Removal Ratio, RR (ft^3/hr)	Effective Volume Ratio, V_E/V_R[1]	Fraction Removed Under Quiescent Conditions[2]	Fraction Captured Under Quiescent Conditions, E_Q
1	10	0.17	0.75	0.120	0.12	1.20
2	20	0.38	1.69	0.130	0.12	2.40
3	30	0.68	3.00	0.140	0.13	3.90
4	20	1.06	4.68	0.145	0.14	2.80
5	20	1.52	6.74	0.150	0.15	3.00
Total	**100**					**13.3**

[1] Based on Figure 9.29 from Ref. 4, using RR and V_B/V_R.

V_B = reservoir volume = 87,120 ft^3, assuming a 0.5-acre pond with an average depth of 4 feet.
V_B/V_R = 0.164

[2] Based on Figure 9.30 from Ref. 4 with CV_R = 1.74.

5. Calculate the total fraction of sediment trapped under combined conditions, E_T.

$$E_T = 1 - (1 - E_D) * (1 - E_Q)$$ (Ref. 3)

E_T = 17.0 %

Refer to page IIIF-F-3-7 for the total efficiency of ponds for different soil loss reduction amounts.

6. Verify that pond design is adequate to reduce given soil loss to 50 tons/acre/year or less.

a. Calculate net soil loss (i.e., sediment not captured by pond).

Total Soil Loss =	60.0	tons/ac/yr	
E_T =	17.0	%	(from Step 5)

Net Soil Loss = Total Soil Loss x (1 - E_T/100)

Net Soil Loss = 49.8 tons/ac/yr

Refer to page IIIF-F-3-7 for the net soil loss for different soil loss reduction amounts.

b. Calculate the required pond size per unit drainage area factor.

Drainge Area =	20.0	acres	(from Step 1)
Pond Area =	0.5	acres	(from Step 3)

Required Pond Size / Unit Drainage Area Factor = 0.025

This factor was calculated using a drainage area of 20 acres and a pond area of 0.5 acres. If a 40-acre drainage area drains to the pond, then a 1.0-acre pond will be required to achieve the above efficiency and net soil loss estimate (40 acres x 0.025 = 1.0 acre). Refer to page IIIF-F-3-7 for the required pond size/unit drainage area factor for different soil loss reduction amounts.

Conclusion:

A 0.5-acre pond will sufficiently capture enough sediment from a 20-acre drainage area so that no more than 50 tons/acre/year of net soil loss occurs on external embankment slopes. If the size of the drainage area changes, this procedure will need to be updated. Refer to the table on page IIIF-F-3-7 for a summary of the pond efficiencies and net soil loss estimates for different soil loss reduction amounts.

Prep By: BPY
Date: 11/15/2021

TURKEY CREEK LANDFILL
0771-368-11-123
SEDIMENT CONTROL POND DESIGN

Chkd By: CRM
Date: 11/15/2021

SEDIMENT CONTROL POND SUMMARY

External Slope Area Soil Loss (Tons/Acre/Year)	Percent Efficiency of Pond (Dynamic Conditions)	Percent Efficiency of Pond (Quiescent Conditions)	Total Efficiency of Pond (%)	Net Soil Loss (Tons/Acre/Year)	Pond Area Required Per Unit Drainage Area[1]	50 Tons/Acre/Year or Less?
60	4.3	13.3	17.0	49.8	0.025	YES
70	5.1	25.5	29.3	49.5	0.040	YES
80	6.1	34.0	38.1	49.6	0.060	YES
90	6.9	41.5	45.5	49.0	0.075	YES
100	8.4	46.4	50.9	49.1	0.110	YES
200	16.4	71.2	75.9	48.2	0.300	YES

[1] This factor multiplied by a given drainage area will give the required pond size to achieve the efficiencies shown in the table.

APPENDIX IIIF-G

EXCERPTS FROM PROPOSED CLOMR

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CONTENTS

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FLOODPLAIN SUMMARY

As discussed in Parts I/II in Section 11, Parts I/II-Appendix I/IIC, and Part III-Appendix IIIF, the floodplain for Turkey Creek is located on the north and west sides of the permit boundary. A Conditional Letter of Map Revision (CLOMR) was developed for the proposed expansion to revise the floodplain limits as a part of the proposed landfill development.

This appendix addresses §330.61(m).

Excerpts from the CLOMR are included in Appendix IIIF-G-A. As shown in Appendix IIIF-G-A, the proposed solid waste fill areas will not be located within the limits of the post-development 100-year floodplain in the proposed CLOMR.

APPENDIX IIIF-G-A

EXCERPTS FROM THE PROPOSED CLOMR APPLICATION

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2-22-22

1 INTRODUCTION

1.1 Purpose

The purpose of this study is to request a Conditional Letter of Map Revision (CLOMR) from Johnson County and the Federal Emergency Management Agency (FEMA) for proposed revisions to Flood Hazard Zones within a 219.6-acre tract of land in Johnson County, Texas. This property is owned by Texas Regional Landfill Company, LP. All proposed revisions are within the property and associated with the existing Turkey Creek Landfill which is operated within its boundaries. The proposed revisions to the landfill design are necessary to increase the landfill capacity as part of ongoing efforts to address long term waste disposal needs of the communities in Johnson and surrounding counties. The proposed expansion to the landfill will increase the currently permitted 146.4 acres (per MSW 1417C and MSW 1417D – Part I/II-1-1) waste disposal area to 171.9 acres, once the proposed expansion is approved by Texas Commission of Environment Equality (TCEQ).

A general site location map is shown on Figure 1.1, showing the landfill being located approximately 2.5 miles south of Alvarado, Texas. The site entrance is located off the Southbound Interstate Highway 35 West (IH-35W) Frontage Road immediately north at County Road 107.

This CLOMR request has been developed to obtain approval to revise the Flood Insurance Rate Map (FIRM) if the proposed expansion of the landfill and its infrastructure is constructed as proposed. The scope of this study is limited to two unnamed tributaries of Turkey Creek near the landfill, referenced as Stream A which is located west of the landfill, and Stream B which is located southeast of the landfill. Stream A is proposed to be impacted by the west landfill expansion area and Stream B is proposed to be impacted by southeast landfill expansion area.

These waterways are shown on the aerial photo included in Figure 1.2. This CLOMR will allow for the relocation of portions of the two streams and the continued development of the existing landfill operation as demonstrated on Figure 1.3. Figures 1.4 and 1.5 demonstrate comparisons of the current and proposed conditions of the landfill property. A summary of the effective and post-project floodplain delineations are provided on Figures 1.6 and 1.7, respectively and listed below.

- **Relocation of the Stream A.** Stream A currently flows through the west landfill expansion area as it traverses southwest to northeast. This CLOMR proposes to relocate the stream around the west parts of the proposed expansion area footprint. The proposed relocated channel ties into the existing Stream A alignment within the landfill permit boundary at the upstream and downstream end of the project. At the north side of the landfill property boundary, the original stream stays unchanged as it continues downstream towards Turkey Creek, as depicted on Figure 1.3.
- **Relocation of the Stream B.** Stream B currently flows through the southeast landfill expansion area as it travels south to northeast. This CLOMR proposes to relocate the stream around the east parts of the proposed expansion area footprint. Relocation of the stream ends upstream of the existing culverts that run underneath southbound IH-35W frontage road at the landfill property boundary and the original stream continues downstream of the culvert towards Turkey Creek as depicted on Figure 1.3.

The results of this study will be used to revise floodplain boundaries and to provide FEMA with the required technical data to issue a CLOMR for the proposed project. The proposed stream relocations included in this CLOMR request is detailed on the drawings presented in Appendix A.

1.2 Project Background

The Turkey Creek Landfill is an existing Type I municipal solid waste (MSW) landfill operating under TCEQ Permit No. MSW-1417C. The existing landfill currently provides solid waste disposal services for residences and businesses in Johnson County and communities in surrounding counties. With this expansion, the landfill disposal footprint will increase from approximately 146.4 acres currently permitted by the TCEQ to 171.9 acres. Turkey Creek Landfill is owned and operated by Texas Regional Landfill Company, LP. As shown on Figure 1.1, the site is located approximately 2.5 miles south of Alvarado, Texas. The site entrance is located off the Southbound Interstate Highway 35 West (IH-35W) Frontage Road immediately north of County Road 107. Figure 1.2 shows the existing landfill development, as well as the proposed landfill expansion area, on a recent aerial photograph. For over 35 years, the landfill has been a part of the community and is one of the main providers of waste disposal services to the residents and businesses of Johnson County and surrounding areas.

1.3 Proposed Site Development

As demonstrated on Figure 1.3, relative to the currently permitted landfill configuration, the landfill is proposed to develop on the west and southeast side of the existing disposal area. Figures 1.4 and 1.5 show the Zone A, existing and post-project floodplain delineations for the different site conditions for both stream models discussed in this CLOMR. The specifics of each condition are discussed in Sections 1.5.1 and 1.5.2, respectively. The post-project condition includes proposed revisions to the floodplain, as discussed in Section 1.5.2 and shown in detail on Figure 1.7.

1.4 Scope

The scope of this study is limited to the Stream A west of the landfill area, and Stream B southeast of the landfill area, as shown on Figure 1.3. The proposed landfill development included in this CLOMR request is detailed on Figure 1.7 and the drawings presented in Appendix A.

The following conditions are included in this CLOMR request and shown on Figures 1.4 and 1.5.

- Duplicate Effective Conditions – The Turkey Creek Landfill is located near the Zone A floodplain of Turkey Creek and Steams A and B. No stream has a detailed study associated with the floodplain delineation on the effective FIRM, and no base flood elevations have been established. Therefore, the effective condition floodplain is based on the graphical delineation on the effective FIRM only.
- Existing Conditions – The existing condition represents the current existing conditions of Stream A and B. In order to create a baseline for comparison, existing hydrologic and hydraulic models were developed for the current conditions of Streams A and B. The existing condition was developed by using composite topography and on-site survey. Peak flow rates were calculated using HEC-1 modeling software. Streams A and B were modeled in HEC-RAS as two separate rivers. Stream A and Stream B are shown on Figures 1.6 and 1.7.
- Post-Project Condition – The post-project condition represents the proposed condition of the landfill development after the landfill expansion, and related site improvements have been made as shown on Figure 1.7. Refer to Drawing A.8 for tie-in locations between proposed and effective floodplains. For Stream A, the post-project hydraulic models include effective condition cross sections A-1500 through A-5600 (called A-1500 through A-5430 in post-project condition). Because the relocated Stream A channel length is different than the effective channel length, cross sections upstream of cross section A-1500 were renamed to represent the cross section location along the stream centerline. For Stream B, the effective condition hydraulic model includes cross sections B-0 through B-3350 (called B-0 through B-3310 in the post-project condition). Because the relocated Stream B channel length is different than the effective channel length, cross sections upstream of cross section B-520 were renamed to represent the cross section location along the stream centerline. Also included in the post-project condition is a tributary to Stream B named "Stream B West." Stream B West runs east of Stream B

along the southern side of the landfill area as shown on Figure 1.7. For Stream B West, the post-project hydraulic model includes cross sections BW-100 through BW-1050. Cross sections B-2585 through B-3310 were modeled on a separate reach named "Stream B South."

1.5 Scenarios Investigated

The analysis for all scenarios investigated in this CLOMR are discussed in detail below. The HEC-RAS output files and hydraulic models for each condition are provided electronically. The existing and proposed stream layouts with details of the hydraulic structures modeled can be found on Figures 1.4 and 1.5.

1.5.1 Existing Condition

The existing condition of Stream A and B (Figure 1.4) contains Zone A flood hazard areas as shown on the effective FIRM panels for the area. These floodplain delineations were not based on a detailed study and were therefore not used as the basis of comparison for the CLOMR. Detailed existing hydrologic and hydraulic models were developed for Streams A and B to establish the baseline 100-year floodplain areas, as shown on Figure 1.6. The existing condition was created using composite topography from FirmaTek, Dallas Aerial Surveys, North Central Texas Council of Governments, and U.S.G.S. 7.5 minute topography. A 42-inch corrugated metal pipe, running underneath the landfill's perimeter road southwest of the disposal area, was modeled in Stream A.

Two 42-inch corrugated metal pipes running underneath County Road 313 were modeled in Stream B. In addition, a series of box culverts running underneath IH-35W and access roads were modeled. The culverts included a 5-foot by 14-foot box culvert underneath the west access road, three 5-foot by 6-foot box culverts underneath IH-35W, and three 4-foot by 5-foot box culverts underneath the east access road. The culverts underneath I-35W were modeled with the bottom 2 feet blocked based on photographs of the culverts. This provides a conservative analysis as the blocked culverts results in higher water surface elevations in comparison to a clean, unblocked condition.

1.5.2 Post-Project Condition

- Stream A: The post-project condition hydraulic model for Stream A incorporates the proposed relocation of Stream A included in the proposed landfill development, shown on Figure 1.5 and Drawing A.5 (Post-Project 100-Year Floodplain Delineation). The proposed landfill development relocates the existing Stream A around the west side of the landfill disposal footprint, to allow for the development of a continuous landfill disposal area.

The runoff entering Stream A from upstream areas of the landfill discharges into Stream A at the same location as in the effective condition.

The proposed stream relocation includes an earthen section with typical sideslopes of 2.5:1, an armored section with a left sideslope of 1.5:1, a right sideslope of 2.5:1, and a detention pond with three 54-inch corrugated metal pipes (CMP) Gabions will be used at the beginning of the channel to prevent erosion. Within the armored section of the channel, the left sideslope will be lined with gabions and the bottom and right sideslopes will be lined with Turf Mat. An Erosion Protection Plan with additional information is provided in Appendix B.3, Attachment 1.

Cross sections 1750 through A-4510 in Stream A were added to the post-project hydraulic model. Cross sections upstream of A-4510 in Stream A were renamed to represent the change in flow length from the stream relocation. The cross section A-1500 remains consistent with the effective condition. The limits of the 100-year floodplain, as well as tie-in points, are shown on Figure 1.7. A profile of the study area is also shown on Drawing A.7 in Appendix A.

- Stream B: The post-project condition hydraulic model is illustrated on Figure 1.5. The proposed landfill development relocates the existing Stream B around the southeast side of the landfill disposal footprint, to allow for the development of a continuous landfill disposal area. The runoff entering Stream B from upstream areas of the landfill discharges into Stream B at the same downstream location as in the effective condition.

  The proposed stream relocation includes an earthen portion with typical sideslopes of 2.5:1 throughout the channel and a detention pond with five 42-inch Reinforced Concrete Pipes (RCP). After the detention pond, flow exits the site through the existing culverts underneath IH-35W and access roads. Gabions and turf reinforcement mats will be used to reduce velocities and prevent erosion in several locations. Locations of the erosion structures are shown on Figure 1.5, and an Erosion Protection Plan is provided in Appendix B.3, Attachment 1.

  Cross sections upstream of B-2585 in Stream B were renamed to represent the change in flow length from the stream relocation. The cross sections B-0 through B-520 remain consistent with the effective condition. The limits of the 100-year floodplain, as well as tie-in points, are shown on Figure 1.7. A profile of the study area is also shown on Drawing A.7 in Appendix A.

- Stream B West: The post-project condition hydraulic model includes the Stream B West tributary of Stream B included in the proposed landfill development, shown on Figure 1.5. The proposed landfill development adds Stream B West south of the landfill disposal area to add capacity and storage for upstream flow. A profile of the study area is also shown on Drawing A.7.

1.6 Concepts and Methods

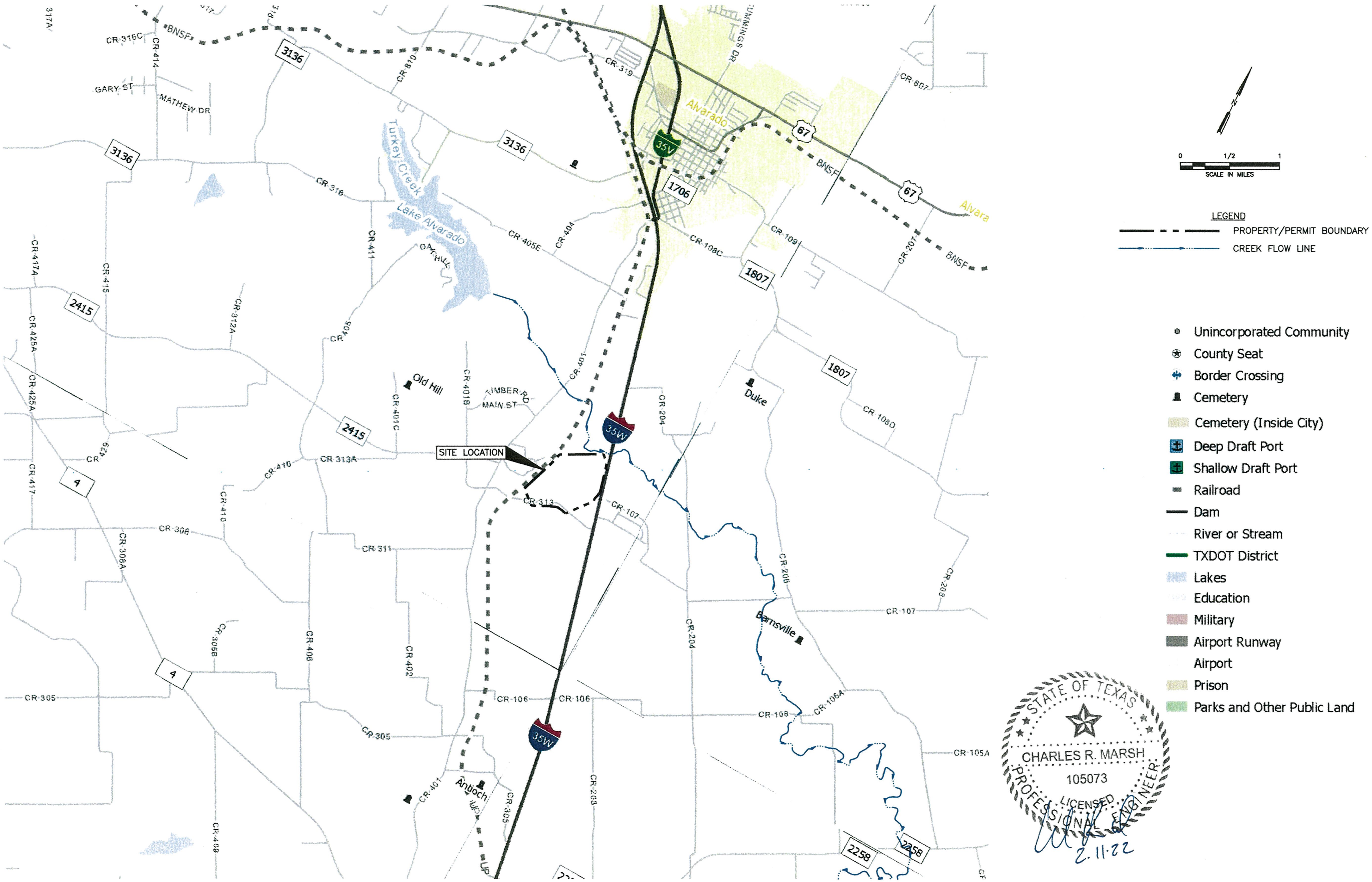
The hydrologic and hydraulic methods employed in this study are consistent with the requirements of FEMA, Johnson County, and the Texas Department of Environmental Quality. Peak flow rates were determined from a hydrologic analysis of the study area. The 100-year storm event within the study area were evaluated using the HEC-1 modeling software. Hydrologic calculations are presented in Appendix C. The USACE HEC-RAS (Ref. 2) computer program, Version 6.0.0, was used to determine water surface profiles and floodplain limits. The floodplain presented in this study represent effective and post-project conditions (after completion of proposed development). Analyses of the peak flow rates, floodplains and floodplain limits, for these conditions proceeded in the following sequence:

(1) Peak flow rates were calculated using HEC-1 modeling software. HEC-1 output files can be found in Appendix C.

(2) Hydraulic models were developed to evaluate flood elevations for the streams under peak flow conditions using HEC-RAS.

(3) The floodplains were delineated using the results of the hydraulic modeling.

Peak flow rates, water surface elevations, and floodway boundaries are based on 100-year storm frequency.



NOTE:

1. REPRODUCED FROM 2018 TEXAS DEPARTMENT OF TRANSPORTATION COUNTY MAPS, JOHNSON COUNTY.

☐ DRAFT	
☒ FOR PERMITTING PURPOSES ONLY	
☐ ISSUED FOR CONSTRUCTION	
DATE: 02/2022	DRAWN BY: RAA
FILE: 0771-368-11	DESIGN BY: BPY
CAD: 1.1-SITE LOCATION MAP.DWG	REVIEWED BY: CRM

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
TEXAS REGIONAL LANDFILL COMPANY, LP

REVISIONS

NO.	DATE	DESCRIPTION

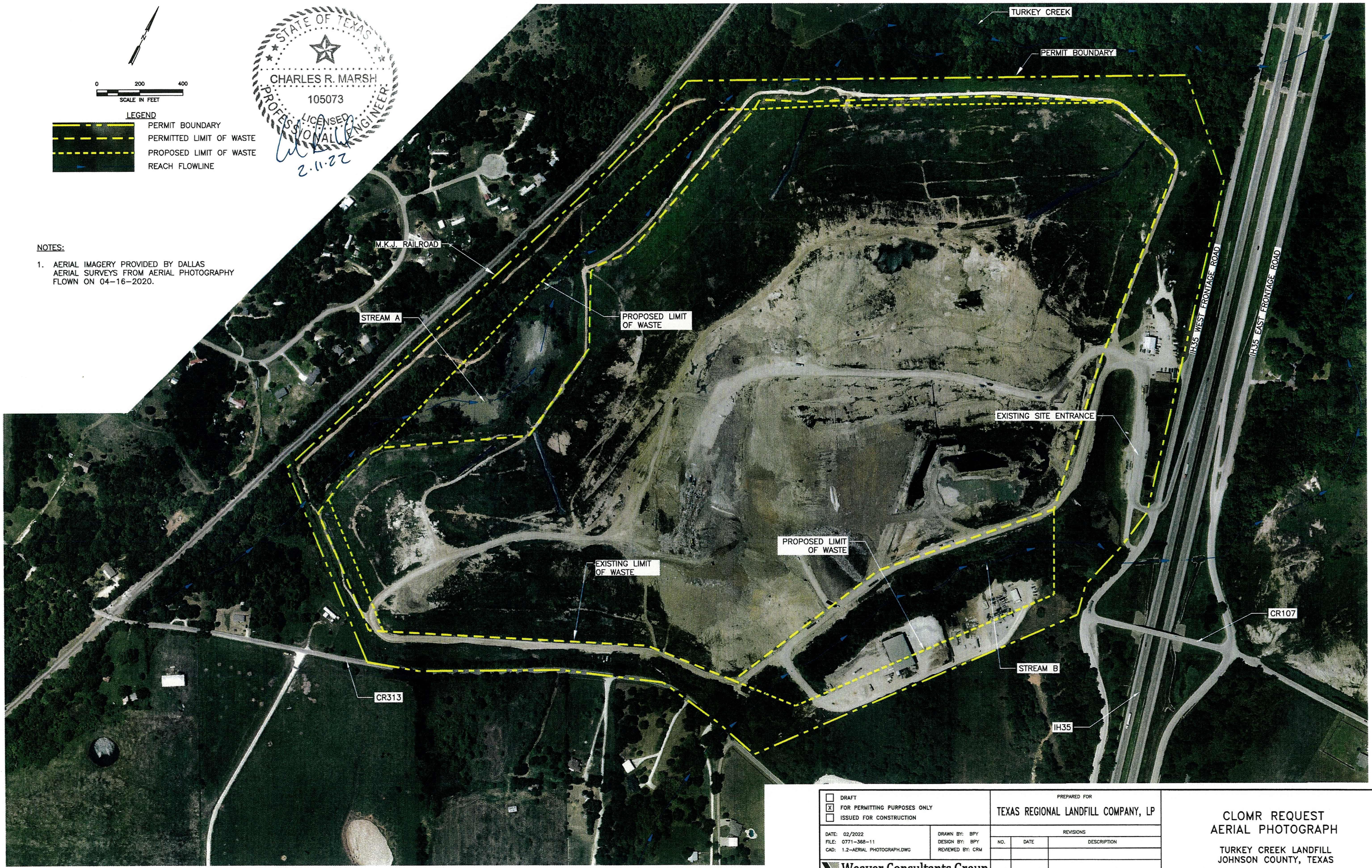
CLOMR REQUEST
SITE LOCATION MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

WWW.WCGRP.COM

FIGURE 1.1

O:\0771\368\EXPANSION 2021\CLOMR\1.1-SITE LOCATION MAP.dwg, rarrington, 1:2



NOTES:

1. AERIAL IMAGERY PROVIDED BY DALLAS AERIAL SURVEYS FROM AERIAL PHOTOGRAPHY FLOWN ON 04-16-2020.

☐ DRAFT ☒ FOR PERMITTING PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR TEXAS REGIONAL LANDFILL COMPANY, LP	CLOMR REQUEST AERIAL PHOTOGRAPH TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS
DATE: 02/2022 FILE: 0771-368-11 CAD: 1.2-AERIAL PHOTOGRAPH.DWG DRAWN BY: BPY DESIGN BY: BPY REVIEWED BY: CRM	REVISIONS NO. / DATE / DESCRIPTION	
Weaver Consultants Group TBPE REGISTRATION NO. F-3727		WWW.WCGRP.COM / FIGURE 1.2

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PERMITTED LANDFILL COMPLETION PLAN

PROPOSED LANDFILL COMPLETION PLAN

0 300 600
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LIMITS OF WASTE
- 750 EXISTING CONTOUR
- EASEMENT
- 870 FINAL COVER CONTOUR
- REACH FLOWLINE
- DRAINAGE LETDOWN
- DRAINAGE SWALE

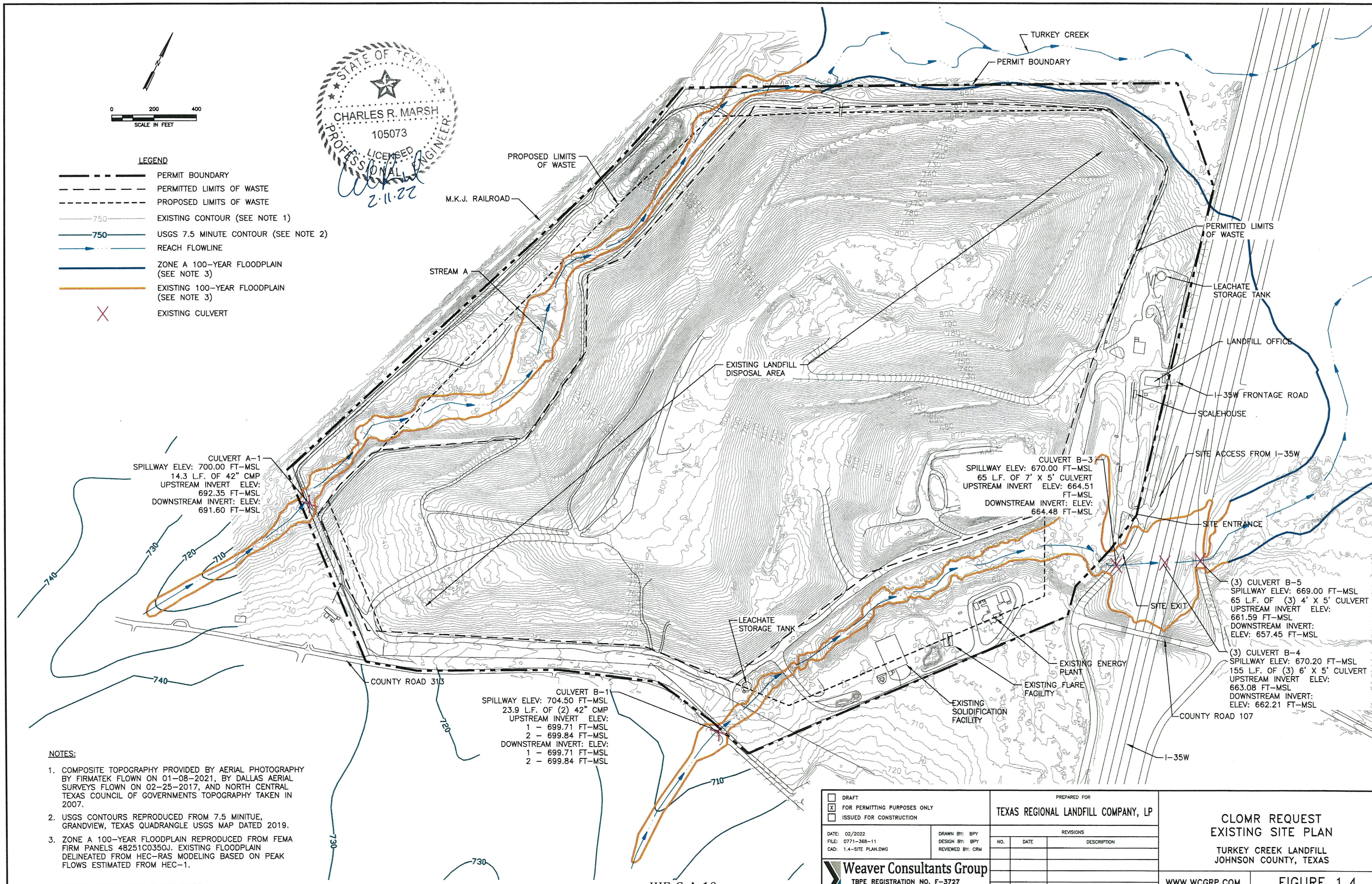
NOTES:

1. EXISTING CONTOURS AND ELEVATIONS PROVIDED BY FIRMATEK FROM AERIAL PHOTOGRAPHY FLOWN ON 01-08-2021.
2. PERMITTED LANDFILL COMPLETION PLAN, INCLUDING DRAINAGE FACILITIES HAS BEEN OBTAINED FROM THE CURRENT SITE DEVELOPMENT PLAN APPROVED BY TCEQ ON 10-08-2020.

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2-11-22

☐ DRAFT ☒ FOR PERMITTING PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR TEXAS REGIONAL LANDFILL COMPANY, LP		CLOMR REQUEST EXPANSION COMPARISON SUMMARY TURKEY CREEK LANDFILL JOHNSON COUNTY, TEXAS
DATE: 02/2022 FILE: 0771-368-11 CAD: 1.3-LANDFILL COMP. PLAN.DWG	DRAWN BY: RAA DESIGN BY: BPY REVIEWED BY: CRM	REVISIONS NO. / DATE / DESCRIPTION	
Weaver Consultants Group TBPE REGISTRATION NO. F-3727			WWW.WCGRP.COM — FIGURE 1.3

O:\0771\368\EXPANSION 2021\CLOMR\1.3-EXPANSION COMPARISON SUMMARY.dwg, rarrington, 1:2



LEGEND

- PERMIT BOUNDARY
- PERMITTED LIMITS OF WASTE
- PROPOSED LIMITS OF WASTE
- 750 EXISTING CONTOUR (SEE NOTE 1)
- 750 USGS 7.5 MINUTE CONTOUR (SEE NOTE 2)
- REACH FLOWLINE
- ZONE A 100-YEAR FLOODPLAIN (SEE NOTE 3)
- EXISTING 100-YEAR FLOODPLAIN (SEE NOTE 3)
- X EXISTING CULVERT

NOTES:

1. COMPOSITE TOPOGRAPHY PROVIDED BY AERIAL PHOTOGRAPHY BY FIRMATEK FLOWN ON 01-08-2021, BY DALLAS AERIAL SURVEYS FLOWN ON 02-25-2017, AND NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS TOPOGRAPHY TAKEN IN 2007.
2. USGS CONTOURS REPRODUCED FROM 7.5 MINITUE, GRANDVIEW, TEXAS QUADRANGLE USGS MAP DATED 2019.
3. ZONE A 100-YEAR FLOODPLAIN REPRODUCED FROM FEMA FIRM PANELS 48251C0350J. EXISTING FLOODPLAIN DELINEATED FROM HEC-RAS MODELING BASED ON PEAK FLOWS ESTIMATED FROM HEC-1.

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CLOMR REQUEST
EXISTING SITE PLAN

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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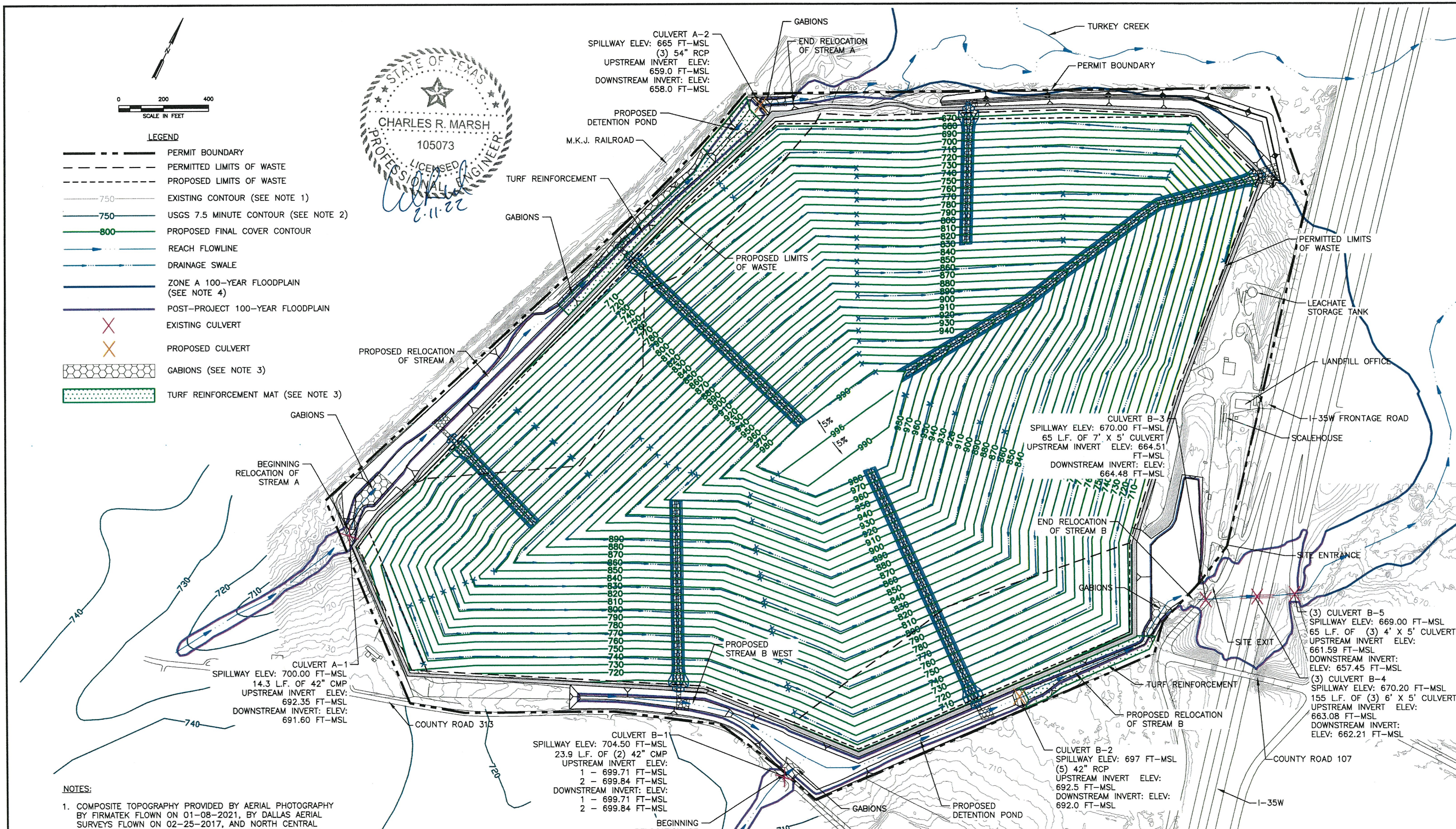
FIGURE 1.4

O:\0771\368\EXPANSION 2021\CLOMR\1.4-EXISTING SITE PLAN.dwg, rarrington, 1:2



NOTES:

1. COMPOSITE TOPOGRAPHY PROVIDED BY AERIAL PHOTOGRAPHY BY FIRMATEK FLOWN ON 01-08-2021, BY DALLAS AERIAL SURVEYS FLOWN ON 02-25-2017, AND NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS TOPOGRAPHY TAKEN IN 2007.
2. USGS CONTOURS REPRODUCED FROM 7.5 MINITUE, GRANDVIEW, TEXAS QUADRANGLE USGS MAP DATED 2019.
3. SEE APPENDIX B.3, ATTACHMENT 1 FOR AN EROSION PROTECTION PLAN FOR STREAM A AND B.
4. ZONE A 100-YEAR FLOODPLAIN REPRODUCED FROM FEMA FIRM PANELS 48251C0350J. POST-PROJECT FLOODPLAIN DELINEATED FROM HEC-RAS MODELING BASED ON PEAK FLOWS ESTIMATED FROM HEC-1.

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CAD: 1.5- POST-PROJECT SITE PLAN.DWG	REVIEWED BY: CRM

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CLOMR REQUEST
POST-PROJECT SITE PLAN
TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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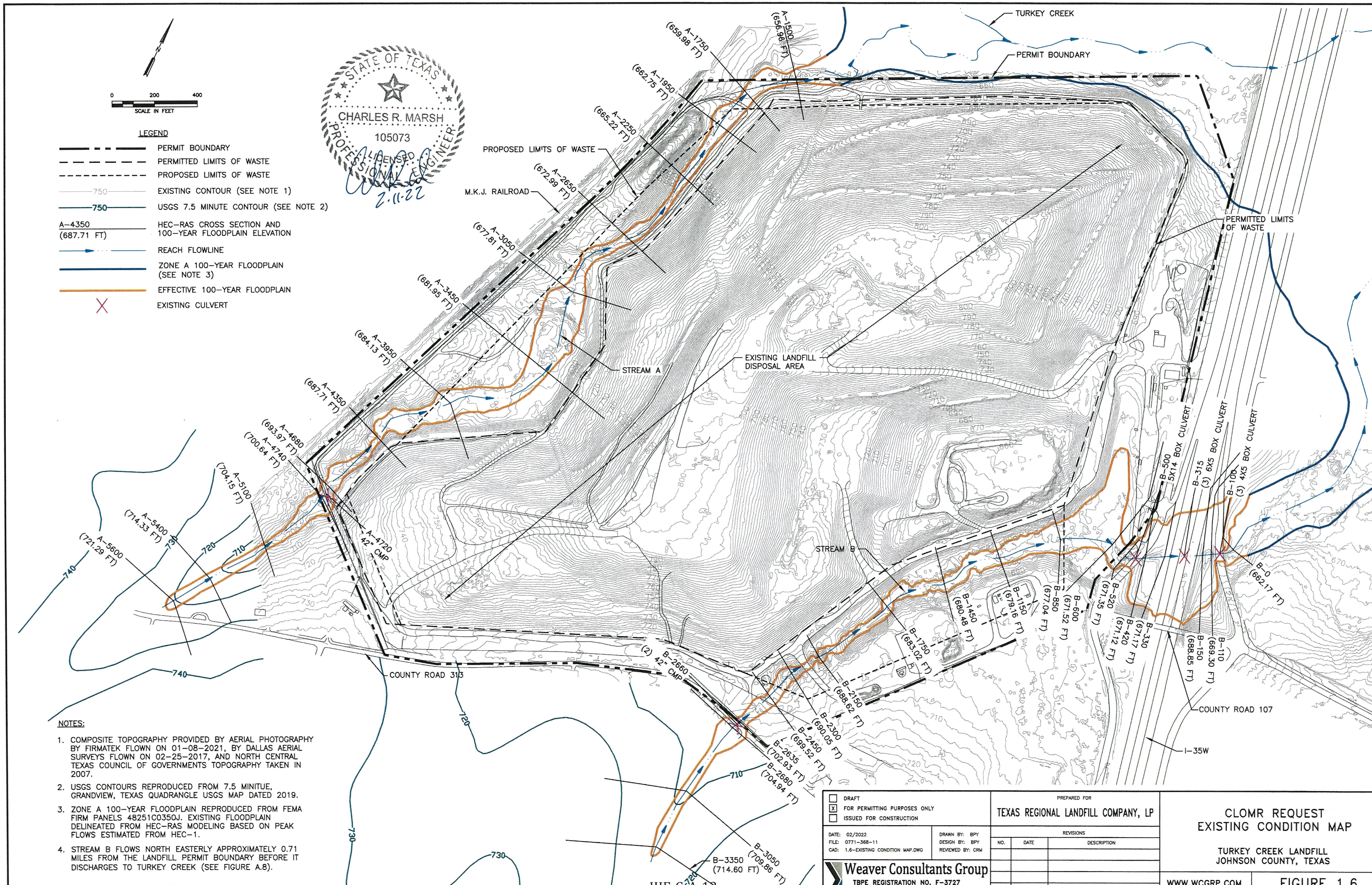
FIGURE 1.5

O:\0771\368\EXPANSION 2021\CLOMR\1.5-POST-PROJECT SITE PLAN.dwg, rarrington, 1:2



NOTES:

1. COMPOSITE TOPOGRAPHY PROVIDED BY AERIAL PHOTOGRAPHY BY FIRMATEK FLOWN ON 01-08-2021, BY DALLAS AERIAL SURVEYS FLOWN ON 02-25-2017, AND NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS TOPOGRAPHY TAKEN IN 2007.
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4. STREAM B FLOWS NORTH EASTERLY APPROXIMATELY 0.71 MILES FROM THE LANDFILL PERMIT BOUNDARY BEFORE IT DISCHARGES TO TURKEY CREEK (SEE FIGURE A.8).

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CLOMR REQUEST
EXISTING CONDITION MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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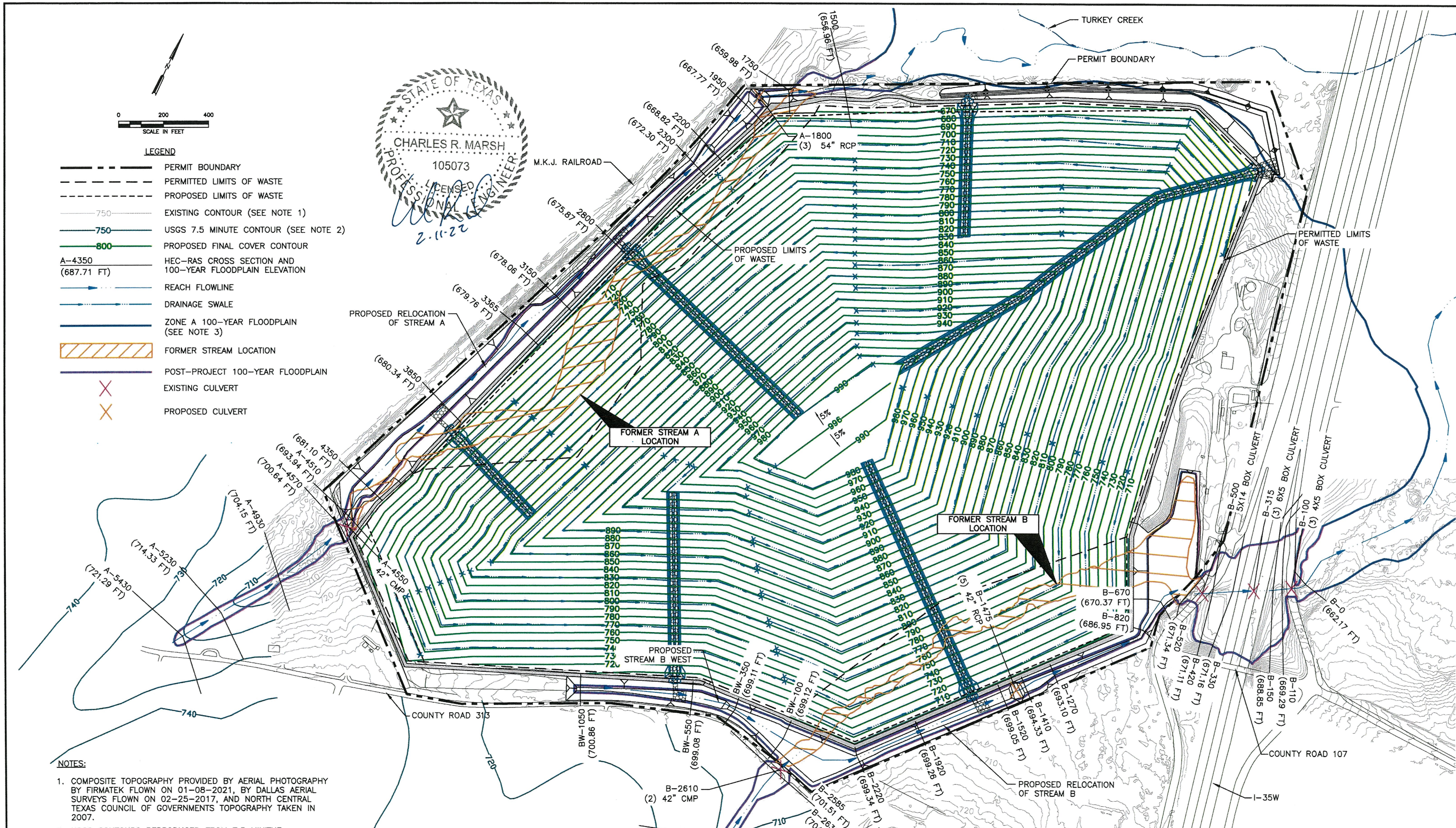
FIGURE 1.6

O:\0771\368\EXPANSION 2021\CLOMR\1.6-EXISTING CONDITION MAP.dwg, rarrington, 1:2



NOTES:

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4. STREAM B FLOWS NORTH EASTERLY APPROXIMATELY 0.71 MILES FROM THE LANDFILL PERMIT BOUNDARY BEFORE IT DISCHARGES TO TURKEY CREEK (SEE FIGURE A.8).

B-3010 (709.86 FT)
B-3310 (714.60 FT)

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FILE: 0771-368-11	DESIGN BY: BPY
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CLOMR REQUEST
POST-PROJECT CONDITION MAP

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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FIGURE 1.7

O:\0771\368\EXPANSION 2021\CLOMR\1.7-POST-PROJECT CONDITION MAP.dwg, rarrington, 1:2

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP
FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- (B) 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- (8) Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary

STATE OF TEXAS
CHARLES R. MARSH
105073
LICENSED PROFESSIONAL ENGINEER
2.11.22

0 500 1000
SCALE IN FEET

LEGEND

PROPERTY BOUNDARY

NOTES:

1. REPRODUCED FROM FEMA FIRM NUMBERS 4808810350J AND 4808790350J FOR CITY OF GRANDVIEW, AND JOHNSON COUNTY, UNINCORPORATED AREAS, EFFECTIVE DECEMBER 4TH, 2010.

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CLOMR REQUEST
FLOOD INSURANCE RATE MAP (FIRM)

TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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FIGURE A.2

O:\0771\368\EXPANSION 2021\CLOMR\A.2-FIRM.dwg, rarrington, 1:2

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR DRAFT FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	20.2 Cross Sections with 1% Annual Chance
	17.5 Water Surface Elevation
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary

N

0 500 1000
SCALE IN FEET

LEGEND

PROPERTY BOUNDARY

POST–PROJECT FLOODWAY

NOTES:

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CLOMR REQUEST
REVISED FLOOD INSURANCE
RATE MAP (FIRM)
TURKEY CREEK LANDFILL
JOHNSON COUNTY, TEXAS

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FIGURE A.8

O:\0771\368\EXPANSION 2021\CLOMR\A.8-REVISED FIRM.dwg, rarrington, 1:2