Volume 2
Part III Landfill Permit Amendment
Site Development Plan
TCEQ MSW Permit No. 1522B

Volume 2 of 5

prepared for

City of Victoria, Texas
City of Victoria Landfill Lateral and Vertical Expansion
Victoria County, Texas

STATE OF TEXAS
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4/5/2022

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Notes

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The responsible engineer has signed, sealed, and dated applicable engineering documents within the application as required by the Texas Engineering Practice Act.

The responsible geoscientist has signed, sealed, and dated applicable documents within the application as required by the Texas Geoscientist Practice Act

Certification

I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the City of Victoria, Texas or others without specific verification or adaptation by the Engineer.

Part III Landfill Permit Amendment
Site Development Plan
TCEQ MSW Permit No. 1522B

City of Victoria, Texas

City of Victoria Landfill Lateral and Vertical Expansion
Project No. 107608

Revision 0, March 28, 2022

Part III Landfill Permit Amendment
Site Development Plan
TCEQ MSW Permit No. 1522B

prepared for

City of Victoria, Texas
City of Victoria Landfill Lateral and Vertical Expansion
Victoria County, Texas

Project No. 107608

Revision 0, March 28, 2022

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I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the City of Victoria, Texas or others without specific verification or adaptation by the Engineer.

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
amsl	Above mean sea level
ASD	Alternative source demonstration
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
COG	Golden Crescent Regional Planning Commission
CP&L	Central Power and Light Company
Existing Area	Previously permitted landfill area including closed (Pre-Subtitle D and Subtitle D), constructed, and To Be Constructed (TBC) cells.
Expansion Area	Design area comprised of the lateral expansion south of the existing area and the vertical expansion over the entire footprint of Trenches #7 and #8 and portions of Trenches #5 and #6.
FM	Farm to Market Road
FML	Flexible membrane liner
FMLER	Flexible Membrane Liner Evaluation Report
HDPE	High density polyethylene
LQCP	Liner Quality Control Plan
NHIW	Non-Hazardous Industrial Waste
NPDES	National Pollutant Discharge Elimination System
POTW	Publicly Owned Treatment Works
SLER	Soil Liner Evaluation Report
SLQCP	Soil Liner Quality Control Plan
SOP	Site Operating Plan
SSI	Statistically significant increase
TBC	To Be Constructed
TCEQ	Texas Commission on Environmental Quality

Abbreviation	**Term/Phrase/Name**
TPWD	Texas Parks and Wildlife Department
USFWS	United States Fish and Wildlife Service

1.0 INTRODUCTION

The City of Victoria, Texas is operating a Type I municipal solid waste facility approximately six miles south of Victoria on Farm to Market Road (FM) 1686. This document is an application for a permit amendment to increase the height of fill in a portion of the existing permitted waste footprint, expand the waste footprint laterally into the adjacent property, and allow for the option of below-grade Class 1 non-hazardous industrial waste (NHIW) within the lateral expansion area.

2.0 GENERAL FACILITY DESIGN

30 TAC §330.63(b)

Facility design, construction, and operation must comply with this permit and Commission Rules, including 30 TAC §330.121 through §330.179.

2.1 Facility Access [30 TAC §330.63(b)(1)]

Access control at the currently permitted landfill area (Existing Area) includes a perimeter barbed wire fence and locking gates located at the entrance road and across the driveway to the landfill gas flare, building and leachate storage tank. As part of this permit amendment, the perimeter fence will be extended to provide access control to the expansion area (Cells A1 through I2) as shown in Attachment 1 – Drawing C001. Access gates will be locked after normal hours of operation to prevent the entry of livestock onto the site, control unauthorized entry and uncontrolled dumping. Any waste material illegally dumped at the gate will be promptly removed by the City or its appointed operator and placed in an authorized disposal area. The City will pursue legal action against anyone found to engage in illegal dumping activity.

Consistent with 30 TAC §330.131 and the Part IV Site Operating Plan (SOP), the perimeter fence and gate will be inspected periodically as specified in the SOP and maintenance will be performed as necessary to prevent uncontrolled access. In the event of a breach, the Commission's regional office, and any local pollution agency with jurisdiction that has requested to be notified, will be notified of the breach within 24 hours of detection. The breach must be temporarily repaired within 24 hours of detection and must be permanently repaired by the time specified to the commission's regional office when it was reported in the initial breach report. If a permanent repair can be made within eight hours of detection, no notice to the commission's regional office is required.

Currently, the site is in a rural area with two residential areas and two industrial areas within one mile of the facility. As the site is developed, the visual effect of the disposal activities will be minimized by all-weather disposal facilities and internal roads which will reduce the possibility of unsightly dirt and mud accumulation on FM 1686.

2.2 Waste Movement [30 TAC §330.63(b)(2)]

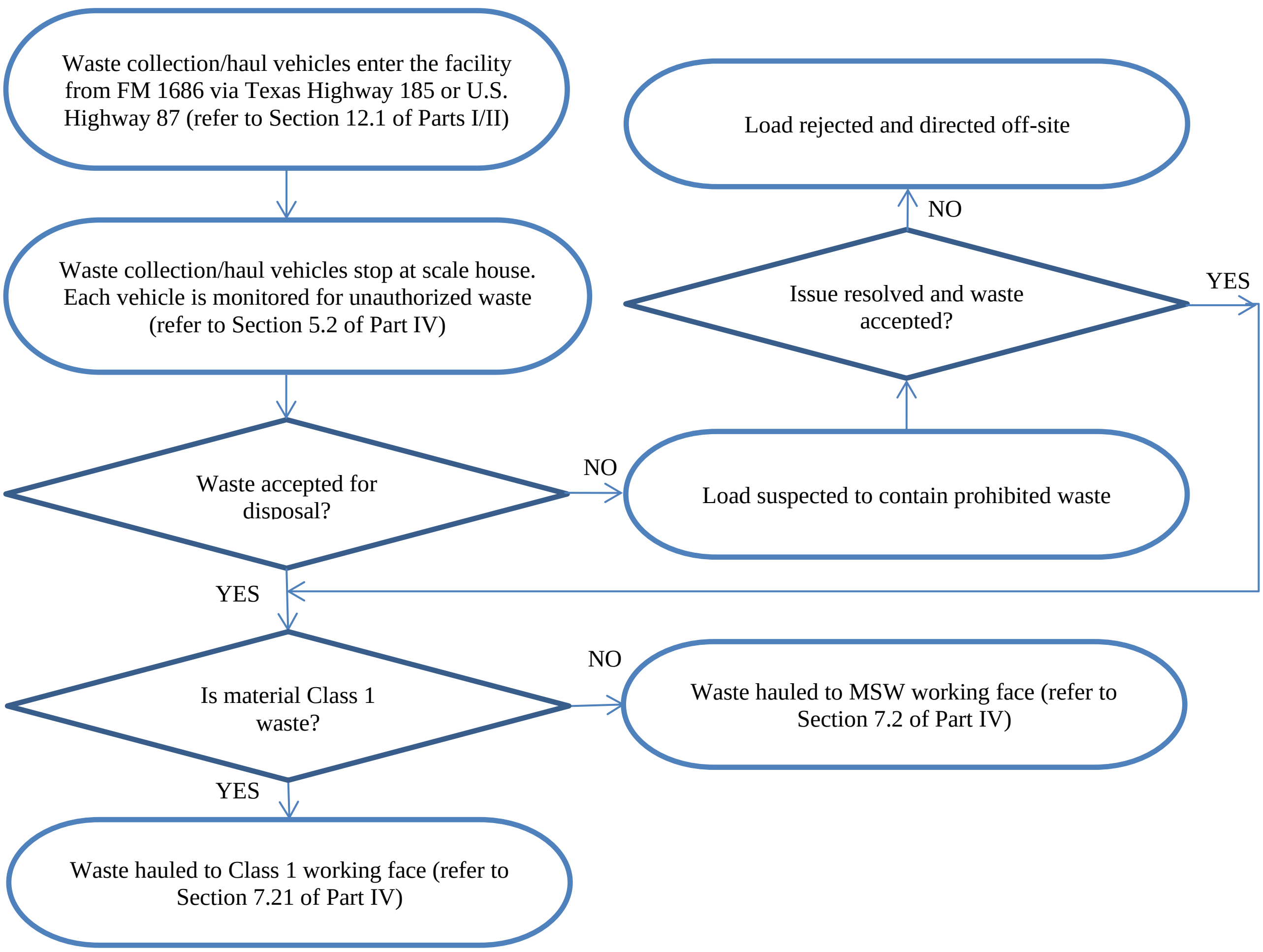
The major classifications of solid waste to be accepted at the Victoria Landfill include municipal solid waste, construction and demolition waste, Class 1, 2, and 3 non-hazardous industrial wastes (NHIW), and other and special wastes authorized by 30 TAC §330.171(c) and described in Part I/II Waste Acceptance Plan.

Waste disposal facilities located at the facility include the previously permitted municipal solid waste disposal area and the lateral expansion area (Cells A1 – I2). The lateral expansion area includes the option for below-grade Class 1 NHIW disposal consistent with 30 TAC §330.179.

The only storage facilities at the Landfill are leachate storage tanks. Storage and processing areas will be located outside of the 100-year floodplain or within the landfill footprint to be protected by perimeter berms.

A waste flow diagram describing the storage, processing, and disposal sequences for each type of waste accepted at the facility can be found in Figure 2-1.

Figure 2-1: Waste Flow Diagram



As shown in the drawings in 0, waste enters the facility via the site entrance road and passes through the scalehouse where the scalehouse attendant conducts screening, weighing, and documentation of incoming waste loads. The gate attendant will be familiar with the types of waste that can or cannot be accepted at the Landfill and will direct the hauler to the appropriate area for MSW or Class 1 disposal or load inspection. If prohibited loads are discovered, the scalehouse attendant can reject the load and require the hauler or transporter to remove the load immediately upon discovery. At the working face, trained personnel will observe unloading and will have the authority and responsibility to reject loads that contain any prohibited wastes. Accepted loads will be directed to the working face for landfill disposal. Generalized construction details of the leachate storage tanks and sumps showing approximate dimensions and capacities, construction materials, vents, covers, enclosures, protective coatings of surfaces, etc. are provided in Attachment 1 – Drawing C-502. Ventilation and odor control measures are discussed in greater detail in Part IV, the Site Operating Plan, Section 7.0.

Locations and engineering design details of all containment dikes or walls (with indicated freeboard) proposed to enclose all storage and processing components are shown in Attachment 1 - Drawings C004, C005, C-301, C-302, C-303.

2.2.1 Waste Disposal Approach

Waste is disposed using the area fill method. The fill sequence is shown in Attachment 1 – Drawing C003, starting with the Trenches previously permitted within the Existing Area (Trench 9, 6, 8 and 7, respectively). Fill sequence in the lateral expansion area begins with Cell G2 and proceeds west through Cell A1, followed by construction and fill of Cell H1 and proceeding east through Cell I2. Waste other than Class 1 NHIW and special wastes accepted for disposal will be directed to the active working face to be unloaded, spread in layers, and compacted. Daily cover will be applied to control for odors, windblown waste, disease vectors, fires, scavenging, and to promote runoff from the fill area. Daily cover may consist of a minimum of six inches of soil or an approved alternative daily cover.

Within the lateral expansion area (Cells A1 – I2), there is the option for cells to be constructed for below-grade Class 1 NHIW disposal in accordance with the requirements of 30 TAC §330 and 30 TAC §335 related to disposal of Class 1 industrial solid waste in Type I MSW landfill units. If the option for below-grade Class 1 disposal is exercised, then both cells sharing a sump will be constructed to meet Class 1 requirements and Class 1 wastes will be accepted at the facility and directed to the working face for below-grade disposal. Consistent with 30 TAC §330.173(e), Class 1 NHIW will not be disposed in excess of 20 percent of the total amount of waste accepted during the current or previous year. Class 1 NHIW will not be accepted for above-grade disposal in any cells or below-grade disposal in cells not designed and constructed in accordance with the requirements of 30 TAC §330 and 30 TAC §335 related to disposal of Class 1 industrial solid waste in Type I MSW landfill units, and as described herein.

Stormwater runoff from the active portion of the landfill shall be managed in accordance with 30 TAC §§330.55(b)(3), and 330.133(b). Contaminated water shall be managed in accordance with 30 TAC §330.56(0), and as described in Attachment 3.

2.3 Storage and Processing Units [30 TAC §330.63(b)(4)]

The only storage units at the Landfill are the leachate storage tanks. In accordance with 30 TAC §330.63(b)(2)(D), construction details for the leachate storage tanks are provided on Drawing C004 (Base Grading Plan – West) and Drawing C005 (Base Grading Plan – East) in 0. Leachate storage facilities will be maintained and operated to manage run-on and direct rainfall during the peak discharge from the 25-year, 24-hour storm event. The secondary containment facilities and initial buildout of the leachate storage tanks located southeast of the existing landfill scale in the Expansion Area will be installed as part of the Cell G2 cell construction project and will be designed to prevent run-on from the 100-year, 24-hour storm event. Secondary containment design information is included in Attachment 3, Section 3.6 and the layout of the containment facility is shown on 0– Drawing C005. Leachate storage tank secondary containment facilities will feature a low point where water collected during storm events, or leachate accumulated from a potential release inside the tank area can be removed with a portable or dedicated pump. If the water is suspected to be leachate from a release, it will be managed in accordance with Attachment 3. No solid waste processing units are included in this permit.

2.4 Protection of Endangered Species [30 TAC §330.63(b)(5)]

Consistent with 30 TAC §330.63, endangered species were investigated at the site to inform a facility design that protects endangered species. In a September 2018 Protected Species Report (updated February 2021), a “no effect” determination was found for all federally listed endangered, threatened, or candidate species and “no impact” findings for all state listed threatened and endangered species (including bald and golden eagles) that may occur within Victoria County, Texas.

A coordination letter was submitted to the United States Fish and Wildlife Service (USFWS) in April 2019. The letter was updated and submitted to USFWS and to the Texas Parks & Wildlife Department (TPWD) in February 2021. The endangered species report targeted to the lateral expansion area (Cells A1-I2) is provided in Part I/II as Appendix G.

3.0 FACILITY SURFACE WATER DRAINAGE REPORT

30 TAC §330.63(c)

The Surface Water Drainage Report is provided in Attachment 2. This Facility Surface Water Drainage Report is intended to meet the requirements of 30 TAC §330.303(a) and §330.303(b).

3.1 Water Discharge Considerations

The site operator will monitor the activities of the site to ensure that no pollutants, solid wastes, dredged or fill material, or non-point source pollution of the waters of the United States occurs at any time. The Landfill will maintain coverage under the Texas Pollution Discharge Elimination System (TPDES) multi-sector general permit (MSGP) for industrial activity (Permit No. TXR05EI73) included in Appendix I/II - I. All discharges will follow the requirements of this permit, as well as the requirements of the Texas Water Code §26.121, the Federal Clean Water Act 404, as amended, and the Federal Clean Water Act §208 or §319, as amended. All water that has encountered waste will be contained and tested prior to discharge from the site in accordance with Attachment 3 - Leachate and Contaminated Water Plan.

3.2 Run-on Control [330.305(b)]

Existing surface drainage in the site vicinity runs generally north to south. FM 1686, which borders the site to the north, diverts water from the north to a drainage ditch west of the site and to Chocolate Bayou east of the site. These structures are sufficient to prevent the run-on of water to the active portion of the landfill from the 25-year, 24-hour storm event.

In accordance with 30 TAC §301.34(6), the landfill perimeter berm for Cells A1-I2 is designed to provide three feet of freeboard above the 100-year flood elevation. The 100-year flood elevation has been determined to be 63.4 ft amsl, according to a floodplain analysis completed for FEMA Conditional Letter of Map Revision (CLOMR) Case No.: 20-06-2477R. Thus, the top of the berm will be 66.4 ft amsl. The Landfill is outside of the 100-year floodway, thus in accordance with Texas Water Code §16.236(h)(6) the perimeter berm is not subject to §16.236(a) levee requirements.

3.3 Run-off Control [330.305(c)]

Stormwater runoff from the active portion of the landfill shall be managed in accordance with 30 TAC §330.303 and §330.305. Contaminated water shall be managed in accordance with Attachment 3 - Leachate and Contaminated Water Plan.

Internal drainage on the site will segregate stormwater from stormwater that has encountered solid waste. All contaminated water will be contained by permanent and/or temporary dikes in the active fill areas, pumped to the leachate storage tanks or absorbed into the working face of the fill. Stormwater will flow, by a series of ditches, into the existing Victoria County Drainage District #2 maintained ditch which is located in the CP&L easement near the southwest corner of the site (see 0). Temporary dikes or berms will be constructed as necessary to divert or contain stormwater around the active working area. Temporary containment structures will be a minimum of 24 inches in height, which is sufficient to contain the volume of stormwater generated from the working face and the area between the working face and the temporary dikes by the 25-year, 24-hour storm event, as demonstrated in Attachment 3 – Leachate and Contaminated Water Plan.

The entire waste management facility shall be designed, constructed, operated, and maintained to prevent the release and migration of any waste, contaminant, or pollutant beyond the point of compliance as defined in 30 TAC §330.3 and to prevent inundation or discharge from the areas surrounding the facility components. Each receiving, storage, processing, and disposal area shall have a containment system that will collect spills and incidental precipitation in such a manner as to:

- Preclude the release of any contaminated runoff, or spills;
- Prevent washout of any waste by a 100-year storm; and
- Prevent run-on into the disposal areas from off-site areas.

The site shall be designed and operated so as not to cause a violation of:

- The requirements of the Texas Water Code §26.121;
- Any requirements of the Federal Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements §402 as amended;
- The requirements under the Federal Clean Water Act §404, as amended; and
- Any requirement of an area wide or statewide water quality management plan that has been approved under the Federal Clean Water Act §208 or §319, as amended.

All leachate, gas condensate, and working-face contaminated water shall be handled, stored, treated disposed of, and managed in accordance with 30 TAC §330.177, §330.207, and with Attachment 3 – Leachate and Contaminated Water Plan and/or by one or more of the following methods:

- Discharge to an authorized Publicly Owned Treatment Works (POTW) or commercial treatment facility in accordance with existing TPDES permits and other required discharge permits.
- Discharge from an on-site treatment facility in accordance with TPDES permits and other required permit.

4.0 WASTE MANAGEMENT UNIT DESIGN

30 TAC §330.63(d)

4.1 All Weather Operation [330.63(d)(4)(A)]

Sufficient all-weather roads will be continually maintained to permit operation of the site during periods of wet weather. A paved entrance road provides access to the site from FM 1686. Internal all-weather roads, as discussed in the Part IV Site Operating Plan (SOP), provide access to designated unloading areas used during wet weather. The internal access roads are maintained to minimize the tracking of mud onto publicly accessed roads. This road will vary as the fill progresses and the remaining portion of the site is developed. Additionally, roads will be inspected, and mud removed from the entrance roads by scraping with appropriate equipment, swept with a mechanical sweeper, or washed with a water truck.

4.2 Landfilling Methods [330.63(d)(4)(B)]

The area fill method will be used at the site, with a systematic, phased development plan shown in Attachment 1 – Drawing C003 (Waste Placement Phasing Plan). Typical cross sections through the completed site and proposed southern expansion area are shown in 0. The final contours of the completed landfill and proposed expansion area are also shown in 0.

Excavations will be performed with appropriate equipment. Waste will be placed in lifts and will be compacted with a compactor or other suitable equipment prior to the application of daily cover.

4.3 Landfill Design Parameters [330.63(d)(4)(C)]

The 454.5 permitted acres will include 359.7 acres for waste disposal and 94.8 acres of buffer area. The maximum elevation of final cover will be 187.9 feet amsl. Accounting for the total final cover thickness including geosynthetic components, the maximum waste elevation will be 185.4 ft amsl.

Based on review of historical permit documents *Permit Modification Request - Waste Footprint, Final Grade, Base Grade and Drainage Modification, SCS Engineers, Approved 2009* and *Amendment for Increased Height of Fill, JFK Group, Inc., Approved 1997*, the elevation of the deepest existing elevation is 31.0 ft amsl and corresponds to the sumps that drain Trenches 5, 6, 9, and 10.

Constructed cell excavation sideslopes are generally 3H:1V. The uppermost portion of the final cover over cells that have been constructed (Trench 5, Trench 6, areas denoted as “Previously Filled Waste Area”, and the western portions of Trench 9, and Trench 10) will have slopes varying from 2.5 percent to 3.4 percent as indicated, side slopes will be installed at 4H:1V slopes.

Refer to Attachment 1, Attachments 1B (excavation grades), 2A (for extent of “Previously Filled Waste Area”), 15C (leachate collection sump), and 2B through 2D (final cover slopes and elevations west of the vertical expansion over Trenches 7 and 8)).

The elevation of the deepest proposed excavation will be 31.5 ft amsl at the sump that drains future Trench 7 and future Trench 8, within the existing permitted landfill footprint. The elevation of deepest proposed excavation in the southern expansion area (Cells A1 through I2) will be 34.0 feet amsl to account for potential for Class 1 waste being disposed of in each cell and the associated Class 1 engineered subgrade and liner profile. Excavation depths where Class 1 waste will not be disposed will be 36.5 feet amsl. Discussion of groundwater separation and liner design requirements are presented later in this Section.

Proposed cell excavation side slopes will be installed at 3H:1V (Horizontal:Vertical). Final cover side slopes for the lateral and vertical expansion area will be 3H:1V, with the exception of the north slope of Trench 8 and Trench 9 which will be installed at a 4H:1V to match final cover elevations along the north slope. The uppermost portion of the final cover will be constructed with 5 percent slopes.

Refer to 0, Drawing C004 and C005 for proposed top of liner grades, Drawing C-501 for leachate sump details, Drawing C006 and C007 for proposed final cover elevations and slopes.

4.4 Site Life Projection [330.63(d)(4)(D)]

The Landfill currently receives approximately 155,000 tons per year of waste. As of FY 2020 annual reporting to TCEQ, there are 6,073,335 cubic yards of volume available for fill at the landfill. The vertical and lateral expansion in this permit amendment will add an additional 35.9 million cubic yards of air space. Based on the assumptions as outlined below, the City of Victoria Landfill is expected to have a total site life of approximately 147 years (as of January 2022).

Assuming:

> Annual average of 155,000 tons of waste = 465,465 cubic yards in trucks at gate (666 pounds/cubic yard in trucks); Landfill volume is used 80% for waste placement and 20% for daily and final cover; 2.0 cubic yards of waste in garbage trucks occupies one cubic yard of space in the landfill; (465,465 gate yards = 232,733 cubic yards per year in place) Waste growth is assumed limited to near zero due to implementation of waste reduction and recycling.

Summary of Calculations:

36,922,849 (expansion volume) + 6,073,335 (remaining volume) = 42,996,184 cubic yards remaining

42,996,184 • 80% = 34,396,947 cubic yards remaining for waste placement

34,396,947 cubic yards remaining for waste placement / 232,733 cubic yards waste in place per year = 148 years site life remaining as of the end of FY 2020.

If additional volumes of waste are received at the landfill, site life will be reduced.

4.5 Landfill Cross Sections and Perimeter Details [330.63(d)(4)(E) and (F)]

Landfill cross sections are provided in Attachment 1 – Drawings C-301, C-302, and C-303. The location of each section was chosen to represent proposed conditions across the entire site. The Landfill cross sections show the top of the perimeter berm, top of fill, top of waste, maximum elevation of proposed fill, existing ground, bottom of the excavations, and side slopes of trenches and fill areas. In addition, the cross sections show gas monitoring wells, groundwater monitoring wells, and the seasonal high static water level. Cross sections accurately depict the Existing Area and Expansion Area depths of all fill areas within the site. The fill cross sections go through or very near the soil borings to show boring logs on the soil profile. Lastly, the cross sections show construction and design details of proposed compacted perimeter and toe berms and aerial-fill waste disposal areas. The disposal area will be excavated with side slopes no steeper than 3H:1V.

4.6 Liner Design [330.331 and 330.335]

A composite liner is included as part of the landfill design to meet the requirements of 30 TAC §330.331(a)(1), §330.331(a)(2), §330.331(e), and §330.335. The landfill liner and leachate collection system design is provided in Table 4-1. The currently permitted leachate collection system consists of one of two options:

1. 12 inches of granular drainage sand material with minimum hydraulic conductivity of $1x10^{-2}$ cm/sec and 12 inches of protective cover soil, or
2. 200-mil double-sided geocomposite drainage layer overlain with 24 inches of protective cover soil.

The proposed composite liner system featuring a 200-mil double-sided geocomposite drainage layer overlain with 24 inches of protective cover soil is shown in Attachment 1 - Drawing C-501. Chimneys (areas of higher hydraulic conductivity) will be employed at a maximum spacing of every 200 feet if protective cover permeability is less than 1×10^{-4} cm/sec.

For Trenches 7 and 8 and the lateral expansion area (Cells A1-I2), a composite liner shall be constructed as provided in Table 4-1 consisting of a constructed clay liner and flexible membrane liner installed over the entire bottom and sidewalls of the landfill excavation in accordance with procedures described in 0.

Table 4-1: Liner System Components for Landfill Areas

Liner System Component (top to bottom)	Existing Area Pre-Subtitle D	Existing Area Subtitle D Option 1	Existing Area Subtitle D Option 2	Expansion Area Trenches 7 and 8 and Cells A1-I2 (MSW Only)	Expansion Area Cells A1-I2 (Class 1 Option)
Protective Cover	See preceding text in this Section	12-inch protective cover	24-inch protective soil layer	24-inch protective soil layer	24-inch protective soil layer
Leachate Collection System		12-inch granular drainage sand (minimum of $1x10^{-2}$ cm/sec)	Drainage Geocomposite	Drainage Geocomposite	Drainage Geocomposite
Geomembrane	NA	60-mil HDPE Geomembrane	60-mil HDPE Textured Geomembrane	60-mil HDPE Textured Geomembrane	60-mil HDPE Textured Geomembrane
Compacted Soil Liner	24-inch compacted clay liner (1 x 10^{-7} cm/sec)	24-inch compacted clay liner (1 x 10^{-7} cm/sec)	24-inch compacted clay liner (1 x 10^{-7} cm/sec)	24-inch compacted clay liner (1 x 10^{-7} cm/sec)[1]	36-inch compacted clay liner (1 x 10^{-7} cm/sec)[1]
Subgrade	Prepared Subgrade	Prepared Subgrade	Prepared Subgrade	Prepared Subgrade	18-inch engineered subgrade ($1x10^{-8}$ cm/sec)[2]

[1]Leachate collection system sumps will also include a GCL underneath the primary liner and a secondary geomembrane for additional protection against contaminant migration.
[2]There will be a minimum of 18 inches of engineered subgrade (prepared to a maximum hydraulic conductivity of $1x10^{-8}$ centimeters per second [cm/sec]) placed prior to placement of the compacted soil liner to conform with the intent of 30 TAC §335.584(b)(2).

Historical groundwater elevations from past groundwater monitoring reports were reviewed for the period of December 2007 to September 2021 to assess the seasonal high groundwater elevation for the existing site. The maximum observed groundwater elevation during the period of review was 32.26 feet amsl in March 2011 at observation well OW-28. In the lateral expansion area, the maximum observed groundwater elevation of 33.50 feet amsl occurred in August 2020 at the EB-11 piezometer. The EB-11 piezometer is located near an existing sedimentation basin in the current borrow soil excavation area, which may influence groundwater elevations via increased infiltration and recharge due the removal of surficial, low permeability, clay material and accumulation/ponding of water in the soil borrow source area.

Burns & McDonnell developed a spreadsheet that tabulated groundwater water level data from December 2007 through September 2021. While approximately 99 percent of the reported groundwater level data was below the elevation of 32 feet amsl, 33.5 feet amsl is being references as the seasonal high static water level to be conservatively protective of groundwater.

There are 5 feet of soil and liner materials separate the seasonal high static water level (33.5 feet amsl) from the base of the planned leachate sumps in the lateral expansion area (38.5 feet amsl). Accounting for protective cover thickness, the minimum elevation of waste disposal shall be approximately 43 feet amsl for Cells A1-I2 as shown in Attachment 1 – Drawing C-501. The base geomembrane liner elevation beyond the sump extent is 41 feet amsl, or 7.5 feet above the seasonal high static water level.

The maximum observed groundwater level (33.5 feet amsl) is 0.4 feet higher than the base of the proposed leachate sump in Trench 7/8 (33.1 feet amsl). The base geomembrane liner elevation beyond the sump extent is 35.6 feet amsl, or 3.6 feet above the seasonal high static water level. To demonstrate that the sump is properly ballasted by the aggregate within the sump, the following calculation was performed:

If (Weight of Ballast) > (Buoyant Force of Groundwater), Then Sump is Properly Ballasted

Weight of Ballast = (Density of Aggregate) x (Aggregate Thickness per Square Foot)
= (150 lb/cf) x (2.5 ft) = 375 lbs/sf

Buoyant Force = (Density of Water) x (Groundwater Depth per Square Foot)
= (62.4 lb/cf) x (0.4 ft) = 24.96 lbs/sf

375 lb/sf > 24.96 lb/sf, (Ok)

Accounting for protective cover thickness, the minimum elevation of waste disposal shall be approximately 37.6 feet amsl in Trench 8 as shown in Attachment 1 – Drawing C-501.

As noted in Table 4-1, a GCL will be installed underneath the primary liner and a secondary geomembrane will also be installed within the Expansion Area (including Trench 7, Trench 8, and Cells A1-I2) for additional protection against contaminant migration in proposed leachate sumps. Based on Darcy's Law, the added GCL (equivalent to two feet of compacted soil liner) and Geomembrane (effective hydraulic conductivity of 2×10^{-13} cm/sec based on Hydrologic Evaluation of Landfill Performance Version 4.0 defaults), will be at least as protective of the liner system requirements stated in the referenced regulations. Using Darcy's Law, the secondary geomembrane alone is equivalent to 2,500 feet of clay. A sample calculation is provided herein:

$$0.06\text{-inches (geomembrane thickness)} \quad x \quad \frac{1x10^{-7}\ \text{cm/sec}}{2x10^{-13}\ \text{cm/sec}} \quad x \quad \frac{1\ \text{foot}}{12\ \text{inches}} = 2{,}500\ \text{feet}$$

Consistent with 30 TAC §330.331, the liner design ensures that concentration values will not be exceeded in the uppermost aquifer at the point of compliance. The liner design includes a composite liner and a leachate collection system that is designed and constructed to maintain less than a 30-centimeter (approximately one-foot) depth of leachate over the liner throughout the landfill life and post-closure care period, and considers the following:

- The hydrogeologic characteristics of the facility and surrounding land
- The climatic factors of the area
- The volume and physical and chemical characteristics of the leachate
- The quantity, quality, and direction of flow of groundwater
- The public health, safety, and welfare effects
- The practicable capability of the owner or operator

4.6.1 Class 1 Waste Landfill Cells Liner Design [330.331, 330.335 and 335.590]

The composite liner design is consistent with 30 TAC §330.331(e)(1) and 30 TAC §335.590(24)(A)(ii) requirements for Class 1 cells and consists of three feet of compacted soil liner with a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec overlain with a 60-mil HDPE geomembrane. In addition, the liner design includes an alternative liner system in accordance with 30 TAC §330.335. The liner profile can be found on Attachment 1 - Drawing C-501. As noted in Table 4-1, Cells A1-I2 are being proposed as having the option to receive below grade Class 1 wastes.

Base excavation grades are designed to maintain separation from the seasonal high groundwater level to eliminate the need for design and installation of a liner ballast system and minimize the potential of having to manage groundwater during cell construction activities. There are additional potentially-applicable restrictions for Class 1 cells related to groundwater protection based on existing soil types (30 TAC §335.584(b)(1)) and protected regional aquifers (30 TAC §335.584(b)(2)).

There are certain portions of the expansion area where compliance with 30 TAC §335.584(b)(1) can be documented; however, there are also portions of the expansion area that would need to be designed using an alternative subgrade soil permeability and thickness to conform with 30 TAC §335.584(b)(1) requirements. Based on initial feedback from TCEQ during the planning stages of the preparation of this Permit Amendment, the alternative subgrade areas would require a minimum of 6 inches of engineered subgrade (that meets standard compacted soil liner requirements) prior to placement of the compacted soil liner to conform with the intent of §335.584(b)(1); however, additional protection is necessary based on requirements provided in 30 TAC §335.584(b)(2) and is discussed in the next series of paragraphs.

According to the Texas Water Development Board Report 380, *Aquifers of Texas*, the Site overlies formations belonging to the Gulf Coast Aquifer. A review of regional aquifer conditions was conducted as part of the preparation of the Geology Report. In general, confined conditions were not encountered during the field investigation, which is corroborated by historical hydrogeologic information discussed in Attachment 5 – Geology Report. Please refer to Section 2.3 and Section 4.0 of the Geology Report.

Based on the 30 TAC §335.584(b)(2) siting requirements, the underlying subgrade of the standard Class 1 landfill cell base liner has been designed using an alternative soil permeability and thickness equivalent to the 30 TAC §335.584(b)(2) requirements. As shown in Table 4-1, the alternative subgrade in Class 1 cells shall have a minimum of 18 inches of engineered subgrade (prepared to a maximum hydraulic conductivity of $1x10^{-8}$ centimeters per second [cm/sec]) prior to placement of the compacted soil liner.

To demonstrate equivalency to the regional aquifer siting requirement of 30 TAC §335.584(b)(2), Burns & McDonnell calculated the steady-state travel time for fluid to flow through the prescribed underlying soil unit and compared this travel time to that of alternative soil barriers of different thicknesses and hydraulic conductivities. If the alternative soil barrier produces a travel time of equal-to or greater-than the prescribed travel time, the alternative soil barrier is acceptable.

The methodology for the equivalency demonstration is from the publication Comparison of Leachate Flow through Compacted Clay Liners and Geosynthetic Clay Liners in Landfill Liner Systems, a technical paper by J.P. Giroud, K Badu-Tweneboah, and K.L. Soderman (Giroud). Equation 18 from this paper provides the steady-state travel time for leachate to adjectively flow through a liner. This equation is as follows:

$$t_{sst} = \frac{\mathrm{nT}}{\mathrm{k}(1 + h/T)}$$

t_{sst} = steady state travel time (sec)
n = effective porosity (%)
T = soil layer thickness (cm)
k = hydraulic conductivity (cm/sec)
h = head (cm)

The following assumptions were made:

- The effective porosity of the prescribed and alternative underlying soil units is 30%. This is within the recommended range provided in Giroud and has also been utilized in a similar TCEQ landfill application that is available for public review online.
- The assumed pressure from liquid on top of the soil column (head) used for all calculations was 30.48 cm (1 foot). This is a conservative assumption, as the head is expected to be lower (30 cm of head is the maximum allowed on top of the landfill liner in TCEQ's solid waste regulations).

The travel time for fluid through 10 feet of soil with a hydraulic conductivity of $1x10^{-7}$ cm/sec (i.e., the prescribed underlying soil unit in 30 TAC §335.584(b)(2)) is 26 years. The selected alternative is: 1.5 feet of soil with a hydraulic conductivity of $1x10^{-8}$ cm/sec, which gives a travel time of 26 years, equivalent to the travel time of the prescribed underlying soil unit.

4.6.2 Cell Drainage / Settlement Analysis

The base grades and leachate drainage approach follows the TCEQ requirements and industry best practices for the protection of groundwater and human health. Geomembrane liner grades have been designed to maintain separation from the seasonal high groundwater level (32 feet amsl) to eliminate the need for design and installation of a geomembrane liner ballast system.

The base grades have been designed with a two percent minimum slope toward the leachate collection system piping and leachate collection piping at 0.5 percent minimum slope will be used to facilitate leachate drainage to sumps along the South side of Cells A1-I2 and to the sump along the north side of Trenches 7 and 8. The slopes toward the leachate collection system piping generally mirror the design of Trenches 6 and 10 in the Existing Area footprint. The leachate collection system piping increases in slope from 0.5 percent to 1 percent approximately 250 feet from the limits of the sump in Trench 7/8 and Cells A1-I2 to account for potential settlement of the subgrade soils. Trenches 7 and 8 each will be approximately 11 acres (22.2 acres total) and share a common sump in Trench 8. Cells A1-I2 will be 11-14.5 acres with every two cells sharing a common sump (~25 acres per sump).

4.6.2.1 Landfill Settlement

Based on site specific data obtained during the planned geotechnical investigation, the maximum total liner settlement is expected to be 33 inches, occurring at the base of the landfill directly below the maximum landfill elevation in the expansion area. A settlement analysis was conducted through two critical cross sections: one along the leachate pipe invert through the maximum landfill elevation and another along the leachate pipe invert of Trench 7/8. The maximum settlement of Trench 7/8 is expected to be 25 inches. Settlement calculations are provided in Attachment 7.

The settlement analysis results necessitate the increased slope of the leachate pipe invert as discussed in the previous section. A continuous slope of 0.5% at construction, if used, would be inadequate to convey leachate in the span between the sump and the top of the final cover side slope, after settlement had occurred. To counteract this effect, the typical 0.5% slope was increased to 1.0% along the South extent of the lateral expansion area (Cells A1-I2) and along the North extent of Trench 7.

The settlement analysis results constrained the areas of Trench 6 and 9 that could accommodate increased waste depth resulting from the vertical expansion. Portions of the landfill base grades of Trench 6 and 9 including the leachate pipe invert are constructed (or anticipated to be constructed prior to the issuance of this Amendment), therefore are unable to be modified as discussed above. No fill was added over the leachate collection system line within Trench 9 and limited fill was added in the southern extent of Trench 6. A vertical expansion was only feasible in Trench 7 and 8 (where base grades can be revised with greater slopes) and on the final southern exterior slopes of Trench 6.

4.6.3 Soil and Liner Quality Control Plan [330.339]

Consistent with 30 TAC §330.339, a Soil and Liner Quality Control Plan (LQCP) has been prepared under the direction of a licensed professional engineer in Attachment 4. The LQCP includes procedures for the installation and testing of both soil and geomembrane liners. The constructed liner details, showing slope, widths, and thicknesses of compaction lifts, can be found on Drawings C-501 to C-503. The soil and liner quality-control testing procedures will include sampling frequency in addition to all field sampling and testing during construction and after completion. The professional of record who has signed the soil liner evaluation report, or his representative will be on site during all liner construction. In addition, quality control of construction and quality assurance of sampling and testing procedures shall follow the latest technical guidelines of the Executive Director. Excavated waste will be returned to another location in a constructed cell.

4.6.4 Liner Evaluation Reports [330.339 and 330.341]

Soil Liner Evaluation Reports (SLERs) and Flexible Membrane Liner Evaluation Reports (FMLERs) shall be submitted to the TCEQ for evaluation and approval in accordance with 30 TAC §330.339 – Liner Quality Control Plan and 30 TAC §330.341 – Soil Liner Evaluation Report and Geomembrane Liner Evaluation Report.

4.7 Leachate Collection System and Leachate Recirculation [330.333]

The leachate collection system (LCS) shall be designed, constructed, and maintained in accordance with 30 TAC §330.331 and §330.333 – Leachate Collection System, and in accordance with Attachment 2 –

Surface Water Drainage Report, Attachment 3 – Leachate and Contaminated Water Plan, Attachment 4 – Soil and Liner Quality Control Plan (SLQCP), and Part IV – Site Operating Plan.

As detailed in Attachment 3– Leachate and Contaminated Water Plan, the leachate collection system has been designed to maintain less than a 30 centimeter depth of leachate over the liner throughout the landfill life and postclosure period. The LCS has been designed according to the requirements as specified in 30 TAC §330.333:

- Constructed of materials that are chemically resistant to the leachate expected to be generated
- Constructed of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill
- Designed and operated to function through the scheduled closure and post-closure care period of the landfill considering the factors specified in 30 TAC 330.333(A) through (G).

As shown in Table 4-1, the leachate collection layer within the Expansion Area will consist of a double-sided geocomposite drainage layer, which consists of a geosynthetic drainage net with a geotextile bonded to both sides. Constructed Subtitle D cells within the Existing Area were permitted with two options: the use of 12 inches of granular drainage sand of a minimum $1x10^{-2}$ cm/sec or the drainage geocomposite. Leachate collection chimney drains will be used where needed for leachate collection, including in the option of below-grade Class 1 disposal in the lateral expansion. In the Class 1 option, chimney drains will have a maximum spacing of 200 ft, and will be used to facilitate leachate collection from MSW placed above-grade and over the four-foot layer of compacted clay-rich soil required by §330.457(b).

Drainage is facilitated as described in Section 4.6.2 toward the LCS piping, which has been sized based on leachate generation estimates using the Hydraulic Evaluation of Landfill Performance (HELP) Model Version 4.0.1. The HELP model is a hydrologic model of water movement across, into, through, and out of landfills. Landfill leachate generation was estimated based on local climatic factors, soil, and design data in a daily sequential analysis that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, percolation, soil moisture storage, and lateral drainage. A description of the HELP modeling is provided in 10-4Attachment 3– Leachate and Contaminated Water Plan.

Leachate will be collected in the sumps (located as described in Section 4.6.2), to be pumped to leachate storage tanks. Leachate collected in the Existing Area is conveyed to the on-site leachate storage tank area in the north of the site. This area was designed and previously permitted for two storage tanks. Currently, one 64,000-gallon tank has been constructed. Leachate in the Expansion Area that encompasses Cells A1-

I2 will be conveyed to a storage tank area on the east portion of the site, with four 64,000-gallon tanks based on estimated leachate generation.

Leachate is currently trucked off-site for treatment and disposal through the publicly-owned treatment network. Consistent with §330.177, recirculation of leachate and gas condensate may occur only on areas designed and constructed with a leachate collection system and composite liner. HELP modeling of the Expansion Area (Attachment 3– Leachate and Contaminated Water Plan) indicates that up to 100 percent of leachate could be recirculated while cells are active and maintain less than a 30 centimeter depth of leachate over the liner. If utilized, procedures for recirculation may include:

- Discharge to trenches containing perforated pipes or prefabricated infiltration units spaced at regular horizontal and vertical intervals throughout the waste;
- Discharge to open trenches temporarily excavated into the waste which are then backfilled with waste and covered in accordance with §330.133;
- Spray application of leachate to working face;

4.8 Above-Grade Waste Placement

Above-grade waste placement design is presented in the following locations:

- All waste deposited above grade shall be limited to the grades and elevations shown in Attachment 1 – Drawing C006 (Final Closure Plan West), Drawing C007 (Final Closure Plan East), Drawings C-301 to C-303 (Cross Sections-1 to Cross Sections-3), and C-502 (Detail Sheet 2).
- As a part of the lateral expansion, the maximum elevation of the final cover shall be 187.8 feet amsl, as shown in Attachment 1 – Drawing C006 (Final Closure Plan West), Drawing C007 (Final Closure Plan East).
- Top of cover and side embankment slopes of all above-grade waste disposal portions of the landfill shall be constructed to the grades and elevations as shown in Attachment 1 – Drawing C006 (Final Closure Plan West), Drawing C007 (Final Closure Plan East).
- Landfill development and construction sequencing of below-grade, aerial fill areas, and site appurtenances shall be performed as shown in Attachment 1 – Drawing C002 (Landfill Expansion Plan), Attachment 1 – Drawing C003 (Waste Placement Phasing Plan).

Prior to above-grade waste placement in the lateral expansion areas, any cells receiving below-grade Class 1 waste will be covered with a four-foot clay-rich soil barrier, above which MSW will be placed for above-grade aerial fill. No Class 1 waste will be placed above-grade. Class 1 cell design is shown in 0.

4.9 Final Cover

The final cover shall serve as a barrier to waste, leachate, and gas migration and shall also limit the infiltration of rainfall and provide methane oxidation benefits.

The final cover system shall be constructed in accordance with 30 TAC §330.457 - Closure Requirements for MSWLF Units That Receive Waste on or after October 9, 1993, and Attachment 1 – Drawing C001 (Existing and Permitted Conditions with Proposed Expansion Footprint), Drawing C006 (Final Closure Plan West), Drawing C007 (Final Closure Plan East), Attachment 9 – Final Closure Plan, and Attachment 10 - Final Cover Quality Control Plan.

Temporary erosion and sedimentation control measures shall remain functional until the permanent vegetative cover has become established or as required to control erosion on areas having completed final cover throughout the post-closure care period in accordance with Attachment 2 – Surface Water Drainage Report and Attachment 3 – Leachate and Contaminated Water Plan.

The footprint of the vertical expansion permitted under the Expansion Area extends above portions of Trench 5, 6, 7 and 8. In these areas of the Existing Area waste unit directly below the Expansion Area waste unit, only the final cover system of the Expansion Area waste unit will be installed, at the design elevations provided in 0– Drawings C006 and C007.

The final cover system for Cells A1 – I2, Trench 7/8 as well as the final cover to be constructed over Subtitle D cells that have not been closed is an alternative design; the sequence of the clay-rich soil layer and geomembrane were switched for constructability purposes and to maintain the integrity of the geomembrane. Consistent with 30 TAC §330.457(a), the final cover system design for all future Subtitle D cell closure activities will include the following layers from bottom to top:

- 18 inches of clay-rich soil with a coefficient of permeability no greater than 1×10^{-5} cm/sec
- A 40-mil LLDPE geomembrane (textured both sides)
- A 200-mil geocomposite drainage layer
- A 12-inch soil layer capable of sustaining native plant growth

Table 4-2 details the final cover system scenario for each disposal cell type.

Table 4-2: Final Cover System Components for Landfill Areas

Cover System	Pre-Subtitle-D	Subtitle-D	Alternative Composite
Final Cover System Component	Existing Area – Pre-Subtitle D (CLOSED) & Existing Area - Constructed	Existing Area – Subtitle D (CLOSED) & Existing Area – Trench 11	Existing Area – Trenches 5 through 10 & Expansion Area – Cells A1 through I2
Soil Erosion Layer	6-inch protective soil layer	24-inch erosion layer capable of sustaining native plant growth	12-inch protective soil layer
Drainage Geocomposite	None	200-mil double-sided drainage geocomposite (side slopes) and cushion geotextile (top deck)	200-mil double-sided drainage geocomposite
Geomembrane	None	40-mil LLDPE geomembrane (smooth on top deck and textured on sides)	40-mil LLDPE Textured Geomembrane
Compacted Clay Layer	18-inch compacted clay-rich soil with permeability no greater than 1 x 10^{-7} cm/sec	18-inch compacted clay-rich soil with permeability no greater than 1 x 10^{-5} cm/sec	18-inch compacted clay-rich soil with permeability no greater than 1 x 10^{-5} cm/sec

5.0 GEOLOGY REPORT

30 TAC §330.63(e)

The Geology Report was prepared consistent with 30 TAC §330.63(e). See Attachment 5 for the complete Geology Report.

6.0 GROUNDWATER SAMPLING AND ANALYSIS PLAN

30 TAC §330.63(f)

A Groundwater Sampling and Analysis Plan (GWSAP) and Groundwater Monitoring Plan (GMP) has been prepared to address the requirements in 30 TAC Subpart J – Groundwater Monitoring and Corrective Action. The GWSAP/GMP is provided in Attachment 6.

The groundwater monitoring system has been designed in conjunction with the Geology Report in Attachment 5 and GWSAP/GMP. The groundwater monitoring system shall be used to monitor the quality of groundwater in the uppermost aquifer in accordance with 30 TAC §330.403.

Monitoring wells shall be sampled in accordance with a monitoring program defined in the GWSAP/GMP, 30 TAC §330.405, and 30 TAC §330.407.

Any monitoring well that is no longer used shall be properly plugged and abandoned in accordance with 30 TAC §330.421.

7.0 LANDFILL GAS MANAGEMENT PLAN

30 TAC §330.63(g)

An active landfill gas (LFG) extraction system has been constructed and will be used to reduce the potential for off-site subsurface migration of LFG. The landfill gas system is designed and operated in accordance with 30 TAC §330.371, and as described in the Landfill Gas Management Plan (Attachment 8).

A LFG monitoring system will be installed to detect off-site subsurface LFG migration and to detect any LFG within facility structures. This shall be accomplished by a perimeter network of LFG monitoring probes and building detectors and non-dedicated monitoring in buildings, where applicable. The design, location, and operation of the LFG probes and detectors shall be as described in the Landfill Gas Management Plan (Attachment 8). At a minimum, the probes shall be sampled quarterly by appropriately trained persons.

Further information regarding design, LFG monitoring procedures, and regulatory applicability is included in the Landfill Gas Management Plan (Attachment 8).

8.0 CLOSURE PLAN

30 TAC §330.63(h)

The Landfill shall be completed and closed in accordance with 30 TAC §330.63(h) – Closure Plan and 30 TAC Subpart K – Closure and Post-Closure, as laid out in the Final Closure Plan (Attachment 9). Upon closure, the permittee shall submit to the Executive Director documentation of closure as prescribed in 30 TAC §330.457 – Closure Requirements for Municipal Solid Waste Landfill Units that Receive Waste on or after October 9, 1993.

8.1 Existing – Closed Area Final Cover System

In 2015, final cover was constructed over approximately 51.6-acres along the western portion (top and deck slopes) of the pre-Subtitle D (29.2) acres and Subtitle D (22.4 acres) fill areas. Additional discussion of the Existing – Closed Area final cover systems can be found in Attachment 9C – Final Cover System Evaluation Report. The relevant drawings indicating the extent of the constructed final cover can be found in Attachment 9C – Final Cover System Evaluation Report. The Existing Area – Closed final cover system profiles are defined in Table 4-2 and Attachment 9 – Final Closure Plan.

8.2 Final Cover System

The final cover system is designed and shall be constructed to minimize infiltration and erosion. For MSW units with a synthetic bottom liner, a synthetic membrane that has permeability less than or equal to the permeability of any bottom liner system overlain by clay-rich soil cover layer. The final cover profile and design details are described in Table 4-2 and Attachment 9 – Final Closure Plan. The topmost portion of the final cover will be installed at a five percent slope, while the side slopes will be installed at 33 percent and 25 percent, as indicated in Attachment 1 – Drawings C006 and C007.

Design calculations demonstrating the acceptability of the sideslopes greater than 25 percent can be found in the Slope Stability and Settlement Analysis Report (Attachment 7), inclusive of slopes to accommodate stormwater drainage features.

8.3 Final Cover – Soil Erosion Loss Calculations

The following calculations were completed using the Revised Universal Soil Loss Equations, Version 2 (RUSLE2) program which is developed and maintained by the Natural Resources Conservation Service (NRCS). RUSLE2 uses six factors, including climatic erosivity, soil erodibility, slope length, slope steepness, cover-management, and support practices to compute soil loss.

As this project takes place in Victoria County, TX, the following databases were imported within the program:

- CMZ58 (Crop Management Zone Database encompassing Site area)
- TX clim011603 (Climate Database that encompassing Site area)
- SSURGO (Soil Database for USA)

The NRCS Web Soil Survey was used to identify the soil type for the site. Laewest clay (LaA), 0 to 1 percent slopes was identified as the soil type for the site (see Attachment 14A) and was chosen from the SSURGO soil database.

As multiple stormwater diversion berms (also referred to as "terraces") are planned for the landfill from top to bottom of slope, the Compare Field Alternatives option was chosen to calculate the soil loss from each typical section of the landfill between terraces. Two typical sections are identified in the RUSLE2 report and figures (included in Attachment 14) as Field 1 (Scenarios 1A-1F) and Field 2 (Scenarios 2A – 2E). The soil loss results from the RUSLE2 program are shown in Table 8-1 (Intermediate Cover Phase) and Table 8-2 (90 percent Cover) as well as the weighted soil loss calculations for each landfill section analyzed.

The calculations showed weighted soil loss values of less than 50 tons/acre/year per TCEQ guideline RG-417 for both sections analyzed for the intermediate cover scenario. The calculations represent a condition immediately following the completion of final cover, where seeding and mulching BMPs are used to decrease erosion.

The calculations showed weighted soil loss values of less than 3 tons/acre/year, per TCEQ guideline RG-417 soil loss regulation for both sections analyzed for the 90 percent vegetation scenario. The calculations represent a condition of vegetative growth with approximately 90 percent coverage over the entire landfill, which has been successfully achieved at other regional facilities. Until such coverage is achieved, all slopes will be inspected and managed per Attachment 9 – Final Closure Plan and Attachment 11 – Post-Closure Plan. If any areas demonstrate a need for corrective action as laid out in Attachment 11 – Post-Closure Plan, they will receive immediate corrective action. Regular inspections and maintenance will continue throughout the post-closure care period to maintain.

Table 8-1: RUSLE 2 Soil Loss Results – Intermediate Cover Phase

Sub-Scenario	Section Length (feet)	Soil Loss (tons/acre/yr)	% Total Length	Weighted Soil Loss (tons/acre/yr)
1A	250	23	35.2	8.1
1B	180	20	25.3	5.1
1C	60	48	8.4	4.1
1D	80	56	11.3	6.3
1E	80	56	11.3	6.3
1F	61	20	8.6	1.7
Total Length	711		**Total Soil Loss**	**31.5**
2A	180	20	32.0	6.4
2B	100	47	17.2	8.1
2C	110	51	19.5	10.0
2D	110	54	19.5	10.6
2E	66	18	11.7	2.1
Total Length	563		**Total Soil Loss**	**37.1**

Table 8-2: RUSLE 2 Soil Loss Results – Final Cover Phase

Sub-Scenario	Section Length (feet)	Soil Loss (tons/acre/yr)	% Total Length	Weighted Soil Loss (tons/acre/yr)
1A	250	1	35.2	0.4
1B	180	1	25.3	0.3
1C	60	3	8.4	0.3
1D	80	3	11.3	0.3
1E	80	3	11.3	0.3
1F	61	1	8.6	0.1
Total Length	711		**Total Soil Loss**	**1.6**
2A	180	1	32.0	0.3
2B	100	2	17.2	0.3
2C	110	2	19.5	0.4
2D	110	2	19.5	0.4
2E	66	1	11.7	0.1
Total Length	563		**Total Soil Loss**	**1.6**

9.0 POST-CLOSURE PLAN

30 TAC §330.63(i)

Consistent with 30 TAC §330.63(i), a post-closure plan has been prepared under the direction of a licensed professional engineer and is provided in Attachment 11. Post-closure construction and maintenance shall be conducted in accordance with the plan for a period of 30 years or as otherwise determined by the Executive Director pursuant to 30 TAC §330.463.

10.0 COST ESTIMATE FOR CLOSURE AND POST-CLOSURE CARE

30 TAC §330.63(j)

Authorization to operate the facility is contingent upon compliance with provisions contained within the permit and maintenance of financial assurance in accordance with 30 TAC Chapter 330, Subchapter K – Financial Assurance.

10.1 Closure Cost Estimate

Consistent with 30 TAC §330.503(a), a cost estimate of hiring a third party to close the largest waste fill area that could potentially be open in the year to follow and those areas that have not received final cover is provided in Attachment 12. The Closure Cost estimate in 2021 dollars is $7,357,403. A review of facility's permit conditions, current active areas, and cost estimates will be provided annually in accordance with 30 TAC §330.503(a)(1).

The City shall establish financial assurance for closure in accordance with 30 TAC Chapter 37, Subchapter R (relating to Financial Assurance for Municipal Solid Waste Facilities). Continuous financial assurance coverage for closure shall be provided until the facility is officially placed under the post-closure maintenance period and all requirements of the final closure plan have been approved as evidenced in writing by the TCEQ.

10.2 Post-Closure Cost Estimates

Consistent with 30 TAC §330.507(a), a cost estimate of hiring a third party to conduct post-closure care activities is provided in Attachment 13. The-Post Closure Cost estimate in 2021 dollars is $11,139,083.

The City shall establish financial assurance for the costs of post-closure care of the unit in accordance with 30 TAC Chapter 37, Subchapter R (relating to Financial Assurance for Municipal Solid Waste Facilities). Continuous financial assurance coverage for post-closure care shall be provided until the facility is officially released in writing by the TCEQ from the post-closure care period in accordance with all requirements of the post-closure care plan.

10.3 Corrective Action Cost Estimate

Consistent with 30 TAC §330.509, a corrective action program and a detailed written cost estimate of the cost of hiring a third party to perform the corrective action program is required if requested by the TCEQ. Currently a corrective action cost estimate for the site has not been requested by the TCEQ but will be provided if required.

ATTACHMENT 1 - PERMIT AMENDMENT DRAWINGS

City of Victoria Landfill

Landfill Expansion Permit Amendment

City of Victoria, TX

TCEQ Permit No. 1522B

MARCH 2022

BMcD Project No. 107608

ONE OR TWO CHARACTER DISCIPLINE DESIGNATOR (MAY NOT BE PRESENT IF CALLOUT AND TITLE ARE ON DRAWINGS WITHIN THE SAME DISCIPLINE)

A
FP001

LETTER OR NUMBER DESIGNATOR

DRAWING SEQUENCE NUMBER INDICATES WHERE TITLE IS LOCATED (MAY NOT BE PRESENT IF CALLOUT AND TITLE ARE ON THE SAME DRAWING)

SECTION, DETAIL, AND ELEVATION SYMBOL IDENTIFIERS

A FP001 A FP001

SECTION CALLOUT EXAMPLE

7 FP001

DETAIL CALLOUT EXAMPLE

B A001

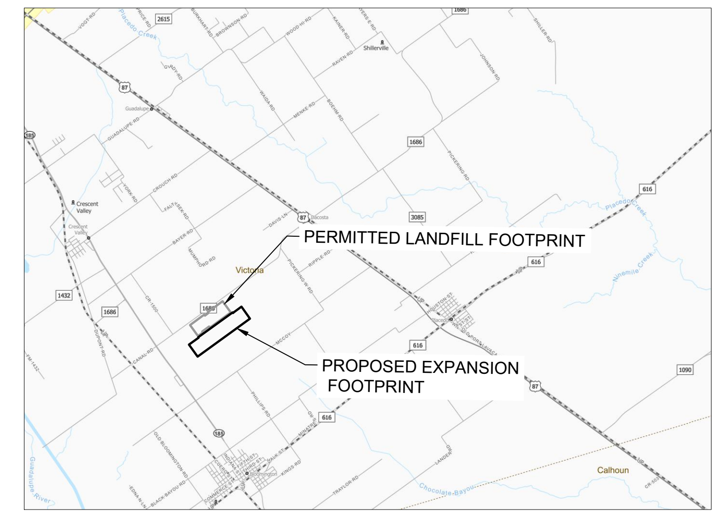
ELEVATION CALLOUT EXAMPLE

THE WORD "SECTION" MAY BE REPLACED WITH "ELEVATION" OR "DETAIL"

SECTION A 001

SECTION, DETAIL, OR ELEVATION TITLE EXAMPLE

SECTION, DETAIL, AND ELEVATION IDENTIFICATION SYSTEM



GENERAL LOCATION MAP

0 10000' 20000'
SCALE IN FEET
N

List of Drawings

DWG. NO.	TITLE	DWG. NO.	TITLE
	COVER - INDEX	C-301	CROSS SECTIONS - 1
G001	GENERAL NOTES, LEGEND, AND ABBREVIATIONS	C-302	CROSS SECTIONS - 2
C001	EXISTING CONDITIONS WITH EXPANSION FOOTPRINT WITH PROPOSED EXPANSION FOOTPRINT	C-303	CROSS SECTIONS - 3
C002	LANDFILL CELL EXPANSION PLAN	C-501	DETAIL SHEET 1
C003	WASTE PLACEMENT PHASING PLAN	C-502	DETAIL SHEET 2
C004	BASE GRADING PLAN - WEST	C-503	DETAIL SHEET 3
C005	BASE GRADING PLAN - EAST	C-504	DETAIL SHEET 4
C006	FINAL GRADING PLAN - WEST	C-505	DETAIL SHEET 5
C007	FINAL GRADING PLAN - EAST	C-506	DETAIL SHEET 6
C008	LARGEST OPEN AREA	C-507	DETAIL SHEET 7
C009	LFG COLLECTION SYSTEM PLAN - WEST		
C010	LFG COLLECTION SYSTEM PLAN - EAST		
C011	FINAL ENVIRONMENTAL MONITORING PLAN		

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

SCOTT MARTIN P.E.
LICENSE NO.120819

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

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BURNS McDONNELL
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KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

COVER - INDEX

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. VICTORIA LANDFILL SITE TOPOGRAPHY (NORTHERN PROPERTY AND EXISTING LANDFILL GRADES) PROVIDED BY COOPER AERIAL SURVEYS CO. DATE OF AERIAL SURVEY: NOVEMBER 24, 2019. SURVEY LIMITS SHOWN ON DRAWING C001.
2. EXPANSION PROPERTY SITE TOPOGRAPHY PROVIDED BY CIVIL CORP. DATE OF GROUND SURVEY: OCTOBER 2, 2018. SURVEY LIMITS SHOWN ON DRAWING C001.
3. TOPOGRAPHY OUTSIDE OF THE AREA DESCRIBED IN NOTES 1 AND 2 WAS OBTAINED FROM THE TEXAS NATURAL RESOURCES INFORMATION SYSTEM, DATED APRIL 1999.
4. THE SURVEY COORDINATES ARE ON THE TEXAS SOUTH CENTRAL STATE PLANE '83, COORDINATE SYSTEM. HORIZONTAL DATUM IS NAVD 1983. VERTICAL DATUM IS NAVD 1988.

ABBREVIATIONS

AC	ACRE
AMSL	HEIGHT ABOVE MEAN SEA LEVEL
BMcD	BURNS & MCDONNELL
CM	CENTIMETER
DWG	DRAWING
E	EAST/EASTING
EB	EXISTING BORING
EL.	ELEVATION
EX.	EXISTING
FM1686	FARM-TO-MARKET ROAD 1686
FT.	FEET
GCCS	GAS COLLECTION AND CONTROL SYSTEM
GCL	GEOSYNTHETIC CLAY LINER
GMP	GAS MONITORING PROBE
HDPE	HIGH-DENSITY POLYETHYLENE
IN.	INCH
INV.	INVERT

ABBREVIATIONS CONT.

K	HYDRAULIC CONDUCTIVITY
LFG	LANDFILL GAS
MIL	1/1,000-INCH
MIN	MINIMUM
MW	MONITORING WELL
N	NORTH / NORTHING
NO.	NUMBER
OZ	OUNCE
OW	OBSERVATION WELL
RCP	REINFORCED CONCRETE PIPE
ROW	RIGHT OF WAY
S	SOUTH
SEC	SECOND
TBC	TO BE CONSTRUCTED
TYP.	TYPICAL
W	WEST
YD	YARD

PLAN LEGEND

- PROPERTY BOUNDARY (℄)
- EXISTING PAVED ROAD
- EXISTING GRAVEL ROAD
- EXISTING/PERMITTED WASTE LIMITS
- SURVEY LIMITS
- ADJACENT PARCEL LIMIT
- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR (120)
- EXISTING DRAINAGE PATH
- EXISTING POND
- EXISTING CHOCOLATE BAYOU FLOOD ZONE
- GROUNDWATER SURFACE CONTOUR
- EXISTING STRUCTURE
- EXISTING FENCE
- EXISTING OVERHEAD ELECTRICAL (OH)
- EXISTING EASEMENT
- EXISTING LEACHATE/CONDENSATE FORCE MAIN (FM)
- EXISTING AIR SUPPLY LINE (AIR)
- EXISTING LFG HEADER/LATERAL
- EXISTING LFG EXTRACTION WELL
- SURVEY CONTROL POINT
- EXISTING GAS MONITORING PROBE
- EXISTING GROUNDWATER MONITORING WELL
- EXISTING GEOTECHNICAL BORING LOCATION
- EXISTING CULVERT
- EXISTING VALVE
- EXISTING CONDENSATE SUMP
- EXISTING LIGHT POLE
- EXISTING TBC DESIGN 10' CONTOUR (120)
- EXISTING TBC DESIGN 2' CONTOUR
- PROPOSED 2' CONTOUR (2)
- PROPOSED 10' CONTOUR (10)
- PROPOSED PAVED ROAD
- PROPOSED GRAVEL ROAD
- PROPOSED LIMIT OF FILL
- PROPOSED PERMIT BOUNDARY/PROJECT LIMIT
- PROPOSED WASTE LIMITS
- PROPOSED CELL BOUNDARY
- PROPOSED LEACHATE PIPE COLLECTION SYSTEM (LCP)
- PROPOSED LEACHATE/CONDENSATE FORCE MAIN (FM)
- EXISTING AIR SUPPLY LINE (AIR)
- PROPOSED LFG HEADER
- PROPOSED LFG LATERAL
- PROPOSED LFG JUMPER LINE

PLAN LEGEND (CONT.)

- PROPOSED CONDENSATE SUMP
- PROPOSED LFG EXTRACTION WELL
- PROPOSED GROUNDWATER MONITORING WELL
- PROPOSED LFG MONITORING PROBE
- PROPOSED VALVE
- MAXIMUM SEASONAL HIGH GROUNDWATER
- LETDOWN CHUTE
- STORMAWATER CHANNEL/DIVERSION BERM
- PROPOSED BARBED WIRE FENCE

DETAIL LEGEND

- GEOMEMBRANE
- GEOCOMPOSITE (xxxxxxxxxxxxxxxxxxxxxxxx)
- GEOTEXTILE
- COMPACTED SOIL LINER
- COMPACTED SOIL FINAL COVER/ GENERAL COMPACTED SOIL
- GEOSYNTHETIC CLAY LINER (GCL)
- PROTECTIVE COVER
- PERFORATED PIPE
- CHIMINEY DRAIN/SUMP DRAINAGE ROCK
- SUBGRADE
- VEGETATIVE SOIL
- STORMWATER DETENTION POND AREA

STATE OF TEXAS
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date	detailed
MARCH 2022	T. CAMMACK
designed	**checked**
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

1522B PERMIT AMENDMENT

GENERAL NOTES, LEGEND, AND ABBREVIATIONS

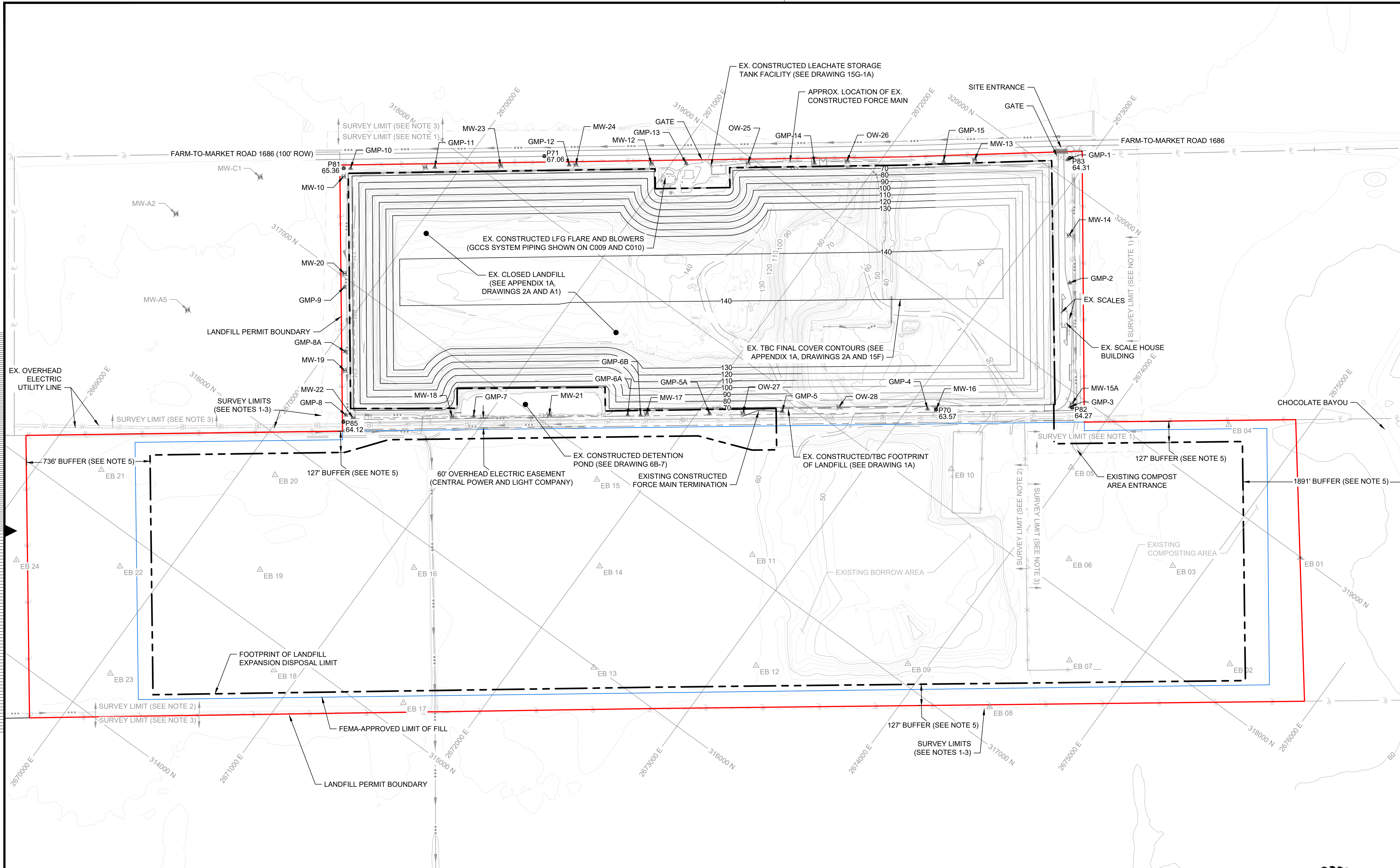
project	contract
107608	-

drawing G001 – rev. A

sheet 2 of 23 sheets

file 107608G001.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL



SITE CONTROL POINTS			
POINT ID	NORTHING	EASTING	ELEVATION (FT AMSL)
70	318435.19	2673139.67	63.57
71	318285.02	2670362.64	67.06
81	317523.31	2669436.40	65.36
82	318921.55	2673790.18	64.27
83	320118.09	2672904.15	64.31
85	316299.10	2670324.48	64.12

NOTE:

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4. THE SURVEY COORDINATES ARE ON THE TEXAS SOUTH CENTRAL STATE PLANE '83, COORDINATE SYSTEM. HORIZONTAL DATUM IS NAVD 1983. VERTICAL DATUM IS NAVD 1988.
5. BUFFERS SHOWN REPRESENT DISTANCE BETWEEN LIMITS OF WASTE AND THE PROPERTY BOUNDARIES.
6. DESIGN CONTOURS REPRESENT TOP OF PREVIOUSLY PERMITTED FINAL COVER. CONTOUR INTERVAL IS 10-FEET.

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designed	checked
T. SCHMIDT	S. MARTIN

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Victoria County, Texas

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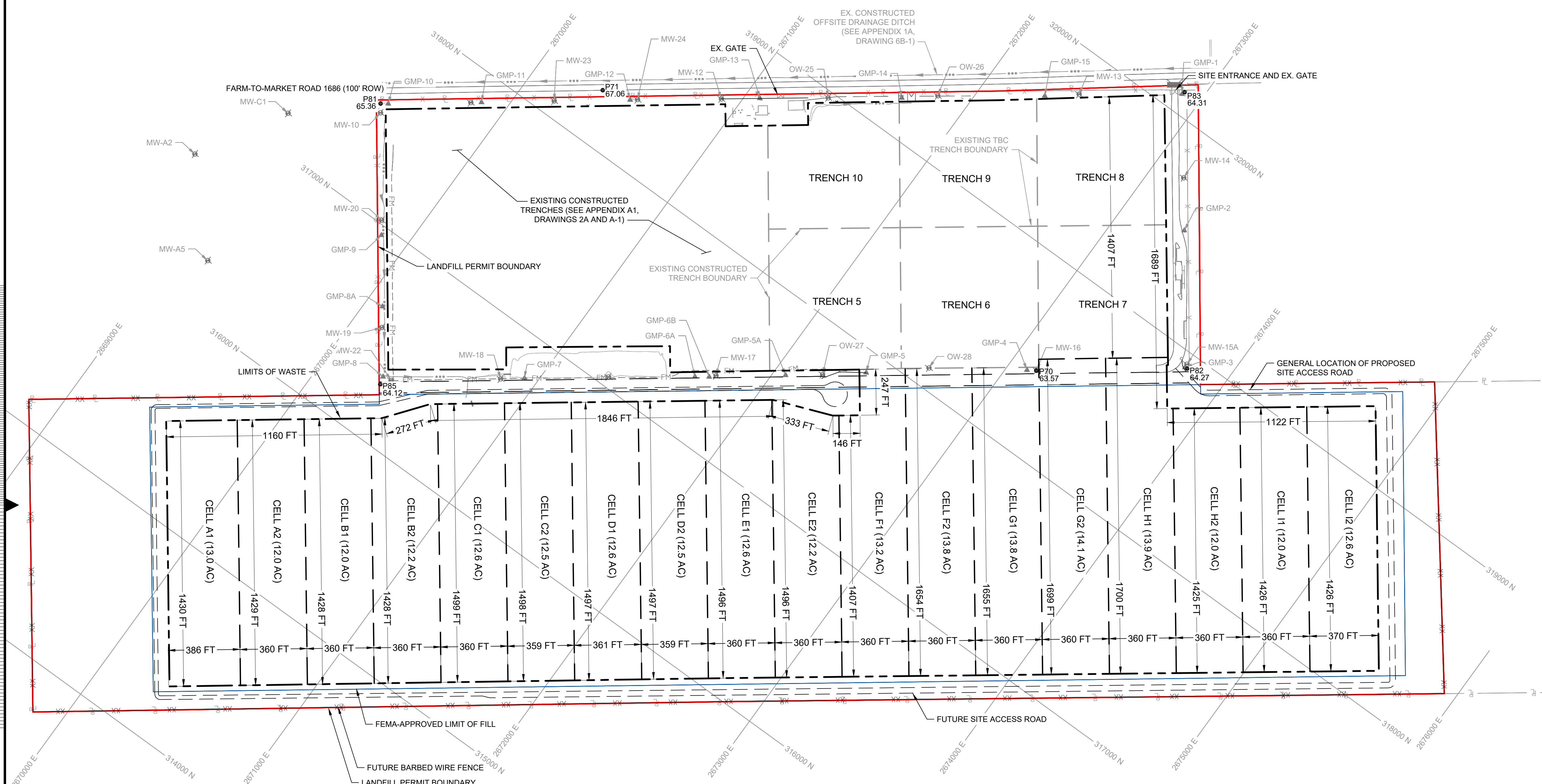
EXISTING CONDITIONS WITH EXPANSION FOOTPRINT

project	contract
107608	-

drawing C001 – rev. A

sheet 3 of 23 sheets

file 107608C001.dwg



no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. THE SURVEY COORDINATES ARE ON THE TEXAS SOUTH CENTRAL STATE PLANE '83, COORDINATE SYSTEM. HORIZONTAL DATUM IS NAVD 1983. VERTICAL DATUM IS NAVD 1988.

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designed	checked
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1522B PERMIT AMENDMENT

LANDFILL CELL EXPANSION PLAN

project	contract
107608	-

drawing **C002** rev. **A**

sheet 4 of 23 sheets

file 107608C002.dwg

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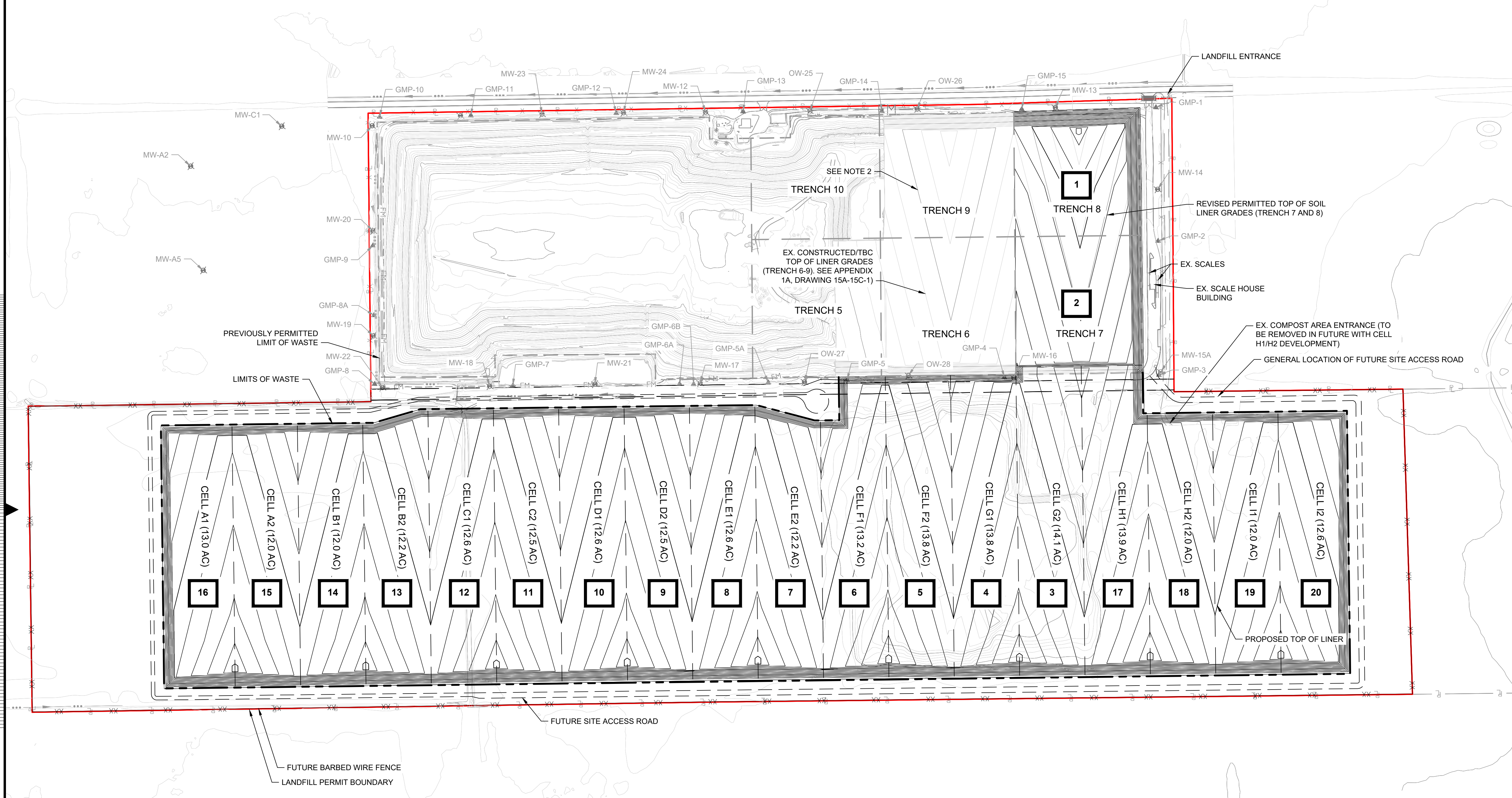

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. CELLS A1-I2 ARE SUITABLE FOR DISPOSAL OF BOTH MSW AND CLASS 1 WASTE. CLASS 1 WASTE SHALL BE DISPOSED BELOW THE EXTERIOR BERM ELEVATION (66.4' AMSL), AND COVERED BY A 4-FOOT CLAY RICH SOIL BARRIER. MSW WASTE MAY BE DISPOSED OF BELOW THE EXTERIOR BERM ELEVATION AND/OR ABOVE THE CLASS 1 WASTE CLAY BARRIER.
2. THE WESTERN HALF OF TRENCH 9 AND THE NORTHERN 250 FEET OF TRENCH 6 WEST IS CONSTRUCTED AND IN SERVICE AS OF MAY 2019.
3. DESIGN CONTOURS REPRESENT TOP OF SOIL LINER. CONTOUR INTERVAL IS 2-FEET. BACKGROUND CONTOURS REPRESENT EXISTING GROUND, EXCEPT WITHIN THE TRENCH 6-9 BOUNDARIES AND EASTERN PORTION OF TRENCH 5, WHERE CONTOURS REPRESENT THE PREVIOUSLY PERMITTED TOP OF SOIL LINER.

LEGEND

1 ORDER OF CELL CONSTRUCTION

PRELIMINARY - NOT FOR CONSTRUCTION

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1522B PERMIT AMENDMENT

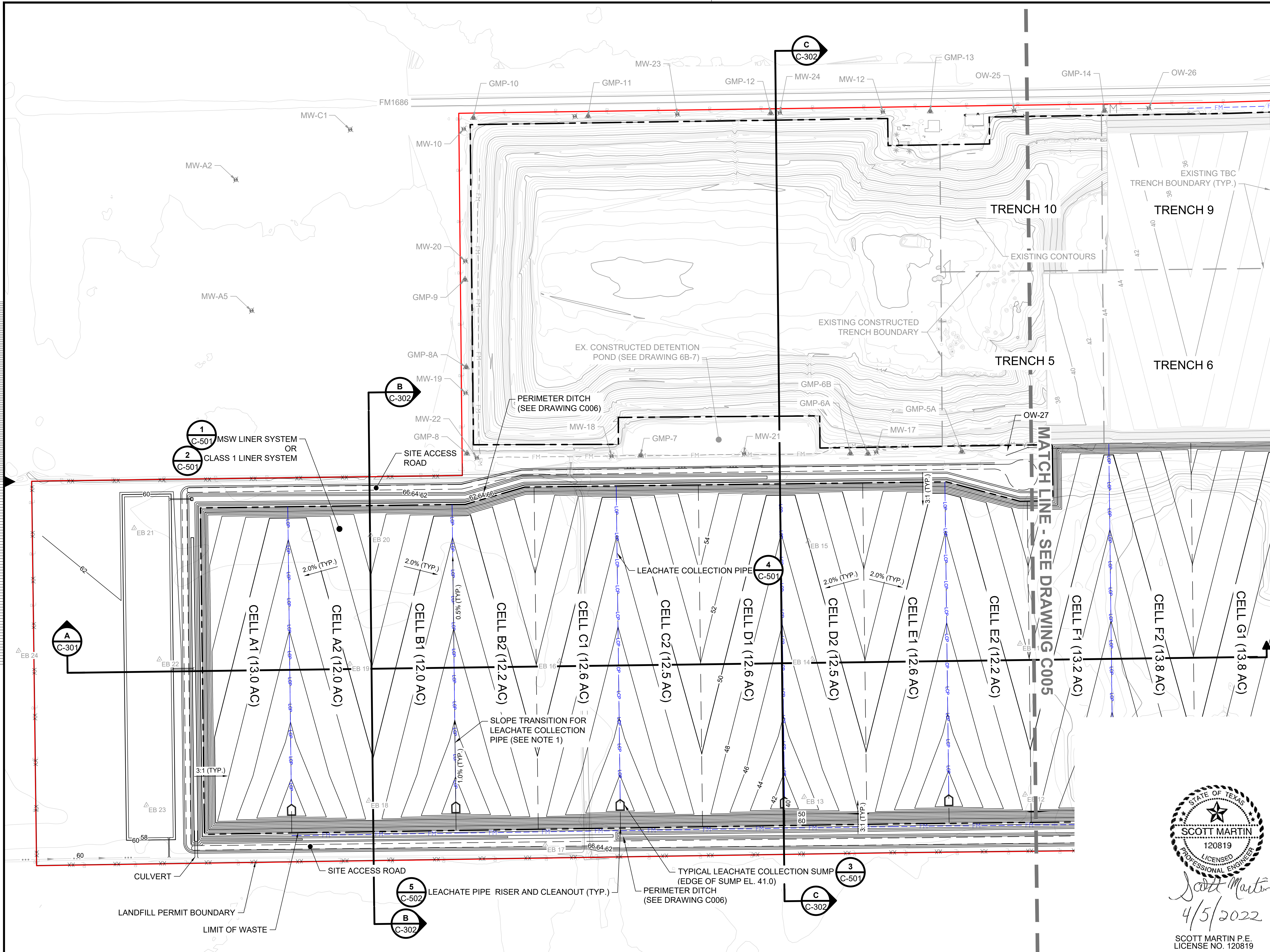
WASTE PLACEMENT PHASING PLAN

project	contract
107608	-

drawing C003 — rev. A

sheet 5 of 23 sheets

file 107608C003.dwg



no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. LINER GRADING THROUGH THE FLOWLINE TRANSITIONS FROM 0.5% TO 1.0% AT 250' FROM THE NORTH EDGE OF EACH SUMP. THE TRANSITION IS NECESSARY TO MAINTAIN 0.5% SLOPE THROUGHOUT THE LEACHATE COLLECTION PIPE AFTER LANDFILL SETTLEMENT.
2. DESIGN CONTOURS REPRESENT TOP OF SOIL LINER. CONTOUR INTERVAL IS 2-FEET. BACKGROUND CONTOURS REPRESENT EXISTING GROUND, EXCEPT WITHIN THE TRENCH 6-9 BOUNDARIES AND EASTERN PORTION OF TRENCH 5, WHERE CONTOURS REPRESENT THE PREVIOUSLY PERMITTED TOP OF SOIL LINER.

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Victoria County, Texas

1522B PERMIT AMENDMENT

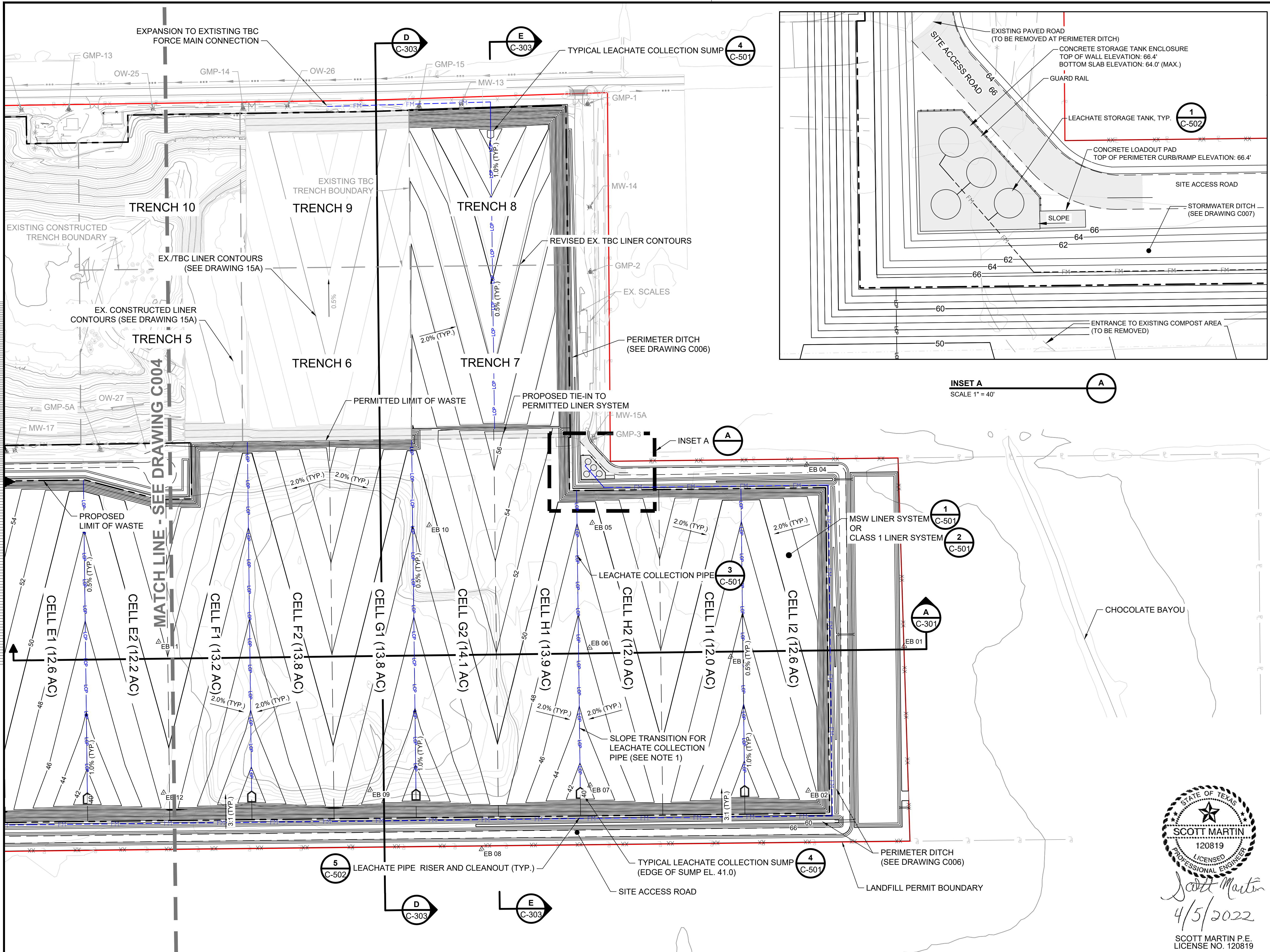
BASE GRADING PLAN - WEST

project	contract
107608	-

drawing C004 – rev. A

sheet 6 of 23 sheets

file 107608C004.dwg



no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. LINER GRADING THROUGH THE FLOWLINE TRANSITIONS FROM 0.5% TO 1.0% AT 200' FROM THE NORTH EDGE OF EACH SUMP. THE TRANSITION IS NECESSARY TO MAINTAIN 0.5% SLOPE THROUGHOUT THE LEACHATE COLLECTION PIPE AFTER LANDFILL SETTLEMENT.
2. DESIGN CONTOURS REPRESENT TOP OF SOIL LINER. CONTOUR INTERVAL IS 2-FEET. BACKGROUND CONTOURS REPRESENT EXISTING GROUND, EXCEPT WITHIN THE TRENCH 6-9 BOUNDARIES AND EASTERN PORTION OF TRENCH 5, WHERE CONTOURS REPRESENT THE PREVIOUSLY PERMITTED TOP OF SOIL LINER.

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FIRM REG. NO. F-845

date: MARCH 2022
detailed: T. CAMMACK
designed: T. SCHMIDT
checked: S. MARTIN

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Victoria County, Texas

STATE OF TEXAS
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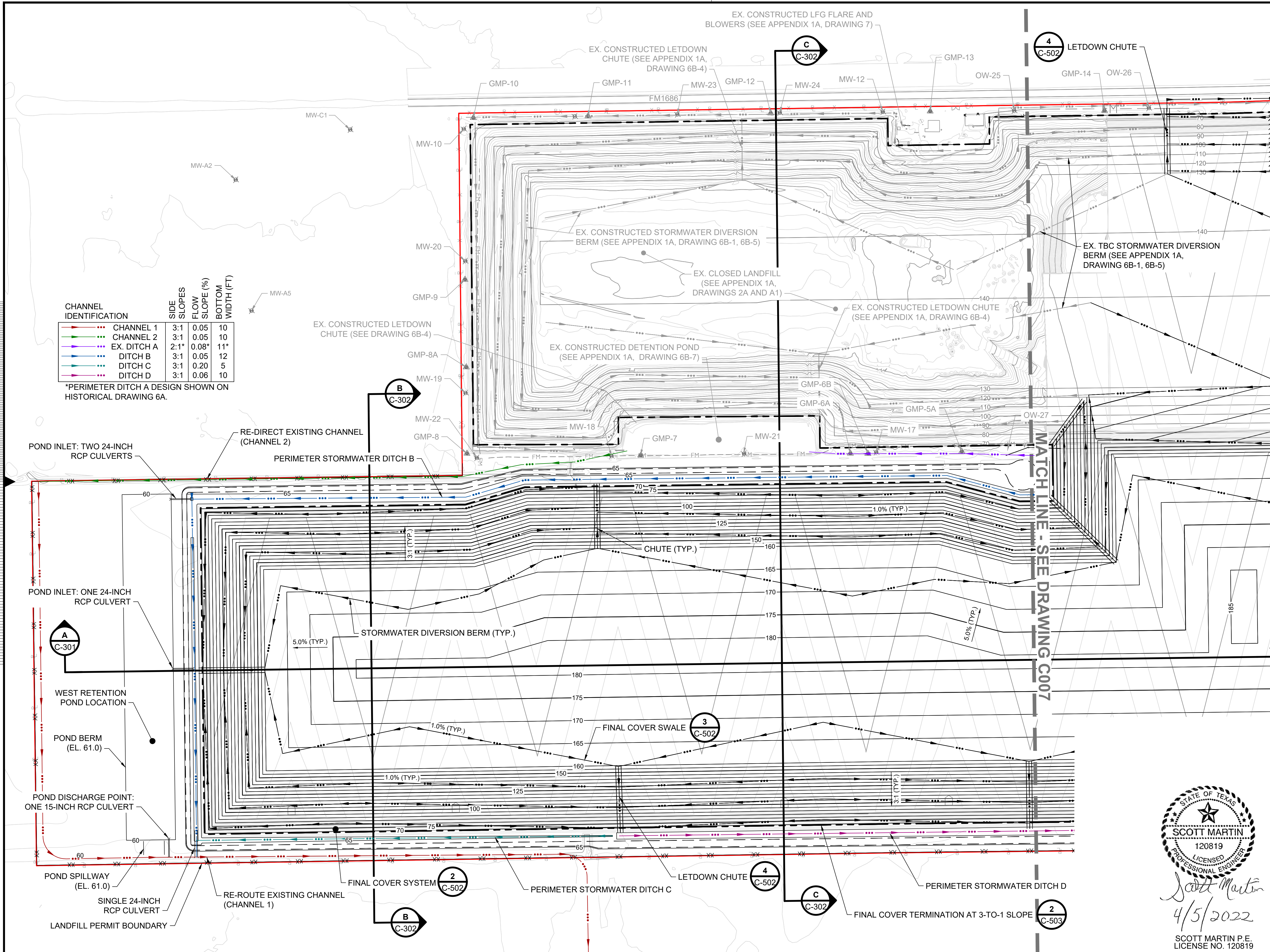
1522B PERMIT AMENDMENT

BASE GRADING PLAN - EAST

project: 107608
contract: -
drawing: C005 – rev. A
sheet 7 of 23 sheets
file 107608C005.dwg



CHANNEL IDENTIFICATION	SIDE SLOPES	FLOW SLOPE (%)	BOTTOM WIDTH (FT)
CHANNEL 1	3:1	0.05	10
CHANNEL 2	3:1	0.05	10
EX. DITCH A	2:1*	0.08*	11*
DITCH B	3:1	0.05	12
DITCH C	3:1	0.20	5
DITCH D	3:1	0.06	10

*PERIMETER DITCH A DESIGN SHOWN ON HISTORICAL DRAWING 6A.

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. DESIGN CONTOURS REPRESENT TOP OF FINAL COVER. DESIGN CONTOUR INTERVAL IS 5-FEET. BACKGROUND CONTOURS REPRESENT TOP OF SOIL LINER AND EXISTING GROUND (OUTSIDE OF TRENCHES 6-9, EASTERN PORTION OF TRENCH 5 AND CELLS A1-I2). BACKGROUND CONTOUR INTERVAL IS 2-FEET.

PRELIMINARY - NOT FOR CONSTRUCTION

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FIRM REG. NO. F-845

date: MARCH 2022
detailed: T. CAMMACK
designed: T. SCHMIDT
checked: S. MARTIN

STATE OF TEXAS
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4/5/2022
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LICENSE NO. 120819

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

1522B PERMIT AMENDMENT
FINAL GRADING PLAN - WEST

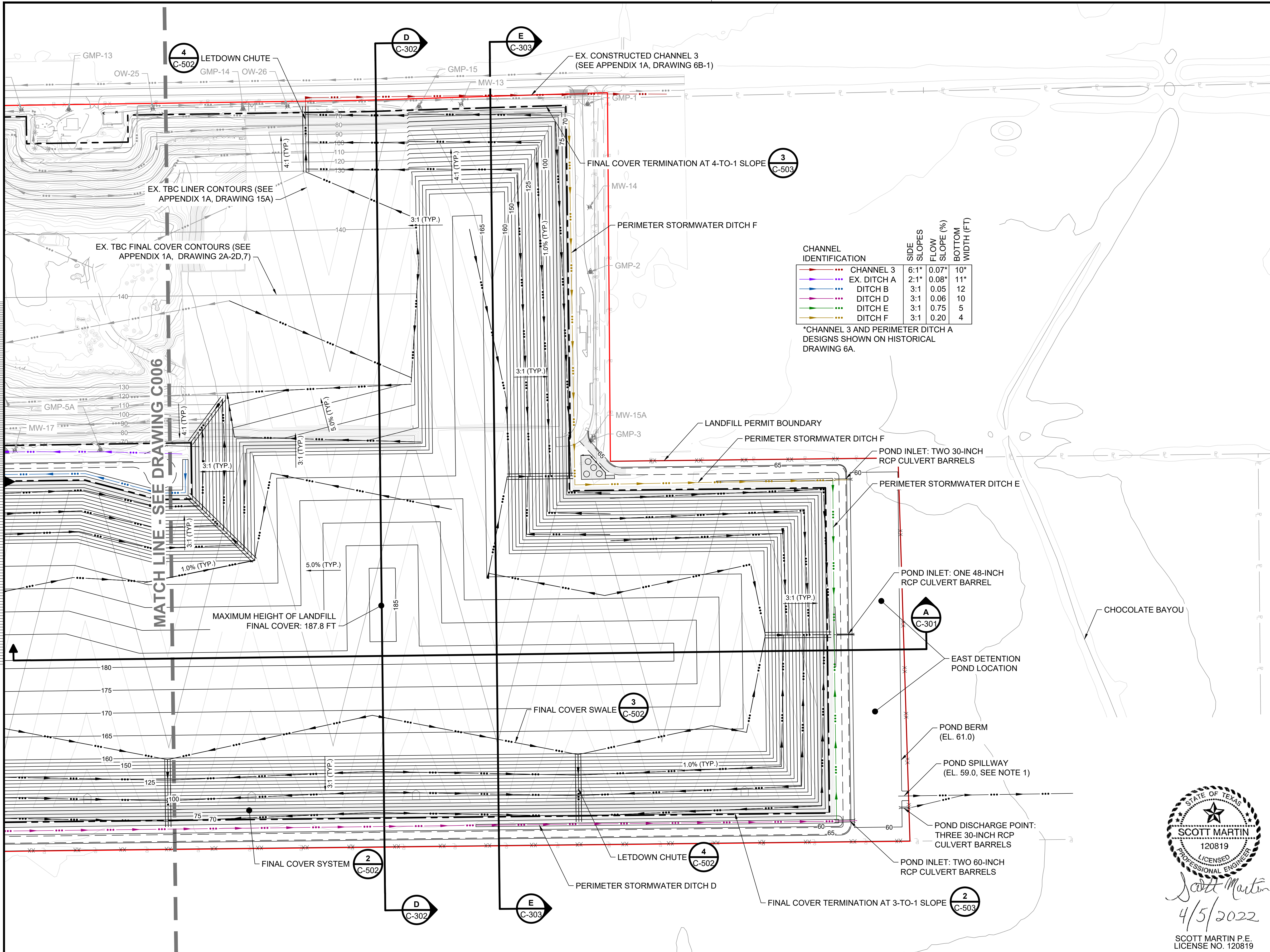
project: 107608
contract: -
drawing: C006 – rev. A
sheet 8 of 23 sheets
file 107608C006.dwg

Scale For Microfilming
Millimeters
Inches

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. THE EAST POND DISCHARGES INTO AN EXISTING DITCH NOT SHOWN IN THE EXISTING TOPOGRAPHY.
2. DESIGN CONTOURS REPRESENT TOP OF FINAL COVER. DESIGN CONTOUR INTERVAL IS 5-FEET. BACKGROUND CONTOURS REPRESENT TOP OF SOIL LINER AND EXISTING GROUND (OUTSIDE OF TRENCHES 6-9, EASTERN PORTION OF TRENCH 5 AND CELLS A1-I2). BACKGROUND CONTOUR INTERVAL IS 2-FEET.



CHANNEL IDENTIFICATION	SIDE SLOPES	FLOW SLOPE (%)	BOTTOM WIDTH (FT)
CHANNEL 3	6:1*	0.07*	10*
EX. DITCH A	2:1*	0.08*	11*
DITCH B	3:1	0.05	12
DITCH D	3:1	0.06	10
DITCH E	3:1	0.75	5
DITCH F	3:1	0.20	4

*CHANNEL 3 AND PERIMETER DITCH A DESIGNS SHOWN ON HISTORICAL DRAWING 6A.

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date	detailed
MARCH 2022	T. CAMMACK
designed	checked
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Victoria County, Texas

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Scott Martin
4/5/2022

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1522B PERMIT AMENDMENT

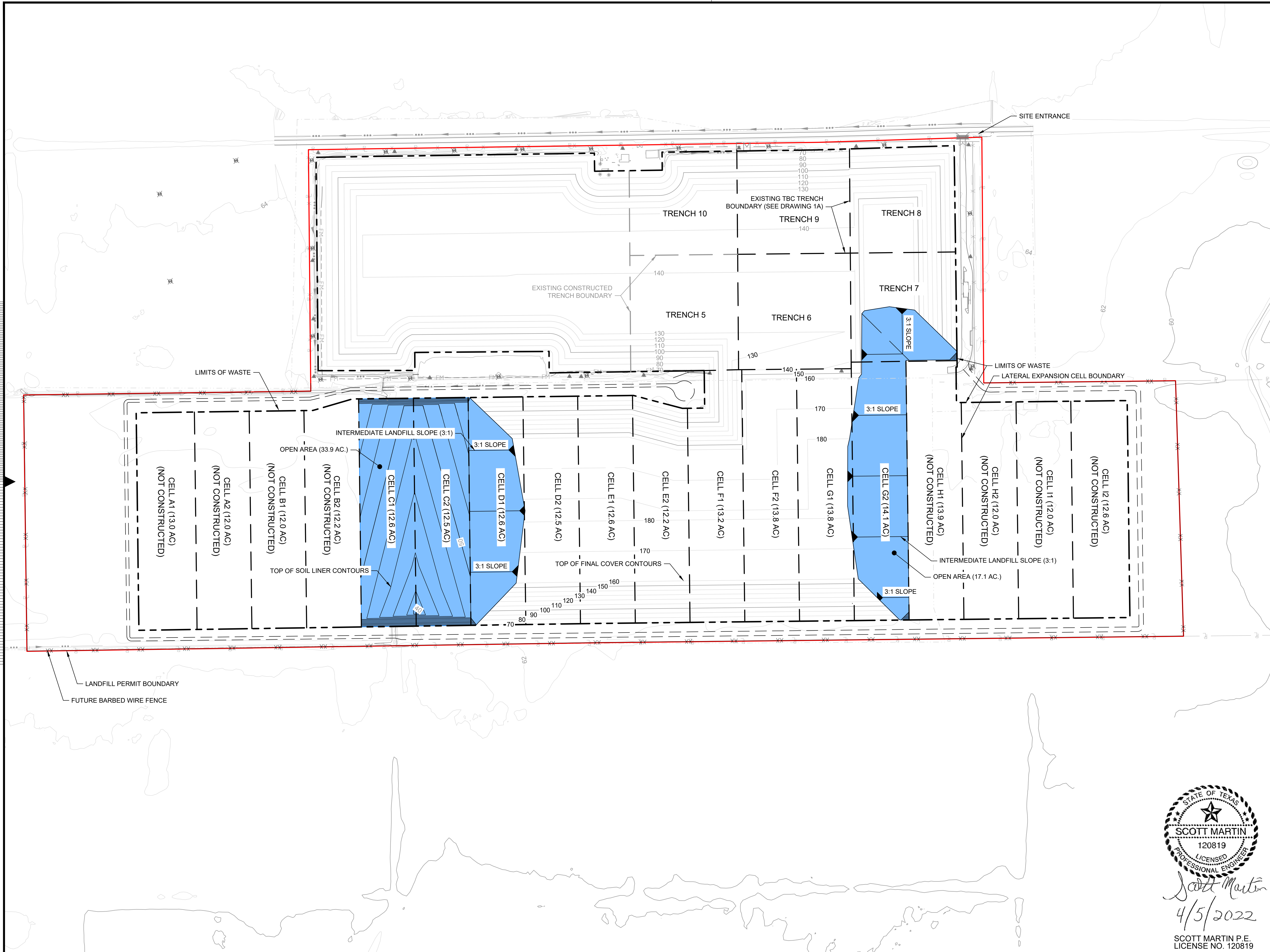
FINAL GRADING PLAN - EAST

project	contract
107608	-

drawing **C007** rev. **A**

sheet 9 of 23 sheets

file 107608C007.dwg



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6. CONDITIONS REPRESENT PHASE 12 (SEE C003).

NORTH

0 300' 600'
SCALE IN FEET

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date	detailed
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T. SCHMIDT	S. MARTIN

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Victoria County, Texas

1522B PERMIT AMENDMENT

LARGEST OPEN AREA

project	contract
107608	-

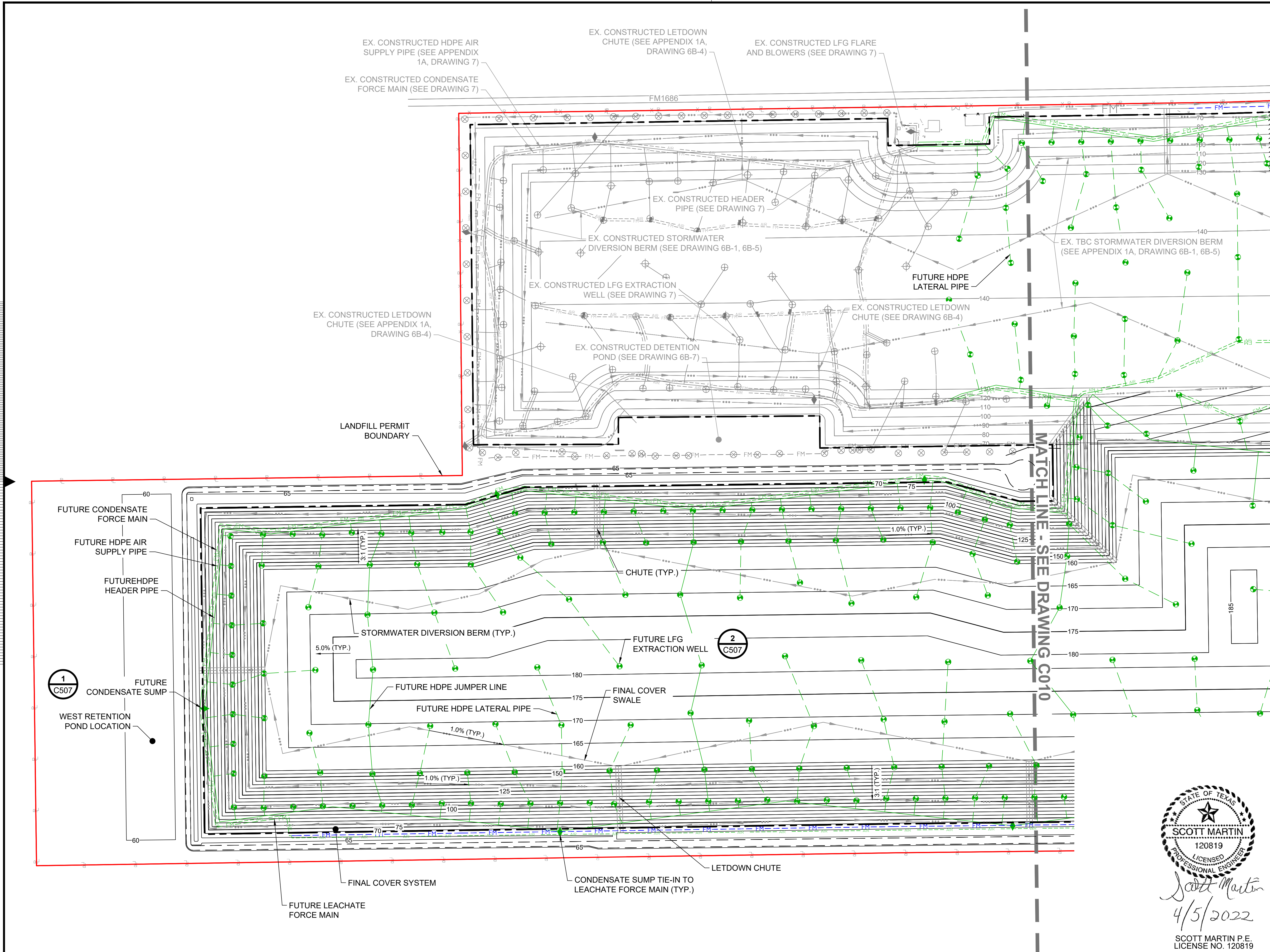
drawing C008 – rev. A

sheet 10 of 23 sheets
file 107608C008.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. FUTURE GCCS COLLECTION PIPING, AIR LINES, AND FORCE MAIN TIE IN TO EXISTING FLARE SYSTEM. EXPANSION OF FLARE AND BLOWER CAPACITY TO BE EVALUATED THROUGHOUT LANDFILL LIFE.



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MARCH 2022	T. CAMMACK
designed	checked
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Victoria County, Texas

1522B PERMIT AMENDMENT

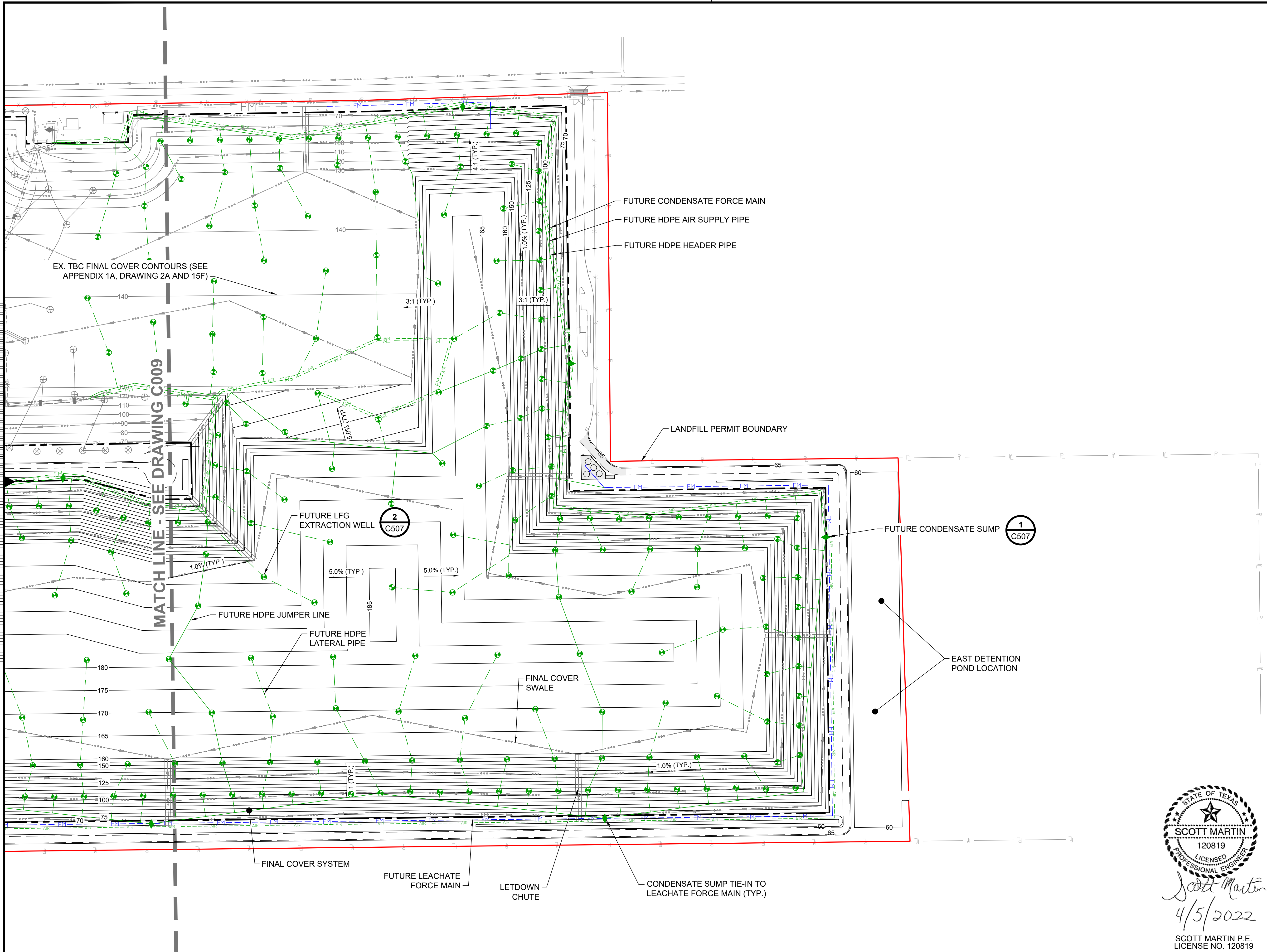
LFG COLLECTION SYSTEM PLAN - WEST

project	contract
107608	-

drawing **C009** rev. **A**

sheet 11 of 23 sheets

file 107608C009.dwg



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checked: S. MARTIN

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Victoria County, Texas

STATE OF TEXAS
SCOTT MARTIN
120819
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Scott Martin
4/5/2022
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LICENSE NO. 120819

1522B PERMIT AMENDMENT

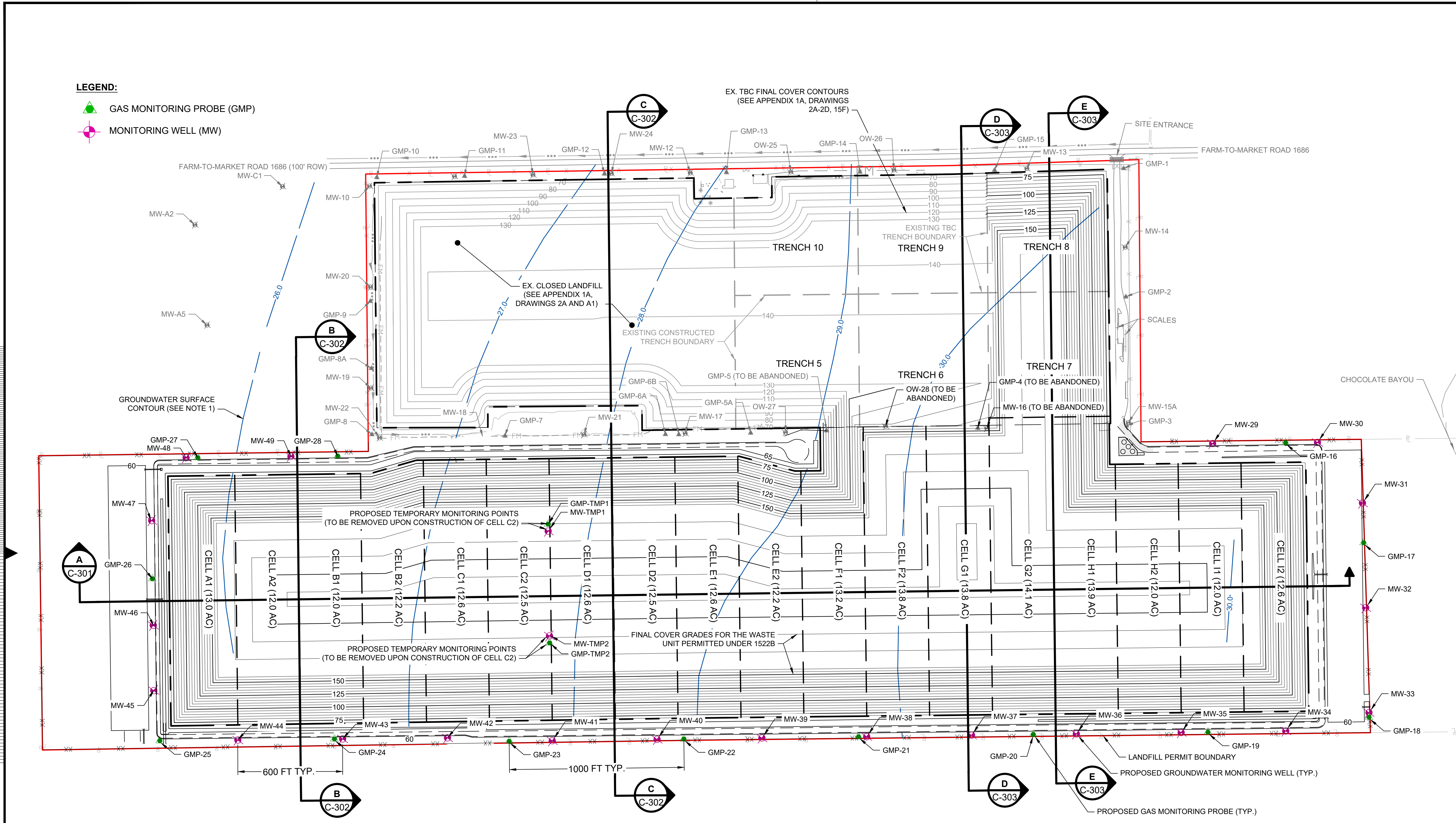
LFG COLLECTION SYSTEM PLAN - EAST

project: 107608
contract: -
drawing: **C010**
rev.: **A**
sheet 12 of 23 sheets
file 107608C010.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

NOTES:

1. GROUNDWATER CONTOUR LINES SHOWN WERE OBTAINED FROM THE SEPTEMBER 2021 GROUNDWATER ELEVATION MAP IN THE 2021 GEOLOGY REPORT, PREPARED BY BURNS & MCDONNELL ENGINEERING COMPANY INC.
2. PROPOSED POINT OF COMPLIANCE MONITORING WELLS FOR THE EXPANSION AREA INCLUDE MONITORING WELLS MW-17, MW-21, MW-37 THROUGH MW-41, MW-TMP-1, MW-TMP-2, AND OW-27 DURING OPERATION OF CELLS D1 THROUGH G2. UPON CONSTRUCTION OF CELLS A1 THROUGH C2, POINT OF COMPLIANCE MONITORING WELLS WILL ALSO INCLUDE MW-18, MW-22, AND MW-42 THROUGH MW-49. UPON CONSTRUCTION OF CELLS H1 THROUGH I2, MONITORING WELLS MW-15A, MW-29, MW-35, AND MW-36 WILL BE CONVERTED FROM UPGRADIENT MONITORING WELLS TO POINT OF COMPLIANCE MONITORING WELLS.
3. SAMPLE RESULTS FROM THE MARCH 2021 SEMIANNUAL MONITORING EVENT INDICATED ARSENIC EXCEEDED ITS GROUNDWATER PROTECTION STANDARD IN FOUR MONITORING WELLS (MW-18, MW-19, MW-20, AND MW-21). PREVIOUS FINDINGS INDICATE LANDFILL GAS, NOT A RELEASE OF LEACHATE, IS THE CAUSE OF ARSENIC CONCENTRATIONS REPORTED FOR THE CITY OF VICTORIA LANDFILL.



FOR PERMITTING PURPOSES ONLY

BURNS MCDONNELL

9400 WARD PARKWAY
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816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
MARCH 2022	T. CAMMACK
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

1522B PERMIT AMENDMENT

FINAL ENVIRONMENTAL MONITORING PLAN

project 107608 contract -
drawing C011 – rev. A
sheet 13 of 23 sheets
file 107608C011.dwg

INSTALLATION/ABANDONMENT TABLE		
WELL/PROBE ID	INSTALL DURING CONSTRUCTION OF	ABANDON DURING CONSTRUCTION OF
MW-16	EXISTING	CELL G2
GMP-4	EXISTING	CELL G2
OW-28	EXISTING	CELL F2
GMP-5	EXISTING	CELL F1
MW-29	CELL G2	N/A
MW-30	CELL G2	N/A
MW-31	CELL G2	N/A
MW-32	CELL G2	N/A
MW-33	CELL G2	N/A
MW-34	CELL G2	N/A
MW-35	CELL G2	N/A
MW-36	CELL G2	N/A
MW-37	CELL G2	N/A
MW-38	CELL G2	N/A

INSTALLATION/ABANDONMENT TABLE		
WELL/PROBE ID	INSTALL DURING CONSTRUCTION OF	ABANDON DURING CONSTRUCTION OF
MW-39	CELL G2	N/A
MW-40	CELL G2	N/A
MW-41	CELL G2	N/A
GMP-16	CELL G2	N/A
GMP-17	CELL G2	N/A
GMP-18	CELL G2	N/A
GMP-19	CELL G2	N/A
GMP-20	CELL G2	N/A
GMP-21	CELL G2	N/A
GMP-22	CELL G2	N/A
GMP-TMP1	CELL G2	CELL D1
GMP-TMP2	CELL G2	CELL D1
MW-TMP1	CELL G2	CELL D1
MW-TMP2	CELL G2	CELL D1

INSTALLATION/ABANDONMENT TABLE		
WELL/PROBE ID	INSTALL DURING CONSTRUCTION OF	ABANDON DURING CONSTRUCTION OF
MW-42	CELL D1	N/A
MW-43	CELL D1	N/A
MW-44	CELL D1	N/A
MW-45	CELL D1	N/A
MW-46	CELL D1	N/A
MW-47	CELL D1	N/A
MW-48	CELL D1	N/A
MW-49	CELL D1	N/A
GMP-23	CELL D1	N/A
GMP-24	CELL D1	N/A
GMP-25	CELL D1	N/A
GMP-26	CELL D1	N/A
GMP-27	CELL D1	N/A
GMP-28	CELL D1	N/A

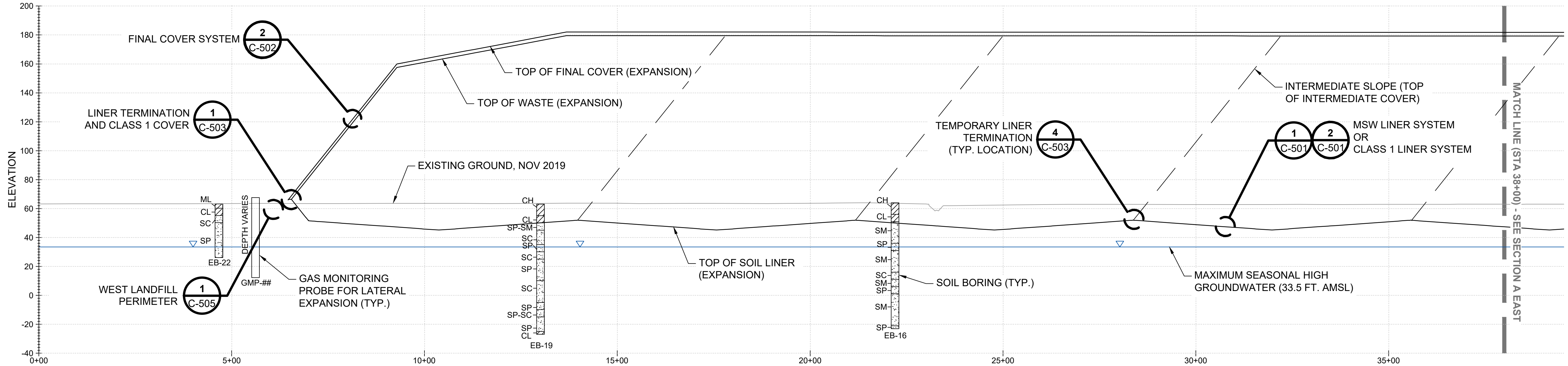
STATE OF TEXAS
DAVID SCOTT BARKER
GEOLOGY
12931
LICENSED
PROFESSIONAL GEOSCIENTIST
04/04/2022

DAVID BARKER, P.G.
LICENSE NO. 12931

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

SCOTT MARTIN P.E.
LICENSE NO. 120819



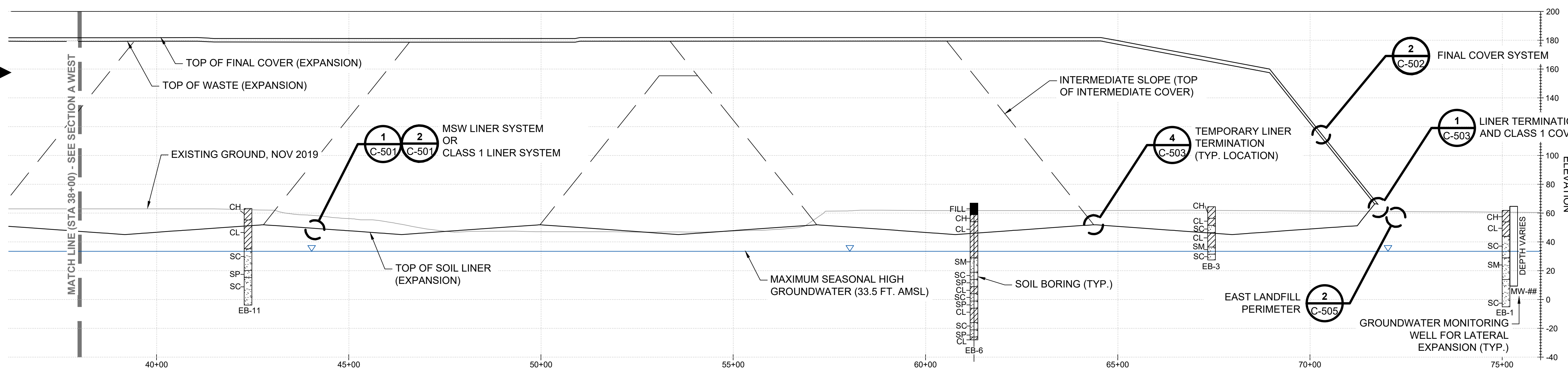
SECTION (WEST)

A C004

C005, C006, C007, C011

HORIZONTAL SCALE IN FEET 0 150' 300'

VERTICAL SCALE IN FEET 0 20' 40' 80'



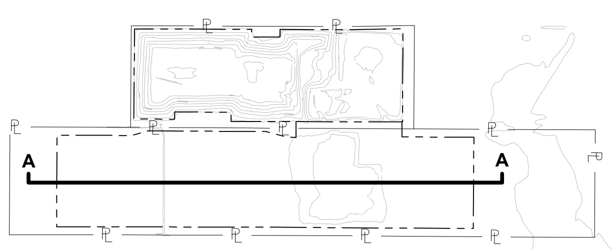
SECTION (EAST)

A C004

C005, C006, C007, C011

HORIZONTAL SCALE IN FEET 0 150' 300'

VERTICAL SCALE IN FEET 0 20' 40' 80'



KEY MAP
(SCALE 1" = 1500')

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

SCOTT MARTIN P.E.
LICENSE NO. 120819

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

PRELIMINARY - NOT FOR CONSTRUCTION

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9400 WARD PARKWAY
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date	detailed
MARCH 2022	T. CAMMACK
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

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CROSS SECTIONS - 1

project 107608 | contract -

drawing C-301 – rev. A

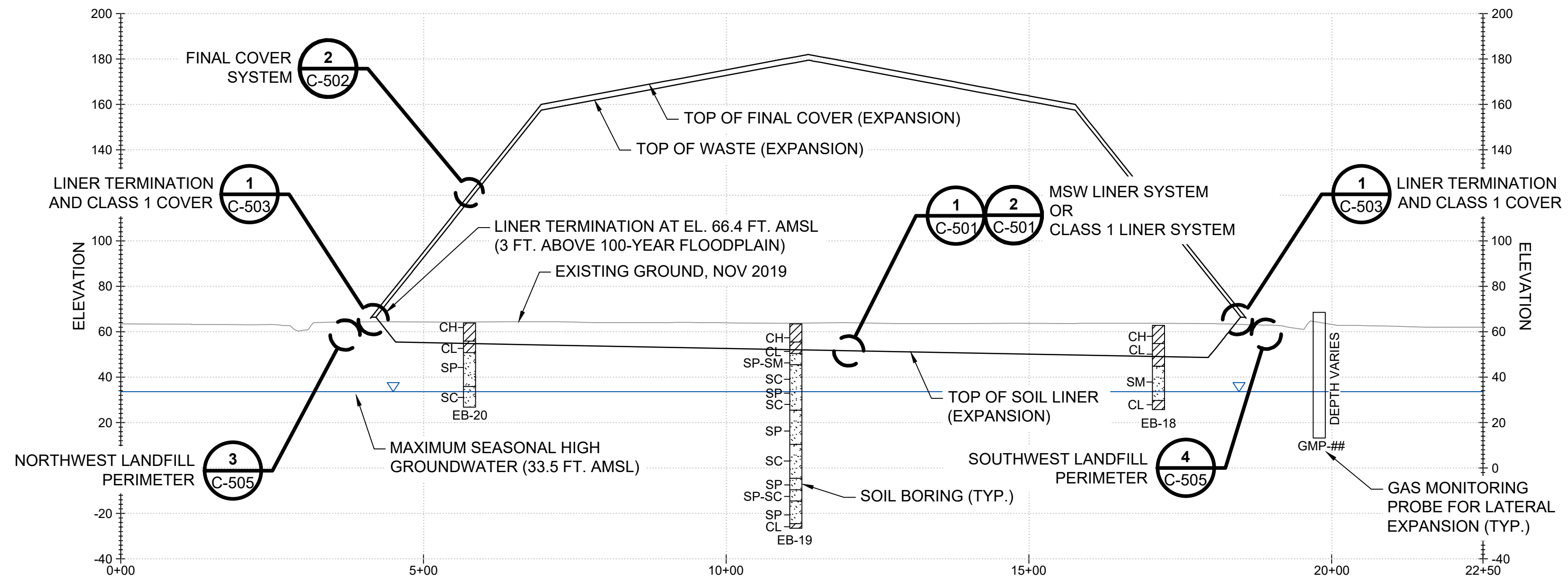
sheet 14 of 23 sheets

file 107608C301.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

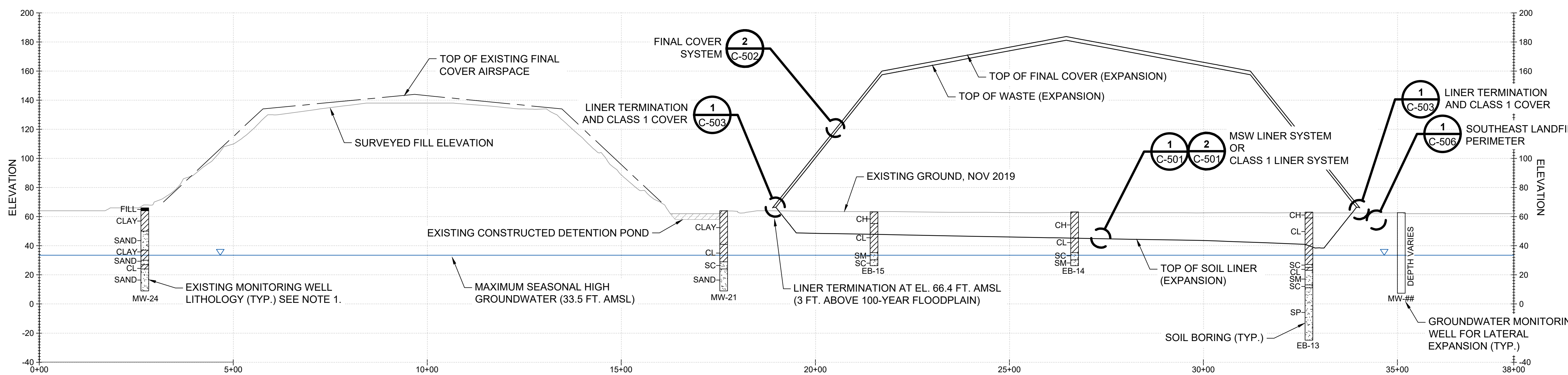
NOTES:

1. MW-21 AND MW-24 LITHOLOGY OBTAINED FROM STATE OF TEXAS WELL REPORTS.



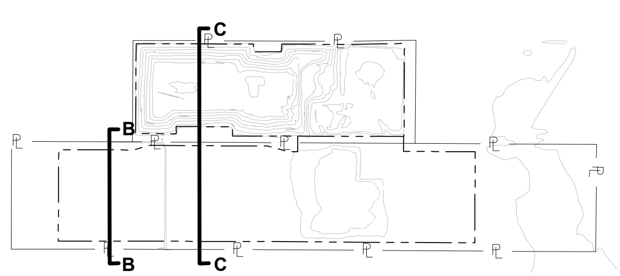
SECTION B C004 C006

HORIZONTAL SCALE IN FEET 0 150' 300' — VERTICAL SCALE IN FEET 0 20' 40' 80'



SECTION C C004 C006

HORIZONTAL SCALE IN FEET 0 150' 300' — VERTICAL SCALE IN FEET 0 20' 40' 80'



KEY MAP
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Victoria County, Texas

1522B PERMIT AMENDMENT

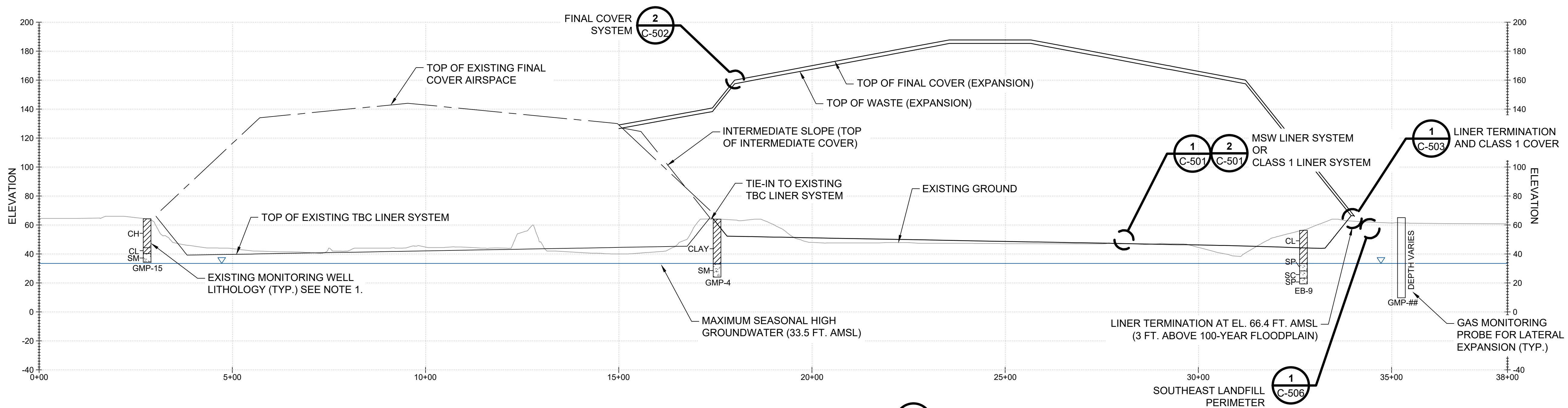
CROSS SECTIONS - 2

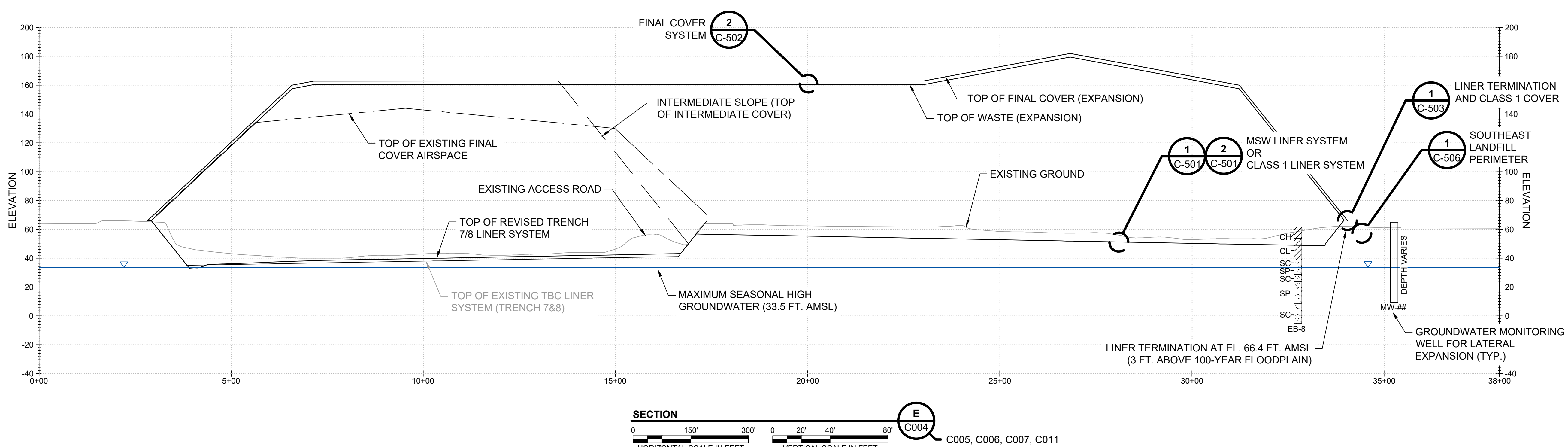
project	contract
107608	-

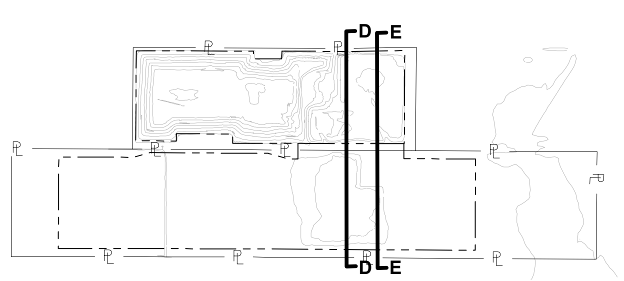
drawing **C-302** rev. **A**

sheet 15 of 23 sheets

file 107608C302.dwg







KEY MAP
(SCALE 1" = 1500')

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED PROFESSIONAL ENGINEER
Scott Martin
4/5/2022
SCOTT MARTIN P.E.
LICENSE NO. 120819

no.	date	by	ckd	description
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NOTES:

1. GMP-4 AND GMP-15 LITHOLOGY OBTAINED FROM BORING LOGS PREPARED BY MORRIS-KNUDSEN.

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date: MARCH 2022
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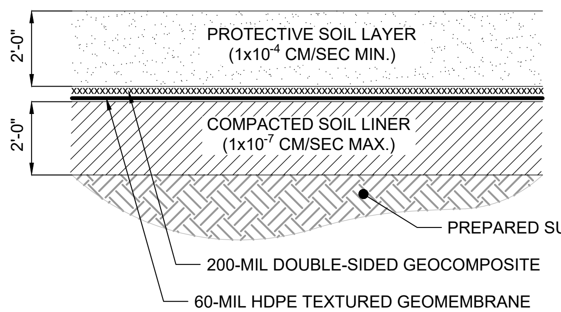
designed: T. SCHMIDT
checked: S. MARTIN

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

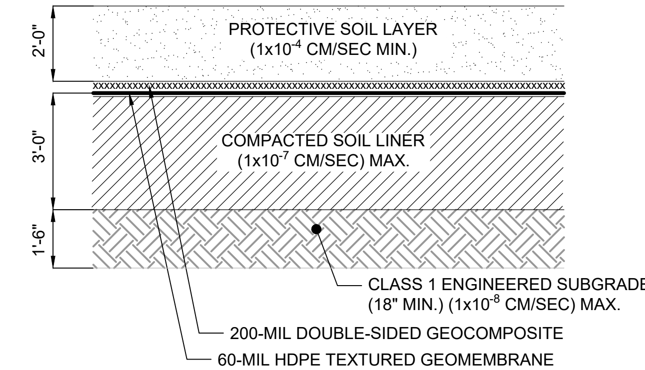
1522B PERMIT AMENDMENT

CROSS SECTIONS - 3

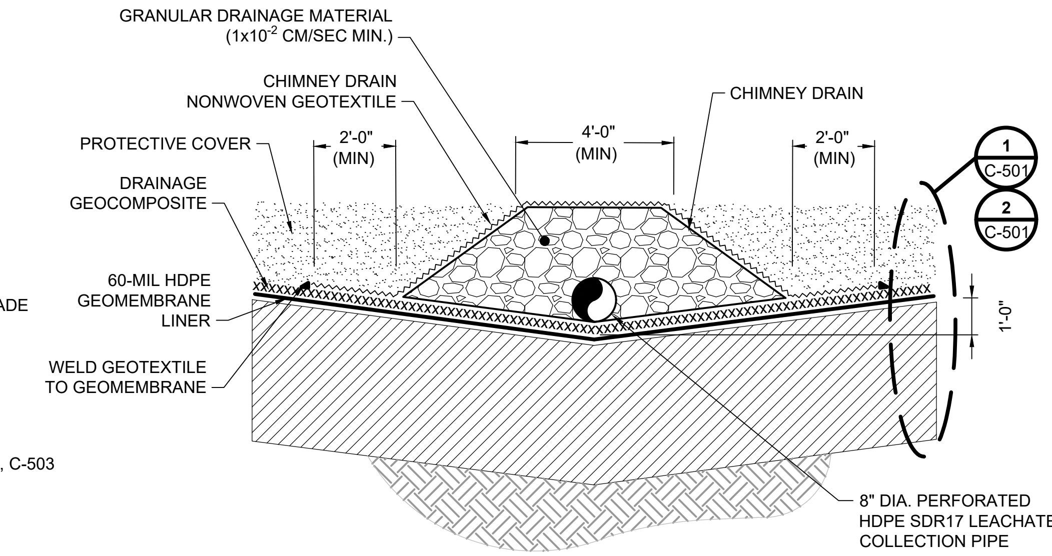
project: 107608
contract: -
drawing: C-303
rev.: A
sheet 16 of 23 sheets
file 107608C303.dwg



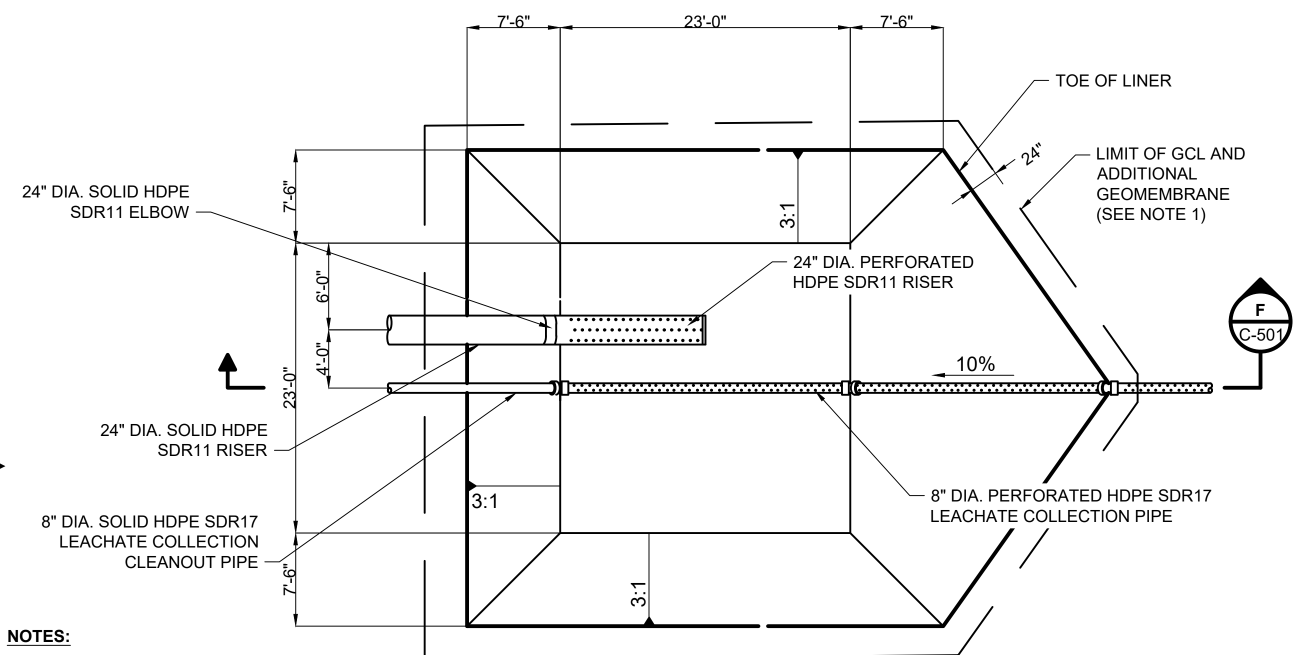
MSW LINER SYSTEM 1 / C004
NOT TO SCALE
C005, C-501, C-503



CLASS 1 LINER SYSTEM 2 / C004
NOT TO SCALE
C005, C-501, C-503



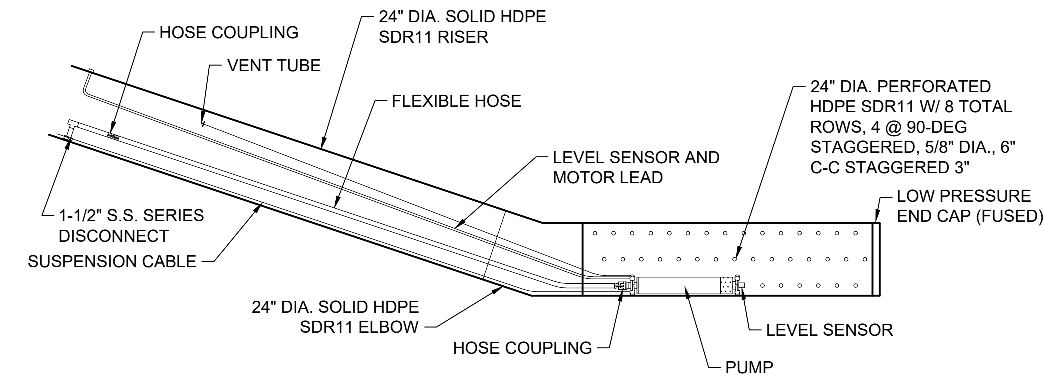
LEACHATE COLLECTION PIPE 3 / C004
NOT TO SCALE
C005



NOTES:

1. GCL SHALL HAVE 6 NEEDLE-PUNCHED NON-WOVEN GEOTEXTILE FABRIC ON BOTH SIDES OR ENGINEER APPROVED EQUIVALENT.

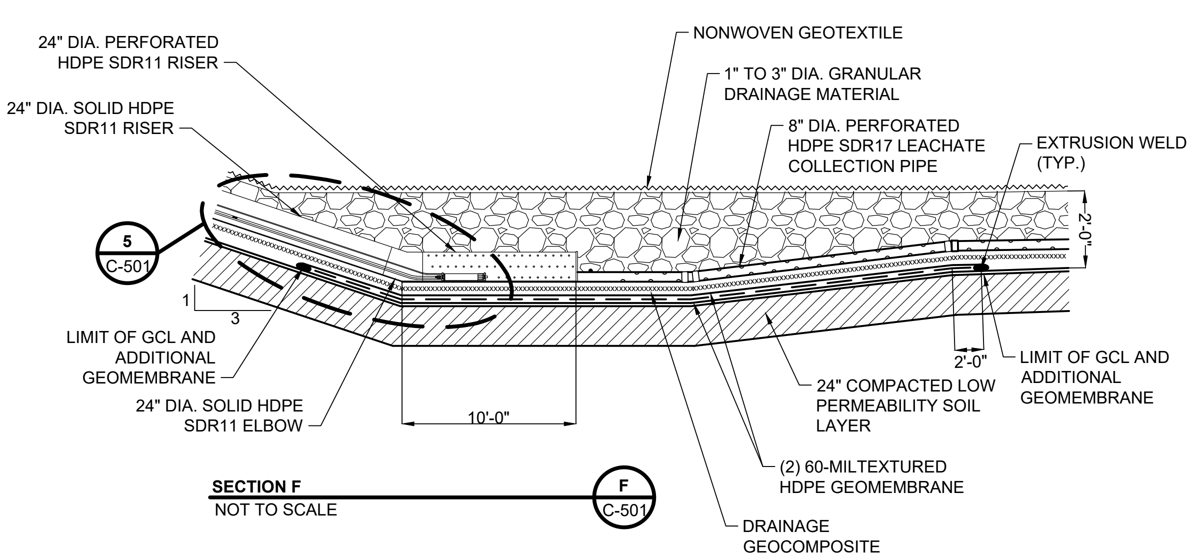
TYPICAL LEACHATE COLLECTION SUMP 4 / C004
NOT TO SCALE
C005, C-302



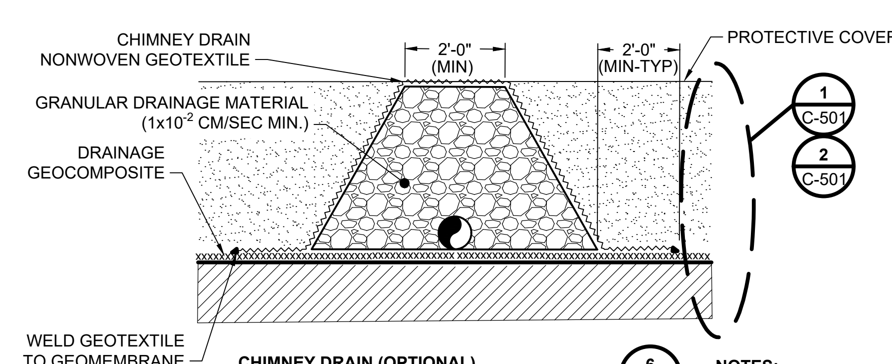
SUMP PUMP SCHEMATIC 5 / C-501
NOT TO SCALE

ELEVATION TABLE: SOUTHERN EXPANSION AREA (CELLS A1 THROUGH I2)				
WASTE TYPE	EXCAVATION GRADE	TOP OF ENGINEERED SUBGRADE (CLASS 1 ONLY)	TOP OF COMPACTED SOIL LINER	TOP OF PROTECTIVE COVER/BASE OF WASTE PLACEMENT
MSW ONLY	36.5 FT AMSL	N/A	38.5 FT AMSL	43 FT AMSL
CLASS 1	34 FT AMSL	35.5 FT AMSL	38.5 FT AMSL	43 FT AMSL

ELEVATION TABLE: TRENCH 7/8			
WASTE TYPE	EXCAVATION GRADE	TOP OF COMPACTED SOIL LINER	TOP OF PROTECTIVE COVER/BASE OF WASTE PLACEMENT
MSW ONLY	31.1 FT AMSL	33.1 FT AMSL	37.6 FT AMSL



SECTION F F / C-501
NOT TO SCALE



CHIMNEY DRAIN (OPTIONAL) 6 / C-501
NOT TO SCALE

NOTES:

1. NOTE: CHIMNEY DRAINS SHALL BE PLACED AT 200-FT INTERVALS.

STATE OF TEXAS
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Scott Martin
4/5/2022

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NOTE:

1. CHIMNEY DRAINS (AREAS OF HIGHER HYDRAULIC CONDUCTIVITY) WILL BE EMPLOYED AT A MAXIMUM SPACING OF EVERY 200-FT IF PROTECTIVE COVER PERMEABILITY IS LESS THAN 1x10^{-4} CM/SEC (SEE DETAIL 6).

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detailed: T. CAMMACK
designed: T. SCHMIDT
checked: S. MARTIN

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

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DETAIL SHEET 1

project: 107608
contract: -
drawing: C-501 – rev. A
sheet 17 of 23 sheets
file 107608C501.dwg

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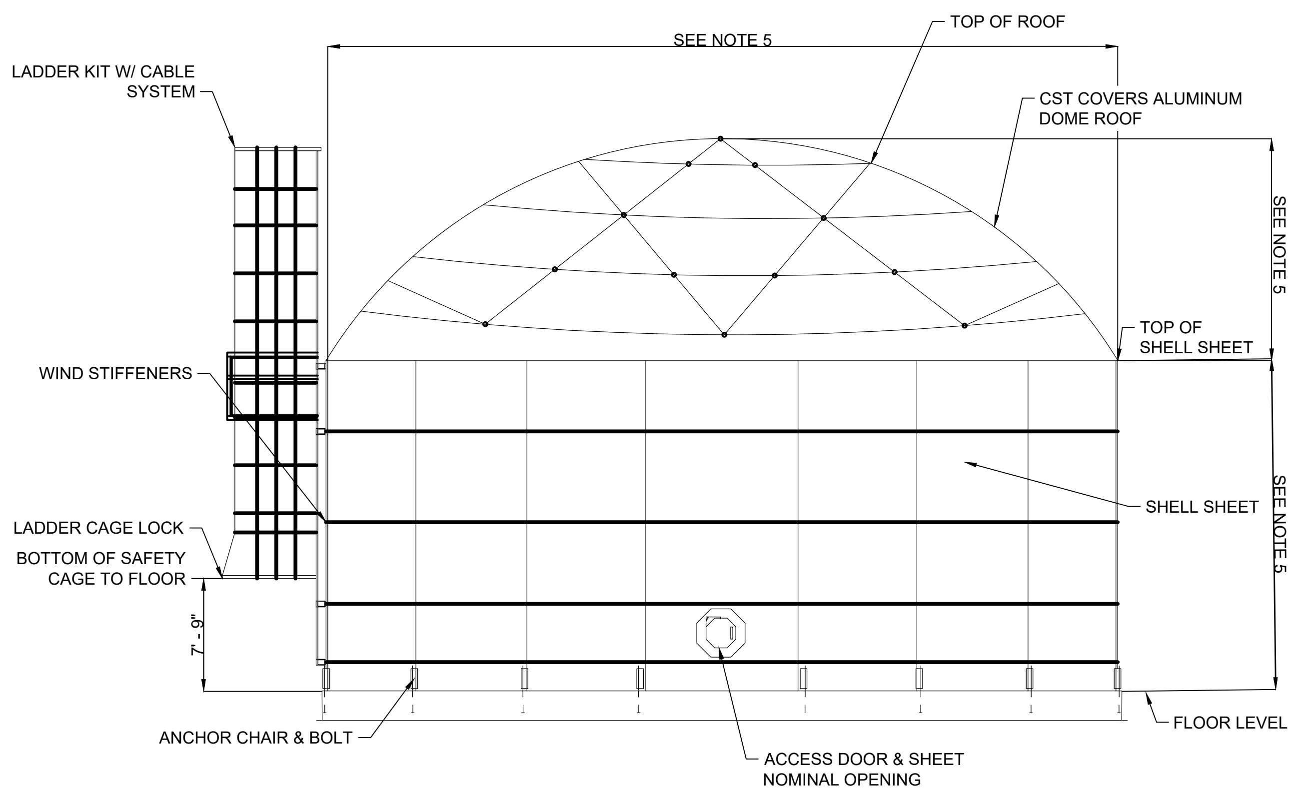
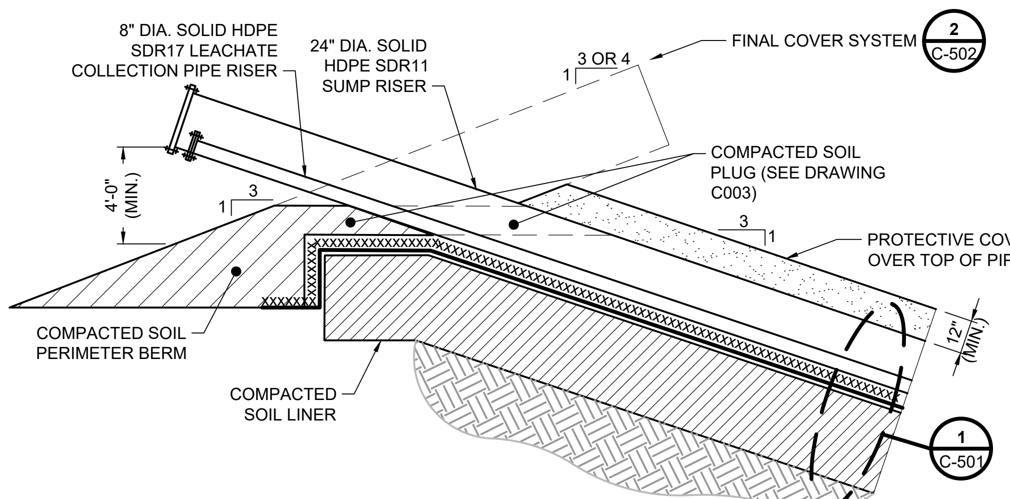


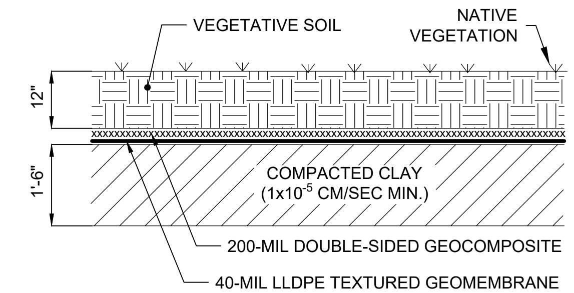
LEACHATE STORAGE TANK 1 / C005
NOT TO SCALE

NOTES:

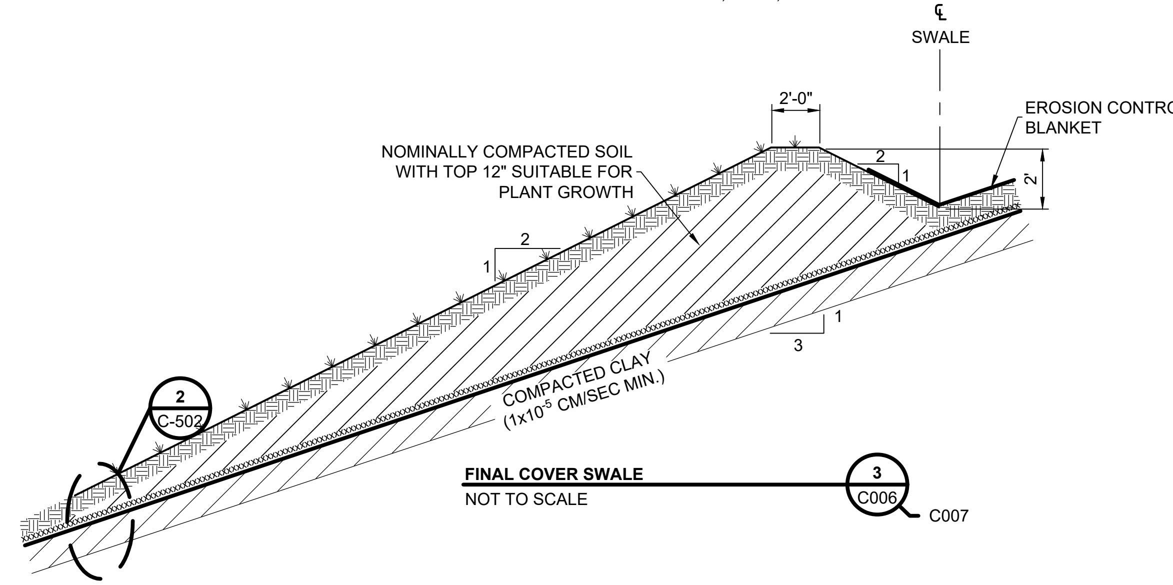
1. PANEL INTERIOR COATING IS WHITE GLASS 97 FUSED GLASS WITH EDGECOAT PROCESS.
2. PANEL EXTERIOR COATING IS FUSED GLASS.
3. FINAL DESIGN DIMENSIONS TO BE PROVIDED TO TCEQ AT DESIGN STAGES.
4. TANKS SHALL BE CAPABLE OF HOLDING 64,000 GALLONS OF LEACHATE.
5. TANK DIMENSIONS SHALL MATCH EXISTING CONSTRUCTED TANK DIMENSIONS, AS SHOWN IN DRAWING 15G-1B (OR EQUIVALENT).
6. THE SECONDARY CONTAINMENT FACILITIES ASSOCIATED WITH THE LEACHATE STORAGE TANKS THAT WILL BE INSTALLED WILL BE DESIGNED TO PREVENT RUN-ON FROM THE 100-YEAR, 24-HOUR STORM EVENT.
7. LEACHATE STORAGE TANK SECONDARY CONTAINMENT WILL BE MAINTAINED AND OPERATED TO MANAGE STORMWATER FROM THE 25-YEAR, 24-HOUR STORM EVENT.



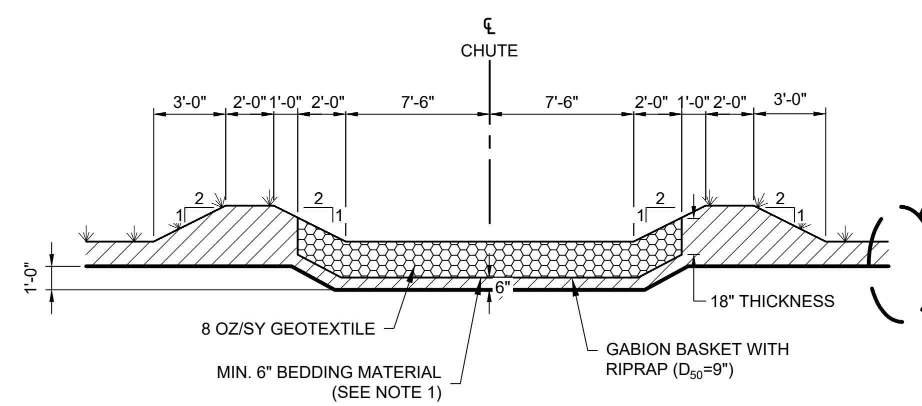
LEACHATE PIPE RISER AND CLEANOUT 5 / C004 C005
NOT TO SCALE



FINAL COVER SYSTEM 2 / C006 C007, C-502, C-503
NOT TO SCALE



FINAL COVER SWALE 3 / C006 C007
NOT TO SCALE



LETDOWN CHUTE 4 / C006 C007

NOTES:

1. BEDDING MATERIAL WILL CONSIST OF CLAYEY SOILS OVERLAIN BY 8 OZ/SY GEOTEXTILE PRIOR TO PLACEMENT OF GABIONS.
2. CHANNEL ARMORING SHALL BE INCISED INTO FINAL COVER. TOP OF ARMORING SHALL MATCH FINAL GRADE ELEVATION AT ALL TERMINATION EDGES. EROSION CONTROL BLANKET IN TERRACE SHALL OVERLAP A MINIMUM OF 1 FOOT AT CONFLUENCE OF TERRACE AND ARMORING.
3. LINER ELEVATIONS SHALL BE LOWERED AS SHOWN TO ACCOUNT FOR 18" GABION BASKET AND BEDDING MATERIAL.
4. GABION KEYWAYS SHALL BE INSTALLED ALONG THE WIDTH OF THE CHUTE AT EVERY TERRACE INTERSECTION. DIMENSIONS SHALL BE 3' THICK X 3' DEEP. FINAL COVER GEOMEMBRANE ELEVATIONS SHALL BE LOWERED IN THESE LOCATIONS TO ACCOUNT FOR ADDITIONAL GABION DEPTH.

STATE OF TEXAS
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120819
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MARCH 2022	T. CAMMACK
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

1522B PERMIT AMENDMENT

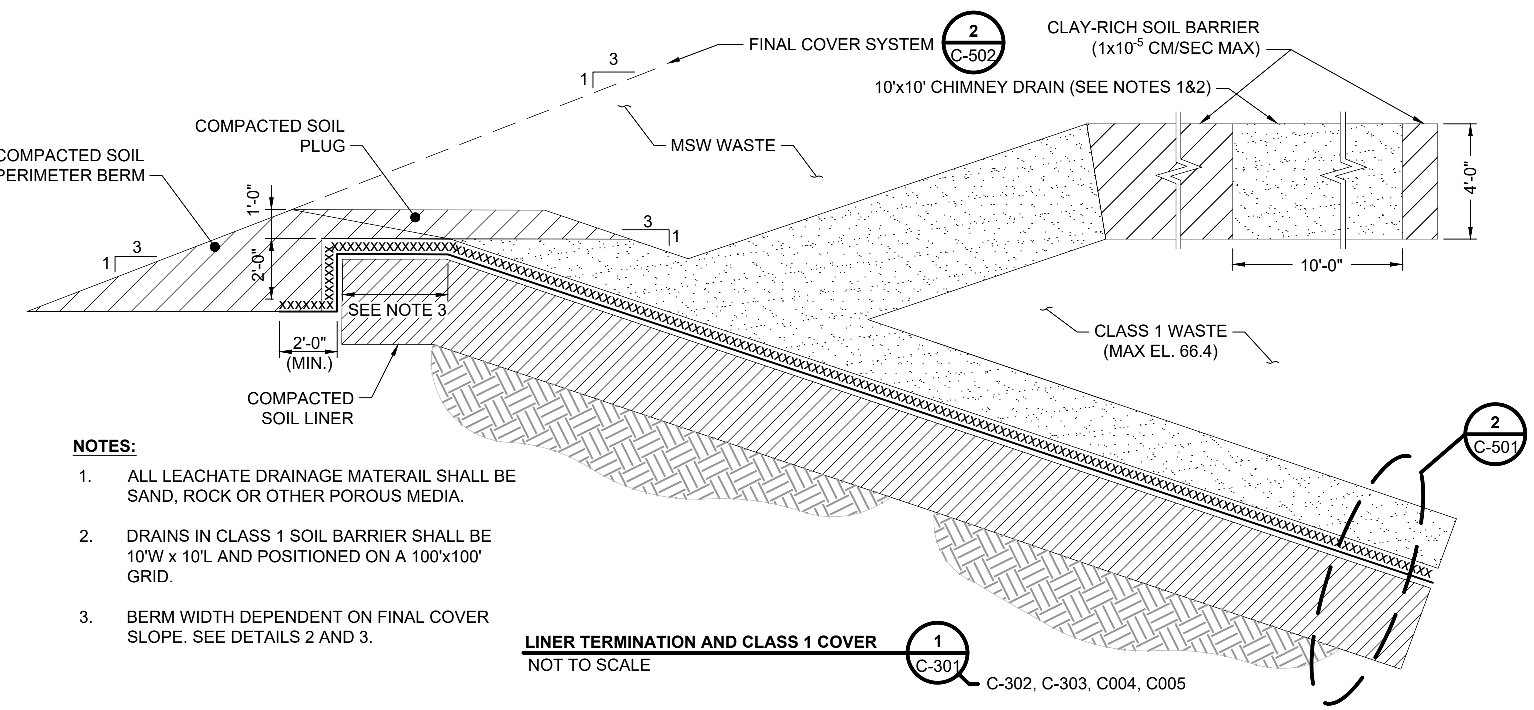
DETAIL SHEET 2

project	contract
107608	-

drawing C-502 rev. A

sheet 18 of 23 sheets

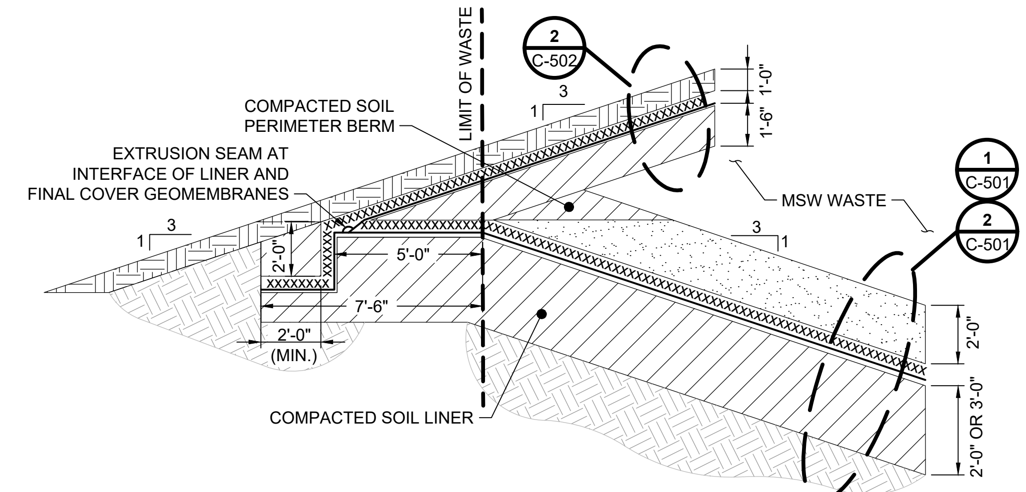
file 107608C502.dwg



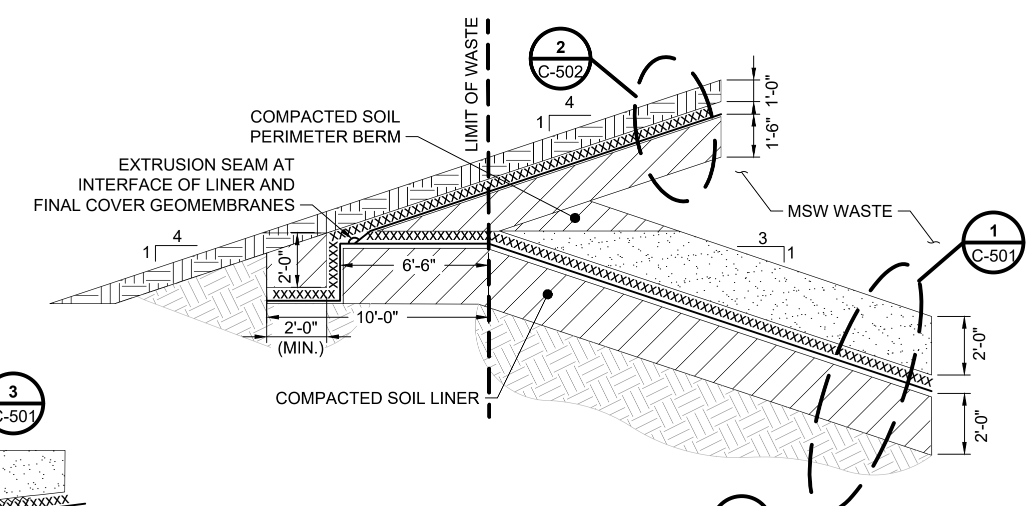
NOTES:

1. ALL LEACHATE DRAINAGE MATERAIL SHALL BE SAND, ROCK OR OTHER POROUS MEDIA.
2. DRAINS IN CLASS 1 SOIL BARRIER SHALL BE 10'W x 10'L AND POSITIONED ON A 100'x100' GRID.
3. BERM WIDTH DEPENDENT ON FINAL COVER SLOPE. SEE DETAILS 2 AND 3.

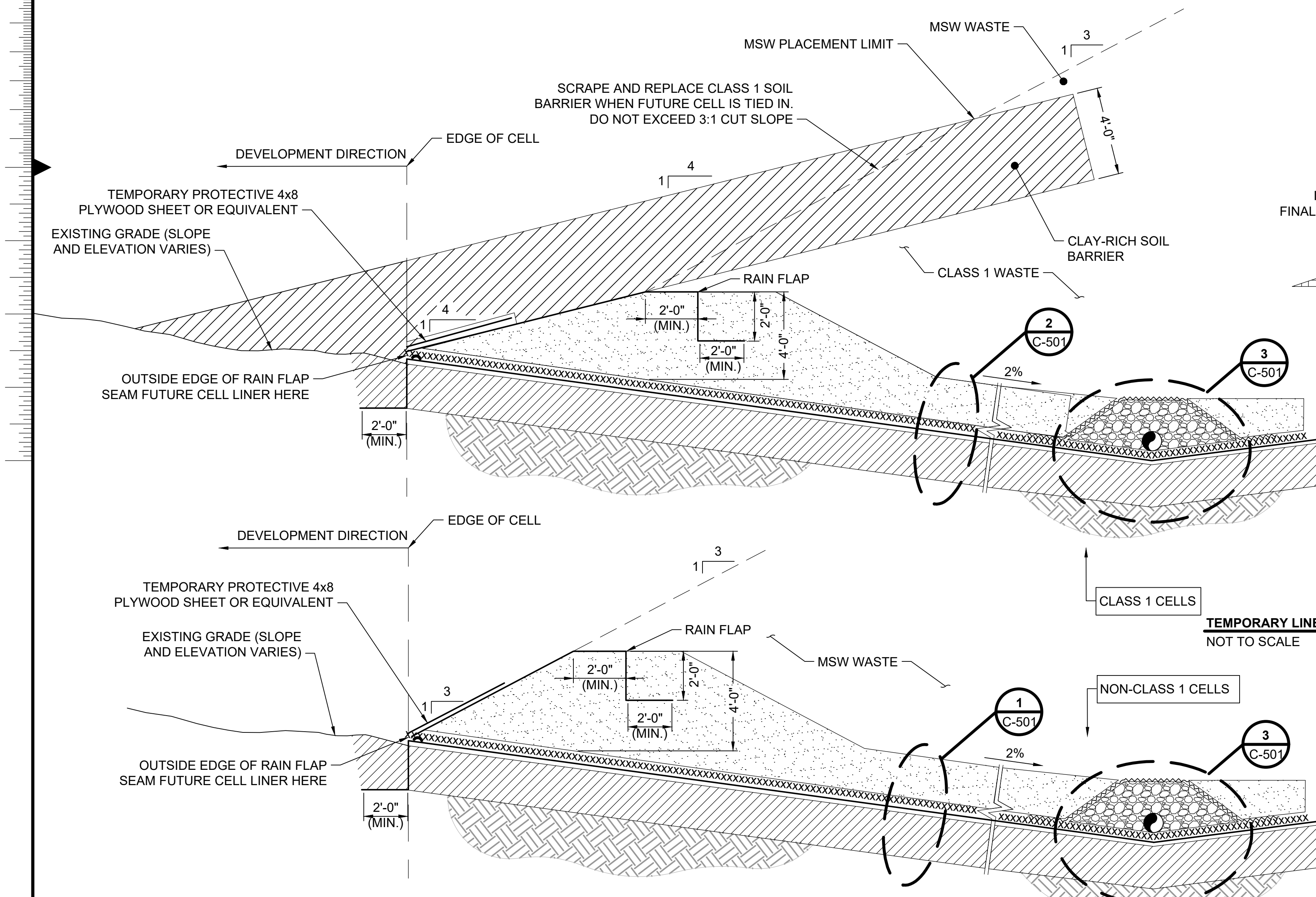
LINER TERMINATION AND CLASS 1 COVER 1 C-301
NOT TO SCALE
C-302, C-303, C004, C005



FINAL COVER TERMINATION AT 3-TO-1 SLOPE 2 C-301
NOT TO SCALE
C-302, C-303, C004, C005



FINAL COVER TERMINATION AT 4-TO-1 SLOPE 3 C-301
NOT TO SCALE
C-302, C-303, C004, C005



TEMPORARY LINER TERMINATION 4 C-301
NOT TO SCALE
C-302, C-303

STATE OF TEXAS
SCOTT MARTIN
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THE CITY OF VICTORIA TEXAS
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1522B PERMIT AMENDMENT

DETAIL SHEET 3

project 107608 | contract -

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sheet 19 of 23 sheets

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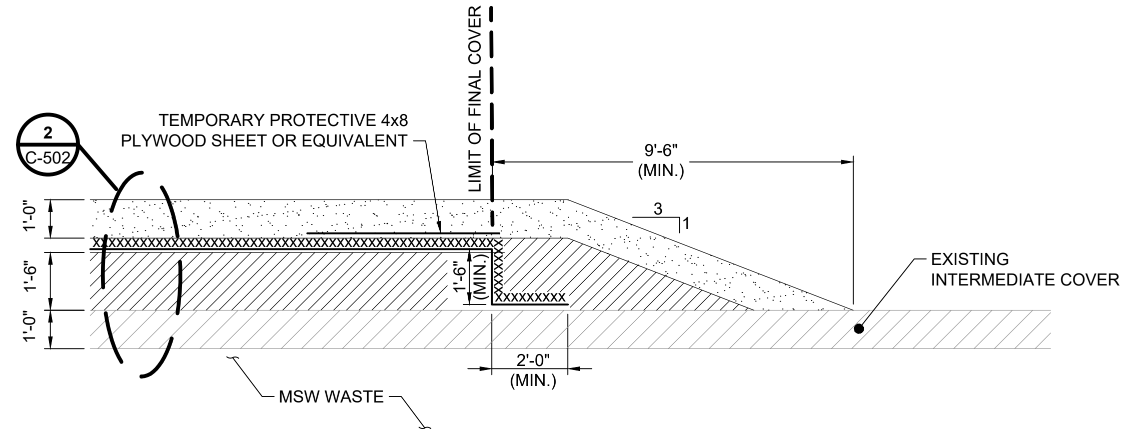
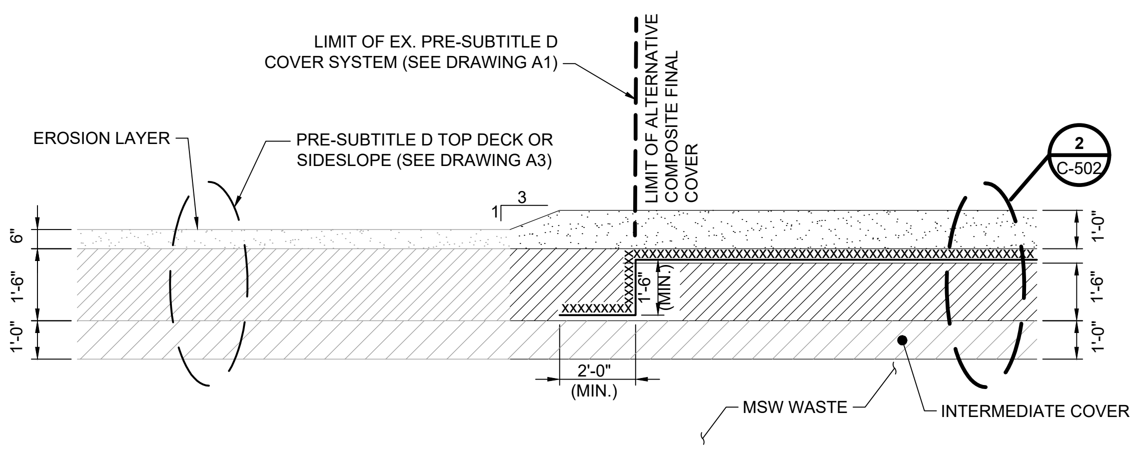
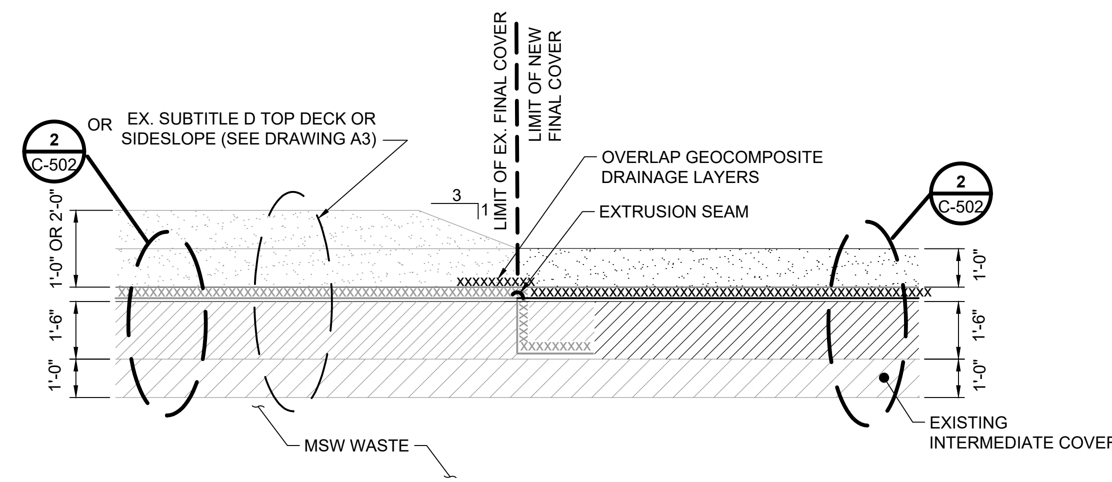


ALTERNATIVE COMPOSITE COVER TERMINATION FOR FUTURE TIE-IN
NOT TO SCALE
1 C-301 C-302, C-303



ALT. COMPOSITE COVER TIE-IN TO PRE-SUBTITLE D COVER
NOT TO SCALE
2 C-504



ALT. COMPOSITE COVER TIE-IN TO VARIOUS SUBTITLE D COVERS
NOT TO SCALE
3 C-504

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LICENSED
PROFESSIONAL ENGINEER
Scott Martin
4/5/2022
SCOTT MARTIN P.E.
LICENSE NO. 120819

1522B PERMIT AMENDMENT

DETAIL SHEET 4

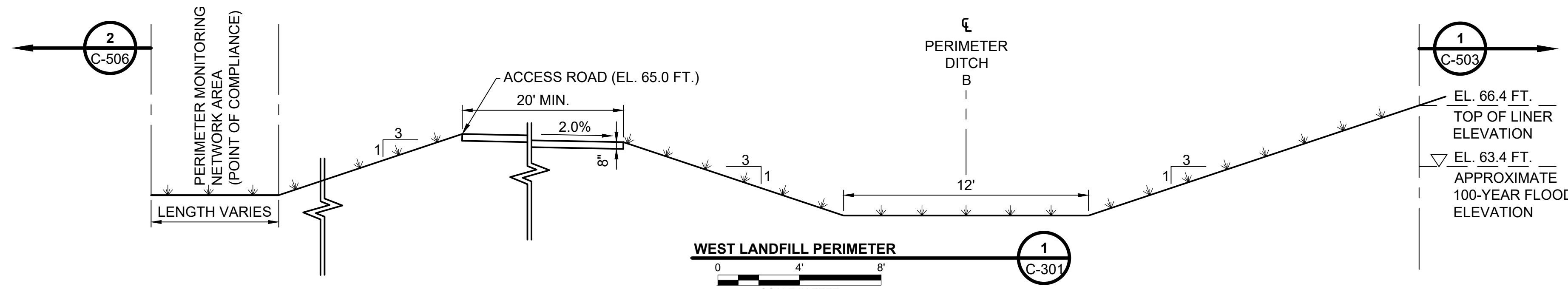
project	contract
107608	-

drawing **C-504** rev. ----

sheet 20 of 23 sheets

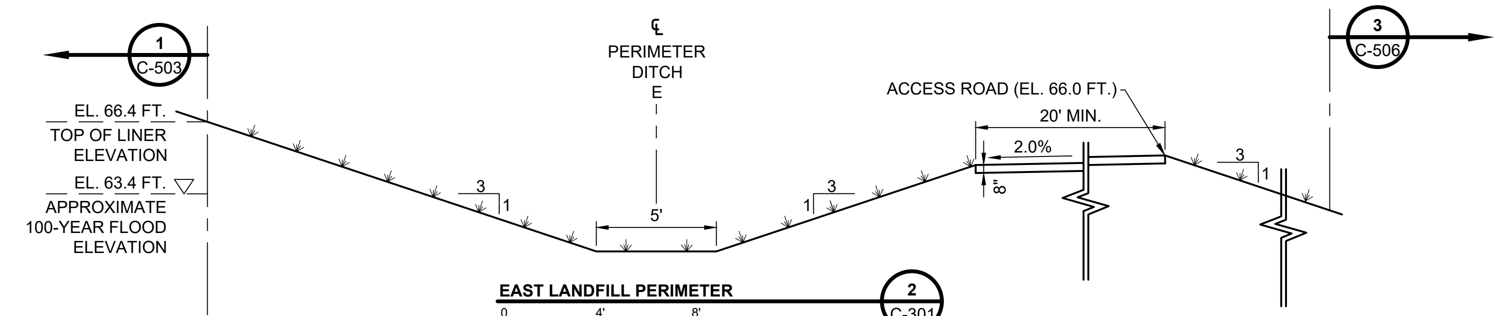
file 107608C503copy.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL



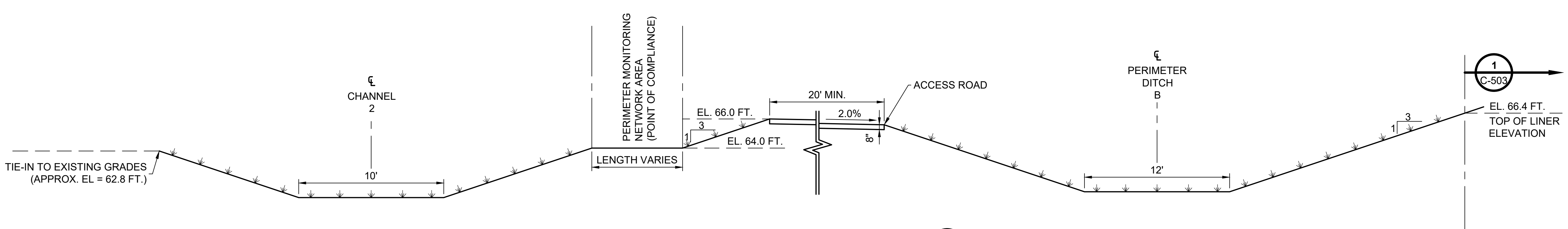
WEST LANDFILL PERIMETER 1 C-301

0 4' 8' SCALE IN FEET



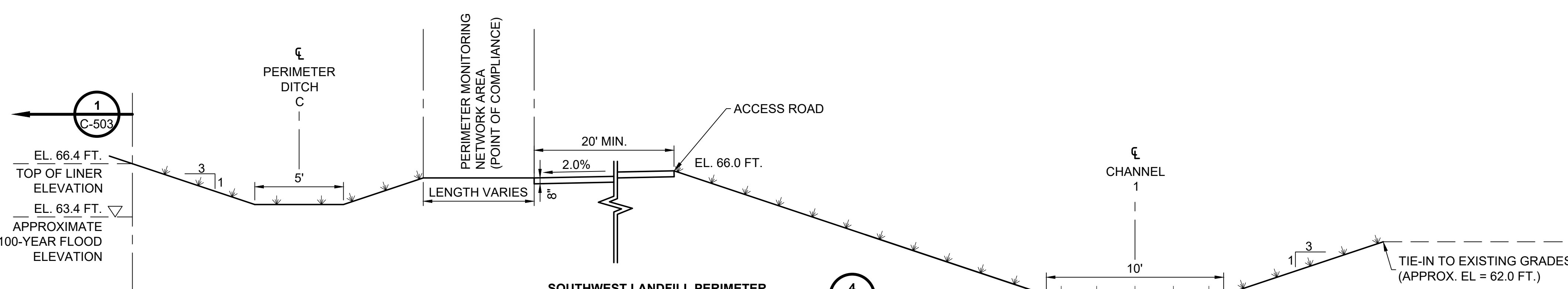
EAST LANDFILL PERIMETER 2 C-301

0 4' 8' SCALE IN FEET



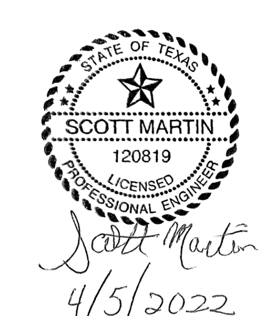
NORTHWEST LANDFILL PERIMETER 3 C-302

0 4' 8' SCALE IN FEET



SOUTHWEST LANDFILL PERIMETER 4 C-302

0 4' 8' SCALE IN FEET



SCOTT MARTIN P.E.
LICENSE NO. 120819

0 4' 8' SCALE IN FEET

PRELIMINARY - NOT FOR CONSTRUCTION

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
MARCH 2022	T. CAMMACK
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

1522B PERMIT AMENDMENT

DETAIL SHEET 5

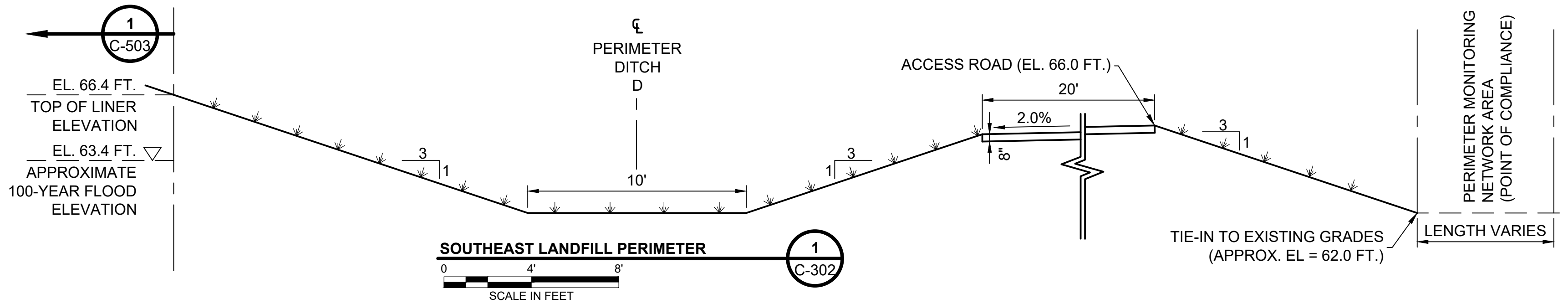
project	contract
107608	-

drawing C-505 – rev. A

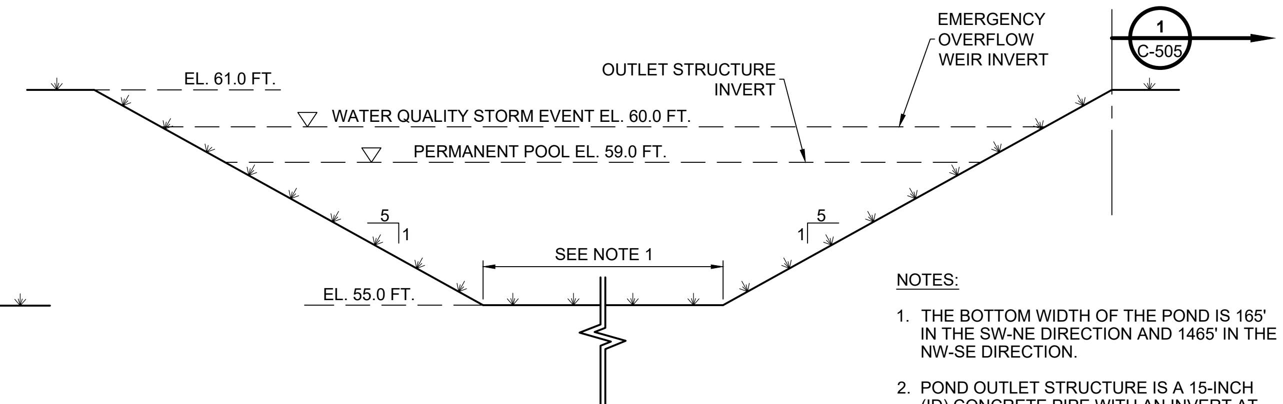
sheet 21 of 23 sheets

file 107608C505.dwg

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL



SOUTHEAST LANDFILL PERIMETER 1 / C-302

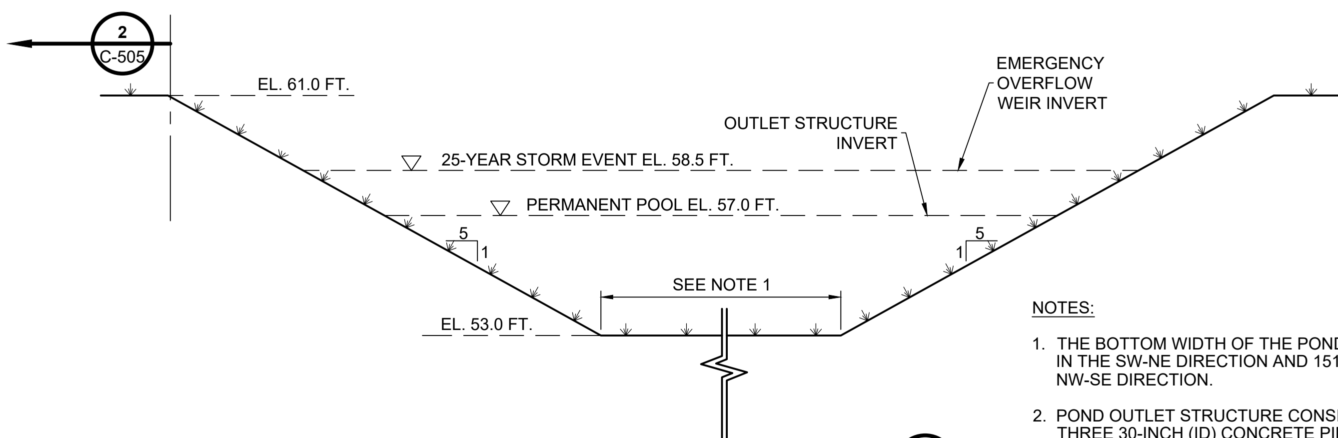


WEST RETENTION POND 2 / C006

NOT TO SCALE

NOTES:

1. THE BOTTOM WIDTH OF THE POND IS 165' IN THE SW-NE DIRECTION AND 1465' IN THE NW-SE DIRECTION.
2. POND OUTLET STRUCTURE IS A 15-INCH (ID) CONCRETE PIPE WITH AN INVERT AT 59.0 FT.



EAST DETENTION POND 3 / C007

NOT TO SCALE

NOTES:

1. THE BOTTOM WIDTH OF THE POND IS 167' IN THE SW-NE DIRECTION AND 1514' IN THE NW-SE DIRECTION.
2. POND OUTLET STRUCTURE CONSISTS OF THREE 30-INCH (ID) CONCRETE PIPES WITH AN INVERT AT 57.0 FT.

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

SCOTT MARTIN P.E.
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BURNS McDONNELL
9400 WARD PARKWAY
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date	detailed
MARCH 2022	T. CAMMACK
designed	**checked**
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

1522B PERMIT AMENDMENT

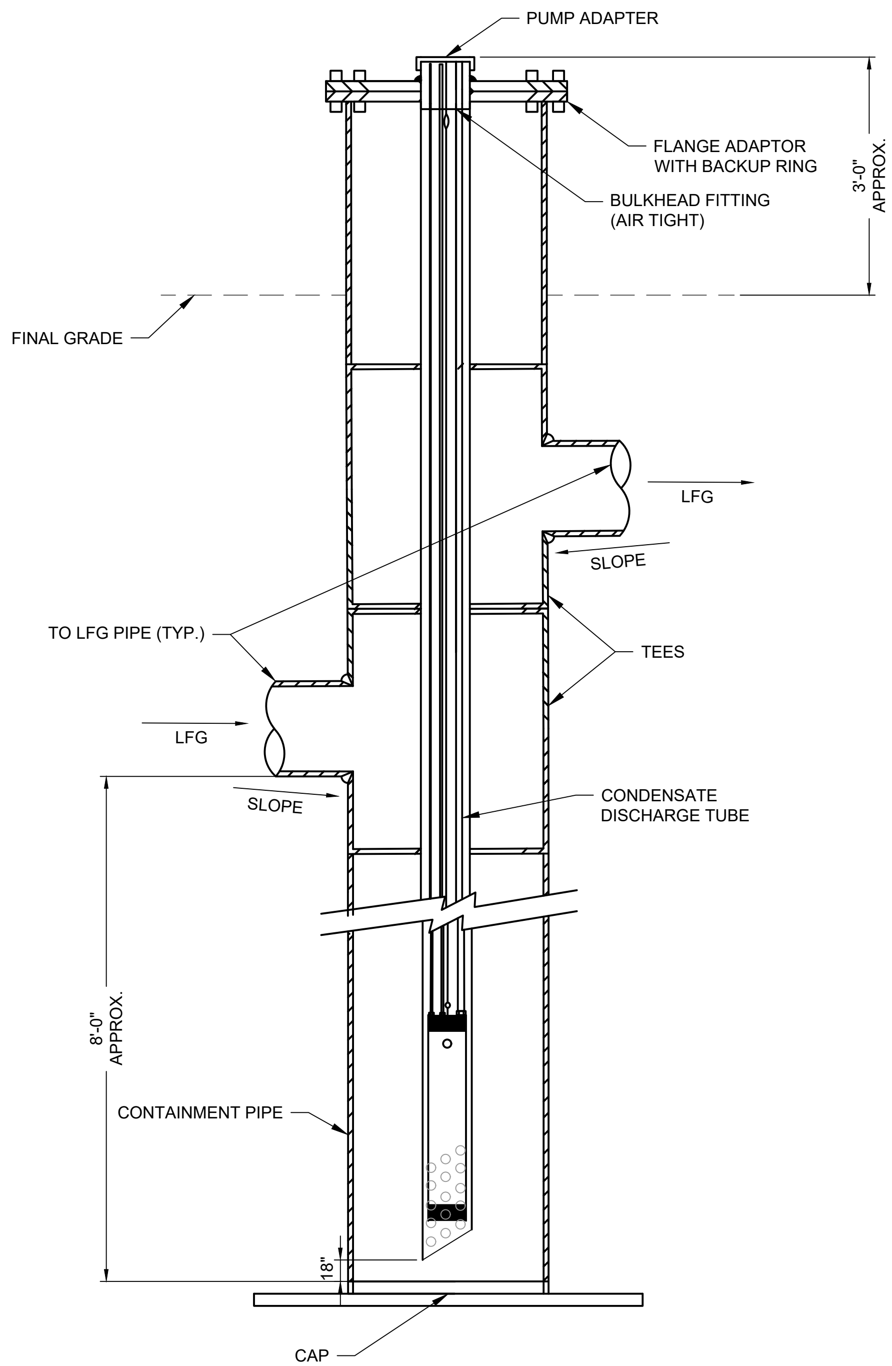
DETAIL SHEET 6

project	contract
107608	-

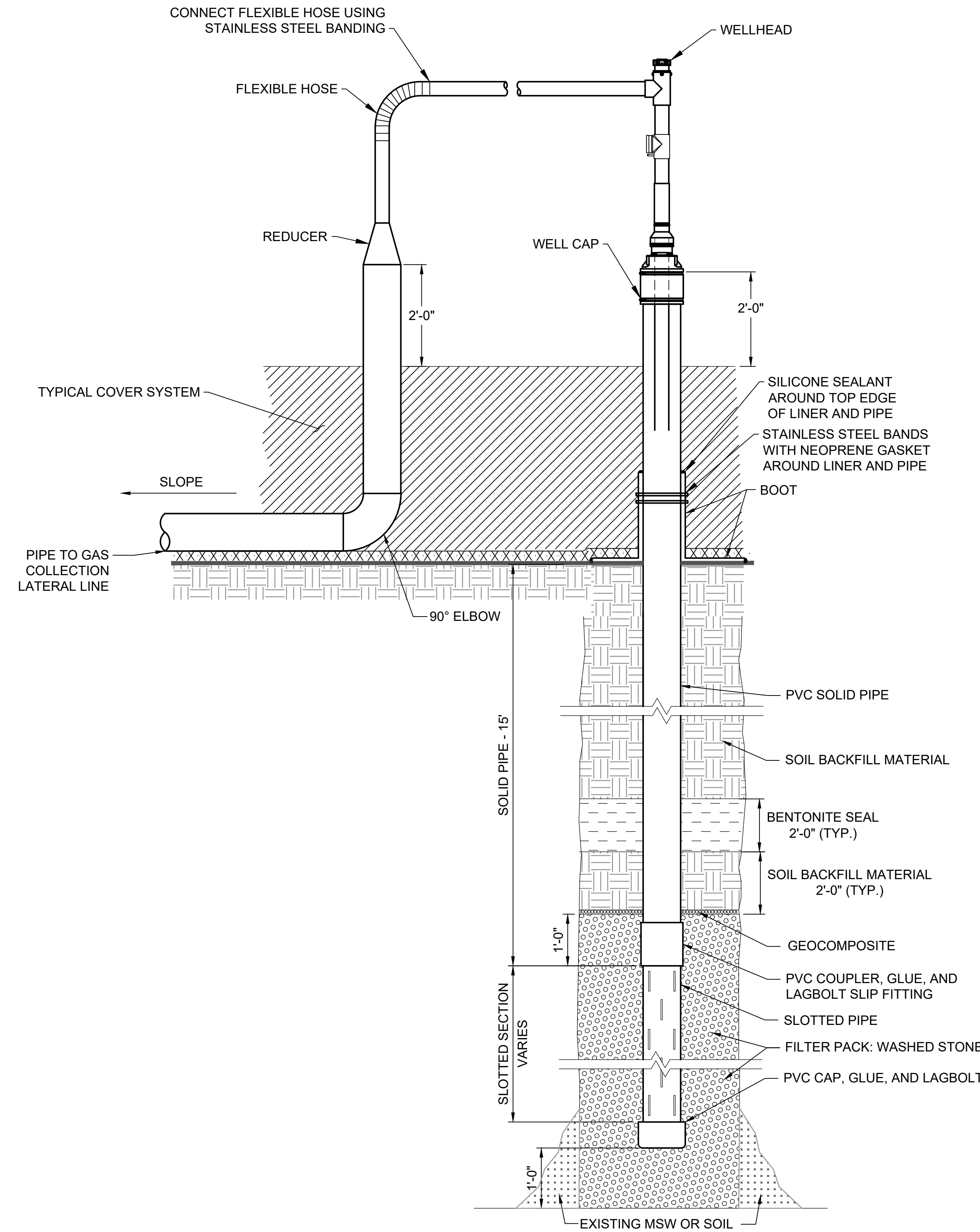
drawing **C-506** – rev. **A**

sheet 22 of 23 sheets

file 107608C506.dwg



TYPICAL CONDENSATE SUMP 1 C008
NOT TO SCALE



TYPICAL GAS WELL 2 C008
NOT TO SCALE

NOTES:

1. AIR/FORCEMAIN AND PUMP HOSES ARE NOT SHOWN IN THIS VIEW.
2. ALL SIZES AND DIMENSIONS ARE APPROXIMATE.

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED PROFESSIONAL ENGINEER
Scott Martin
4/5/2022
SCOTT MARTIN P.E.
LICENSE NO. 120819

no.	date	by	ckd	description
A	3/28/22	TJS	SAM	INITIAL SUBMITTAL

PRELIMINARY - NOT FOR CONSTRUCTION

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
MARCH 2022	T. CAMMACK
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

1522B PERMIT AMENDMENT

DETAIL SHEET 7

project 107608 | contract -
drawing **C-507** rev. **A**
sheet 23 of 23 sheets
file 107608C507.dwg

APPENDIX 1A - HISTORIC DRAWINGS

DRAWING ID	DRAWING NAME
1C	EXCAVATION PLAN
1D	SITE DRIVEWAY DETAIL
2A	TYPICAL CROSS SECTIONS
2B	CROSS SECTION 1-1
2C	CROSS SECTION 2-2
2D	CROSS SECTION 3-3
2E	CROSS SECTION 4-4
2E-2	CROSS SECTION 5-5
2H	CROSS SECTION 3-3 & 4-4
2I	CROSS SECTION 5-5 & 6-6
2J	CROSS SECTION 7-7
6B-1	DRAINAGE DESIGN
6B-2	CROSS SECTIONS
6B-4	DRAINAGE DETAILS
6B-5	DRAINAGE DETAILS
6B-7	DETENTION POND PLAN
7	FINAL CONTOUR MAP
15A	EXCAVATION PLAN
15B	LINER DETAIL

DRAWING ID	DRAWING NAME
15B-1	LINER DETAIL (WITH GEOCOMPOSITE)
15C	DETAILED LEACHATE COLLECTION DETAILS
15C-1	DETAILED LEACHATE COLLECTION DETAILS (WITH GEOCOMPOSITE)
15F	SLOPE STABILITY CROSS SECTION LOCATION MAP
15G-1A	LEACHATE STORAGE FACILITY
15G-1B	LEACHATE STORAGE TANK
"DRAWING 7"	LFG TREATMENT FACILITY LAYOUT
6 OF 11	SOIL PROFILE
7 OF 11	SECTIONS 1-1 & 2-2
8 OF 11	SECTIONS 3-3 & 4-4
9 OF 11	SECTIONS 5-5 & 6-6
10 OF 11	SECTION 7-7
11 OF 11	SECTIONS 8-8 & 9-9
A1	FINAL COVER SYSTEM EVALUATION REPORT SITE PLAN
A2	FINAL COVER SYSTEM EVALUATION REPORT TOP OF FINAL COVER PLAN
A3	FINAL COVER SYSTEM EVALUATION REPORT FINAL COVER DETAILS
A4	FINAL COVER SYSTEM EVALUATION REPORT FINAL COVER DETAILS
A5	FINAL COVER SYSTEM EVALUATION REPORT FINAL COVER DETAILS

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER

Scott Martin
4/5/2022
SCOTT MARTIN P.E.
LICENSE NO. 120819

no.	date	by	ckd	description

FOR PERMITTING PURPOSES ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
March 2022	T. SCHMIDT
designed	checked
T. SCHMIDT	S. MARTIN

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

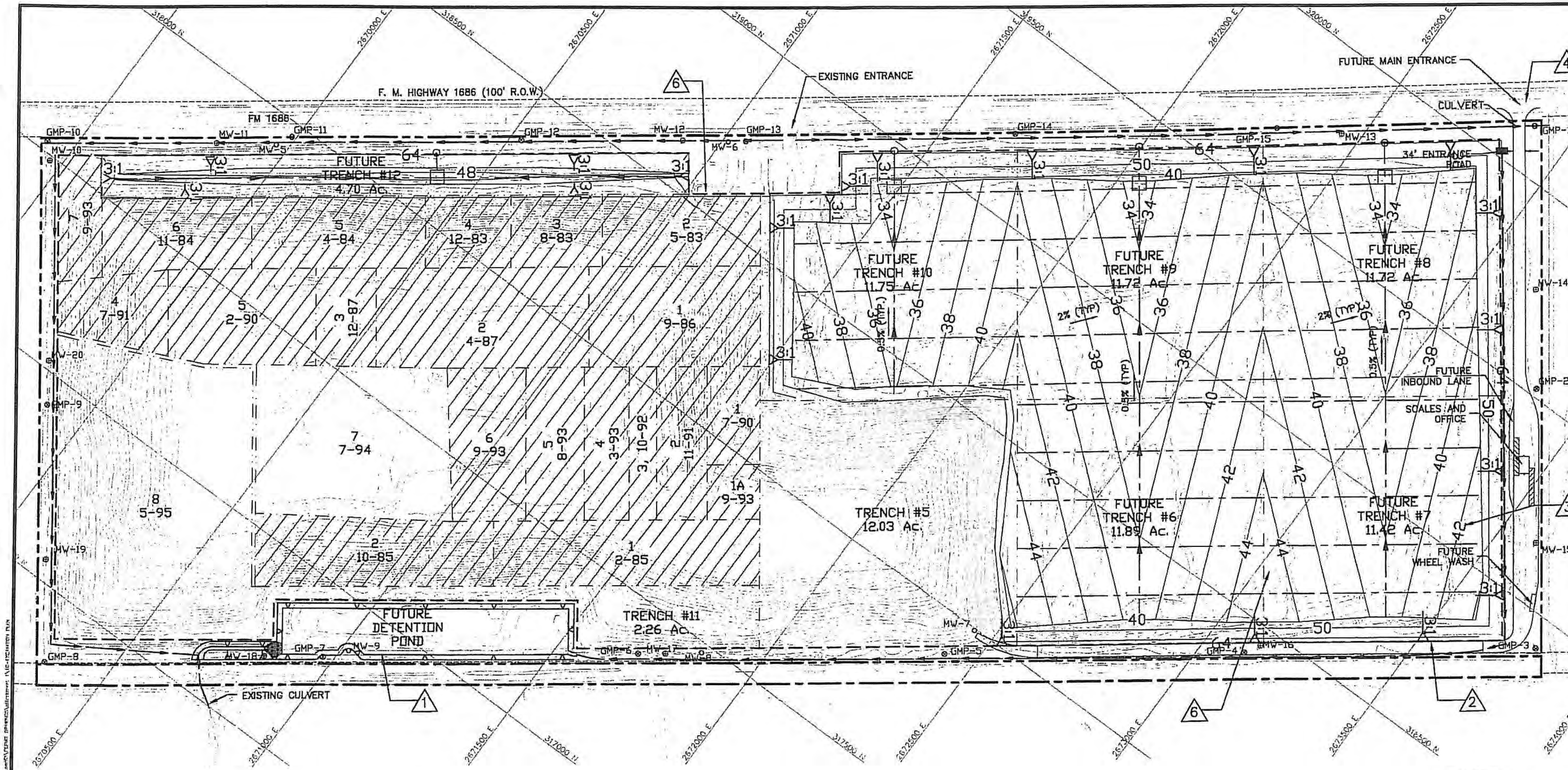
EXPANSION PERMIT DESIGN

HISTORICAL PERMIT DRAWINGS
TABLE OF CONTENTS

project	contract
107608	-

drawing TABLE OF CONTENTS — rev. A

sheet sheets
file



LEGEND

— — —	PERMIT BOUNDARY
— — —	PROPERTY LINE
— — —	LIMITS OF WASTE
2672000 E	STATE PLANE COORDINATE
----	EXISTING CONTOUR
—— 40 ——	EXCAVATION CONTOUR
x64	PROPOSED ROAD SPOT ELEVATION
←	LCS PIPE
- - -	LCS LATERAL PIPE (8")
□	LCS SUMP
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
←	PERIMETER CHANNEL FLOWLINE
△1	INDICATES REVISION
//////	PRE-SUBTITLE D CELLS △5

0 150 300
SCALE IN FEET

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.
2. ALL EXCAVATION GRADES ARE ABOVE MEAN SEA LEVEL.
3. △5 IF A GEOSYNTHETIC DRAINAGE LAYER IS USED FOR THE LEACHATE COLLECTION SYSTEM IN LIEU OF THE GRANULAR DRAINAGE LAYER. THE LCS LATERAL PIPES MAY BE OMITTED IN THOSE AREAS.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER
3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY JEFFREY P. YOUNG (TEXAS P.E. 79809) ON MARCH 8, 2006. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED NOVEMBER 2008 AND MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	ADDED WASTE FILL AREA AND ADDED DETENTION POND	
2	03/2006	REDUCED WASTE FOOTPRINT	
3	03/2006	REVISED EXCAVATION PLAN	
4	03/2006	UPDATED ENTRANCE LOCATION	
5	11/2008	REVISED LEACHATE COLLECTION SYSTEM NOTE	JR
6	03/2009	REVISED EXCAVATION PLAN AND WASTE FOOTPRINT	JR

DRAWING TITLE
EXCAVATION PLAN

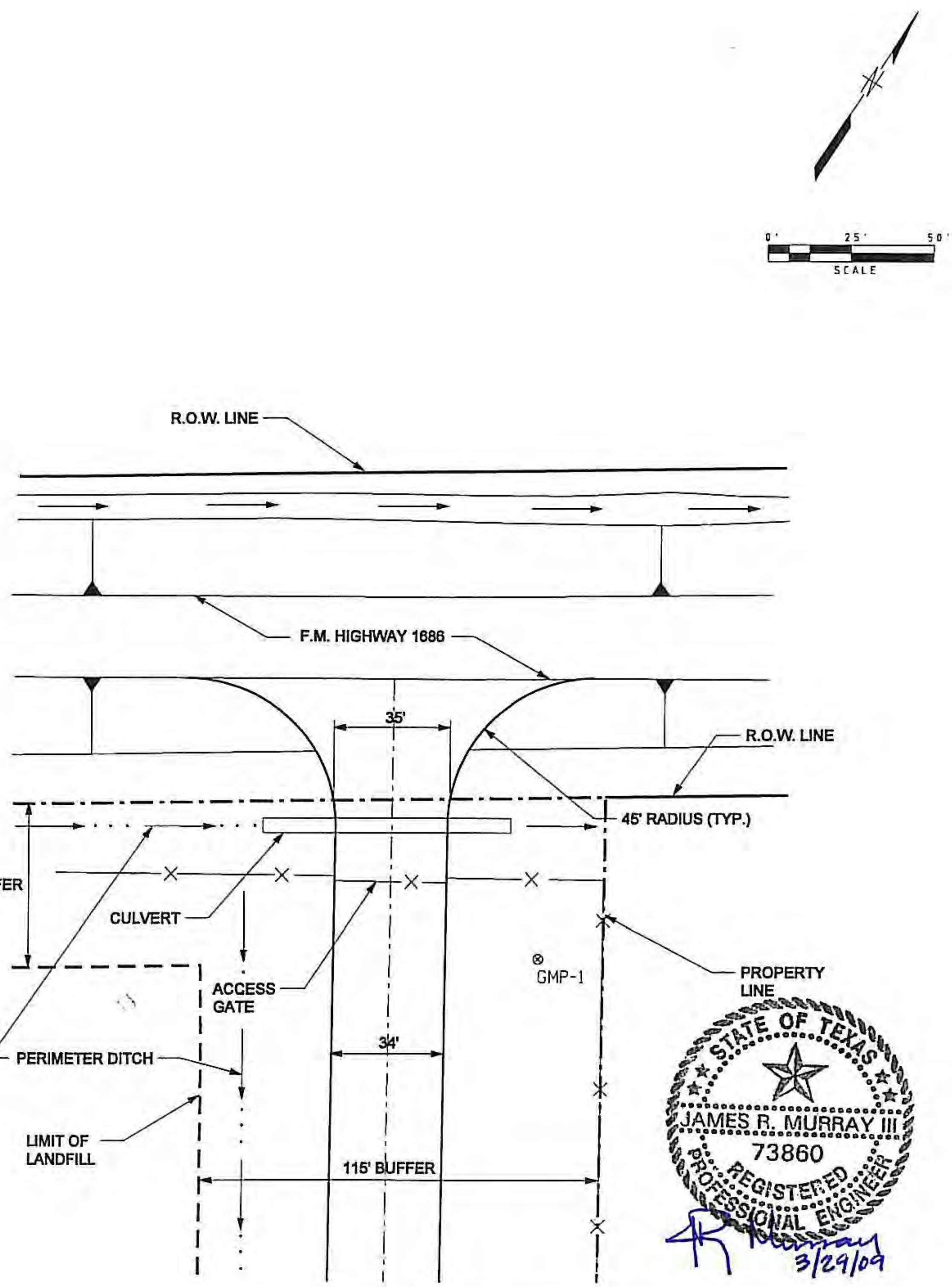
PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541
DWN. BY: JR
CHK. BY: JLJ
DSN. BY: DJM
Q/A RVW BY: DJM
APP. BY: JRM

CADD FILE: 1C-EXCAVATION PLAN
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
1C



FOR PERMITTING PURPOSES ONLY

REV.	DATE	DESCRIPTION	BY
1	9/08	REVISE ENTRANCE	RJR
2	2/09	NOD REVISION	SCS
3	3/09	REVISE CULVERT LOCATION	SCS

REPUBLIC SERVICES INC.

SCS ENGINEERS

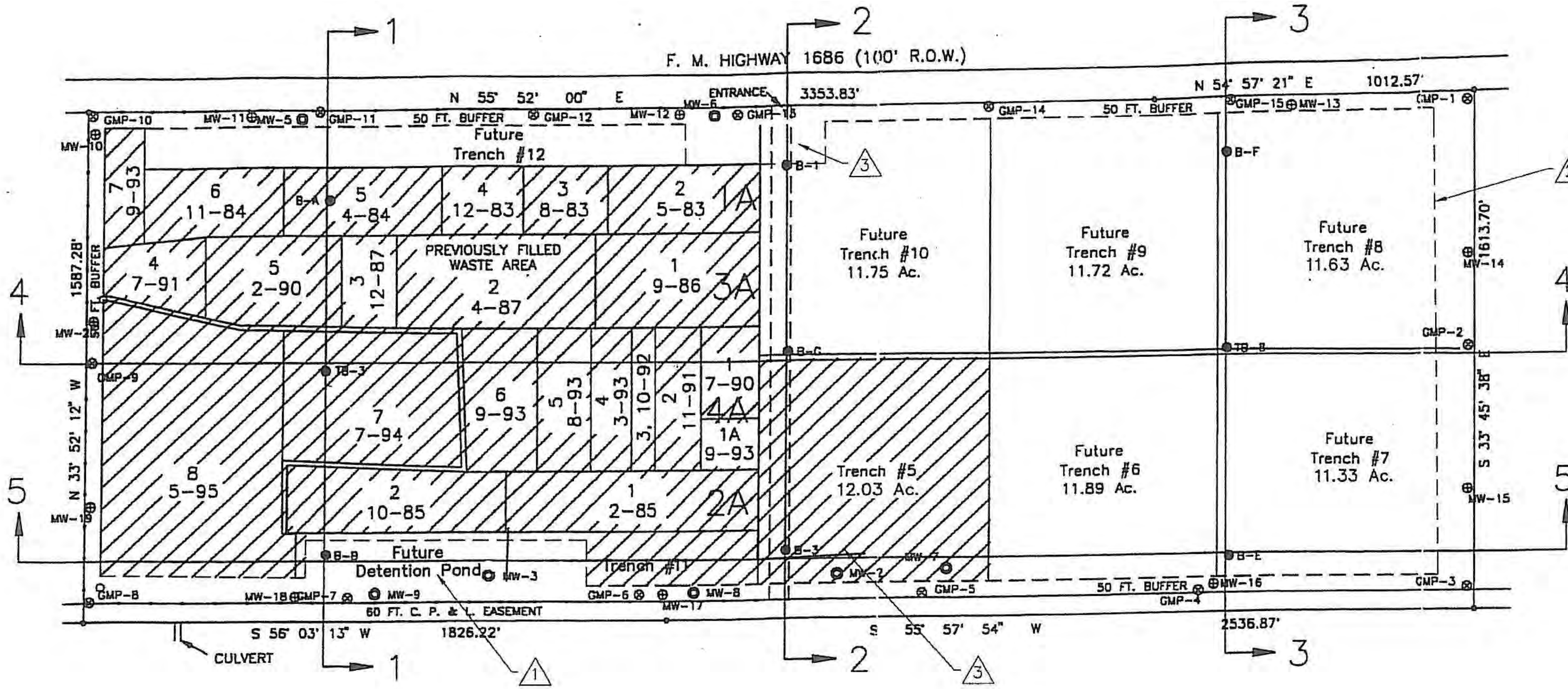
August 2008
Project: 41109
CADD File: fig4.dgn

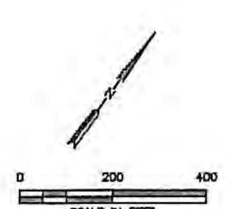
CITY OF VICTORIA LANDFILL
PERMIT MODIFICATION MSW-1522A
NEAR VICTORIA, VICTORIA COUNTY, TEXAS

ATTACHEMNT 1D
SITE DRIVEWAY DETAIL

FIGURE 4 of 4

...\Vcitoria\cadd\41109\fig4.dgn Apr. 08, 2009 15:01:36





NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2A, PREPARED BY JFK GROUP, INC., MAY 1, 1996.
2. ALL EXCAVATION GRADES ARE ABOVE MEAN SEA LEVEL.

LEGEND

MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED

GMP-6 GAS MONITORING PROBES

MW-17 GROUNDWATER MONITORING WELLS

WASTE FILLED AREAS

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	01/2008	REDUCED TRENCH #11 AREA AND ADDED DETENTION POND	
2	03/2008	REDUCED WASTE FOOTPRINT	
3	03/2009	UPDATE WASTE FILLED AREAS AND FOOTPRINT	JR

DRAWING TITLE
TYPICAL CROSS SECTIONS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | CHK. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | DWN. BY: DJM | APP. BY: JRM

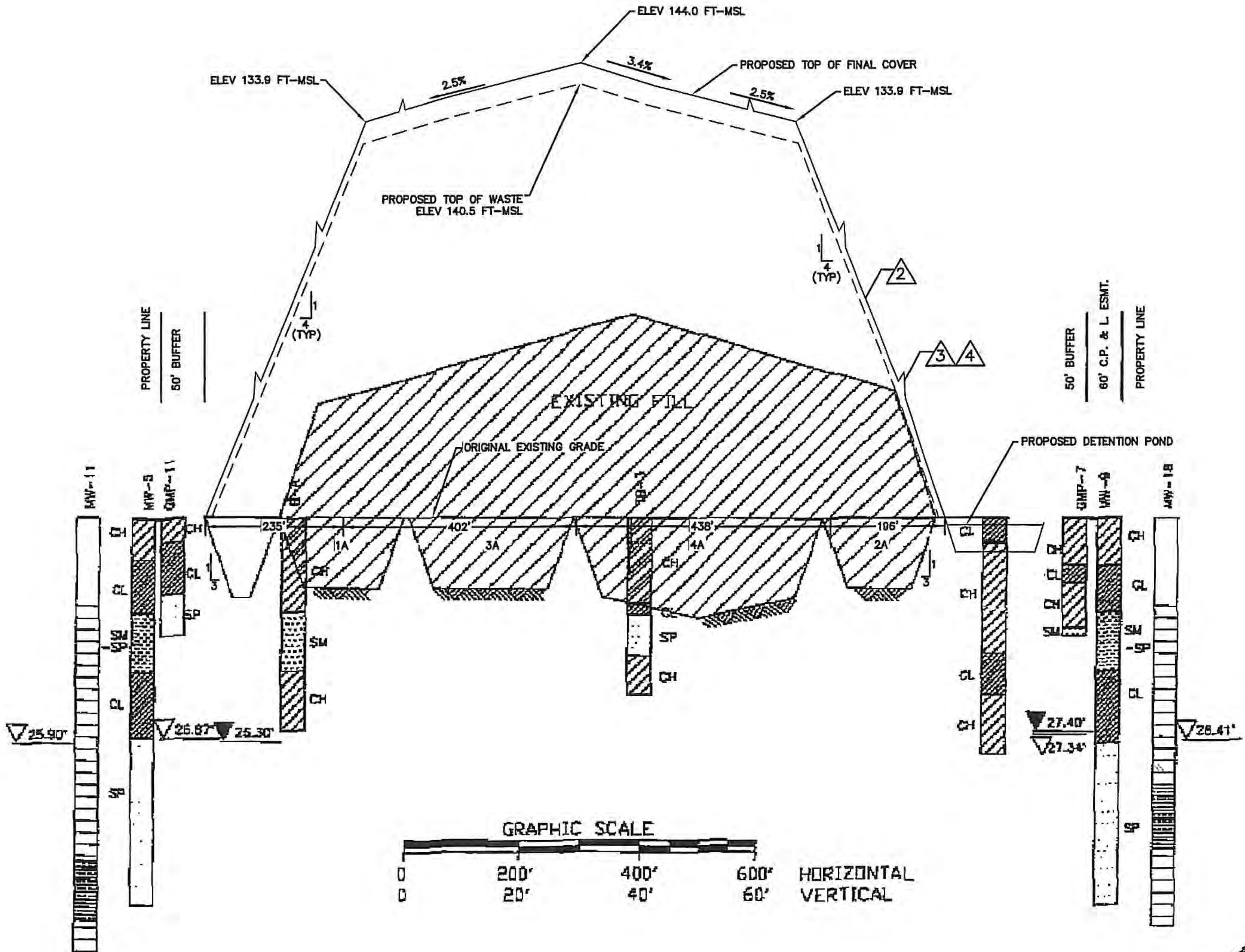
CADD FILE: 2A-CROSS SECTION INDEX

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

2A



NOTES:

1. MAXIMUM TOP OF WASTE ELEVATION 140.5' MSL
2. MAXIMUM FILL ELEVATION 144' MSL
3. NO GAS VENT ARE PROPOSED AT THE SITE
4. ▼ INITIAL LEVEL
5. ▽ HIGHEST STATIC LEVEL
6. = LOCATION OF SCREENS

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

INDICATES REVISION

DRAINAGE SWALE

NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2B, PREPARED BY JFK GROUP, INC., MAY 1, 1996. ONLY THE FINAL COVER HAS CHANGED FOR THE 10-FOOT HEIGHT INCREASE.

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY JEFFREY P. YOUNG (TEXAS P.E. 79809) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED SWALE LOCATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISE SWALE LOCATIONS, BASE GRADES, REDUCED WASTE FOOTPRINT	JR

DRAWING TITLE: CROSS-SECTION 1-1

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
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12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

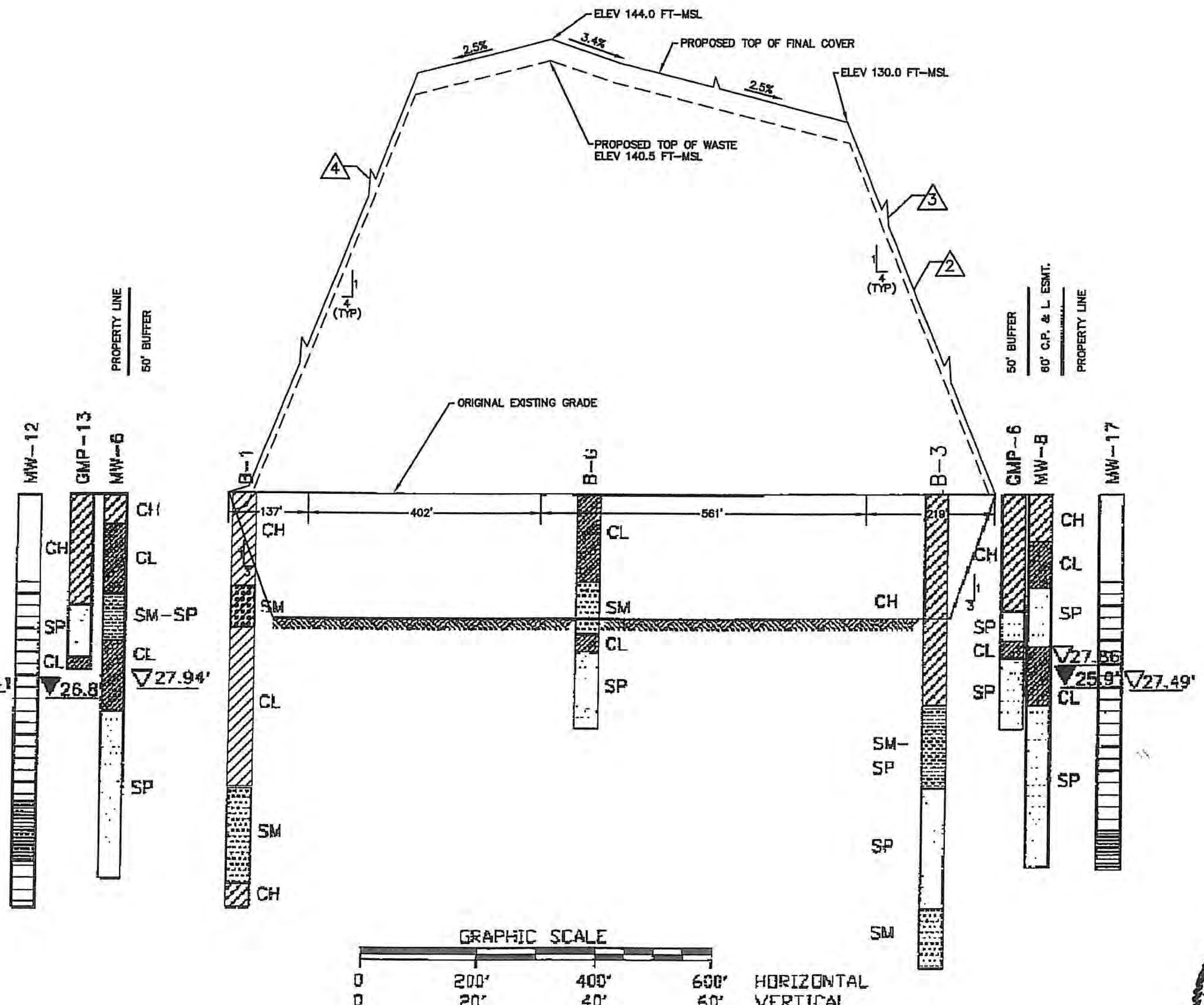
PROJ. NO. 16208541	DWN. BY: JLJ	Q/A RVW BY: DJM
DSN. BY: JR	CHK. BY: DJM	APP. BY: JRM

CADD FILE: 2B-CROSS SECTION 1-1

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT **2B**



NOTES:

1. MAXIMUM TOP OF WASTE ELEVATION 140.5' MSL
2. MAXIMUM FILL ELEVATION 144' MSL
3. NO GAS VENT ARE PROPOSED AT THE SITE
4. ▼ INITIAL LEVEL
5. ∇ HIGHEST STATIC LEVEL
6. = LOCATION OF SCREENS

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

INDICATES REVISION

DRAINAGE SWALE

NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2C, PREPARED BY JFK GROUP, INC., MAY 1, 1996. ONLY THE FINAL COVER HAS CHANGED FOR THE 10 FOOT HEIGHT INCREASE.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2008	REVISED FINAL CONTOUR TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED SWALE LOCATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISE SWALE LOCATIONS, BASE GRADES, REDUCED WASTE FOOTPRINT	JR

DRAWING TITLE: CROSS-SECTION 2-2

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 597-8747 FAX NO. (281) 293-7678

PROJ. NO. 16208541 | DWN. BY JLJ | Q/A RVW BY DJM
DSN. BY JR | CHK. BY DJM | APP. BY JRM

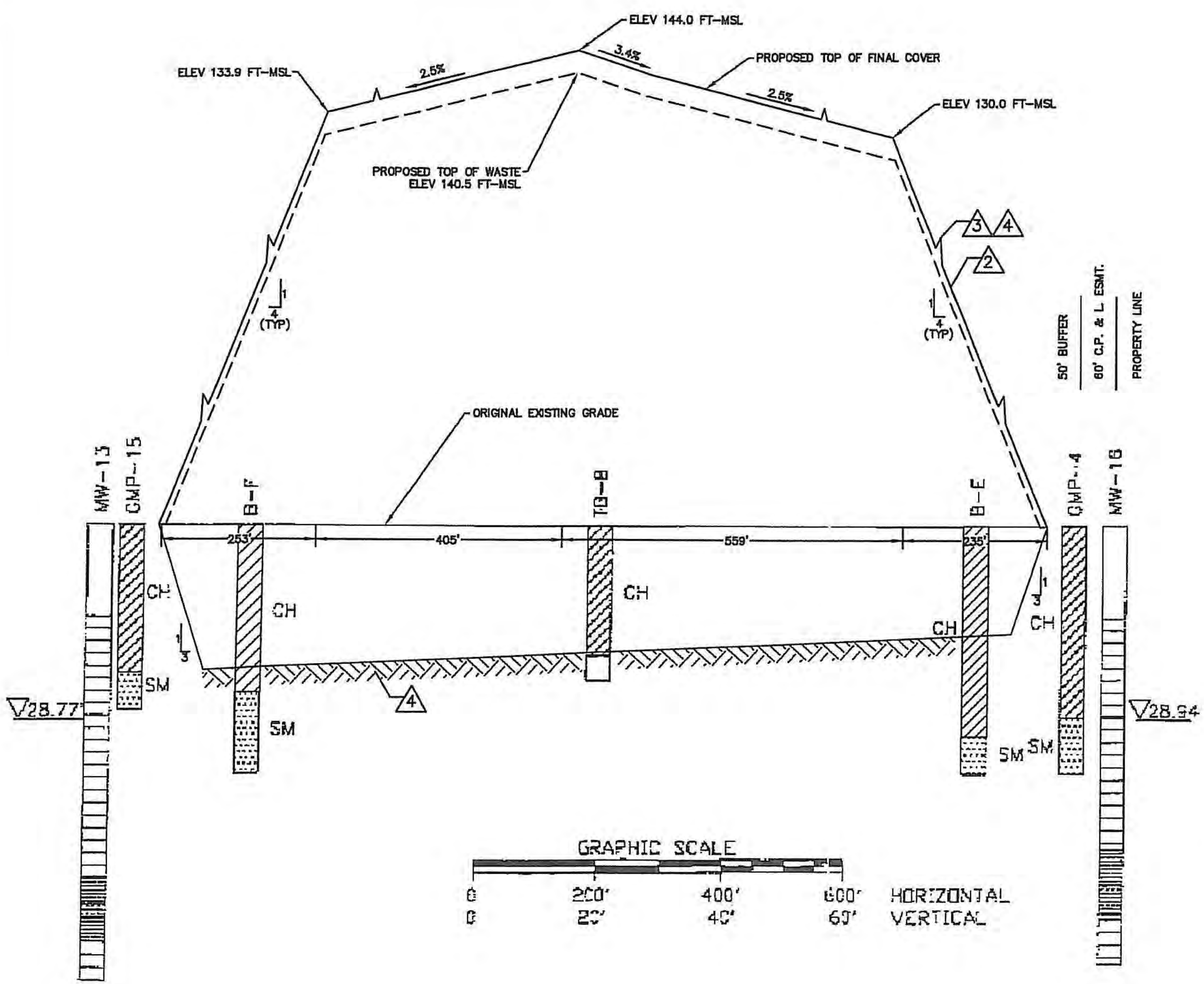
CADD FILE: 2C-CROSS SECTION 2-2

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

2C



NOTES:

1. MAXIMUM TOP OF WASTE ELEVATION 140.5' MSL
2. MAXIMUM FILL ELEVATION 144' MSL
3. NO GAS VENT ARE PROPOSED AT THE SITE
4. ∇ HIGHEST STATIC LEVEL
5. = LOCATION OF SCREENS

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

2 INDICATES REVISION

DRAINAGE SWALE

NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2D, PREPARED BY JFK GROUP, INC., MAY 1, 1996.

STATE OF TEXAS
JAMES R. MURRAY III
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REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED SWALE LOCATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISE SWALE LOCATIONS, BASE GRADES	JR

DRAWING TITLE: CROSS-SECTION 3-3

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

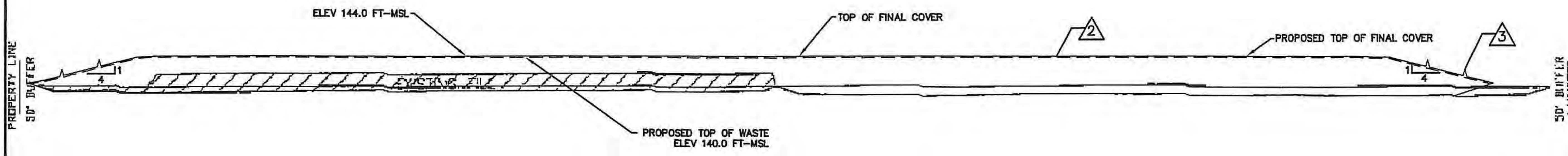
PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

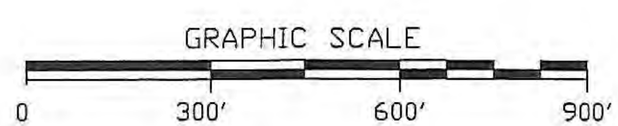
CADD FILE: 2D-CROSS SECTION 3-3

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT **2D**





NOTES:

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

2 INDICATES REVISION

NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2E, PREPARED BY JFK GROUP, INC., MAY 1, 1996. ONLY THE FINAL COVER HAS CHANGED FOR THE 10-FOOT HEIGHT INCREASE.

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3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED SWALE LOCATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISE SWALE LOCATIONS, BASE GRADES	JR

DRAWING TITLE

CROSS-SECTION 4-4

PROJECT TITLE

PERMIT MODIFICATION

CLIENT

REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR., SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

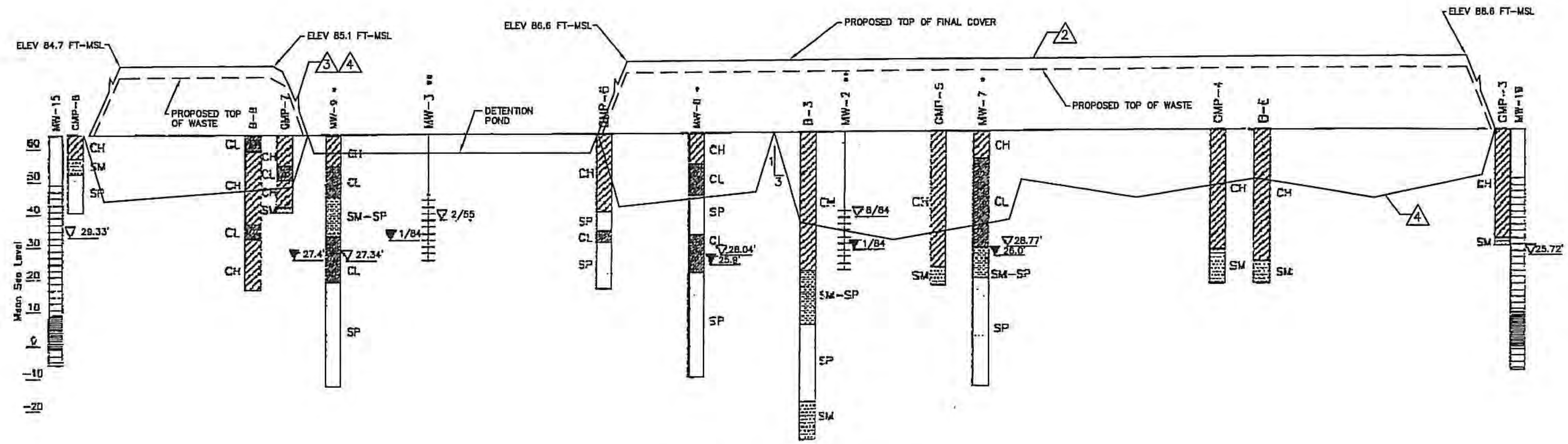
CADD FILE: 2E-CROSS SECTION 4-4

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

2E



GRAPHIC SCALE

0	30'	60'	90' VERT.
0	300'	600'	900' HORZ.

NOTES:

EXCAVATIONS REPRESENT ACTUAL DEPTHS. SEE ATTACHMENT 2A FOR EXACT BORING LOCATIONS.

INITIAL LEVEL IN MSL

HIGHEST STATIC LEVEL IN MSL

* GROUNDWATER MONITORING WELLS TO BE PLUGGED AND ABANDONED

** GROUNDWATER MONITORING WELLS PREVIOUSLY PLUGGED AND ABANDONED

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

INDICATES REVISION

DRAINAGE SWALE

NOTE:

1. THIS DRAWING REPRODUCED FROM SDP ATTACHMENT 2E, PREPARED BY JFK GROUP, INC., MAY 1, 1996.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY JEFFREY P. YOUNG (TEXAS P.E. 79809) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED SWALE LOCATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISE BASE GRADES	JR

DRAWING TITLE: CROSS-SECTION 5-5

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO.: 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

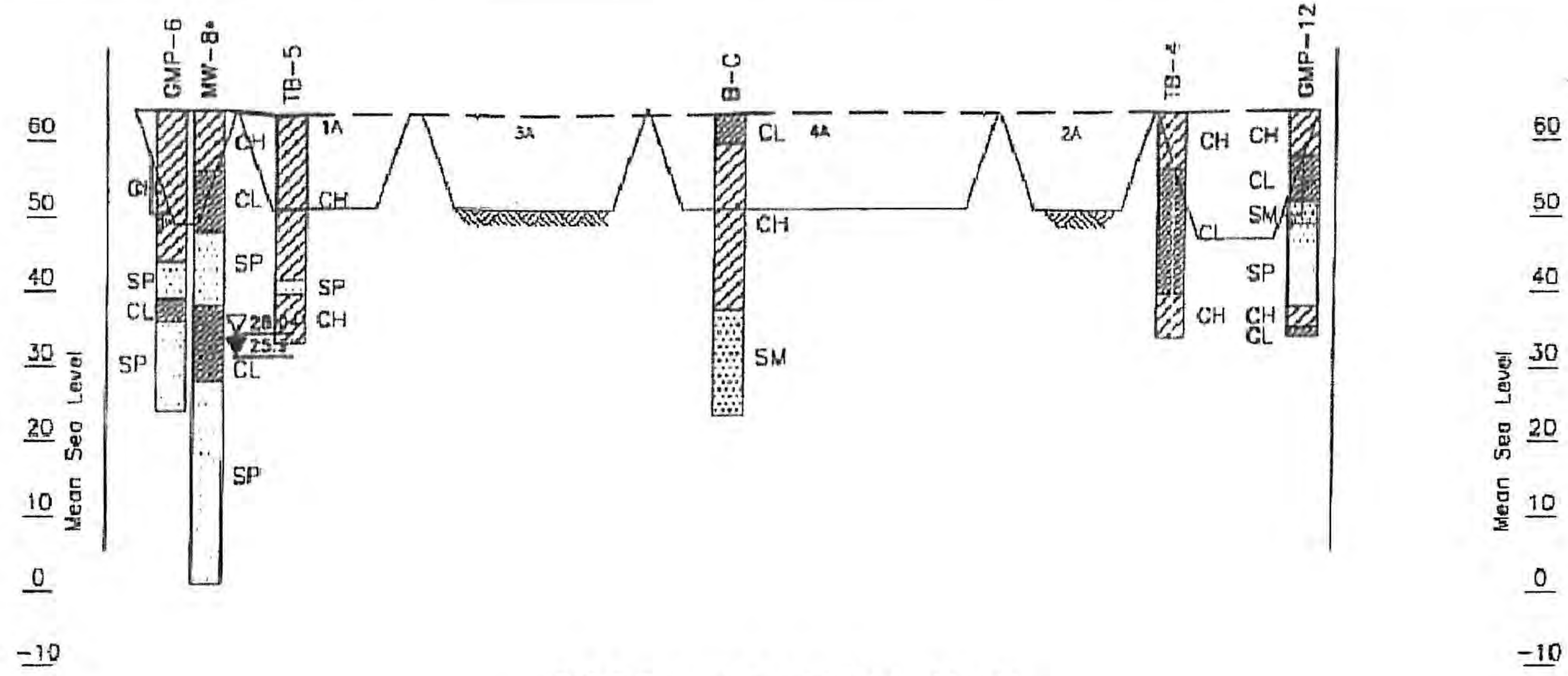
CADD FILE: 2E-2-CROSS SECTION 5-5

DATE: 11/2008

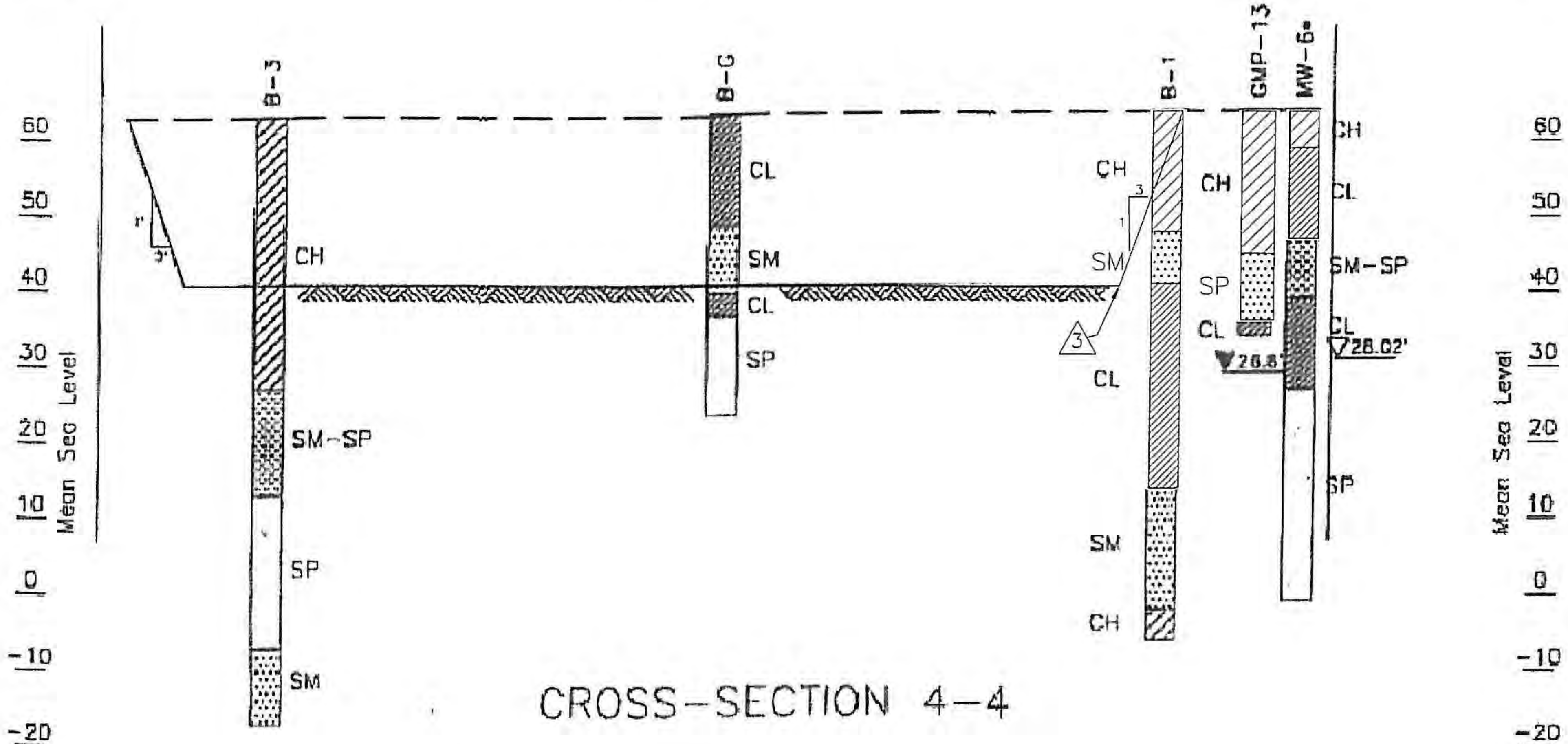
SCALE: AS SHOWN

ATTACHMENT

2E-2



CROSS-SECTION 3-3

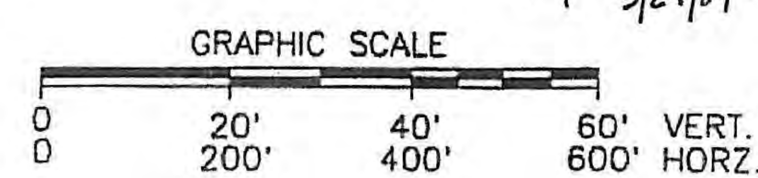


CROSS-SECTION 4-4

NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

JAMES R. MURRAY III
73860
STATE OF TEXAS
REGISTERED PROFESSIONAL ENGINEER
3/29/09



THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY JFK GROUP, AND SIGNED AND SEALED BY J. FLETCHER KELLY (TEXAS P.E. 61815) ON JANUARY 13, 1997. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	12/10/96	GENERAL REVISION	
2	01/13/97	REVISE NOTES	
3	03/2009	REVISE BASE GRADES	JR

DRAWING TITLE: CROSS-SECTION 3-3 & 4-4

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS

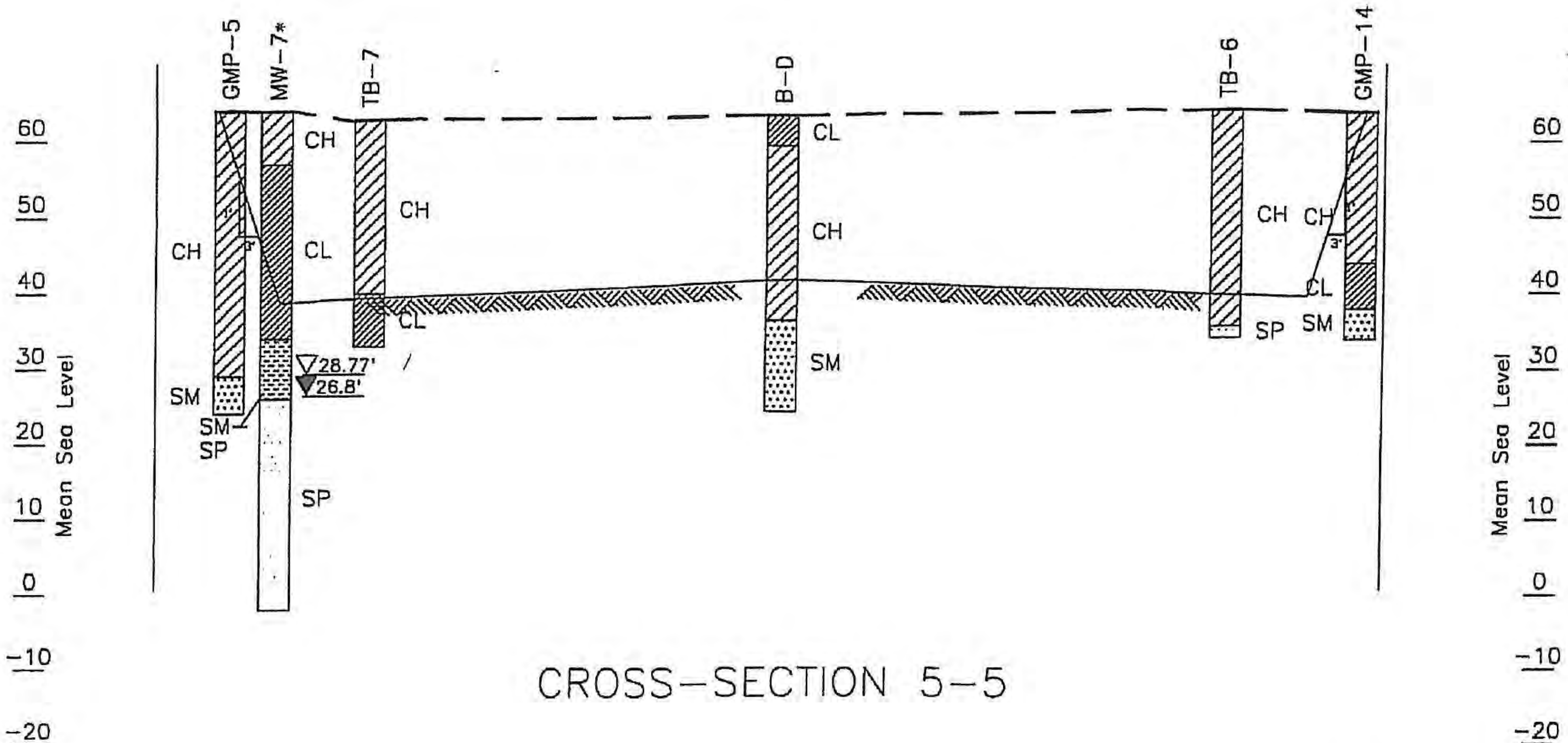
CADD FILE: 2H-CROSS SECTION 3-3

DATE: 11/2008

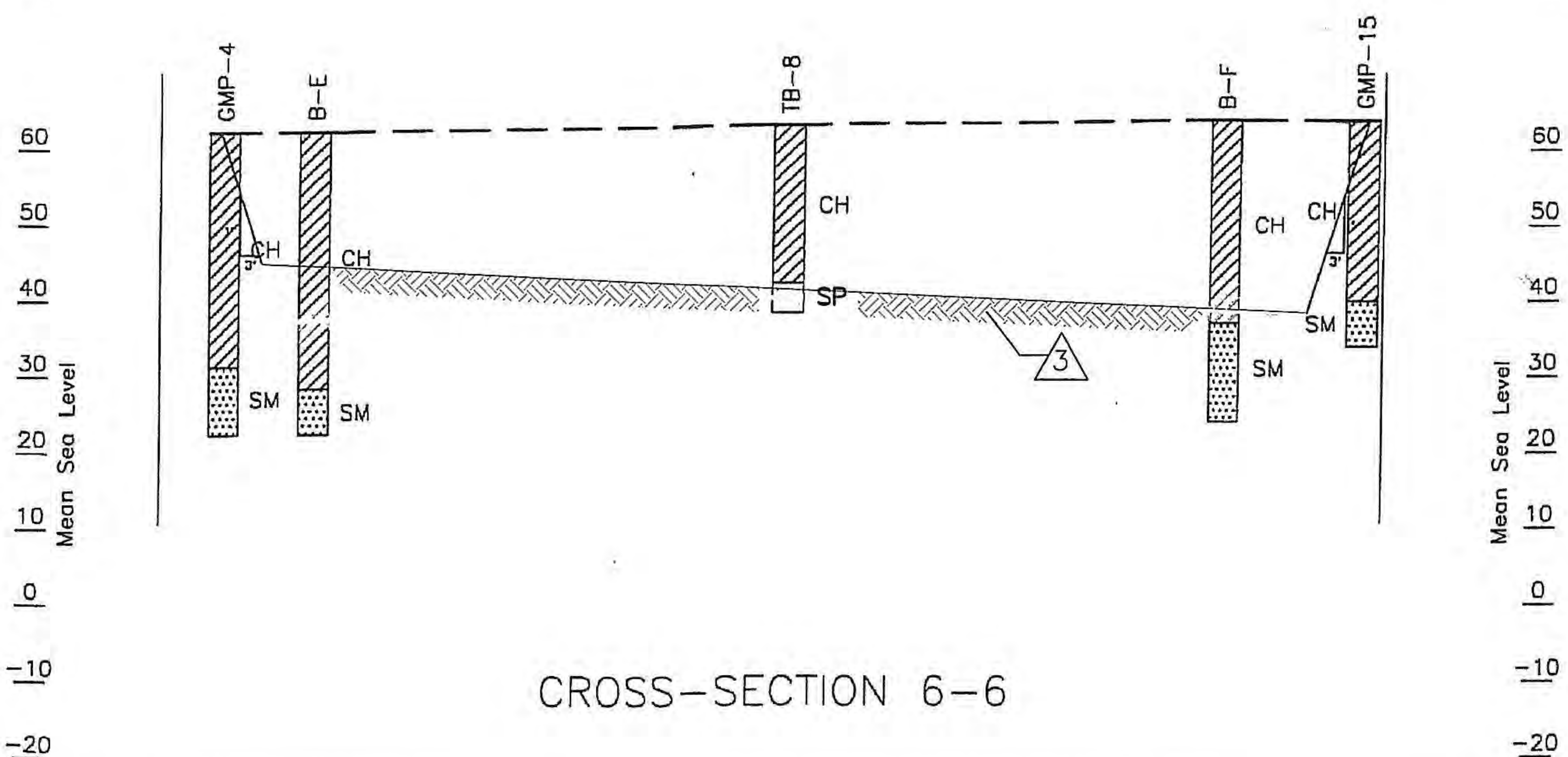
SCALE: AS SHOWN

ATTACHMENT

2H



CROSS-SECTION 5-5



CROSS-SECTION 6-6

NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

GRAPHIC SCALE

0	20'	40'	60'	VERT.
0	200'	400'	600'	HORZ.

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	12/20/95	GENERAL REVISION	
2	01/13/97	ADD NOTE	
3	03/2009	REVISE BASE GRADES	JR

DRAWING TITLE
CROSS-SECTION 5-5 & 6-6

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
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PH (281) 397-8747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | DWN. BY JJ | Q/A RVW BY DJM
DSN. BY JR | CHK. BY DJM | APP. BY JRM

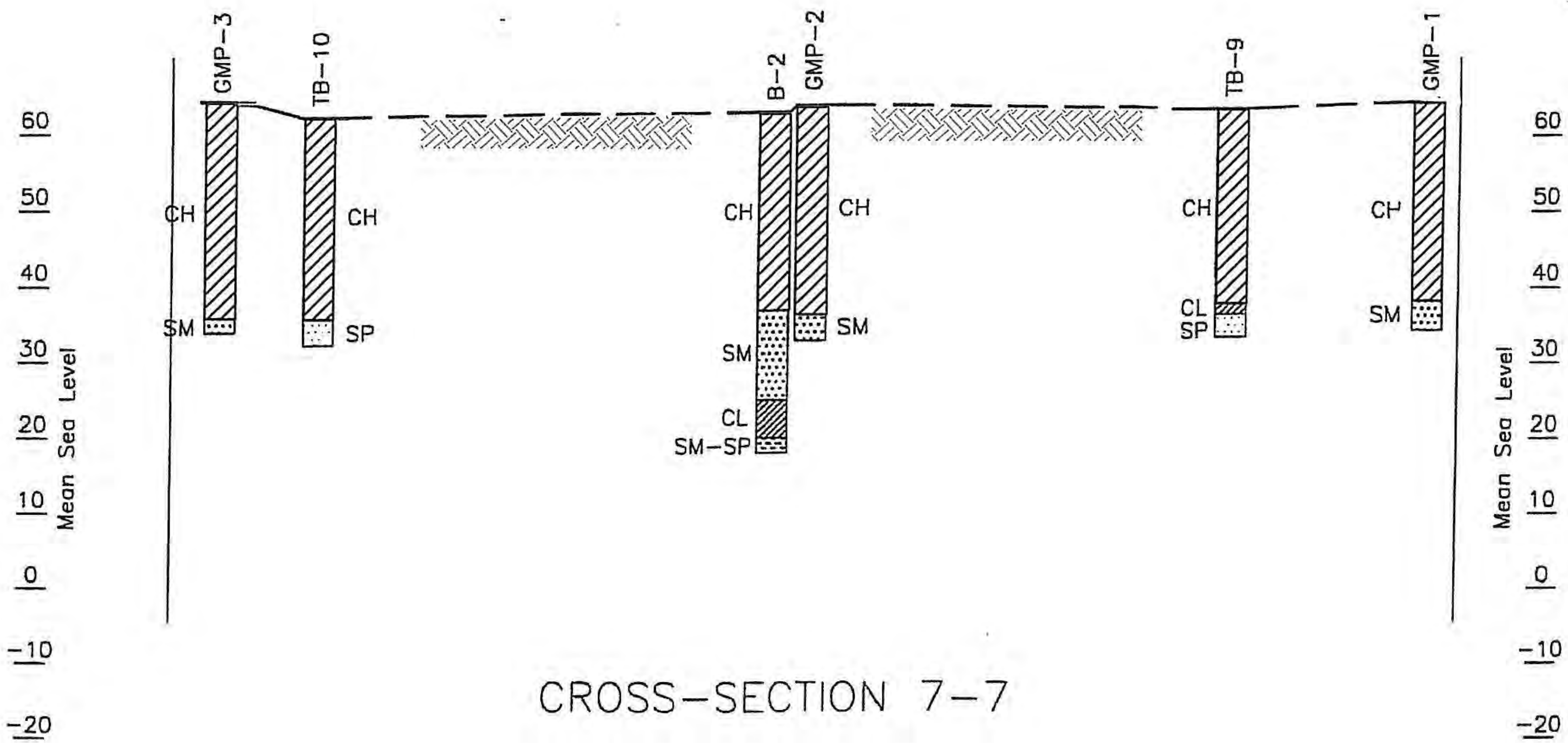
CADD FILE: 2I-CROSS SECTION 5-5

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

2I



CROSS-SECTION 7-7

GRAPHIC SCALE

0 20' 40' 60' VERT.
0 200' 400' 600' HORZ.

NOTE:

1. BORING LOG WIDTHS NOT TO SCALE.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	12/20/96	GENERAL REVISION	
2	01/13/97	ADD NOTE	
3	03/2009	REVISE BASE GRADES	JR

DRAWING TITLE: CROSS-SECTION 7-7

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
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PROJ. NO.: 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
CHK. BY: DJM | APP. BY: JRM | EDIT. BY: JR

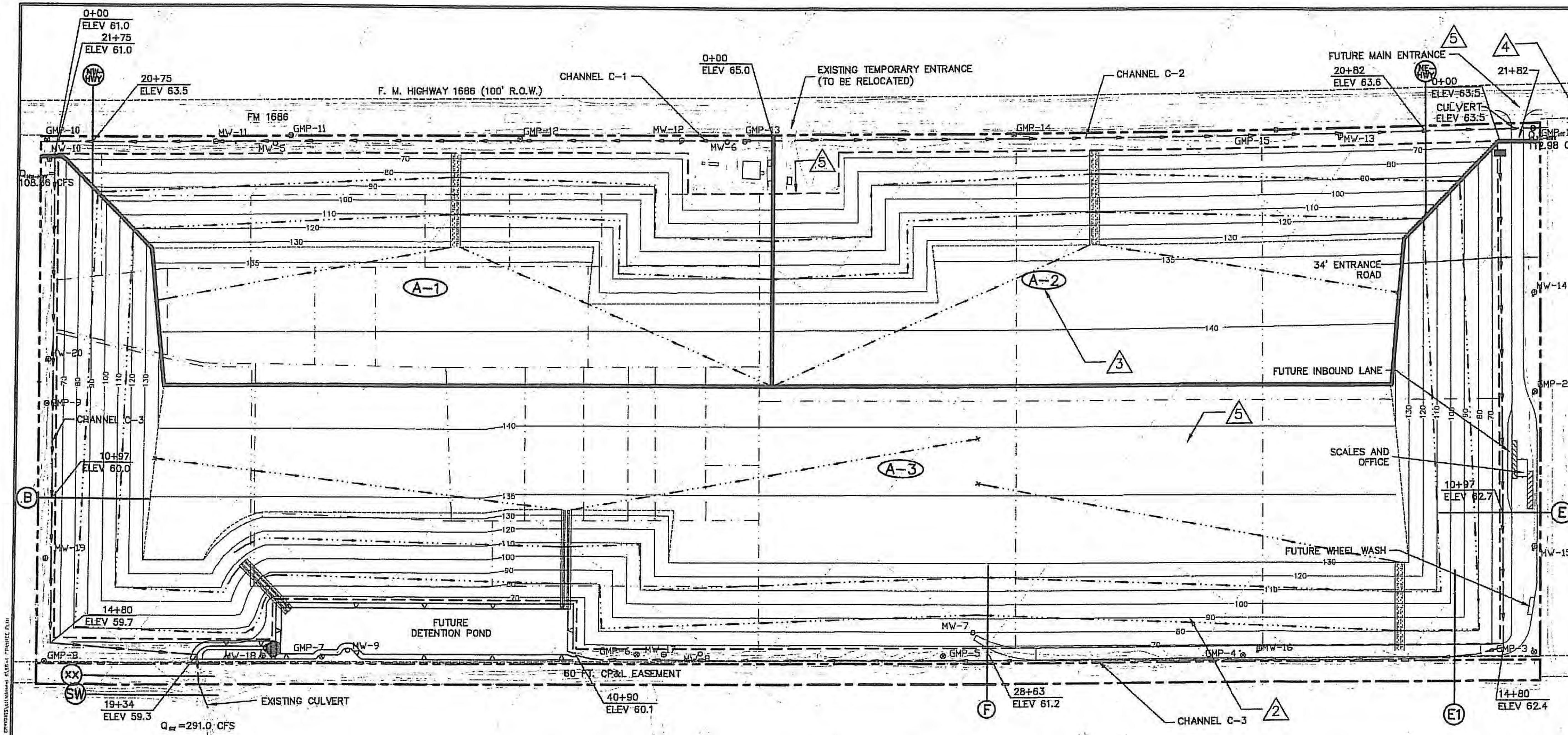
CADD FILE: 2J-CROSS SECTION 7-7

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

2J



NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

0 150 300
SCALE IN FEET

DRAINAGE AREA NO.	AREA (ACRES)
A-1	31.0
A-2	32.3
A-3	91.5

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- LIMITS OF WASTE
- STATE PLANE COORDINATE
- 70 EXISTING CONTOUR
- 66 PROPOSED FINAL CONTOUR
- A-2 DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 GAS MONITORING PROBES
- MW-17 GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 INDICATES REVISION

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER

3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY NEVZAT TURAN (TEXAS P.E. 84059) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	01/2007	UPDATED PEAK FLOWS, 10 FT HEIGHT INCREASE	
5	03/2008	REVISED SWALES, FOOTPRINT	

DRAWING TITLE
DRAINAGE DESIGN

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
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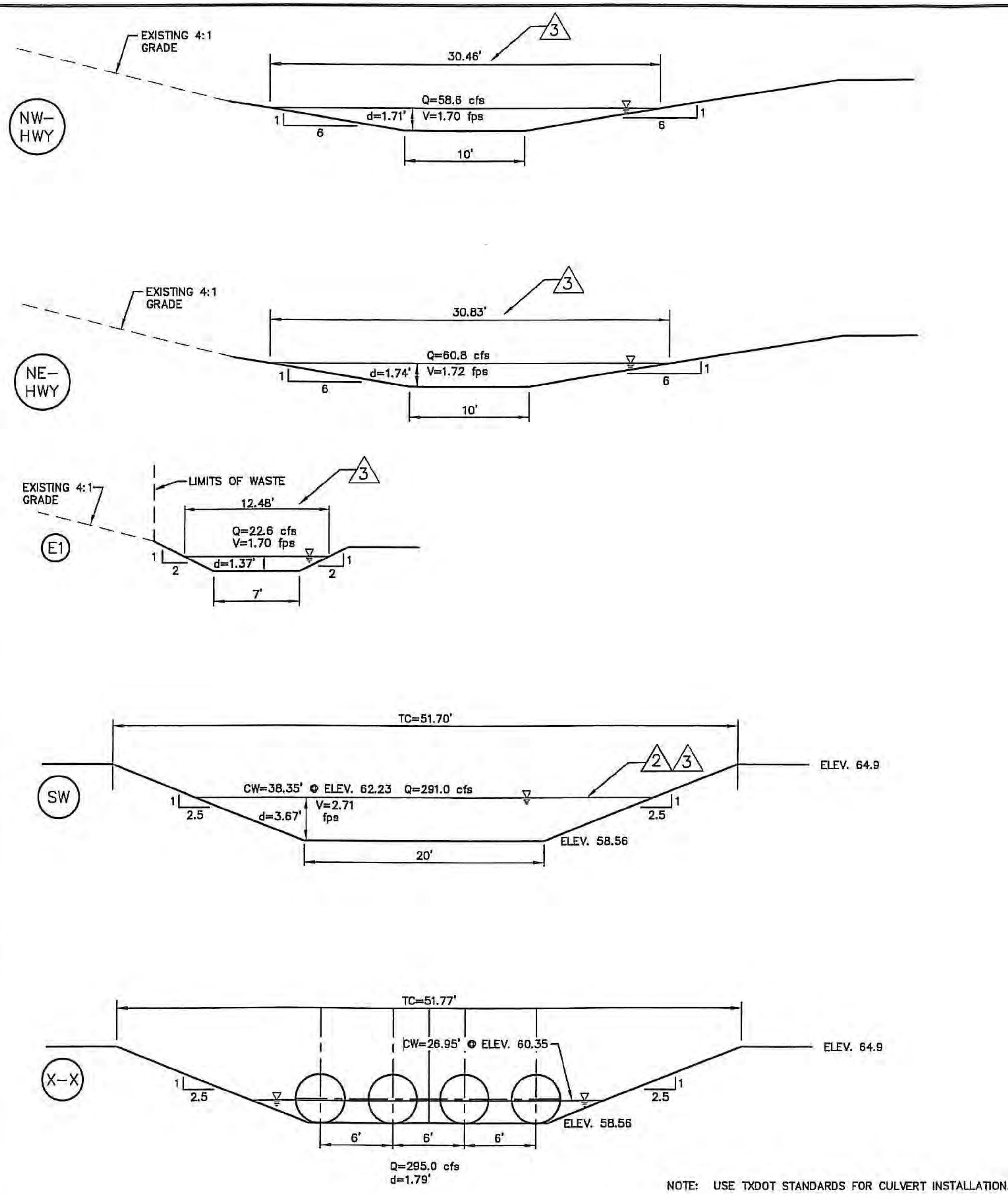
PROJ. NO. 16208541	DWN. BY: JLJ	Q/A RVW BY: DJM
DSN. BY: JR	CHK. BY: DJM	APP. BY: JRM

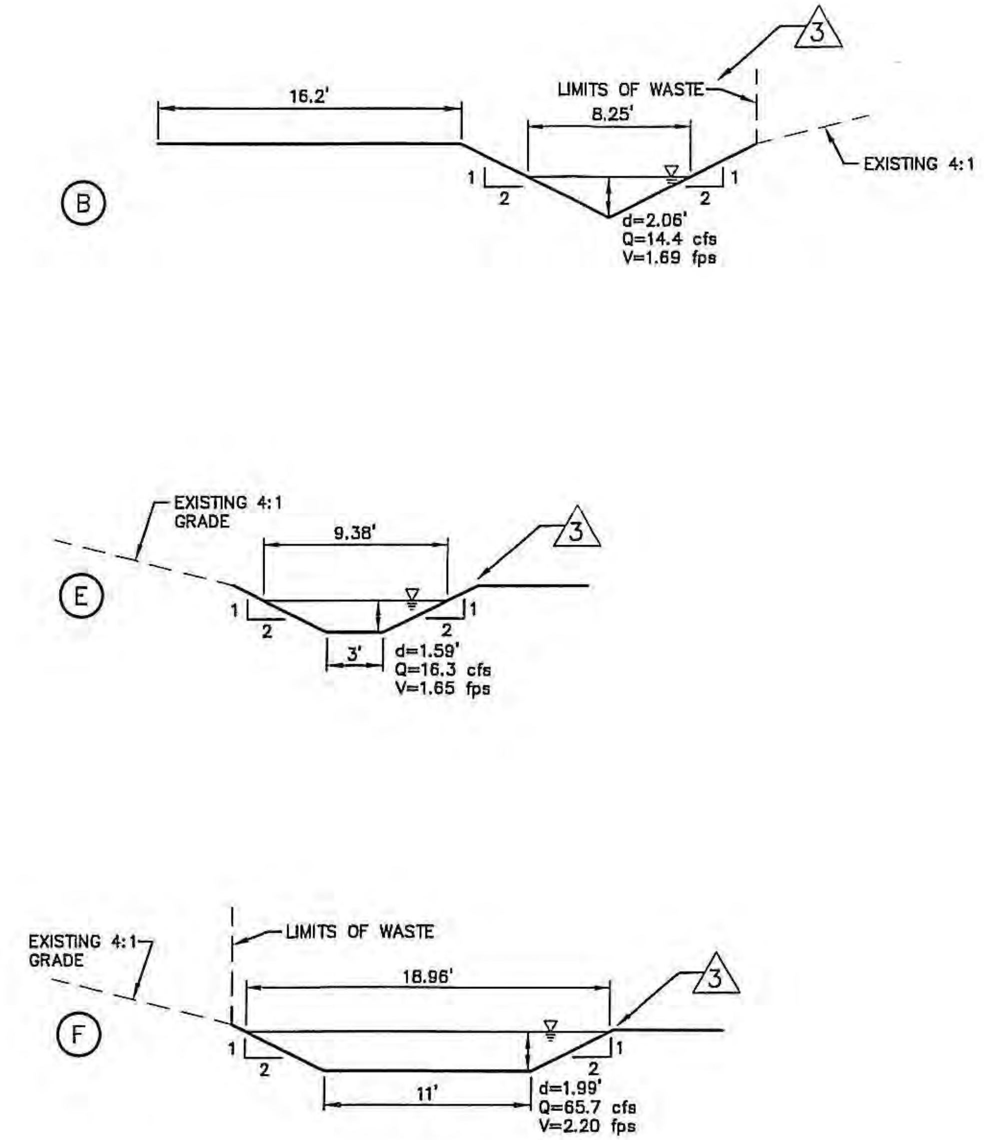
CADD FILE: 6B-1 DRAINAGE PLAN

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT
6B-1





0 5 10
SCALE IN FEET

NOTES:

1. ALL ELEVATIONS SHOWN ARE IN FT-MSL.
2. WATER SURFACE ELEVATIONS SHOWN REPRESENT THE 24-HOUR, 25 YEAR STORM EVENT.

2 INDICATES REVISION

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
3	03/2009	UPDATED FOR PEAK FLOWS, DEPTHS, VELOCITIES AND CHANNEL STATIONS (I.E. REMOVED SECTIONS C AND H)	
2	01/2007	UPDATED FOR PEAK FLOWS, DEPTH AND VELOCITIES	
1	03/2009	UPDATED FOR PEAK FLOWS, DEPTH AND VELOCITIES	

DRAWING TITLE: CROSS SECTIONS

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

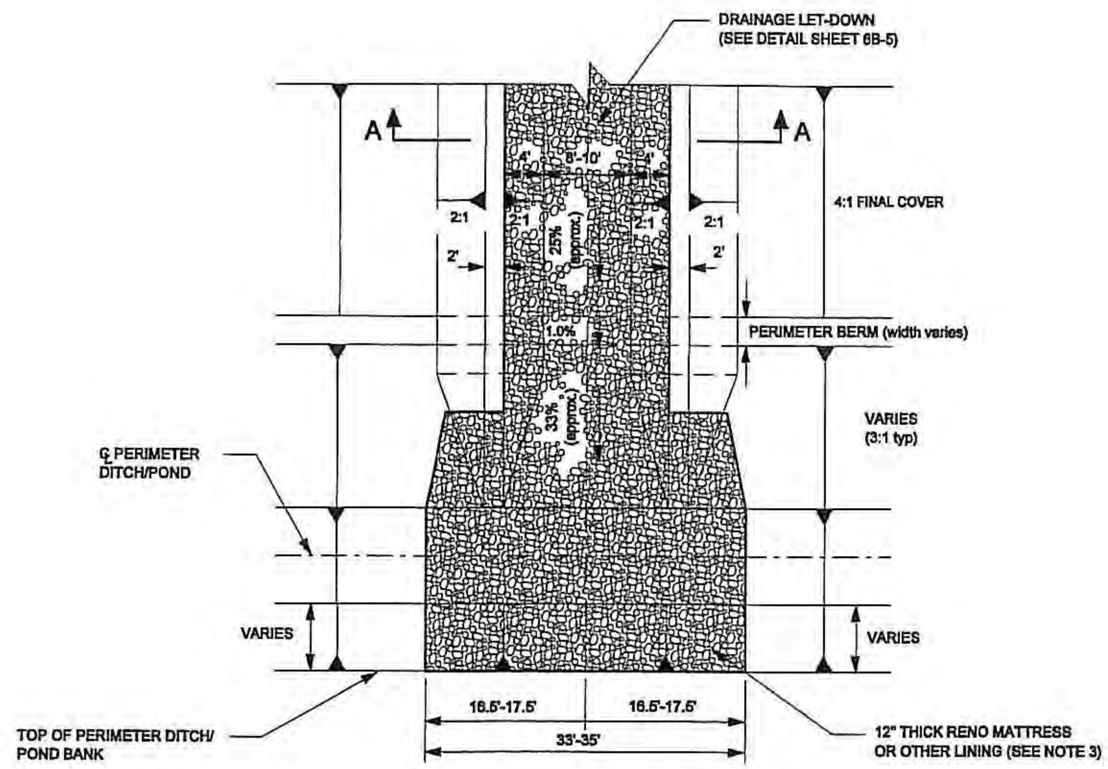
CADD FILE: 6B-2 CROSS SECTIONS

DATE: 11/2008

SCALE: AS SHOWN

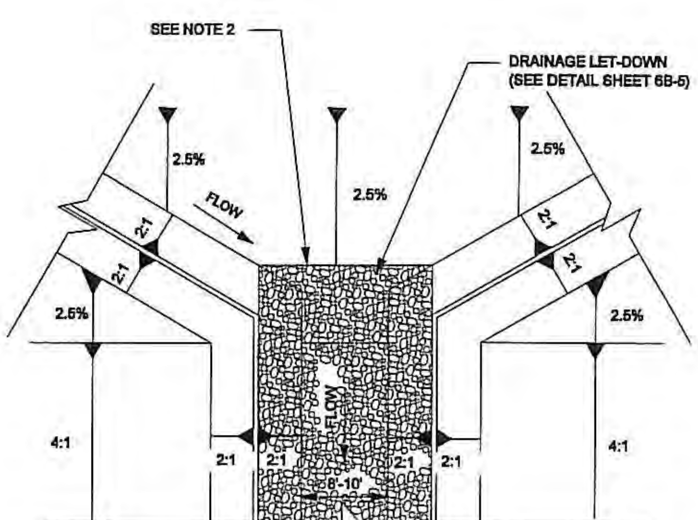
ATTACHMENT

6B-2



CHUTE WITH ENERGY DISSAPATOR

SCALE: 1" = 20'

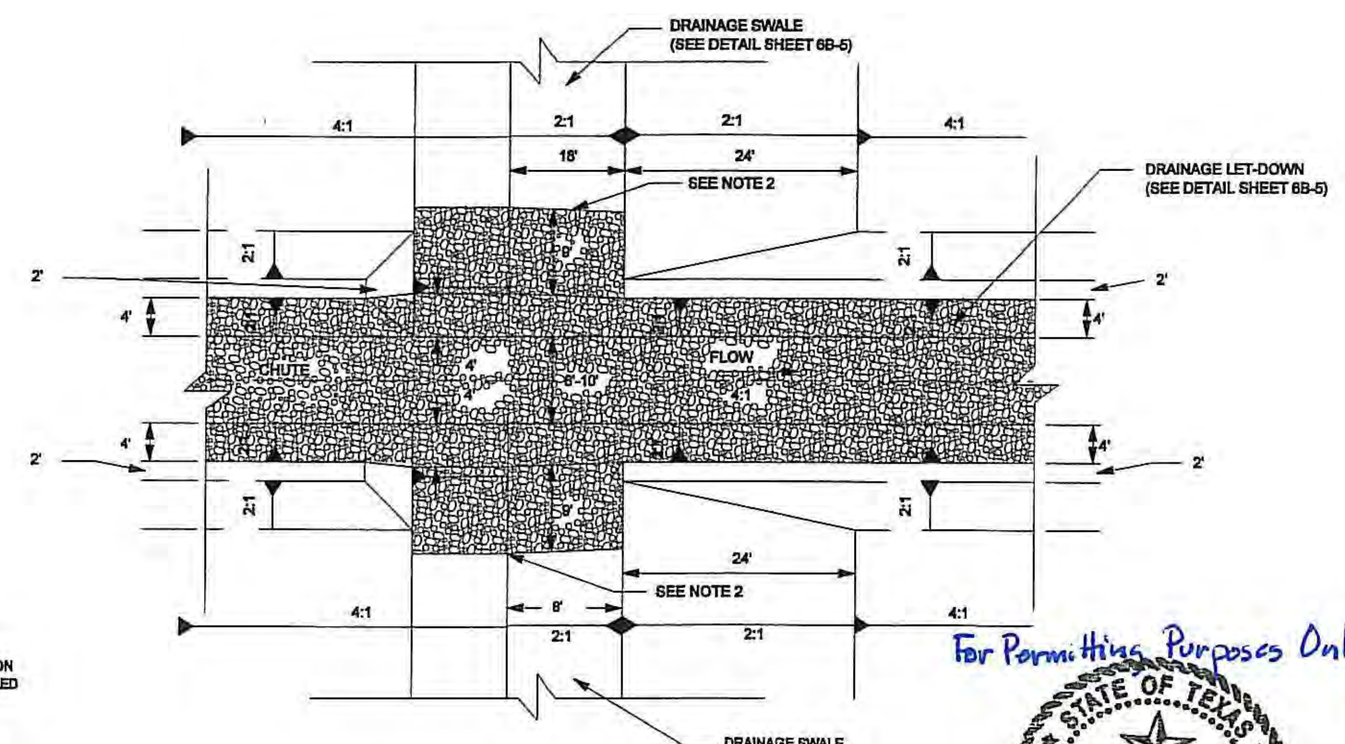


TOP OF CHUTE

NOT TO SCALE

NOTES

1. EROSION PROTECTION SHALL BE RENO MATTRESS OR GABION FOR DOWNDRAIN. EROSION PROTECTION SHALL BE INSTALLED PER MANUFACTURE'S RECOMMENDATION.
2. TOP OF EROSION PROTECTION SHALL BE FLUSH WITH FLOWLINE OF DRAINAGE SWALE.
3. ALL DIMENSIONS ARE MINIMUM UNLESS SPECIFIED OTHERWISE.



SWALE AND CHUTE INTERSECTION

SCALE: 1" = 20'

For Permitting Purposes Only

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER

3/29/09

REV	DATE	DESCRIPTION	BY
			DJH

DRAWING TITLE: DRAINAGE DETAILS

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST, HOUSTON, TEXAS, 77077
PH (281) 397-9747 FAX NO. (281) 293-7878

PROJ. NO. 16208541.00

CADD FILE: b-4.dgn

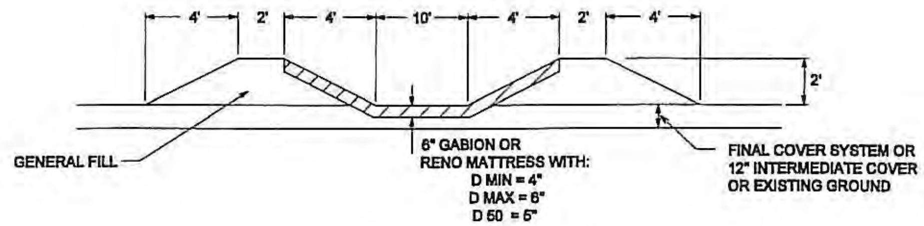
DATE: 1-2009

SCALE: AS SHOWN

ATTACHMENT

6B-4

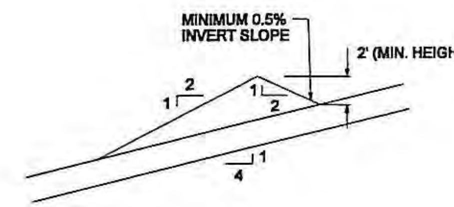
\dgn\Victoria\cadd\8541\b-4.dgn Apr. 08, 2009 10:29:38



NOTE: ALL DIMENSIONS ARE APPROXIMATE

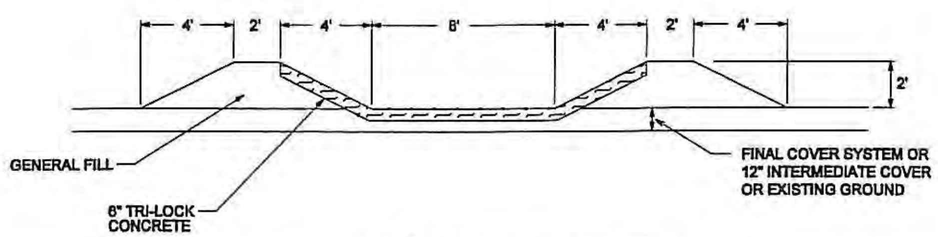
A-A
DRAINAGE LET-DOWN STRUCTURE
6" GABION OR RENO MATTRESS

N.T.S.



DRAINAGE SWALE (TYP.)

N.T.S.



NOTE: ALL DIMENSIONS ARE APPROXIMATE

A-A
DRAINAGE LET-DOWN STRUCTURE
6" TRI-LOCK CONCRETE

N.T.S.

NOTE: ALL DIMENSIONS ARE APPROXIMATE AND MINIMUM DIMENSIONS

For Permitting Purposes Only

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER
3/29/09

REV	DATE	DESCRIPTION	BY
			DJH

DRAWING TITLE: **DRAINAGE DETAILS**

PROJECT TITLE: **PERMIT MODIFICATION**

CLIENT: **REPUBLIC WASTE SERVICES**
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST, HOUSTON, TEXAS, 77077
PH (281) 307-0747 FAX NO. (281) 293-7878

PROJ. NO. 16208541.00

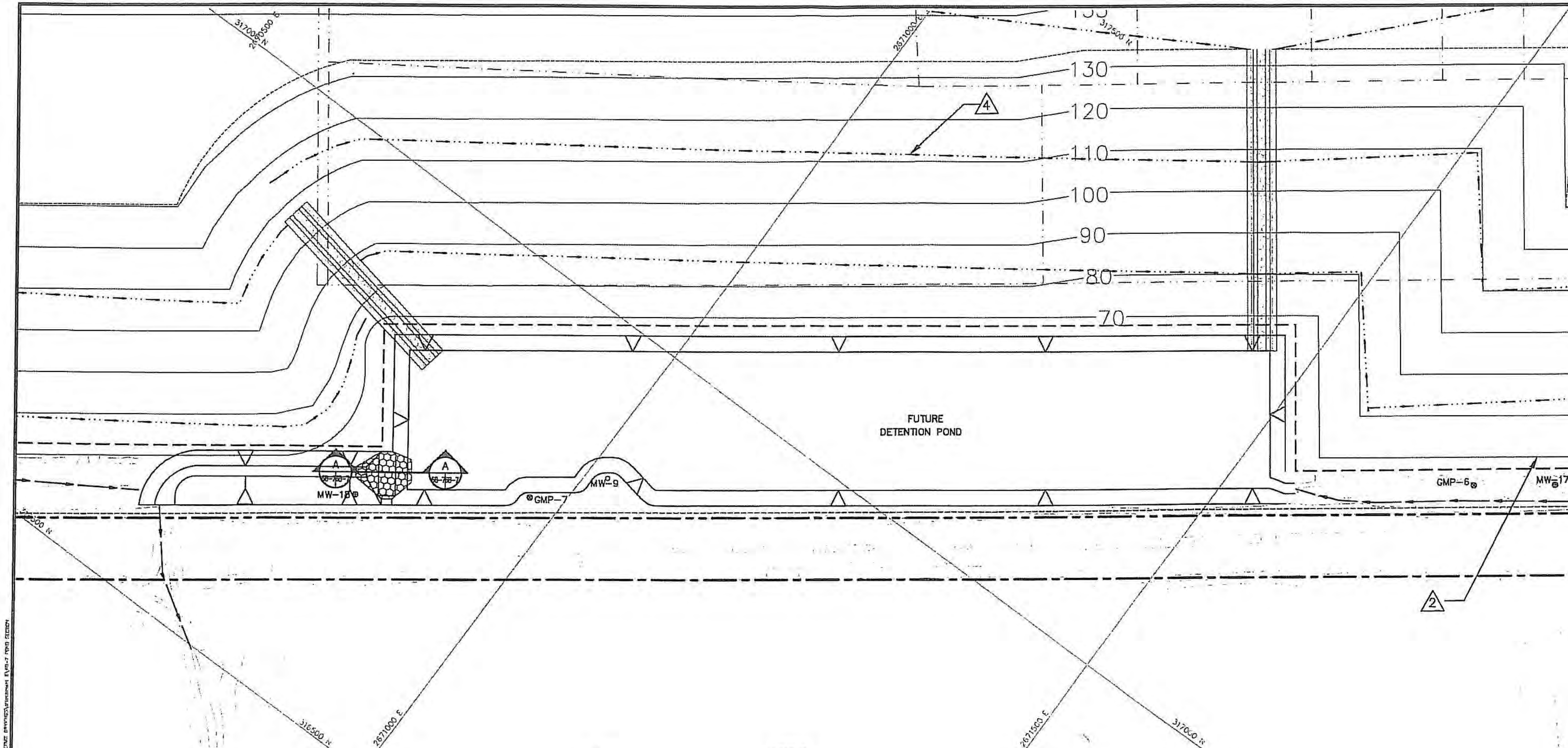
CADD FILE:

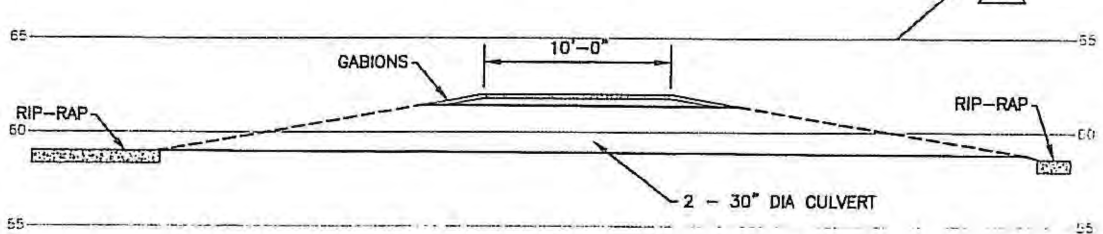
DATE: 1-2009

SCALE: AS SHOWN

ATTACHMENT

6B-5





DETENTION POND OUTLET STRUCTURE A 6B-7 6B-7

SCALE IN FEET

LEGEND

	PERMIT BOUNDARY
	PROPERTY LINE
	LIMITS OF WASTE
2672000 E	STATE PLANE COORDINATE
	EXISTING CONTOUR
66	PROPOSED FINAL CONTOUR
	PROPOSED DRAINAGE LETDOWN
	PROPOSED DRAINAGE SWALE
	PERIMETER CHANNEL FLOWLINE
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
2	INDICATES REVISION

0 50 100
SCALE IN FEET

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER

3/29/09

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	DRAWING ADDED TO SHOW DETENTION POND PLAN	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED PERIMETER DRAINAGE CALCULATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED SWALES AND LETDOWNS	

DRAWING TITLE
DETENTION POND PLAN

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
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PH (281) 397-6747 FAX NO. (281) 293-7878

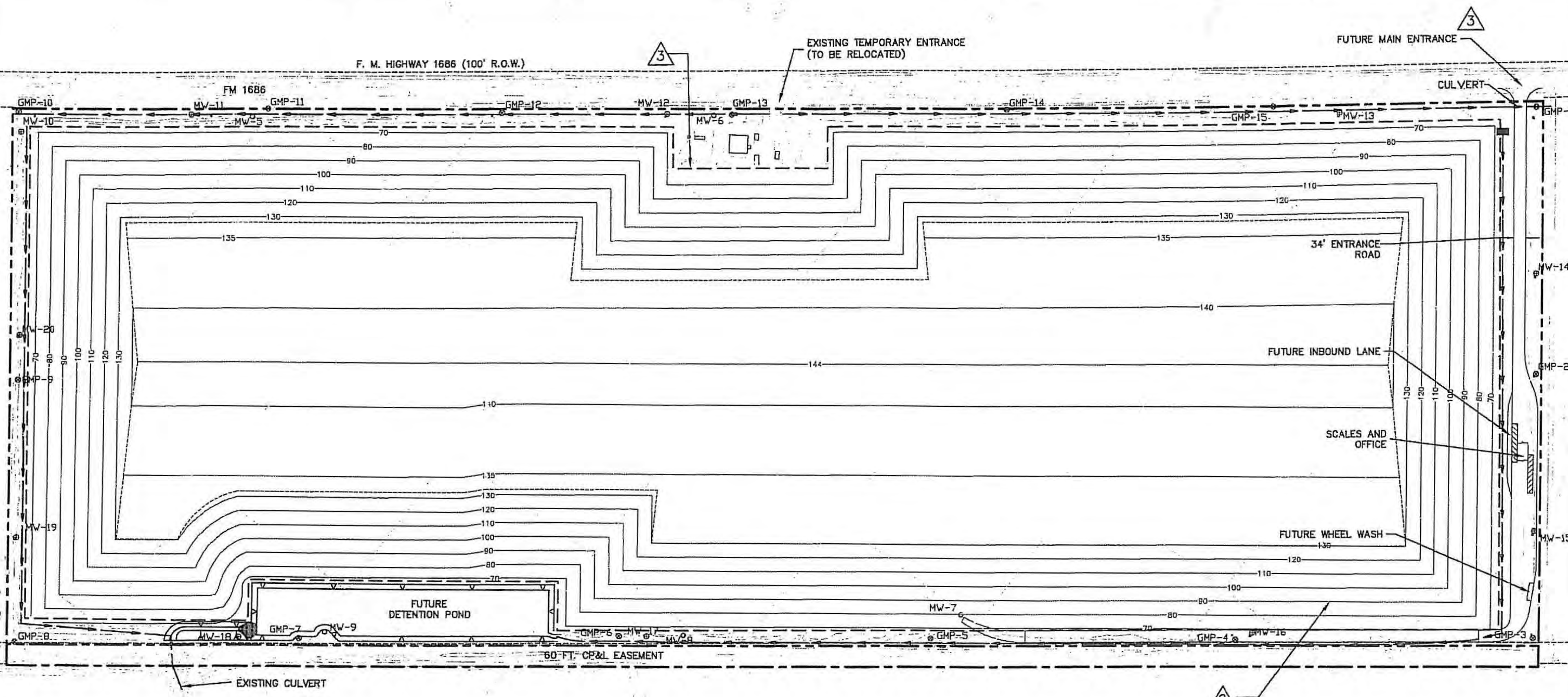
PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

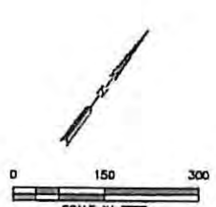
CADD FILE: 6B-7 POND SECTION

DATE: 11/2008.

SCALE: AS SHOWN

ATTACHMENT
6B-7





NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.
2. SEE ATTACHMENT 6 DRAINAGE PLAN FOR DESIGN, CALCULATIONS, AND TABULATIONS OF SURFACE DRAINAGE.
3. SEE ATTACHMENT 12 FINAL CLOSURE PLAN FOR FINAL SLOPE DESIGN AND CALCULATIONS, AND VEGETATION AND EROSION CONTROL DETAILS.
4. SEE ATTACHMENT 2 FILL CROSS-SECTIONS FOR CROSS-SECTIONS OF LANDFILL.
5. THE SITE DOES NOT LIE WITHIN THE 100-YEAR FLOODPLAIN.

LEGEND

	PERMIT BOUNDARY
	PROPERTY LINE
	LIMITS OF WASTE
	STATE PLANE COORDINATE
70	EXISTING CONTOUR
66	PROPOSED FINAL CONTOUR
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
	PERIMETER CHANNEL FLOWLINE
2	INDICATES REVISION

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER

3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	03/2009	REVISE FOOTPRINT, ENTRANCE	

DRAWING TITLE
FINAL CONTOUR MAP

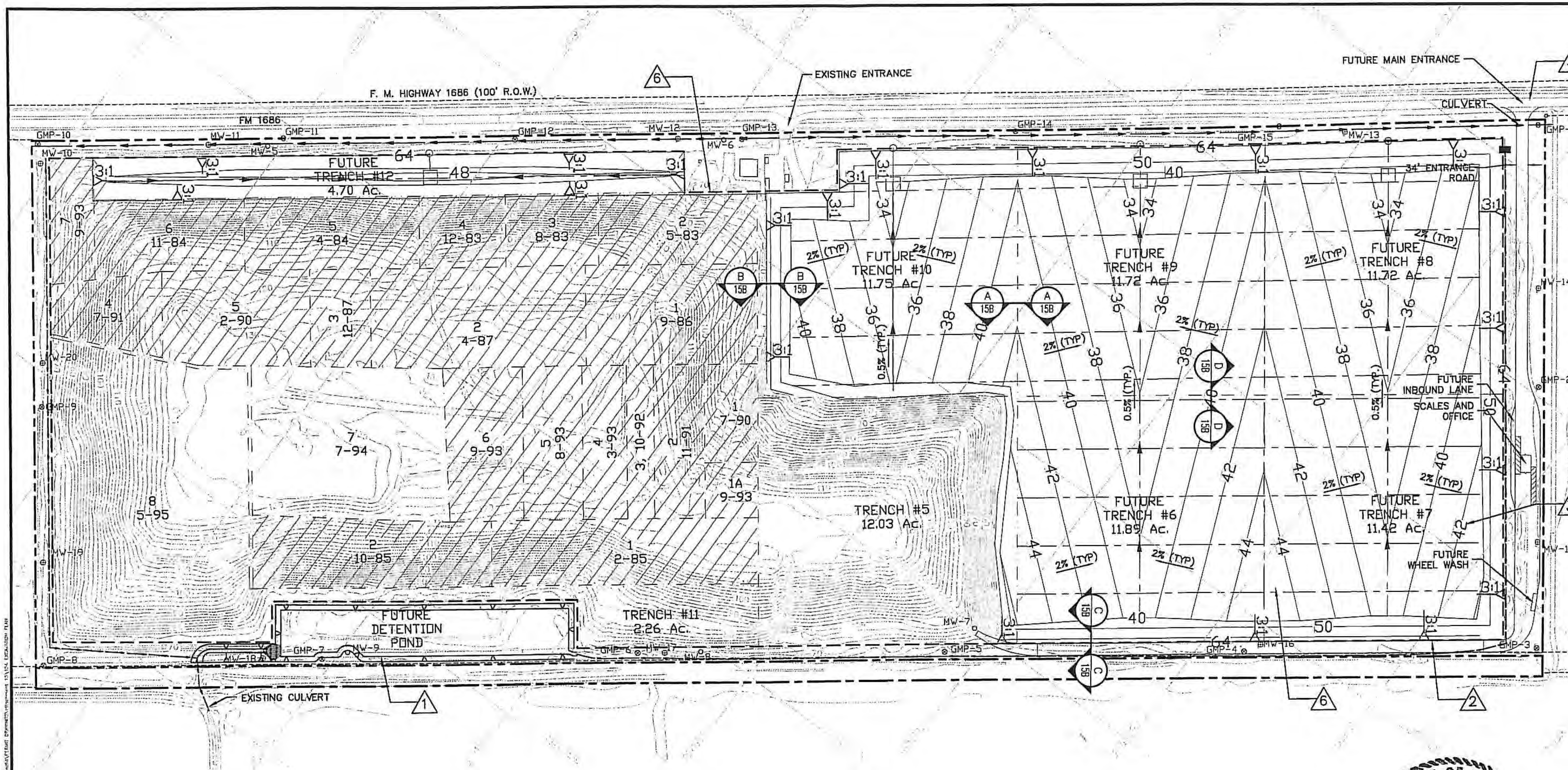
PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541	DWN. BY: JJ	Q/A RVW BY: DJM
DSN. BY: JR	CHK. BY: DJM	APP. BY: JRM

CADD FILE: 7-FINAL CONTOUR MAP
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
7



LEGEND

— - —	PERMIT BOUNDARY
— — —	PROPERTY LINE
- - - -	LIMITS OF WASTE
	STATE PLANE COORDINATE
—70—	EXISTING CONTOUR
—40—	EXCAVATION CONTOUR
x64	PROPOSED ROAD SPOT ELEVATION
	LCS PIPE (8")
	LCS LATERAL PIPE (6")
	LCS SUMP AND SUMP RISER
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
	PERIMETER CHANNEL FLOWLINE
1	INDICATES REVISION
	PRE-SUBTITLE D CELLS 5

0 150 300
SCALE IN FEET

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 8, 2008.
2. ALL EXCAVATION GRADES ARE ABOVE MEAN SEA LEVEL.
3. IF A GEOSYNTHETIC DRAINAGE LAYER IS USED FOR THE LEACHATE COLLECTION SYSTEM IN LIEU OF THE GRANULAR DRAINAGE LAYER, THE LCS LATERAL PIPES MAY BE OMITTED IN THOSE AREAS.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY JFK GROUP, AND SIGNED AND SEALED BY JEFFREY P. YOUNG (TEXAS P.E. 79809) ON MARCH 8, 2006. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED NOVEMBER 2008 AND MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	ADDED WASTE FILL AREA AND ADDED DETENTION POND	
2	03/2006	REDUCED WASTE FOOTPRINT	
3	03/2006	REVISED EXCAVATION PLAN	
4	03/2006	UPDATED ENTRANCE LOCATION	
5	11/2008	REVISED LEACHATE COLLECTION SYSTEM NOTE	JR
6	03/2009	REVISED EXCAVATION PLAN AND WASTE FOOTPRINT	JR

DRAWING TITLE: EXCAVATION PLAN

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
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PROJ. NO. 16208541 | DWN. BY: RJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

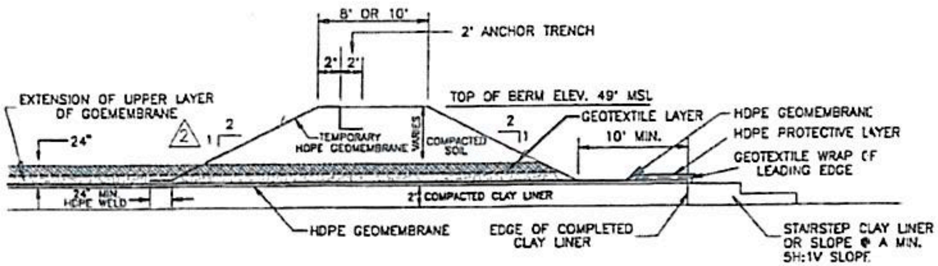
CADD FILE: 15A EXCAVATION PLAN

DATE: 11/2008

SCALE: AS SHOWN

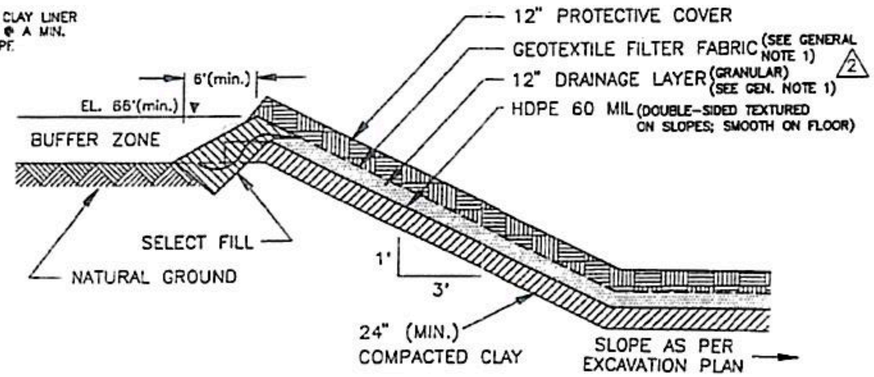
ATTACHMENT **15A**

CROSS-SECTION A-A

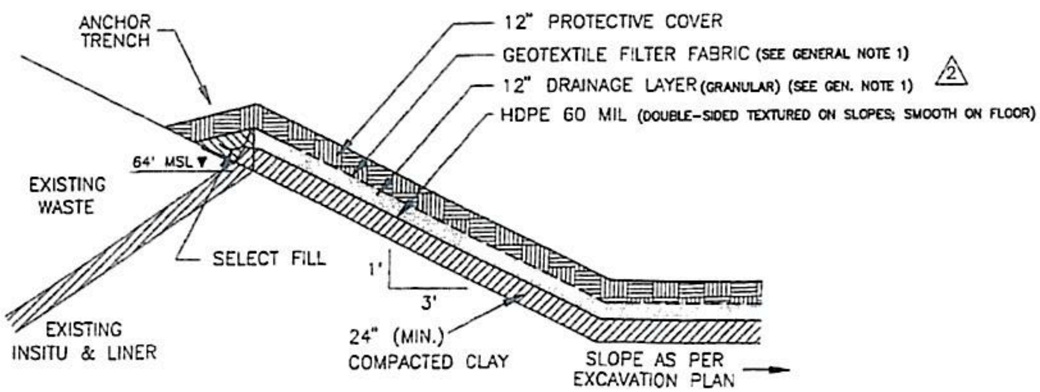


NOTES:
1) THE SAND LAYER IS SEPARATED BY 60 MIL HDPE GEOMEMBRANE ON WASTE SIDE OF BERM TO TEMPORARILY PREVENT LEACHATE FROM TRAVELING UNDER THE BERM. THIS TEMPORARILY HDPE GEOMEMBRANE WILL BE REMOVED UPON COMPLETION OF THE NEXT CELL.
2) ALL TEMPORARY BERM DIMENSION ARE TYPICAL

CROSS-SECTION C-C
HDPE LINER ANCHOR DETAIL AT NATURAL GRADE



CROSS-SECTION B-B
SIDE SLOPE TIE-IN WITH EXISTING INSITU LINERS



GENERAL NOTE: 2

1. THE 12" GRANULAR DRAINAGE LAYER AND GEOTEXTILE FILTER FABRIC MAY BE REPLACED WITH A GEONET AND GEOTEXTILE (MAY BE SEPARATE OR HEAT BONDED ON FLOOR/ DOUBLE-SIDED GEOCOMPOSITE ON SLOPES) OVERLAIN WITH 24" PROTECTIVE COVER. SEE DETAILS ON ATTACHMENT 15B-1.

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY JFK GROUP, INC., AND SIGNED AND SEALED BY J. FLETCHER KELLY (TEXAS P.E. 61815) ON FEBRUARY 10, 1997. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED NOVEMBER 2008.

FOR PERMITTING PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

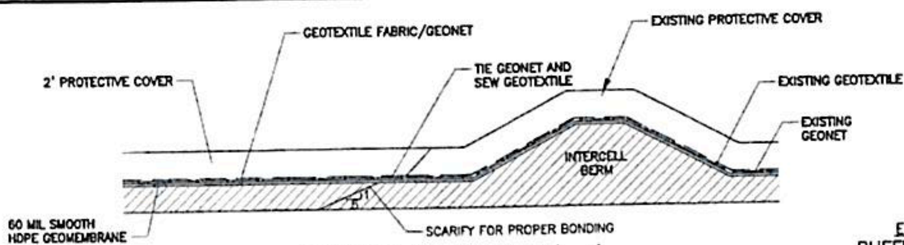
DRAWING TITLE: **LINER DETAIL**

PROJECT TITLE: **PERMIT MODIFICATION**

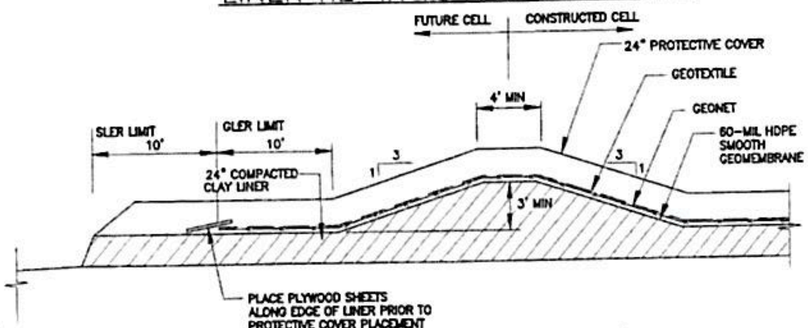
CLIENT: **REPUBLIC WASTE SERVICES**
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS

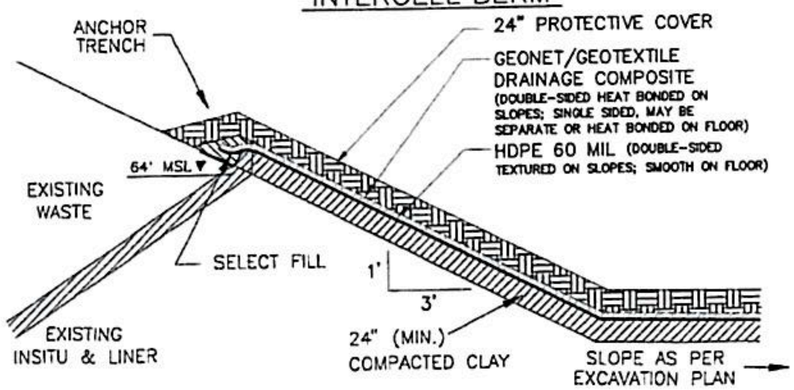
CADD FILE:
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
15B



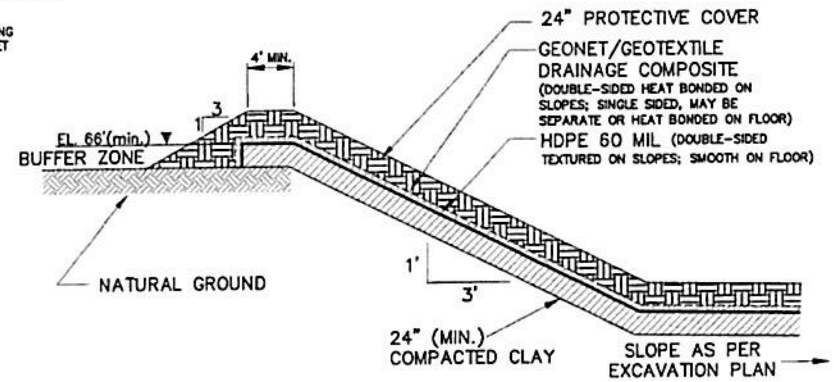
CROSS–SECTION A–A
LINER TIE–IN TO ADJACENT CELL



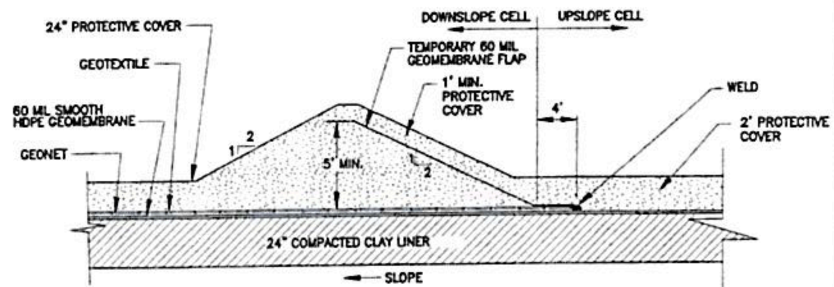
CROSS–SECTION A–A
INTERCELL BERM



CROSS–SECTION B–B
SIDE SLOPE TIE–IN
WITH EXISTING INSITU LINERS



CROSS–SECTION C–C
HDPE LINER ANCHOR DETAIL
AT NATURAL GRADE



NOTE:
THIS DETAIL IS TO BE USED IN THE EVENT A PARTIAL CELL IS CONSTRUCTED OR THE CELL IS DIVIDED BY A TEMPORARY RAINFLAP FOR STORMWATER CONTROL PURPOSES.

CROSS–SECTION D–D
TEMPORARY RAINFLAP

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
12/11/08

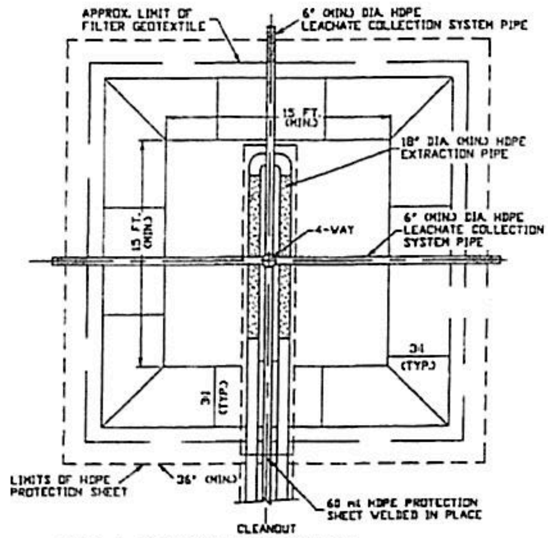
FOR PERMITTING PURPOSES ONLY

LINER DETAIL (WITH GEOCOMPOSITE)
PERMIT MODIFICATION

REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS

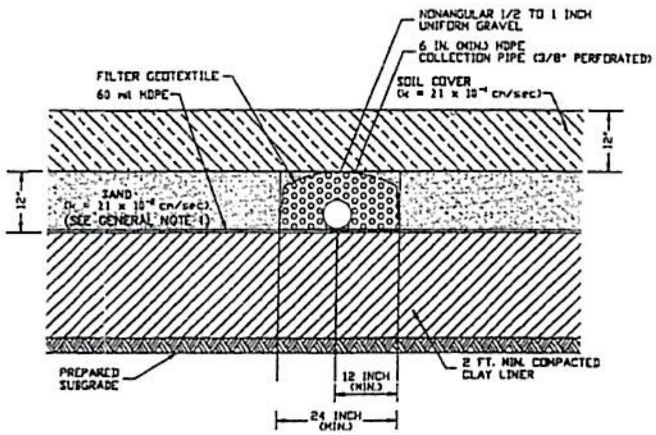
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
15B-1



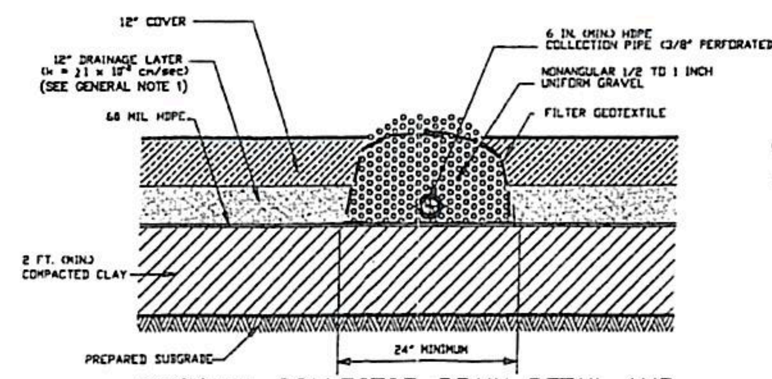
NOTES: 1. PERFORATIONS STOP AT LIMITS OF FILTER GEOTEXTILE (LEACHATE COLLECTION SYSTEM PIPE)

2. SECOND EXTRACTION PIPE IS OPTIONAL

LEACHATE COLLECTION SUMP



COLLECTOR DRAIN DETAIL
AND LEACHATE HEADER/LATERAL



OPTIONAL COLLECTOR DRAIN DETAIL AND
LEACHATE HEADER/LATERAL (CHIMNEY DRAIN)

GENERAL NOTE: 2

1. THE 12" GRANULAR DRAINAGE LAYER AND GEOTEXTILE FILTER FABRIC MAY BE REPLACED WITH A GEONET AND GEOTEXTILE (MAY BE SEPARATE OR HEAT BONDED ON FLOOR/ DOUBLE-SIDED GEOCOMPOSITE ON SLOPES) OVERLAIN WITH 24" PROTECTIVE COVER. SEE DETAILS ON ATTACHMENT 15C-1.

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY JFK GROUP, INC., AND SIGNED AND SEALED BY J. FLETCHER KELLY (TEXAS P.E. 61815) ON FEBRUARY 10, 1997. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED NOVEMBER 2008.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	[illegible]	[illegible]	
2	11/08	[illegible]	

DRAWING TITLE: DETAILED LEACHATE COLLECTION SUMP AND COLLECTOR DRAIN DETAIL

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS

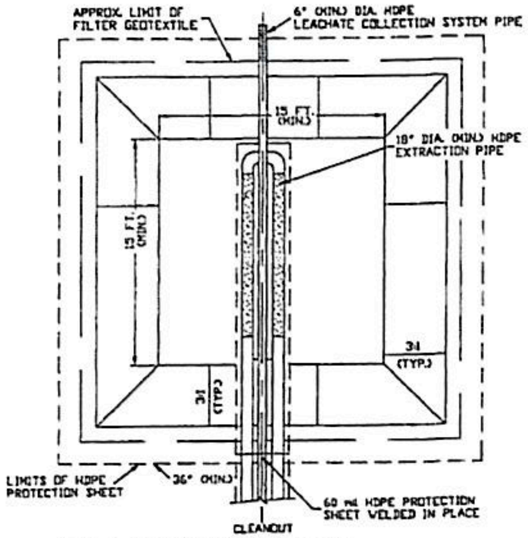
CADD FILE:

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

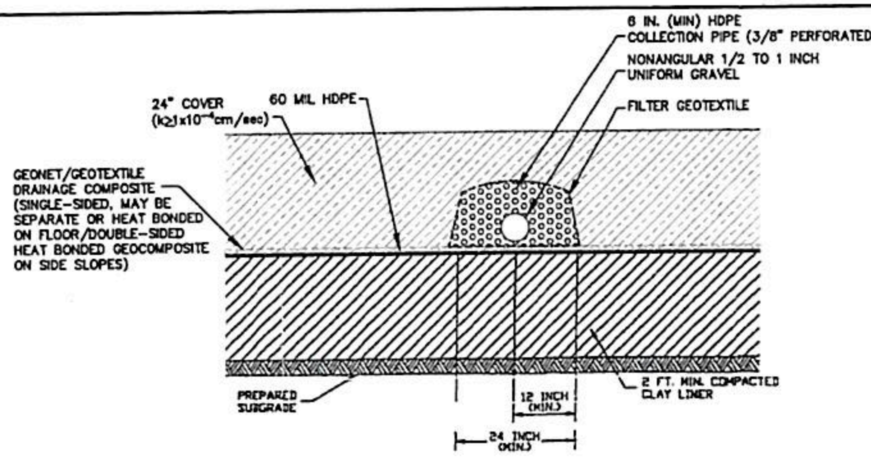
15C



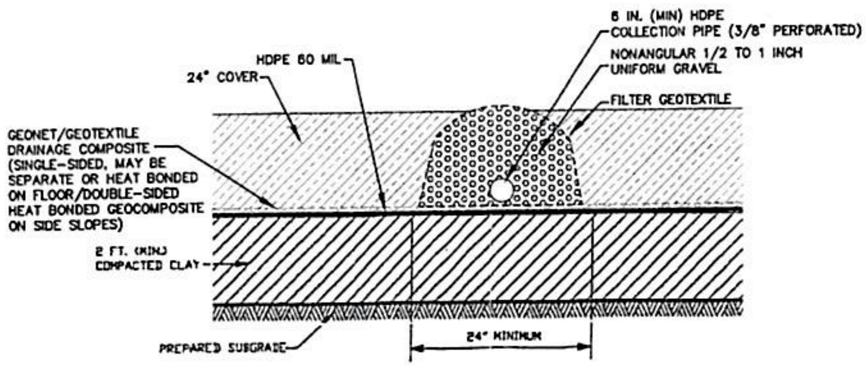
NOTES: 1. PERFORATIONS STOP AT LIMITS OF FILTER GEOTEXTILE (LEACHATE COLLECTION SYSTEM PIPE)

2. SECOND EXTRACTION PIPE IS OPTIONAL

LEACHATE COLLECTION SUMP



COLLECTOR DRAIN DETAIL AND LEACHATE HEADER/LATERAL



OPTIONAL COLLECTOR DRAIN DETAIL AND LEACHATE HEADER/LATERAL (CHIMNEY DRAIN)

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
12/11/08

FOR PERMITTING PURPOSES ONLY

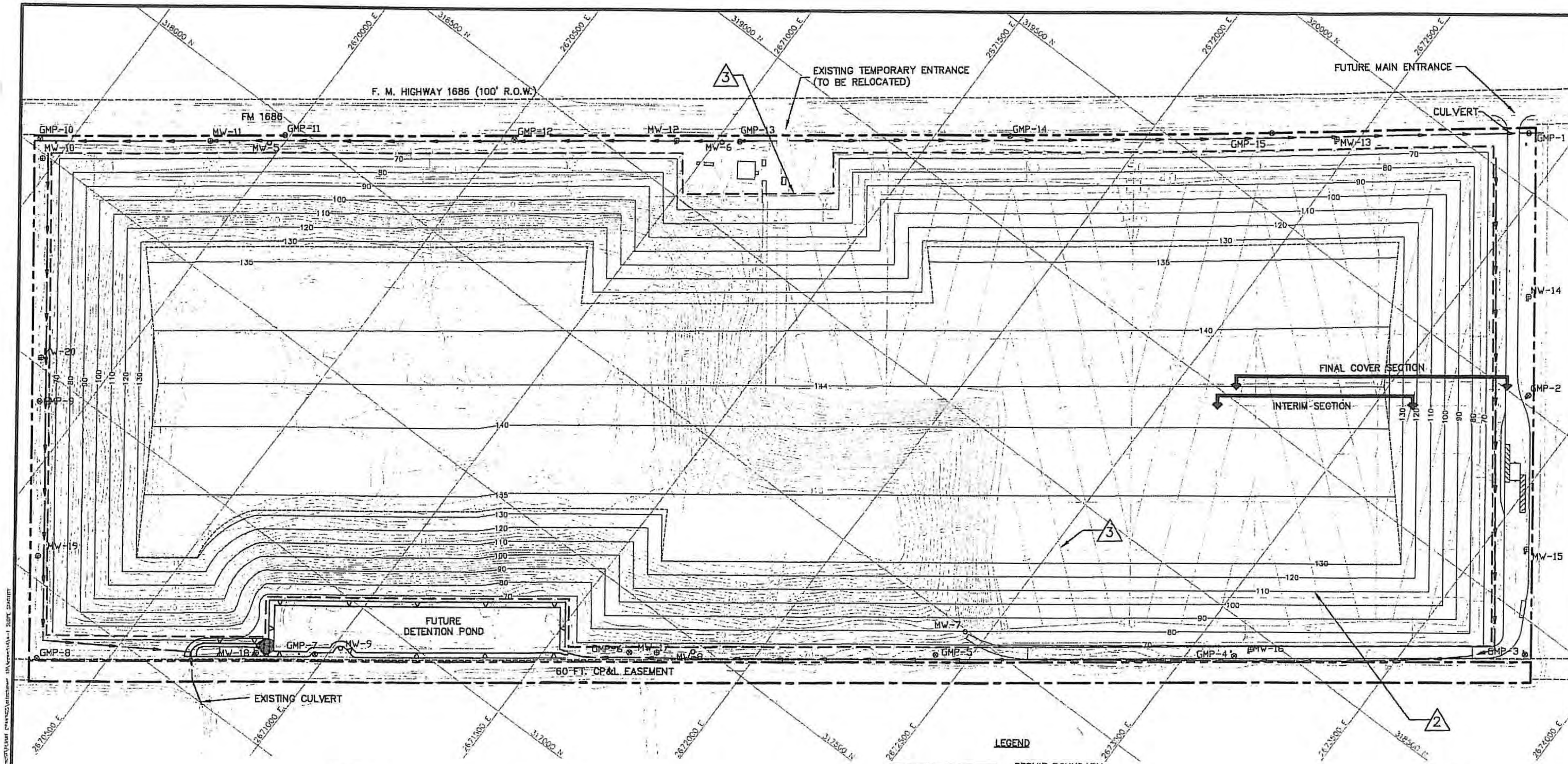
DETAILED LEACHATE COLLECTION SUMP AND COLLECTOR DRAIN DETAIL (WITH GEOCOMPOSITE)

PERMIT MODIFICATION

REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS

DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
15C-1



LEGEND

— - —	PERMIT BOUNDARY
— - - —	PROPERTY LINE
— — —	LIMITS OF WASTE
2672000 E	STATE PLANE COORDINATE
70	EXISTING CONTOUR
66	PROPOSED FINAL CONTOUR
40	TOP OF PROTECTIVE COVER CONTOUR
	PROPOSED DRAINAGE SWALE
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
	PERIMETER CHANNEL FLOWLINE
2	INDICATES REVISION

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

0 150 300
SCALE IN FEET

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER

3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY NEVZAT TURAN (TEXAS P.E. 84059) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	03/2009	REVISE BASE GRADES, FOOTPRINT	JR

DRAWING TITLE: SLOPE STABILITY CROSS-SECTION LOCATION MAP

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
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12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-8747 FAX NO. (281) 293-7878

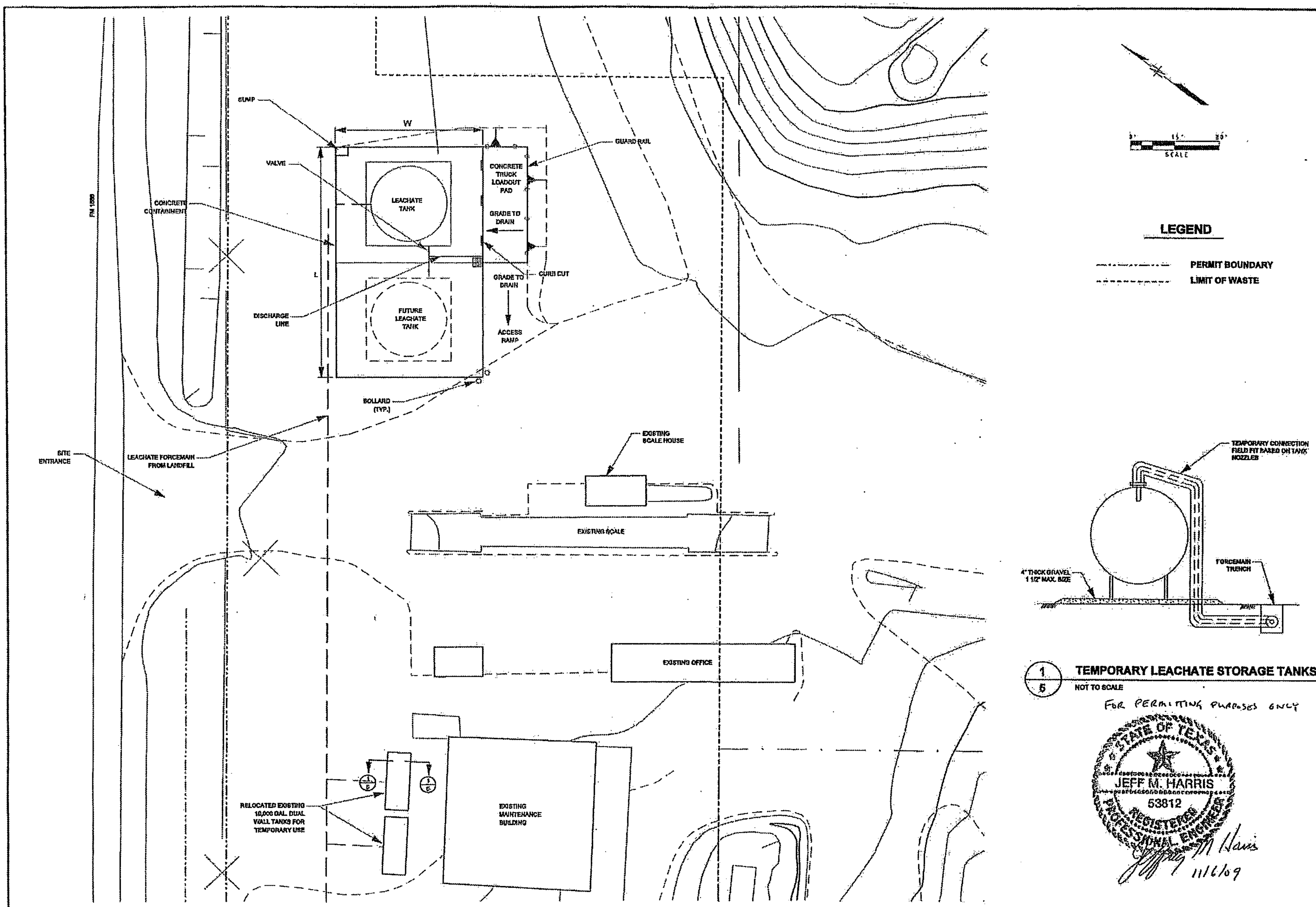
PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
CHK. BY: JR | CK. BY: DJM | APP. BY: JRM

CADD FILE: A-1 SLOPE STABILITY

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT 15F



REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LEACHATE STORAGE FACILITY

PROJECT TITLE
LEACHATE FORCEMAIN AND STORAGE FACILITY CONSTRUCTION DRAWINGS

CLIENT
CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST, HOUSTON, TEXAS 77077
PH (281) 397-8747 FAX NO. (281) 293-7676

CADD FILE: att15g-1a.dgn
DATE: 7-2009
SCALE: AS SHOWN
ATTACHMENT
15G-1A

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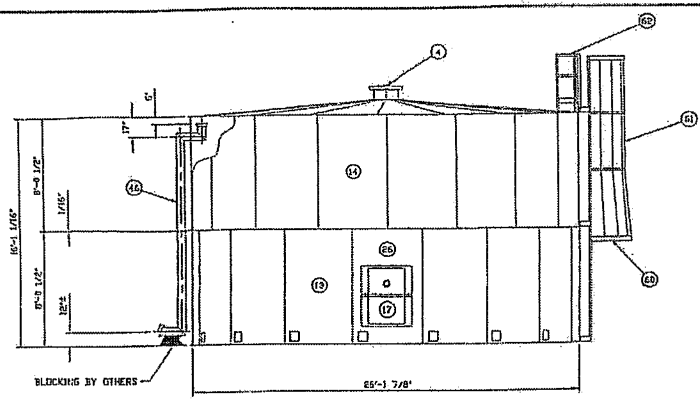
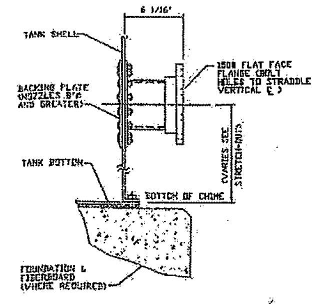


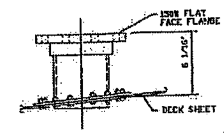
ELEVATION

BOLTED STEEL LEACHATE STORAGE TANK
(60,000 GAL. NOMINAL CAPACITY)

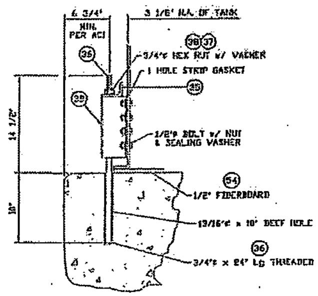


TYPICAL EXTERIOR NOZZLE INSTALLATION

NOTE:
ALL NOZZLES ARE RADIAL UNLESS NOTED AS PARALLEL



TYPICAL HILLSIDE NOZZLE INSTALLATION



3/4" HILTI ANCHORING DETAIL

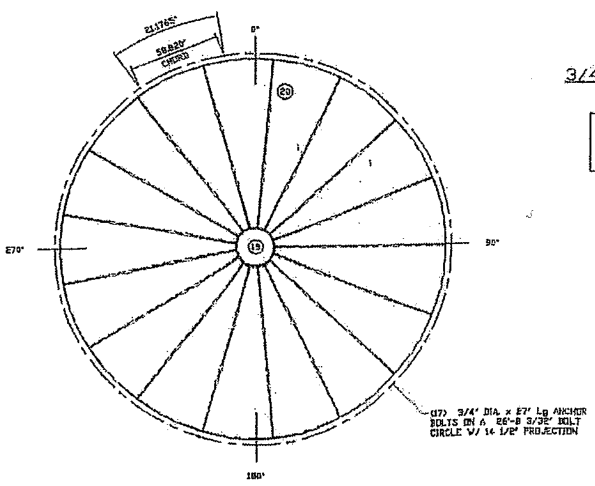
NOTE:
IT IS THE CUSTOMERS RESPONSIBILITY TO DRILL THE ANCHORS AND TO PROVIDE ADHESIVE.

For Permitting Purposes only

STATE OF TEXAS
JEFF M. HARRIS
53812
REGISTERED PROFESSIONAL ENGINEER

Jeffrey M. Harris 11/2/09

SCS Engrs.
Reg. No. F-3407



BOTTOM PLAN

ANCHOR PLAN NOT TO SCALE

NOTES:

1. THIS BILL OF MATERIAL IS FOR ONE TANK.
2. DRAWINGS ARE REQUIRED FOR FIELD USE.
3. INTERIOR AND BOTH SIDES OF BOTTOM PAINTED TWO COATS TRICO BOND THERMOSET CORROSION RESISTANT EPOXY (7 mls average, DFT). EXTERIOR FOUR COAT TRICO BOND PAINT SYSTEM CONSISTING OF ONE COAT OF ZINC RICH PRIMER (2.5 mls avg. DFT), TWO INTERMEDIATE COATS OF EPOXY (4.5 mls avg. DFT) AND ONE TOPCOAT OF TAN POLYURETHANE (1.5 mls avg. DFT) WITH A TOTAL OF 8.5 mls avg. DFT ON THE EXTERIOR.
4. TANK DESIGNED IN ACCORDANCE WITH AWWA D103-97 SPEC. SEISMIC ZONE 0, 90 MPH WINDLOAD, 15 PSF LIVE DECK LOAD.
5. STAVE SHOP DRAWING REQUIRED FOR FABRICATION; OTHERWISE, USE STRETCH-OUT FOR FABRICATION.
6. STANDARD CENTER DOME WITH VENT (EG'S) WILL RELIEVE 24 CFS (11,000 GPM) WHEN CLEAN. ADDITIONAL VENTING TO PREVENT A VACUUM GREATER THAN 0.4 oz. PER SQUARE INCH IS THE RESPONSIBILITY OF THE OWNER.
7. FIBERBOARD SHALL BE INSTALLED IN ACCORDANCE WITH AWWA D103-97, SECTION 11.4

ITEM	PART NUMBER	DESCRIPTION	QUANTITY
1		STD. 12 GA DECK SHEET	
2		12 GA DECK SHEET W/30" SQ. MANWAY OPNG	
3		30" SQUARE DECK MANWAY KIT	
4		MANHOLE COLLAR W/20"ø VENT (30 HL)	
5		12 GA DECK SHEET W/ LIQUID LEVEL IND OPNG	
6		DECK COVER PLATE (51 HL)	
7		LIQUID LEVEL INDICATOR - 16' HIGH TANK	
8		DECK SUPPORT RAFTER - C3 X 4.1	
9		RAFTER HANGER BRACKET	
10		12 GA DECK SHEET W/4"ø HILLSIDE NOZZLE OPNG	
11		ONE PIECE COLUMN - 4" DIA. SCH 40 PIPE X 202 3/8"	
12			
13		12 GA X 60" SP STV X 96 1/2" W/1 STR PCH	
14		12 GA X 60" SP STV X 96 1/2"	
15			
16			
17		30X46, 10 GA. SINGLE PUNCH CLEAN- OUT KIT	
18			
19		12 GA BOTTOM CENTER PLATE (51 HL)	
20		12 GA FLAT BOTTOM SHEET	
21			
22		12 GA X 60" SP STV X 96 1/2" W/1 STR PCH W/6"ø NZL OPNG	
23		12 GA X 60" SP STV X 96 1/2" W/1 STR PCH W/6"ø NZL OPNG	
24		12 GA X 60" SP STV X 96 1/2" W/1 STR PCH W/30X46 CLEANOUT OPNG	
25		12 GA X 60" SP STV X 96 1/2" W/1 STR PCH W/6"ø NZL OPNG	
26		12 GA X 60" SP STV X 96 1/2" W/6"ø NZL OPNG	
27		12 GA X 60" SP STV X 96 1/2" W/6"ø O-FLOW OPNG	
28			
29			
30			
31			
32			
33			
34			
35		STIRRUP CLIP ANGLE- 3" X 2" X 1/4 ANGLE X 4" LG GALV	
36		3/4"ø ALL-THREAD X 24 1/2" LG (A36)	
37		3/4" FLAT STEEL WASHER GALV	
38		3/4"ø HEX NUT - GALV	
39		ANCHOR BOLT STIRRUP - 3/16" X 8 3/4" X 11 23/32" GALV	
40			
41			
42			
43			
44		4"ø HILLSIDE NOZZLE KIT	
45		6"ø EXTERIOR NOZZLE KIT	
46		6"ø OVERFLOW DOWNCOMER KIT	
47			
48			
49			
50			
51			
52			
53			
54		1/2" IMPREGNATED FIBERBOARD, 48" X 5'-0"	
55			
56		EXTERIOR URETHANE TOUCH-UP PAINT	
57		URETHANE CURING AGENT	
58		INTERIOR EPOXY CURING AGENT (COMP.'B')	
59		INTERIOR EPOXY GOLD TOUCH-UP PAINT (COMP.'A')	
60		LOCKABLE HOOP ASSEMBLY	
61		EXTERIOR LADDER W/CAGE	
62		GUARDRAIL - 5' EACH SIDE OF LADDER W/ TOE BOARD	
63			
64		ERECTION MANUAL	
65			
66			
67		ELEVATION, BOTTOM PLAN & BILL OF MATERIAL	
68		STRUCTURE & DECK PLAN - CENTER COLUMN SUPPORTED	
69		TANK STRETCH-OUT	
70		LIQUID TANK DETAILS	
71			

REV	DATE	DESCRIPTION	BY
△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: LEACHATE STORAGE TANK

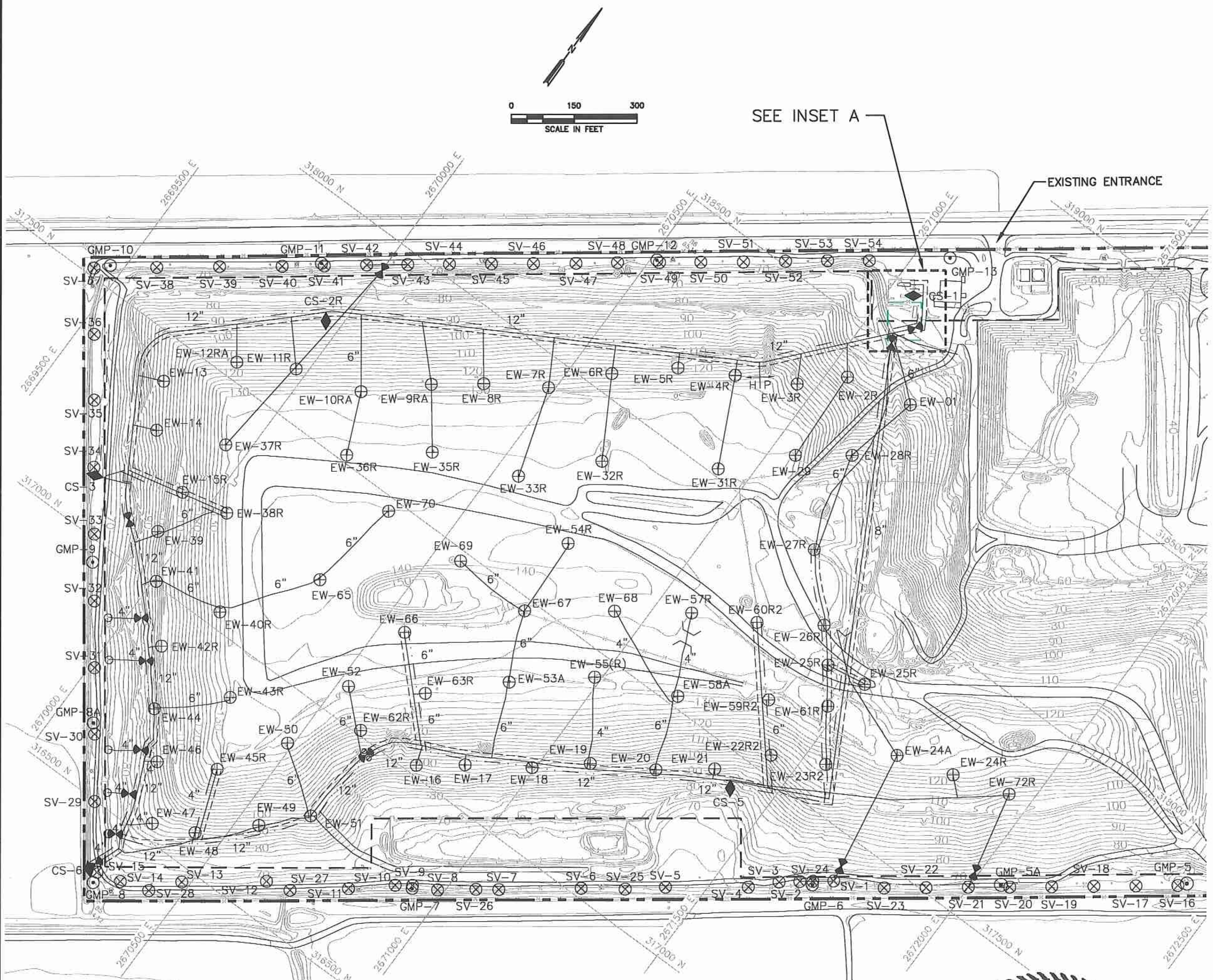
PROJECT TITLE: LEACHATE FORCEMAIN AND STORAGE FACILITY CONSTRUCTION DRAWINGS

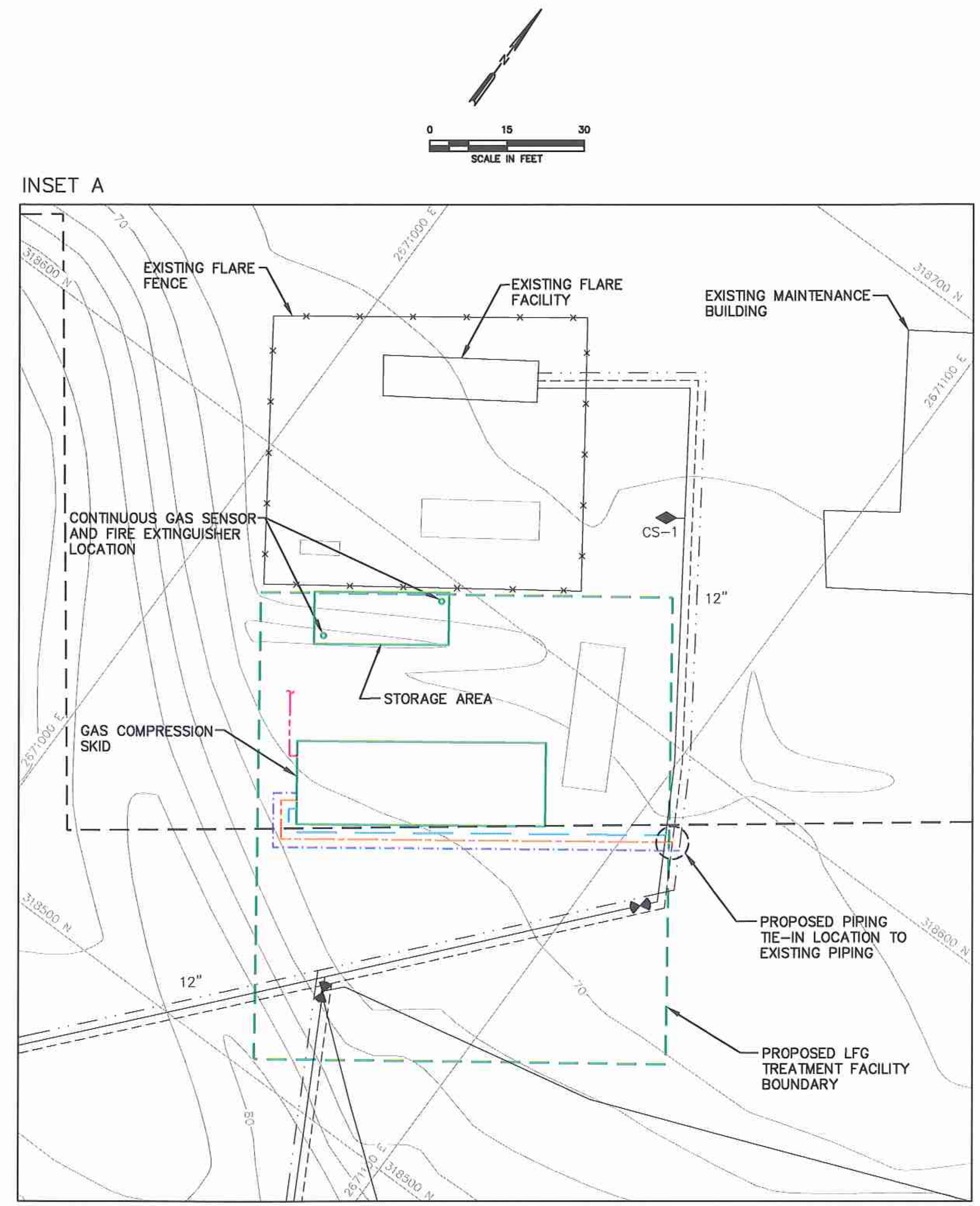
CLIENT: CITY OF VICTORIA LANDFILL VICTORIA COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST, HOUSTON, TEXAS, 77077
PH (281) 397-6747 FAX NO. (281) 293-7078

CADD FILE: att15g.dgn
DATE: 7-2009
SCALE: AS SHOWN
ATTACHMENT: 15G-1B

\scsidc\052003\att15g.dgn Oct. 27, 2009 17:06:17





LEGEND

	PERMIT BOUNDARY
	LIMITS OF WASTE
N 316000	STATE PLANE COORDINATE SYSTEM
110	EXISTING CONTOUR
GMP-10	EXISTING LFG MONITORING PROBE
	EXISTING GAS COLLECTION PIPING
EW-29	EXISTING LFG EXTRACTION WELL
SV-1	EXISTING SOIL VAPOR VENT
	EXISTING LCR CONNECTION
CS-1	EXISTING CONDENSATE SUMP
	EXISTING ISOLATION VALVE
	EXISTING BLIND FLANGE
	EXISTING CONDENSATE FORCEMAIN
	EXISTING AIR SUPPLY LINE
	PROPOSED GAS COLLECTION PIPING
	PROPOSED CONDENSATE FORCEMAIN
	PROPOSED AIR SUPPLY PIPING
	PROPOSED PROCESSED GAS LINE

STATE OF TEXAS
MATT K. STUTZ
93662
LICENSED PROFESSIONAL ENGINEER
5/15/13

NOTES:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY COOPER AERIAL SURVEYS CO. FROM AERIAL PHOTOGRAPHY FLOWN JANUARY 26, 2012.
2. LOCATIONS OF THE PROPOSED LFG COLLECTION SYSTEM COMPONENTS, GAS COMPRESSION SKID, STORAGE AREA, AND PROCESSED GAS LINE ARE APPROXIMATE. EXACT LOCATIONS TO BE DETERMINED BASED ON THE SITE CONDITIONS AT THE TIME OF CONSTRUCTION.

- [ ] DRAFT
- [x] FOR PERMITTING PURPOSES ONLY
- [ ] ISSUED FOR CONSTRUCTION
- [ ] CLIENT APPROVAL BY:

DATE: 05/2013
FILE: 0120-74-11
CAD: 7-FACILITY LOCATION.DWG

DRAWN BY: VRS
DESIGN BY: SR
REVIEWED BY: MKS

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THIS DOCUMENT, AND THE DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF WEAVER BOOS CONSULTANTS, LLC AND IS NOT TO BE USED IN WHOLE OR IN PART, WITHOUT THE WRITTEN AUTHORIZATION OF WEAVER BOOS CONSULTANTS, LLC.

PREPARED FOR
CITY OF VICTORIA

REVISIONS

NO.	DATE	DESCRIPTION

PERMIT MODIFICATION
LFG TREATMENT FACILITY LAYOUT

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

Weaver Boos Consultants
TBPE REGISTRATION NO. F-3727

CHICAGO, IL · NAPERVILLE, IL · COLUMBUS, OH · DENVER, CO · FORT WORTH, TX · EVANSVILLE, IN · RIVERSIDE, MO · GRAND RAPIDS, MI · SOUTH BEND, IN · SPRINGFIELD, IL · CLEARMONT, FL

DRAWING 7

O:\0120\74\2012 LFG\TYPE IX PERMIT MOD (10-12)\7-LFG TREATMENT FACILITY.dwg, 5/14/2013 3:08:37 PM, rsellers, 1:2

PART III
§330.56

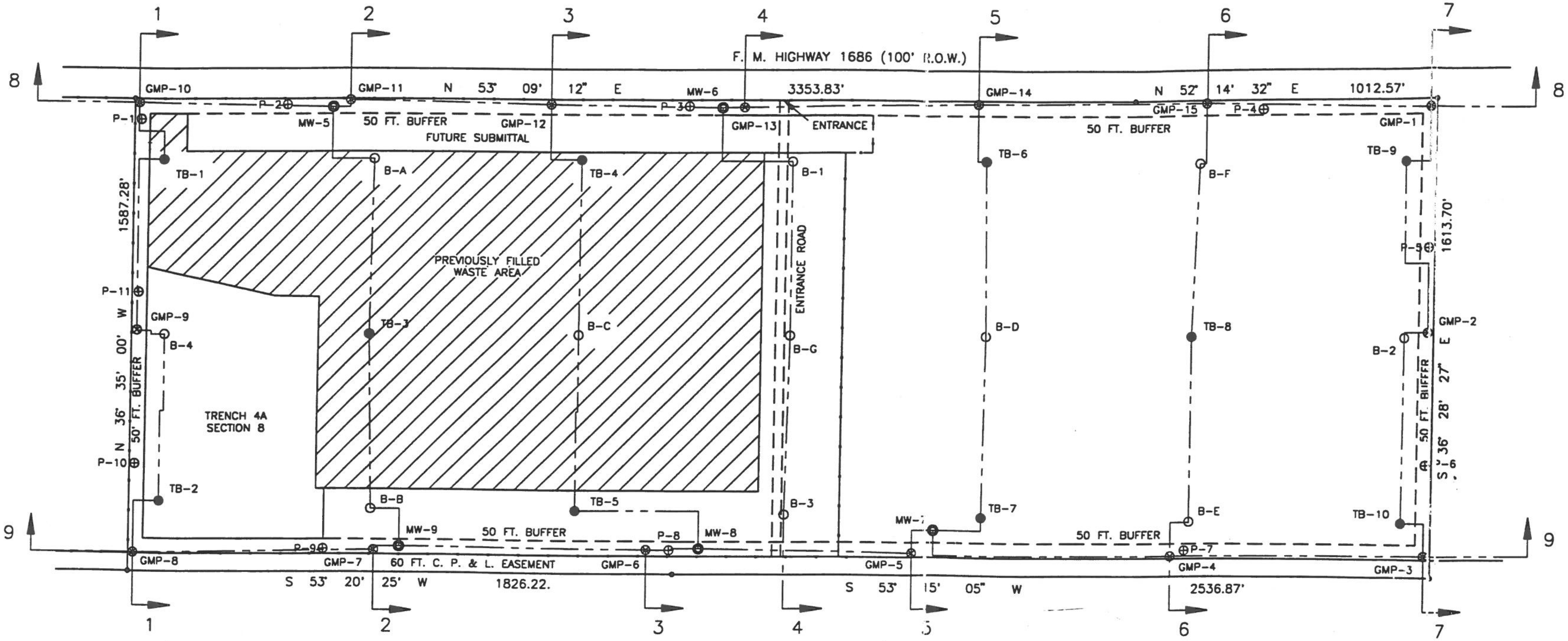
SDP ATTACHMENT 2
FILL CROSS-SECTIONS

CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. MSW-1522
HEIGHT OF FILL AMENDMENT

May 1, 1996
Revised October 21, 1996
Revised January 13, 1997

FOR PERMITTING PURPOSES ONLY

PERMIT DRAWING



GRAPHIC SCALE

0 400' 800' 1200'

LEGEND

- ⊕ — PIEZOMETERS - EMCON 1995
- ⊗ — METHANE GAS PROBES 1993
- ◉ — EXISTING MONITORING WELLS 1992
- ○ — RESOURCE ENGINEERING, INC. 1982
- ● — TRINITY ENGINEERING TESTING CORP. 1980

STATE OF TEXAS
J. FLETCHER KELLY
61815
REGISTERED
PROFESSIONAL ENGINEER
10-21-96

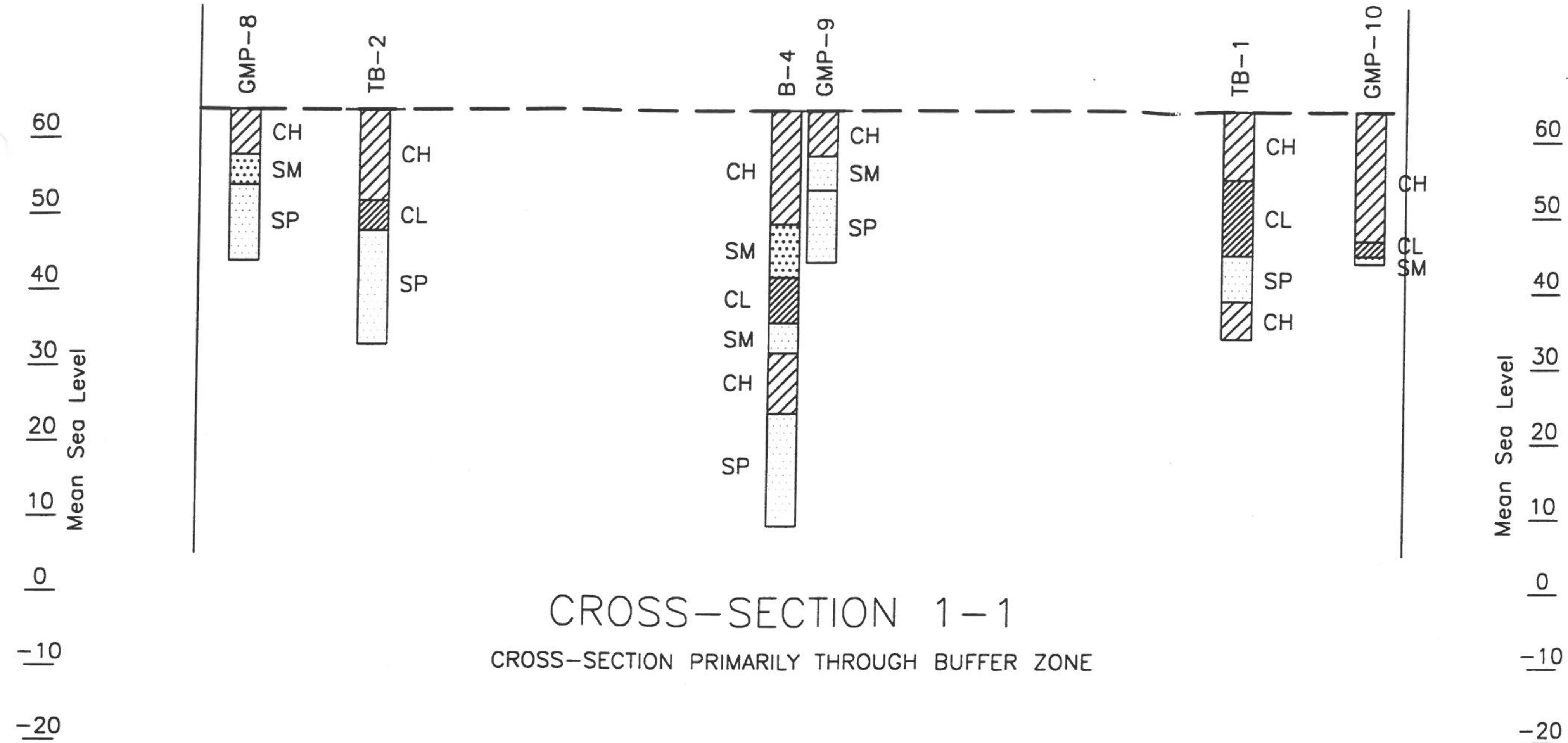
NO.	DATE	REVISIONS	BY
1			

SDP ATTACHMENT 2F
SOIL PROFILE
SECTIONS 1-1, 2-2, 3-3, 4-4
5-5, 6-6, 7-7, 8-8 & 9-9
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.

10 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE AS SHOWN	SHEET NO. 6 OF 11
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.		



CROSS-SECTION 1-1

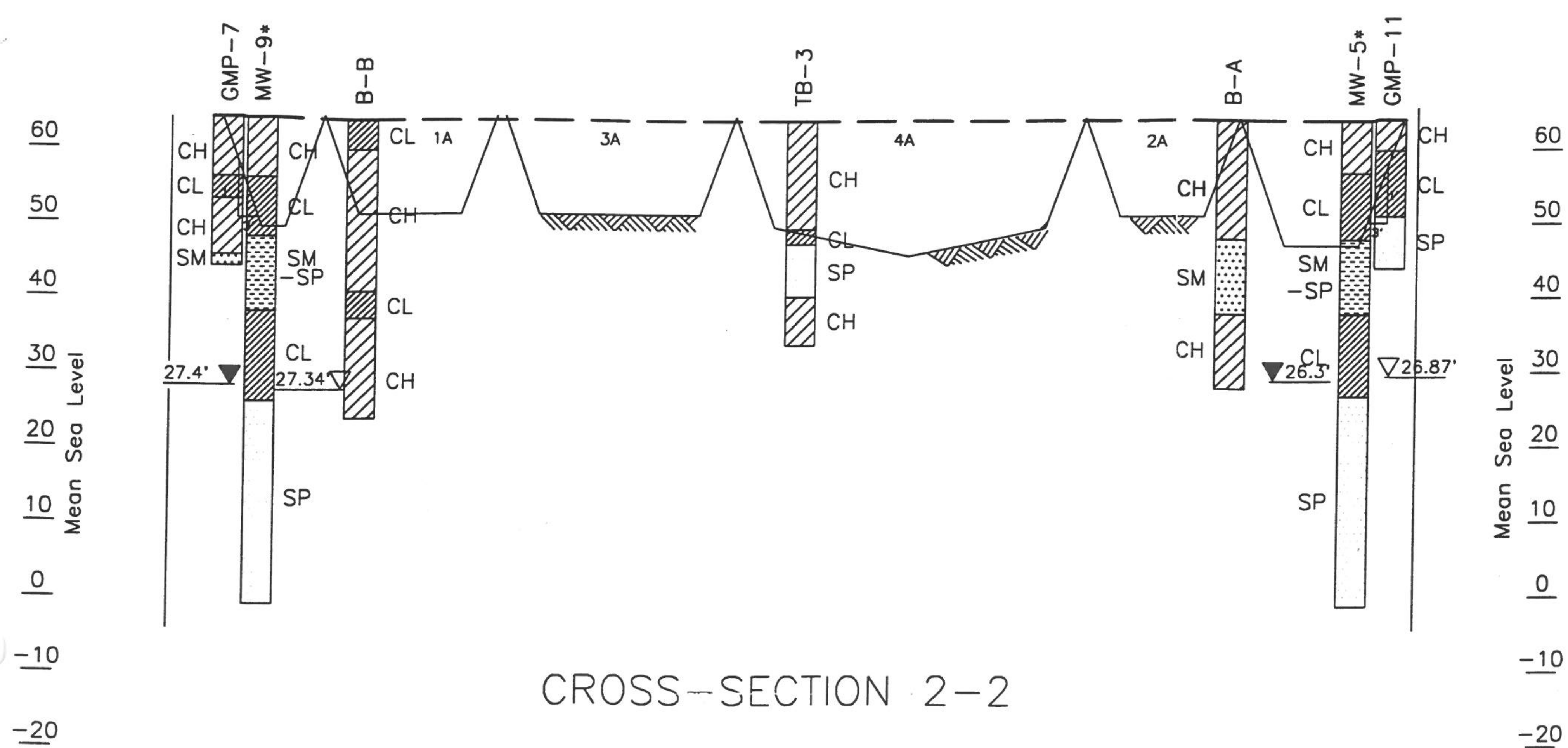
CROSS-SECTION PRIMARILY THROUGH BUFFER ZONE

PERMIT DRAWING

NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

STATE OF TEXAS
J. FLETCHER KELLY
61815
REGISTERED PROFESSIONAL ENGINEER
1-13-97



CROSS-SECTION 2-2

GRAPHIC SCALE

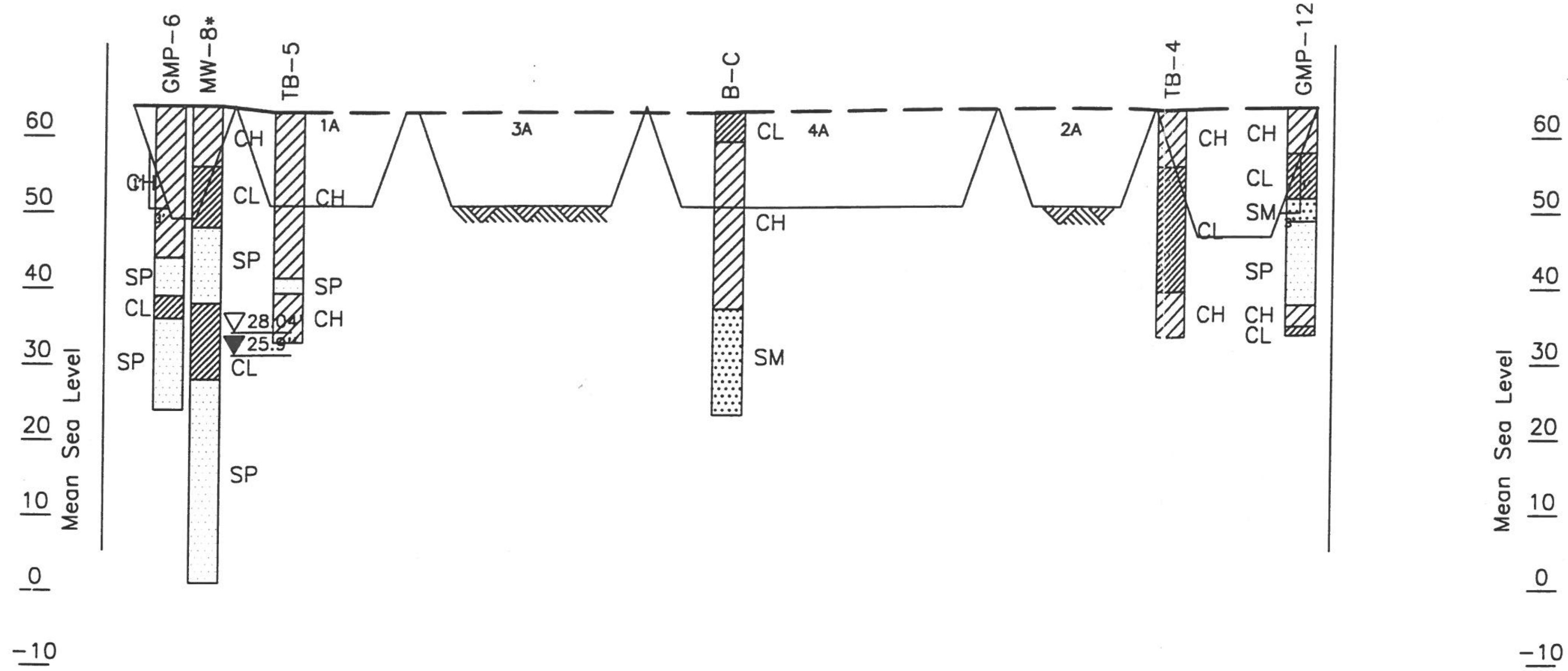
0	20'	40'	60'	VERT.
0	200'	400'	600'	HORZ.

NO.	DATE	REVISION	BY
2	01/13/97	REVISE NOTES	CMP
1	10/04/96	GENERAL REVISIONS	CMP

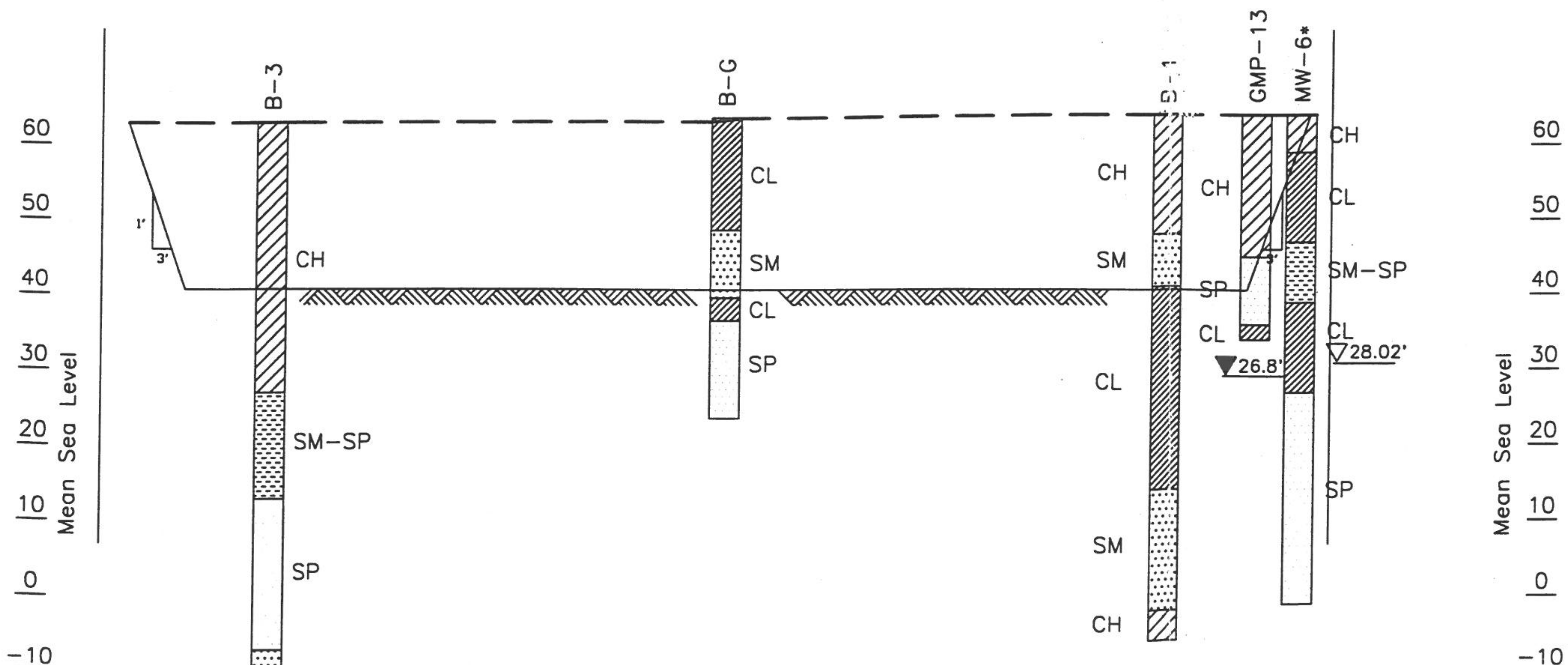
SDP ATTACHMENT 2G
SECTIONS 1-1 & 2-2
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.
201 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE AS SHOWN	SHEET NO. 7 OF 11
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.		



CROSS-SECTION 3-3



CROSS-SECTION 4-4

PERMIT DRAWING

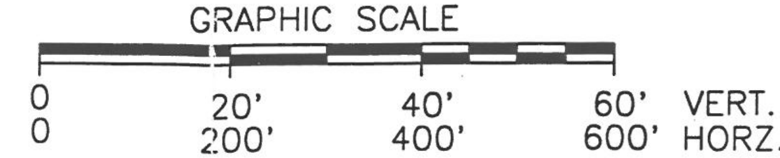
NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

STATE OF TEXAS
J. FLETCHER KELLY
61815
REGISTERED PROFESSIONAL ENGINEER

1-13-97

GRAPHIC SCALE



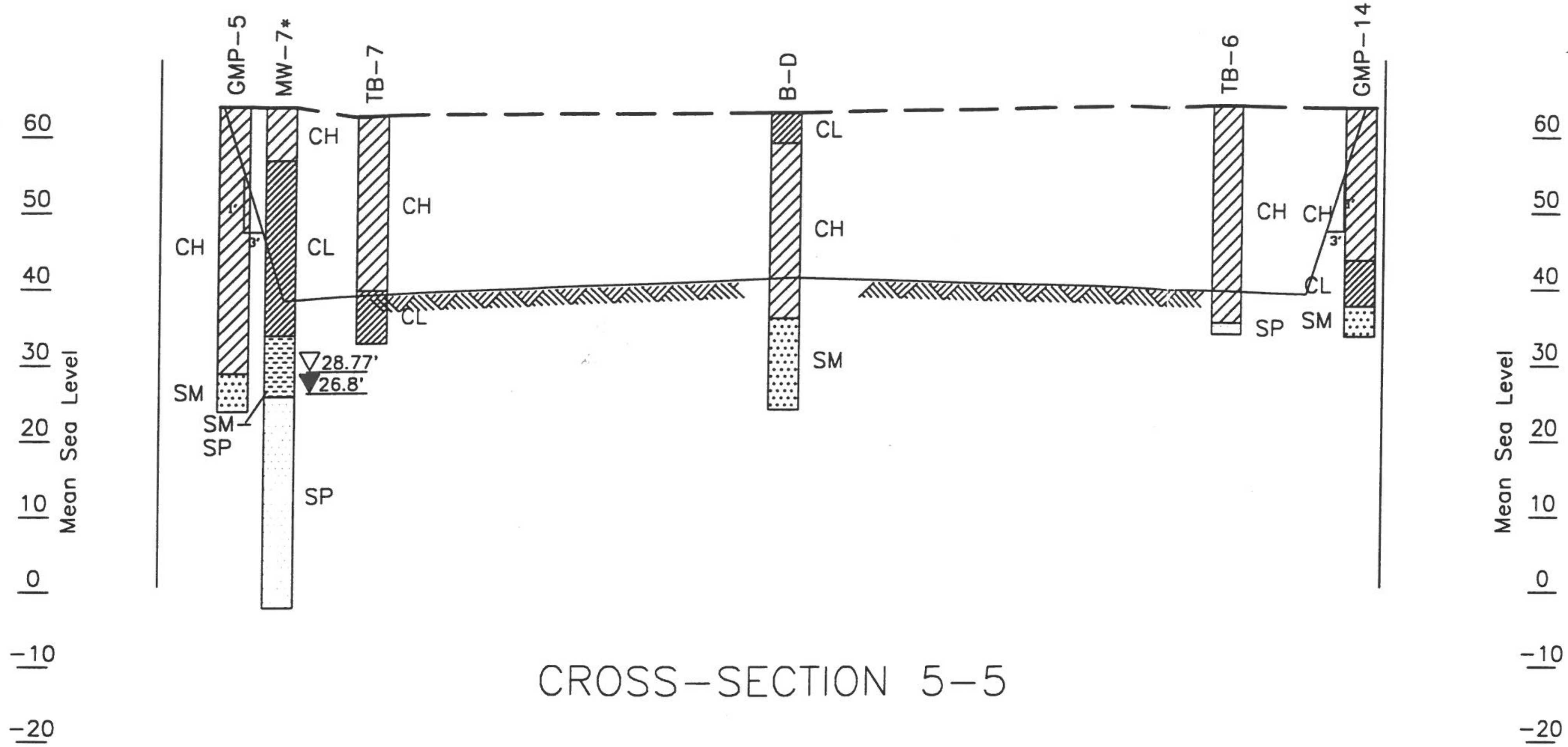
NO.	DATE	REVISION	BY
2	01/13/97	REVISE NOTES	CMP
1	12/10/96	GENERAL REVISION	CMP

SDP ATTACHMENT 2H
SECTIONS 3-3 & 4-4
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

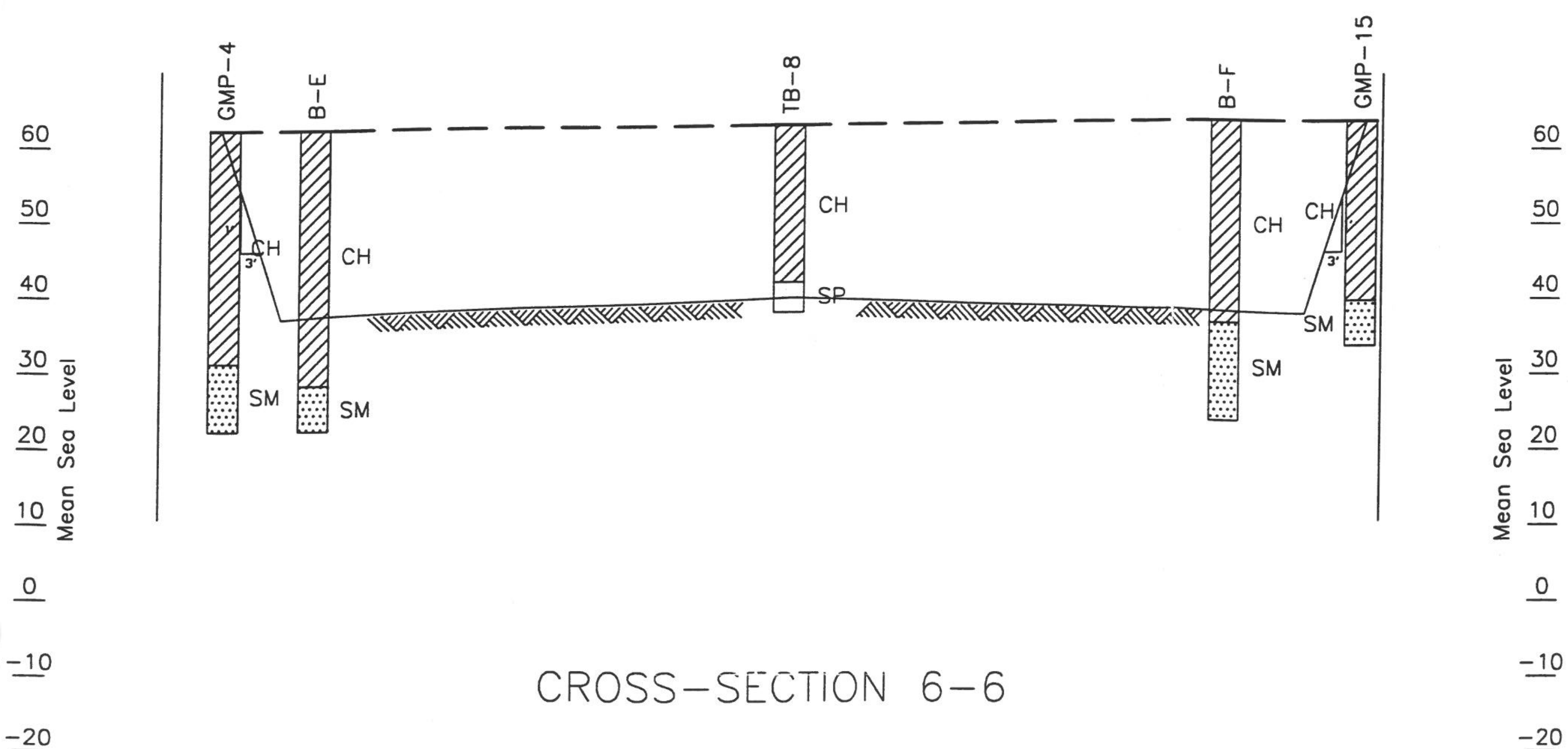
JFK GROUP, INC.

201 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE	SHEET NO.
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.	AS SHOWN	8 OF 11



CROSS-SECTION 5-5



CROSS-SECTION 6-6

PERMIT DRAWING

NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

GRAPHIC SCALE

0	20'	40'	60'	VERT.
0	200'	400'	600'	HORZ.

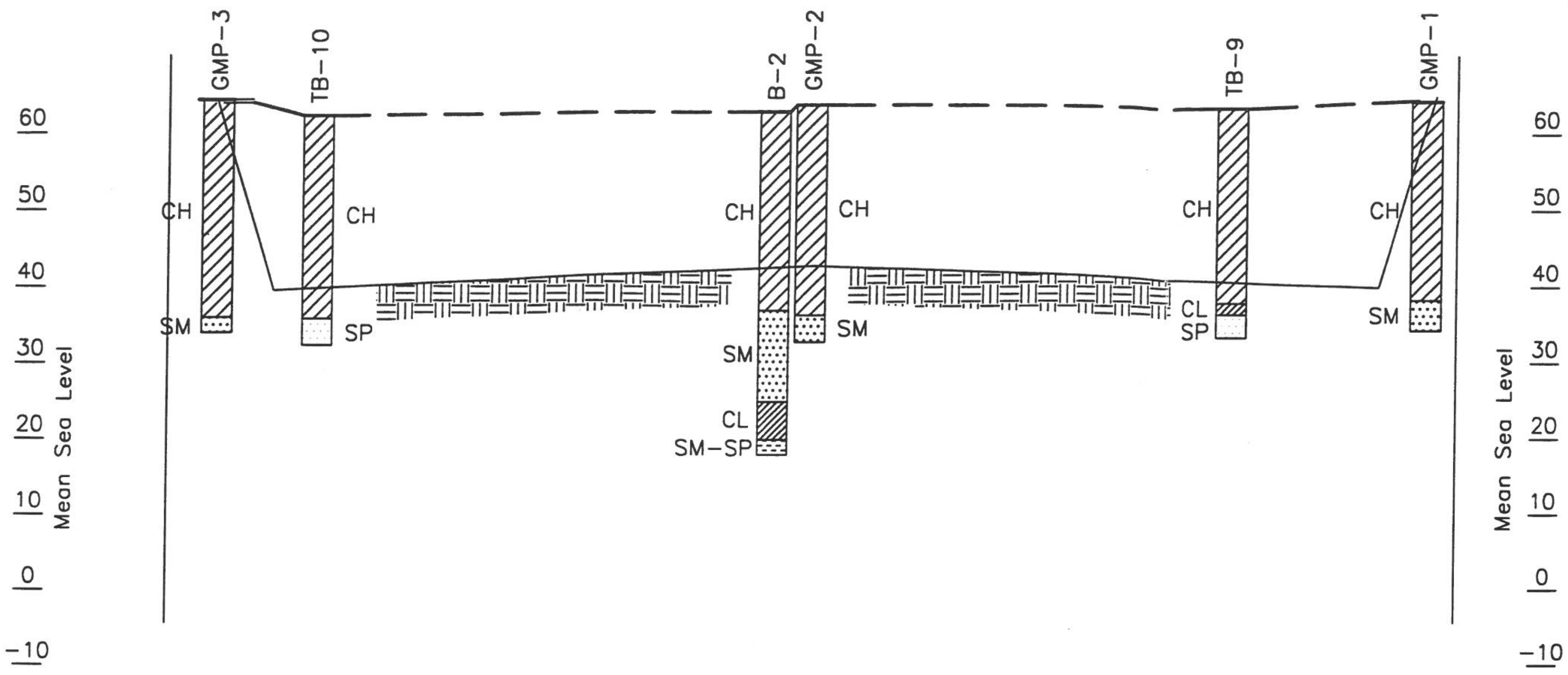
NO.	DATE	REVISION	BY
2	01/13/97	REVISE NOTES	CMP
1	10/04/96	GENERAL REVISION	CMP

SDP ATTACHMENT 21
SECTIONS 5-5 & 6-6
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.

201 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE AS SHOWN	SHEET NO.
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.		9 OF 11



CROSS-SECTION 7-7

PERMIT DRAWING

NOTE:
BORING LOG WIDTHS NOT TO SCALE

GRAPHIC SCALE

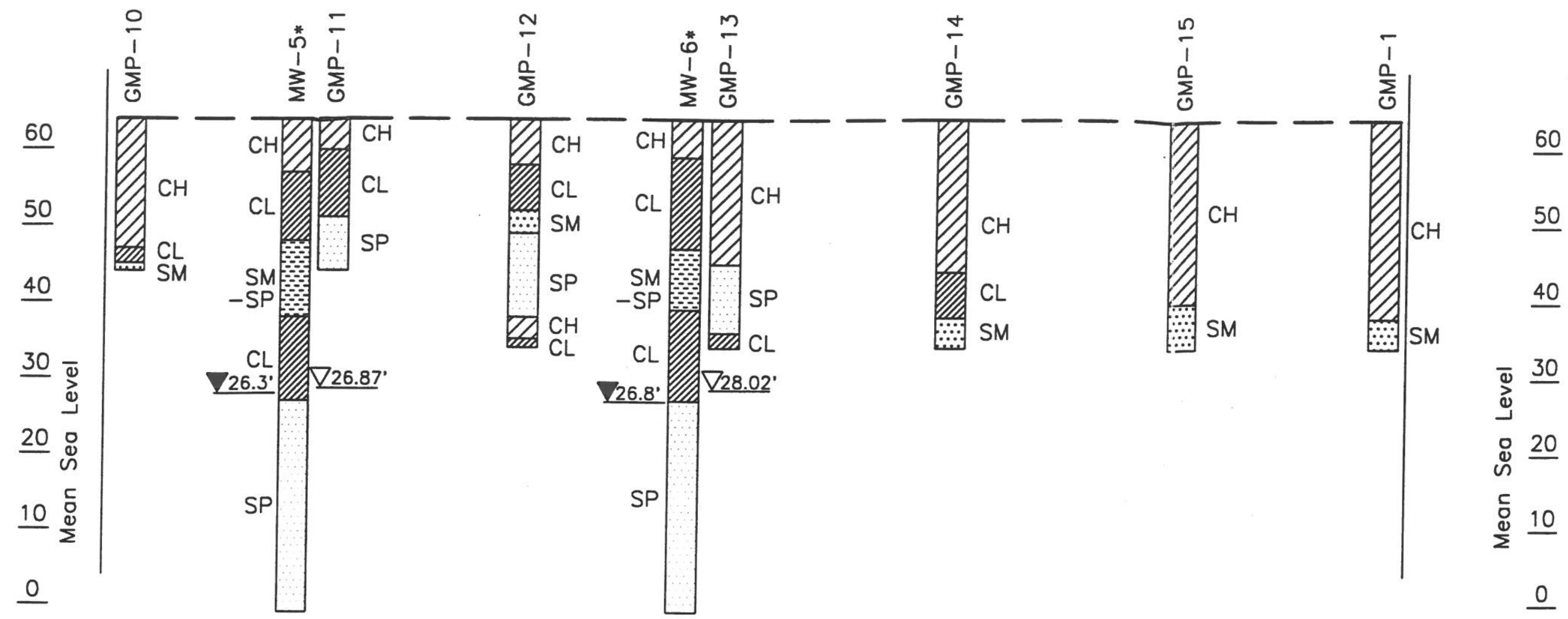
0 20' 40' 60' VERT.
0 200' 400' 600' HORZ.

NO.	DATE	REVISION	NO.
2	01/13/97	ADD NOTE	CMP
1	12/20/96	GENERAL REVISION	CMP

SDP ATTACHMENT 2J
SECTION 7-7
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

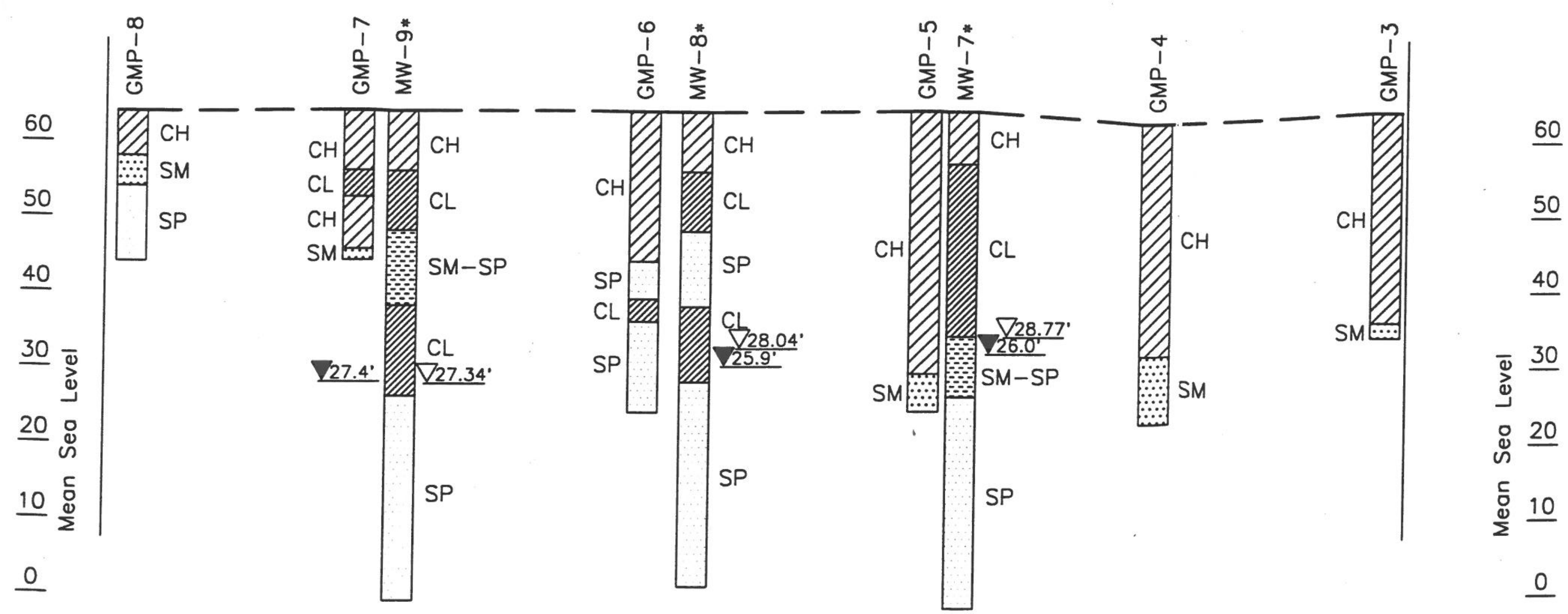
JFK GROUP, INC.
201 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE AS SHOWN	SHEET NO. 10 OF 11
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.		



CROSS-SECTION 8-8

CROSS-SECTION PRIMARILY THROUGH BUFFER ZONE



CROSS-SECTION 9-9

CROSS-SECTION PRIMARILY THROUGH BUFFER ZONE

PERMIT DRAWING

NOTES:

1. * SOIL CLASSIFICATION BY VISUAL INSPECTION ONLY
2. ▼ INITIAL LEVEL
3. ▽ HIGHEST STATIC LEVEL
4. BORING LOG WIDTHS NOT TO SCALE

GRAPHIC SCALE

0	20'	40'	60' VERT.
0	500'	1000'	1500' HORZ.

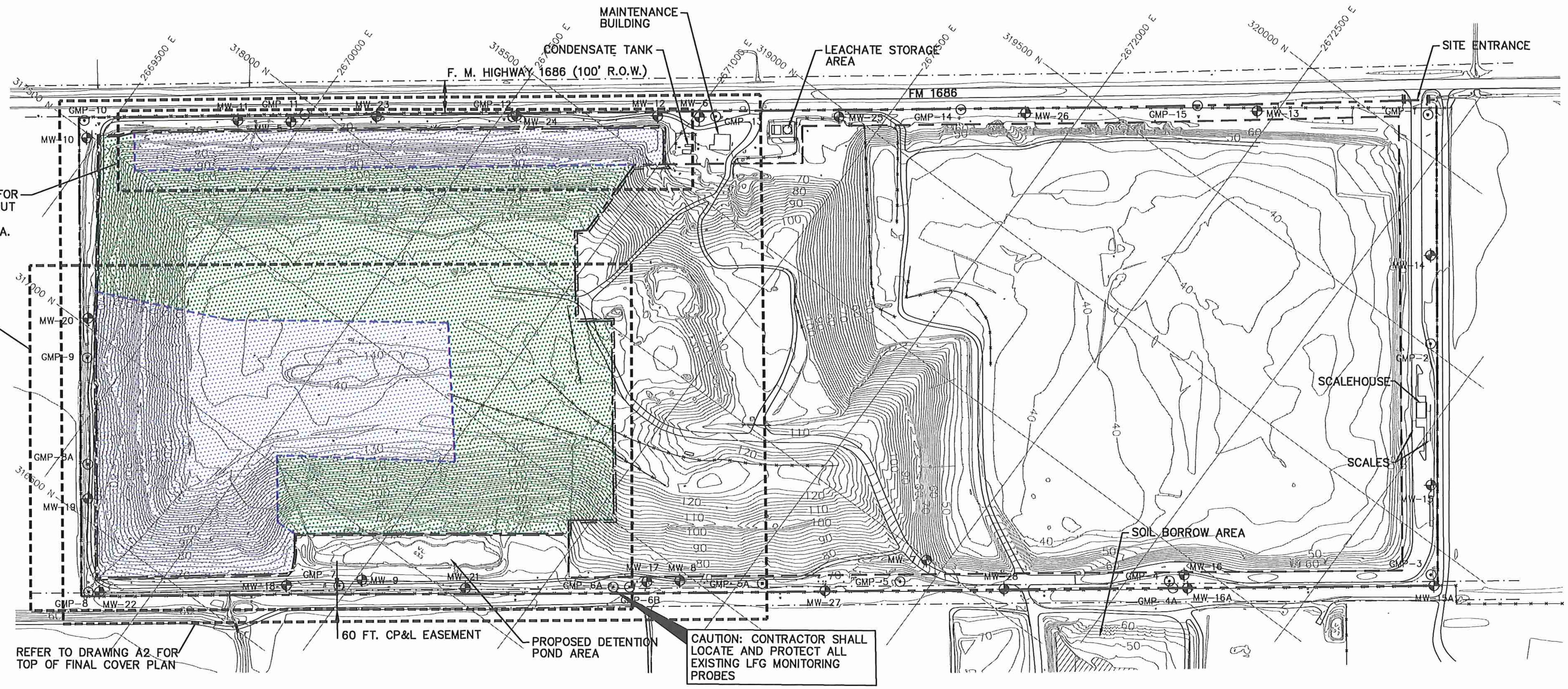
NO.	DATE	REVISION	BY
3	01/13/97	REVISE NOTES	CMP
2	12/10/96	GENERAL REVISION	CMP
1	10/04/96	GENERAL REVISION	CMP

SDP ATTACHMENT 2K
SECTIONS 8-8 & 9-9
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.

201 EAST SINTON STREET • P.O. BOX 460 • SINTON, TEXAS 78387

DESIGN BY	DRAWN BY JMP	REVISED DATE	DATE 05-01-96	SCALE AS SHOWN	SHEET NO. 11 OF 11
CHECKED BY JFK	APPR'D BY JFK	DWG. NO.	JOB NO.		



LEGEND

- PERMIT BOUNDARY
- LIMIT OF WASTE
- PRE–SUBTITLE D/SUBTITLE D FINAL COVER LIMIT
- 90 EXISTING CONTOUR
- 318000 N STATE PLANE COORDINATE SYSTEM
- EASEMENT
- TIE–IN ZONE
- GMP–6 LANDFILL GAS MONITORING PROBE
- MW–17 GROUNDWATER MONITORING WELL
- SV–44 SOIL VAPOR WELL
- PRE–SUBTITLE D AREA (29.2 ACRES)
- SUBTITLE D AREA (22.4 ACRES)

0 200 400
SCALE IN FEET

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS PROVIDED BY COOPER AERIAL SURVEYS, CO., FROM AERIAL PHOTOGRAPHY FLOWN FEBRUARY 6, 2014.

STATE OF TEXAS
KYLE D. GOULD
106018
LICENSED
PROFESSIONAL ENGINEER
8-11-15

☐ DRAFT
☒ FOR INFORMATIONAL PURPOSES ONLY
☐ ISSUED FOR CONSTRUCTION

DATE: 08/2015
FILE: 0120–558–11
CAD: A1–SITE PLAN.DWG

DRAWN BY: JDW
DESIGN BY: GWT
REVIEWED BY: KDG

Weaver Consultants Group
TBPE REGISTRATION NO. F–3727

PREPARED FOR
CITY OF VICTORIA AND REPUBLIC SERVICES

REVISIONS

NO.	DATE	DESCRIPTION

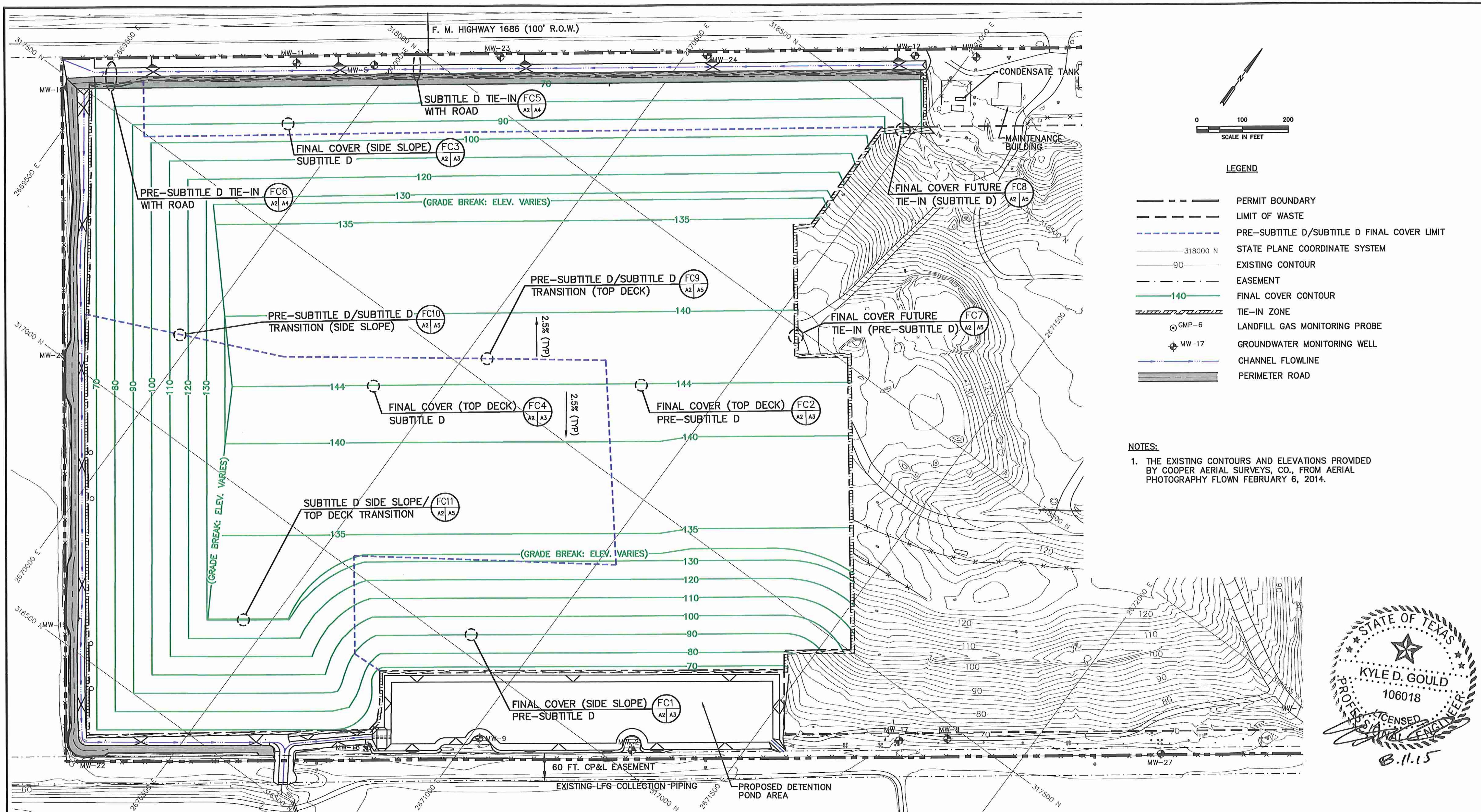
FINAL COVER SYSTEM EVALUATION REPORT
SITE PLAN

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING A1

O:\0120\74\FCSER 2015\A1-SITE PLAN.dwg, jwilson, 1:2



NOTES:

1. THE EXISTING CONTOURS AND ELEVATIONS PROVIDED BY COOPER AERIAL SURVEYS, CO., FROM AERIAL PHOTOGRAPHY FLOWN FEBRUARY 6, 2014.

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☒ FOR INFORMATIONAL PURPOSES ONLY
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DATE: 08/2015 | DRAWN BY: JDW
FILE: 0120-558-11 | DESIGN BY: GWT
CAD: A2-SITE PLAN.DWG | REVIEWED BY: KDG

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
CITY OF VICTORIA AND REPUBLIC SERVICES

REVISIONS

NO.	DATE	DESCRIPTION

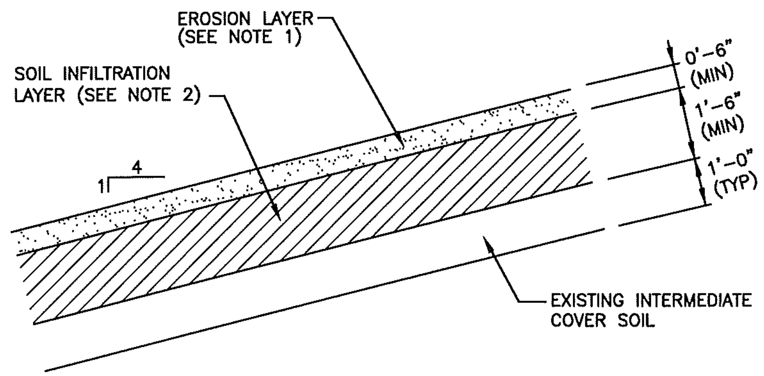
FINAL COVER SYSTEM EVALUATION REPORT
TOP OF FINAL COVER PLAN

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

WWW.WCGRP.COM

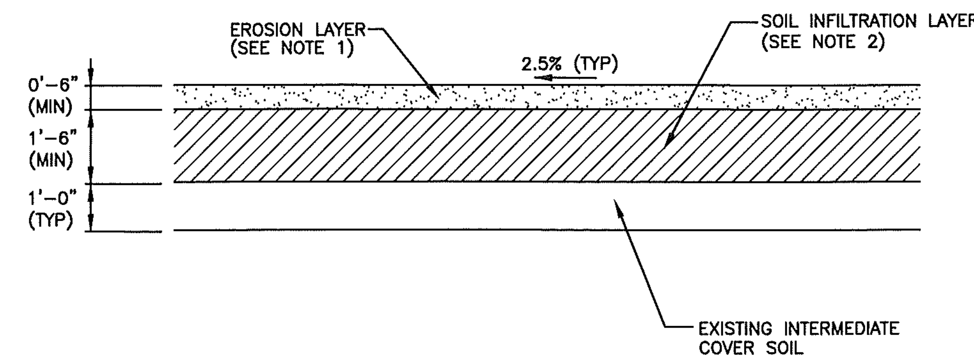
DRAWING A2

O:\0120\74\FCSER 2015\A2-TOP OF FINAL COVER PLAN.dwg, jwilson, 1:2



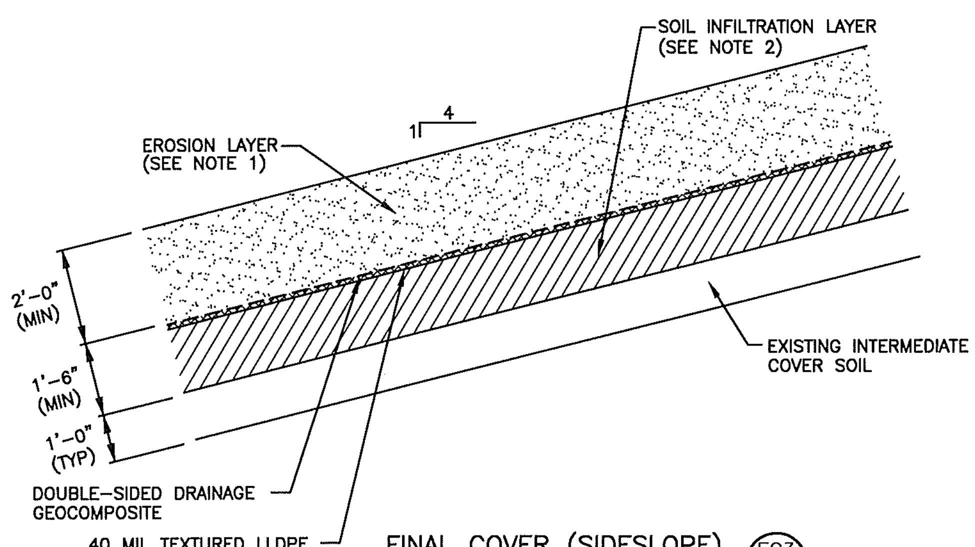
FINAL COVER (SIDESLOPE)
PRE-SUBTITLE D
FC1
A3
A2,A4,A5

0 2 4
SCALE IN FEET



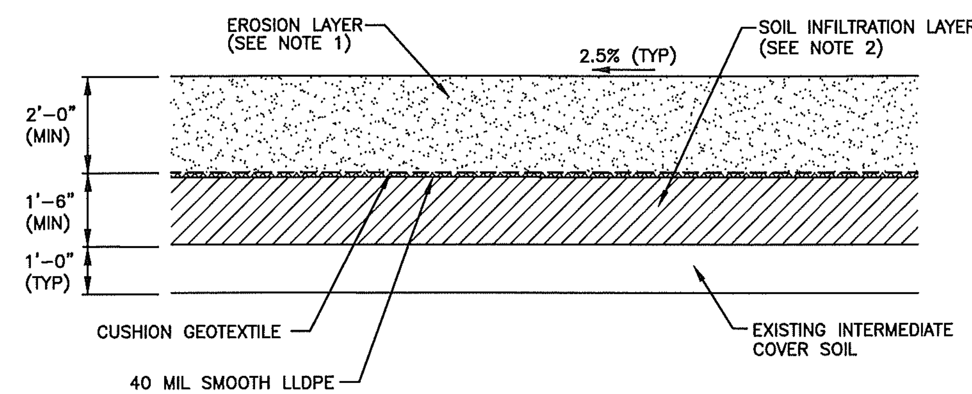
FINAL COVER (TOP DECK)
PRE-SUBTITLE D
FC2
A3
A2,A5

0 2 4
SCALE IN FEET



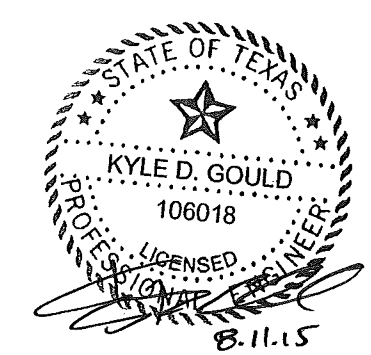
FINAL COVER (SIDESLOPE)
SUBTITLE D
FC3
A3
A2,A4,A5

0 2 4
SCALE IN FEET



FINAL COVER (TOP DECK)
SUBTITLE D
FC4
A3
A2,A5

0 2 4
SCALE IN FEET



NOTES:

1. EROSION LAYER IS CAPABLE OF SUSTAINING VEGETATION.
2. THE SOIL INFILTRATION LAYER IN THE SUBTITLE D AREA CONSISTS OF COMPACTED CLAY WITH A HYDRAULIC CONDUCTIVITY OF 1 X 10^{-5}cm/sec OR LESS.
3. THE SOIL INFILTRATION LAYER IN THE PRE-SUBTITLE D AREA CONSISTS OF COMPACTED CLAY WITH A HYDRAULIC CONDUCTIVITY OF 1 X 10^{-7}cm/sec OR LESS.

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DATE: 08/2015 — DRAWN BY: JDW
FILE: 0120-558-11 — DESIGN BY: GWT
CAD: A3-DETAILS.DWG — REVIEWED BY: KDG

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
CITY OF VICTORIA
AND REPUBLIC SERVICES

REVISIONS

NO.	DATE	DESCRIPTION

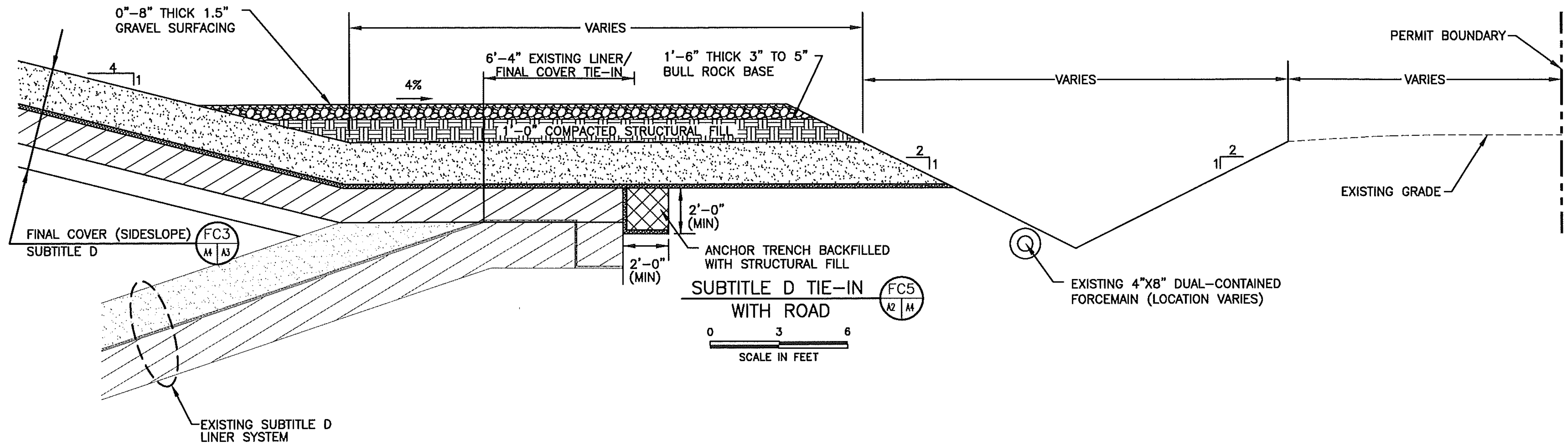
FINAL COVER SYSTEM EVALUATION REPORT
FINAL COVER DETAILS

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

WWW.WCGRP.COM

DRAWING A3

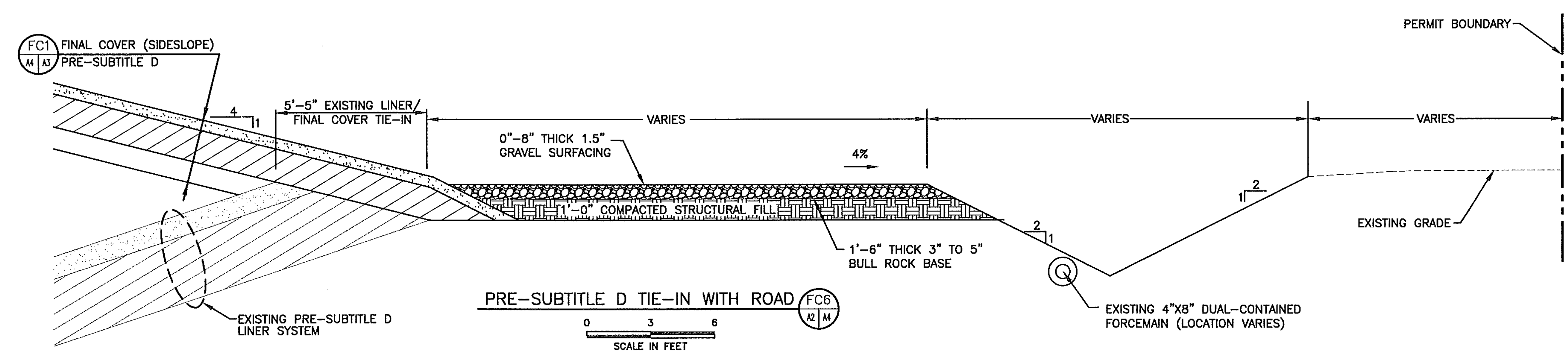
O:\0120\74\FCSER 2015\A3-FINAL COVER DETAILS.dwg, jwilson, 1:2



SUBTITLE D TIE-IN WITH ROAD (FC5 A2 A4)

0 3 6
SCALE IN FEET

STATE OF TEXAS
KYLE D. GOULD
106018
LICENSED
PROFESSIONAL ENGINEER
8.11.15



PRE-SUBTITLE D TIE-IN WITH ROAD (FC6 A2 A4)

0 3 6
SCALE IN FEET

☐ DRAFT	
☒ FOR INFORMATIONAL PURPOSES ONLY	
☐ ISSUED FOR CONSTRUCTION	
DATE: 08/2015	DRAWN BY: JDW
FILE: 0120-558-11	DESIGN BY: GWT
CAD: A4-DETAILS.DWG	REVIEWED BY: KDG

Weaver Consultants Group
TBPE REGISTRATION NO. F-3727

PREPARED FOR
CITY OF VICTORIA
AND REPUBLIC SERVICES

REVISIONS

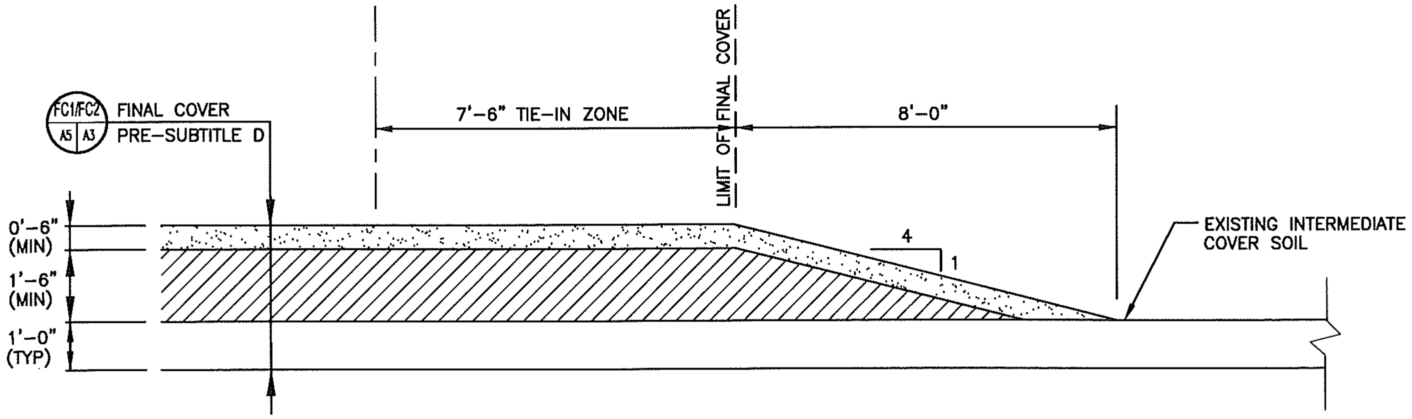
NO.	DATE	DESCRIPTION

FINAL COVER SYSTEM EVALUATION REPORT
FINAL COVER DETAILS

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS

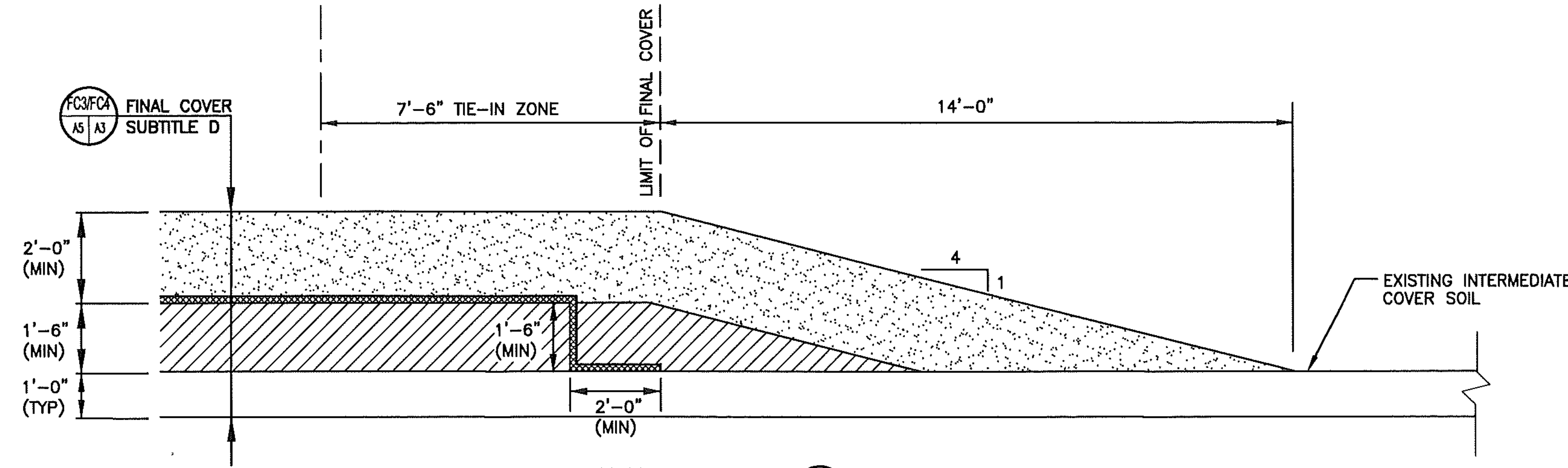
WWW.WCGRP.COM

DRAWING A4



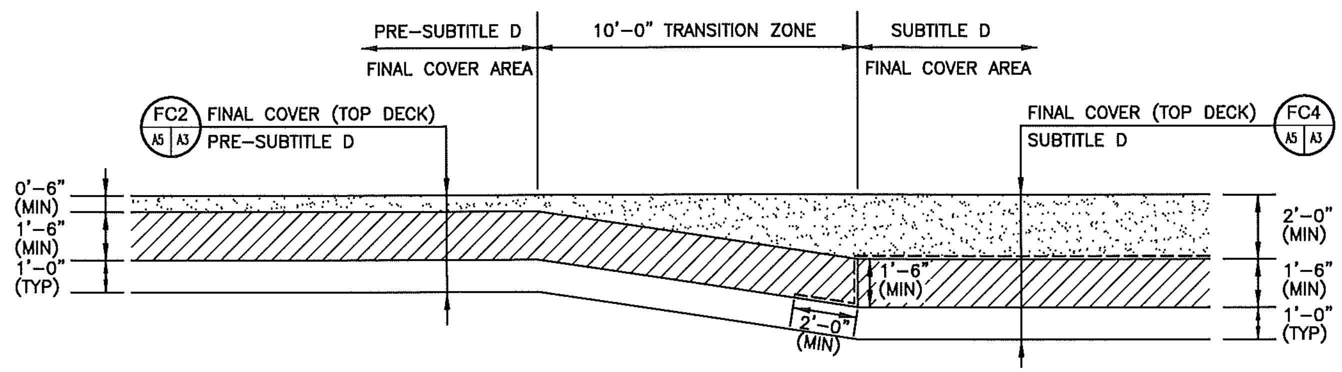
FINAL COVER FUTURE TIE-IN (PRE-SUBTITLE D) FC7 A2 A5

0 2 4
SCALE IN FEET



FINAL COVER FUTURE TIE-IN (SUBTITLE D) FC8 A2 A5

0 2 4
SCALE IN FEET



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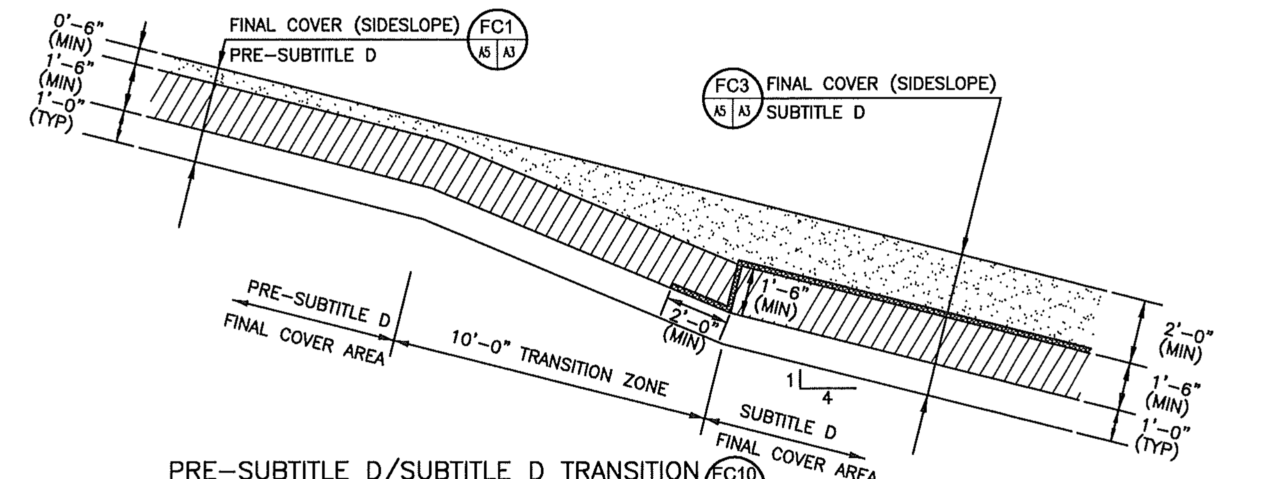
SCALE IN FEET



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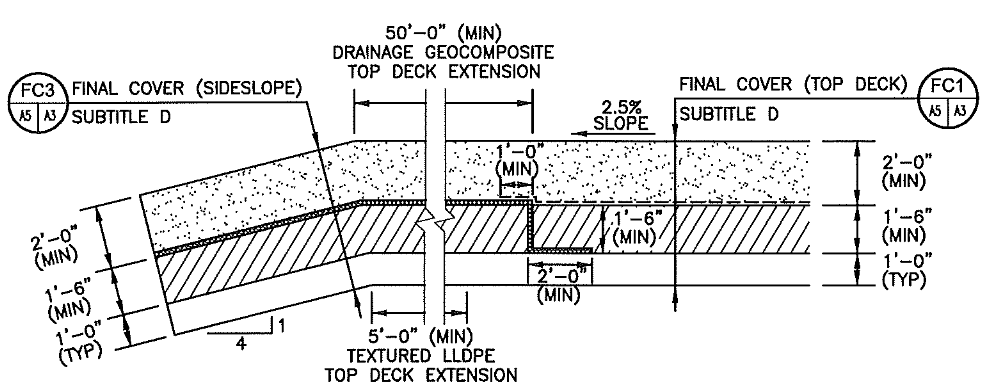
0 3 6
SCALE IN FEET



SUBTITLE D SIDESLOPE/TOP DECK TRANSITION FC11 A2 A5

0 3 6
SCALE IN FEET

STATE OF TEXAS
KYLE D. GOULD
106018
LICENSED
PROFESSIONAL ENGINEER
8-11-15

☐ DRAFT ☒ FOR INFORMATIONAL PURPOSES ONLY ☐ ISSUED FOR CONSTRUCTION	PREPARED FOR CITY OF VICTORIA AND REPUBLIC SERVICES	FINAL COVER SYSTEM EVALUATION REPORT FINAL COVER DETAILS
DATE: 08/2015 FILE: 0120-558-11 CAD: A5-DETAILS.DWG DRAWN BY: JDW DESIGN BY: GWT REVIEWED BY: KDG	REVISIONS NO. / DATE / DESCRIPTION	CITY OF VICTORIA LANDFILL VICTORIA COUNTY, TEXAS
Weaver Consultants Group TBPE REGISTRATION NO. F-3727		WWW.WCGRP.COM / DRAWING A5

O:\0120\74\FCSER 2015\A5-FINAL COVER DETAILS.dwg, jwilson, 1:2

ATTACHMENT 2 – SURFACE WATER DRAINAGE REPORT

Part III, Attachment 2 – Surface Water Drainage Report
TCEQ MSW Permit No.1522B

City of Victoria, Texas

City of Victoria Landfill Lateral and Vertical Expansion
Project No. 107608

Revision 0, March 28, 2022

Part III, Attachment 2 – Surface Water Drainage Report
TCEQ MSW Permit No.1522B

prepared for

City of Victoria, Texas
City of Victoria Landfill Lateral and Vertical Expansion
Victoria County, Texas

Project No. 107608

Revision 0, March 28, 2022

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER
Scott Martin
4/5/2022

prepared by

Burns & McDonnell Engineering Company, Inc.
Austin, Texas
Texas Firm Registration No. F-845

TABLE OF CONTENTS

Page No.

Scott Martin
4/5/2022

LIST OF TABLES

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LIST OF FIGURES

Page No.

LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
BMP	Best Management Practice
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CLOMR	Conditional Letter of Map Revision
CMZ	Crop Management Zone
DS	Downstream
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HEC	Hydraulic Engineering Circular
HEC-RAS	Hydrologic Engineering Center – River Analysis System
LOMR	Letter of Map Revision
MSW	Municipal Solid Waste
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
RUSLE	Revised Universal Soil Loss Equation
SCS	Soil Conservation Service
SFHA	Special Flood Hazard Area
SSURGO	Soil Survey Geographic Database
SWPPP	Storm Water Pollution Prevention Plan
TAC	Texas Administrative Code
TBC	To be constructed
TCEQ	Texas Commission on Environmental Quality
TDPES	Texas Pollutant Discharge Elimination System
US	Upstream
USGS	United States Geological Survey

1.0 INTRODUCTION

The facility was designed to manage the peak flow and erosion potential resulting from a 25-year storm, to comply with Texas Administrative Code (TAC) §330.303. This Surface Water Drainage Report (Report) includes the locations, details and supporting design methodology for the site's stormwater control features, which include erosion and sediment control best management practices (BMPs), final cover swales, letdown chutes, drainage channels, perimeter ditches, swales, culverts, and detention/retention ponds. The facilities requested permit extents were also designed to provide protection from 100-year frequency flooding to comply with TAC §330.307. The project's impact on Federal Emergency Management Agency (FEMA) floodplains and existing properties is evaluated further in this report.

As of March 2022, the existing landfill contains constructed and to-be-constructed (TBC) stormwater features that have been permitted by the Texas Commission on Environmental Quality (TCEQ). This Report includes the surface water drainage and design basis for the landfill expansion area and the ancillary expansion of the Facility, found in Section 2-5 of this Report. Features and drainage of the existing TBC landfill that are not superseded by the expansion will also be included in Sections 2-5. The extent of the landfill expansion is provided in Attachment 1 – Permit Drawings. Further details and design calculations for the surface water drainage corresponding to the Existing Constructed Area can be found in Appendix B - Historic Drainage Calculations. Historic calculations were verified as discussed in Section 6 of this Report.

2.0 EROSION CONTROL

Relevant regulation ID numbers from the checklist:293-295, 297, 298

2.1 Erosional Stability of Landfill Slopes

In accordance with TAC §330.305(d), the landfill top dome and side slopes are designed to provide long term erosional stability during landfill operation, closure, and post-closure care. The soil erodibility calculations for final (vegetated) and interim scenarios are provided in Attachment 14. These calculations were completed using the Revised Universal Soil Loss Equations, Version 2 (RUSLE2) program which is developed and maintained by the Natural Resources Conservation Service (NRCS).

The soil erodibility results for intermediate and final cover conditions are presented in the Part III Landfill Permit Amendment Site Development Plan, Section 8.3. These calculations showed weighted soil loss values of less than 3 tons/acre/year for final cover conditions and less than 50 tons/acre for interim conditions, which complies with the recommendation set forth in TCEQ RG-417: Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill.

The interim external embankment slopes of the landfill shall be no greater than 3:1. These slopes shall be equipped with semi-permanent swales, as discussed in Section 2.2. These swales shall be installed along the slopes with a minimum spacing of 30 vertical feet (90 horizontal feet on 3:1 slopes), which is consistent with the final cover design. This spacing will the limit runoff type to sheet flow with negligible velocity before being collected in the armored swales. All interim landfill slopes (including the top dome) shall be graded with uniform slopes, roughened using dozer tracking, and seeded or covered using blankets and matting, discussed in Section 2.3 of this Report.

2.2 Permanent Erosion and Sediment Controls

Interim and final landfill slopes will consist of permanent or semi-permanent structural controls to manage the velocity of runoff such that erosional stability is not compromised. The permanent controls are shown in Drawings C006 and C007 of Attachment 1. These controls consist of final cover swales and letdown chutes, which are discussed in Sections 3.3 and 3.4 of this Report. Semi-permanent controls shall refer to these same controls, but which are used during interim conditions, therefore shown in locations other than those depicted in Attachment 1. The semi-permanent controls shall not be removed except at the time of final closure or in the case that landfill operation renders them unfeasible (such as the installation of a temporary access road or the waste placement for an adjacent cell). Semi-permanent swales and letdown chutes, controlling runoff of interim slopes, shall be installed in accordance with the final cover designs for these controls (including the applicable temporary erosion and sediment controls discussed in Section 2.3).

Landfill and facility ground surfaces shall be stabilized with vegetation or non-vegetative surfaces. Seeding shall be performed on all landfill final cover surfaces and perimeter surfaces that have reached design grades according to the practices discussed in Section 2.4. Non-vegetative surfaces include:

- Gravel: This material shall be installed within limits of permanent access roads, as depicted in Attachment 1.
- Riprap: This material shall be installed as the lining of letdown chutes and around culvert outlets, as depicted in Attachment 1. Details and specifications for riprap outlet protection is provided in Section 1.3.5 of Appendix C.
- Gabions: This shall be installed within letdown chutes, as depicted in Attachment 1.

2.3 Temporary Erosion and Sediment Controls

Best Management Practices (BMPs) shall be utilized during site operation and construction. Exposed ground surfaces shall be temporarily stabilized with the BMPs discussed in this Section. Appendix C, provides specifications for the following BMPs (Note: The site is not in the Edwards Aquifer, but this guidance document was selected for being a TCEQ publication with the required controls). These BMPs shall be maintained until final stabilization is achieved.

Blankets and Matting: A temporary armoring of fiber blankets, plastic nets, or equivalent will be installed as necessary over areas receiving vegetative cover and 3:1 interim landfill slopes. In most cases, landfill slopes may be stabilized by seeding and mulching alone. Section 1.3.9 of Appendix C provides installation methods, standard details, and products for blankets and matting. Various locations and structures shall require different products. Ponds and general soil slopes shall require a Type A or B product (depending on the sand/clay content of the soil). The inside of final cover swales and perimeter ditches shall require a Type E or F product with an unvegetated velocity specification of 9 ft/s or higher. This will accommodate the peak velocity calculated in Section 5.3.

Dust Control: This BMP shall be implemented near areas of construction and in areas with exposed soil in accordance with specifications in Section 1.3.12 of Appendix C.

Silt Fence: Perimeter sediment controls shall be established along the downgradient edge of any areas undergoing soil disturbance, where there is a potential for sediment to be transported offsite. Silt fences are a type of perimeter barrier for long-term construction activities. This BMP shall be implemented in accordance with the details and specifications in Section 1.4.3 of Appendix C. The maximum drainage area to the fence should not exceed the manufacturer's specification and must not be greater than 0.5 acre per 100 feet of fence.

Check Dams: This BMP shall be implemented along the flowline of the perimeter ditches in accordance with specifications in Section 1.4.8 of Appendix C.

Sediment Basins: The footprint of the east and west ponds serving the waste unit, depicted in Attachment 1, shall serve as sediment basins when receiving flow from unstabilized areas. Temporary sediment ponds within the footprint of undeveloped landfill cells shall be used to manage sediment during interim conditions. Temporary outlet structures and interim pond grading may be used as needed. Section 1.4.13 of Appendix C provides installation methods, standard details, and products for this BMP.

Fiber Rolls: Perimeter sediment controls shall be established along the downgradient edge of any areas undergoing soil disturbance, where there is a potential for sediment to be transported offsite. Fiber rolls are preferable to silt fences when the earthwork boundary is prone to move throughout construction. This BMP shall be implemented in accordance with the details and specifications in Section 1.4.14 of Appendix C.

2.4 Maintenance and Nonstructural Controls

BMPs shall be inspected and maintained in accordance with the current Storm Water Pollution Prevention Plan (SWPPP) for the City of Victoria Landfill. Inspection and maintenance procedures for post-closure conditions are discussed in Attachment 11: Post Closure Plan.

Seeding shall be performed on all landfill final cover surfaces and perimeter surfaces that have reached design grades in accordance with Attachment 9. The installation of vegetation shall incorporate native seed mixes suitable for erosion control. Interim surfaces to be undisturbed for more than one year shall also be seeded with a goal of 60% vegetation.

To minimize the potential for soil erosion, construction activities involving ground disturbance shall occur, when practical, during dry seasons. The application of seed shall typically occur during growing season. The use of dormant seeding is also acceptable for late-season planting.

3.0 DRAINAGE DESIGN

Relevant regulation ID numbers from the checklist: 290, 296-297, 299-300, 303-307, 312-313

3.1 Pre-Development and Post-Development Conditions

The landfill was designed to utilize drainage features of the existing landfill and take advantage of the natural drainage patterns that existed at the site prior to construction. The original, natural topography of the site allowed water to drain off-site generally north to south. All discharge of water will be in accordance with the site's U.S. Environmental Protection Agency TPDES Multi-Sector Stormwater Permit, a copy of which is included in Appendix A.

The pre-development and post-development drainage basin layouts are provided in Figures 1 and 2, which are included in Appendix 2A. FM 1686, which borders the site to the north, acts to divert water from the north around the existing landfill in a series of drainage ditches. To the west, channelized flow enters the expansion site in a man-made tributary drainage ditch at the northwest corner, turns to follow the north expansion boundary, then turns south to bisect the expansion site, and exiting along the south boundary. This ditch will be re-routed towards the west property line to route offsite drainage around the expansion and keep floodplain outside of the permitted landfill extents. To the east, the Chocolate Bayou routes channelized flow north to south outside. This drainageway is already outside of the proposed landfill expansion extents and will remain intact. Due to the natural terrain features, existing ditch network, and existing constructed portions of the landfill, no other significant sheet flow enters the site. Therefore, there is no significant run-on to the site.

Stormwater from the site will flow, by a series of perimeter ditches, into the existing conveyance channels that eventually flow to Chocolate Bayou and then to Lavaca Bay. The route it takes to get to Chocolate bayou is split into east and west portions. The east drainage path exits the site through an existing conveyance channel located near the southwest corner of the proposed landfill boundary that parallels FM 1686 until tying in directly to Chocolate Bayou. The west portion of the site exits through an existing conveyance channel located along the western side of the south proposed landfill boundary running parallel to Highway 185 until tying into Chocolate Bayou further to the south. These drainage paths were essential in the design of the stormwater management as pre-development conditions flows to these conveyance channels set the maximum allowable peak flow for the proposed conditions, as shown in **Table 5.1**.

All drainage and run-off calculations for “pre-development conditions” are based on the configuration of the property prior to landfill development, i.e., cultivated farmland. All post-development drainage and run-off design is based on the final full closure configuration of the landfill.

3.2 Stormwater Management Overview

The conveyance of stormwater is accomplished through a series of swales, chutes, ditches, channels, and ponds. The overall routing of stormwater can be seen in Figure 1.

3.3 Final Cover Swales

Runoff from the final cover system will be collected by swales located along the landfill slopes. Spacing of the swales will not exceed 30 vertical feet. Swales will consist of a 24” deep, V-shaped channel with a nominally compacted soil berm extending vertically beyond the final cover system. The invert flowline of these features will be constructed at a 1% slope, except for certain existing TBC swales designed with a 0.5% invert. Swales will be vegetated. Stormwater collected by these features will be conveyed to letdown chutes. Design methodologies are discussed in Section 3.2 and 3.3 of this report.

The swales permitted under 1522A are also 24” deep and spaced at a maximum of approximately 30 vertical feet. The 1522A swales are designed with a 0.5% minimum flowline.

3.4 Letdown Chutes

A total of nine (9) letdown chutes will be constructed within 1522B design, each serving as the drainage outlet for several final cover swales (discussed in Section 3.3). The letdown chutes shall be oriented directly downslope, with a maximum flowline slope of 3:1, and shall discharge into the perimeter ditches (discussed in Section 3.5). A trapezoidal geometry shall be used for the chutes, with a depth of 12 inches and a bottom width of 12 feet. The chutes will be lined with riprap contained within 18-inch-deep gabion baskets. The mean rock size shall be 9 inches. Design methodologies are discussed in Section 3.2 and 3.3 of this report.

Two types of letdown chutes are permitted for the 1522A waste unit. Both have a trapezoidal geometry with a depth of 24 inches and bottom widths of 8-10 feet. One type utilizes a 6” tri-lock concrete lining material and the other type utilizes a 6” gabion with 5-inch (mean diameter) riprap. Due to the maximum landfill slope of 4:1 for this waste unit, the maximum flowline of these chutes is lower than that which is to be permitted under 1522B.

3.5 Perimeter Ditch

The routing of surface runoff leaving the landfill watersheds via perimeter ditches is shown in Figure 1. The perimeter ditches are located between the proposed perimeter access road and landfill liner boundary. All ditches are trapezoidal in shape with 3:1 side slopes and varying bottom widths from 5 ft. to 12 ft. Each ditch was sized to convey the 25-year storm event with capacity to allow 1 ft. of freeboard. Drainage ditch methodologies and calculations can be found in **Table 5.2** and Section 5.1.2.1.

3.6 Conveyance Channel Reroute

The current site includes an existing conveyance channel that bisects the west half of the proposed landfill expansion, routing offsite flow from the north through the landfill boundary. This channel (labeled Drainage Channel 1 on Figure 1 in Appendix A) will be re-routed along the west and south property lines to keep external runoff and flood flows outside of the permitted landfill boundary, tying back into the existing drainage channel at the southern property boundary. A second channel (labeled Drainage Channel 2) which collects a significant portion of the existing landfill runoff, will also be re-routed along the north property boundary to convey flow from the existing landfill detention pond to the west property boundary, discharging to Drainage Channel 1 at the northwest corner of landfill property. The new routing of the two conveyance channels can be seen on Figure 1 in Appendix A. Re-routed Drainage Channel 1 will also function as the downstream discharge point of the proposed West Pond during storm events larger than the water quality storm event, and Perimeter Ditches B and C.

3.7 Culverts

Concrete culverts are used throughout the site for both perimeter drainage ditches and pond outlet structures. Perimeter Ditch B uses culverts at two locations as inlets (labeled Culvert B-1 & B-2 on Figure 1 in Appendix A) into the Water Quality Pond sized to detain the water quality volume. Perimeter Ditches D, E, and F each use culverts to route flow from the ditch to the Detention Pond on the east side of the landfill. Culverts information can be seen in **Table 5.3** in Section 5.1.2.2.

3.8 West Pond

A Water Quality Pond is located on the west side of the proposed landfill expansion boundary and discharges to Drainage Channel 1 Re-Route through the West Pond Outlet structure labeled on Figure 1 in Appendix A. The pond was sized to detain the Water Quality volume storm event of 1.5-inches cumulative over a 24-hour time span. The west portion of the site in both pre-development and post-development conditions discharges to the same tributary channel mentioned in Section 3.6 near the southwest corner of the proposed landfill boundary. The West Pond does not require any detention of the 25-year storm event as post-development conditions peak runoff to the drainage channel is less than pre-development conditions peak runoff. This can be attributed to changes in drainage boundaries due to landfill grading plan and minimal changes in runoff Curve Numbers. The West Pond is used to detain only the Water Quality storm event as a best management practice for improving the quality of runoff from the proposed solid waste landfill. The West Pond design information and details can be found in Section 5.1.2.3.

3.9 East Pond

A detention pond is located on the east side of the proposed landfill expansion boundary. While the pond will exhibit similar water quality functions as the West Pond as a best management practice, the East Pond was sized to convey the 25-year storm event and serve as a central collection point for Perimeter Ditches D, E & F before discharging through a composite outlet structure located on the east side of the pond to the existing Drainage Channel 3 routed towards Chocolate Bayou. The post-development runoff for the east side of the site exceeded the pre-development conditions peak runoff, so the East Pond is required to decrease the peak flow in post-development conditions for the 25-year event. The Detention Pond design information and details can be found in Section 5.1.2.4.

3.10 Stormwater Drainage During Phased Construction of the Landfill

The landfill cells will be constructed in the order presented in Drawing C003 of Attachment 1 (Waste Placement Phasing Plan). The Stages presented herein refer to the Stages presented in Drawing C003. Phased construction of the drainage system will accommodate drainage and run-off control during interim construction periods. Final cover swales and letdown chutes will be constructed with the installation of the final cover system. Intermediate swales and letdowns shall be installed as necessary. Below is a list of the numerical stages presented in Drawing C003 and descriptions of the corresponding surface water drainage conditions.

Stage 1/2: The north slopes of Trenches 8-10 drain to the channel along Farm-to-Market 1686 and leave site. The slopes of Trenches 6-9 of the Existing TBC Area (except those mentioned previously) will drain into the south-sloping perimeter ditch before reaching the detention pond, as originally permitted. Landfill slopes and final cover swales on the north slopes of Trenches 8/9 and the east slopes of Trenches 7/8 shall be constructed in accordance with Attachment 1. The south slope of Trench 7 will contain a temporary letdown chute, as shown in Appendix B to receive the drainage from the swales along the east slope.

Stage 3/4: The construction of Cell G2 will cause the perimeter ditch east of Trenches 7/8 to be unable to flow into the north detention pond, per Existing TBC conditions in Appendix B. Therefore, the perimeter ditch shall be terminated at the SE corner of Trench 7 and Perimeter Ditch F shall be extended to convey flows east to the East Pond, which shall be constructed fully or partially at this stage (if constructed partially, it shall be progressively constructed and fully constructed by Stage 5/6. The new portion of Perimeter Ditch F shall be adjacent to the northeast perimeter of future cell H1 and northern perimeter of future Cells H2, I1 and I2. The temporary letdown chute in the Trench 7 footprint shall remain, as it is located east of Cell G2 and able to discharge into Perimeter Ditch F.

The portion of Perimeter Ditch D to be constructed at this time shall be from the SW corner of Cell G1 to the discharge point of the East Pond to convey flows from the north and south slopes of the constructed expansion area. A temporary sediment basin shall be constructed at the west edge of Cell G1 to capture flow from the west slope of Cell G1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch D).

The north and south culverts discharging into the East Pond shall be constructed at this time.

Stage 5/6: The portion of Perimeter Ditch D to be constructed at this time shall be from the SW corner of Cell F1 to west extent of the previously constructed portion (SW corner of Cell G1). A small portion of Perimeter Ditch B shall be constructed at this time, along the North edge of Cell F1. A temporary sediment basin shall be constructed at the west edge of Cell F1 to capture flow from the west slope of Cell F1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch B/D). Perimeter Ditch B, running east-west will also discharge into this sediment pond. It is assumed that Perimeter Ditch A (design information in Appendix B) has already been constructed at this time.

Stage 7/8: The portion of Perimeter Ditch D to be constructed at this time shall be from the SW corner of Cell E1 to west extent of the previously constructed portion (SW corner of Cell F1). The portion of Perimeter Ditch B shall be constructed at this time shall be from the NW corner of Cell E1 to west extent of the previously constructed portion (NW corner of Cell F1). A temporary sediment basin shall be constructed at the west edge of Cell F1 to capture flow from the west slope of Cell E1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch B/D). Perimeter Ditch B shall continue to discharge into the temporary sediment pond.

Stage 9/10: At this time, the remaining portions of Perimeter Ditches B and D shall be constructed, along with the West Pond and Drainage Channels 1 and 2. A temporary sediment basin shall be constructed at the west edge of Cell D1 to capture flow from the west slope of Cell E1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch B/D).

At this time, the route of discharge from the existing north detention pond will no longer be active. Flow will instead pass through the regraded Drainage Channel 2 and around the West Pond (via Drainage Channel 1).

Stage 11/12: A temporary sediment basin shall be constructed at the west edge of Cell C1 to capture flow from the west slope of Cell C1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch B/D). Perimeter Ditch C shall be installed in it's entirety at this point.

Stage 13/14: A temporary sediment basin shall be constructed at the west edge of Cell C1 to capture flow from the west slope of Cell C1 (and all areas below the elevation, or otherwise unable to flow into the Perimeter Ditch B/D).

Stage 15/16: No temporary channel shall be installed at this time, due to permanent perimeter controls being in place to handle flows from Cells A1 and A2.

Stage 17/18: The temporary letdown chute in Trench 7 shall be abandoned at this time, to prevent stormwater discharge into Cells H1 and H2. A temporary sediment basin shall be constructed at the east edge of Cell H2 to capture flow from the east slope of Cell H2 (and all areas below the elevation, or otherwise unable to flow out of the new cells).

Stage 19/20: No temporary channel shall be installed at this time. Perimeter Ditch E (along with the third culvert discharging into the East Pond) shall be installed along the east edge of Cell I2. This shall complete the permanent perimeter ditch construction at the Facility.

4.0 CONTAMINATED WATER

Relevant regulation ID numbers from the checklist: 291, 292, 301, 302

The handling, storage, treatment, and disposal of contaminated surface or groundwater shall be in accordance with TAC Rule §330.207. Rainfall that shall come in contact and percolate through the active face of the waste unit shall be considered leachate, which is discussed in Attachment 3 – Leachate and Contaminated Water Plan.

The active face shall be maintained to prevent run on flow and to prevent runoff from leaving the landfill boundary after contacting exposed waste. Furthermore, the active face shall be enclosed within a soil diversion berm and will typically have minimal slopes, as to limit runoff and provide means for rainfall to percolate through the waste. Calculations are provided in Attachment 3 – Leachate and Contaminated Water Plan.

The leachate management system shall convey leachate collected from the bottom of each cell to storage tanks within the Facility. Drawing C005 and C-502 of Attachment 1 provide information on these storage units. Additional discussion is also provided in Attachment 3 – Leachate and Contaminated Water Plan. Further information on the containment structure and the storage units of the Existing Constructed Area can be found in previous permit amendments.

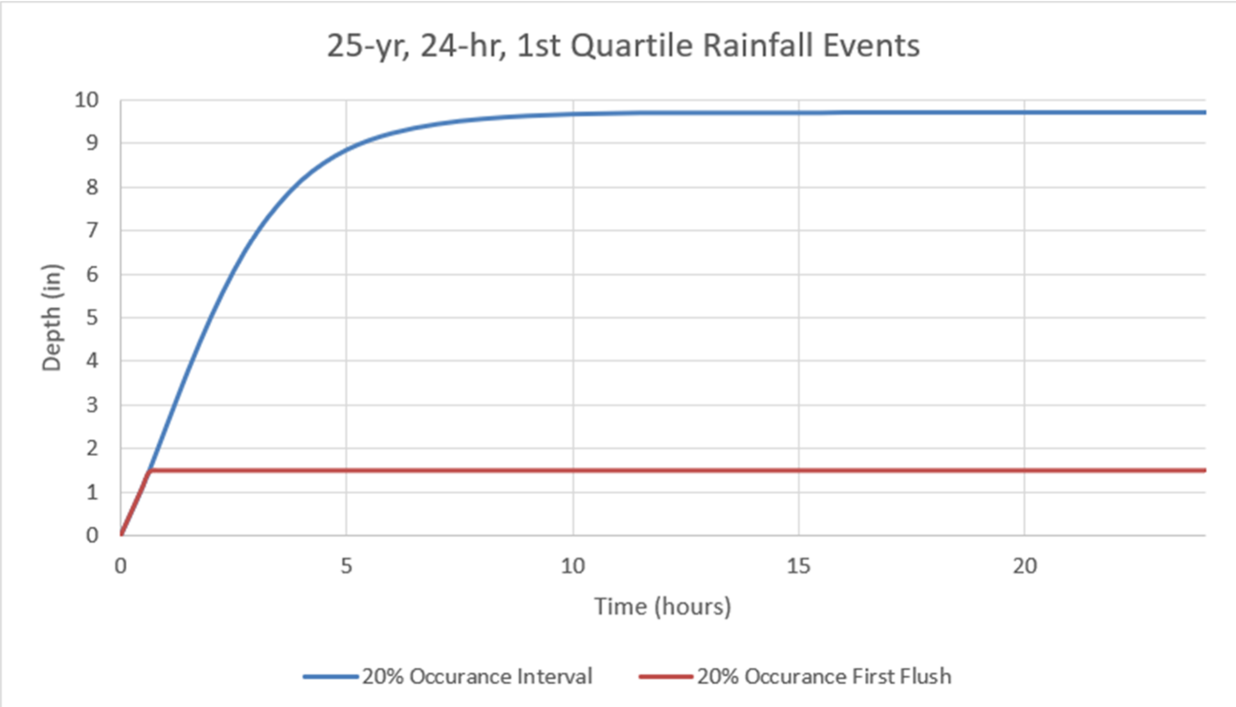
5.0 METHODS AND CALCULATIONS

Relevant regulation ID numbers from the checklist: 308-311

5.1 Storm Drainage Modeling Introduction

Three models were developed using Bentley Systems CivilStorm software. The first model is the Pre-Development Conditions Model to that was used to establish pre-development peak rates of runoff at site discharge locations corresponding to the Tributary Ditch to the west and Chocolate Bayou to the east. Second is the Post-Development Conditions Model which includes the final stormwater elements listed in Section 3.0. Third is the Water Quality Event Model, based on an abbreviated version of the Post-Development Conditions Model. Rainfall data was obtained from the NOAA Atlas 14, Volume 11 (version 2) precipitation frequency tables for the project location. A 25-year recurrence interval and 24-hour duration event were selected giving a cumulative depth of 9.72-inches for both the Pre-Development and Post-Development Conditions Model. Next, a NOAA Atlas 14 temporal distribution of first quartile, 20% occurrence interval was selected for the 9.72-inch cumulative depth. A First Flush rainfall event was also modeled with a cumulative depth of 1.5-inches as the Water Quality Event. The First Flush distribution was designed to match the curve of the 20% occurrence interval until reaching the cumulative 1.5-inch depth. See Figure 5.1 for rainfall distributions used in the modeling process. All three models use the SCS Curve Number methodology for calculating runoff peak flows.

Figure 5.1: NOAA Atlas 14 Cumulative Rainfall Distribution



5.1.1 Pre-Development Conditions Model

The Pre-Development Conditions Model was created to identify the peak runoffs leaving the site to the corresponding watershed to understand the maximum flow to each site discharge point. The watershed boundary splits the pre-development site runoff into two directions. The west portion of the site is approximately 147 acres eventually draining to the rerouted Tributary Ditch drainage channel (reference in Section 3.6) in the middle of the subarea and south off the property. The east portion of the site contains 3 subareas all flowing toward Chocolate Bayou. The east subareas make up approximately 207 cumulative acres. Subarea catchment attributes can be seen in **Table 5.1**.

A single west drainage subarea is classified as Cultivated Agricultural Lands with Straight Row Crops in good condition. For USGS Soil D classification, the SCS Curve Number used was 89.

The east watershed has been split into three subareas, all falling under USGS Soil D Classification. From west to east the three subareas are currently used for the following; borrow pit for existing landfill operations, compost storage, and agricultural row crops. However, for this analysis to use "pre-development" conditions, based on historical aerial imagery the entire east watershed has also been classified as Cultivated Agricultural Lands with Straight Row Crops in good condition. For USGS Soil D classification, the SCS Curve Number used was 89.

5.1.2 Post-Development Conditions Model

The Post-Development Conditions Model shows the integrated network of subarea catchments with proposed perimeter ditches and ponds. **Table 5.1** shows a high-level comparison between cumulative catchment area and corresponding peak runoff, reflecting changes in catchment area due to proposed landfill grading and channel capacity. With more area now contributing to Chocolate Bayou (east outfall), the east Detention Pond is required to decrease peak runoff below the pre-development conditions peak flow as seen in **Table 5.1**. No detention is required on the west side of the site as a reduction in drainage area and changes in landcover SCS Curve Numbers and time of concentrations resulted in lower peak flows in post-development conditions compared to pre-development conditions.

Table 5.1: Pre-Development vs. Post-Development Model Comparison for 25-Year Rain Event

Area	Attribute	Pre-Development Condition Model	Post-Development Condition Model*
West Outfall	Peak Runoff [cfs]	352.20	262.01
	Total Runoff Volume (ac-ft)	102.40	87.08
	Cumulative Catchment Area [acre]	146.65	136.57
East Outfall	Peak Runoff [cfs]	500.16	458.25
	Total Runoff Volume (ac-ft)	144.21	153.04
	Cumulative Catchment Area [acre]	206.52	232.15

*Runoff results are presented with detention provided.

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The post-development conditions catchments were relatively consistent with SCS Curve Number selection. Catchment areas that will be converted from pre-development conditions to landfill were given the classification Fully Developed Urban Areas with Open Space in fair condition (grass cover 50%-75%). This area was defined to have USGS Soil D classification, which provided an SCS Curve Number of 84 for the disturbed areas. The remaining area within the property boundary were assumed to match the pre-development conditions land use classifications.

5.1.2.1 Perimeter Ditch Design

Proposed Perimeter Ditch design attributes can be seen in **Table 5.2**. All ditches are trapezoidal in shape with 3:1 side slopes. Reference Figure 3 in Appendix A for Ditch ID's.

Table 5.2: Perimeter Ditch Attributes

Ditch ID	Bottom Width [ft]	US Invert El [ft]	DS Invert El [ft]	Length[1] [ft]	Ditch Top Width (max) [ft]	Rise(max)/ Depth[2] [%]	Side Slopes	Manning's n	Slope[1] [%]	Velocity [fps]	Discharge [cfs]
B-1	12	62.20	60.28	3,978	48.72	79.7	3:1	0.03	0.05	2.32	157.64
B-2	12	60.28	59.90	733	45.3	44	3:1	0.03	0.05	2.99	160.57
B-3	12	59.90	59.50	763	45	49.6	3:1	0.03	0.05	2.39	118.43
C	5	65	62	1,809	31.4	69.4	3:1	0.03	0.20	1.56	8.21
D	10	61.9	59	4,736	49.4	84.2	3:1	0.03	0.06	2.07	202.56
E[1]	5	65	59	808	49.4	48	3:1	0.03	0.75	1.02	53.50
F	4	64.00	59.00	2,745	49.4	57.2	3:1	0.03	0.20	1.95	73.36

[1]Length and slope listed are from the beginning of the ditch towards outfall as shown with flowline on Figure 3 in Appendix A.

[2]Rise(max)/Depth percent is reflected as the maximum water level depth divided by the total available depth in the ditch.

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5.1.2.2 Culvert Design

Culverts are used where necessary to cross storm drainage infrastructure throughout the proposed site. Figure 3 in Appendix A shows the location and naming convention for the culverts with corresponding attributes listed in **Table 5.3**. All culverts used for stormwater conveyance have been sized as reinforced concrete pipe. However, upon approval by Engineer, corrugated dual wall, smooth interior HDPE pipe may also be used.

Table 5.3: Perimeter Ditch Culvert Attributes

Culvert ID	Diameter [in]	# of Barrels	US Invert El [ft]	DS Invert El [ft]	Length [ft]	Manning's n	Slope [%]	Velocity [fps]	Discharge [cfs]
B-1	24	2	60.28	59.25	100	0.013	1.1	14.61	54.23
B-2	24	1	59.90	59.25	100	0.013	0.7	13.18	27.28
B-3	48	1	59.50	58.50	60	0.013	1.4	15.19	150.35
D	60	2	59.00	58.50	80	0.013	0.6	13.68	201.97
E	48	1	59.00	58.50	85	0.013	0.6	11.57	53.49
F	30	2	59.00	58.50	80	0.013	0.6	10.77	72.96

5.1.2.3 West Pond Design

The elevation-area storage data of the West Pond can be found in **Table 5.4**. The West Pond has two inlet points through culverts B-1 & B-2 (see **Table 5.3**). The inverts of the culverts were placed at the bottom depth of Perimeter Ditch B and were sized to convey just the Water Quality storm runoff to the pond. Runoff exceeding the Water Quality event will bypass these culverts and flow will continue through Perimeter Ditch B to discharge at Culvert B-3. The West Pond was sized to capture the Water Quality storm event volume with 1 ft of water level increase in the pond (i.e. – the volume difference between El. 60' and El. 59'). A composite outlet structure was designed to control the outflow and allow for detention in the pond. The outlet structure consists of a single 15-inch concrete culvert with upstream invert El. 59.00'and downstream invert El. 58.70'. The pipe size and invert are set to control the outflow of the pond during the water quality event without utilizing the emergency overflow weir set to El. 60.00'. The weir crest is 85.00 ft. wide then slopes up to elevation El. 61.00' for a top width of 91 ft. With the outflow pipe set at invert El. 59.00', there will be a 4-foot-deep permanent pool from El. 55.00'.

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Table 5.4: West Water Quality Pond Elevation-Area

Elevation [ft]	Areas [acres]
55.00	5.549
56.00	5.926
57.00	6.307
58.00	6.692
59.00	7.083
60.00	7.478
61.00	7.877

5.1.2.4 East Pond Design

The elevation-area storage of the East Water Quality/Detention Pond can be seen in **Table 5.5**. The Detention Pond has a similar composite outlet structure with concrete pipes and overflow weir design to detain outflow from the pond during a 25-year storm event. Three 30-inch culverts are used to convey the flow from the pond from upstream invert El. 57.00’ to downstream invert El. 56.50’. The weir crest is 42 ft. wide at El. 58.50’. This composite outlet structure discharges to an existing channel (Drainage Channel 3) routed directly to Chocolate Bayou east of the project boundary. With the invert of the outlet pipe at El. 57.00’, there will be a 4 ft. permanent pool starting at El. 53.00’.

Table 5.5: East Detention Pond Elevation-Area

Elevation [ft]	Area [acres]
53.00	5.806
54.00	6.039
55.00	6.273
56.00	6.509
57.00	6.884
58.00	7.127
59.00	7.372
60.00	7.619
61.00	7.867

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5.2 Rational Method Calculations

The Rational Method was used to calculate the peak flows for nine (9) basins that contribute runoff to the letdown chutes in the expansion area, as all these basins were less than 200 acres. The nine basins were delineated by landfill slopes and the orientation of the final cover swales. The drainage basins are shown on Figure 4 in Appendix A. The 25-year peak flows for Basins 1-9 were calculated using unvegetated conditions, as to provide the most conservative scenario for sizing the letdown chutes. One additional basin (D2/D6) was analyzed to support the re-design of the existing TBC swale on the north slope of the existing TBC area (shown on Drawing C007 of Attachment 1). Basin D2/D6 has a unique nomenclature because it was originally a part of the previous permit design calculations for the Facility. More information for the review of historic calculations is provided in Section 6 of this Report.

Three sub-basins were identified for designing final cover swales, which are shown on Figure 4 in Appendix A of this Report. Each sub-basin's 25-year peak flow was calculated for both vegetated and unvegetated conditions to provide the most conservative scenarios for swale design, which is discussed in Section 5.3 of this Report.

The Rational Method calculations can be found in Appendix F. The variables of the rational method equation (Q = CIA) were determined using the Texas Department of Transportation (TxDOT) Hydraulic Design Manual (September 2019 revision). The relevant pages of this manual are included as references within Appendix F. A summary of the rational method is provided in **Table 5.6**.

The Rational Methods assumptions unique to this design are as follows:

- The precipitation data was obtained using NOAA Atlas 14, Volume 11 with a user-inputted location approximately 10 miles SE of Victoria, TX (Latitude: 28.7371°, Longitude: -96.9737°)
- The Relief Runoff Coefficient was determined by using a weighted average of areas within the basin corresponding to certain slopes.
- The Soil Infiltration Coefficient of 0.08 was used, assuming the average soil type from the borrow area is a sandy clay.
- Two Vegetal Cover Coefficients (0.12 and 0.04) and two Manning n-values (0.024 and 0.011) were used, with the assumption that the critical cover scenarios are vegetated and unvegetated (bare soil). The intermediate condition was not considered.
- When calculating time of concentration, some situations did not reach shallow concentrated flow. For those situations, a flow length of zero was inputted into this portion of the spreadsheet.
- For time of concentration of shallow flow, the depth was rounded to the nearest foot when calculating the wetted perimeter.
- Areas and lengths were obtained using AutoCAD Civil 3D 2020.

Table 5.6: Rational Method Results Summary

Basin ID	Area (Ac)	Average Rainfall Intensity (in/hr)	Peak Discharge of 25-Year Storm (cfs)
Basin 1	23.8	6.72	86.3
Basin 2	34.3	6.35	117.6
Basin 3	30.5	7.04	115.9
Basin 4	24.1	6.83	88.7
Basin 5	27.7	6.03	90.1
Basin 6	21.2	6.88	78.7
Basin 7	25.9	6.71	93.6
Basin 8	29.4	6.71	106.3
Basin 9	32.1	6.33	109.7
Basin D2/D6 (Existing TBC nomenclature, used for chute redesign)	24.04	10.23	112.9

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Sub-Basin ID	Area (Ac)	Average Rainfall Intensity (in/hr)	Peak Discharge of 25-Year Storm (cfs)
Sub-Basin 2-1	4.05	7.06 (vegetated) 12.6 (unvegetated)	10.9 (vegetated) 23.5 (unvegetated)
Sub-Basin 4-1	18.51	5.35 (vegetated) 10.6 (unvegetated)	33.7 (vegetated) 82.4 (unvegetated)
Sub-Basin 5-1	9.88	5.59 (vegetated) 9.13 (unvegetated)	17.7 (vegetated) 36.1 (unvegetated)

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5.3 Swale Sizing Methodology

Peak flows for sizing the final cover swales and the letdown chutes were obtained using the Rational Method, discussed in Section 5.2 of this Report. For methods and calculations for the landfill perimeter ditches and drainage channels, see Section 5.1.

Three critical swales were considered for sizing all swales withing the landfill expansion. Swale #1—receiving the runoff of Sub-Basin 2-1—is located on a 3:1 slope, thus representing the narrowest V-shaped cross section of all design swales, with the largest tributary area of these similar swales. Swale #2—receiving the runoff of Sub-Basin 5-1—is located on a 5% slope, thus representing a wider V-shaped cross section than Swale #1 but with a larger tributary area. Swale #3—receiving the runoff of Sub-Basin 4-1—is located between a 4:1 and a 5% slope, thus representing the widest V-shaped cross section of all swales but with the largest tributary area (18.5 acres). All three critical swales were analyzed using the 25-year peak flow for both vegetated and unvegetated conditions. All swales within the landfill expansion, using criteria outlined in Section 3.3 are adequately designed to provide approximately 1-foot of freeboard in a 25-year design storm, with a flow velocity not exceeding 4 ft/sec.

An analysis was also conducted to prove the adequacy of the existing TBC swales using the methodology stated above. More information is provided in Section 6 of this Report.

Three critical letdown chutes also were analyzed. LD-2 represents the typical chute running directly down the 3:1 slope, receiving the largest flow rate of similar features. LD-3 represents the typical chute running along the junction of two 3:1 slope (itself having a slope of approximately 24%), receiving the largest flow rate of similar features. EX-TBC Letdown represents the redesigned chute on the existing TBC area of the landfill, which has a tributary area affected by the landfill expansion. All letdown chutes provide at least 6 inches of freeboard to the top of the bedding material (12 inches to the top of the channel) in a 25-year design storm.

The swales were analyzed using Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. This program utilizes Mannings equation. Reports from this program are provided in Appendix G.

5.4 Swale Lining Calculations

Three critical letdown chutes (LD-2, LD-3, discussed in Section 5.3 of this Report) were analyzed for shear stress to assign adequate lining material to these structures. The method for determining swale lining is from Hydraulic Engineering Circular (HEC) No. 14, Third Edition Hydraulic Design of Energy Dissipators for Culverts and Channels. The relevant pages of this manual are included as references within Appendix H. The spreadsheet-generated calculations are provided within this Attachment.

Assumptions unique to this design are as follows:

- Design flow rates are taken from the Rational Method Calculations, discussed in Section 5.2.
- For constructability, gabion mattress thickness is available in increments of 6” and mean rock size is available in increments of 3”.

6.0 HISTORIC DRAINAGE DESIGN REVIEW

Engineering best practices required the review of calculations included in previous permits for the Facility. This was required to verify that the drainage design of the existing permitted landfill is still appropriate where design guidance may have changed.

Drainage Basins A-1, A-2, and A-3, as shown on Drawing 6B-1 of Appendix B, were analyzed to verify that the post-development discharge flow rates (using updated methodologies consistent with the Landfill expansion design) do not exceed the historic calculations. A summary of the results is included below:

- Basin A-1 (31.0 acres) was analyzed using the geometry shown in Drawing 6B-1. The flow rate at discharge point NW-HWY, using current methodologies (Rational Method, as described in Section 5.2 of this Report) does not exceed the result of the historic calculation. This calculation is included in Appendix F.
- Basin A-2's (32.3 acres) geometry has been altered as a result of the landfill expansion. Notable revisions include an increase of 0.8 acres and additional 4:1 and 3:1 slopes. Because the landfill expansion design utilizes the same discharge point, these revised post development conditions were compared to original Basin A-2 conditions. The flow rate at discharge point NE-HWY, using current methodologies (Rational Method, as described in Section 5.2 of this Report) does not exceed the result of the historic calculation. This calculation is included in Appendix F.
    - The NE-HWY channel (Figure 3, also on Historic Drawing 6B-1 as "Channel C-2") is adequate for conveyance of existing TBC areas associated with the landfill expansion.
- Basin A-3 (91.5 acres) is divided into 8 sub-basins, which are shown on Drawing 6H-6 of Appendix B. This Basin was analyzed using the Rational Method (as described in Section 5.2 of this report) and the HEC-1 results from previous permits were reviewed to verify that the existing detention pond is compatible with the new design. To summarize:
    - The discharge resulting from Sub-Basin P-1, C-4, C-5 and C-6 does not exceed the result of the historic calculation for each respective basin. The Rational Method calculations are included in Appendix F.
    - Sub-Basin C-1 will be completely eliminated from the detention pond located in basin A-3. This area, under the landfill expansion, will be routed to the East Detention Pond and is therefore analyzed in Section 5 of this Report.

- Sub-Basins C-2 and C-3 are significantly altered by the landfill expansion and the discharge was analyzed as a single basin. Because the landfill expansion design utilizes the same discharge point, these revised post development conditions were compared to the combined original Sub-Basin C-2/3 conditions. The discharge does not exceed the result of the historic calculation for the combined basins basin. The Rational Method calculations are included in Appendix F.

- Sub-Basin “DP” HEC-1 and Detention Pond Design calculations from previous permits were reviewed to evaluate the existing detention basin release rate. The existing constructed detention basin is adequate for post development flows for the landfill expansion.

In summary, the review of historic calculations has determined that the post development offsite discharges are not adversely altered when current design methodologies are used. Furthermore, no adverse alterations result from the landfill expansion post-development conditions.

The existing constructed and TBC swales shown on Drawing 6H-24 of Appendix B were also analyzed for flow depth and velocity under peak vegetated and unvegetated flow conditions, to prove the adequacy of the Existing TBC design with methodologies consistent with the landfill expansion design. It was determined that the freeboard of these swales are a minimum of 6 inches and re-design is not required. Appendix F includes the Rational Method calculations and the results of Hydraflow Express for Civil 3D, for determining depth and velocity.

7.0 FLOODPLAIN EVALUATION

Relevant regulation ID numbers from the checklist: 314-316, 318-328, 331

TCEQ guidelines defined in Title 30, Part 1, Chapter 330, Subchapter B, Rule 330.63 requires that municipal solid waste facilities be located outside of the 100-year floodplain or provide a Conditional Letter of Map Change from FEMA. The existing permitted landfill is not located with a FEMA regulatory floodplain. However, portions of the landfill expansion property are located in a FEMA Zone A Special Flood Hazard Area (SFHA 100-year floodplain), as shown on the currently regulated Flood Insurance Rate Map (FIRM) Panel number 4806370200B, effective September 18, 1987. The regulatory FIRM, annotated to show the landfill boundary is included in Appendix I, Appendix J, and Appendix K. Site improvements including grading, excavation, ditch relocation, and floodplain fill will be required for the landfill expansion to meet TCEQ requirements and keep floodwaters out of the landfill expansion boundary.

Flooding through the landfill expansion property occurs from two sources, manmade drainageways identified as the Chocolate Bayou and a Tributary Ditch (an unnamed tributary of the Chocolate Bayou), both of which contain FEMA regulatory Zone A floodplain. The Chocolate Bayou bisects the site near the east property boundary. The proposed landfill expansion slightly encroaches into the edge of the Chocolate Bayou 100-year floodplain. On the west side the unnamed Tributary Ditch to the Chocolate Bayou follows the northern property boundary before turning south to bisect through the expansion site. Removing the Tributary Ditch floodplain from the proposed landfill expansion requires this ditch to be completely rerouted outside of the permitted landfill boundary.

FEMA Zone A is defined as a SFHA without base flood elevations determined, and typically is not accompanied by existing hydrologic or hydraulic modeling that would serve as Effective FEMA modeling. Additionally, a FEMA FIRM map update is anticipated in the future, as a Revised Preliminary FIRM Panel Number 48469C0450H was issued April 30, 2020. This revised mapping is yet to be adopted by FEMA but continues to show a similar portion of the landfill expansion property within a FEMA Zone A floodplain. The revised preliminary FIRM, annotated to show the landfill boundary is included in Appendix I, Appendix J, and Appendix K. Following discussions with City, County, and FEMA Region VI staff it was determined that the Zone A floodplain on the Preliminary mapping was re-delineated using more recent topographic contour/surface data and confirmed that no hydraulic modeling existed that would accompany either the regulatory FIRM or preliminary FIRM.

Since the project area is within a Zone A floodplain and no existing hydrologic and hydraulic modeling has previously been prepared, following methods prescribed in FEMA 265, pre-development and post-project conditions hydrology and hydraulic modeling (HEC-RAS v5.0.6) have been created to determine the impact of the proposed landfill expansion on flood flows and 100-year water surface elevations to both flooding sources, the Chocolate Bayou and Tributary Ditch.

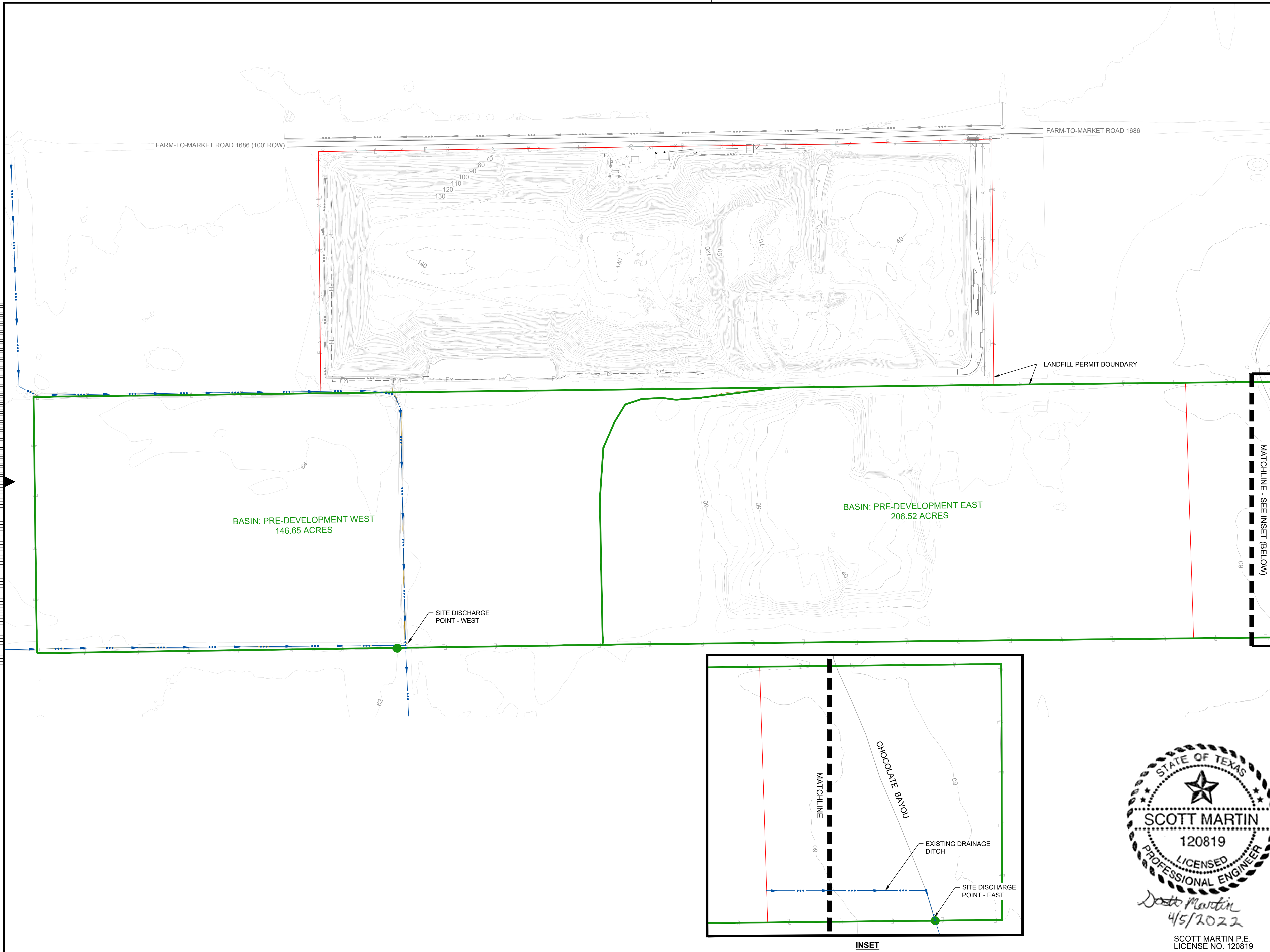
The hydraulic analysis determined the flooding extents to be significantly different than the Zone A floodplain depicted on FEMA FIRM mapping. However, while the proposed landfill boundary significantly encroaches into the 100-year floodplain determined through the project hydraulic modeling, the post-project analysis determined a no-rise condition resulting from compensatory grading to mitigate the proposed landfill construction. Mitigation resulted in no impact to 100-year water surface elevations to adjacent properties both upstream and downstream of the project. The post-project 100-year floodplain is included in Appendix K. These results were captured with endorsement of a Conditional Letter of Map Revision (CLOMR) from FEMA (Case No.: 20-06-2477R). The approved CLOMR is an acknowledgment by FEMA that, if built as proposed, the landfill expansion property would officially be located outside of FEMA regulatory floodplain if a Letter of Map Revision (LOMR) were requested at that time. A copy of the CLOMR is included in Appendix L.

As a stipulation of CLOMR endorsement, FEMA requires all adjacent property owners be notified that they will experience a floodplain revision on their property due to the proposed project, whether the result is any widening, shifting, increase in base flood elevations. As a result of the hydraulic analysis, twenty-five (25) properties surrounding the facility expansion received certified mailings that, if built and as requested through the LOMR process, the regulatory FEMA floodplain will officially be revised on their property. As previously noted, the hydraulic analysis did not reveal any increases in base flood elevations, however it did result in significant widening and shifting of the floodplain extents, even in the pre-development condition. A map of all properties contacted, copies of each notification letter sent, and USPS return receipts are included in Appendix N.

The FEMA CLOMR addresses the full buildout/final closure stage of the completed landfill expansion. However, this long-range plan does not address the interim conditions during landfill operations to meet TAC Rule §330.307 requiring protecting the facility from flooding and providing protection from the 100-year frequency flood. To meet these criteria in the interim condition, a perimeter berm will be constructed around the entire expansion perimeter. This berm is set a minimum 3-feet above the 100-year flood elevation established by the CLOMR, and this limit of fill established by the CLOMR is the same limit as the perimeter berm. Therefore, while the landfill expansion will encroach upon and constrict the

100-year floodplain, according to the hydraulic analysis completed as part of the CLOMR, the landfill expansion will not restrict flow or have an adverse impact upon water surface elevations to the 100-year floodplain, meeting Rule 330.307.

APPENDIX A – FIGURES



no.	date	by	ckd	description

FOR PERMITTING PURPOSES ONLY

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
March 2022	T. SCHMIDT
designed	checked
T. SCHMIDT	J. PARKER

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

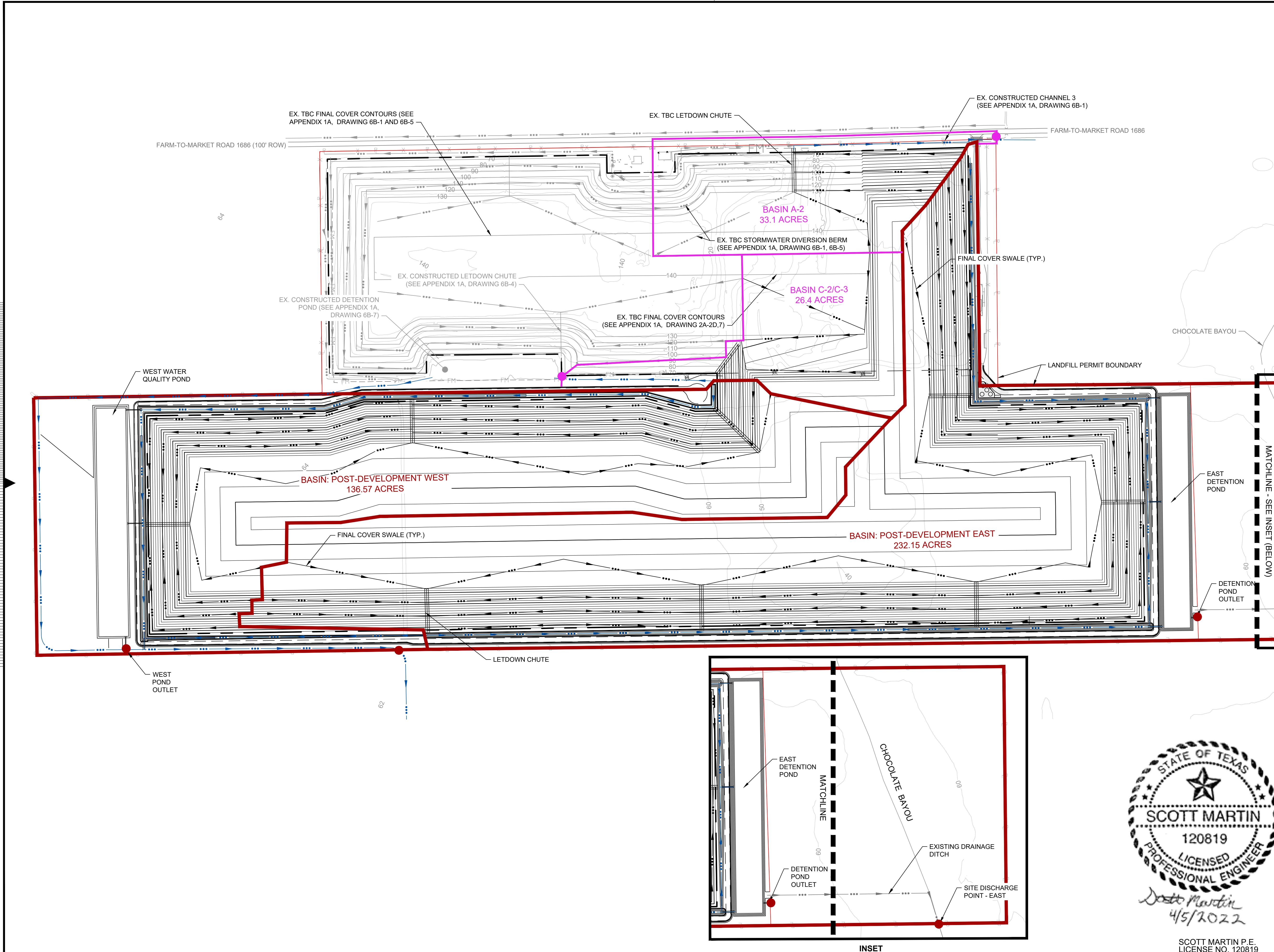
EXPANSION PERMIT DESIGN

STORMWATER DESIGN FIGURE:
LANDFILL PRE-DEVELOPMENT BASINS

project	contract
107608	-
drawing	rev.
SW-FIG-1 —	A

sheet 1 of 4 sheets

file



no.	date	by	ckd	description

NOTE:

1. THE MODIFIED EXISTING BASINS SHOWN ON THE EXISTING TO-BE-CONSTRUCTED LANDFILL SUPPORT THE HISTORIC DRAINAGE DESIGN REVIEW, WHICH CAN BE FOUND IN THE 1522B PERMIT AMENDMENT, ATTACHMENT 2. THESE HISTORIC BASIN AREAS WERE MODIFIED BY THE LANDFILL EXPANSION. THE ORIGINAL BASIN A-2 CAN BE FOUND ON DRAWING 6B-1 OF APPENDIX 2B. THE ORIGINAL BASINS C-2/C-3 CAN BE FOUND ON DRAWING 6H-6 OF APPENDIX 2B.

LEGEND:

- BASIN BOUNDARY
- DISCHARGE POINT
- PERIMETER DITCH FLOWLINE (SEE FIGURE 3)
- MODIFIED EXISTING BASIN (SEE NOTE)
- EXISTING BASIN DISCHARGE POINT

NORTH

0 300' 600'
SCALE IN FEET

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KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Co, Inc.
FIRM REG. NO. F-845

date	detailed
March 2022	T. SCHMIDT
designed	checked
T. SCHMIDT	J. PARKER

THE CITY OF VICTORIA TEXAS
Victoria County, Texas

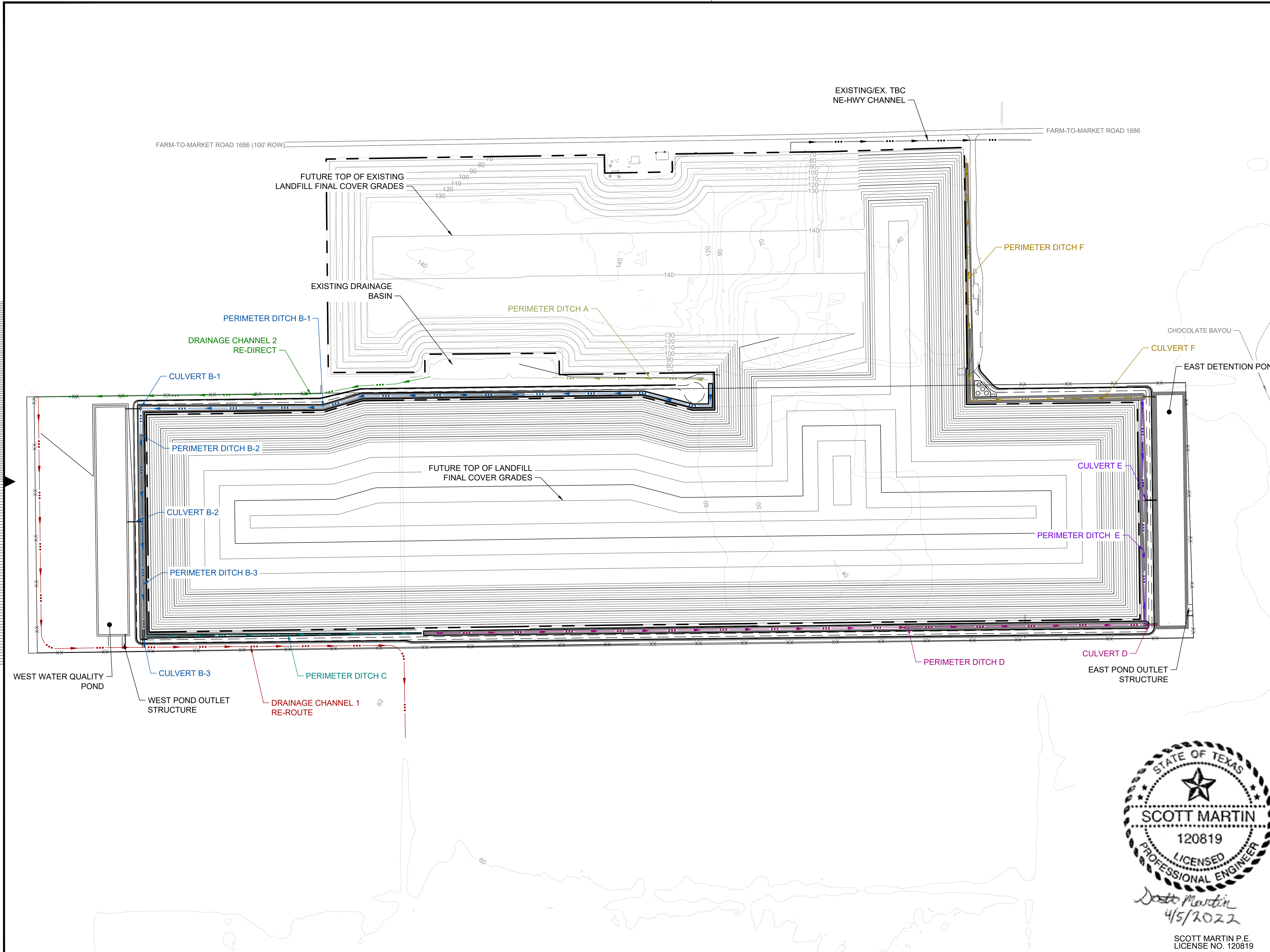
EXPANSION PERMIT DESIGN

STORMWATER DESIGN FIGURE:
LANDFILL POST-DEVELOPMENT BASINS

project	contract
107608	-

drawing **SW-FIG-2 —** rev. **A**

sheet 2 of 4 sheets
file



no.	date	by	ckd	description

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9400 WARD PARKWAY
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FIRM REG. NO. F-845

date	detailed
March 2022	T. SCHMIDT
designed	checked
T. SCHMIDT	J. PARKER

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Victoria County, Texas

EXPANSION PERMIT DESIGN

STORMWATER DESIGN FIGURE

project	contract
107608	-

drawing **SW-FIG-3** rev. **A**

sheet 3 of 4 sheets

file SW-FIG1.dwg

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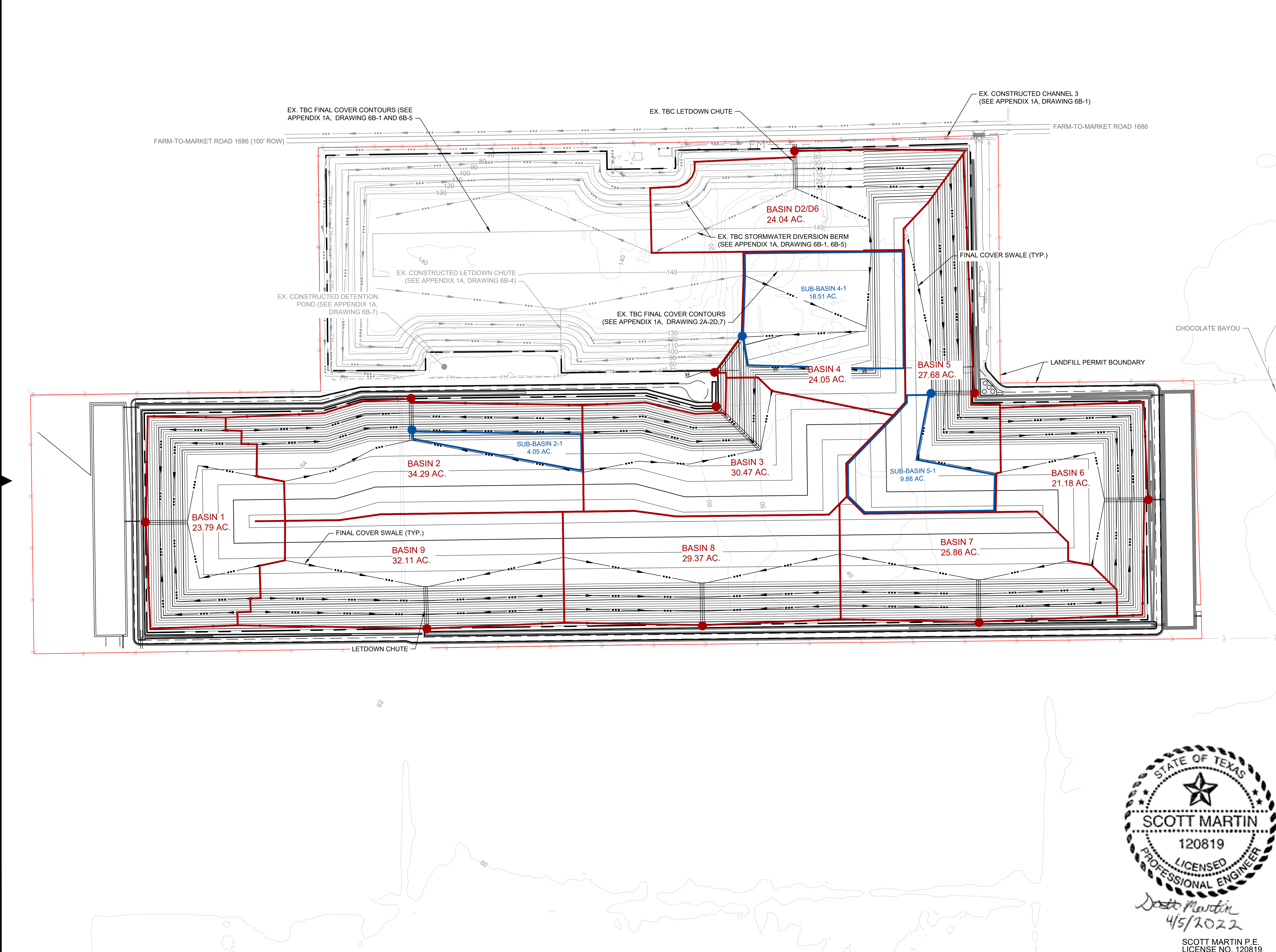

no.	date	by	ckd	description

NOTES:

1. BASIN AREAS USED TO DESIGN LETDOWN CHUTES. SUB-BASIN AREAS USED TO DESIGN FINAL COVER SWALES.
2. BASIN D2/D6 IS THE ORIGINAL NAME OF THE TRIBUTARY AREA IN THE HISTORIC CALCULATION FOR THE EXISTING TBC LETDOWN CHUTE. THE BASIN SHOWN REFLECTS REVISIONS FROM THE LANDFILL EXPANSION GRADING.

LEGEND:

BASIN BOUNDARY

SUB-BASIN BOUNDARY

DISCHARGE POINT

NORTH

0 300' 600'
SCALE IN FEET

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date	detailed
March 2022	T. SCHMIDT
designed	checked
T. SCHMIDT	J. PARKER

THE CITY OF VICTORIA TEXAS

Victoria County, Texas

EXPANSION PERMIT DESIGN

STORMWATER DESIGN FIGURE:
LANDFILL CHUTE/SWALE TRIBUTARY BASINS

project	contract
107608	-

drawing **SW-FIG-4 —** rev. **A**

sheet 4 of 4 sheets

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APPENDIX B – HISTORIC DRAINAGE CALCULATIONS

CITY OF VICTORIA LANDFILL
VICTORIA COUNTY, TEXAS
TCEQ PERMIT NO. MSW-1522A

SITE DEVELOPMENT PLAN

ATTACHMENT 6
GROUNDWATER AND SURFACE WATER PROTECTION PLAN
AND DRAINAGE PLAN

Prepared for

City of Victoria

TCEQ Approved August 29, 1997
Revised March 2006
Revised January 2007
Revised March 2009

January 2007 Revision Prepared by

Weaver Boos Consultants, LLC–Southwest
6420 Southwest Boulevard, Suite 206
Fort Worth, Texas 76109
817-735-9770

March 2009 Revision Prepared by

SCS Engineers
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Site Development Plan

Attachment 6

Groundwater and Surface Water Protection Plan and Drainage Plan

Table of Contents

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(i) The rational method, was used to calculate the peak flows and run-off volumes.

SAMPLE RUNOFF CALCULATION:

Q = CIA

(Q)Discharge = (C) factor * (I) rainfall intensity * (A) area
Q = runoff in cubic feet per second
C = runoff factor (includes slopes, cover)
I = rainfall intensity at the time of concentration in inches per hour
A = area in acres

C factors range for paved areas (0.85 to 0.95)
Residential and construction areas (0.40 to 0.60)
open range flat areas (0.20 to 0.50)

The time of concentration is the time it takes the runoff to travel from the most remote area of the watershed to the outlet point of the watershed. Time of concentration will be calculated from the lengths of the runs divided by the velocities from sheet flow, rill and gully flow and finally channel or culvert flow. The minimum standard time of concentration is 15 minutes.

Rainfall is obtained from Technical Paper #40 from the US Weather Bureau. From TP # 40 the rainfall in the Victoria Texas area for 25 years frequency – 24 hour storm is 9 inches.

Time of concentration for drainage area A-2 is as follows;

Sheet flow distance is 1320'
Channeled Length off landfill slope distance 180'
Drainage length to C2 to NE-hwy section 1340'
Time = 1320'/2.34 fps + 180'/36.63 fps + 1340/1.72 fps = 1348 sec or 22 minutes

The Time of concentration (T_C) from the Intensity/Duration Curve for a 25-year frequency rainfall for a T_C of 22 minutes is 7.0 inches per hour.

Thus the runoff would be computed as:

Q = CIA
Q = 0.50 * 7.0 * 32.28 = 112.98 cfs

Groundwater and Surface Water Protection Plan and Drainage Plan

Introduction

These documents meet the requirements of 30 TAC §330.56(f) and reflect the locations, details and typical sections of dikes, drainage channels, culverts, trench liners, leachate collection systems, existing surface drainage and proposed surface drainage structures, as well as "any other facilities related to the protection of groundwater and surface water." Detailed discussions and calculations regarding liners and leachate collection systems can be found in Site Development Plan (SDP) Attachment 15. Detailed information regarding geologic faults, and final cover are included herein or by reference to such detailed information provided in other attachments to the Site Development Plan. Additional information of faults is contained in SDP, Location Restrictions, Attachment 16-3. The final cover is detailed in SDP, Final Cover Plan, Attachment 12.

Surface Water Protection Plan and Drainage Plan

1. A drawing of the drainage areas is shown in Attachment 6A. Drainage area calculations were performed by computer measurement (AutoCAD 2005) of the areas and are summarized below in Table 6-1:

Table 6.1 – Drainage Areas as shown on drawing 6A

Drainage Area	Area (s.f.)
#1	465,043
#2	490,647
#3	645,049
#4	492,818
#5	554,062
#6	577,308
#7	607,792
#8	755,135
#9	370,731
#10	329,635
#11	328,711
#12	613,308
#13	244,029
#14	255,726

2. There are no levees at the site.

3. No portion of the site is within the 100-year flood plain; see SDP Attachment 6D.

(iv) Prior to the construction of this landfill in 1982, the site was a cultivated farm that drained naturally to the south and eventually into the Victoria Drainage District #1 ditch located near the southeast corner of the landfill or east to Chocolate Bayou. The original permit application by Resources Engineering, Inc, in 1982, took advantage of this natural drainage pattern. The proposed drainage system incorporates five (5) let-down structures, as shown on Attachment 6A from the top of landfill to the drainage system. The let-down structures have been designed to handle the stormwater run-off from the 24-hour, 25-year storm event on 25% side slopes. In addition, the permitted bench swales have been replaced with add-on berm swales and a detention pond has been added near the southeast corner of the facility.

Design calculations performed by computer modeling for the let-downs are presented in Attachment 6H

Each of the drainage areas previously detailed in Table 6.1 were grouped in watersheds A-1 through A-3 as shown in Attachment 6B-1. The discharge quantities for each watershed are outlined in Table 6.3 on page 7. The supporting calculations for the discharge quantities are presented in Attachment 6H.

Currently, the facility is being operated as a Type I municipal solid waste landfill. On going construction activities, including excavations of on-site soils for daily cover materials, has left areas that will collect stormwater run-off. Current drainage is mostly internal to the site and does not present large amounts of off-site run-off. Table 6.4, on page 8, compares the peak discharge before the landfill was built to the peak flow when the landfill is completed. Peak Discharge prior to landfill construction was approximately 504.6 cfs. After final construction of the landfill, Table 6.4 demonstrates that the Peak Discharge will be approximately 512.3 cfs. This increase in flow will not significantly alter the drainage of the site that existed prior to the landfill.

PERIMETER CHANNEL ANALYSIS
TABLE 6.3

Determine Maximum Flow Depth in Perimeter Channels

Channel	Cross Section	Drainage Area (ac)	C	tp (min)	Intensity (in/hr)	Drainage Area (ft2)	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)
C-1	NW-HWY	31.0	0.5	59.1	3.78	1,350,360	58.6	0.0007	0.025	6	6	10	1.71	1.70	0.281	0.04	1.75	34.50	30.46
C-2	NE-HWY	32.3	0.5	59.5	3.77	1,406,117	60.8	0.0007	0.025	6	6	10	1.74	1.72	0.282	0.05	1.78	35.45	30.83
C-3	E	5.2	0.5	25.9	6.28	226,512	16.3	0.0008	0.025	2	2	3	1.59	1.65	0.284	0.04	1.64	9.87	9.38
	E1	7.2	0.5	25.9	6.28	313,632	22.6	0.0008	0.025	2	2	7	1.37	1.70	0.290	0.04	1.41	13.31	12.47
	F	39.4	0.5	71.4	3.33	1,716,264	65.7	0.0008	0.025	2	2	11	1.99	2.20	0.309	0.08	2.07	29.81	18.96
Pond[2]							282.0	0.002	0.025	3	3	10	3.26	4.37	0.521	0.30	3.56	64.55	29.57
	SW						291.0	0.0008	0.03	2.5	2.5	20	3.67	2.71	0.286	0.11	3.79	107.25	38.37
C-4	B	5.00	0.5	30.2	5.74	217,800	14.4	0.0009	0.025	2	2	0	2.06	1.69	0.294	0.04	2.10	8.51	8.25

1. Calculations were performed using the HYDROCALC HYDRAULICS program developed by Dodson and Associates (Version 1.2a, 1996). Example calculation shown on Page 7a and 7b.
2. Flow rate taken from HEC-1 analysis of detention pond. See Attachment 6H for hydrologic summary.

STATE OF TEXAS
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Table 6.4
Peak Flows

After Landfill Construction[1]					Before Landfill Construction					
Watershed	Area	Area-S.F.	Acres	Discharge	Area	Area–Acres	C Factor	Intensity	Discharge Unit	Unit
WATERSHED										
A-1	#1	465,043	10.68		#1	11.57	0.5	7.2	41.66	cfs
A-1	#5	554,062	12.72		#7	7.83	0.5	7.2	28.19	cfs
A-1	#10	329,635	7.57		#2	7.31	0.5	7.2	26.30	cfs
					#8	4.32	0.5	7.2	15.55	cfs
		PEAK	Q NW-HWY	108.36 cfs			PEAK	Q NW-HWY	111.71	cfs
WATERSHED										
A-2	#2	490,647	11.26		#3	11.61	0.5	7.2	41.78	cfs
A-2	#6	577,308	13.25		#9	8.03	0.5	7.2	28.92	cfs
A-2	#11	328,711	7.55		#2	7.31	0.5	7.2	26.30	cfs
					#8	4.32	0.5	7.2	15.55	cfs
		PEAK	Q NE-HWY	112.98 cfs			PEAK	Q NE-HWY	112.55	cfs
WATERSHED										
A-3	#3	645,049	14.81		#4	11.59	0.5	7.2	41.72	cfs
A-3	#4	492,818	11.31		#5	14.65	0.5	7.2	52.75	cfs
A-3	#7	607,792	13.95		#6	11.61	0.5	7.2	41.81	cfs
A-3	#8	755,135	17.34		#10	7.71	0.5	7.2	27.77	cfs
A-3	#9	370,731	8.51		#11	8.16	0.5	7.2	29.39	cfs
A-3	#12	613,308	14.08		#12	8.70	0.5	7.2	31.31	cfs
A-3	#13	244,029	5.60		#13	7.86	0.5	7.2	28.28	cfs
A-3	#14	255,726	5.87		#14	7.58	0.5	7.2	27.28	cfs
		PEAK	Q SW	291 cfs			PEAK	Q SW	280.31	cfs
		Total Site Peak Discharges		**512.3**					**504.6**	**cfs**

1 Refer to Attachment 6H for supporting calculations.

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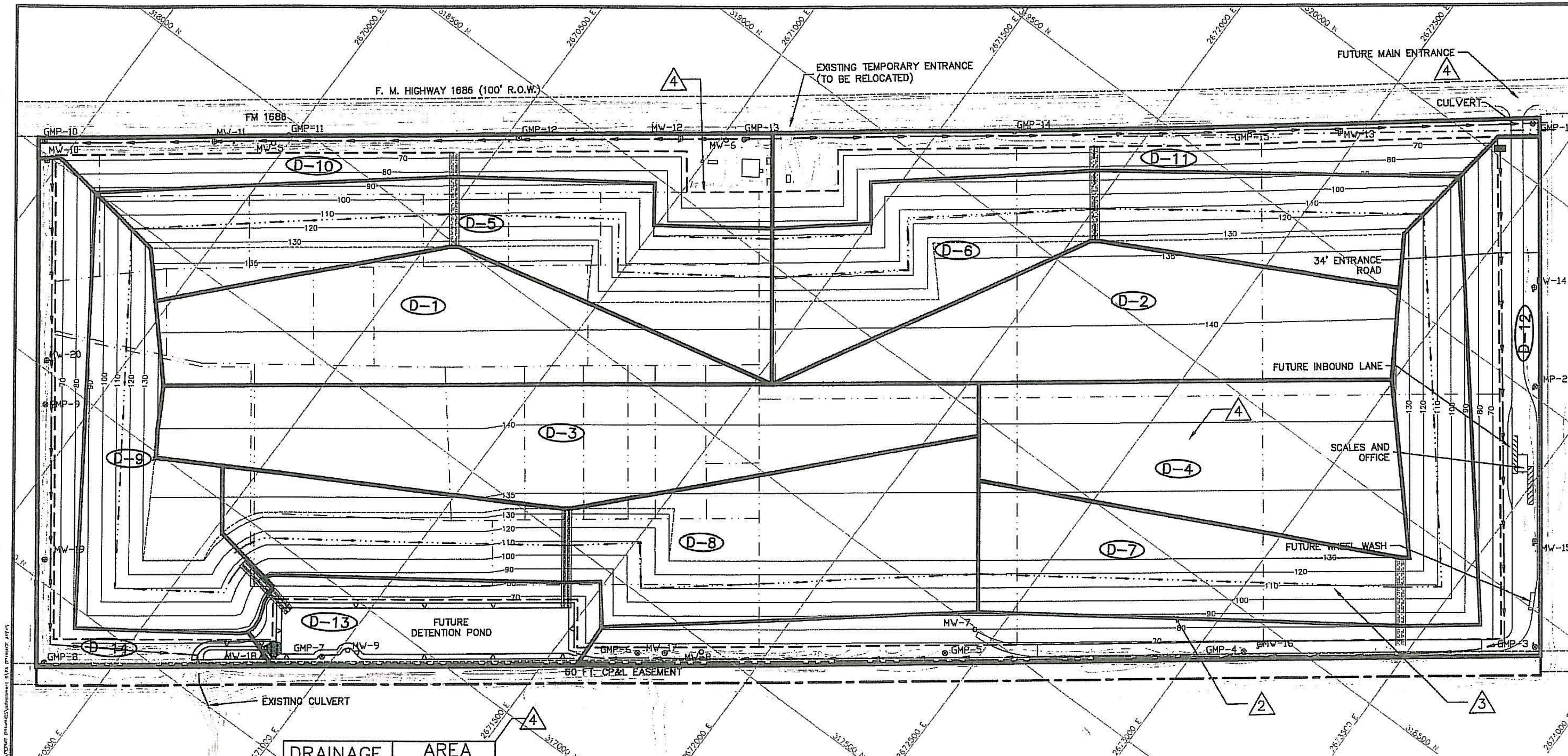

DRAINAGE AREA	AREA (SF)
D-1	465,043
D-2	490,647
D-3	645,049
D-4	492,818
D-5	554,062
D-6	577,308
D-7	607,792
D-8	755,135
D-9	370,731
D-10	329,635
D-11	328,711
D-12	613,308
D-13	244,029
D-14	255,726

0 150 300
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- 2572000 E — STATE PLANE COORDINATE
- 70 — EXISTING CONTOUR
- 66 — PROPOSED FINAL CONTOUR
- D-2 — DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 — MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 — GAS MONITORING PROBES
- MW-17 — GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 — INDICATES REVISION
- DRAINAGE FLOWLINE

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

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3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2008	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED SWALES, FOOTPRINT, DRAINAGE AREAS	

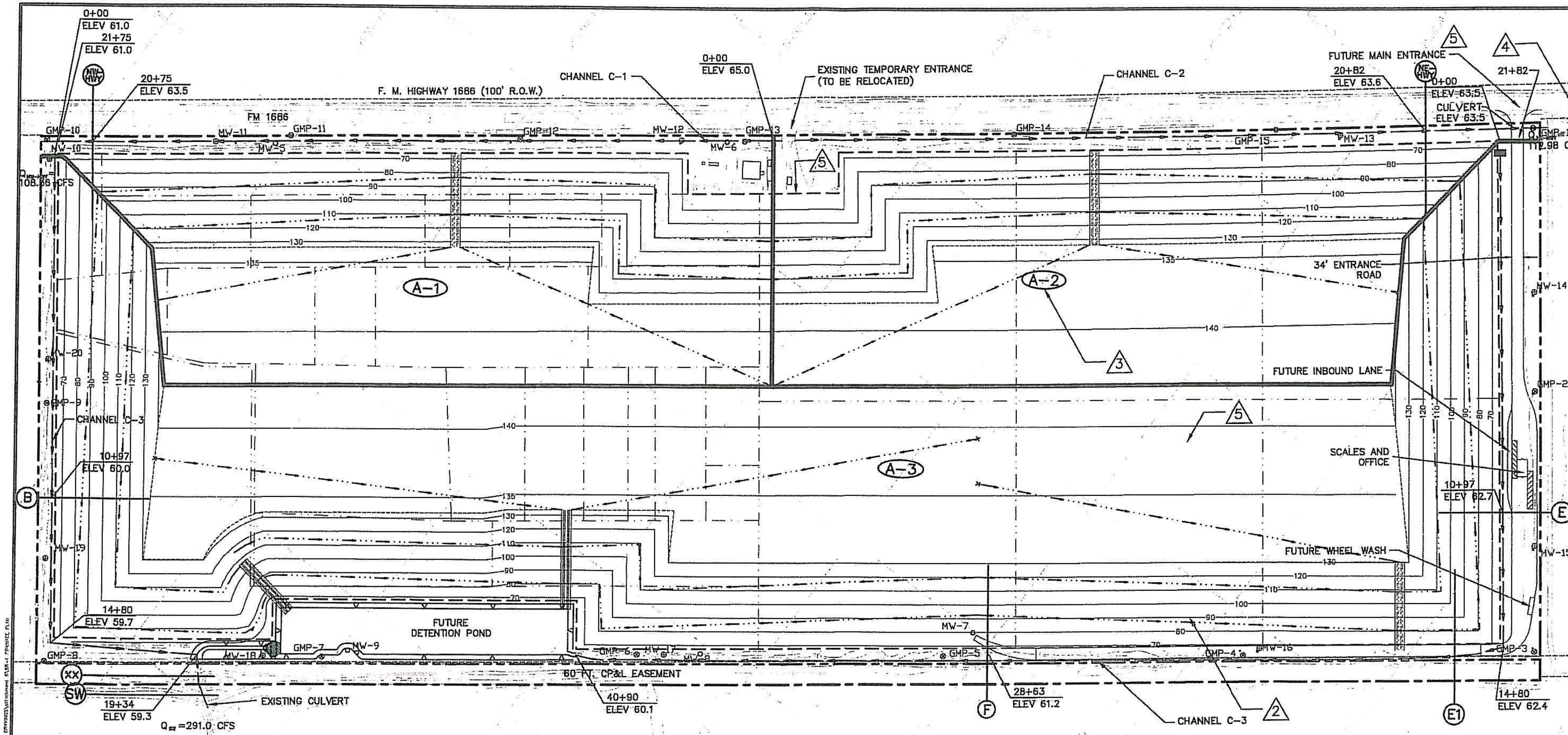
DRAWING TITLE
DRAINAGE AREAS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS

CADD FILE: 6A DRAINAGE AREAS
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT 6A



NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

0 150 300
SCALE IN FEET

DRAINAGE AREA NO.	AREA (ACRES)
A-1	31.0
A-2	32.3
A-3	91.5

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- LIMITS OF WASTE
- STATE PLANE COORDINATE
- 70 EXISTING CONTOUR
- 66 PROPOSED FINAL CONTOUR
- A-2 DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 GAS MONITORING PROBES
- MW-17 GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 INDICATES REVISION

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2009	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	01/2007	UPDATED PEAK FLOWS, 10 FT HEIGHT INCREASE	
5	03/2009	REVISED SWALES, FOOTPRINT	

DRAWING TITLE
DRAINAGE DESIGN

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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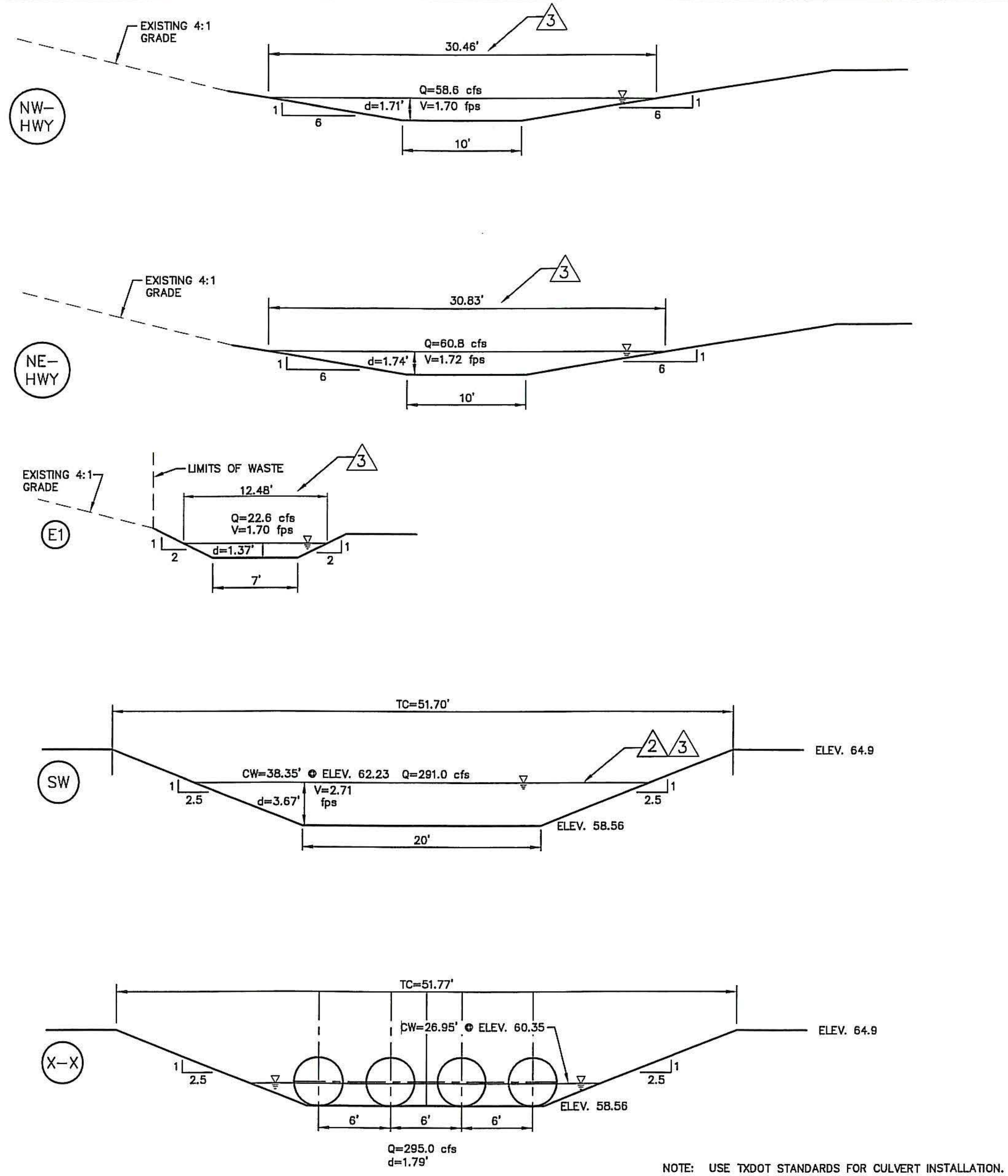
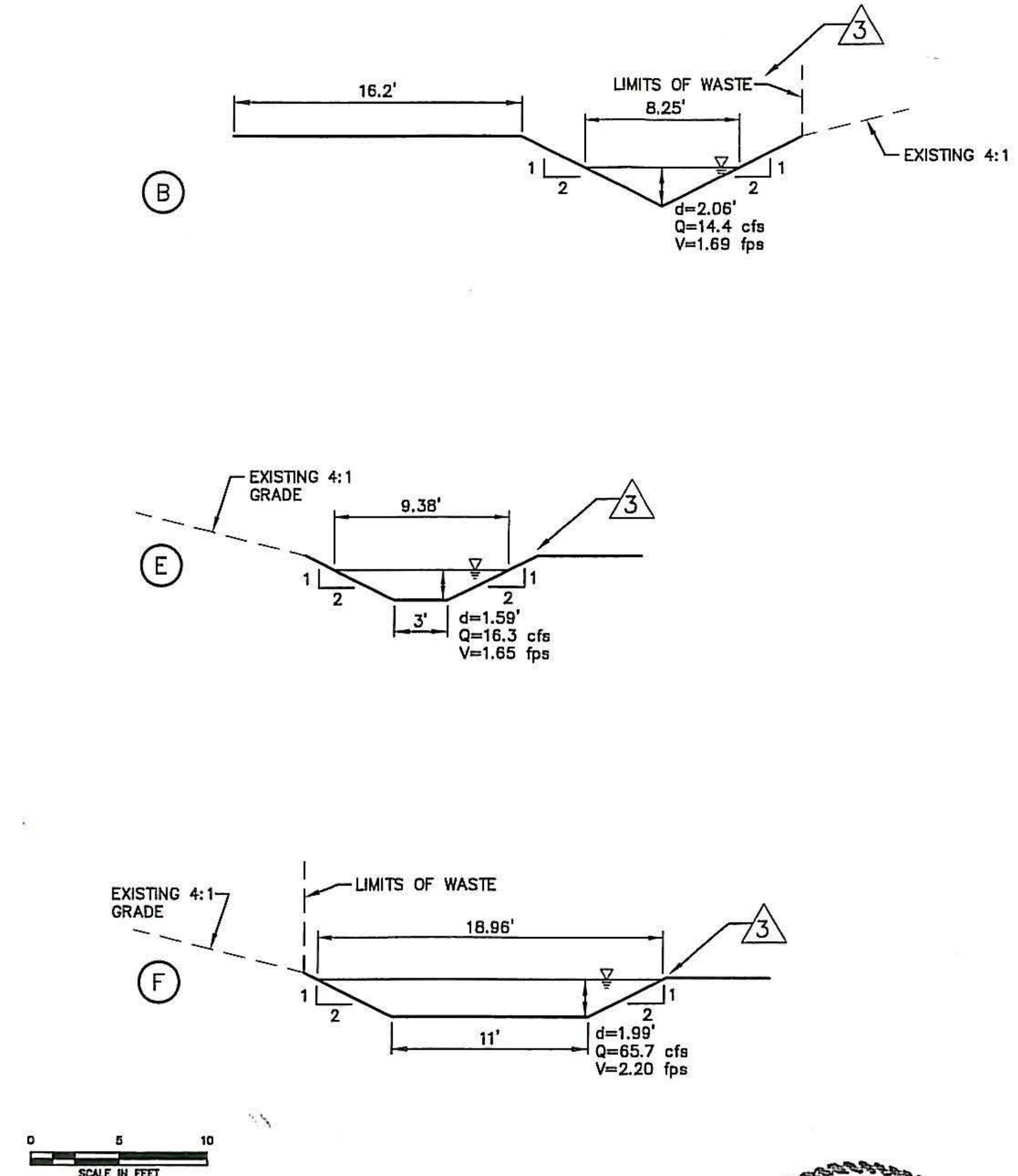
PH (281) 597-6747 FAX NO. (281) 293-7878

CADD FILE: 6B-1 DRAINAGE PLAN
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
6B-1





NOTE: USE TXDOT STANDARDS FOR CULVERT INSTALLATION.

NOTES:

1. ALL ELEVATIONS SHOWN ARE IN FT-MSL.
2. WATER SURFACE ELEVATIONS SHOWN REPRESENT THE 24-HOUR, 25 YEAR STORM EVENT.

2 INDICATES REVISION

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3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	UPDATED FOR PEAK FLOWS, DEPTHS, VELOCITIES AND CHANNEL STATIONS (I.E. REMOVED SECTIONS G AND H)	
2	01/2007	UPDATED FOR PEAK FLOWS, DEPTH AND VELOCITIES	
3	03/2009	UPDATED FOR PEAK FLOWS, DEPTH AND VELOCITIES	

DRAWING TITLE
CROSS SECTIONS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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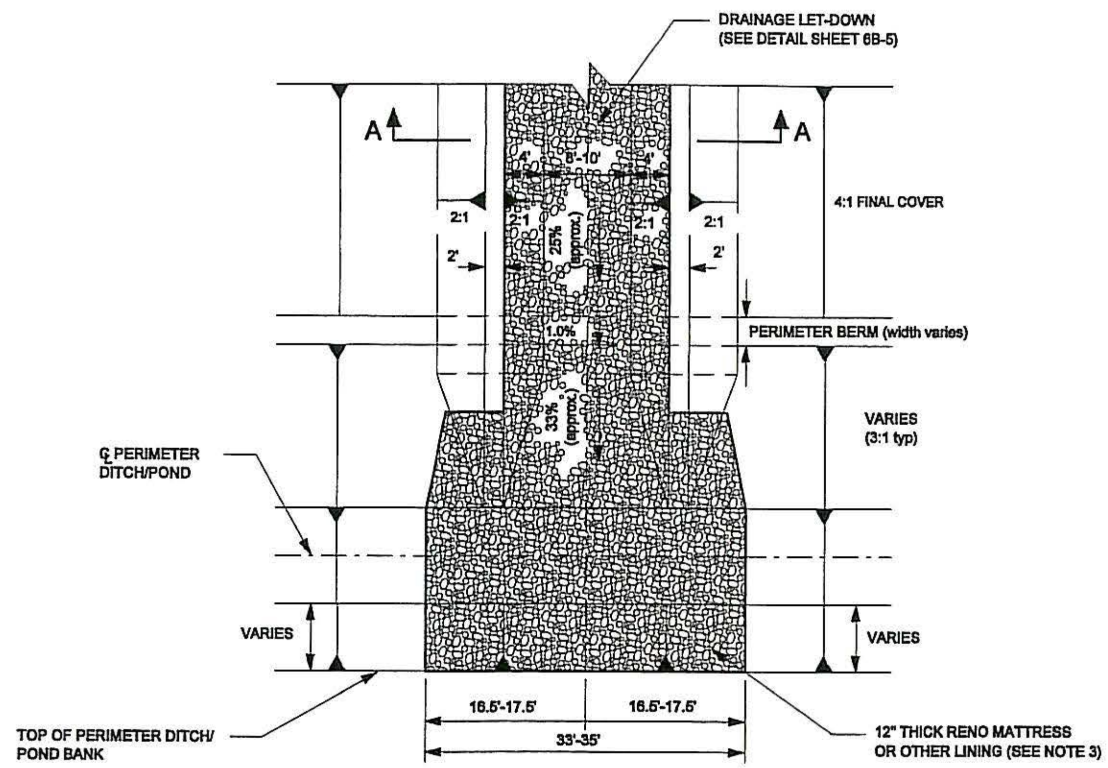
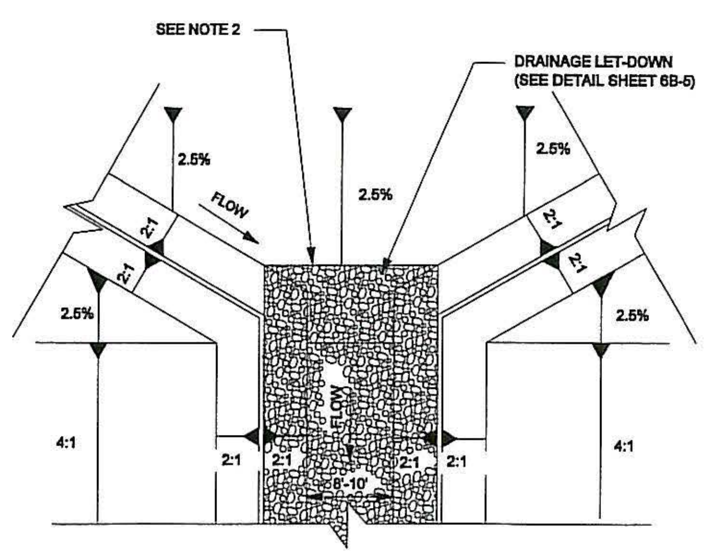
PROJ. NO. 16208541 | DWN. BY: JJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

CADD FILE: 6B-2 CROSS SECTIONS
DATE: 11/2008
SCALE: AS SHOWN
ATTACHMENT
6B-2



CHUTE WITH ENERGY DISSAPATOR

SCALE: 1" = 20'

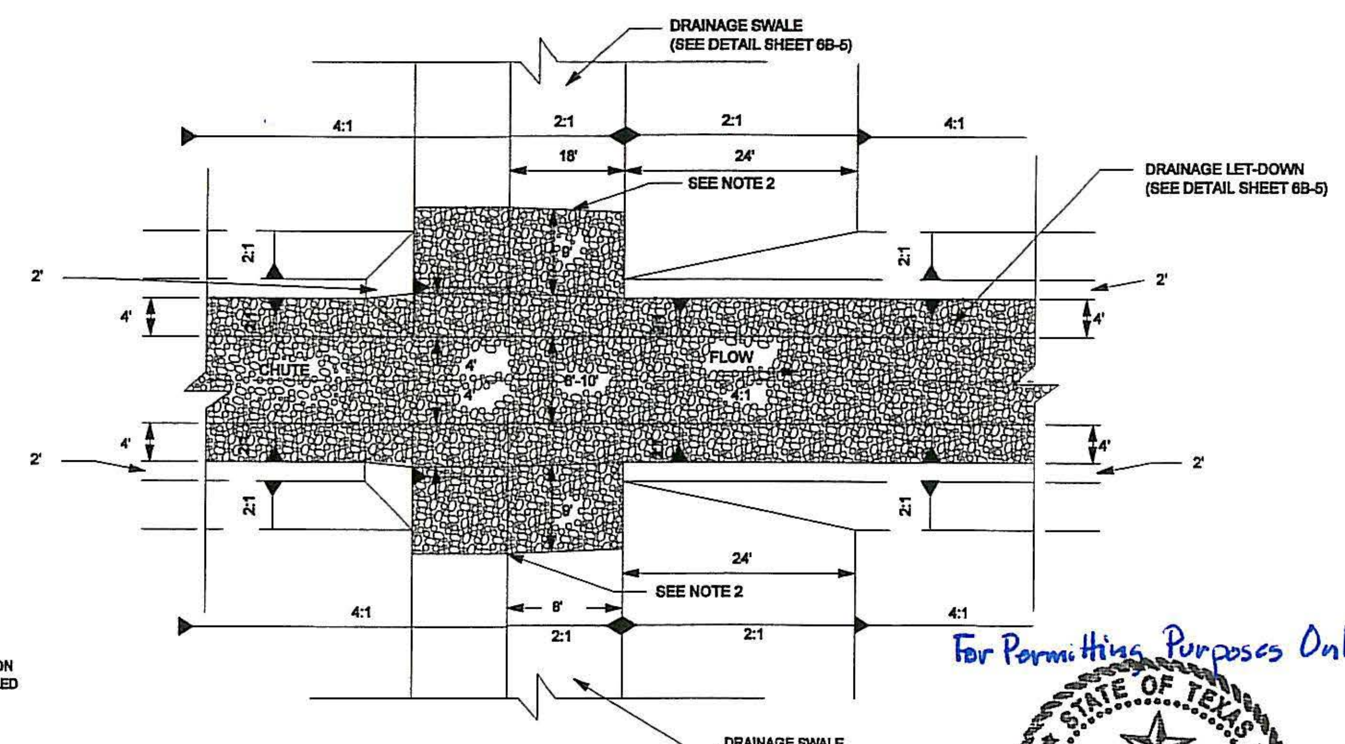


TOP OF CHUTE

NOT TO SCALE

NOTES

1. EROSION PROTECTION SHALL BE RENO MATTRESS OR GABION FOR DOWNDRAIN. EROSION PROTECTION SHALL BE INSTALLED PER MANUFACTURE'S RECOMMENDATION.
2. TOP OF EROSION PROTECTION SHALL BE FLUSH WITH FLOWLINE OF DRAINAGE SWALE.
3. ALL DIMENSIONS ARE MINIMUM UNLESS SPECIFIED OTHERWISE.



SWALE AND CHUTE INTERSECTION

SCALE: 1" = 20'

For Permitting Purposes Only

STATE OF TEXAS
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PROFESSIONAL ENGINEER

3/29/09

REV	DATE	DESCRIPTION	BY
			DJH

DRAWING TITLE
DRAINAGE DETAILS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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PROJ. NO. 16208541.00

CADD FILE: b-4.dgn

DATE: 1-2009

SCALE: AS SHOWN

ATTACHMENT **6B-4**

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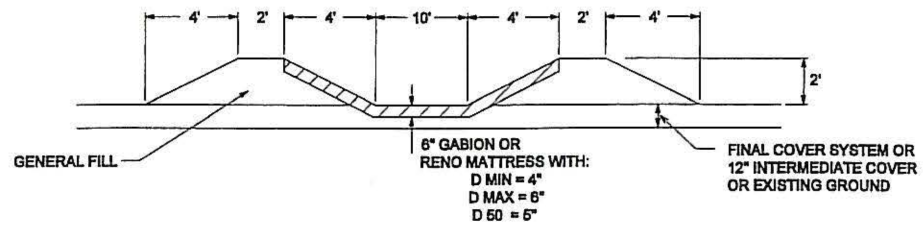
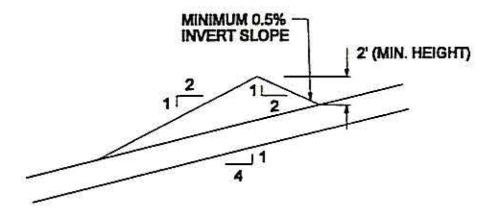


NOTE: ALL DIMENSIONS ARE APPROXIMATE

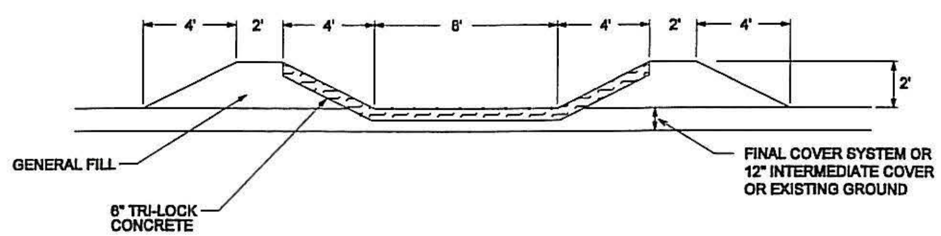
A-A
DRAINAGE LET-DOWN STRUCTURE
6" GABION OR RENO MATTRESS

N.T.S.



DRAINAGE SWALE (TYP.)

N.T.S.



NOTE: ALL DIMENSIONS ARE APPROXIMATE

A-A
DRAINAGE LET-DOWN STRUCTURE
6" TRI-LOCK CONCRETE

N.T.S.

NOTE: ALL DIMENSIONS ARE APPROXIMATE AND MINIMUM DIMENSIONS

For Permitting Purposes Only

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER
3/29/09

REV	DATE	DESCRIPTION	BY
			DJH

DRAWING TITLE
DRAINAGE DETAILS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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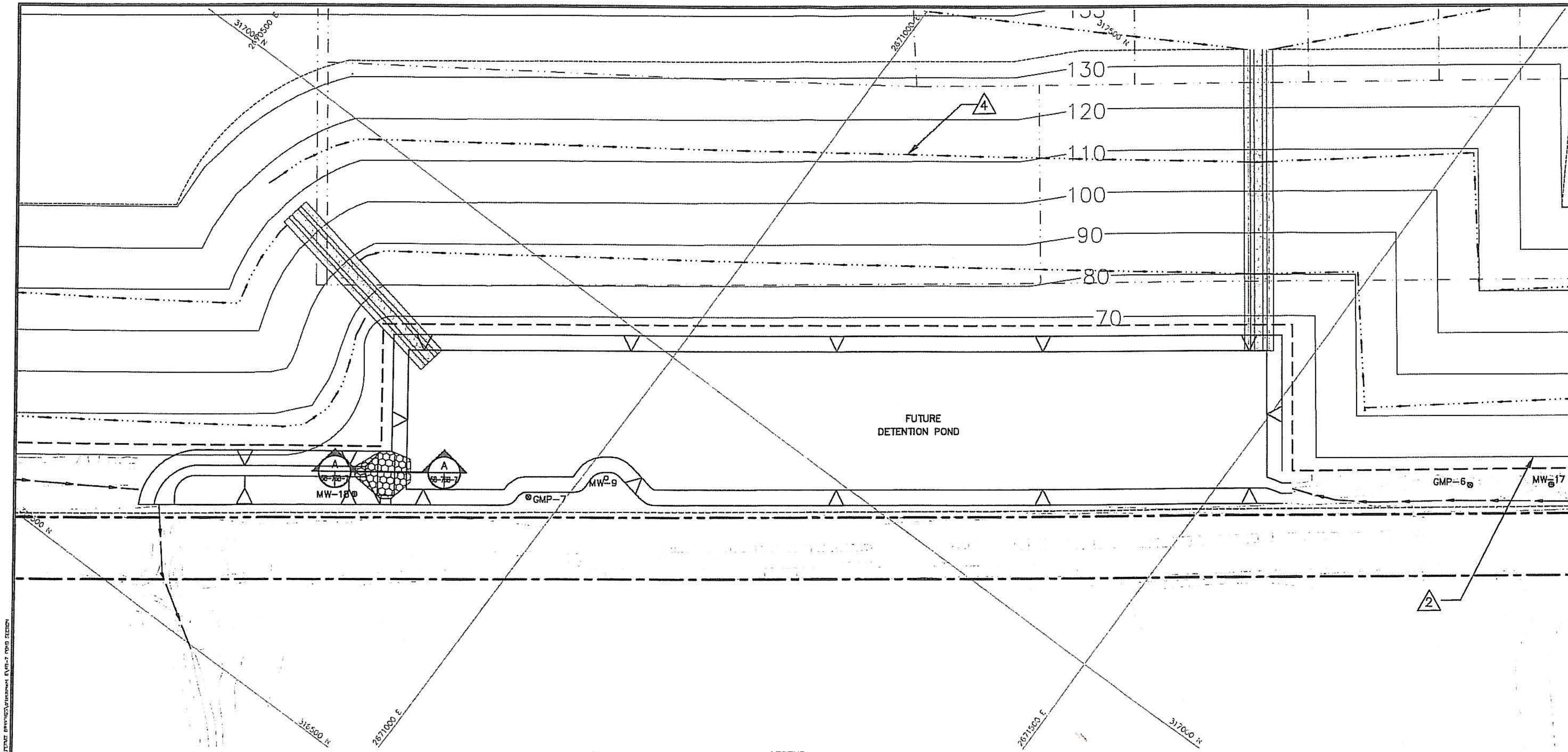
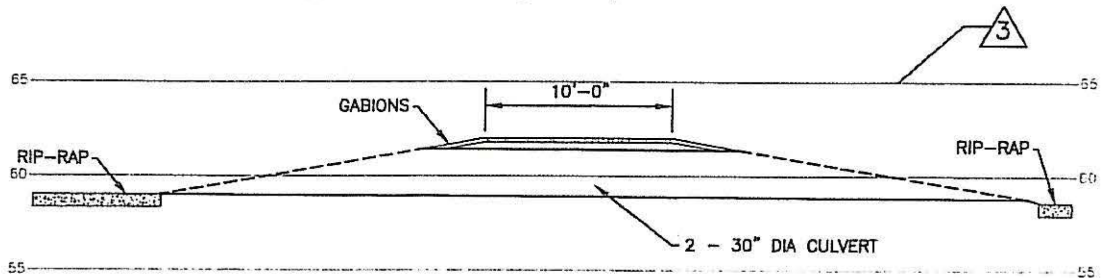
12651 BRIAR FOREST, HOUSTON, TEXAS, 77077
PH (281) 307-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541.00

CADD FILE:
DATE: 1-2009
SCALE: AS SHOWN
ATTACHMENT
6B-5

\dgn\Vcitoria\cadd\8541\b-5.dgn Apr. 08, 2009 10:37:41





DETENTION POND OUTLET STRUCTURE A 6B-7 6B-7

SCALE IN FEET

LEGEND

	PERMIT BOUNDARY
	PROPERTY LINE
	LIMITS OF WASTE
2672000 E	STATE PLANE COORDINATE
	EXISTING CONTOUR
66	PROPOSED FINAL CONTOUR
	PROPOSED DRAINAGE LETDOWN
	PROPOSED DRAINAGE SWALE
	PERIMETER CHANNEL FLOWLINE
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
2	INDICATES REVISION

0 50 100

SCALE IN FEET

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER

3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	DRAWING ADDED TO SHOW DETENTION POND PLAN	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED PEIT REVISED DRAINAGE CALCULATIONS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED SWALES AND LETDOWNS	

DRAWING TITLE
DETENTION POND PLAN

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

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PH (281) 397-6747 FAX NO. (281) 293-7678

PROJ. NO. 16208541

CADD FILE: 6B-7 POND SECTION

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT **6B-7**

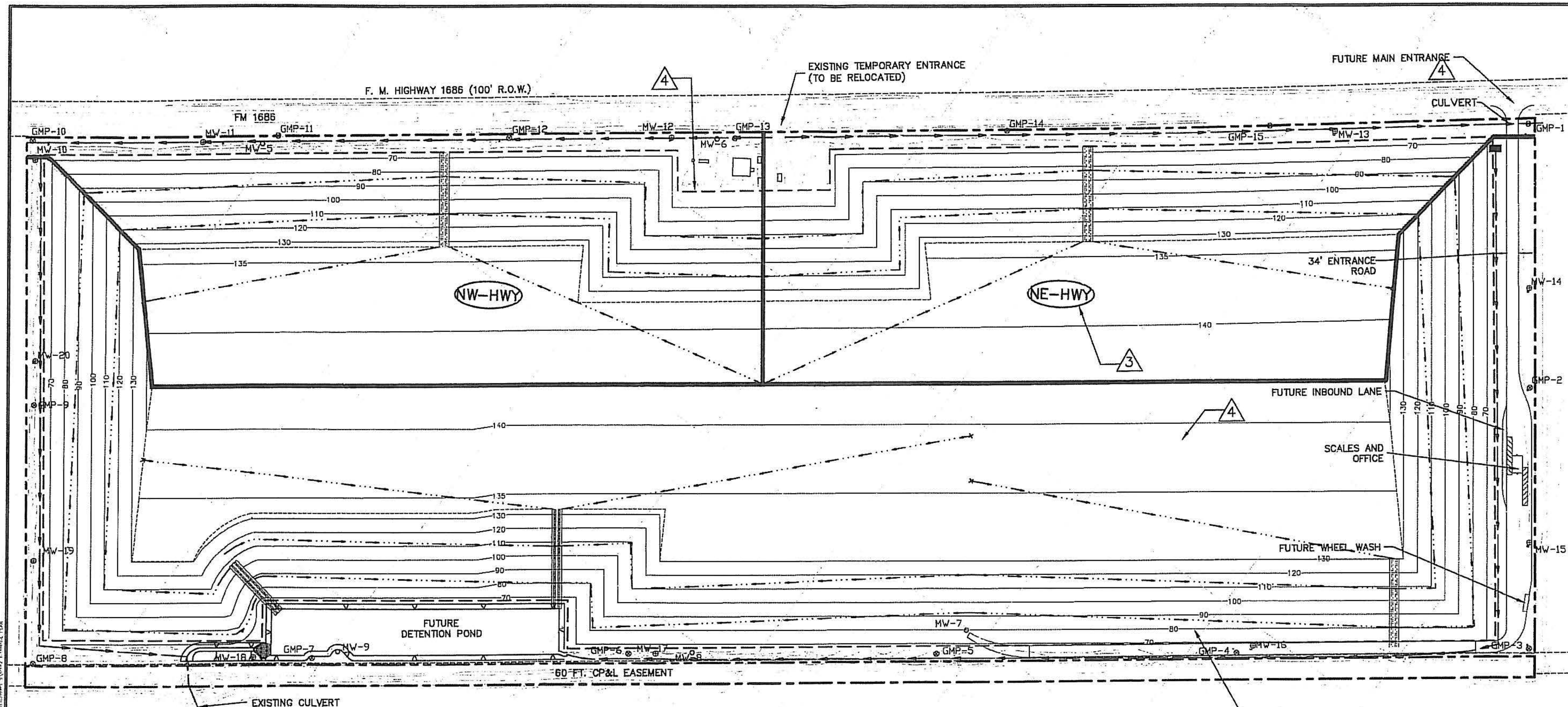
ATTACHMENT 6H

DRAINAGE PLAN – PROPOSED CONDITIONS

CONTENTS

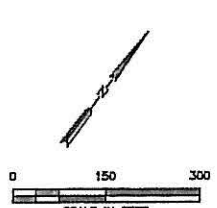
STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER

3/29/09



NOTE:

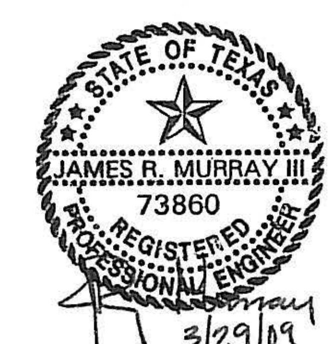
1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.



DRAINAGE AREA NO.	AREA (ACRES)
NW-HWY	31.0
NE-HWY	32.3

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- LIMITS OF WASTE
- STATE PLANE COORDINATE
- 70 EXISTING CONTOUR
- 66 PROPOSED FINAL CONTOUR
- NW-HWY DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 GAS MONITORING PROBES
- MW-17 GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 INDICATES REVISION



THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY NEVZAT TURAN (TEXAS P.E. 84059) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2008	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED SWALES, FOOTPRINT	JR

DRAWING TITLE: RATIONAL METHOD DRAINAGE AREA

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR., SUITE 250, HOUSTON, TX 77077
PH (281) 307-6747 FAX NO. (281) 293-7078

PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

CADD FILE: 6H-2 DRAINAGE PLAN

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

6H-2

Required: Find peak flow rates at the three permitted discharge points.

Given:

1. Drainage areas analyzed are presented on Sheets 6H-2 and 6H-6.

Method:

1. Use rational method to calculate peak flows at discharge points NW-HWY and NE-HWY
2. Use HEC-1 with pond routing to calculate peak flow at discharge point SW.

References:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, 3rd Edition, December 1985.
2. United States Department of Agriculture, Soil Conservation Service, Engineering Division, *TR-55 - Urban Hydrology for Small Watersheds*, 1986.
3. Dodson & Associates, Inc. *ProHEC1 Plus Program Documentation*, June 1995.

Prep By: PJ
Date: 3/1/2009

VICTORIA LANDFILL
PEAK 25-YEAR FLOW RATES

Chkd By: JRM
Date: 3/1/2009

Solution: 1. Calculate 25-Year Storm Event Peak Flow using Rational Method

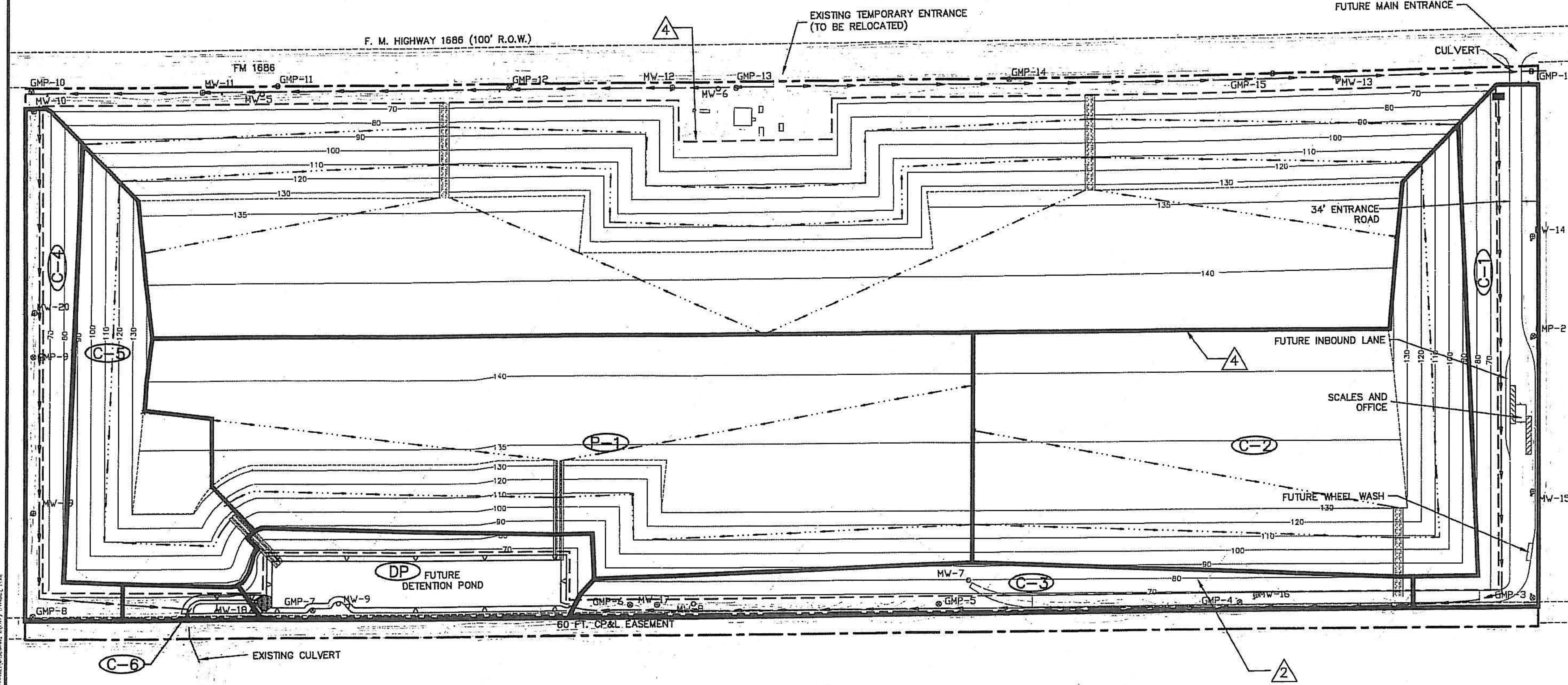
Calculation of Time of Concentration
(For use in calculation of Intensity for Rational Method)

Drainage Basin	Area	Area (acres)	C Factor	Intensity[1] (in/hr)	Discharge[2] (cfs)
NW-HWY	#1	10.7	0.5	7.0	37.38
	#5	12.7	0.5	7.0	44.45
	#10	7.6	0.5	7.0	26.53
NE-HWY	#2	11.3	0.5	7.0	39.66
	#6	13.3	0.5	7.0	46.66
	#11	7.6	0.5	7.0	26.67

Drainage Basin	Total Area (ac)	Runoff Coeff.	Intensity[1] (in/hr)	Peak 25-yr Discharge[2] (cfs)
NW-HWY	31.0	0.5	7.00	108.36
NE-HWY	32.3	0.5	7.00	112.98

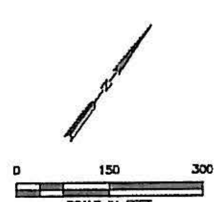
[1] Intensity is calculated on page 3 of Attachment 6.

[2] Discharge = Area x C Factor x Intensity



NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.



DRAINAGE AREA NO.	AREA (ACRES)
DP	5.6
P-1	32.1
C-1	7.2
C-2	25.3
C-3	6.9
C-4	5.0
C-5	8.5
C-6	0.9

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- LIMITS OF WASTE
- STATE PLANE COORDINATE
- 70 EXISTING CONTOUR
- 66 PROPOSED FINAL CONTOUR
- NW-HWY DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 GAS MONITORING PROBES
- MW-17 GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 INDICATES REVISION

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY NEVZAT TURAN (TEXAS P.E. 84059) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED HEC-1 DRAINAGE AREA PLAN	JR

DRAWING TITLE: **HEC-1 DRAINAGE AREA PLAN**

PROJECT TITLE: **PERMIT MODIFICATION**

CLIENT: **REPUBLIC WASTE SERVICES**
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM | DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

CADD FILE: 6H-2 DRAINAGE PLAN

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT **6H-6**

Area No.	Area (acres)	Max. Flow Length (L) (ft)	S (ft/ft)	I (%)[1]	Manning "n"[1]	Φ^2	T_r[3] (min)	T_{lag}[4] (min)	T_{lag} (hr)	Area (sq mi)	q_{p5} (cfs/sq mi)	C_{p6}
C1	7.20	1,690	0.0008	2	0.03	0.86	71.0	68.5	1.14	0.0113	395.5	0.70
C4	5.00	1,660	0.0008	2	0.03	0.86	70.7	68.2	1.14	0.0078	403.0	0.72
DP	5.60	835	0.0020	45	0.01	0.6	15.6	13.1	0.22	0.0088	2024.6	0.69

[1] Drainage areas that includes ponds assumed to be minimum 45 percent impervious with minimum roughness to provide smallest conveyance coefficient.

[2] Conveyance efficiency coefficient from Dodson & Associates Inc., *ProHec-1 Program Documentation*, 1995, pages 6-19 and 6-20.

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

[4] $T_{lag} = T_r - 5/2$

[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)
q_p = unit hydrograph peak discharge (cfs/sq mi)
C_p = Snyder's peaking coefficient

Example Calculation: Unit Hydrograph Data Area No. C1

$$T_r = 3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(\Phi^{1.57})$$
$$= 3.1(1{,}690^{0.23})(0.0008^{-0.25})(2^{-0.18})(0.86^{1.57})$$
$$= \boxed{71.0 \text{ minutes}}$$

$$T_{lag} = T_r - 5/2$$
$$= 71.0-(5/2)$$
$$= 68.5 \text{ minutes}$$
$$= \boxed{1.14 \text{ hours}}$$

$$q_p = 31600(A^{-0.04})(T_r^{-1.07})$$
$$= 31600(0.0113^{-0.04})(71.0^{-1.07})$$
$$= \boxed{395.5 \text{ cfs/sq mi}}$$

$$C_p = 49.375(A^{-0.04})(T_r^{-1.07})(T_{lag})$$
$$= 49.375(0.0113^{-0.04})(71.0^{-1.07})(1.14)$$
$$= \boxed{0.7}$$

```
***************************************
*                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*             JUN   1998              *
*           VERSION 4.1               *
*                                     *
*  RUN DATE   09JAN09  TIME  08:45:39 *
*                                     *
***************************************
```

```
***************************************
*                                     *
*   U.S. ARMY CORPS OF ENGINEERS      *
*   HYDROLOGIC ENGINEERING CENTER     *
*        609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616        *
*         (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

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

              *DIAGRAM
   1          ID        VICTORIA LANDFILL
   2          ID        ATTACHMENT 6
   3          ID        25-YEAR,24 HOUR STORM EVENT
   4          ID        P:\SOLIDWASTE\ALLIED\VICTORIA\10 FT HIGHT INCREASE\
   5          ID        HEC1\VICTORIALF.IH1
              *
   6          IT       5       0    2400     576       0       0
   7          IO       3       0       0
              *

   8          KK      C1
   9          KO       0       0       0       7      21
  10          PH       0       0     .76    1.67    3.66    4.75    5.25     6.5     7.5     9.0
  11          BA  0.0113
  12          LS       0      90
  13          US    1.14     0.7
              *

  14          KK      C2
  15          KO       0       0       0       7      21
  16          BA  0.0395
  17          LS       0      90
  18          UK     295    .028      .3     100
  19          RD    1245   0.005     .03            TRAP               2
              *

  20          KK     C/2
  21          KO       0       0       0       7      21
  22          HC       2
              *

  23          KK    R/C3
  24          KO       0       0       0       7      21
  25          BA  0.0107       8
  26          LS       0      90
  27          UK      80    .333      .3     100
  28          RD    2435   .0008     .03            TRAP      10       3     YES
              *

  29          KK      C5
  30          KO       0       0       0       7      21
  31          BA  0.0133
  32          LS       0      90
  33          UK      80     .25      .3     100
  34          RD    2000    .005     .03            TRAP               2
              *

  35          KK      P1
  36          KO       0       0       0       7      21
  37          BA  0.0501       4
  38          LS       0      90
  39          UK     150    .028      .3     100
  40          RD    1195    .005     .03            TRAP       0       2
              *
```

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

  41           KK      DP
  42           KO       0       0       0       7      21
  43           BA  0.0088
  44           LS       0     100
  45           US     .22    0.69
               *

  46           KK  C/POND
  47           KO       0       0       0       7      21
  48           HC       4
               *

  49           KK  R/POND
  50           KO       0       0       0       7      21
  51           RS       1    ELEV      59
  52           SA    2.56    2.69    2.97    3.25    3.25
  53           SE      59      60      62      64      66
  54           SL    59.8    9.82      .7      .5
  55           SS      62      40    2.64     1.5
               *

  56           KK      C4
  57           KO       0       0       0       7      21
  58           BA  0.0078
  59           LS       0      90
  60           US    1.14     .72
               *

  61           KK    R/C6
  62           KO       0       0       0       7      21
  63           BA  0.0014
  64           LS       0      90
  65           UK      80     .25      .3     100
  66           RD     185   .0008    0.03            TRAP       6       3     YES
               *

  67           KK  C/DISCHARGE POINT
  68           KO       0       0       0       7      21
  69           HC       2
  70           ZZ
```

```
               SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

              C1
               .
               .
  14           .         C2
               .          .
               .          .
  20          C/2..........
               V
               V
  23         R/C3 ***
               .
               .
  29           .         C5
               .          .
               .          .
  35           .          .         P1
               .          .          .
               .          .          .
  41           .          .          .         DP
               .          .          .          .
               .          .          .          .
  46        C/POND..............................
               V
               V
  49        R/POND
               .
               .
  56           .        C4
               .        V
               .        V
  61           .      R/C6 ***
               .        .
               .        .
  67        C/DISC.........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
*****************************************                              *****************************************
*                                       *                              *                                       *
*   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   09JAN09  TIME  08:45:39    *                              *           (916) 756-1104              *
*                                       *                              *                                       *
*****************************************                              *****************************************



                           VICTORIA LANDFILL
                           ATTACHMENT 6
                           25-YEAR,24 HOUR STORM EVENT
                           P:\SOLIDWASTE\ALLIED\VICTORIA\10 FT HIGHT INCREASE\
                           HEC1\VICTORIALF.IH1

   7 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        576  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      3   0  ENDING DATE
                     NDTIME       2355  ENDING TIME
                      ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   47.92 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


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

            **************
            *            *
   8 KK     *      C1    *
            *            *
            **************

   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        576  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

  11 BA          SUBBASIN CHARACTERISTICS
                      TAREA        .01  SUBBASIN AREA

                 PRECIPITATION DATA

  10 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
                   .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                                  STORM AREA =      .01

  12 LS          SCS LOSS RATE
                     STRTL         .22  INITIAL ABSTRACTION
                    CRVNBR       90.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

  13 US          SNYDER UNITGRAPH
                        TP        1.14  LAG
                        CP         .70  PEAKING COEFFICIENT

                 SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                           ***

                                                  UNIT HYDROGRAPH PARAMETERS
                                            CLARK    TC=  1.31 HR,        R=   .84 HR
                                            SNYDER   TP=  1.13 HR,       CP=   .70
```



```
                                                       UNIT HYDROGRAPH
                                                   62 END-OF-PERIOD ORDINATES
        0.          0.          1.          1.          2.          2.          3.          3.          4.          4.
```

```
   4.      4.      5.      5.      5.      4.      4.      4.      3.      3.
   3.      2.      2.      2.      2.      2.      1.      1.      1.      1.
   1.      1.      1.      1.      1.      1.      1.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.

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

              HYDROGRAPH AT STATION        C1

   TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW    TIME                        MAXIMUM AVERAGE FLOW
  (CFS)      (HR)                 6-HR       24-HR      72-HR    47.92-HR
    17.     13.17     (CFS)        7.          2.         1.          1.
                    (INCHES)     5.917       7.750      7.753       7.753
                     (AC-FT)        4.          5.         5.          5.

                    CUMULATIVE AREA =      .01 SQ MI


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


          **************
          *            *
 14 KK    *        C2  *
          *            *
          **************

 15 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        576  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

 16 BA         SUBBASIN CHARACTERISTICS
                    TAREA        .04  SUBBASIN AREA

               PRECIPITATION DATA

 16 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
                 .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00      .00     .00     .00     .00

                                                 STORM AREA =      .04

 17 LS         SCS LOSS RATE
                   STRTL         .22  INITIAL ABSTRACTION
                  CRVNBR       90.00  CURVE NUMBER
                   RTIMP         .00  PERCENT IMPERVIOUS AREA

               KINEMATIC WAVE
 18 UK           OVERLAND-FLOW ELEMENT NO. 1
                       L        295.  OVERLAND FLOW LENGTH
                       S       .0280  SLOPE
                       N        .300  ROUGHNESS COEFFICIENT
                      PA       100.0  PERCENT OF SUBBASIN
                   DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
               MUSKINGUM-CUNGE
 19 RD           MAIN CHANNEL
                       L       1245.  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       .83    1.67      2.23     59.00    158.71    725.40      7.78       .44
          MAIN        1.63    1.33      3.61    622.50    155.69    729.38      7.65      5.75

ONT.  TY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .1641E+02 OUTFLOW= .1611E+02 BASIN STORAGE= .2353E-02 PERCENT ERROR=   1.8

                              INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

          MAIN        1.63    1.33      5.00              152.89    730.00      7.65

 ***         ***         ***         ***         ***
```

```
                    HYDROGRAPH AT STATION         C2

   TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
  (CFS)        (HR)                 6-HR        24-HR        72-HR      47.92-HR
   153.       12.17       (CFS)       26.           8.           4.           4.
                        (INCHES)    6.034        7.642        7.651        7.651
                         (AC-FT)      13.          16.          16.          16.

                    CUMULATIVE AREA =      .04 SQ MI


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

         **************
         *            *
 20 KK   *       C/2  *
         *            *
         **************

 21 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        576  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


 22 HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                              ***

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

                    HYDROGRAPH AT STATION        C/2

PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
  (CFS)        (HR)                 6-HR        24-HR        72-HR      47.92-HR
   159.       12.17       (CFS)       33.          10.           5.           5.
                        (INCHES)    5.974        7.666        7.674        7.674
                         (AC-FT)      16.          21.          21.          21.

                    CUMULATIVE AREA =      .05 SQ MI


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

         **************
         *            *
 23 KK   *      R/C3  *
         *            *
         **************

 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        576  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT       .083  TIME INTERVAL IN HOURS


             SUBBASIN RUNOFF DATA

 25 BA          SUBBASIN CHARACTERISTICS
                      TAREA        .01  SUBBASIN AREA
                       SNAP       8.00  NORMAL ANNUAL PRECIPITATION
                      RATIO        .00  RATIO OF HYDROGRAPH

                PRECIPITATION DATA

 10 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
                  .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                                    STORM AREA =       .01

 26             SCS LOSS RATE
                     STRTL         .22  INITIAL ABSTRACTION
                    CRVNBR       90.00  CURVE NUMBER
                     RTIMP         .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
 27 UK             OVERLAND-FLOW ELEMENT NO. 1
                         L          60.  OVERLAND FLOW LENGTH
                         S        .3330  SLOPE
                         N         .300  ROUGHNESS COEFFICIENT
                        PA        100.0  PERCENT OF SUBBASIN
```

```
               DXMIN           5  MINIMUM NUMBER OF DX INTERVALS
            MUSKINGUM-CUNGE
 28 RD        MAIN CHANNEL
                   L        2435.  CHANNEL LENGTH
                   S        .0008  SLOPE
                   N         .030  CHANNEL ROUGHNESS COEFFICIENT
                  CA          .01  CONTRIBUTING AREA
               SHAPE         TRAP  CHANNEL SHAPE
                  WD        10.00  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      2.87      1.67         .55      16.00     60.42    724.91      7.79         .66
             MAIN         .39      1.42        5.00     811.67    145.42    740.00      7.65        2.88

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2079E+02  EXCESS= .4446E+01 OUTFLOW= .2508E+02 BASIN STORAGE= .4312E-02 PERCENT ERROR=    .6

                                  INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


             MAIN         .39      1.42        5.00               145.42    740.00      7.65

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

                  HYDROGRAPH AT STATION      R/C3

   TOTAL RAINFALL =    9.00, TOTAL LOSS =     1.21, TOTAL EXCESS =     7.79

 PEAK FLOW      TIME                             MAXIMUM AVERAGE FLOW
   (CFS)        (HR)                 6-HR         24-HR        72-HR      47.92-HR
    145.       12.33       (CFS)      39.           13.          6.           6.
                         (INCHES)   5.944         7.638        7.646        7.646
                          (AC-FT)     19.           25.          25.          25.

                  CUMULATIVE AREA =      .06 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***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          *            *
 29 KK    *      C5    *
          *            *
          **************

 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         576  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT        .083  TIME INTERVAL IN HOURS

          SUBBASIN RUNOFF DATA

 31 BA          SUBBASIN CHARACTERISTICS
                     TAREA         .01  SUBBASIN AREA

                PRECIPITATION DATA

 10 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
                 .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                              STORM AREA =       .01

 32 LS          SCS LOSS RATE
                    STRTL          .22  INITIAL ABSTRACTION
                   CRVNBR        90.00  CURVE NUMBER
                   RTIMP           .00  PERCENT IMPERVIOUS AREA

                KINEMATIC WAVE
 33 UK            OVERLAND-FLOW ELEMENT NO. 1
                        L          80.  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
 34 RD            MAIN CHANNEL
                        L        2000.  CHANNEL LENGTH
                        S        .0050  SLOPE
                        N         .030  CHANNEL ROUGHNESS COEFFICIENT
                       CA          .01  CONTRIBUTING AREA
                    SHAPE         TRAP  CHANNEL SHAPE
                       WD           00  BOTTOM WIDTH OR DIAMETER
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            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        .55       16.00       75.02     724.86       7.79       .60
      MAIN          1.63       1.33       5.00     1000.00       67.39     725.00       7.15      4.76

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .5526E+01 OUTFLOW= .5072E+01 BASIN STORAGE= .1028E-02 PERCENT ERROR=   8.2

                                  INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


      MAIN          1.63       1.33       5.00                 67.39     725.00       7.15

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

               HYDROGRAPH AT STATION        C5

  TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
  (CFS)       (HR)               6-HR        24-HR       72-HR      47.92-HR
    67.      12.08     (CFS)       8.           3.          1.           1.
                     (INCHES)    5.812       7.150       7.151       7.151
                      (AC-FT)      4.           5.          5.           5.

               CUMULATIVE AREA =      .01 SQ MI



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          *            *
 35 KK    *       P1   *
          *            *
          **************

 36 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        576  LAST ORDINATE PUNCHED OR SAVED
                    TIMINT       .083  TIME INTERVAL IN HOURS


            SUBBASIN RUNOFF DATA

 37 BA          SUBBASIN CHARACTERISTICS
                     TAREA        .05  SUBBASIN AREA
                      SNAP       4.00  NORMAL ANNUAL PRECIPITATION
                     RATIO        .00  RATIO OF HYDROGRAPH

              PRECIPITATION DATA

 10 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
               .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                          STORM AREA =       .05

 38 LS          SCS LOSS RATE
                     STRTL        .22  INITIAL ABSTRACTION
                    CRVNBR      90.00  CURVE NUMBER
                     RTIMP        .00  PERCENT IMPERVIOUS AREA

              KINEMATIC WAVE
 39 UK          OVERLAND-FLOW ELEMENT NO. 1
                         L       150.  OVERLAND FLOW LENGTH
                         S      .0280  SLOPE
                         N       .300  ROUGHNESS COEFFICIENT
                        PA      100.0  PERCENT OF SUBBASIN
                     DXMIN          5  MINIMUM NUMBER OF DX INTERVALS
              MUSKINGUM-CUNGE
 40 RD          MAIN CHANNEL
                         L      1195.  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
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6H-17


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

          PLANE1       .83      1.67        1.40     30.00     237.28    725.50      7.79       .36
          MAIN        1.63      1.33        3.16    597.50     228.13    725.67      7.62      6.31

CO'  'UITY SUMMARY (AC-FT) - INFLOW= .0000E+00  EXCESS= .2082E+02 OUTFLOW= .2037E+02 BASIN STORAGE= .1444E-02 PERCENT ERROR=   2.2

                                    INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL

          MAIN        1.63      1.33        5.00               221.20    725.00      7.62

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

                  HYDROGRAPH AT STATION       P1

  TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                   6-HR        24-HR        72-HR      47.92-HR
    221.      12.08       (CFS)       32.          10.           5.           5.
                        (INCHES)    6.028        7.621        7.625        7.625
                         (AC-FT)      16.          20.          20.          20.

                  CUMULATIVE AREA =      .05 SQ MI



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

         **************
         *            *
 41 KK   *        DP  *
         *            *
         **************

 42 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        576  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS

             SUBBASIN RUNOFF DATA

 43 BA        SUBBASIN CHARACTERISTICS
                    TAREA        .01  SUBBASIN AREA

              PRECIPITATION DATA

 10 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
                .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00      .00     .00     .00     .00

                                               STORM AREA =      .01

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

 45 US        SNYDER UNITGRAPH
                      TP         .22  LAG
                      CP         .69  PEAKING COEFFICIENT

              SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                              ***

                                                 UNIT HYDROGRAPH PARAMETERS
                                           CLARK   TC=    .26 HR,       R=   .17 HR
                                          SNYDER   TP=    .22 HR,      CP=   .69

                                                      UNIT HYDROGRAPH
                                                 13 END-OF-PERIOD ORDINATES
             3.        12.        17.        14.         9.         5.         3.         2.         1.         1.
             0.         0.         0.

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

                  HYDROGRAPH AT STATION       DP

  '  .L RAINFALL =    9.00, TOTAL LOSS =     .00, TOTAL EXCESS =    9.00

EAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
 (CFS)        (HR)                   6-HR        24-HR        72-HR      47.92-HR
   32.       12.25        (CFS)        6.           2.           1.           1.
                        (INCHES)    6.463        8.959        8.972        8.972
                         (AC-FT)       3.           4.           4.           4.

                  CUMULATIVE AREA =      .01 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

         **************
         *            *
    K    *   C/POND   *
         *            *
         **************

 47 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         576  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS


 48 HC          HYDROGRAPH COMBINATION
                      ICOMP           4  NUMBER OF HYDROGRAPHS TO COMBINE

                                                             ***

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

                      HYDROGRAPH AT STATION    C/POND

PEAK FLOW      TIME                            MAXIMUM AVERAGE FLOW
  (CFS)        (HR)                  6-HR          24-HR         72-HR      47.92-HR
   419.       12.08       (CFS)       86.            28.           14.           14.
                        (INCHES)    5.966          7.653         7.676         7.676
                         (AC-FT)      43.            55.           55.           55.

                       CUMULATIVE AREA =      .13 SQ MI


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

         **************
         *            *
 49 KK   *   R/POND   *
         *            *
         **************

 50 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         576  LAST ORDINATE PUNCHED OR SAVED
                     TIMINT        .083  TIME INTERVAL IN HOURS


             HYDROGRAPH ROUTING DATA

 51 RS          STORAGE ROUTING
                      NSTPS           1  NUMBER OF SUBREACHES
                       ITYP        ELEV  TYPE OF INITIAL CONDITION
                     RSVRIC       59.00  INITIAL CONDITION
                          X         .00  WORKING R AND D COEFFICIENT

 52 SA               AREA         2.6         2.7         3.0         3.3         3.3

 53 SE          ELEVATION       59.00       60.00       62.00       64.00       66.00

 54 SL          LOW-LEVEL OUTLET
                      ELEVL       59.80  ELEVATION AT CENTER OF OUTLET
                      CAREA        9.82  CROSS-SECTIONAL AREA
                       COQL         .70  COEFFICIENT
                       EXPL         .50  EXPONENT OF HEAD

 55 SS          SPILLWAY
                       CREL       62.00  SPILLWAY CREST ELEVATION
                      SPWID       40.00  SPILLWAY WIDTH
                       COQW        2.64  WEIR COEFFICIENT
                       EXPW        1.50  EXPONENT OF HEAD

                                                             ***

                                          COMPUTED STORAGE-ELEVATION DATA

     STORAGE         .00        2.62        8.28       14.50       21.00
   ELEVATION       59.00       60.00       62.00       64.00       66.00

                                          COMPUTED OUTFLOW-ELEVATION DATA

     OUTFLOW         .00         .00       68.92       70.50       72.16       73.89       75.72       77.63       79.65       81.77
   ELEVATION       59.00       59.80       61.36       61.44       61.51       61.60       61.69       61.78       61.89       62.00

     OUTFLOW       86.50       98.90      123.52      164.44      225.76      311.56      425.96      573.08      757.06      982.07
   ELEVATION       62.09       62.24       62.47       62.76       63.12       63.55       64.06       64.64       65.28       66.00
```

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	2.09	2.62	6.42	6.63	6.85	7.10	7.36	7.64	7.95
OUTFLOW	.00	.00	24.65	68.92	70.50	72.16	73.89	75.72	77.63	79.65
ELEVATION	59.00	59.80	60.00	61.36	61.44	61.51	61.60	61.69	61.78	61.89
STORAGE	8.28	8.56	9.01	9.68	10.57	11.70	13.07	14.50	14.69	16.57
OUTFLOW	81.77	86.50	98.90	123.52	164.44	225.76	311.56	411.66	425.96	573.08
ELEVATION	62.00	62.09	62.24	62.47	62.76	63.12	63.55	64.00	64.06	64.64
STORAGE	18.67	21.00								
OUTFLOW	757.06	982.07								
ELEVATION	65.28	66.00								

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

HYDROGRAPH AT STATION R/POND

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	47.92-HR
282.	12.42	(CFS)	84.	27.	13.	13.
		(INCHES)	5.863	7.382	7.383	7.383
		(AC-FT)	42.	53.	53.	53.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	47.92-HR
13.	12.42	6.	3.	2.	2.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	47.92-HR
63.41	12.42	61.35	60.23	59.91	59.91

CUMULATIVE AREA = .13 SQ MI

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              **************
              *            *
 56 KK        *      C4    *
              *            *
              **************

 57 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        576  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT       .083  TIME INTERVAL IN HOURS

              SUBBASIN RUNOFF DATA

 58 BA           SUBBASIN CHARACTERISTICS
                       TAREA        .01  SUBBASIN AREA

                 PRECIPITATION DATA

 10 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
                   .76    1.67    3.66   4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                                   STORM AREA =      .01

 59 LS           SCS LOSS RATE
                      STRTL         .22  INITIAL ABSTRACTION
                     CRVNBR       90.00  CURVE NUMBER
                      RTIMP         .00  PERCENT IMPERVIOUS AREA

 60 US           SNYDER UNITGRAPH
                         TP        1.14  LAG
                         CP         .72  PEAKING COEFFICIENT

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

UNIT HYDROGRAPH PARAMETERS
CLARK TC= 1.34 HR, R= .78 HR
SNYDER TP= 1.14 HR, CP= .72

UNIT HYDROGRAPH
59 END-OF-PERIOD ORDINATES

0.	0.	1.	1.	1.	1.	2.	2.	2.	3.
3.	3.	3.	3.	3.	3.	3.	3.	2.	2.
2.	2.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	

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

HYDROGRAPH AT STATION C4

```
  TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR        24-HR       72-HR      47.92-HR
    12.       13.17       (CFS)       5.          2.          1.           1.
                        (INCHES)   5.933       7.753       7.756        7.756
                         (AC-FT)      2.          3.          3.           3.

                   CUMULATIVE AREA =     .01 SQ MI
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*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
 61 KK    *     R/C6   *
          *            *
          **************

 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        576  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


            SUBBASIN RUNOFF DATA

 63 BA        SUBBASIN CHARACTERISTICS
                    TAREA        .00  SUBBASIN AREA

              PRECIPITATION DATA

 10 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
                .76    1.67    3.66    4.75    5.25    6.50    7.50    9.00     .00     .00     .00     .00

                                              STORM AREA =      .00

 64 LS        SCS LOSS RATE
                   STRTL         .22  INITIAL ABSTRACTION
                  CRVNBR       90.00  CURVE NUMBER
                   RTIMP         .00  PERCENT IMPERVIOUS AREA

            . KINEMATIC WAVE
 65 UK          OVERLAND-FLOW ELEMENT NO. 1
                        L         80.  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
 66 RD          MAIN CHANNEL
                        L        185.  CHANNEL LENGTH
                        S       .0008  SLOPE
                        N        .030  CHANNEL ROUGHNESS COEFFICIENT
                       CA         .00  CONTRIBUTING AREA
                    SHAPE        TRAP  CHANNEL SHAPE
                       WD        6.00  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       2.48       1.67         .55      16.00       7.90    724.86       7.79        .60
              MAIN          .47       1.38        2.31     185.00      12.75    786.22       7.76       1.33

CONTINUITY SUMMARY (AC-FT) - INFLOW= .3226E+01  EXCESS= .5817E+00 OUTFLOW= .3809E+01 BASIN STORAGE= .2692E-03 PERCENT ERROR=    .0

                                 INTERPOLATED TO SPECIFIED COMPUTATION INTERVAL


              MAIN          .47       1.38        5.00                 12.74    785.00       7.76

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

                   HYDROGRAPH AT STATION      R/C6

  TOTAL RAINFALL =    9.00, TOTAL LOSS =    1.21, TOTAL EXCESS =    7.79

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                  6-HR        24-HR       72-HR      47.92-HR
    13.       13.08       (CFS)       6.          2.          1.           1.
                        (INCHES)   5.923       7.761       7.764        7.764
                         (AC-FT)      3.          4.          4.           4.

                   CUMULATIVE AREA =     .01 SQ MI
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          **************
          *            *
   K      *   C/DISC   *     HARGE POINT
          *            *
          **************

 68 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          576  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT         .083  TIME INTERVAL IN HOURS

 69 HC          HYDROGRAPH COMBINATION
                       ICOMP            2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

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

                     HYDROGRAPH AT STATION   C/DISC

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  (CFS)       (HR)                   6-HR        24-HR        72-HR     47.92-HR
    291.     12.42       (CFS)        90.          28.          14.          14.
                       (INCHES)      5.867        7.403        7.407        7.407
                        (AC-FT)       45.          56.          56.          56.

                    CUMULATIVE AREA =      .14 SQ MI
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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	C1	17.	13.17	7.	2.	1.	.01		
HYDROGRAPH AT	C2	153.	12.17	26.	8.	4.	.04		
2 COMBINED AT	C/2	159.	12.17	33.	10.	5.	.05		
HYDROGRAPH AT	R/C3	145.	12.33	39.	13.	6.	.06		
HYDROGRAPH AT	C5	67.	12.08	8.	3.	1.	.01		
HYDROGRAPH AT	P1	221.	12.08	32.	10.	5.	.05		
HYDROGRAPH AT	DP	32.	12.25	6.	2.	1.	.01		
4 COMBINED AT	C/POND	419.	12.08	86.	28.	14.	.13		
ROUTED TO	R/POND	282.	12.42	84.	27.	13.	.13	63.41	12.42
HYDROGRAPH AT	C4	12.	13.17	5.	2.	1.	.01		
HYDROGRAPH AT	R/C6	13.	13.08	6.	2.	1.	.01		
2 COMBINED AT	C/DISC	291.	12.42	90.	28.	14.	.14		

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

						INTERPOLATED TO COMPUTATION INTERVAL			
ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
C2	MANE	3.61	155.69	729.38	7.65	5.00	152.89	730.00	7.65

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1641E+02 OUTFLOW= .1611E+02 BASIN STORAGE= .2353E-02 PERCENT ERROR= 1.8

R/C3	MANE	5.00	145.42	740.00	7.65	5.00	145.42	740.00	7.65

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2079E+02 EXCESS= .4446E+01 OUTFLOW= .2508E+02 BASIN STORAGE= .4312E-02 PERCENT ERROR= .6

C5	MANE	5.00	67.39	725.00	7.15	5.00	67.39	725.00	7.15

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .5526E+01 OUTFLOW= .5072E+01 BASIN STORAGE= .1028E-02 PERCENT ERROR= 8.2

P1	MANE	3.16	228.13	725.67	7.62	5.00	221.20	725.00	7.62

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .2082E+02 OUTFLOW= .2037E+02 BASIN STORAGE= .1444E-02 PERCENT ERROR= 2.2

R/C6	MANE	2.31	12.75	786.22	7.76	5.00	12.74	785.00	7.76

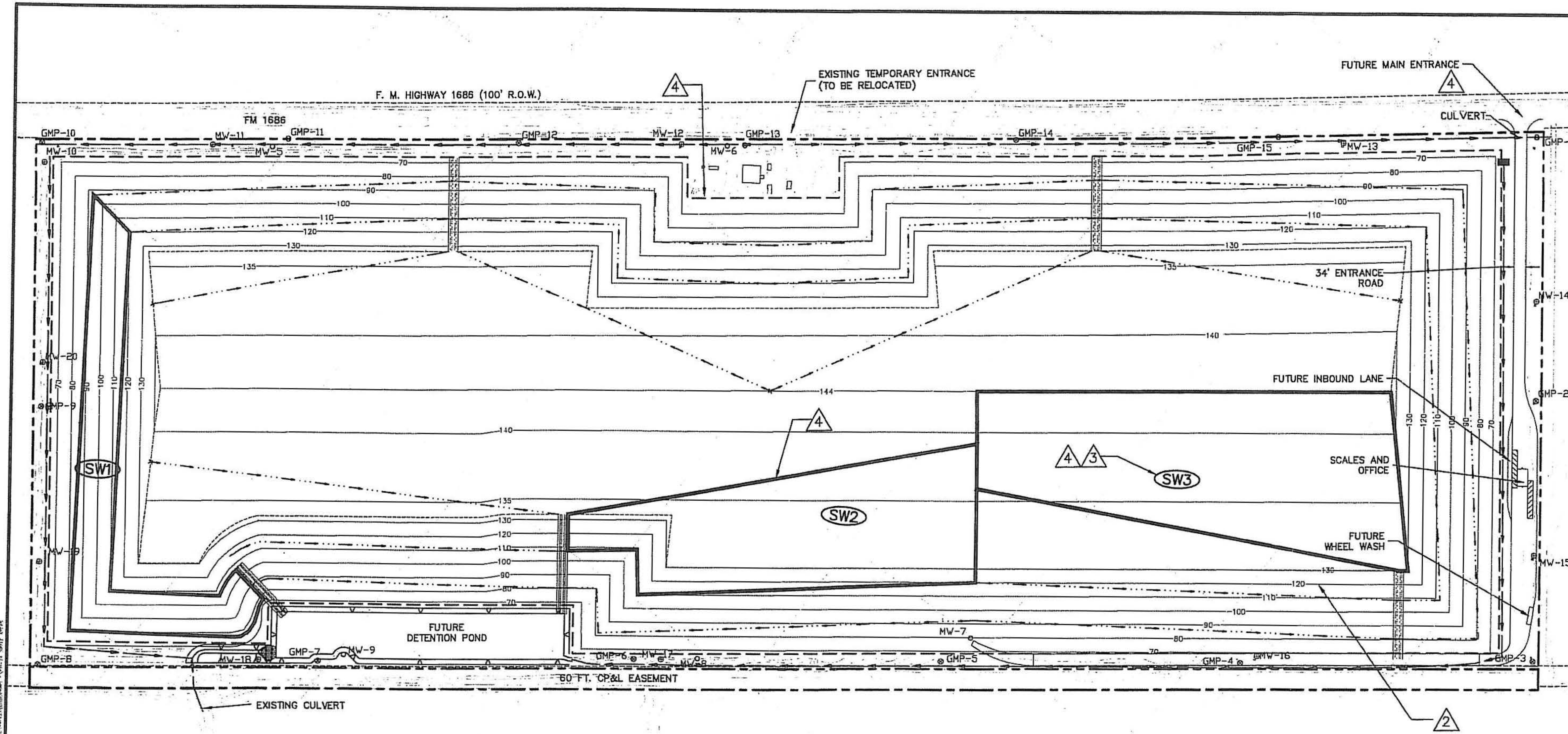
CONTINUITY SUMMARY (AC-FT) - INFLOW= .3226E+01 EXCESS= .5817E+00 OUTFLOW= .3809E+01 BASIN STORAGE= .2692E-03 PERCENT ERROR= .0

*** NORMAL END OF HEC-1 ***

DRAINAGE SWALE DESIGN

- The drainage swale layout is shown on Attachment 6A. A swale detail is provided on Attachment 6B-5 - Drainage Details.
- Swale Design Summary:
  - Drainage areas analyzed are shown on sheet 6H-24.
  - Hydraulic calculations are summarized on page 6H-26.
  - Maximum normal depth is 1.54 feet (SW2).
  - Maximum flow velocity is 4.0 fps (SW2).

Vegetation will be established on the swales to protect against erosion.



0 150 300
SCALE IN FEET

DRAINAGE AREA	AREA (SF)
SW1	189,069
SW2	353,488
SW3	491,780

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- LIMITS OF WASTE
- STATE PLAN COORDINATE
- 70 EXISTING CONTOUR
- 66 PROPOSED FINAL CONTOUR
- SW2 DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 GAS MONITORING PROBES
- MW-17 GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 INDICATES REVISION

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN ARPIL 5, 2008.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED
PROFESSIONAL ENGINEER

3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY WEAVER BOOS CONSULTANTS, AND SIGNED AND SEALED BY NEVZAT TURAN (TEXAS P.E. 84059) ON JANUARY 15, 2007. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2008	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED SWALE DRAINAGE AREAS	

DRAWING TITLE
SWALE DRAINAGE AREAS

PROJECT TITLE
PERMIT MODIFICATION

CLIENT
REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
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PROJ. NO. 16208541 | DWN. BY: JLJ | Q/A RVW BY: DJM
DSN. BY: JR | CHK. BY: DJM | APP. BY: JRM

CADD FILE: 6H-24 SWALE AREAS

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT
6H-24

Required: Analyze swales to determine adequacy of the swale design.

Method:

1. Determine the 25-year rates for the swale drainage areas shown on Sheet 6H-24.
2. Determine the maximum depth of flow for the swale drainage areas shown on Sheet 6H-24.

Reference:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, 3rd Edition, December 1985.
2. JFK Group, Inc. *Type 1 Municipal Solid Waste Landfill, TNRCC No. MSW-1522 Amendment for Increased Height of Fill*, technically complete January 1997.

Solution:

1. Determine the 25-year storm event flow rates.

Swale Label	Area (ac)	C Factor	Intensity[1] (in/hr)	Flow Rate[2] (cfs)
SW1	4.34	0.50	7.0	15.2
SW2	8.10	0.50	7.0	28.4
SW3	11.30	0.50	7.0	39.6

[1] Intensity is calculated on page 3 of Attachment 6.
[2] Discharge = Area x C Factor x Intensity

2. Determine the maximum depth of flow.

Swale	Flow Rate (cfs)	Bottom Slope (ft/ft)[1]	n-value	Side Slope[2] (left)	Side Slope[2] (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)
SW1	15.2	0.01	0.03	2	4	0	1.22	3.42	0.772	0.18	1.40	4.44	7.30
SW2	28.4	0.01	0.03	2	4	0	1.54	4.00	0.805	0.25	1.78	7.09	9.22
SW3	39.6	0.005	0.03	2	40	0	0.94	2.12	0.544	0.07	1.01	18.64	39.57

[1] Swales will have a minimum 0.5 percent slope on top slope and 1.0 percent on side slope.

[2] Swale side slopes are 2 Horizontal(H) to 1 Vertical(V) on berm, 4H:1V on landfill side slopes, and minimum of 40H:1V (2.5 percent) on landfill top deck.

[3] Calculations were performed using the HYDROCALC HYDRAULICS program developed by Dodson and Associates (Version 1.2a, 1996).

Maximum flow depth is 1.54 ft < 2.0 ft (swale height)

Design is acceptable.

Example Calculation: Calculate the normal depth for the swale for drainage area SW1 (See Sheet 6H-26)

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 sideslope of swale
z_l = z-ratio (ratio of run to rise for channel sideslope) for left sideslope 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 =	15.2	cfs (from page 6H-28)
S =	0.01	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 = 1.22 ft

R = 0.575 ft

A_f = 4.45 sf

solve for Q: Q = 15.2 cfs

if Q is not equal to Q_d, select a new d and repeat calculations

Step 2 - solve for velocity, T (wet perimeter), Froude number, velocity head, and energy head

$Q = VA \Rightarrow \quad V = Q/A$

$V = 3.42$ ft/s

$T = b + d(z_l + z_r)$

$T = 7.31$ ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

$F_r = 0.772$

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 0.18 ft

Energy Head = water elevation + velocity head

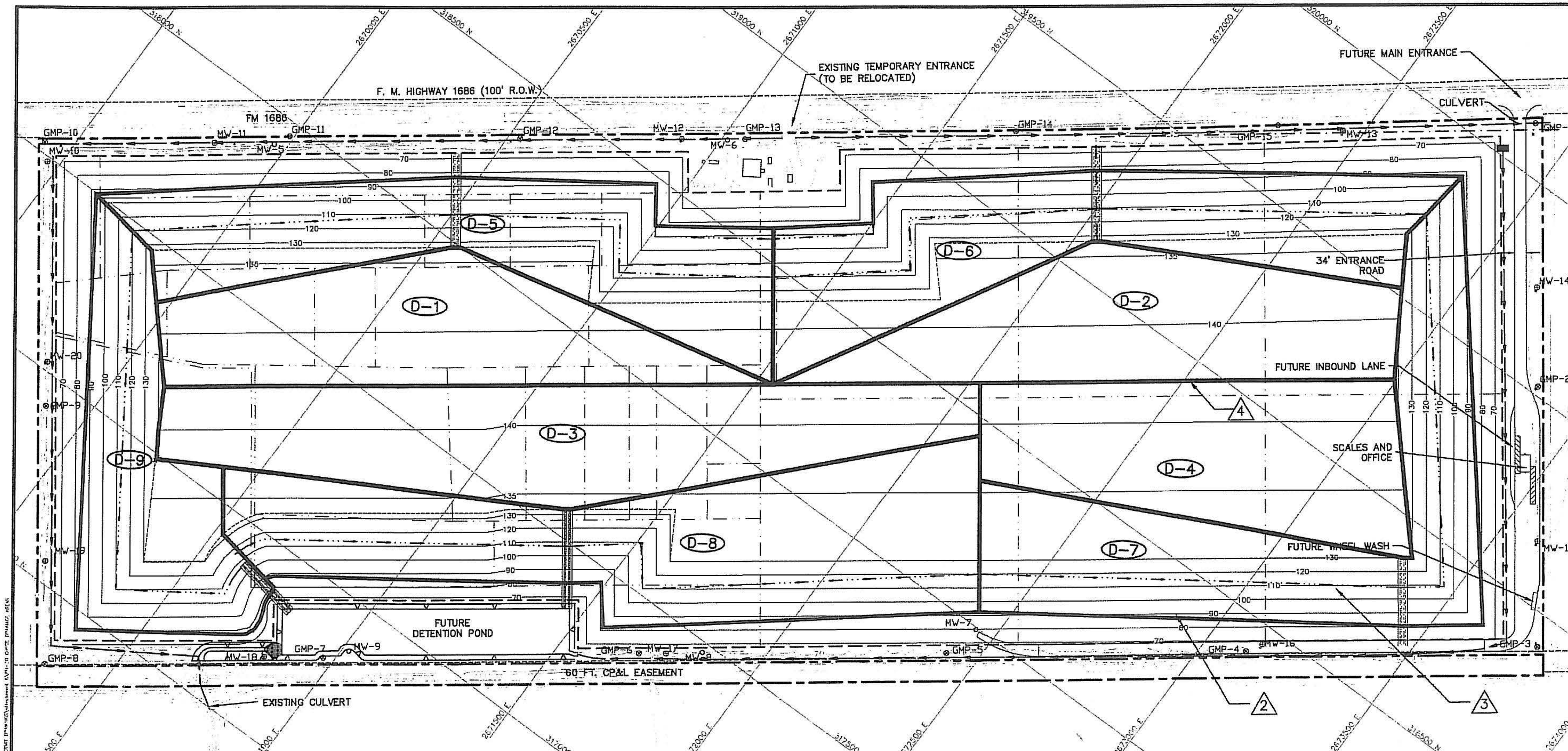
Energy Head = 1.40 ft

DRAINAGE LETDOWN (OR CHUTE) DESIGN

The letdown structures will be designed using either Reno mattress, gabion or 6" Tri-lock concrete blocks for the chutes. The Reno mattress, gabion or 6" Tri-lock concrete blocks are placed along the entire chute in order to protect the chute bottom and the final cover from erosion due to potential erosive velocities.

- Chute layout is shown on Attachment 6A. Chute details are provided on Attachments 6B-4 through 6B-5.
- Design peak flow calculations are summarized on page 6H-33.

Design calculations for chutes are presented on pages 6H-34 through 6H-37.



DRAINAGE AREA	AREA (SF)
D-1	465,043
D-2	490,647
D-3	645,049
D-4	492,818
D-5	554,062
D-6	577,308
D-7	607,792
D-8	755,135
D-9	370,731

0 150 300
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- PROPERTY LINE
- 2672000 E — STATE PLANE COORDINATE
- 70 — EXISTING CONTOUR
- 66 — PROPOSED FINAL CONTOUR
- D-2 — DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- PROPOSED DRAINAGE LETDOWN
- PROPOSED DRAINAGE SWALE
- MW-8 — MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GMP-6 — GAS MONITORING PROBES
- MW-17 — GROUNDWATER MONITORING WELLS
- PERIMETER CHANNEL FLOWLINE
- 2 — INDICATES REVISION
- DRAINAGE FLOWLINE

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 5, 2008.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

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FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2006	REVISED FINAL CONTOUR PLAN TO REMOVE BENCH	
2	01/2007	REVISED FINAL CONTOUR PLAN, 10 FT HEIGHT INCREASE	
3	01/2007	REVISED DRAINAGE AREAS, 10 FT HEIGHT INCREASE	
4	03/2009	REVISED CHUTE DRAINAGE AREA	

DRAWING TITLE: **CHUTE DRAINAGE AREA PLAN**

PROJECT TITLE: **PERMIT MODIFICATION**

CLIENT: **REPUBLIC WASTE SERVICES CITY OF VICTORIA LANDFILL**
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
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PROJ. NO. 16208541 | DSN. BY: JR | CHK. BY: DJM | DWN. BY: JLJ | Q/A RVW BY: DJM | APP. BY: JRM

CADD FILE: 6H-30 CHUTE DRAINAGE AREAS

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT

6H-30

Required: Find peak flow rates using the Rational Method for the chute drainage areas shown on 6H-30.

Given:
1. Drainage areas analyzed are presented on page 6H-30.

Method:
1. Use rational method to calculate peak flows for the selected drainage areas.

References:

1. State of Texas, Department of Transportation, Bridge Division, Hydraulic Manual, 3rd Edition, December 1985.
2. United States Department of Agriculture, Soil Conservation Service, Engineering Division, *TR-55 - Urban Hydrology for Small Watersheds*, 1986.
3. Dodson & Associates, Inc. *ProHEC1 Plus Program Documentation*, June 1995.

Prep By: PJ
Date: 3/1/2009

VICTORIA LANDFILL
CHUTE PEAK 25-YEAR FLOW RATE

Chkd By: JRM
Date: 3/1/2009

Solution:

1. Calculate Peak Flow using Rational Method

Drainage Basin	Area (sf)	Area (acres)	C Factor	Intensity[1] (in/hr)
D-1	465,043	10.7	0.5	7.0
D-2	490,647	11.3	0.5	7.0
D-3	645,049	14.8	0.5	7.0
D-4	492,818	11.3	0.5	7.0
D-5	554,062	12.7	0.5	7.0
D-6	577,308	13.3	0.5	7.0
D-7	607,792	14.0	0.5	7.0
D-8	755,135	17.3	0.5	7.0
D-9	370,731	8.5	0.5	7.0

[1] Intensity is calculated on page 3 of Attachment 6.

Prep By: PJ
Date: 3/1/2009

VICTORIA LANDFILL
CHUTE PEAK 25-YEAR FLOW RATE

Chkd By: JRM
Date: 3/1/2009

Drainage Basin	Total Area (ac)	Runoff Coeff.	Intensity[1] (in/hr)	Peak 25-yr Flow[2] (cfs)
D-1	10.7	0.5	7.0	37.4
D-2	11.3	0.5	7.0	39.4
D-3	14.8	0.5	7.0	51.8
D-4	11.3	0.5	7.0	39.6
D-5	12.7	0.5	7.0	44.5
D-6	13.3	0.5	7.0	46.4
D-7	14.0	0.5	7.0	48.8
D-8	17.3	0.5	7.0	60.7
D-9	8.5	0.5	7.0	29.8

[1] Intensity is calculated on page 3 of Attachment 6.

[2] Discharge = Area x C Factor x Intensity

Prep By: PJ
Date: 3/1/2009

Chkd By: JRM
Date: 3/1/2009

VICTORIA LANDFILL
FINAL COVER EROSION CONTROL STRUCTURE DESIGN
CHUTE DESIGN

Required:

Provide design for a reno mattress, gabion or tri-lock concrete block letdown structure (or chute)

Method:

1. Obtain the 25-year, frequency flow rates for the chute drainage areas.
2. Design the chutes.

Solution:

1. Determine the 25-year, frequency flow rates.

The following peak flow rates were taken from the chute peak flow calculations shown on page 6H-33.

Letdown	Area (ac)	Flow Rate (cfs)
D1/D5	25.5	77.0
D2/D6	22.6	85.8
D3/D8	27.5	112.5
D4/D7	24.6	88.4
D9	8.0	29.8

2a. Uniform flow design for reno matress or gabion lined chutes.

Letdown	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)
D1/D5	77.0	0.25	0.03	2.0	2.0	8.0	0.56	15.2	3.810	3.59	4.15	5.06	10.22
D2/D6	85.8	0.25	0.03	2.0	2.0	8.0	0.59	15.8	3.857	3.89	4.48	5.42	10.36
D3/D8	112.5	0.25	0.03	2.0	2.0	10.0	0.61	16.4	3.900	4.19	4.80	6.85	12.44
D4/D7	88.4	0.25	0.03	2.0	2.0	8.0	0.60	16.0	3.866	3.97	4.57	5.53	10.40
D9	29.8	0.25	0.03	2.0	2.0	8.0	0.32	10.9	3.528	1.84	2.16	2.74	9.27

1. Drainage areas utilized for chute calculations are shown on Sheet 6H-30.
2. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 1.2a, 1996).
3. The maximum allowable velocity for reno mattres is 16.4 fps and the maximum allowable velocity for gabion is 19 fps, the maximum velocity in the above table is 16.4 fps. Therefore the design of chute is acceptable.

2b. Uniform flow design for 6" tri-lock concrete lined chutes.

Letdown	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)
D1/D5	77.0	0.25	0.026	2.0	2.0	8.0	0.51	16.8	4.364	4.36	4.87	4.60	10.04
D2/D6	85.8	0.25	0.026	2.0	2.0	8.0	0.54	17.4	4.401	4.70	5.24	4.93	10.17
D3/D8	112.5	0.25	0.026	2.0	2.0	8.0	0.64	19.1	4.494	5.65	6.29	5.90	10.55
D4/D7	88.4	0.25	0.026	2.0	2.0	8.0	0.55	17.6	4.411	4.80	5.35	5.03	10.21
D9	29.8	0.25	0.026	2.0	2.0	8.0	0.29	11.9	4.020	2.21	2.50	2.50	9.17

1. Drainage areas utilized for chute calculations are shown on Sheet 6H-30.
2. Calculations were performed using the HYDROCALC Hydraulics for Windows program developed by Dodson and Associates (Version 1.2a, 1996).
3. The maximum allowable velocity for 6" tri-lock concrete is 20 fps and the maximum velocity in the above table is 19.1 fps.Therefore the design of chute is acceptable.

Example Calculation: Calculate the normal depth for the chute for D1/D5

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 =	77.0	cfs
S =	0.25	ft/ft
b =	8	ft
z =	2	(H) : 1 (V)
n =	0.03	

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 = 0.56 ft

R = 0.483 ft

A_f = 5.06 sf

solve for Q: Q = 77.0 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 = 15.21 ft/s

$T = b + 2(z \times d)$

T = 10.22 ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

$F_r =$ 3.808

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 3.59 ft

Energy Head = water elevation + velocity head

Energy Head = 4.15 ft

DETENTION POND DESIGN

The detention pond has been analyzed by using HEC-1 storage routing method. A summary of HEC-1 results for the detention pond is presented on page 6H-39. As can be seen in the table, the pond flows over its spillway. Spillway reinforcement will be designed with either riprap or gabions.

Downstream side of the low-level outlet will be designed with either rock riprap or gabions. The detention pond details are shown on Attachment 6B-7.

Purpose: Demonstrate that the detention pond outlet structure design is adequate to convey runoff from the subbasin to the discharge point.

Method:
1. Use the 25-year, 24-hour flow rates and water surface elevations for the drainage areas that will discharge to the detention pond from the HEC-1 analysis.
2. Use the Weir Equation to calculate the flow rate over the spillway as appropriate.

Solution:

	POND
Bottom ELEV, ft	59.0
Spillway ELEV, ft	62.0
Spillway Length, ft	40
Top of Road/Berm, ft	64.0
Discharge Pipe Downstream Invert ELEV, ft	58.6
Peak Inflow Q_{25}, cfs	417
Peak Outflow Q_{25}, cfs	282
Peak Stage in Pond Q_{25}, ft	63.41
Est. Flow (Q_{25}) over Spillway, cfs	177
Velocity (V_{25}) over Spillway, fps	11.1

Note:

1) Details of the pond outlet structure are presented on Attachment 6B-7. As shown, gabions or riprap are provided for both upstream and downstream of the spillways.
2) The flow over the spillway is estimated either 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, by subtracting the capacity of low level outlet from the peak flow. The flow over the spillway conservatively assumes no flow through the low water outlet.
3) Calculations for velocity over the spillway were performed using the HYDROCALC HYDRAULICS FOR WINDOWS Computer Program developed by Dodson and Associates (Version 1.2a, 1996).

APPENDIX C – BEST MANAGEMENT PRACTICES GUIDANCES FROM TCEQ RG-348

RG-348
Revised July 2005

Complying with the Edwards Aquifer Rules

Technical Guidance on Best Management Practices

Includes Errata Sheet (March 28, 2009) and Addendum Sheet (Jan. 20, 2017). Note: Addendum (June 5, 2018) is retracted and under review.

Field Operations Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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(4) More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), and long grades.

(5) When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.

1.3.5 Outlet Stabilization

The goal of outlet stabilization is to prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating the energy. This practice applies where the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

The outlets of channels, conduits, and other structures are points of high erosion potential, because they frequently carry flows at velocities that exceed the allowable limit for the area downstream. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels. A riprap-lined apron is the most commonly used practice for this purpose because of its relatively low cost and ease of installation. The riprap apron should be extended downstream until stable conditions are reached even though this may exceed the length calculated for design velocity control.

Riprap-stilling basins or plunge pools reduce flow velocity rapidly. They should be considered in lieu of aprons where overfalls exit at the ends of pipes or where high flows would require excessive apron length. Consider other energy dissipaters such as concrete impact basins or paved outlet structures (see Figure 1-10) where site conditions warrant.

Materials:

(1) Materials—Ensure that riprap consists of a well-graded mixture of stone. Larger stone should predominate, with sufficient smaller sizes to fill the voids between the stones. The maximum stone diameter should be no greater than 1.5 times the d_{50} size.

(2) Thickness—Make the minimum thickness of riprap 1.5 times the maximum stone diameter.

(3) Stone quality—Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant. The specific gravity of the individual stones should be at least 2.5.

(4) Geotextile Fabric—Install appropriate barrier to prevent soil movement through the openings in the riprap. The barrier should consist of a graded gravel layer or a synthetic filter cloth.

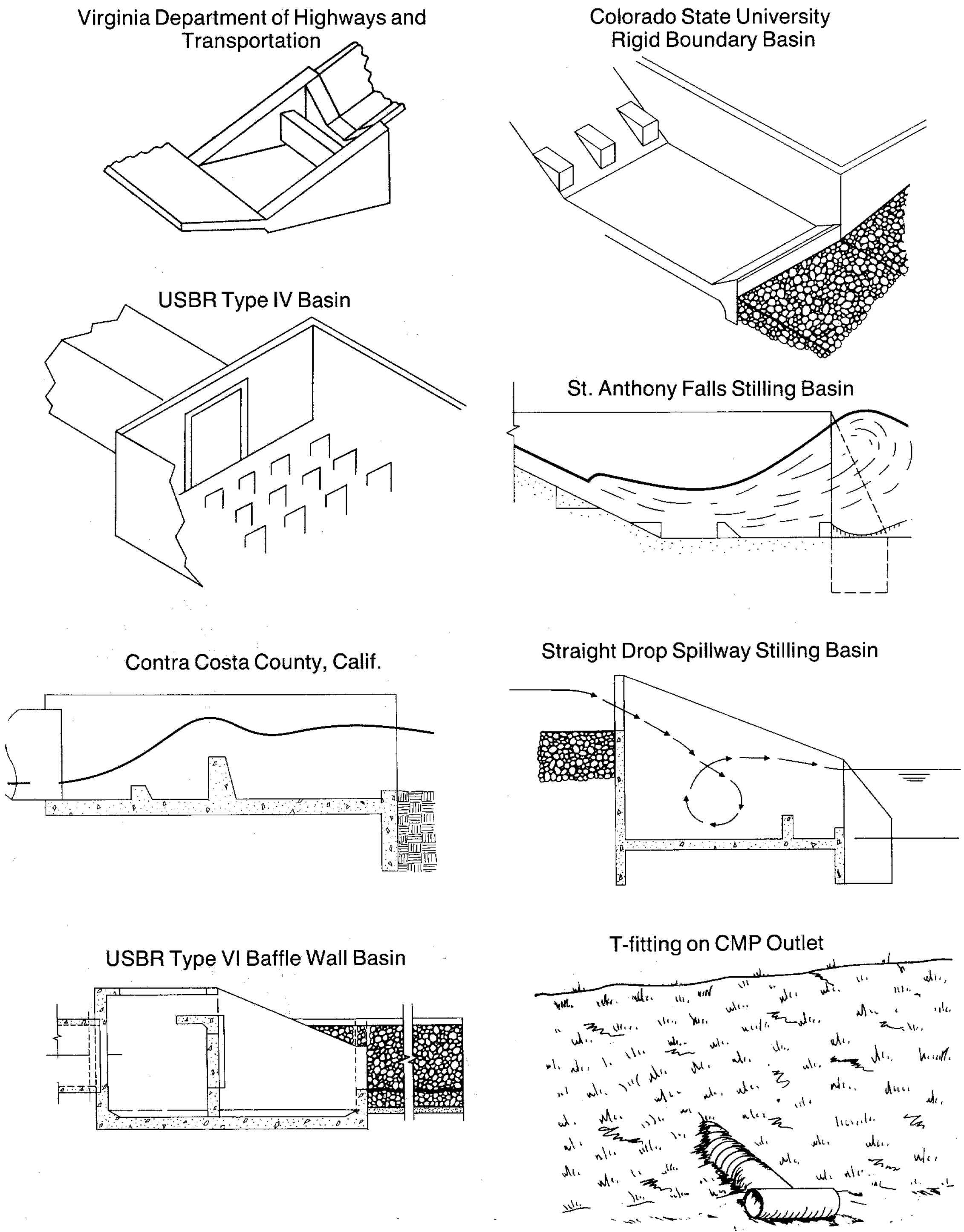


Figure 1-10 Examples of Stilling Basin Designs (North Carolina, 1993)

Design Guidelines:

(1) Capacity—10-yr, 3-hour peak runoff or the design discharge of the water conveyance structure, whichever is greater.

(2) Apron size—If the water conveyance structure discharges directly into a well-defined channel, extend the apron across the channel bottom and up the channel banks to an elevation of 0.5 ft above the maximum tailwater depth or to the top of the bank, whichever is less (see Figure 1-11). Determine the maximum allowable velocity for the receiving stream, and design the riprap apron to reduce flow to this velocity before flow leaves the apron. Calculate the apron length for velocity control or use the length required to meet stable conditions downstream, whichever is greater.

(3) Grade—Ensure that the apron has zero grade. There should be no overfall at the end of the apron; that is, the elevation of the top of the riprap at the downstream end should be the same as the elevation of the bottom of the receiving channel or the adjacent ground if there is no channel.

(4) Alignment—The apron should be straight throughout its entire length, but if a curve is necessary to align the apron with the receiving stream, locate the curve in the upstream section of riprap.

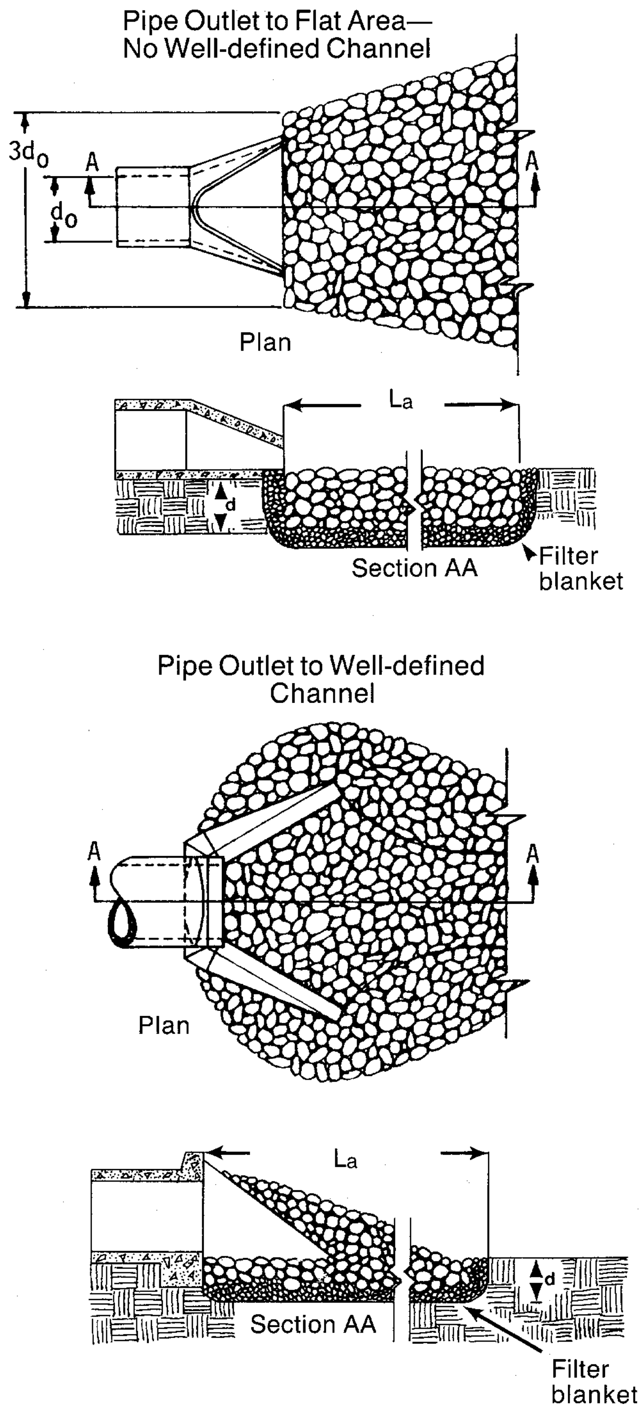
Installation:

(1) Ensure that the subgrade for the fabric and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.

(2) The riprap and fabric must conform to the specified grading limits shown on the plans.

(3) Filter cloth must be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter cloth over the damaged area. All connecting joints should overlap a minimum of 1 ft. If the damage is extensive, replace the entire filter cloth.

(4) Riprap may be placed by equipment, but take care to avoid damaging the fabric.



Notes

1. L_a is the length of the riprap apron.
2. $d = 1.5$ times the maximum stone diameter but not less than 6″.
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6″ above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

Figure 1-11 Riprap Outlet Design (North Carolina, 1993)

(5) The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.

(6) Riprap may be field stone or rough quarry stone. It should be hard, angular, highly weather-resistant and well graded.

(7) Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.

(8) Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.

(9) Immediately after construction, stabilize all disturbed areas with vegetation.

Inspection and Maintenance Guidelines:

(1) Inspect riprap outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

1.3.6 <u>Level Spreaders</u>

A level spreader is used as an outlet device for dikes and diversions and consists of an excavated depression constructed at zero grade across a slope. The purpose is to convert concentrated runoff to sheet flow and release it uniformly onto areas stabilized by existing vegetation.

Level spreaders should be used where there is a need to divert stormwater away from disturbed areas to avoid overstressing erosion control measures or where sediment free storm runoff can be released in sheet flow down a stabilized slope without causing erosion. A perspective view of a level spreader is shown in Figure 1-12.

This practice applies only in those situations where the spreader can be constructed on undisturbed soil and the area below the level lip is uniform with a slope of 10% or less and is stabilized by natural vegetation. The runoff water should not be allowed to re-concentrate after release unless it occurs during interception by another measure (such as a permanent pond or detention basin) located below the level spreader.

1.3.9 Blankets and Matting

Blankets and matting material can be used as an aid to control erosion on critical sites during establishment period of protective vegetation. The most common uses are: in channels where designed flow exceeds 3.5 feet per second; on interceptor swales and diversion dikes when design flow exceeds 6 feet per second; on short, steep slopes where erosion hazard is high and planting is likely to be slow to establish adequate protective cover; and on stream banks where moving water is likely to wash out new vegetative plantings.

Blankets and matting can also be used to create erosion stops on steep, highly erodible watercourses. Erosion stops should be placed approximately 3 feet down channel from point of entry of a concentrated flow such as from culverts, tributary channels or diversions or at points where a change in gradient or course of channel occurs. Spacing of erosion stops on long slopes will vary, depending on the erodibility of the soil and velocity and volume of flow. Erosion stops are placed beneath blankets and matting.

Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

Jute is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Excelsior (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life.

Straw blanket should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket.

Wood fiber blanket is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation.

The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Coconut fiber blanket should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket.

Coconut fiber mesh is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Straw coconut fiber blanket should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

Plastic netting is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Plastic mesh is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Synthetic fiber with netting is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Bonded synthetic fibers consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Combination synthetic and biodegradable RECPs consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Materials:

New types of blankets and matting materials are continuously being developed. The Texas Department of Transportation (TxDOT) has defined the critical performance factors for these types of products, and has established minimum performance standards which must be met for any product seeking to be approved for use within any of TxDOT's construction or maintenance activities. The products that have been approved by TxDOT are also appropriate for general construction site stabilization. TxDOT maintains a web site at:

http://www.dot.state.tx.us/insdtdot/orgchart/cmd/erosion/contents.htm

which is continually updated as new products are evaluated. The following tables list applications and products approved by TxDOT as of February 2001.

CLASS 1 "SLOPE PROTECTION"

Type A - Slopes 1:3 or Flatter - Clay Soils:

- Airtrol
- Anti-wash/Geojute
- BioD-Mesh 60
- Carthage Mills Veg Net
- C-Jute
- Contech Standard
- Contech Standard Plus
- Contech Straw/Coconut Fiber Mat w/Kraft Net
- Contech C-35
- Conwed 3000
- Curlex I
- Curlex™-LT
- Earth Bound
- EcoAegis™
- Econo-Jute
- ECS Excelsior Blanket Standard
- ECS High Velocity Straw Mat
- ECS Standard Straw
- EnviroGuard Plus
- Formula 480 Liquid Clay
- Futerra®
- Grass Mat
- Greenfix WSO72
- GeoTech TechMat™ SCKN
- Green Triangle Regular
- Green Triangle Superior
- Greenstreak Pec-Mat
- Landlok BonTerra EcoNet™ ENS2
- Landlok BonTerra EcoNet™ ENCS2
- Landlok BonTerra S1
- Landlok BonTerra S2
- Landlok BonTerra CS2
- Landlok BonTerra SFB12
- Landlok 407GT
- Landlok FRS 3112
- Landlok TRM 435
- Miramat TM8
- North American Green S150
- North American Green S75
- North American Green® S75 BN
- North American Green SC150
- North American Green® S150 BN
- Maccaferri MX287
- Pennzsuppress®
- Poplar Erosion Blanket
- Soil Guard
- Soil Saver
- SuperGro
- Terra-Control®
- TerraJute
- verdyol Ero-Mat
- verdyol Excelsior High Velocity
- verdyol Excelsior Standard
- Webtec Terraguard 44P
- Xcel Regular
- Xcel Superior

Type B - 1:3 or Flatter - Sandy Soils:

C-Jute
Carthage Mills Veg Net
Contech Standard
Contech Standard Plus
Contech Straw/Coconut Fiber Mat w/Kraft Net
Contech C-35
Curlex LT
Earth Bound
ECS Standard Straw
ECS Excelsior Blanket Standard
ECS High Velocity Straw Mat
EcoAegis™
EnviroGuard Plus
Futerra®
Greenfix WSO72
Geojute Plus 1
GeoTech TechMat™ SCKN
Green Triangle Regular
Green Triangle Superior
Landlok® BonTerra S1
Landlok® BonTerra S2
Landlok® BonTerra CS2
Landlok® BonTerra®EcoNet™ENCS2™
Landlok® BonTerra®EcoNet™ ENS2
Landlok FRS 3112
Landlok 407GT
Landlok TRM 435
Maccaferri MX287
Miramat 1000
Miramat TM8
North American Green S75
North American Green® S75 BN
North American Green S150
North American Green SC150
North American Green® S150 BN
Poplar Erosion Blanket
Soil Guard
Terra-Control®
TerraJute
verdyol Ero-Mat
verdyol Excelsior Standard
Webtec Terraguard 44P
Xcel Regular
Xcel Superior

Type C - Slopes Steeper than 1:3 - Clay Soils:

- Airtrol
- Anti-Wash/Geojute
- Carthage Mills Veg Net
- C-Jute
- Contech Standard Plus
- Contech Straw/Coconut Fiber Mat w/Kraft Net
- Contech C-35
- Conwed 3000
- Curlex I
- Earth Bound
- Econo Jute
- ECS High Velocity Straw Mat
- ECS Standard Straw
- EnviroGuard Plus
- Formula 480 Liquid Clay
- Futerra®
- Greenfix WSO72
- Green Triangle Superior
- GeoTech TechMat™ SCKN
- Greenstreak Pec-Mat
- Landlok® BonTerra® EcoNet™ ENCS2
- Landlok® BonTerra S2
- Landlok BonTerra CS2
- Landlok® BonTerra SFB12
- Landlok 407GT
- Landlok FRS 3112
- Landlok TRM 435
- Maccaferri MX287
- Miramat TM8
- North American Green S150
- North American Green S75
- North American Green SC150
- North American Green® S150 BN
- Pennzsuppress®
- Poplar Erosion Blanket
- Soil Guard
- Soil Saver
- SuperGro
- TerraJute
- verdyol Excelsior High Velocity
- Webtec Terraguard 44P
- Xcel Superior

<u>Type D - Slopes Steeper than 1:3 - Sandy Soils:</u>

- C-Jute
- Carghage Mills Veg Net
- Contech Standard Plus
- Contech Straw/Coconut Fiber Mat w/Kraft Net
- Contech C-35
- Curlex I
- ECS High Velocity Straw Mat
- ECS Standard Straw
- EnviroGuard Plus
- Futerra®
- Greenfix WSO72
- Geojute Plus 1
- GeoTech TechMat™ SCKN
- Green Triangle Superior
- Landlok® BonTerra S2
- Landlok® BonTerra CS2
- Landlok® BonTerra®EcoNet™ENCS2™
- Landlok 407GT
- Landlok FRS 3112
- Landlok TRM 435
- Maccaferri MX287
- Miramat 1000
- Miramat TM8
- North American Green S150
- North American Green SC150
- North American Green® S150 BN
- Soil Guard
- TerraJute
- Webtec Terraguard 44P
- Xcel Superior

CLASS 2 - "FLEXIBLE CHANNEL LINER”

Type E - Shear Stress Range 0 - 96 Pascal (0 - 2 Pounds Per Square Foot):

Contech TRM C-45
Contech C-35
Contech C50
Contech Coconut/Poly Fiber Mat
Contech Coconut Mat w/Kraft Net
Curlex® II Stitched
Curlex® III Stitched
Curlex® Channel Enforcer 1
Curlex® Channel Enforcer II
Earth-Lock
Earth-Lock II
ECS High Impact Excelsior
ECS Standard Excelsior
ECS High Velocity Straw Mat
Enkamat 7018
Enkamat 7020
Enkamat Composite 30
Enkamat Composite NPK**
Enviromat
Geotech TechMat™ CP 3-D
Geotech TechMat™ CKN
Greenfix CFO 72RP **
Greenfix CFO 72RR
Greenstreak Pec-Mat
Koirmat™ 700
Landlok® BonTerra® C2
Landlok® BonTerra® CP2
Landlok® BonTerra® EcoNet™ ENC2
Landlok® BonTerra® SFB™
Landlok® BonTerra SFB12
Landlok TRM 435
Landlok TRM 450
Landlok TRM 1050
Landlok TRM 1060
Maccaferri MX287
Miramat TM8
Multimat 100
North American Green C125 BN
North American Green C350 Three Phase
North American Green SC150 BN
North American Green S350
North American Green® P350
North American Green S150
Pyramat®
Webtec Terraguard 44P
Webtec Terraguard 45P
Xcel PP-5

Type F - Shear Stress Range 0 - 192 Pascal (0 - 4 Pounds Per Square Foot):

Curlex® II Stitched
Curlex® III Stitched
Curlex® Channel Enforcer 1
Curlex® Channel Enforcer II
Contech C50
Contech TRM C-45
Contech C-35
Contech Coconut/Poly Fiber Mat
Contech Coconut Mat w/Kraft Net
Earth-Lock
Earth-Lock II
ECS High Impact Excelsior
ECS High Velocity Straw Mat
ECS Standard Excelsior
Enkamat 7018
Enkamat Composite 30
Enkamat Composite NPK **
Enkamat Composite P/T**
Enviromat
Geotech TechMat™ CP 3-D
Geotech TechMat™ CKN
Greenfix CFO 72RP **
Greenfix CFO 72RR
Greenstreak Pec-Mat
Koirmat™ 700
Landlok® BonTerra® C2
Landlok® BonTerra® CP2
Landlok® BonTerra® EcoNet™ ENC2
Landlok BonTerra® SFB™
Landlok BonTerra SFB12
Landlok TRM 435
Landlok TRM 450
Landlok TRM 1050
Landlok TRM 1060
Maccaferri MX287
Miramat TM8
Multimat 100
North American Green C125 BN
North American Green C350 Three Phase
North American Green SC150 BN
North American Green S350
North American Green® P350
North American Green S150
Pyramat®
Webtec Terraguard 44P
Webtec Terraguard 45P
Xcel PP-5

Type G - Shear Stress Range 0 - 287 Pascal (0 - 6 Pounds Per Square Foot):

Contech TRM C-45
Contech C-35
Contech C50
Contech Coconut/Poly Fiber Mat
Curlex® III Stitched
Curlex® Channel Enforcer II
Earth-Lock
Earth-Lock II
Enkamat 7018
Enkamat Composite 30
Geotech TechMat™ CP 3-D
Greenstreak Pec-Mat
Koirmat™ 700
Landlok® BonTerra® CP2
Landlok® BonTerra® SFB™
Landlok® BonTerra SFB12
Landlok TRM 1050
Landlok TRM 1060
Landlok TRM 435
Landlok TRM 450
North American Green C350 Three Phase
North American Green S350
North American Green® P350
Pyramat®
Webtec Terraguard 44P
Webtec Terraguard 45P

Type H - Shear Stress Range 0 - 383 Pascal (0 - 8 Pounds Per Square Foot):

Contech TRM C-45
Contech C-35
Contech C50
Contech Coconut/Poly Fiber Mat
Curlex® III Stitched
Geotech TechMat™ CP 3-D
Landlok® BonTerra SFB12
Landlok TRM 435
Landlok TRM 450
Landlok TRM 1050
Landlok TRM 1060
North American Green C350 Three Phase
North American Green S350
North American Green® P350
Pyramat®
Webtec Terraguard 44P
Webtec Terraguard 45P

"SEEDING FOR EROSION CONTROL"

Cellulose Fiber Mulches

Clay or Tight Soils:

Agri-Fiber
American Fiber Mulch
American Fiber Mulch (with Hydro-Stick)
Conwed Hydro Mulch
Enviro-Gro
Evercycle™ Hydro-Mulch
Excel Fibermulch II (with Exact-Tac)
Lay-Low Mulch
Oasis Fiber Mulch
Pennzsuppress®
Pro Mat
Pro Mat (with RMBplus)
Pro Mat XL
Second Nature Regenerated Paper Fiber Mulch
Silva Fiber Plus

Sandy or Loose Soils:

American Fiber Mulch
American Fiber Mulch (with Hydro-Stick)
American Fiber Mulch with Stick Plus
Conwed Hydro Mulch
Enviro-Gro
Evercycle™ Hydro-Mulch
Excel Fibermulch II (with Exact-Tac)
Lay-Low Mulch
Oasis Fiber Mulch
Pennzsuppress®
Pro Mat
Pro Mat (with RMBplus)
Pro Mat XL
Second Nature Regenerated Paper Fiber Mulch

Installation:

Proper installation of blankets and matting is necessary for these materials to function as intended. They should always be installed in accordance with the manufacturer's recommendations. Proper anchoring of the material and preparation of the soil are two of the most important aspects of installation. Typical anchoring methods are shown in Figure 1-20 and Figure 1-21.

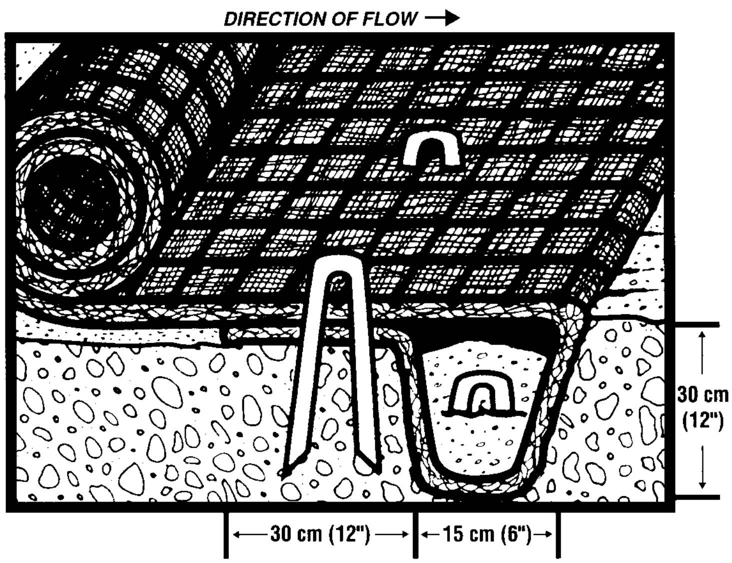


Figure 1-20 Initial Anchor Trench for Blankets and Mats

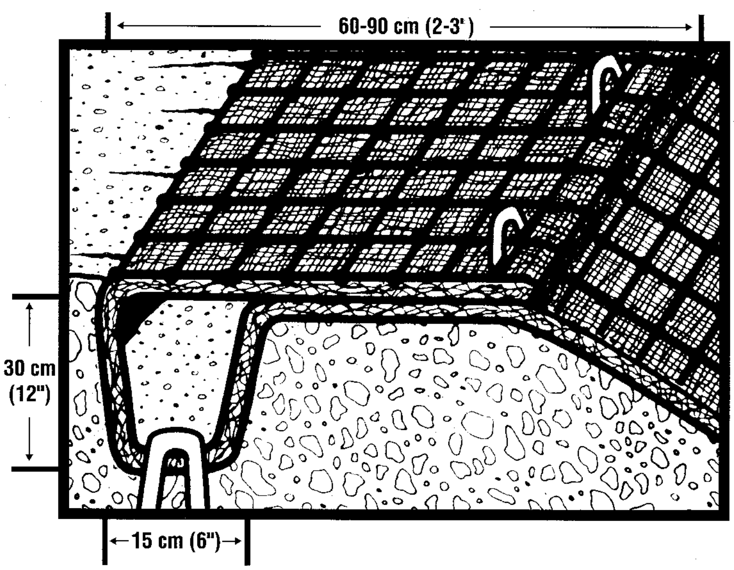


Figure 1-21 Terminal Anchor Trench for Blankets and Mats

Soil Preparation

(1) After site has been shaped and graded to approved design, prepare a friable seed bed relatively free from clods and rocks more than 1.5 inches in diameter and any foreign material that will prevent contact of the protective mat with the soil surface.

(2) Fertilize and seed in accordance with seeding or other type of planting plan.

(3) The protective matting can be laid over sprigged areas where small grass plants have been planted. Where ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Erosion Stops

(1) Erosion stops should extend beyond the channel liner to full design cross-section of the channel to check any rills that might form outside the channel lining.

(2) The trench may be dug with a spade or a mechanical trencher, making sure that the down slope face of the trench is flat; it should be uniform and perpendicular to line of flow to permit proper placement and stapling of the matting.

(3) The erosion stop should be deep enough to penetrate solid material or below level of ruling in sandy soils. In general, erosion stops will vary from 6 to 12 inches in depth.

(4) The erosion stop mat should be wide enough to allow a minimum of 2 inch turnover at bottom of trench for stapling, while maintaining the top edge flush with channel surface.

(5) Tamp backfill firmly and to a uniform gradient of channel.

Final Check:

- Make sure matting is uniformly in contact with the soil.
- All lap joints are secure.
- All staples are flush with the ground.
- All disturbed areas seeded.

Inspection and Maintenance Guidelines:

(1) Blankets and matting should be inspected weekly and after each rain event to locate and repair any damage. Apply new material if necessary to restore function.

1.3.12 Dust Control

The purpose of dust control is to prevent blowing and movement of dust from exposed soil surfaces, reduce on and off-site damage, health hazards and improve traffic safety. This practice is applicable to areas subject to dust blowing and movement where on and off-site damage is likely without treatment.

Construction activities inevitably result in the exposure and disturbance of soil. Fugitive dust is emitted both during the activities (i.e., excavation demolition, vehicle traffic, human activity) and as a result of wind erosion over the exposed earth surfaces. Large quantities of dust are typically generated in 'heavy' construction activities, such as road and street construction and subdivision, commercial or industrial development, which involve disturbance of significant areas of the soil surface. Research on construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction (VA Dept of Conservation, 1992). Earth moving activities comprise the major source of construction dust emissions, but traffic and general disturbance of the soil also generate significant dust emissions.

Temporary Methods:

(1) Vegetative Cover – See Section 1.3.8.

(2) Mulches – See Section 1.3.10 – Chemical mulch binders may be used to bind mulch material. Commercial binders should be used according to manufacturer's recommendations.

(3) Commercially available dust suppressors if applied in accordance with the manufacturers' directions

(4) Tillage – to roughen surface and bring clods to the surface. This is an emergency measure that should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows and similar plows are examples of equipment that may produce the desired effect.

(5) Irrigation – Site is sprinkled with water until the surface is moist. Repeat as needed. Irrigation can be particularly effective for controlling dust during trenching operations. A dedicated water truck placed next to the trencher and using a "pulse" fog pattern applied to the discharge belt can effectively control dust. This method is more effective than spraying the ground ahead of the trencher or the trench itself as it is being dug.

(6) Barriers – Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar materials can be used to control air currents and soil blowing.

Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

Permanent Methods:

(1) Permanent Vegetation – trees or large shrubs may afford valuable protection if left in place.

(2) Topsoil – Covering with less erosive soil material.

(3) Stone – Cover surface with crushed stone or coarse gravel.

Inspection and Maintenance Guidelines:

(1) When dust is evident during dry weather, reapply dust control BMPs.

1.4.3 Silt Fence

A silt fence is a barrier consisting of geotextile fabric supported by metal posts to prevent soil and sediment loss from a site. When properly used, silt fences can be highly effective at controlling sediment from disturbed areas. They cause runoff to pond, allowing heavier solids to settle out. If not properly installed, silt fences are not likely to be effective. A schematic illustration of a silt fence is shown in Figure 1-26.

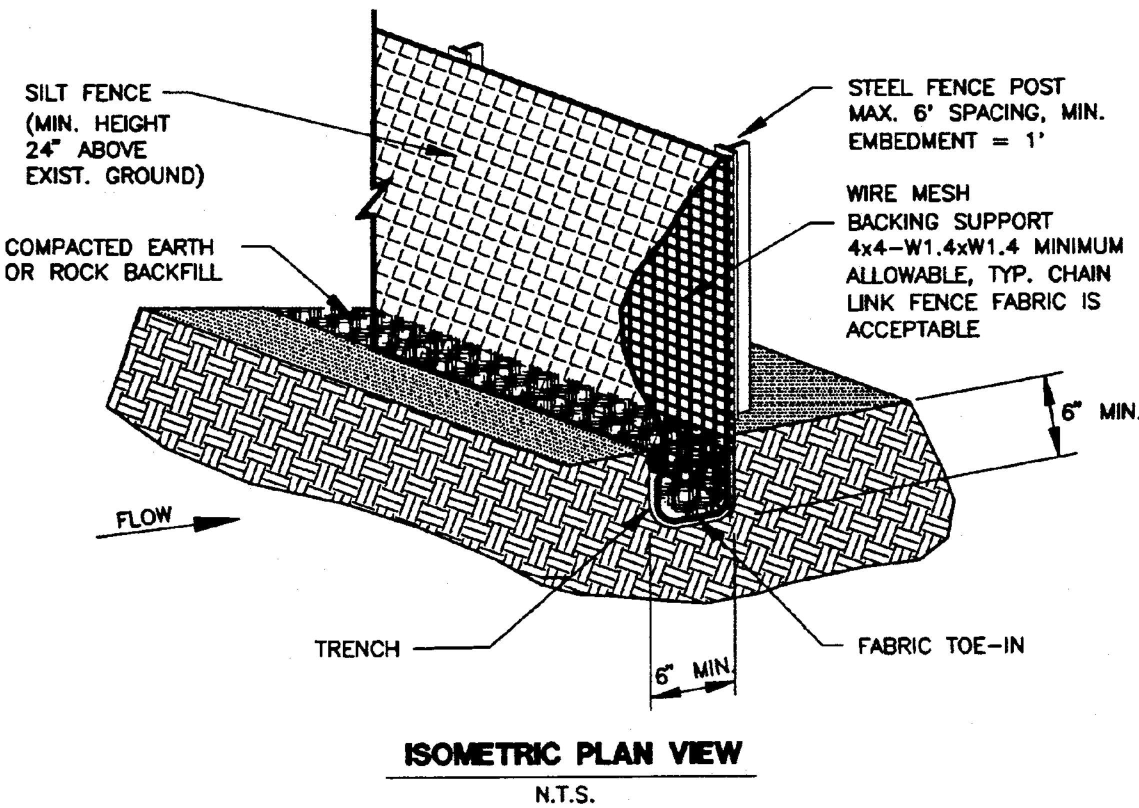


Figure 1-26 Schematic of a Silt Fence Installation (NCTCOG, 1993b)

The purpose of a silt fence is to intercept and detain water-borne sediment from unprotected areas of a limited extent. Silt fence is used during the period of construction near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. This fence should remain in place until the disturbed area is permanently stabilized. Silt fence should not be used where there is a concentration of water in a channel or drainage way. If concentrated flow occurs after installation, corrective action must be taken such as placing a rock berm in the areas of concentrated flow.

Silt fencing within the site may be temporarily moved during the day to allow construction activity provided it is replaced and properly anchored to the ground at the end of the day. Silt fences on the perimeter of the site or around drainage ways should not be moved at any time.

Materials:

(1) Silt fence material should be polypropylene, polyethylene or polyamide woven or nonwoven fabric. The fabric width should be 36 inches, with a minimum unit weight of 4.5 oz/yd, mullen burst strength exceeding 190 lb/in^2, ultraviolet stability exceeding 70%, and minimum apparent opening size of U.S. Sieve No. 30.

(2) Fence posts should be made of hot rolled steel, at least 4 feet long with Tee or Y-bar cross section, surface painted or galvanized, minimum nominal weight 1.25 lb/ft^2, and Brindell hardness exceeding 140.

(3) Woven wire backing to support the fabric should be galvanized 2” x 4” welded wire, 12 gauge minimum.

Installation:

(1) Steel posts, which support the silt fence, should be installed on a slight angle toward the anticipated runoff source. Post must be embedded a minimum of 1-foot deep and spaced not more than 8 feet on center. Where water concentrates, the maximum spacing should be 6 feet.

(2) Lay out fencing down-slope of disturbed area, following the contour as closely as possible. The fence should be sited so that the maximum drainage area is ¼ acre/100 feet of fence.

(3) The toe of the silt fence should be trenched in with a spade or mechanical trencher, so that the down-slope face of the trench is flat and perpendicular to the line of flow. Where fence cannot be trenched in (e.g., pavement or rock outcrop), weight fabric flap with 3 inches of pea gravel on uphill side to prevent flow from seeping under fence.

(4) The trench must be a minimum of 6 inches deep and 6 inches wide to allow for the silt fence fabric to be laid in the ground and backfilled with compacted material.

(5) Silt fence should be securely fastened to each steel support post or to woven wire, which is in turn attached to the steel fence post. There should be a 3-foot overlap, securely fastened where ends of fabric meet.

(6) Silt fence should be removed when the site is completely stabilized so as not to block or impede storm flow or drainage.

Common Trouble Points:

(1) Fence not installed along the contour causing water to concentrate and flow over the fence.

(2) Fabric not seated securely to ground (runoff passing under fence)

(3) Fence not installed perpendicular to flow line (runoff escaping around sides)

(4) Fence treating too large an area, or excessive channel flow (runoff overtops or collapses fence)

Inspection and Maintenance Guidelines:

(1) Inspect all fencing weekly, and after any rainfall.

(2) Remove sediment when buildup reaches 6 inches.

(3) Replace any torn fabric or install a second line of fencing parallel to the torn section.

(4) Replace or repair any sections crushed or collapsed in the course of construction activity. If a section of fence is obstructing vehicular access, consider relocating it to a spot where it will provide equal protection, but will not obstruct vehicles. A triangular filter dike may be preferable to a silt fence at common vehicle access points.

(5) When construction is complete, the sediment should be disposed of in a manner that will not cause additional siltation and the prior location of the silt fence should be revegetated. The fence itself should be disposed of in an approved landfill.

1.4.8 Check Dams

Check dams are small barriers consisting of rock or earthen berms placed across a drainage swale or ditch. They reduce the velocity of small concentrated flows, provide a limited barrier for sediment and help disperse concentrated flows, reducing potential erosion.

They are used primarily in long drainage swales or ditches in which permanent vegetation may not be established and erosive velocities are present. They are typically used in conjunction with other techniques such as inlet protection, riprap or other sediment reduction techniques. Check dams provide limited treatment. They are more useful in reducing flow to acceptable levels for other techniques (NCTCOG, 1993b).

Although check dams are effective in reducing flow velocity and thereby the potential for channel erosion, it is usually better to establish a protective vegetative lining before flow is confined or to install a structural channel lining. However, under circumstances where this is not feasible, check dams are useful.

Materials:

Although many different types of material can be used to create check dams, aggregate and riprap produce a more stable structure.

(1) If the drainage area is less than 2 acres, coarse aggregate alone can be used for the dam.

(2) For drainage areas between 2 and 10 acres, a combination of coarse aggregate and riprap as shown in Figure 1-31 should be used.

Guidelines for installation:

(1) The dam height should be between 18 and 36 inches.

(2) The center of the check dam should be at least 6 inches lower than the outer edges. Field experience has shown that many dams are not constructed to promote this "weir" effect. Stormwater flows are then forced to the stone-soil interface, thereby promoting scour at that point and subsequent failure of the structure to perform its intended function.

(3) The dam should be designed so that the 2-year, 24-hour storm can pass the dam without causing excessive upstream flooding.

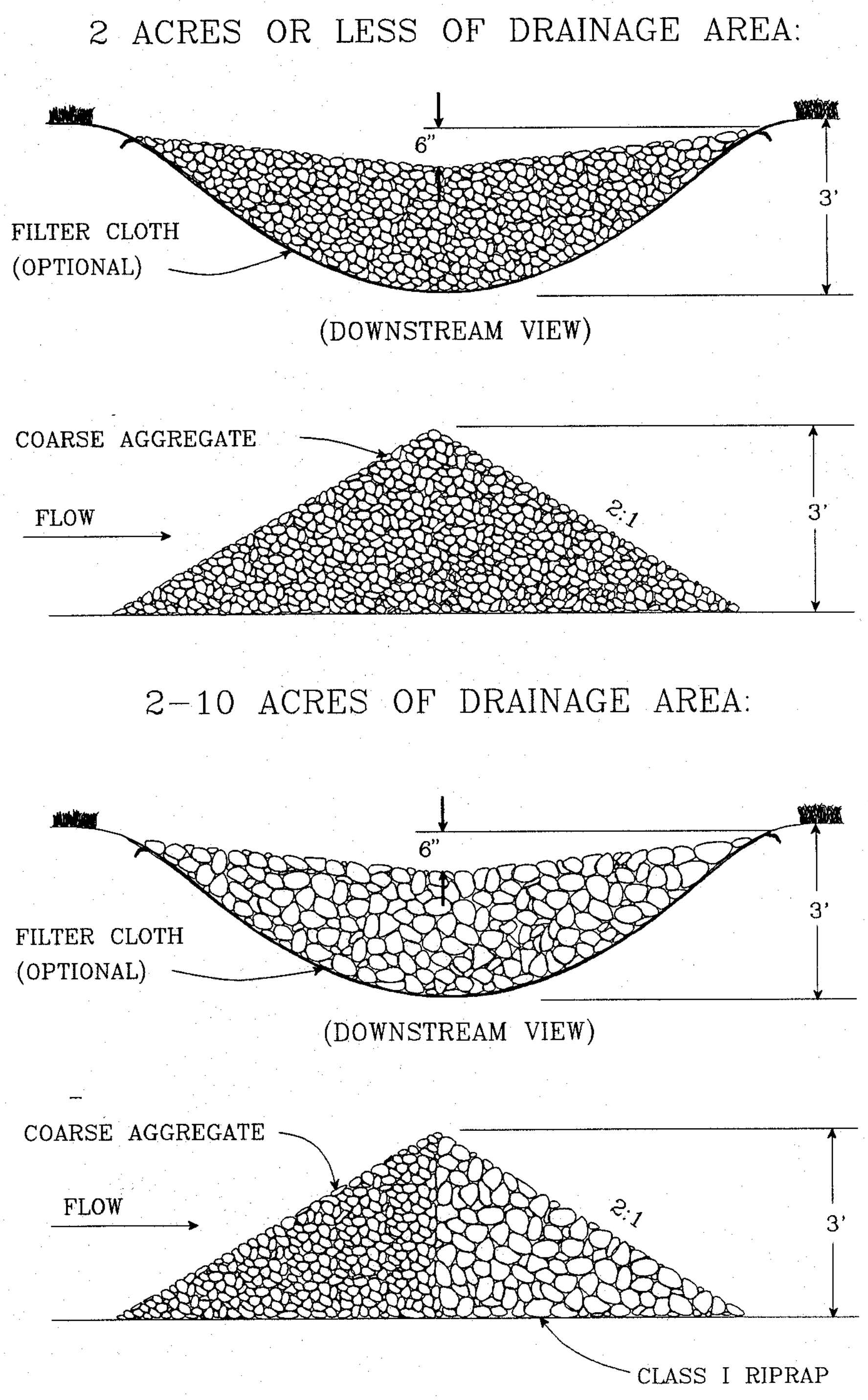


Figure 1-31 Diagram of a Rock Check Dam (VA Dept. of Conservation, 1992)

(4) For added stability, the base of the check dam can be keyed into the soil approximately 6 inches.

(5) The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

(6) Stone should be placed according to the configuration in Figure 1-31. Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to insure that the center of the dam is lower than the edges.

(7) Filter cloth may be used under the stone to provide a stable foundation and to facilitate the removal of the stone.

Common Trouble Points:

(1) Check dams installed in grass-lined channels may kill the vegetative lining if submergence after rains is too long and/or silting is excessive.

(2) If check dams are used in grass-lined channels that will be mowed, care should be taken to remove all the stone when the dam is removed. Stones often wash downstream and can damage mowing equipment and present a safety hazard.

Inspection and Maintenance Guidelines:

(1) Check dams should be inspected and checked for sediment accumulation after each runoff-producing storm event.

(2) Sediment should be removed when it reaches one half of the original height of the measure.

(3) Regular inspections should be made to insure that the center of the dam is lower than the edges. Erosion caused by high flows around the edges of the dam should be corrected immediately.

1.4.13 Sediment Basins

The purpose of a sediment basin is to intercept sediment-laden runoff and trap the sediment in order to protect drainage ways, properties and rights of way below the sediment basin from sedimentation. A sediment basin is usually installed at points of discharge from disturbed areas. The drainage area for a sediment basin is recommended to be less than 100 acres.

Sediment basins are effective for capturing and slowly releasing the runoff from larger disturbed areas thereby allowing sedimentation to take place. A sediment basin can be created where a permanent pond BMP is being constructed. Guidelines for construction of the permanent BMP should be followed, but revegetation, placement of underdrain piping, and installation of sand or other filter media should not be carried out until the site construction phase is complete. A schematic of a sediment basin is shown in Figure 1-41.

Materials:

(1) Riser should be corrugated metal or reinforced concrete pipe or box and should have watertight fittings or end to end connections of sections.

(2) An outlet pipe of corrugated metal or reinforced concrete should be attached to the riser and should have positive flow to a stabilized outlet on the downstream side of the embankment.

(3) An anti-vortex device and rubbish screen should be attached to the top of the riser and should be made of polyvinyl chloride or corrugated metal.

Basin Design and Construction:

(1) For common drainage locations that serve an area with ten or more acres disturbed at one time, a sediment basin should provide storage for a volume of runoff from a two-year, 24-hour storm from each disturbed acre drained. The rainfall depths for the design storm are shown for each county in Table 1-6.

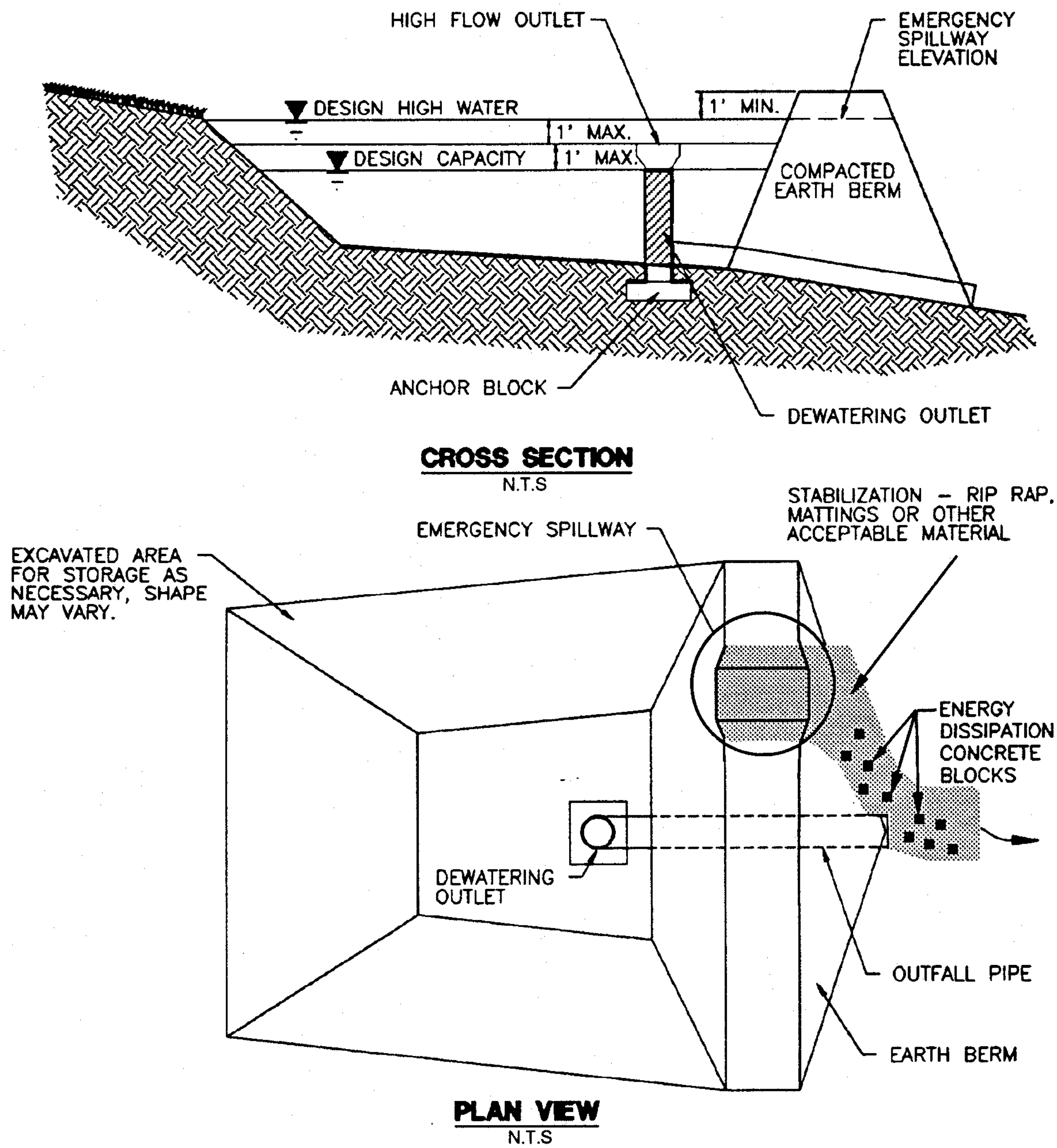


Figure 1-41 Schematic of a Sediment Basin (NCTCOG, 1993)

Table 1-6 Design Storm Depth by County (Asquith and Roussel, 2004)

County	2-year, 24-hour Storm Depth (in)
Bexar	3.8
Comal	3.7
Hays	3.5
Kinney	3.2
Medina	3.4
Travis	3.4
Uvalde	3.3
Williamson	3.4

(2) The basin length to width ratio should be at least 2:1 to improve trapping efficiency. The shape may be attained by excavation or the use of baffles. The lengths should be measured at the elevation of the riser de-watering hole.

(3) Place fill material in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the material. Compact each layer to 95 percent standard proctor density. Do not place material on surfaces that are muddy or frozen. Side slopes for the embankment should be 3:1 (H:V).

(4) An emergency spillway should be installed adjacent to the embankment on undisturbed soil and should be sized to carry the full amount of flow generated by a 10-year, 3-hour storm with 1 foot of freeboard less the amount which can be carried by the principal outlet control device.

(5) The emergency spillway should be lined with riprap as should the swale leading from the spillway to the normal watercourse at the base of the embankment.

(6) The principal outlet control device should consist of a rigid vertically oriented pipe or box of corrugated metal or reinforced concrete. Attached to this structure should be a horizontal pipe, which should extend through the embankment to the toe of fill to provide a de-watering outlet for the basin.

(7) An anti-vortex device should be attached to the inlet portion of the principal outlet control device to serve as a rubbish screen.

(8) A concrete base should be used to anchor the principal outlet control device and should be sized to provide a safety factor of 1.5 (downward forces = 1.5 buoyant forces).

(9) The basin should include a permanent stake to indicate the sediment level in the pool and marked to indicate when the sediment occupies 50% of the basin volume (not the top of the stake).

(10) The top of the riser pipe should remain open and be guarded with a trash rack and anti-vortex device. The top of the riser should be 12 inches below the elevation of the emergency spillway. The riser should be sized to convey the runoff from the 2-year, 3-hour storm when the water surface is at the emergency spillway elevation. For basins with no spillway the riser must be sized to convey the runoff from the 10-yr, 3-hour storm.

(11) Anti-seep collars should be included when soil conditions or length of service make piping through the backfill a possibility.

(12) The 48-hour drawdown time will be achieved by using a riser pipe perforated at the point measured from the bottom of the riser pipe equal to ½ the volume of the basin. This is the maximum sediment storage elevation. The size of the perforation may be calculated as follows:

$$A_o = \frac{A_s \times \sqrt{2h}}{C_d \times 980{,}000}$$

Where:

A_o = Area of the de-watering hole, ft^2
A_s = Surface area of the basin, ft^2
C_d = Coefficient of contraction, approximately 0.6
h = head of water above the hole, ft

Perforating the riser with multiple holes with a combined surface area equal to A_o is acceptable.

Common Trouble Points:

(1) Storm events that exceed the design storm event can cause damage to the spillway structure of the basin and may cause adverse impacts downstream.

(2) Piping (flow occurring in the fill material) around outlet pipe can cause failure of the embankment.

Inspection and Maintenance Guidelines:

(1) Inspection should be made weekly and after each rainfall. Check the embankment, spillways, and outlet for erosion damage, and inspect the embankment for piping and settlement. Repair should be made promptly as needed by the contractor.

(2) Trash and other debris should be removed after each rainfall to prevent clogging of the outlet structure.

(3) Accumulated silt should be removed and the basin should be re-graded to its original dimensions at such point that the capacity of the impoundment has been reduced to 75% of its original storage capacity.

(4) The removed sediment should be stockpiled or redistributed in areas that are protected from erosion.

1.4.14 Fiber Rolls

A fiber roll consists of straw, coconut fibers, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles

Limitations:

- Fiber rolls are not effective unless trenched
- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Material:

(1) Core material: Core material should be biodegradable or recyclable. Material may be compost, mulch, aspen wood fibers, chipped site vegetation, agricultural rice or wheat straw, coconut fiber, 100% recyclable fibers, or similar materials.

(2) Containment Mesh: Containment mesh should be 100% biodegradable, photodegradable or recyclable such as burlap, twine, UV photodegradable plastic, polyester, or similar material. When the fiber role will remain in place as part of a vegetative system use biodegradable or photodegradable mesh. For temporary installation recyclable mesh is recommended.

Implementation:

(1) Locate fiber rolls on level contours spaced as follows:

Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.

Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).

Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).

(2) Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.

(3) Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.

(4) Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.

(5) Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.

(6) If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Inspection and Maintenance Guidelines:

(1) Inspect prior to forecast rain, daily during extended rain events, after rain events, and weekly.

(2) Repair of replace split, torn, unraveling, or slumping fiber rolls.

(3) If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates behind the role must be periodically removed tin order to maintain its effectiveness. Sediment should be removed when the accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.

APPENDIX D – PRE-DEVELOPMENT MODEL SUMMARY

Existing Conditions

Hydraulic Model Properties

Title	City of Victoria Landfill Expansion
Engineer	Jon Parker
Company	Burns & McDonnell
Date	8/12/2021
Notes	Existing Conditions

Scenario Summary

ID	1
Label	Base
Notes	
Active Topology	Base Active Topology
User Data Extensions	Base User Data Extensions
Physical	Base Physical
Boundary Condition	Base Boundary Condition
Initial Settings	Base Initial Settings
Hydrology	Base Hydrology
Output	Base Output
Infiltration and Inflow	Base Infiltration and Inflow
Rainfall Runoff	Base Rainfall Runoff
Water Quality	Base Water Quality
Sanitary Loading	Base Sanitary Loading
Headloss	Base Headloss
Operational	Base Operational
Design	Base Design
System Flows	Base System Flows
SCADA	Base SCADA
Solver Calculation Options	Base Calculation Options

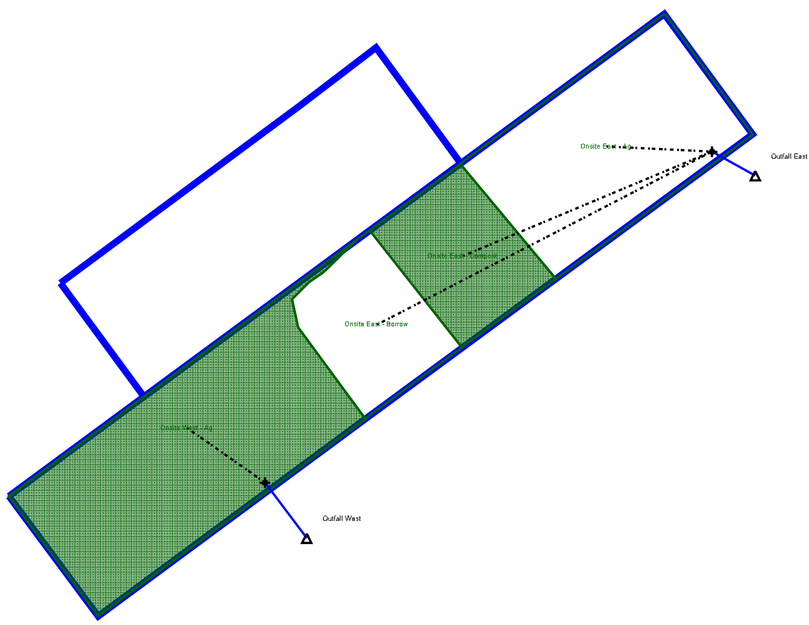
Hydraulic Summary

Active Numerical Solver	Implicit (SewerGEMS Dynamic Wave)	Output Increment	0.050
Simulation Start Date	1/1/2000	Calculation Time Step	0.025
Simulation Start Time	12:00 AM	Receding Limb Multiplier	1.000
Duration	24.000	Minimum Tc	0.083

Existing Conditions

Network Inventory			
Conduit	0	Catchment	4
Lateral	0	Low Impact Development	0
Channel	2	Pond	0
Gutter	0	Pond Outlet Structure	0
Pressure Pipe	0	Headwall	0
Catch Basin	0	Pump	0
Manhole	0	Wet Well	0
Property Connection	0	Pressure Junction	0
Tap	0	SCADA Element	0
Transition	0	Pump Station	0
Cross Section	2	Variable Speed Pump Battery	0
Outfall	2	Air Valve	0

Existing - Time: 0.00 hours



Existing Conditions

Catchment Table - Time: 24.00 hours

ID	Label	Runoff Method	SCS CN	Tc Data Collection	Loss Method	Unit Hydrograph Method	Area (Unified) (acres)	Flow (Maximum) (cfs)	Volume (Total Runoff) (gal)
122	Onsite West - Ag	Unit Hydrograph	89.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph	146.651	352.25	33,368,509.8
124	Onsite East - Borrow	Unit Hydrograph	89.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph	48.903	118.50	11,127,579.2
140	Onsite East - Compost	Unit Hydrograph	94.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph	49.554	128.45	12,102,590.1
141	Onsite East - Ag	Unit Hydrograph	90.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph	108.065	264.21	24,951,219.9

Existing Conditions

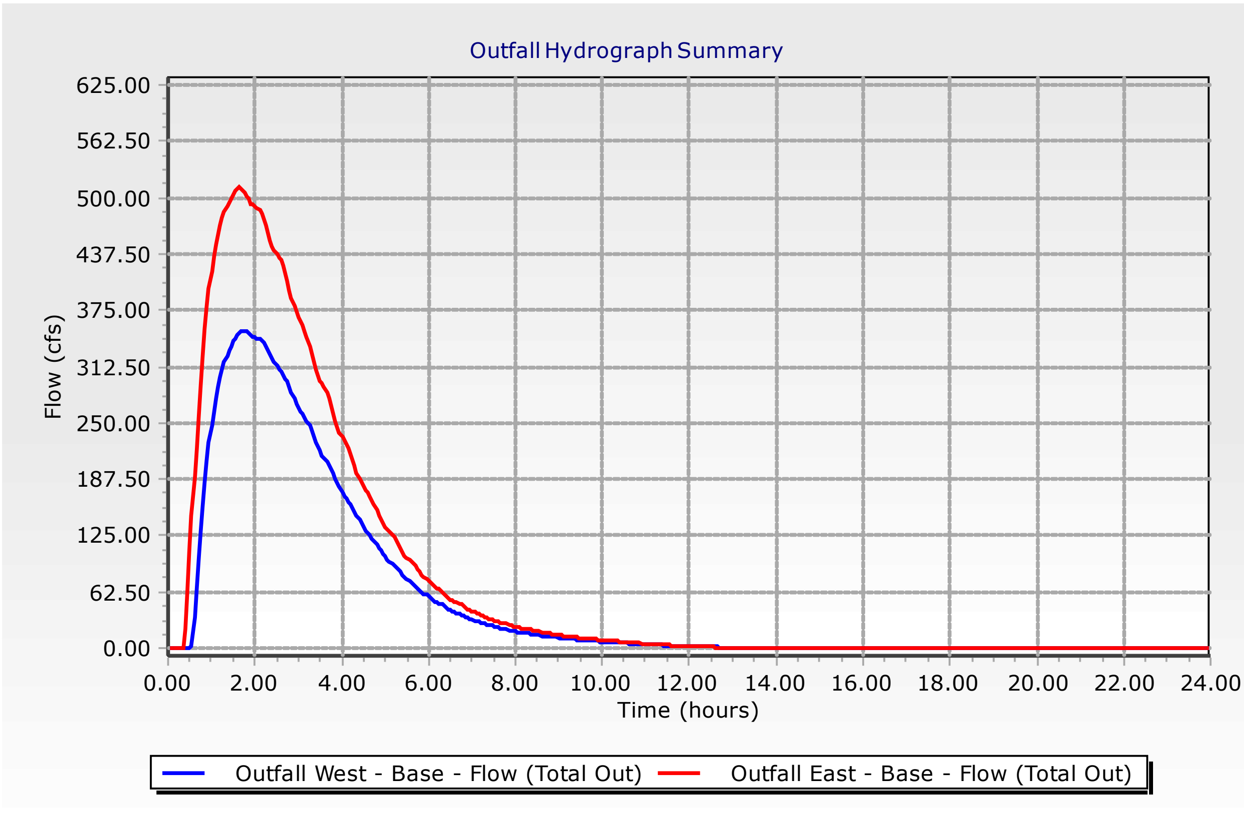
Outfall Table - Time: 24.00 hours

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Boundary Element
135	Outfall West	60.00	True	56.50	Free Outfall	<None>
138	Outfall East	60.00	True	56.50	Free Outfall	<None>

Elevation (User Defined Tailwater) (ft)	Elevation-Flow Curve	Time-Elevation Curve	Cyclic Time-Elevation Curve	Tidal Gate?	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	56.54	0.07
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	56.54	0.30

Notes

Existing Conditions



APPENDIX E – POST-DEVELOPMENT MODEL SUMMARY

Proposed Condition

Hydraulic Model Properties

Title	City of Victoria Landfill Expansion
Engineer	Jon Parker
Company	Burns & McDonnell
Date	8/12/2021
Notes	

Proposed Condition

Channel Table - Time: 24.00 hours

ID	Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Has User Defined Length?
63	CH-B(1)	WCD_3	62.20	WC_4	61.20	False
76	CH-2		61.00	CS-13	60.00	False
122	CH-A	WC_2	60.90	O-A	60.10	False
164	CH-D(2)	SC_1	61.00	SC_2	60.10	False
174	CH-D(1)	CS-22	61.90	SC_1	61.00	False
259	CH-E(3)	CS-34	59.25	H-9	59.00	False
266	CH-F(1)	CS-37	64.00	EC_2	61.50	False
267	CH-F(2)	EC_2	61.50	H-11	59.00	False
269	CH-D(3)	SC_2	60.10	H-3	59.00	False
273	CH-D(4)	H-4	58.50	O-D	57.00	False
274	CH-E(4)	H-10	58.50	O-E	57.00	False
275	CH-F(3)	H-12	58.50	O-F	57.00	False
287	CH-B(2)	WC_4	61.20	CS-38	60.28	False
357	CH-E(2)	CS-34	59.25	CS-47	65.00	False
359	CH-E(1)	CS-48	65.00	CS-34	59.25	False
404	CH-B(5)	CS-28	59.90	CS-51	59.90	False
405	CH-B(6)	CS-51	59.90	H-5	59.50	False
408	CH-B(3)	CS-38	60.28	CS-52	60.28	False
409	CH-B(4)	CS-52	60.28	CS-28	59.90	False
415	CH-C(1)	CS-53	65.00	CS-54	62.00	False
416	CH-C(2)	CS-54	62.00	H-5	59.50	False

Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Flow (Middle) (cfs)	Depth (Middle) (ft)	Area (Full Flow) (ft²)	Flow (Maximum) (cfs)
0.0	2,121.8	0.000	0.03	0.11	(N/A)	72.42
0.0	2,658.3	0.000	(N/A)	(N/A)	(N/A)	(N/A)
0.0	1,030.6	0.001	0.03	0.03	(N/A)	53.75
0.0	1,805.5	0.000	0.05	0.06	(N/A)	141.09
0.0	1,792.7	0.001	0.01	0.02	(N/A)	72.75
0.0	24.1	0.010	0.00	0.02	(N/A)	53.50
0.0	1,576.3	0.002	0.01	0.02	(N/A)	13.16
0.0	1,168.1	0.002	0.03	0.04	(N/A)	73.36
0.0	1,137.8	0.001	0.07	0.06	(N/A)	202.65
0.0	17.6	0.085	0.09	0.01	(N/A)	202.05
0.0	10.1	0.149	0.01	0.01	(N/A)	53.49
0.0	11.0	0.136	0.06	0.02	(N/A)	72.97
0.0	1,795.9	0.001	0.06	0.11	(N/A)	157.40
0.0	783.6	-0.007	0.00	0.00	(N/A)	0.16
0.0	643.2	0.009	0.00	0.00	(N/A)	0.53
0.0	3.7	0.000	0.03	0.11	(N/A)	167.71
0.0	757.7	0.001	0.04	0.11	(N/A)	141.22
0.0	3.7	0.000	0.04	0.11	(N/A)	156.98
0.0	732.4	0.001	0.02	0.11	(N/A)	107.85
0.0	1,808.6	0.002	0.00	0.01	(N/A)	8.21
0.0	20.2	0.124	0.00	0.00	(N/A)	8.17

Proposed Condition

Channel Table - Time: 24.00 hours

Velocity (Maximum Calculated) (ft/s)
0.97
(N/A)
2.09
1.61
0.90
1.02
1.31
1.95
2.08
5.48
3.63
2.90
2.25
0.27
0.23
2.88
2.37
2.56
1.79
1.56
0.46

Proposed Condition
Conduit Table - Time: 24.00 hours

ID	Label	Start Node	Set Invert to Start?	Invert (Start) (ft)	Stop Node	Set Invert to Stop?
206	CO-D	H-3	True	59.00	H-4	True
226	CO-B3	H-5	True	59.50	O-West	True
258	CO-E	H-9	True	59.00	H-10	True
262	CO-F	H-11	True	59.00	H-12	True
354	CO-East	POS-6	False	57.00	O-East	True
406	CO-B2	CS-51	True	59.90	O-B(2)	True
410	CO-B1	CS-52	True	60.28	O-B(1)	True
423	CO-19	POS-5	False	59.00	O-West	True

Invert (Stop) (ft)	Has User Defined Length?	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)	Section Type	Diameter (in)
58.50	False	0.0	88.3	0.006	Circle	60.0
58.70	False	0.0	57.3	0.014	Circle	48.0
58.50	False	0.0	65.6	0.008	Circle	48.0
58.50	False	0.0	58.3	0.009	Circle	30.0
56.50	False	0.0	104.0	0.005	Trapezoidal Channel	(N/A)
59.25	False	0.0	96.4	0.007	Circle	24.0
59.25	False	0.0	96.9	0.011	Circle	24.0
58.70	False	0.0	132.6	0.002	Circle	15.0

Manning's n	Flow (Middle) (cfs)	Velocity (ft/s)	Depth (Middle) (ft)	Capacity (Full Flow) (cfs)	Flow / Capacity (Design) (%)	Depth/Rise (%)
0.013	0.10	0.64	0.09	392.04	0.0	1.8
0.013	0.08	0.59	0.14	169.75	0.0	3.5
0.013	0.01	0.58	0.04	125.38	0.0	1.0
0.013	0.07	1.05	0.05	75.95	0.1	1.8
0.030	2.27	1.00	0.18	789.63	0.3	4.0
0.013	0.00	0.00	0.29	18.58	0.0	14.6
0.013	0.00	0.00	0.29	46.62	0.0	14.6
0.013	1.66	5.77	0.36	3.07	54.1	28.5

Notes

Proposed Condition

Combined Pipe/Node Report - Time: 24.00 hours

Label	Start Node	Stop Node	Branch ID	GVFConduitResults_BranchElementID	Length (Unified) (ft)	GVFConduitResults_UpstreamInletC
CO-D	H-3	H-4	(N/A)		88.3	
CO-B3	H-5	O-West	(N/A)		57.3	
CO-E	H-9	H-10	(N/A)		65.6	
CO-F	H-11	H-12	(N/A)		58.3	
CO-East	POS-6	O-East	(N/A)		104.0	
CO-B2	CS-51	O-B(2)	(N/A)		96.4	
CO-B1	CS-52	O-B(1)	(N/A)		96.9	
CO-19	POS-5	O-West	(N/A)		132.6	

System Intensity (in/h)	GVFConduitResults_UpstreamInletDrainageArea	GVFConduitResults_TotalRationalFlowToInlet	System CA (acres)	System Intensity (in/h)	System Rational Flow (cfs)	Rise (Unified) (ft)
(N/A)			(N/A)	(N/A)	(N/A)	5.00
(N/A)			(N/A)	(N/A)	(N/A)	4.00
(N/A)			(N/A)	(N/A)	(N/A)	4.00
(N/A)			(N/A)	(N/A)	(N/A)	2.50
(N/A)			(N/A)	(N/A)	(N/A)	4.50
(N/A)			(N/A)	(N/A)	(N/A)	2.00
(N/A)			(N/A)	(N/A)	(N/A)	2.00
(N/A)			(N/A)	(N/A)	(N/A)	1.25

Capacity (Full Flow) (cfs)	Velocity (ft/s)	Invert (Start) (ft)	Invert (Stop) (ft)	Slope (Calculated) (ft/ft)	Notes
392.04	0.64	59.00	58.50	0.006	
169.75	0.59	59.50	58.70	0.014	
125.38	0.58	59.00	58.50	0.008	
75.95	1.05	59.00	58.50	0.009	
789.63	1.00	57.00	56.50	0.005	
18.58	0.00	59.90	59.25	0.007	
46.62	0.00	60.28	59.25	0.011	
3.07	5.77	59.00	58.70	0.002	

Proposed Condition

Outfall Table - Time: 24.00 hours

ID	Label	Elevation (Ground) (ft)	Set Rim to Ground Elevation?	Elevation (Invert) (ft)	Boundary Condition Type	Boundary Element
116	O-A	66.40	True	60.10	Free Outfall	<None>
270	O-F	61.00	True	57.00	Boundary Element	East Pond
271	O-E	61.00	True	57.00	Boundary Element	East Pond
272	O-D	61.00	True	57.00	Boundary Element	East Pond
294	O-B(1)	61.00	True	59.25	Boundary Element	West Pond
297	O-B(2)	61.00	True	59.25	Boundary Element	West Pond
323	O-West	61.25	True	58.70	Free Outfall	<None>
353	O-East	61.00	True	56.50	Free Outfall	<None>

Elevation (User Defined Tailwater) (ft)	Elevation-Flow Curve	Time-Elevation Curve	Cyclic Time-Elevation Curve	Tidal Gate?	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	60.14	0.01
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	57.32	0.06
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	57.32	0.01
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	57.32	0.09
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	59.71	-0.02
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	59.71	-0.03
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	58.84	1.75
0.00	<Collection: 0 items>	<Collection: 0 items>	<Collection: 0 items>	False	56.61	2.30

Notes

Proposed Condition

Cross Section Table - Time: 0.00 hours

ID	Label	Cross Section Type	Irregular Channel Section	Elevation (Invert) (ft)	Bottom Width (ft)	Height (ft)
41	WC_2	User Defined	<Collection: 0 items>	60.90	11.0	5.50
43	WCD_3	User Defined	<Collection: 0 items>	62.20	12.0	4.20
60	WC_4	User Defined	<Collection: 0 items>	61.20	12.0	5.20
72		User Defined	<Collection: 0 items>	61.00	10.0	5.40
73	CS-13	User Defined	<Collection: 0 items>	60.00	10.0	6.40
93	EC_2	User Defined	<Collection: 0 items>	61.50	5.0	4.90
96	SC_1	User Defined	<Collection: 0 items>	61.00	10.0	5.40
97	SC_2	User Defined	<Collection: 0 items>	60.10	10.0	6.30
106	CS-22	User Defined	<Collection: 0 items>	61.90	10.0	4.50
159	CS-28	User Defined	<Collection: 0 items>	59.90	12.0	5.10
228	CS-34	User Defined	<Collection: 0 items>	59.25	5.0	7.15
265	CS-37	User Defined	<Collection: 0 items>	64.00	3.0	2.40
286	CS-38	User Defined	<Collection: 0 items>	60.28	12.0	6.12
356	CS-47	User Defined	<Collection: 0 items>	65.00	5.0	1.40
358	CS-48	User Defined	<Collection: 0 items>	65.00	5.0	1.40
403	CS-51	User Defined	<Collection: 0 items>	59.90	12.0	5.10
407	CS-52	User Defined	<Collection: 0 items>	60.28	12.0	6.12
412	CS-53	User Defined	<Collection: 0 items>	65.00	0.0	1.40
414	CS-54	User Defined	<Collection: 0 items>	62.00	5.0	2.40

Slope (Left Side) (H:V)	Slope (Right Side) (H:V)	Manning's n	Hydraulic Grade (ft)	Notes
2.000	2.000	0.030	60.90	
3.000	3.000	0.030	62.20	
3.000	3.000	0.030	61.20	
3.000	3.000	0.030	(N/A)	
3.000	3.000	0.030	(N/A)	
3.000	3.000	0.030	61.50	
3.000	3.000	0.030	61.00	
3.000	3.000	0.030	60.10	

Proposed Condition

Cross Section Table - Time: 0.00 hours

Slope (Left Side) (H:V)	Slope (Right Side) (H:V)	Manning's n	Hydraulic Grade (ft)	Notes
3.000	3.000	0.030	61.90	
3.000	3.000	0.030	59.90	
3.000	3.000	0.030	59.25	
3.000	3.000	0.030	64.00	
3.000	3.000	0.030	60.28	
3.000	3.000	0.030	65.00	
3.000	3.000	0.030	65.00	
3.000	3.000	0.030	59.90	
3.000	3.000	0.030	60.28	
3.000	3.000	0.030	65.00	
3.000	3.000	0.030	62.00	

Proposed Condition

Catchment Table - Time: 24.00 hours

ID	Label	Runoff Method	SCS CN	Tc Data Collection	Loss Method	Unit Hydrograph Method
31	LD-1	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
32	LD-9	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
33	LD-8	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
34	LD-7	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
35	LD-6	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
36	LD-5	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
37	LD-4	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
38	LD-3	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
39	LD-2	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
82	Existing Landfill (Not Active)	Unit Hydrograph	84.000	<Collection: 1 item>	SCS CN	SCS Unit Hydrograph
253	East Undisturbed - Ag	Unit Hydrograph	89.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
254	West Open Area	Unit Hydrograph	77.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
276	PD-D1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
277	PD-D2	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
279	PD-D3	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
280	PD-E1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
281	PD-F1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
282	PD-B1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
283	PD-B2	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
284	PD-B3	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
350	East Pond	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
365	West Pond	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
417	PD-C1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
424	Drainage Ditch DA 1	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph

Proposed Condition
Catchment Table - Time: 24.00 hours

ID	Label	Runoff Method	SCS CN	Tc Data Collection	Loss Method	Unit Hydrograph Method
425	East Pond Additional Area	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
426	Drainage Ditch DA 2	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph
427	South Additonal Area	Unit Hydrograph	84.000	<Collection: 0 items>	SCS CN	SCS Unit Hydrograph

Area (Unified) (acres)	Flow (Maximum) (cfs)	Volume (Total Runoff) (gal)
23.786	53.22	5,010,287.3
32.111	72.01	6,763,339.5
29.370	65.70	6,186,546.6
25.860	57.85	5,447,194.5
21.180	47.50	4,460,947.9
27.680	61.39	5,830,264.4
24.050	53.91	5,065,590.8
30.470	68.50	6,417,919.1
34.290	76.38	7,222,875.3
101.848	(N/A)	(N/A)
60.102	144.78	13,675,421.7
17.004	33.39	3,173,154.0
1.750	3.99	368,632.5
3.439	7.84	724,353.7
4.050	9.23	852,966.2
2.730	5.98	574,922.8
5.889	13.38	1,240,449.6
2.941	6.47	619,439.4
5.243	11.54	1,104,438.8
4.507	9.73	949,300.3
10.279	23.77	2,164,907.2
10.467	24.20	2,204,509.1
3.633	8.27	765,219.7
1.212	2.30	255,347.5
1.049	2.35	220,944.6
3.102	7.17	653,356.0
6.443	14.90	1,357,078.4

Proposed Condition
Pond Table - Time: 24.00 hours

ID	Label	Volume Type	Initial Elevation Type	Elevation (Initial) (ft)	Hydraulic Grade (ft)	Storage (Maximum) (gal)
364	East Pond	Elevation-Area	Invert	0.00	57.32	7,114,644.1
366	West Pond	Elevation-Area	Invert	0.00	59.71	3,501,300.1

Flow (Total In) (cfs)	Flow (Total Out) (cfs)	Is Overflowing?	Notes	Flow (Out to Links Maximum) (cfs)	Flow (Total In Maximum) (cfs)
0.17	2.27	False		326.11	348.92
-0.05	1.71	False		87.74	105.28

Flow (Overflow Maximum) (cfs)
0.00
0.00

Proposed Condition

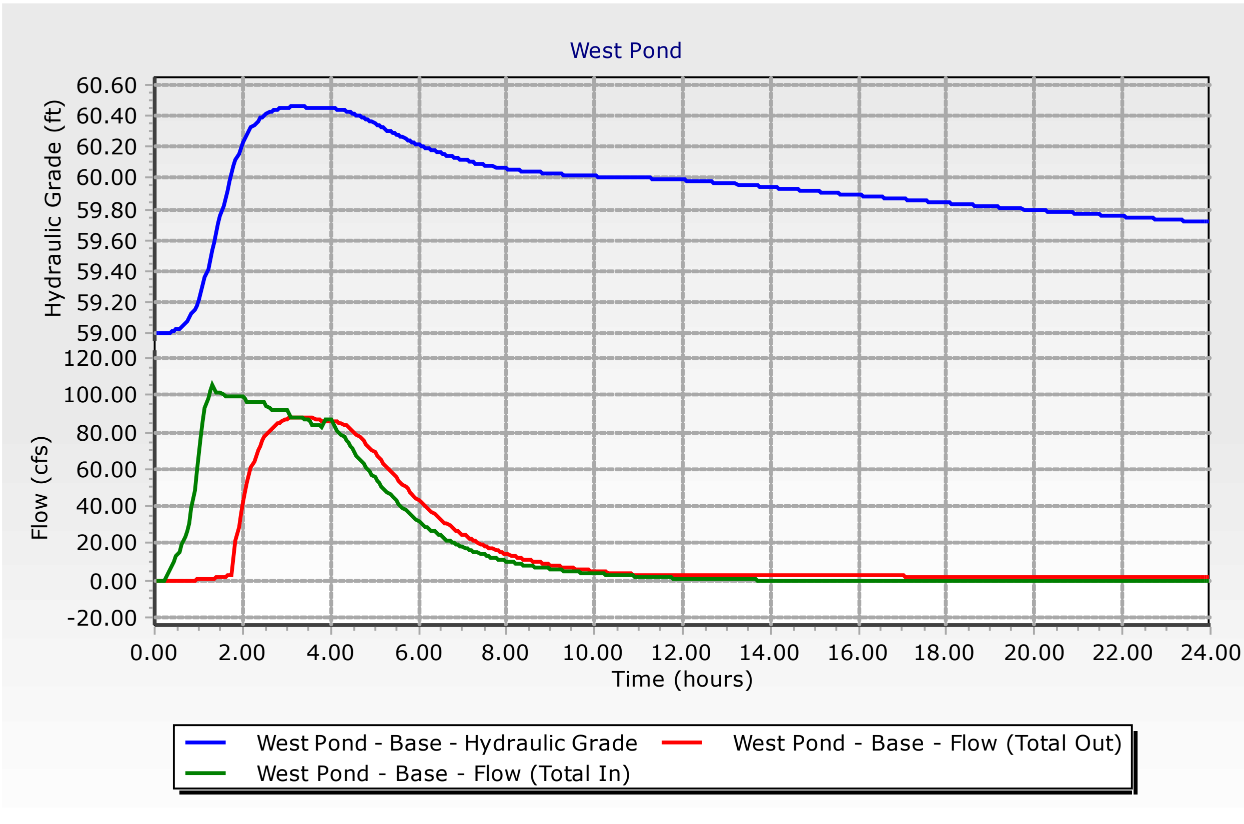
Pond Outlet Structure Table - Time: 24.00 hours

ID	Label	Upstream Pond	Has Control Structure?	Composite Outlet Structure	Notes
318	POS-5	West Pond	Yes	West pond	
341	POS-6	East Pond	Yes	East Pond	

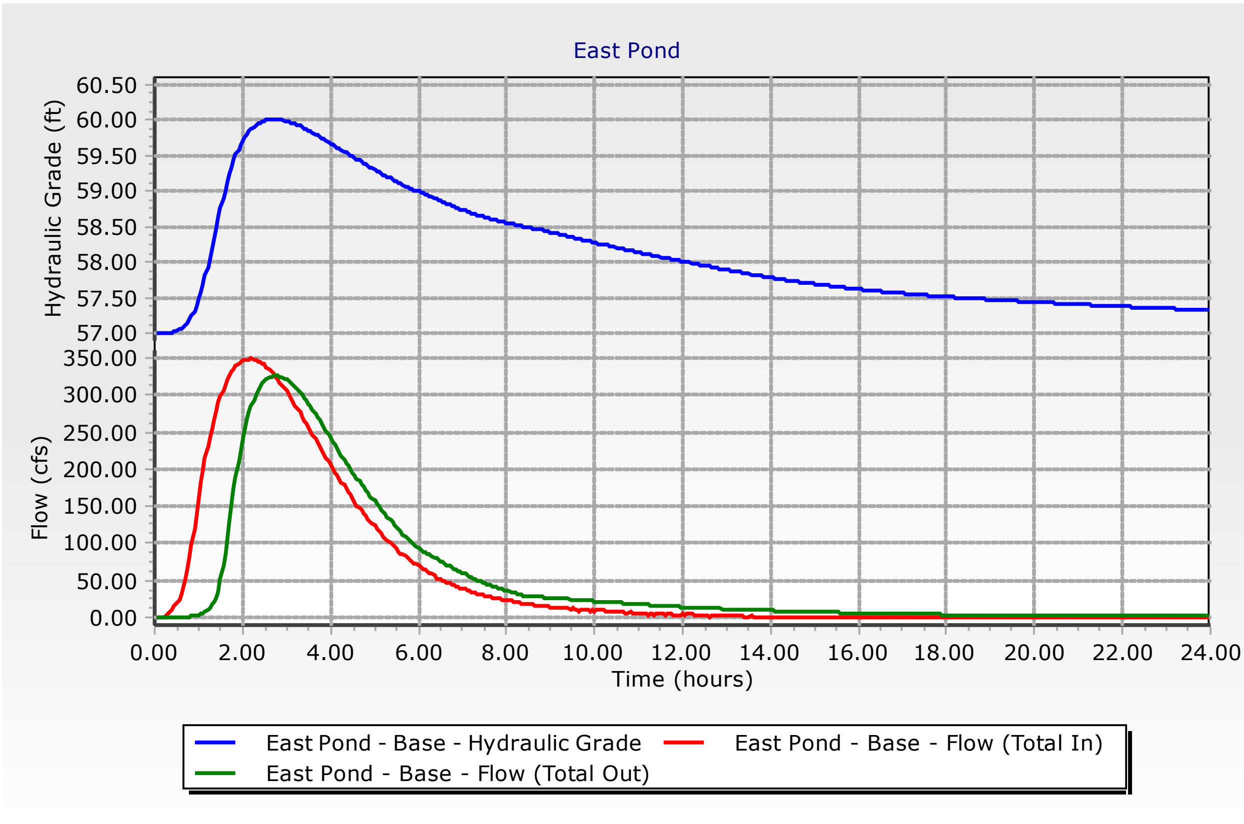
Proposed Condition
Headwall Table - Time: 24.00 hours

ID	Label	Has Cross Section?	Inlet Description	Culvert Barrel Shape	Upstream Pond	Boundary Condition Type	Network Boundary Type	CulvertInletEquationForm	InletChart	Physical_CulvertC	Physical_CulvertK	Physical_CulvertKe	Physical_CulvertKr	Physical_CulvertM	Physical_CulvertSlopeCorrection	Flow (Total Out) (cfs)	Notes
199	H-3	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.10	
202	H-4	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.09	
221	H-5	True	<None>	(N/A)	<None>	Free Outfall	(N/A)									0.08	
256	H-9	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.01	
257	H-10	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.01	
263	H-11	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.07	
264	H-12	True	Concrete - Square edge w/headwall	(N/A)	<None>	Free Outfall	(N/A)									0.06	

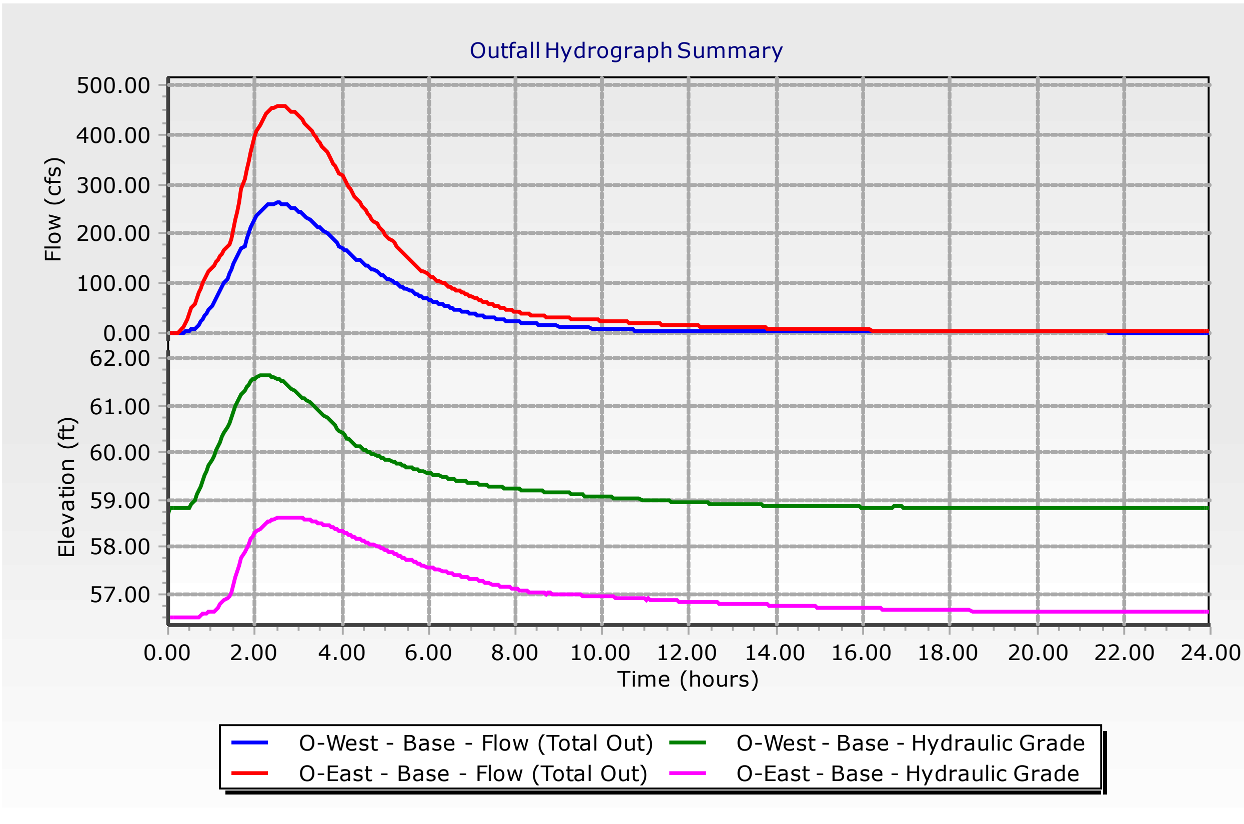
Proposed Condition



Proposed Condition



Proposed Condition



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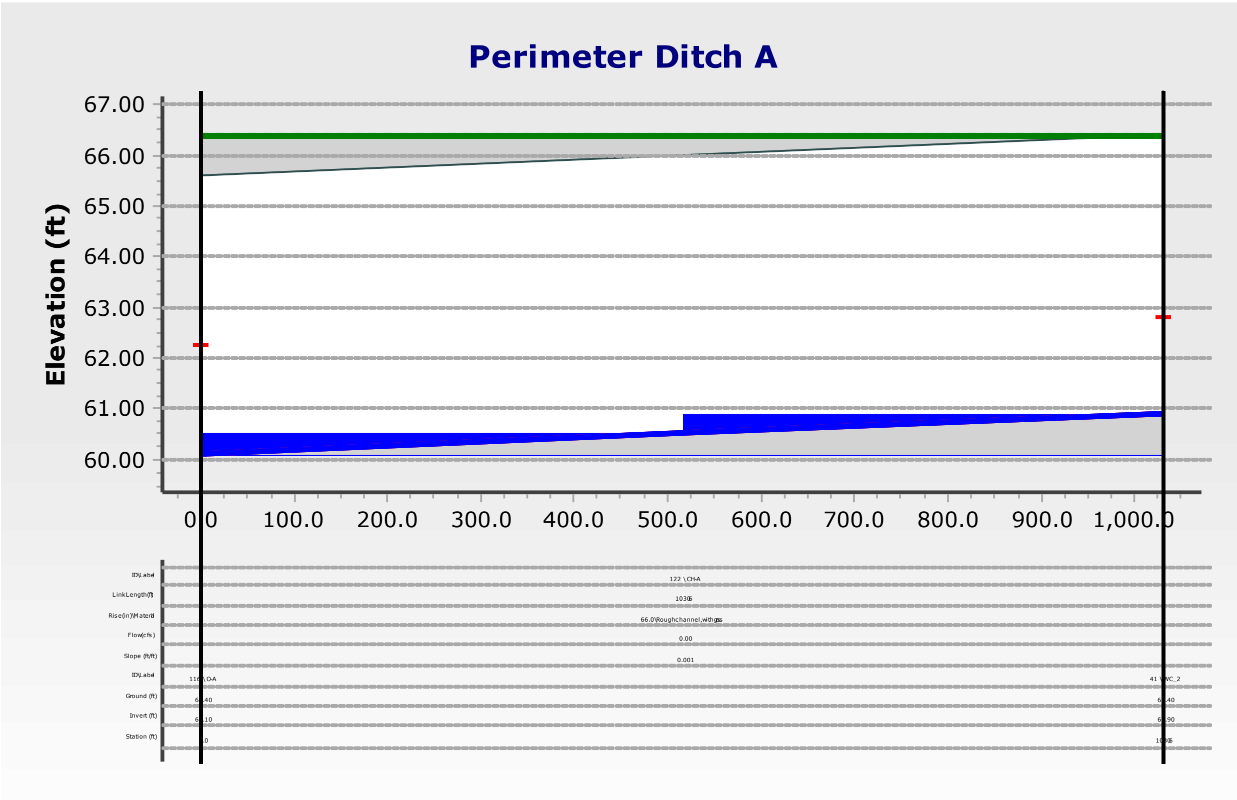

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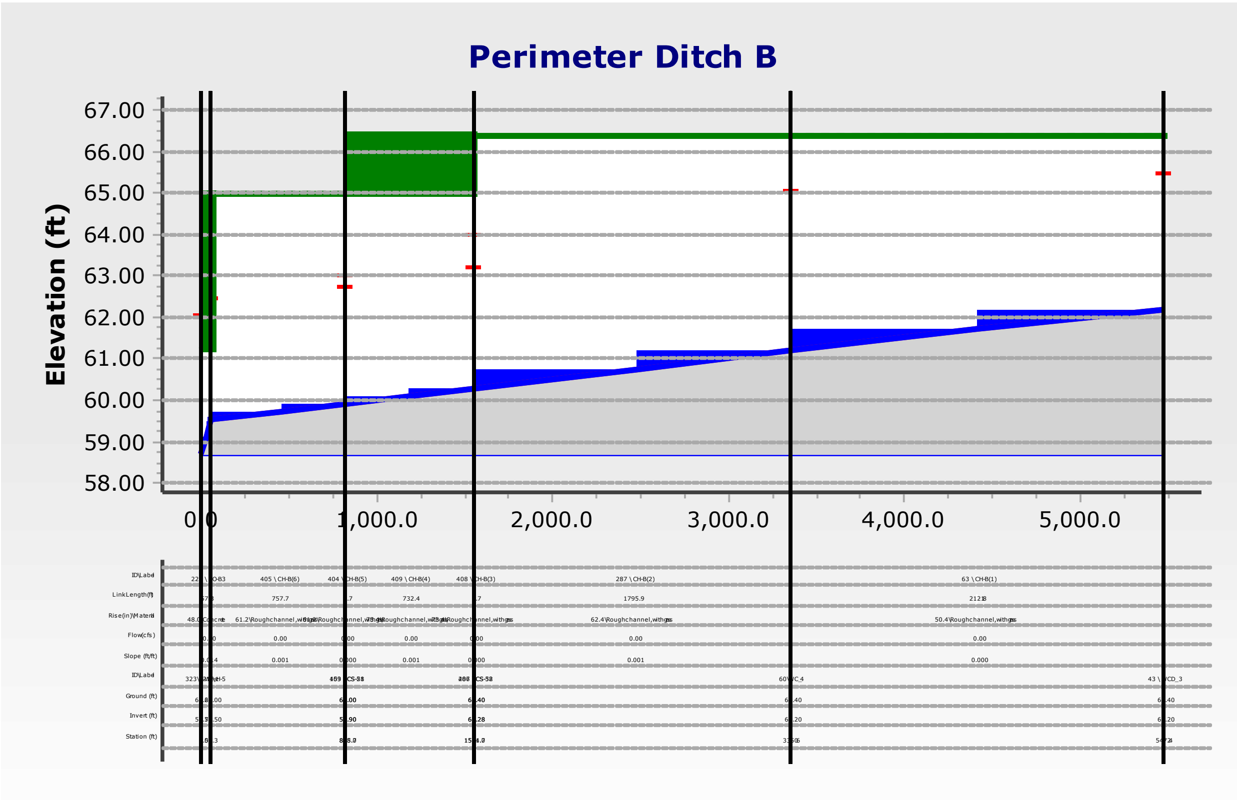

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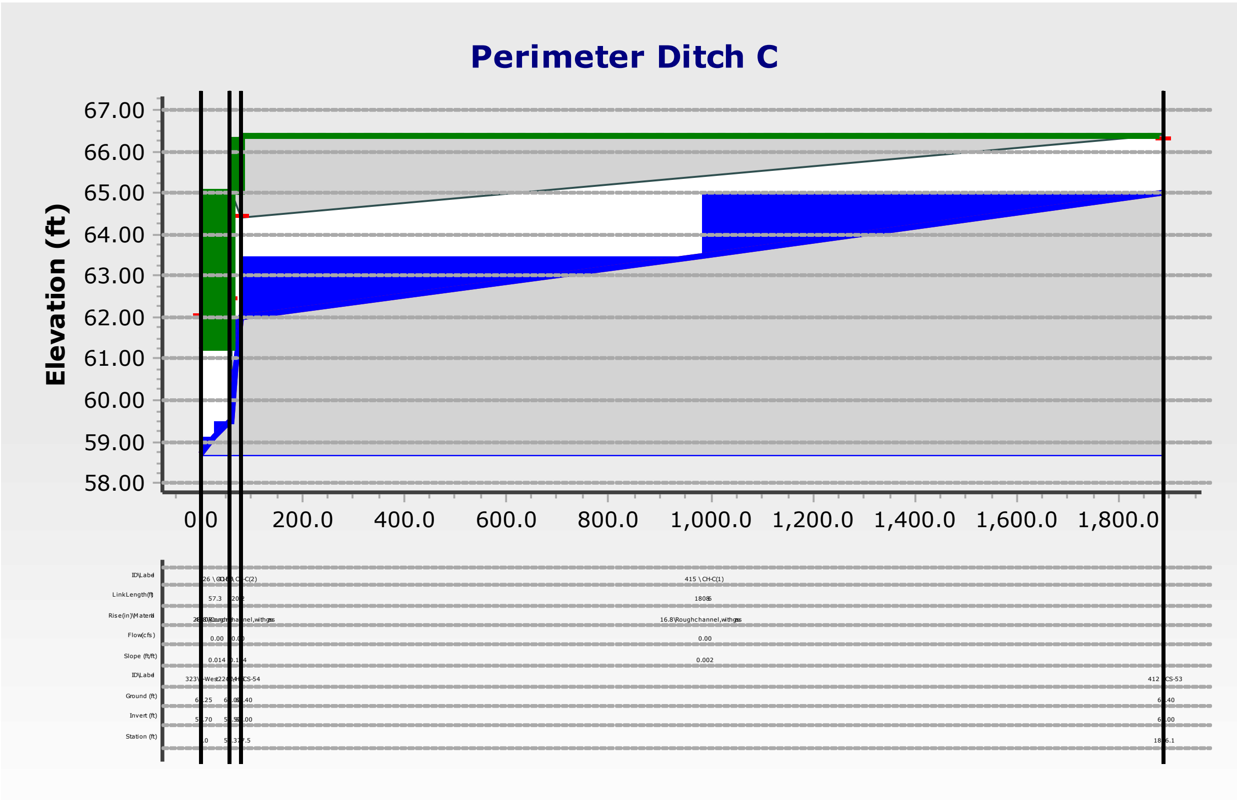

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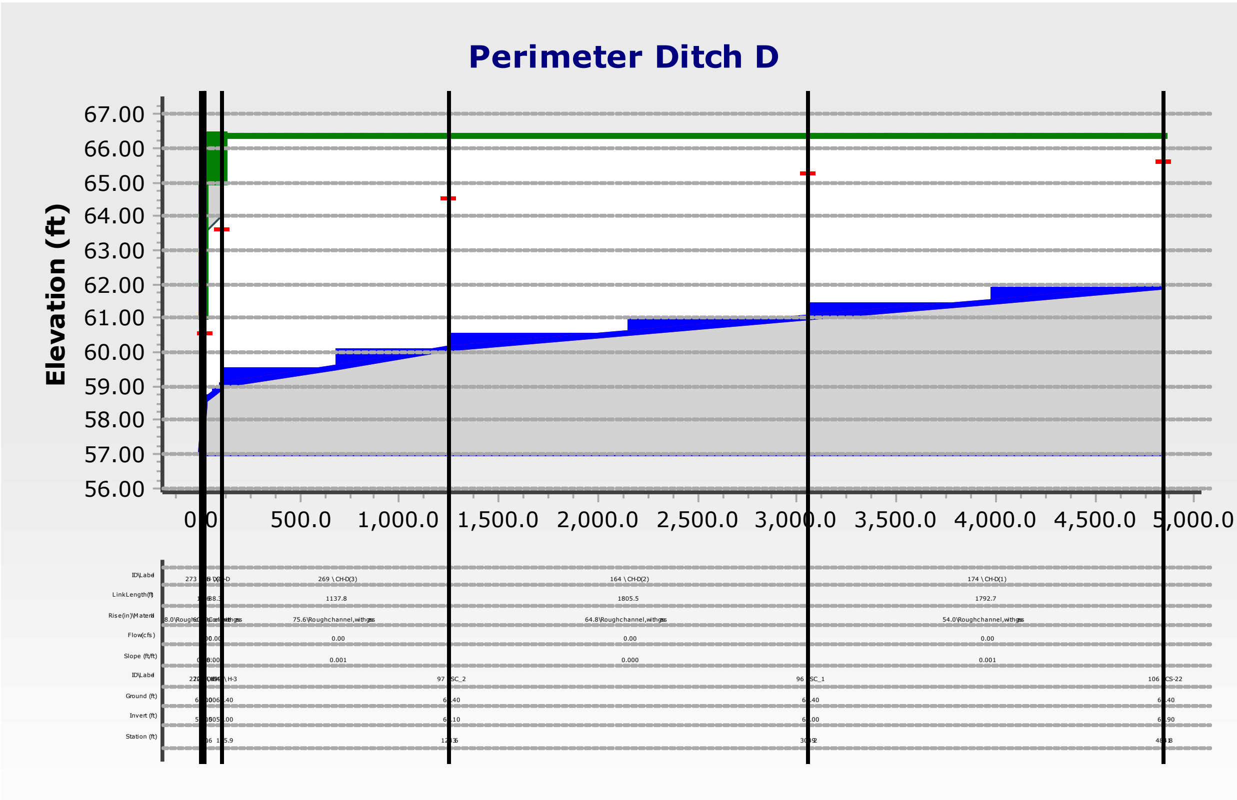

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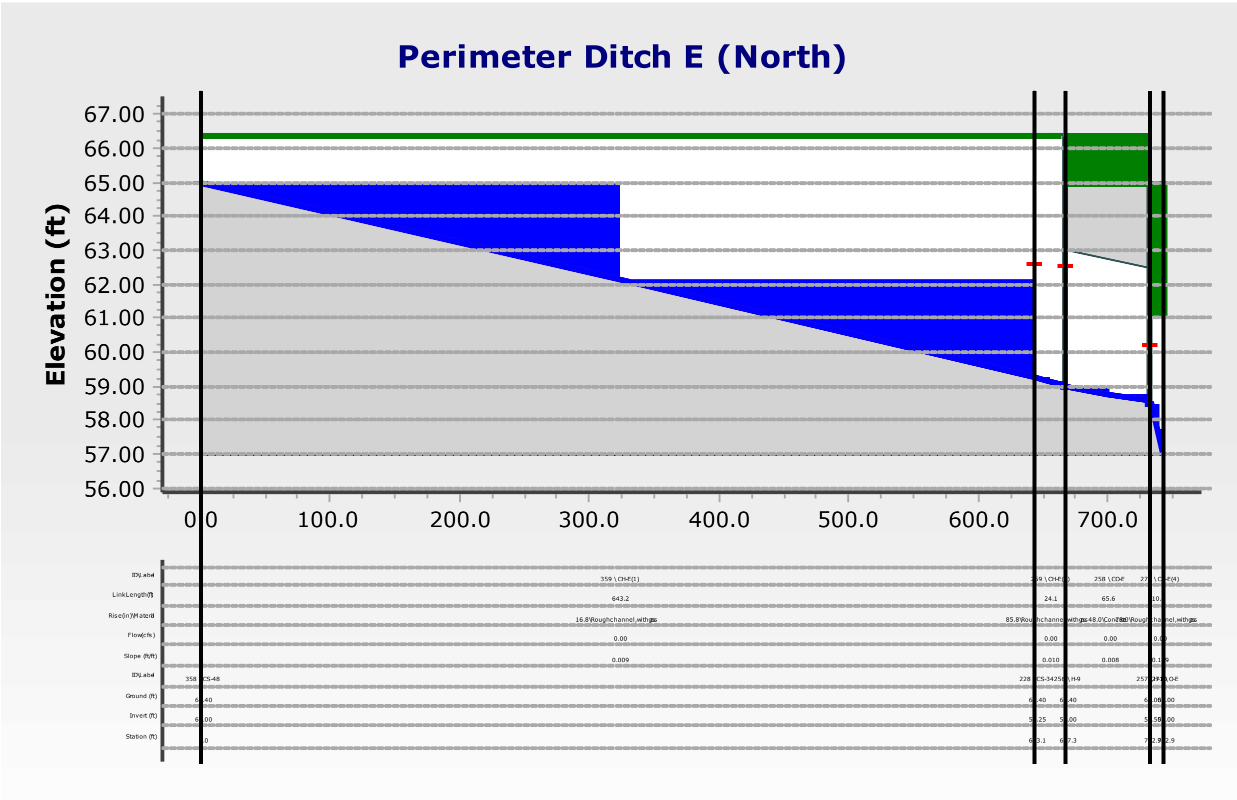

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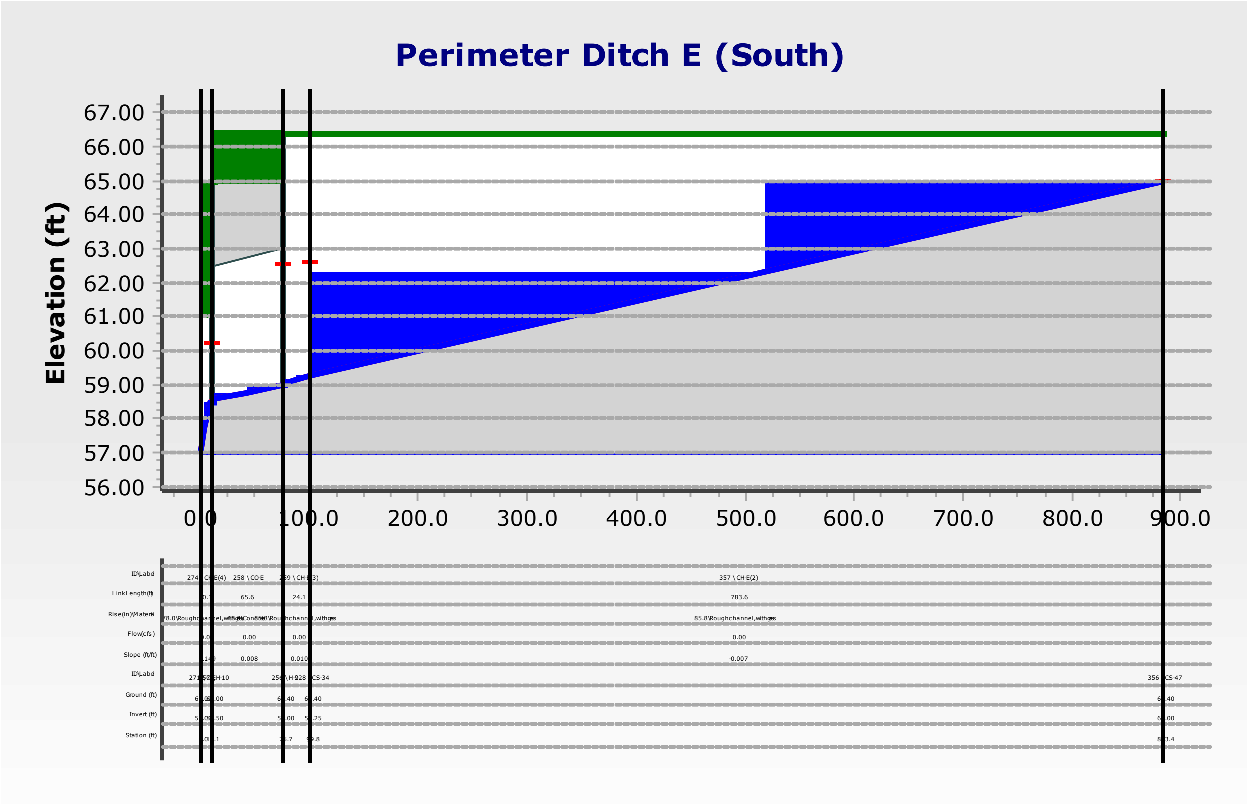

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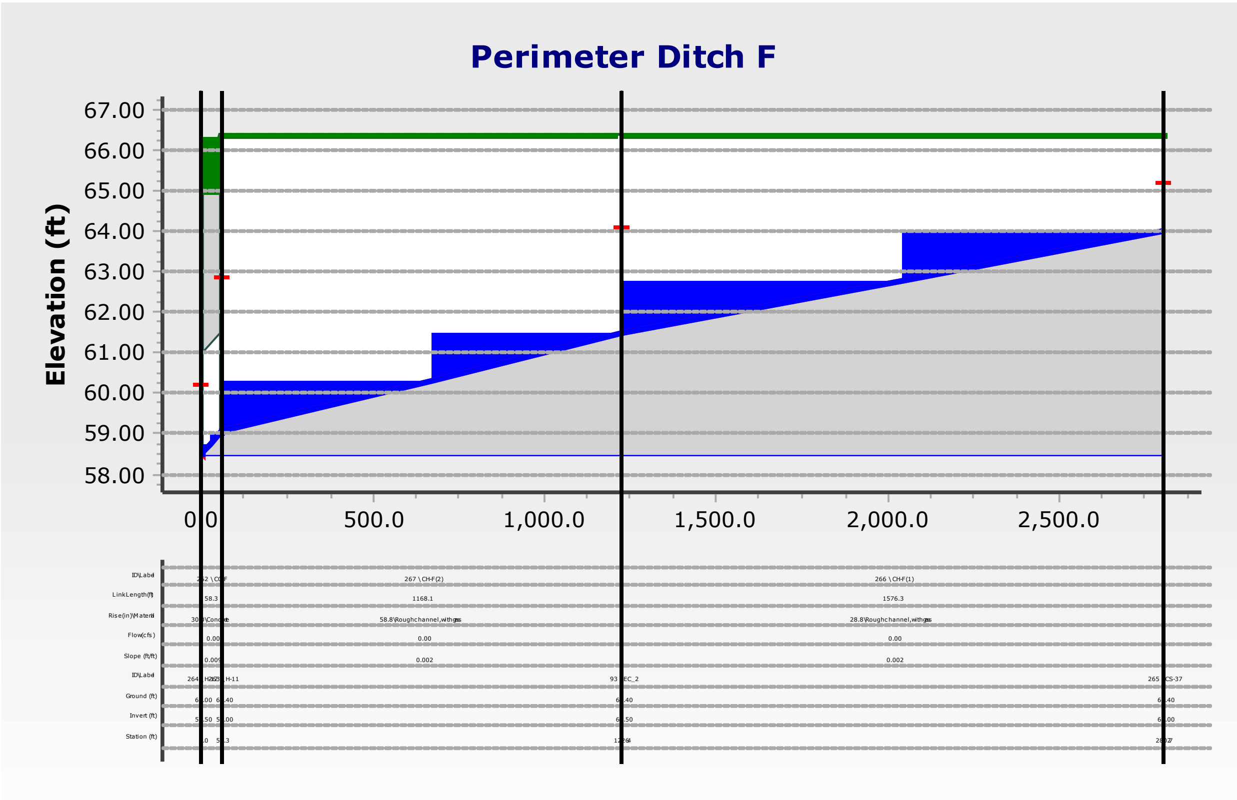


APPENDIX F – RATIONAL METHOD CALCULATIONS

Rational Method Calculations: Basins/Letdown Chutes

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 7/14/2021

Drainage Basin ID Basin 1 Letdown (Straight, 3:1 Slope)

				Reference
Runoff Coefficient, C				
Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	182	177		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	177	160		
Elevation difference, Δ	Δ =	17	ft	
Flow Length, L	**L =**	340	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.341	hr	

	Upstream	Downstream		
Channelized Flow elevation range	160	64		
Elevation difference, Δ	Δ =	96	ft	
Flow Length, L	**L =**	288	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.333	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	21.974	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.004	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.356	hr	Reference 1
	T_c =	21.350	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 1 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	21.350	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	6.716	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	**A =**	23.80	Ac
Q= Total Discharge from Watershed = C x I x A	**Q =**	86.3	**cfs**

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 2 Letdown (Straight, 3:1 Slope)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.54**		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	184	179		
Elevation difference, Δ	Δ =	**5**	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	**0.050**	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	**0.01**	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	179	160		
Elevation difference, Δ	Δ =	**19**	ft	
Flow Length, L	**L =**	380	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	**0.050**	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	**0.381**	hr	

	Upstream	Downstream		
Channelized Flow elevation range	160	64		
Elevation difference, Δ	Δ =	**96**	ft	
Flow Length, L	**L =**	288	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	**4.50**	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	**6.71**	ft	
Hydraulic Radius, R = A / P	**R =**	**0.671**	ft	
Slope, s = Δ elev / length	**s =**	**0.333**	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**21.974**	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.004**	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	**0.396**	hr	Reference 1
	T_c =	**23.754**	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 2 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	23.754	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	6.348	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	A =	34.30	Ac
Q= Total Discharge from Watershed = C x I x A	Q =	117.6	cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 3 Letdown (Straight, 24% Slope)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	188	183		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	183	169		
Elevation difference, Δ	Δ =	14	ft	
Flow Length, L	**L =**	278	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.280	hr	

	Upstream	Downstream		
Channelized Flow elevation range	169	64		
Elevation difference, Δ	Δ =	105	ft	
Flow Length, L	**L =**	1,293	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.081	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	10.846	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.033	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.324	hr	Reference 1
	T_c =	19.451	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 3 Letdown (Straight, 24% Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	19.451	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	7.044	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	**A =**	30.47	Ac
Q= Total Discharge from Watershed = C x I x A	**Q =**	115.9	**cfs**

NOTE:

Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 7/14/2021

Drainage Basin ID Basin 4 Letdown (Straight, 20% Slope)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	144	141		
Elevation difference, Δ	Δ =	3	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.030	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	141	130		
Elevation difference, Δ	Δ =	11	ft	
Flow Length, L	**L =**	398	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.028	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.296	hr	

	Upstream	Downstream		
Channelized Flow elevation range	130	64		
Elevation difference, Δ	Δ =	66	ft	
Flow Length, L	**L =**	1,120	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.059	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	9.239	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.034	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.344	hr	Reference 1
	T_c =	20.658	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 4 Letdown (Straight, 20% Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	20.658	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	6.832	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	**A =**	24.05	Ac
Q= Total Discharge from Watershed = C x I x A	**Q =**	88.7	**cfs**

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 7/14/2021

Drainage Basin ID Basin 5 Letdown (Straight, 3:1 Slope)

Reference

Runoff Coefficient, C

				Reference
Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	188	183		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	183	165		
Elevation difference, Δ	Δ =	18	ft	
Flow Length, L	**L =**	470	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.038	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.412	hr	

	Upstream	Downstream		
Channelized Flow elevation range	165	64		
Elevation difference, Δ	Δ =	101	ft	
Flow Length, L	**L =**	624	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.162	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	15.312	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.011	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.435	hr	Reference 1
	T_c =	26.099	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 5 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	26.099	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	6.031	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	A =	27.68	Ac
Q= Total Discharge from Watershed = C x I x A	Q =	90.1	cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 6 Letdown (Straight, 3:1 Slope)

Reference

Runoff Coefficient, C

				Reference
Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	182	177		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	177	161		
Elevation difference, Δ	Δ =	16	ft	
Flow Length, L	**L =**	324	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.049	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.323	hr	

	Upstream	Downstream		
Channelized Flow elevation range	161	64		
Elevation difference, Δ	Δ =	97	ft	
Flow Length, L	**L =**	367	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.264	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	19.567	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.005	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.339	hr	Reference 1
	T_c =	20.362	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 6 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	20.362	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	6.882	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	A =	21.18	Ac
Q= Total Discharge from Watershed = C x I x A	Q =	78.7	cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 7 Letdown (Straight, 3:1 Slope)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	182	177		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	$\mathbf{P_2}$ **=**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	$\mathbf{T_t}$ **=**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	177	160		
Elevation difference, Δ	Δ =	17	ft	
Flow Length, L	**L =**	342	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	$\mathbf{T_t}$ **=**	0.342	hr	

	Upstream	Downstream		
Channelized Flow elevation range	160	64		
Elevation difference, Δ	Δ =	96	ft	
Flow Length, L	**L =**	294	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.327	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	21.749	ft/s	
Channelized travel time, Tt = L / 3600*V	$\mathbf{T_t}$ **=**	0.004	hr	
Time of Concentration, $T_c = T_t + T_o$	$\mathbf{T_c}$ **=**	0.357	hr	Reference 1
	$\mathbf{T_c}$ **=**	21.417	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 7 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	21.417	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	6.705	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	A =	25.86	Ac
Q= Total Discharge from Watershed = C x I x A	Q =	93.6	cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 8 Letdown (Straight, 3:1 Slope)

Runoff Coefficient, C

				Reference
Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	182	177		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	177	160		
Elevation difference, Δ	Δ =	17	ft	
Flow Length, L	**L =**	342	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.342	hr	

	Upstream	Downstream		
Channelized Flow elevation range	160	64		
Elevation difference, Δ	Δ =	96	ft	
Flow Length, L	**L =**	294	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.327	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	21.749	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.004	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.357	hr	Reference 1
	T_c =	21.417	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 8 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	T_c =	21.417	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	6.705	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	A =	29.37	Ac
Q= Total Discharge from Watershed = C x I x A	Q =	106.3	cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 7/14/2021

Drainage Basin ID Basin 9 Letdown (Straight, 3:1 Slope)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.28		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.54		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	184	179		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	100	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	P_2 =	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	T_t =	0.01	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	179	160		
Elevation difference, Δ	Δ =	19	ft	
Flow Length, L	**L =**	385	ft	
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.049	ft/ft	
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	T_t =	0.383	hr	

	Upstream	Downstream		
Channelized Flow elevation range	160	64		
Elevation difference, Δ	Δ =	96	ft	
Flow Length, L	**L =**	294	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2		
Flow Depth, d	**d =**	1.5	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.50	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	6.71	ft	
Hydraulic Radius, R = A / P	**R =**	0.671	ft	
Slope, s = Δ elev / length	**s =**	0.327	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.03		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	21.749	ft/s	
Channelized travel time, Tt = L / 3600*V	T_t =	0.004	hr	

Time of Concentration, $T_c = T_t + T_o$	T_c =	0.399	hr	Reference 1
	T_c =	23.911	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Drainage Basin ID Basin 9 Letdown (Straight, 3:1 Slope)

Average Rainfall Intensity, I (continued)

Time of Concentration, T (from previous sheet)	**T_c =**	23.911	min	**Reference**
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	6.326	in/hr	Reference 3

Peak Flow, Q

Drainage Area, A	**A =**	32.11	Ac
Q= Total Discharge from Watershed = C x I x A	**Q =**	109.7	**cfs**

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Existing TBC Letdown Chute Basin (D2/D6 Revised)

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.18	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.46**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	144	120	
Elevation difference, Δ	Δ =	**24**	ft
Flow Length, L	**L =**	312	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.077**	ft/ft
Shallow Concentrated Flow travel time, Tt = L / $3600KS^{0.5}$	$\mathbf{T_t}$ =	**0.019**	hr

	Upstream	Downstream	
Channelized Flow elevation range	120	110	
Elevation difference, Δ	Δ =	**10**	ft
Flow Length, L	**L =**	1,084	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	**0.50**	sq ft
Wetted Perimeter, P = $2*d*(Z^2+1)^{1/2}$	**P =**	**2.24**	ft
Hydraulic Radius, R = A / P	**R =**	**0.224**	ft
Slope, s = Δ elev / length	**s =**	**0.009**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, V = $(1.49*R^{2/3}s^{1/2})$ / n	**V =**	**2.636**	ft/s
Channelized travel time, Tt = L / 3600*V	$\mathbf{T_t}$ =	**0.114**	hr

Time of Concentration, T_c = Sum of T_t	$\mathbf{T_c}$ =	**0.134**	hr
	$\mathbf{T_c}$ =	**8.016**	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

<u>Average Rainfall Intensity, I (continued)</u>

Time of Concentration, T	T_c =	8.016	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	10.228	in/hr

<u>Peak Flow, Q</u>

Drainage Area, A	**A =**	24.00	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	112.9	**cfs**	Compare to 77 cfs Since flow rate is higher, re-design of the chute is required.

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Rational Method Calculations: Review of Historic Basins

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Basin A-1 (Expansion Design)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.21
Soil Infiltration Component, Ci	**Ci =**	0.08
Vegetal Cover Component, Cv	**Cv =**	0.06
Surface Type Component, Ct	**Ct =**	0.08
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.43**

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Sheet Flow elevation range	144	142	
Elevation difference, Δ	Δ =	**2**	ft
Flow Length, L	**L =**	100	ft
Slope, s = Δ elev / length	**s =**	**0.020**	ft/ft
Roughness Coefficient (Manning's), n	**n =**	0.011	
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	**0.02**	hr

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	142	138	
Elevation difference, Δ	Δ =	**4**	ft
Flow Length, L	**L =**	154	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.026**	ft/ft
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	**0.016**	hr

	Upstream	Downstream	
Channelized Flow elevation range	138	134	
Elevation difference, Δ	Δ =	**4**	ft
Flow Length, L	**L =**	826	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	**0.50**	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	**2.24**	ft
Hydraulic Radius, R = A / P	**R =**	**0.224**	ft
Slope, s = Δ elev / length	**s =**	**0.005**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**1.910**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.120**	hr

	Upstream	Downstream	
Channelized Flow elevation range	133	64	
Elevation difference, Δ	Δ =	**68.7**	ft
Flow Length, L	**L =**	310	ft

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	6.00	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	12.24	ft
Hydraulic Radius, R = A / P	**R =**	0.490	ft
Slope, s = Δ elev / length	**s =**	0.222	ft/ft
Manning's Roughness Coeff., n	**n =**	0.025	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	17.447	ft/s
Channelized travel time, Tt = L / 3600*V	$\mathbf{T_t}$ **=**	0.005	hr

	Upstream	Downstream	
Channelized Flow elevation range	64	64	
Elevation difference, Δ	Δ =	0.7	ft
Flow Length, L	**L =**	1,200	ft
Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	2.0	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	36.00	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	18.94	ft
Hydraulic Radius, R = A / P	**R =**	1.900	ft
Slope, s = Δ elev / length	**s =**	0.001	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	1.840	ft/s
Channelized travel time, Tt = L / 3600*V	$\mathbf{T_t}$ **=**	0.181	hr
Time of Concentration, T_c = Sum of T_t	$\mathbf{T_c}$ **=**	0.339	hr
	$\mathbf{T_c}$ **=**	20.359	min

<u>Average Rainfall Intensity, I (continued)</u>

Time of Concentration, T	$\mathbf{T_c}$ **=**	20.359	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	6.883	in/hr

<u>Peak Flow, Q</u>

Drainage Area, A	**A =**	31.00	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	91.7	**cfs**	Compare to 108 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Basin A-2 (Expansion Design)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.18	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.46**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Channelized Flow elevation range	144	133	
Elevation difference, Δ	Δ =	**11**	ft
Flow Length, L	**L =**	1,014	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	**0.50**	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	**2.24**	ft
Hydraulic Radius, R = A / P	**R =**	**0.224**	ft
Slope, s = Δ elev / length	**s =**	**0.011**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**2.859**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.099**	hr

	Upstream	Downstream	
Channelized Flow elevation range	133	64	
Elevation difference, Δ	Δ =	**68.7**	ft
Flow Length, L	**L =**	310	ft
Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	**6.00**	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	**12.24**	ft
Hydraulic Radius, R = A / P	**R =**	**0.490**	ft
Slope, s = Δ elev / length	**s =**	**0.222**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.025	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**17.447**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.005**	hr

	Upstream	Downstream	
Channelized Flow elevation range	64	64	
Elevation difference, Δ	Δ =	**0.7**	ft
Flow Length, L	**L =**	1,291	ft
Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Flow Depth, d	**d =**	2.0	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	36.00	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	18.94	ft
Hydraulic Radius, R = A / P	**R =**	1.900	ft
Slope, s = Δ elev / length	**s =**	0.001	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	1.774	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.202	hr
Time of Concentration, T_c = Sum of T_t	**T_c =**	0.306	hr
	T_c =	18.335	min

Average Rainfall Intensity, I (continued)

Time of Concentration, T	**T_c =**	18.335	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	7.254	in/hr

Peak Flow, Q

Drainage Area, A	**A =**	33.10	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	111.6	**cfs**	Compare to 113 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Sub-Basin P-1 of Basin A-3

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.21	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.49**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	144	139	
Elevation difference, Δ	Δ =	**5**	ft
Flow Length, L	**L =**	152	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.033**	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	**0.014**	hr

	Upstream	Downstream	
Channelized Flow elevation range	139	133	
Elevation difference, Δ	Δ =	**6**	ft
Flow Length, L	**L =**	1,213	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	4	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	**1.00**	sq ft
Wetted Perimeter, P = 2*d*(Z^2+1)$^{1/2}$	**P =**	**4.12**	ft
Hydraulic Radius, R = A / P	**R =**	**0.243**	ft
Slope, s = Δ elev / length	**s =**	**0.005**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, V = (1.49*R$^{2/3}$s$^{1/2}$) / n	**V =**	**2.038**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.165**	hr

	Upstream	Downstream	
Channelized Flow elevation range	133	80	
Elevation difference, Δ	Δ =	**53**	ft
Flow Length, L	**L =**	206	ft
Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, A = Bd+Zd^2	**A =**	**6.00**	sq ft
Wetted Perimeter, P = B+2*d*(S^2+1)$^{1/2}$	**P =**	**12.24**	ft
Hydraulic Radius, R = A / P	**R =**	**0.490**	ft
Slope, s = Δ elev / length	**s =**	**0.257**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.025	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	18.799	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.003	hr
Time of Concentration, T_c = Sum of T_t	**T_c =**	0.183	hr
	T_c =	10.970	min

Average Rainfall Intensity, I (continued)

Time of Concentration, T	**T_c =**	10.970	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	9.118	in/hr

Peak Flow, Q

Drainage Area, A	**A =**	32.00	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	143.0	**cfs**	Compare to 221 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Sub-Basin C-4 of Basin A-3

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.25	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.06	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.47	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	92	61	
Elevation difference, Δ	Δ =	31	ft
Flow Length, L	**L =**	125	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	0.248	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	0.004	hr

	Upstream	Downstream	
Channelized Flow elevation range	61	59	
Elevation difference, Δ	Δ =	1.7	ft
Flow Length, L	**L =**	1,549	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	0.50	sq ft
Wetted Perimeter, P = 2*d*(Z^2+1)$^{1/2}$	**P =**	2.24	ft
Hydraulic Radius, R = A / P	**R =**	0.224	ft
Slope, s = Δ elev / length	**s =**	0.001	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, V = (1.49*R$^{2/3}$s$^{1/2}$) / n	**V =**	0.606	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.710	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	0.714	hr
	T_c =	42.850	min

Average Rainfall Intensity, I (continued)

Time of Concentration, T	T_c =	42.850	min
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	4.504	in/hr

Peak Flow, Q

Drainage Area, A	A =	4.90	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	10.5	**cfs**	Compare to 12 cfs

NOTE:

Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Sub-Basin C-5 of Basin A-3

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.25
Soil Infiltration Component, Ci	**Ci =**	0.08
Vegetal Cover Component, Cv	**Cv =**	0.06
Surface Type Component, Ct	**Ct =**	0.08
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.47

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	120	92	
Elevation difference, Δ	Δ =	28	ft
Flow Length, L	**L =**	110	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	0.255	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	0.004	hr

	Upstream	Downstream	
Channelized Flow elevation range	92	78	
Elevation difference, Δ	Δ =	14	ft
Flow Length, L	**L =**	1,792	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	0.50	sq ft
Wetted Perimeter, P = 2*d*(Z^2+1)$^{1/2}$	**P =**	2.24	ft
Hydraulic Radius, R = A / P	**R =**	0.224	ft
Slope, s = Δ elev / length	**s =**	0.008	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, V = (1.49*R$^{2/3}$s$^{1/2}$) / n	**V =**	1.617	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.308	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	0.312	hr
	T_c =	18.693	min

Average Rainfall Intensity, I (continued)

Time of Concentration, T	T_c =	18.693	min
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	7.185	in/hr

Peak Flow, Q

Drainage Area, A	A =	8.50	Ac	
Q= Total Discharge from Watershed = C x I x A	Q =	28.5	**cfs**	Compare to 67 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Sub-Basin C-6 of Basin A-3

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.27	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.06	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.49	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	80	59	
Elevation difference, Δ	Δ =	20.7	ft
Flow Length, L	**L =**	79	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	0.262	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	0.003	hr

	Upstream	Downstream	
Channelized Flow elevation range	59	59	
Elevation difference, Δ	Δ =	0.3	ft
Flow Length, L	**L =**	220	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	0.50	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	2.24	ft
Hydraulic Radius, R = A / P	**R =**	0.224	ft
Slope, s = Δ elev / length	**s =**	0.001	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	0.676	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.090	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	0.093	hr
	T_c =	5.586	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Average Rainfall Intensity, I (continued)

Time of Concentration, T	$T_c =$	5.586	min
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	11.407	in/hr

Peak Flow, Q

Drainage Area, A	A =	0.90	Ac	
Q= Total Discharge from Watershed = C x I x A	Q =	5.0	**cfs**	Compare to 13 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Discharge Evaluation: Sub-Basins C-2/3 of Basin A-3 *
*Revised for Landfill Expansion Geometry

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.15	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.43	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	144	140	
Elevation difference, Δ	Δ =	4	ft
Flow Length, L	**L =**	148	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	0.027	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	0.016	hr

	Upstream	Downstream	
Channelized Flow elevation range	140	120	
Elevation difference, Δ	Δ =	20	ft
Flow Length, L	**L =**	1,672	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	4	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	1.00	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	4.12	ft
Hydraulic Radius, R = A / P	**R =**	0.243	ft
Slope, s = Δ elev / length	**s =**	0.012	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	3.169	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.147	hr

	Upstream	Downstream	
Channelized Flow elevation range	120	61	
Elevation difference, Δ	Δ =	59	ft
Flow Length, L	**L =**	286	ft
Base width of trapezoidal channel, B	**B =**	15	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	8.50	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	17.24	ft
Hydraulic Radius, R = A / P	**R =**	0.493	ft
Slope, s = Δ elev / length	**s =**	0.206	ft/ft
Manning's Roughness Coeff., n	**n =**	0.025	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	16.897	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.005	hr

	Upstream	Downstream	
Channelized Flow elevation range	61	60	
Elevation difference, Δ	Δ =	0.9	ft
Flow Length, L	**L =**	1,026	ft
Base width of trapezoidal channel, B	**B =**	10	
Side slopes of trapezoidal channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	0.5	ft
Cross Sectional Flow Area, $A = Bd+Zd^2$	**A =**	6.00	sq ft
Wetted Perimeter, $P = B+2*d*(S^2+1)^{1/2}$	**P =**	12.24	ft
Hydraulic Radius, R = A / P	**R =**	0.490	ft
Slope, s = Δ elev / length	**s =**	0.001	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	1.372	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.208	hr
Time of Concentration, T_c = Sum of T_t	**T_c =**	0.374	hr
	T_c =	22.469	min

Average Rainfall Intensity, I (continued)

Time of Concentration, T	**T_c =**	22.469	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	6.539	in/hr

Peak Flow, Q

Drainage Area, A	**A =**	26.40	Ac	
Q= Total Discharge from Watershed = C x I x A	**Q =**	74.3	**cfs**	Compare to 159 cfs

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Rational Method Calculations: Critical Final Cover Swale

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 1: 1115' on 3:1 Slopes* @ 1% (Vegetated)

*Swale corresponding to Sub-Basin 2-1

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.20		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.04		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.38		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	171	148		
Elevation difference, Δ	Δ =	23	ft	
Flow Length, L	**L =**	260	ft	
Slope, s = Δ elev / length	**s =**	0.088	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.240		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.23	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	148	148		N/A
Elevation difference, Δ	Δ =	0	ft	N/A
Flow Length, L	**L =**	0	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.000	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.000	hr	N/A

	Upstream	Downstream		
Channelized Flow elevation range	148	138		
Elevation difference, Δ	Δ =	10	ft	
Flow Length, L	**L =**	1,115	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	2.00	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	4.47	ft	
Hydraulic Radius, R = A / P	**R =**	0.447	ft	
Slope, s = Δ elev / length	**s =**	0.009	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.024		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	3.438	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.090	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.323	hr	Reference 1
	T_c =	19.357	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 1: 1115' on 3:1 Slopes* @ 1% (Vegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	19.357	min	
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	7.061	in/hr	
Peak Flow, Q				
Drainage Area, A	A =	4.05	Ac	Sub-Basin 2-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	Q =	10.9	cfs	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 10/1/2021

Drainage Basin ID FC Swale 1: 1115' on 3:1 Slopes* @ 1% (Unvegetated)
*Swale corresponding to Sub-Basin 2-1

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.20		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.46		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	171	148		
Elevation difference, Δ	Δ =	23	ft	
Flow Length, L	**L =**	260	ft	
Slope, s = Δ elev / length	**s =**	0.088	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	P_2 =	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	T_t =	0.02	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	148	148		N/A
Elevation difference, Δ	Δ =	0	ft	N/A
Flow Length, L	**L =**	0	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.000	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	T_t =	0.000	hr	N/A

	Upstream	Downstream		
Channelized Flow elevation range	148	138		
Elevation difference, Δ	Δ =	10	ft	
Flow Length, L	**L =**	1,115	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	2.00	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	4.47	ft	
Hydraulic Radius, R = A / P	**R =**	0.447	ft	
Slope, s = Δ elev / length	**s =**	0.009	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.011		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	7.502	ft/s	
Channelized travel time, Tt = L / 3600*V	T_t =	0.041	hr	

Time of Concentration, $T_c = T_t + T_o$	T_c =	0.061	hr	Reference 1
	T_c =	3.662	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 1: 1115' on 3:1 Slopes* @ 1% (Unvegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	3.662	min	
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	12.594	in/hr	
Peak Flow, Q				
Drainage Area, A	**A =**	4.05	Ac	Sub-Basin 2-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	**Q =**	23.5	**cfs**	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 2: 948' on 5% Slopes* @ 1% (Vegetated)

*Swale corresponding to Sub-Basin 5-1

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr		**Cr =**	0.14		Reference 1
Soil Infiltration Component, Ci		**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv		**Cv =**	0.04		Reference 1
Surface Type Component, Ct		**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct			0.32		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		Reference
Sheet Flow elevation range	187	172		
Elevation difference, Δ	Δ =	15	ft	
Flow Length, L	**L =**	300	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.240		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.33	hr	Reference 1

	Upstream	Downstream		Reference
Shallow Concentrated Flow elevation range	172	165		N/A
Elevation difference, Δ	Δ =	7	ft	N/A
Flow Length, L	**L =**	140	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.140	hr	N/A

	Upstream	Downstream		Reference
Channelized Flow elevation range	165	160		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	430	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	2.00	sq ft	
Wetted Perimeter, $P = 2{*}d{*}(Z^2+1)^{1/2}$	**P =**	4.47	ft	
Hydraulic Radius, R = A / P	**R =**	0.447	ft	
Slope, s = Δ elev / length	**s =**	0.012	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.024		Reference 1
Velocity, $V = (1.49{*}R^{2/3}s^{1/2}) / n$	**V =**	3.915	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.031	hr	
Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.498	hr	Reference 1
	T_c =	29.902	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 10/1/2021

Drainage Basin ID FC Swale 2: 948' on 5% Slopes* @ 1% (Vegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	29.902	min	
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	5.586	in/hr	
Peak Flow, Q				
Drainage Area, A	**A =**	9.88	Ac	Sub-Basin 5-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	**Q =**	17.7	**cfs**	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 2: 948' on 5% Slopes* @ 1% (Unvegetated)

*Swale corresponding to Sub-Basin 5-1

				Reference
Runoff Coefficient, C				
Watershed Relief Component, Cr	**Cr =**	0.14		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.40		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	187	172		
Elevation difference, Δ	Δ =	15	ft	
Flow Length, L	**L =**	300	ft	
Slope, s = Δ elev / length	**s =**	0.050	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	P_2 =	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	T_t =	0.03	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	172	165		N/A
Elevation difference, Δ	Δ =	7	ft	N/A
Flow Length, L	**L =**	140	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.050	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	T_t =	0.140	hr	N/A

	Upstream	Downstream		
Channelized Flow elevation range	165	160		
Elevation difference, Δ	Δ =	5	ft	
Flow Length, L	**L =**	430	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	2.00	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	4.47	ft	
Hydraulic Radius, R = A / P	**R =**	0.447	ft	
Slope, s = Δ elev / length	**s =**	0.012	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.011		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	8.542	ft/s	
Channelized travel time, Tt = L / 3600*V	T_t =	0.014	hr	
Time of Concentration, $T_c = T_t + T_o$	T_c =	0.182	hr	Reference 1
	T_c =	10.924	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 2: 948' on 5% Slopes* @ 1% (Unvegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	10.924	min	
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	9.133	in/hr	
Peak Flow, Q				
Drainage Area, A	**A =**	9.88	Ac	Sub-Basin 5-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	**Q =**	36.1	**cfs**	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 3: 810' btwn. 5%/4:1 Slopes* @ 1% (Vegetated)
*Swale corresponding to Sub-Basin 4-1

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.16		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.04		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.34		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	140	132		
Elevation difference, Δ	Δ =	8	ft	
Flow Length, L	**L =**	300	ft	
Slope, s = Δ elev / length	**s =**	0.027	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.240		Reference 1
2-year Rainfall Depth (24 hour), P_2	$\mathbf{P_2}$ **=**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	$\mathbf{T_t}$ **=**	0.42	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	132	130		N/A
Elevation difference, Δ	Δ =	2	ft	N/A
Flow Length, L	**L =**	80	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.025	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	$\mathbf{T_t}$ **=**	0.057	hr	N/A

	Upstream	Downstream		
Channelized Flow elevation range	130	122		
Elevation difference, Δ	Δ =	8	ft	
Flow Length, L	**L =**	810	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	4	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.00	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	8.25	ft	
Hydraulic Radius, R = A / P	**R =**	0.485	ft	
Slope, s = Δ elev / length	**s =**	0.010	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.024		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	3.809	ft/s	
Channelized travel time, Tt = L / 3600*V	$\mathbf{T_t}$ **=**	0.059	hr	
Time of Concentration, $T_c = T_t + T_o$	$\mathbf{T_c}$ **=**	0.537	hr	Reference 1
	$\mathbf{T_c}$ **=**	32.219	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 3: 810' btwn. 5%/4:1 Slopes* @ 1% (Vegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	32.219	min	
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	5.350	in/hr	
Peak Flow, Q				
Drainage Area, A	**A =**	18.51	Ac	Sub-Basin 4-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	**Q =**	33.7	**cfs**	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 3: 810' btwn. 5%/4:1 Slopes* @ 1% (Unvegetated)

*Swale corresponding to Sub-Basin 4-1

Reference

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.16		Reference 1
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1
Surface Type Component, Ct	**Ct =**	0.06		Reference 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		0.42		Reference 1

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream		
Sheet Flow elevation range	140	132		
Elevation difference, Δ	Δ =	8	ft	
Flow Length, L	**L =**	300	ft	
Slope, s = Δ elev / length	**s =**	0.027	ft/ft	
Roughness Coefficient (Manning's), n	**n =**	0.011		Reference 1
2-year Rainfall Depth (24 hour), P_2	**P_2 =**	4.70	inches	Reference 2
Sheet Flow travel time, $T_t = 0.007(nL)^{0.8}/P_2^{0.5}\ s^{0.4}$	**T_t =**	0.04	hr	Reference 1

	Upstream	Downstream		
Shallow Concentrated Flow elevation range	132	130		N/A
Elevation difference, Δ	Δ =	2	ft	N/A
Flow Length, L	**L =**	80	ft	N/A
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13		Reference 1
Watercourse Slope, s = Δ elev / length	**S =**	0.025	ft/ft	N/A
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	0.057	hr	N/A

	Upstream	Downstream		
Channelized Flow elevation range	130	122		
Elevation difference, Δ	Δ =	8	ft	
Flow Length, L	**L =**	810	ft	
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	4	ft	
Flow Depth, d	**d =**	1.0	ft	
Cross Sectional Flow Area, $A = Zd^2$	**A =**	4.00	sq ft	
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	8.25	ft	
Hydraulic Radius, R = A / P	**R =**	0.485	ft	
Slope, s = Δ elev / length	**s =**	0.010	ft/ft	
Manning's Roughness Coeff., n	**n =**	0.011		Reference 1
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	8.311	ft/s	
Channelized travel time, Tt = L / 3600*V	**T_t =**	0.027	hr	

Time of Concentration, $T_c = T_t + T_o$	**T_c =**	0.120	hr	Reference 1
	T_c =	7.171	min	

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 10/1/2021

Drainage Basin ID FC Swale 3: 810' btwn. 5%/4:1 Slopes* @ 1% (Unvegetated)

Average Rainfall Intensity, I (continued)				**Reference**
Time of Concentration, T (from previous sheet)	T_c =	7.171	min	
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	10.605	in/hr	
Peak Flow, Q				
Drainage Area, A	A =	18.51	Ac	Sub-Basin 4-1 (Figure)
Q= Total Discharge from Watershed = C x I x A	Q =	82.4	cfs	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Rational Method Calculations: Review of Historic Swales

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Calculation Verification for Swale SW1 (Un-Veg.)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.26	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.54**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	120	92	
Elevation difference, Δ	Δ =	**28**	ft
Flow Length, L	**L =**	113	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.248**	ft/ft
Shallow Concentrated Flow travel time, $Tt = L / 3600KS^{0.5}$	**T_t =**	**0.004**	hr

	Upstream	Downstream	
Channelized Flow elevation range	92	78	
Elevation difference, Δ	Δ =	**14**	ft
Flow Length, L	**L =**	1,820	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	1.0	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	**2.00**	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	**4.47**	ft
Hydraulic Radius, R = A / P	**R =**	**0.447**	ft
Slope, s = Δ elev / length	**s =**	**0.008**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**3.821**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.132**	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	**0.136**	hr
	T_c =	**8.173**	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Average Rainfall Intensity, I (continued)

Time of Concentration, T	**T_c =**	8.173	min
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.773	
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	10.161	in/hr

Peak Flow, Q

Drainage Area, A	**A =**	4.30	Ac
Q= Total Discharge from Watershed = C x I x A	**Q =**	23.6	**cfs**

Channel (Hydraflow Express for Civil 3D)

Depth =	1.33	ft	Compare to 1.22
Velocity =	4.52	ft/s	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Calculation Verification for Swale SW1 (Veg.)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.26
Soil Infiltration Component, Ci	**Ci =**	0.08
Vegetal Cover Component, Cv	**Cv =**	0.06
Surface Type Component, Ct	**Ct =**	0.06
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.46**

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	120	92	
Elevation difference, Δ	Δ =	**28**	ft
Flow Length, L	**L =**	113	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.248**	ft/ft
Shallow Concentrated Flow travel time, Tt = $L / 3600KS^{0.5}$	**T_t =**	**0.004**	hr

	Upstream	Downstream	
Channelized Flow elevation range	92	78	
Elevation difference, Δ	Δ =	**14**	ft
Flow Length, L	**L =**	1,820	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	1.0	ft
Cross Sectional Flow Area, $A = Zd^2$	**A =**	**2.00**	sq ft
Wetted Perimeter, $P = 2*d*(Z^2+1)^{1/2}$	**P =**	**4.47**	ft
Hydraulic Radius, R = A / P	**R =**	**0.447**	ft
Slope, s = Δ elev / length	**s =**	**0.008**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, $V = (1.49*R^{2/3}s^{1/2}) / n$	**V =**	**2.547**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.198**	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	**0.202**	hr
	T_c =	**12.142**	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Average Rainfall Intensity, I (continued)

Time of Concentration, T	T_c =	12.142	min	
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	8.750	in/hr	

Peak Flow, Q

Drainage Area, A	A =	4.30	Ac	
Q= Total Discharge from Watershed = C x I x A	Q =	17.3	cfs	Compare to 15.2 cfs

Channel (Hydraflow Express for Civil 3D)

	Depth =	1.30	ft	Compare to 1.22
	Velocity =	3.55	ft/s	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Calculation Verification for Swale SW2 (Un-Veg.)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.14	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.12	
Surface Type Component, Ct	**Ct =**	0.08	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.42**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	139	120	
Elevation difference, Δ	Δ =	**19**	ft
Flow Length, L	**L =**	402	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.047**	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	T_t =	**0.032**	hr

	Upstream	Downstream	
Channelized Flow elevation range	120	108	
Elevation difference, Δ	Δ =	**12**	ft
Flow Length, L	**L =**	1,340	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	1.0	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	**2.00**	sq ft
Wetted Perimeter, P = 2*d*(Z^2+1)$^{1/2}$	**P =**	**4.47**	ft
Hydraulic Radius, R = A / P	**R =**	**0.447**	ft
Slope, s = Δ elev / length	**s =**	**0.009**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.02	
Velocity, V = (1.49*R$^{2/3}$s$^{1/2}$) / n	**V =**	**4.123**	ft/s
Channelized travel time, Tt = L / 3600*V	T_t =	**0.090**	hr

Time of Concentration, T_c = Sum of T_t	T_c =	**0.122**	hr
	T_c =	**7.328**	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Average Rainfall Intensity, I (continued)

Time of Concentration, T	T_c =	7.328	min	
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	10.533	in/hr	
Peak Flow, Q				
Drainage Area, A	A =	8.10	Ac	
Q= Total Discharge from Watershed = C x I x A	Q =	35.8	**cfs**	
Channel (Hydraflow Express for Civil 3D)				
	Depth =	1.45	ft	Compare to 1.54
	Velocity =	5.71	ft/s	

NOTE:

Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Drainage Basin ID Historic Calculation Verification for Swale SW2 (Veg.)

Runoff Coefficient, C

Watershed Relief Component, Cr	**Cr =**	0.14	
Soil Infiltration Component, Ci	**Ci =**	0.08	
Vegetal Cover Component, Cv	**Cv =**	0.06	
Surface Type Component, Ct	**Ct =**	0.06	
Overall Runoff Coefficient, C = Cr + Ci + Cv + Ct		**0.34**	

Average Rainfall Intensity, I

Time of Concentration

	Upstream	Downstream	
Shallow Concentrated Flow elevation range	139	120	
Elevation difference, Δ	Δ =	**19**	ft
Flow Length, L	**L =**	402	ft
K Coefficient (16.13 for unpaved / 20.32 for paved)	**K =**	16.13	
Watercourse Slope, s = Δ elev / length	**S =**	**0.047**	ft/ft
Shallow Concentrated Flow travel time, Tt = L / 3600KS$^{0.5}$	**T_t =**	**0.032**	hr

	Upstream	Downstream	
Channelized Flow elevation range	120	108	
Elevation difference, Δ	Δ =	**12**	ft
Flow Length, L	**L =**	1,340	ft
Side slopes of Triangular channel, Z (?H:1V)	**Z =**	2	ft
Flow Depth, d	**d =**	1.0	ft
Cross Sectional Flow Area, A = Zd^2	**A =**	**2.00**	sq ft
Wetted Perimeter, P = 2*d*(Z^2+1)$^{1/2}$	**P =**	**4.47**	ft
Hydraulic Radius, R = A / P	**R =**	**0.447**	ft
Slope, s = Δ elev / length	**s =**	**0.009**	ft/ft
Manning's Roughness Coeff., n	**n =**	0.03	
Velocity, V = (1.49*R$^{2/3}$s$^{1/2}$) / n	**V =**	**2.749**	ft/s
Channelized travel time, Tt = L / 3600*V	**T_t =**	**0.135**	hr

Time of Concentration, T_c = Sum of T_t	**T_c =**	**0.167**	hr
	T_c =	**10.036**	min

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Average Rainfall Intensity, I (continued)

Time of Concentration, T	T_c =	10.036	min	
25- Year Intensity-Frequency-Duration Coefficient, e	e =	0.773		
25- Year Intensity-Frequency-Duration Coefficient, b	b =	97.500	in	
25- Year Intensity-Frequency-Duration Coefficient, d	d =	10.440	min	
Average Rainfall Intensity, $I = b/(T_c + d)^e$	I =	9.438	in/hr	

Peak Flow, Q

Drainage Area, A	A =	8.10	Ac	
Q= Total Discharge from Watershed = C x I x A	Q =	26.0	**cfs**	Compare to 28.4 cfs

Channel (Hydraflow Express for Civil 3D)

Depth =	1.490	ft	Compare to 1.54
Velocity =	3.900	ft/s	

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

APPENDIX G – CHANNEL ANALYSIS BY AUTOCAD HYDRAFLOW EXPRESS

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Oct 21 2021

Critical Swale #1 (Corresponding to Sub-Basin 2-1 - 1115' on 3:1 Slopes), Unvegetated

Triangular

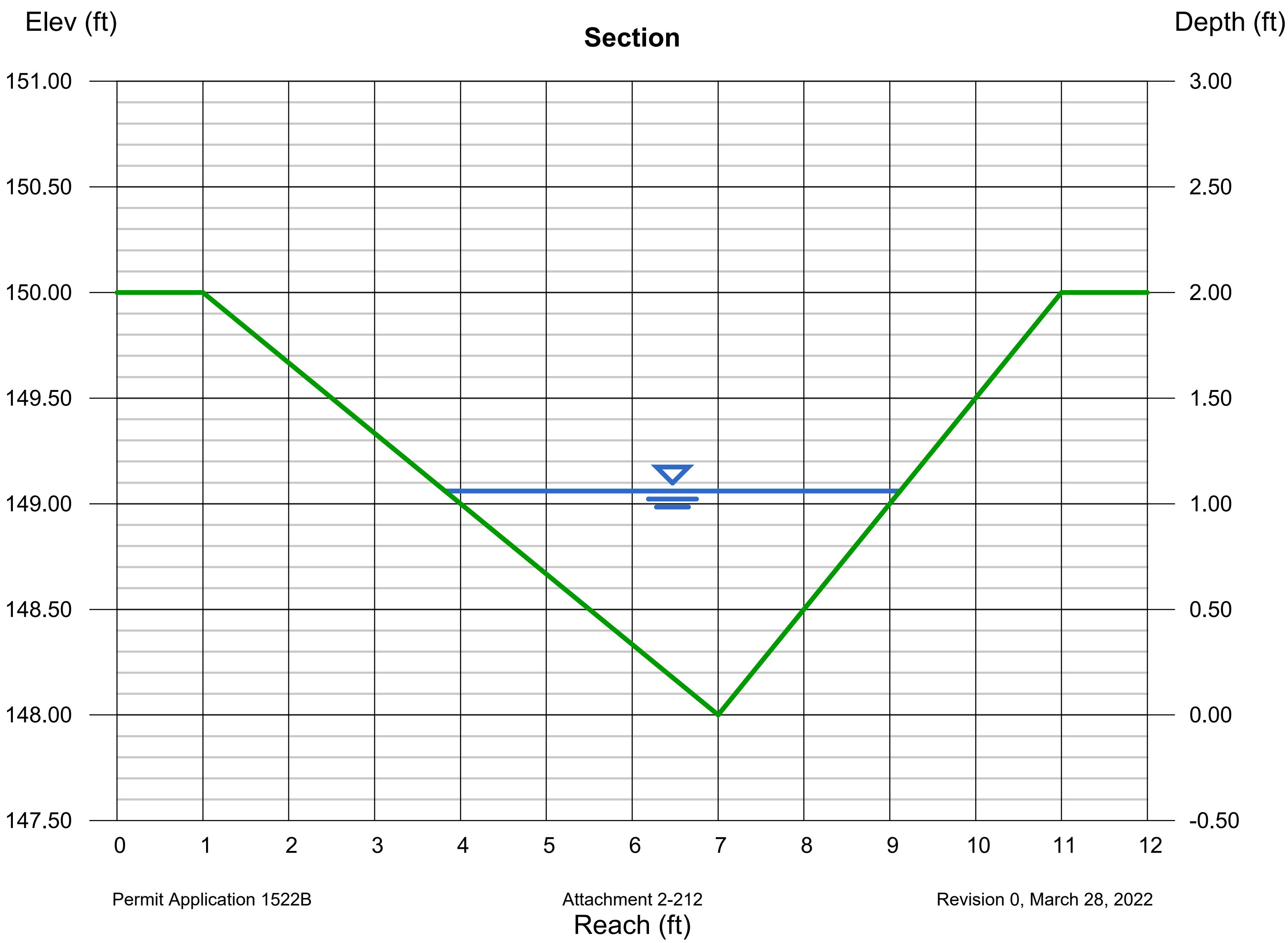
Side Slopes (z:1)	= 3.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 148.00
Slope (%)	= 1.00
N-Value	= 0.011

Calculations

Compute by:	Known Q
Known Q (cfs)	= 23.50

Highlighted

Depth (ft)	= 1.06
Q (cfs)	= 23.50
Area (sqft)	= 2.81
Velocity (ft/s)	= 8.37
Wetted Perim (ft)	= 5.72
Crit Depth, Yc (ft)	= 1.41
Top Width (ft)	= 5.30
EGL (ft)	= 2.15



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Oct 21 2021

Critical Swale #1 (Corresponding to Sub-Basin 2-1 - 1115' on 3:1 Slopes), Vegetated

Triangular

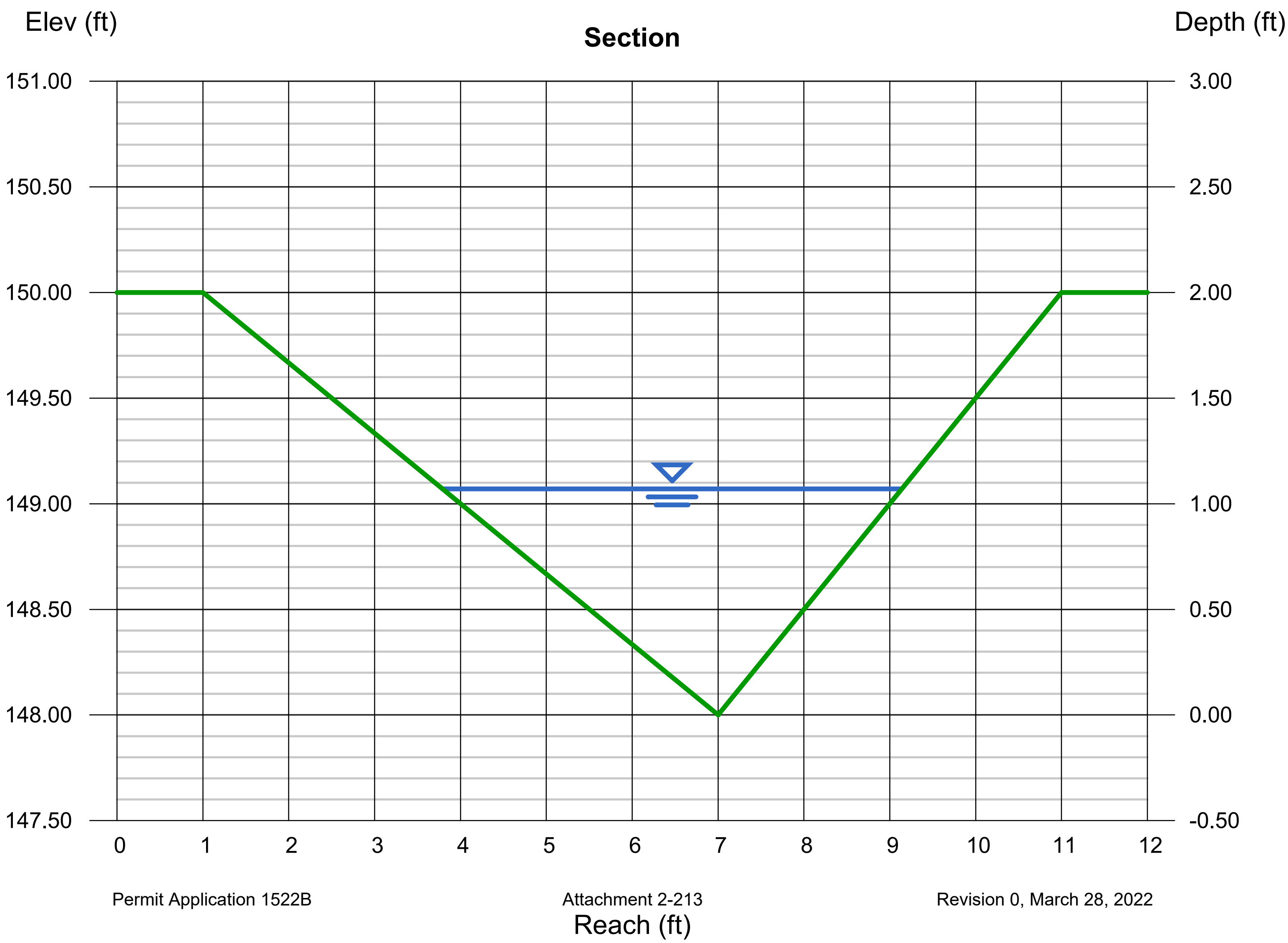
Side Slopes (z:1)	= 3.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 148.00
Slope (%)	= 1.00
N-Value	= 0.024

Calculations

Compute by:	Known Q
Known Q (cfs)	= 10.90

Highlighted

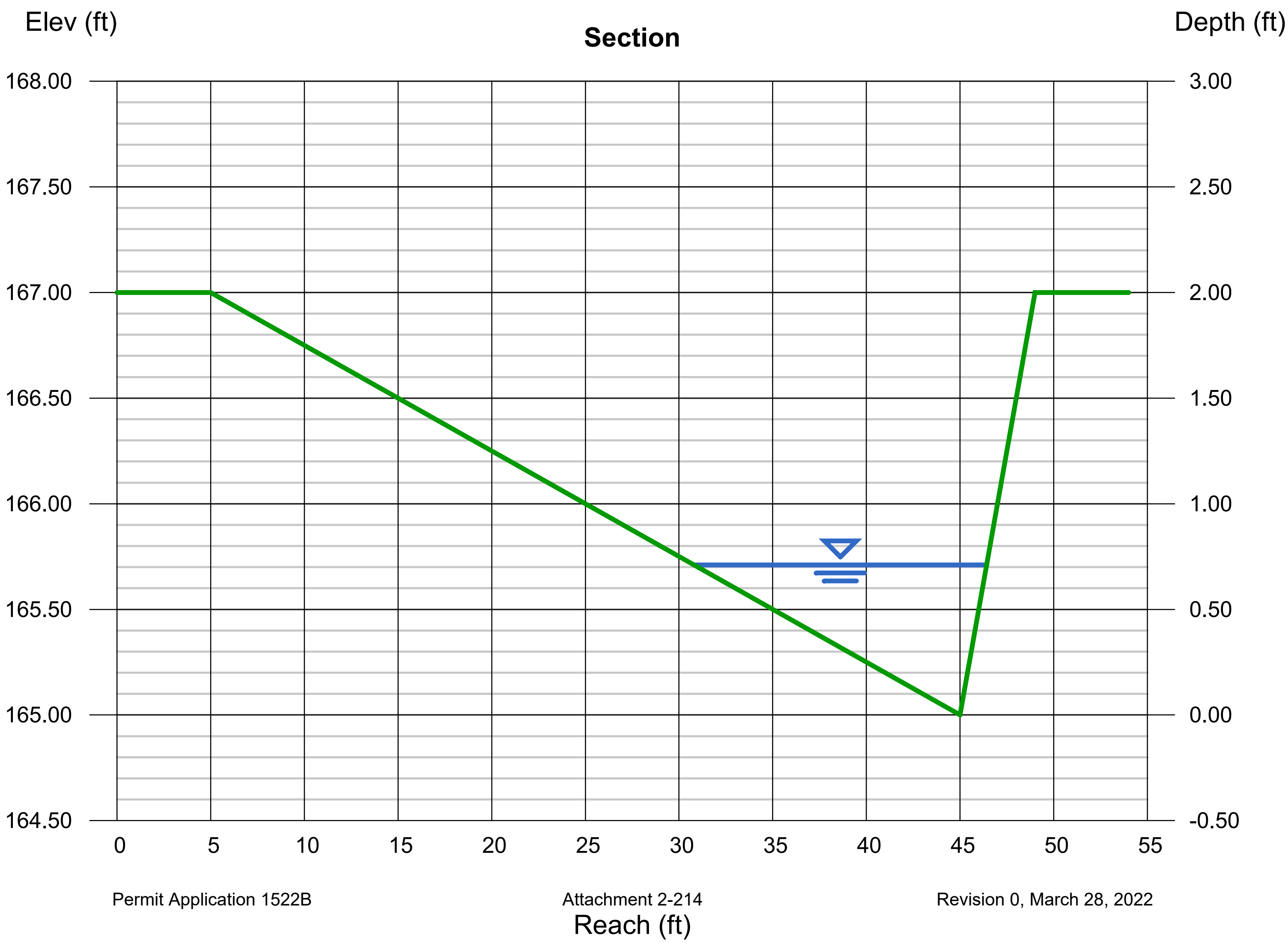
Depth (ft)	= 1.07
Q (cfs)	= 10.90
Area (sqft)	= 2.86
Velocity (ft/s)	= 3.81
Wetted Perim (ft)	= 5.78
Crit Depth, Yc (ft)	= 1.04
Top Width (ft)	= 5.35
EGL (ft)	= 1.30



Channel Report

Critical Swale #2 (Corresponding to Sub-Basin 5-1 - 948' on 5% Slopes), Unvegetated

Triangular		**Highlighted**	
Side Slopes (z:1)	= 20.00, 2.00	Depth (ft)	= 0.71
Total Depth (ft)	= 2.00	Q (cfs)	= 36.10
		Area (sqft)	= 5.55
Invert Elev (ft)	= 165.00	Velocity (ft/s)	= 6.51
Slope (%)	= 1.00	Wetted Perim (ft)	= 15.81
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.93
		Top Width (ft)	= 15.62
Calculations		EGL (ft)	= 1.37
Compute by:	Known Q		
Known Q (cfs)	= 36.10		



Channel Report

Critical Swale #2 (Corresponding to Sub-Basin 5-1 - 948' on 5% Slopes), Vegetated

Triangular

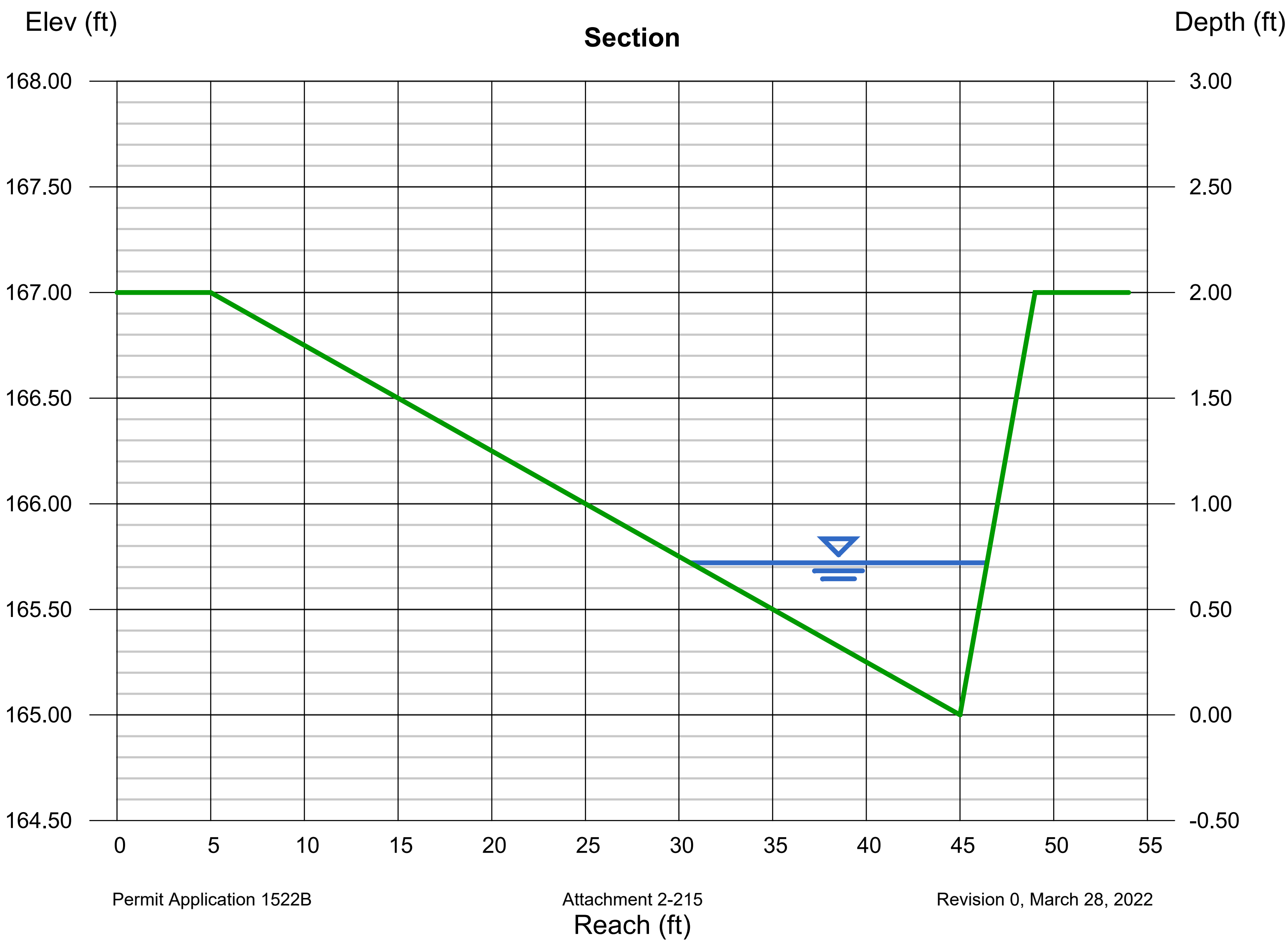
Side Slopes (z:1)	= 20.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 165.00
Slope (%)	= 1.00
N-Value	= 0.024

Calculations

Compute by:	Known Q
Known Q (cfs)	= 17.70

Highlighted

Depth (ft)	= 0.72
Q (cfs)	= 17.70
Area (sqft)	= 5.70
Velocity (ft/s)	= 3.10
Wetted Perim (ft)	= 16.03
Crit Depth, Yc (ft)	= 0.70
Top Width (ft)	= 15.84
EGL (ft)	= 0.87



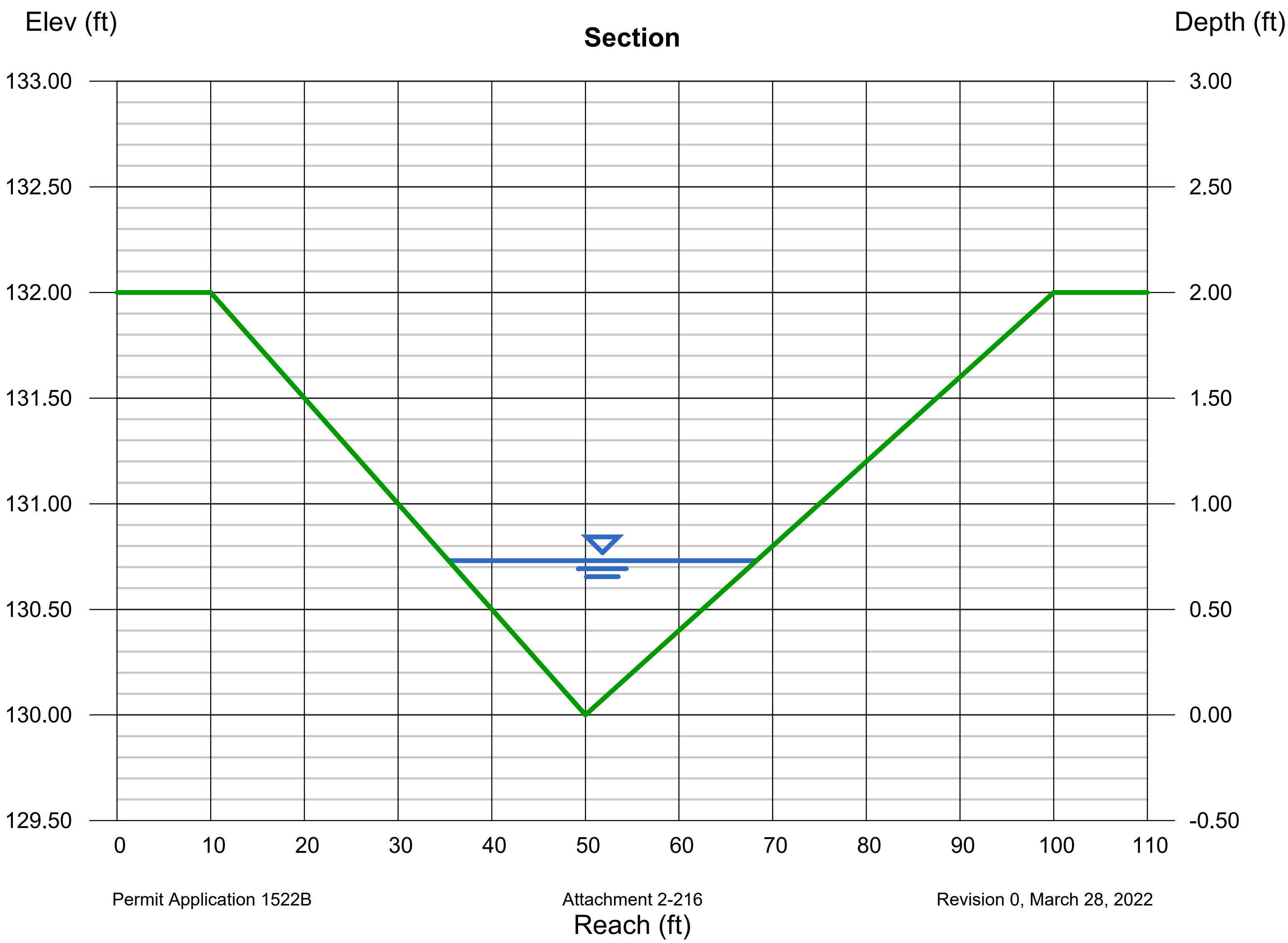
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Oct 21 2021

Critical Swale #3 (Corresponding to Sub-Basin 4-1 - 810' between 5% / 4:1 Slopes), Unve

Triangular	
Side Slopes (z:1)	= 20.00, 25.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 130.00
Slope (%)	= 1.00
N-Value	= 0.011
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 82.40

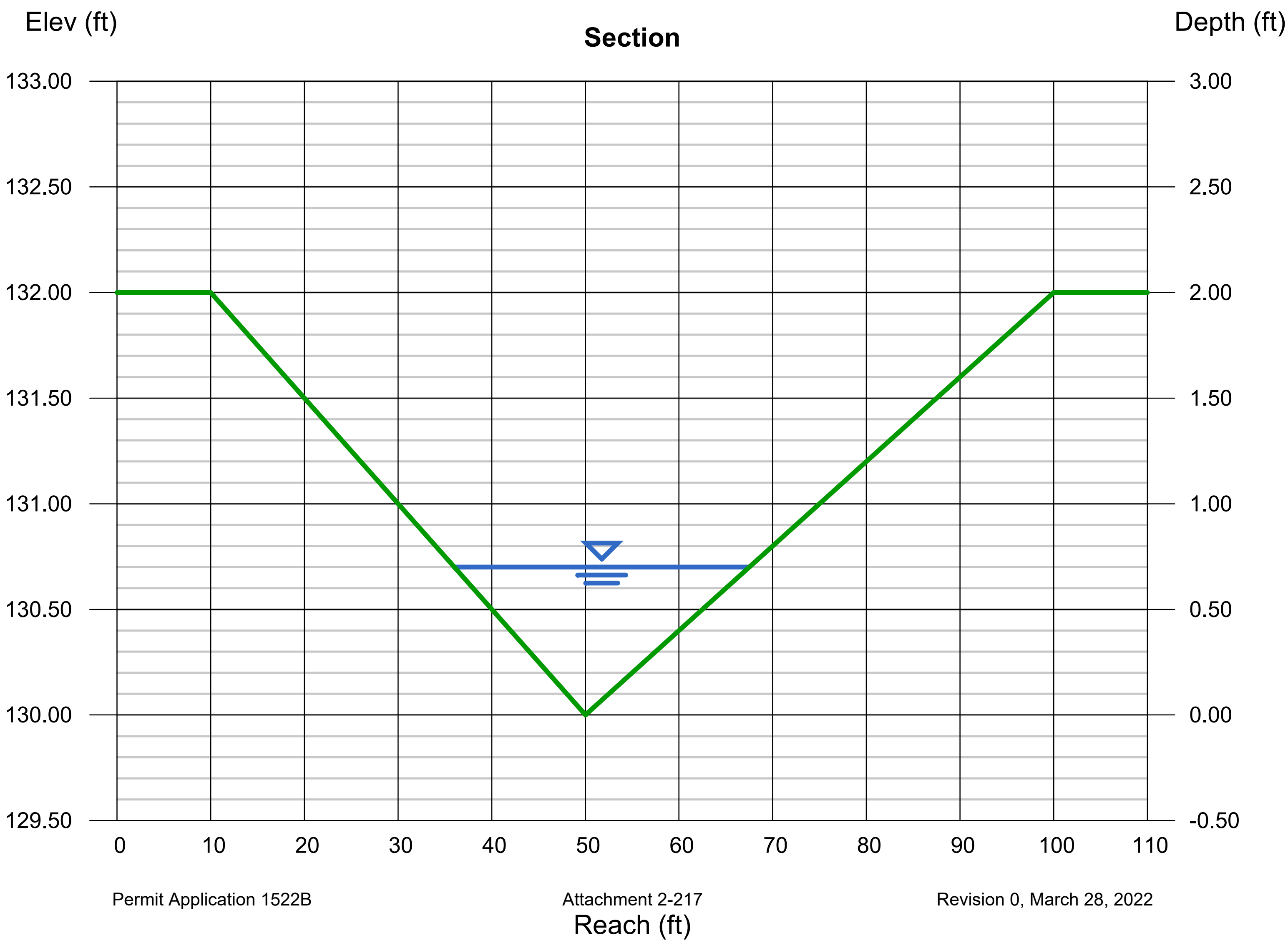
Highlighted	
Depth (ft)	= 0.73
Q (cfs)	= 82.40
Area (sqft)	= 11.99
Velocity (ft/s)	= 6.87
Wetted Perim (ft)	= 32.88
Crit Depth, Yc (ft)	= 0.97
Top Width (ft)	= 32.85
EGL (ft)	= 1.46



Channel Report

Critical Swale #3 (Corresponding to Sub-Basin 4-1 - 810' between 5% / 4:1 Slopes), Vege

Triangular		**Highlighted**	
Side Slopes (z:1)	= 20.00, 25.00	Depth (ft)	= 0.70
Total Depth (ft)	= 2.00	Q (cfs)	= 33.70
		Area (sqft)	= 11.02
Invert Elev (ft)	= 130.00	Velocity (ft/s)	= 3.06
Slope (%)	= 1.00	Wetted Perim (ft)	= 31.53
N-Value	= 0.024	Crit Depth, Yc (ft)	= 0.68
		Top Width (ft)	= 31.50
Calculations		EGL (ft)	= 0.85
Compute by:	Known Q		
Known Q (cfs)	= 33.70		



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 15 2021

Letdown Chute LD-2

Trapezoidal

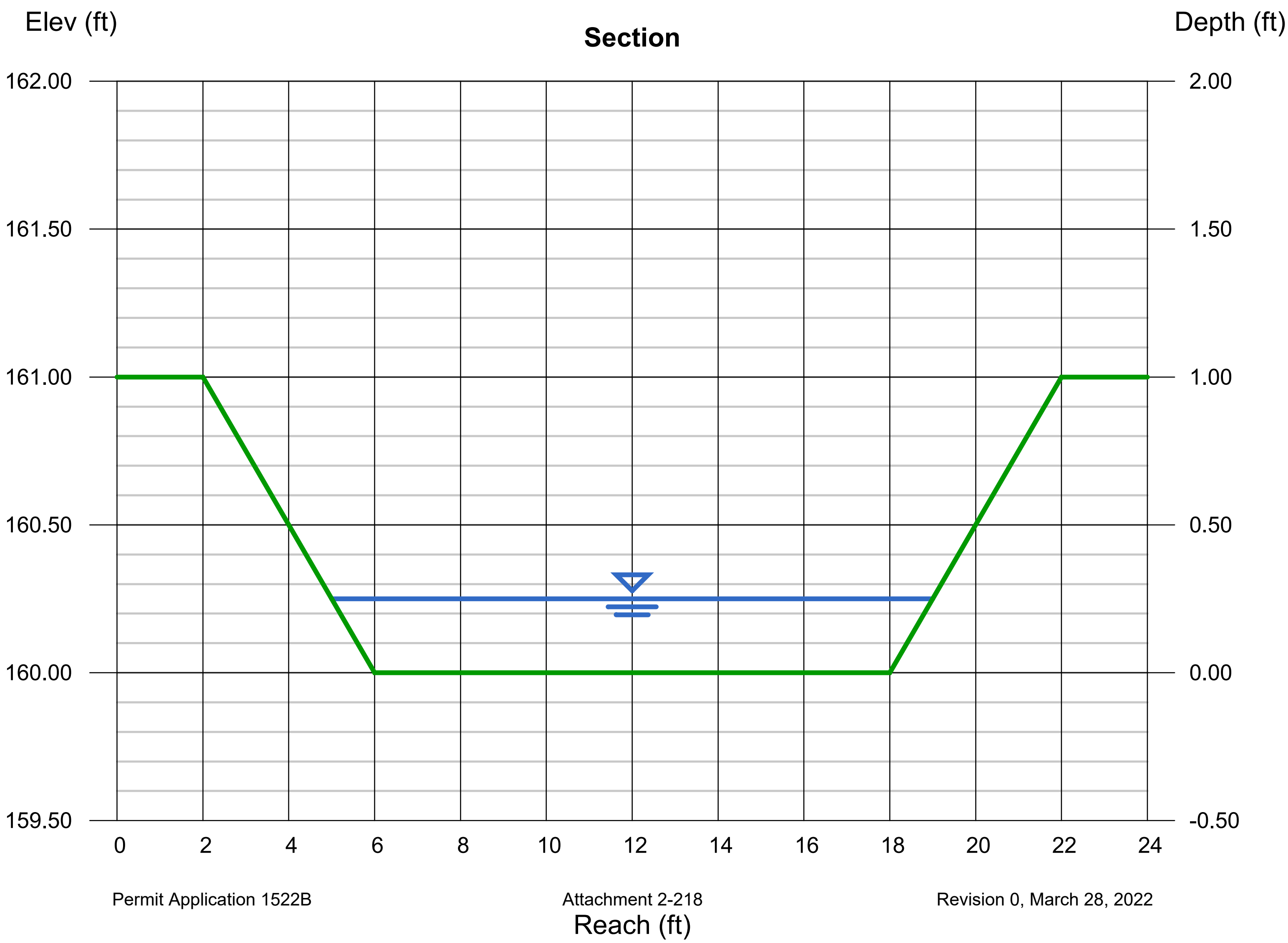
Bottom Width (ft)	=	12.00
Side Slopes (z:1)	=	4.00, 4.00
Total Depth (ft)	=	1.00
Invert Elev (ft)	=	160.00
Slope (%)	=	33.00
N-Value	=	0.009

Calculations

Compute by:		Known Q
Known Q (cfs)	=	113.00

Highlighted

Depth (ft)	=	0.25
Q (cfs)	=	113.00
Area (sqft)	=	3.25
Velocity (ft/s)	=	34.77
Wetted Perim (ft)	=	14.06
Crit Depth, Yc (ft)	=	1.00
Top Width (ft)	=	14.00
EGL (ft)	=	19.05

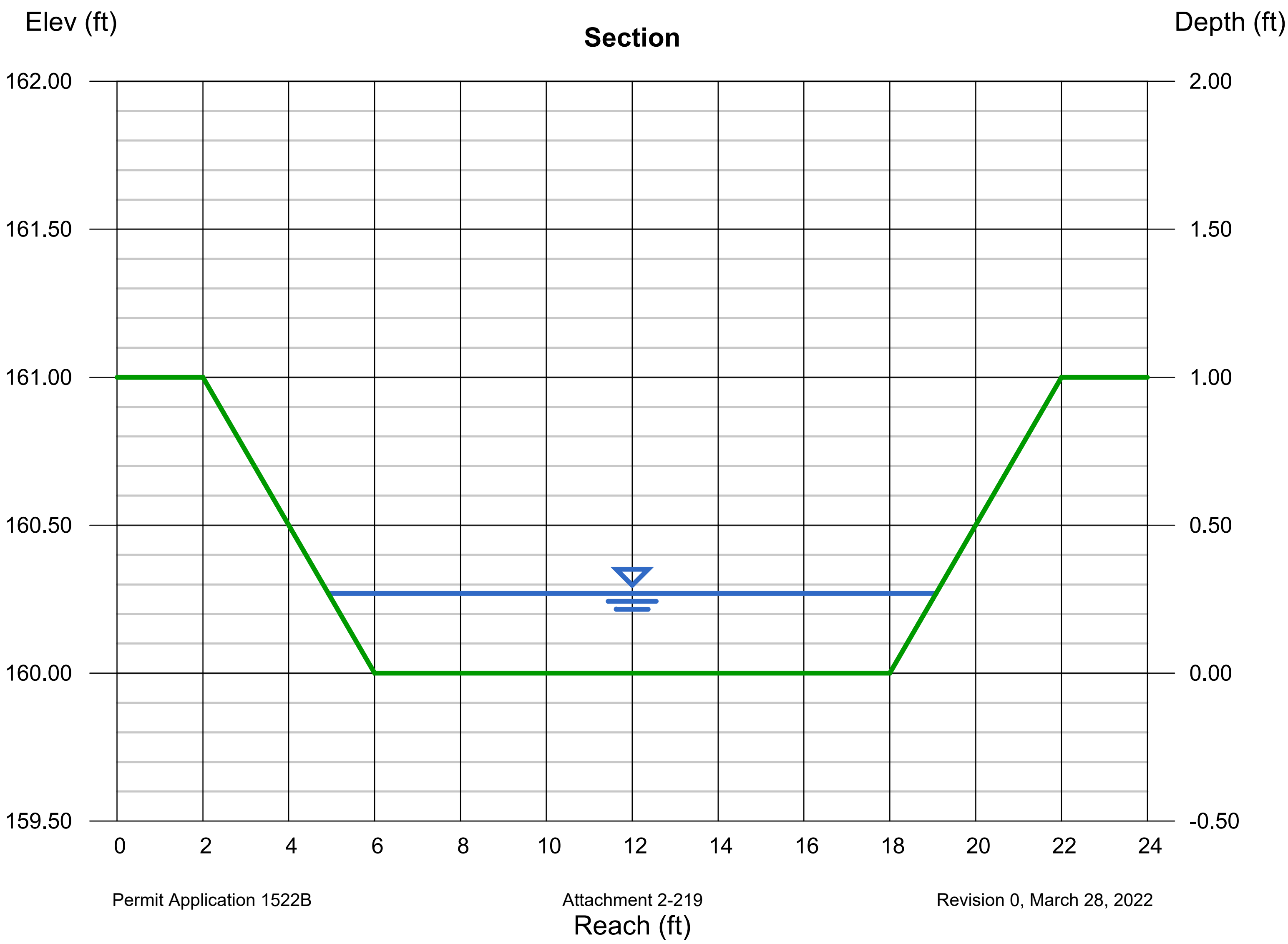


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 15 2021

Letdown Chute LD-3

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 12.00	Depth (ft)	= 0.27
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 111.00
Total Depth (ft)	= 1.00	Area (sqft)	= 3.53
Invert Elev (ft)	= 160.00	Velocity (ft/s)	= 31.43
Slope (%)	= 23.60	Wetted Perim (ft)	= 14.23
N-Value	= 0.009	Crit Depth, Yc (ft)	= 1.00
		Top Width (ft)	= 14.16
Calculations		EGL (ft)	= 15.63
Compute by:	Known Q		
Known Q (cfs)	= 111.00		



APPENDIX H – LETDOWN CHUTE LINING CALCULATIONS

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Letdown Chute ID Critical 3:1 Letdown Chute (LD-2)

				Reference
Length of Channel Section, L		290	ft	
Upstream Elevation		160	ft	
Downstream Elevation		64	ft	
Average channel slope, $S_0 = \Delta$ elev / length	$S_0 =$	0.331	ft/ft	
Bottom Width, B	B =	15	ft	
Side slope eg. 3:1, z	z =	2		
Design Flow Rate, Q	Q =	150.0	ft^3/s	Basin 2 Rational Method, 150 cfs exceeds required flow.
Acceleration due to gravity, g	g =	32.2	ft/s^2	
Gabion Mattress Thickness, Mt	Mt =	1.50	ft	
Mean Rock Size, D_{50}	$D_{50} =$	0.75	ft	
Reynolds Number (Re) = $(gdS_0)^{1/2} \times D_{50} / 1.217$	Re =	62,827.09		
Rock Unit Weight, γ_s	$\gamma_s =$	170	lb/ft^3	
Channel Normal Depth, d	d =	0.31	ft	
Cross-sectional Area of Flow Prism, $A = Bd + Zd^2$	A =	4.84	ft^2	See Reference 1-2
Wetted Perimeter of Flow Prism, $P = B + 2d (Z^2 + 1)^{1/2}$	P =	16.39	ft	See Reference 1-2
Hydraulic Radius, R = A/P	R =	0.30	ft	
Channel Top Width (water surface), T = B + 2dz	T =	16.24	ft	See Reference 1-2
Flow Velocity, V = Q / A	V =	30.98	ft/s	
Average Depth of Flow, $d_a = A / T$	$d_a =$	0.298	ft	
Relative Depth Ratio, d_a / D_{50}	$d_a / D_{50} =$	0.398		
Mannings Roughness Coefficient, n				
$d_a/D_{50} < 1.5$, therefore $n = (1.49\ d_a^{1/6}) / g^{1/2}$ f(Fr) f(REG) f(GC)	n =	0.012		See Reference 1-1
Froude Number, $Fr = V / (g\ d_a)^{1/2}$	Fr =	10.00		See Reference 1-3
function-Froude Number, $f(Fr) = (0.28Fr / b)^{\log(0.755 / b)}$	f(Fr) =	9.857		See Reference 1-1
function-Roughness Element Geometry, $f(REG) = 13.343\ (T/D_{50})^{0.492}\ b^{1.025(T/D50)^{\wedge}}$	f(REG) =	3.143		See Reference 1-1
function-Channel Geometry, $f(GC) = (T / d_a)^{-b}$	f(GC) =	0.586		See Reference 1-1
Roughness Concentration Parameter, $b = 1.14\ (D_{50} / T)^{0.453}\ (d_a / D_{50})^{0.814}$	b =	0.13		See Reference 1-1
Calculate Flowrate using Manning's Equation, $Q_c = (1.49/n)\ A\ R^{2/3}\ S^{1/2}$	$Q_c =$	155.8		See Reference 1-4
Q_c within 5% of Q		OK		
Specific weight of water, γ	$\gamma =$	62.4	lb/ft^3	See Reference 1-5
Shields' Parameter, F	F =	0.10		See Reference 1-6
Thickness Constant, Mt_c	$Mt_c =$	4.07	ft	See Reference 1-6
Permissible Shear Stress, $\tau_p = F\ (\gamma_s - \gamma)\ D_{50}$	$\tau_p =$	8.07	lb/ft^2	See Reference 1-7
Permissible Shear Stress for mattress thickness, $\tau_p = 0.0091\ (\gamma_s - \gamma)\ (Mt + Mt_c)$	$\tau_p =$	5.45	lb/ft^2	See Reference 1-6
Controlling Permissible Shear Stress, τ_p	$\tau_p =$	8.07	lb/ft^2	
Actual Shear Stress, $\tau_d = \gamma\ d\ S_o$	$\tau_d =$	6.41	lb/ft^2	See Reference 1-8
Safety Factor, SF	SF =	1.25		See Reference 1-6
$t_p > SF*t_d$		OK		

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS Date: 2/15/2022

Letdown Chute ID	Basin 3 Letdown Chute (LD-3)		Reference
Length of Channel Section, L	425	ft	
Upstream Elevation	160	ft	
Downstream Elevation	60	ft	
Average channel slope, $S_0 = \Delta$ elev / length	$S_0 =$ 0.235	ft/ft	
Bottom Width, B	B = 15	ft	
Side slope eg. 3:1, z	z = 2		
Design Flow Rate, Q	Q = 111.0	ft^3/s	Basin 3 Rational Method Calculation
Acceleration due to gravity, g	g = 32.2	ft/s^2	
Gabion Mattress Thickness, Mt	Mt = 1.50	ft	
Mean Rock Size, D_{50}	$D_{50} =$ 0.75	ft	
Reynolds Number (Re) = $(gdS_0)^{1/2} \times D_{50} / 1.217$	Re = 47,566.92		
Rock Unit Weight, γ_s	$\gamma_s =$ 170	lb/ft^3	
Channel Normal Depth, d	d = 0.25	ft	
Cross-sectional Area of Flow Prism, $A = Bd + Zd^2$	A = 3.88	ft^2	See Reference 1-2
Wetted Perimeter of Flow Prism, $P = B + 2d (Z^2 + 1)^{1/2}$	P = 16.12	ft	See Reference 1-2
Hydraulic Radius, R = A/P	R = 0.24	ft	
Channel Top Width (water surface), T = B + 2dz	T = 16.00	ft	See Reference 1-2
Flow Velocity, V = Q / A	V = 28.65	ft/s	
Average Depth of Flow, $d_a = A / T$	$d_a =$ 0.242	ft	
Relative Depth Ratio, d_a / D_{50}	$d_a / D_{50} =$ 0.323		
Mannings Roughness Coefficient, n			
$d_a/D_{50} < 1.5$, therefore $n = (1.49\, d_a^{1/6}) / g^{1/2}\, f(Fr)\, f(REG)\, f(GC)$	n = 0.009		See Reference 1-1
Froude Number, $Fr = V / (g\, d_a)^{1/2}$	Fr = 10.26		See Reference 1-3
function-Froude Number, $f(Fr) = (0.28Fr / b)^{\log(0.755 / b)}$	f(Fr) = 14.264		See Reference 1-1
function-Roughness Element Geometry, $f(REG) = 13.343\, (T/D_{50})^{0.492}\, b^{1.025(T/D50)^{\wedge}}$	f(REG) = 2.469		See Reference 1-1
function-Channel Geometry, $f(GC) = (T / d_a)^{-b}$	f(GC) = 0.621		See Reference 1-1
Roughness Concentration Parameter, $b = 1.14\, (D_{50} / T)^{0.453}\, (d_a / D_{50})^{0.814}$	b = 0.11		See Reference 1-1
Calculate Flowrate using Manning's Equation, $Q_c = (1.49/n)\, A\, R^{2/3}\, S^{1/2}$	$Q_c =$ 114.3		See Reference 1-4
Q_c within 5% of Q	OK		
Specific weight of water, γ	$\gamma =$ 62.4	lb/ft^3	See Reference 1-5
Shields' Parameter, F	F = 0.10		See Reference 1-6
Thickness Constant, Mt_c	$Mt_c =$ 4.07	ft	See Reference 1-6
Permissible Shear Stress, $\tau_p = F\, (\gamma_s - \gamma)\, D_{50}$	$\tau_p =$ 8.07	lb/ft^2	See Reference 1-7
Permissible Shear Stress for mattress thickness, $\tau_p = 0.0091\, (\gamma_s - \gamma)\, (Mt + Mt_c)$	$\tau_p =$ 5.45	lb/ft^2	See Reference 1-6
Controlling Permissible Shear Stress, τ_p	$\tau_p =$ 8.07	lb/ft^2	
Actual Shear Stress, $\tau_d = \gamma\, d\, S_o$	$\tau_d =$ 3.67	lb/ft^2	See Reference 1-8
Safety Factor, SF	SF = 1.25		See Reference 1-6
$t_p > SF^*t_d$	OK		

Victoria Landfill
STORM WATER MANAGEMENT CALCULATION

Calculation by: TJS   Date: 2/15/2022

Letdown Chute ID	EX-TBC Letdown (Northwest)		**Reference**
Length of Channel Section, L	280	ft	
Upstream Elevation	134	ft	
Downstream Elevation	64	ft	
Average channel slope, $S_0 = \Delta$ elev / length	$S_0 =$ 0.250	ft/ft	
Bottom Width, B	B = 15	ft	
Side slope eg. 3:1, z	z = 2		
Design Flow Rate, Q	Q = 113.0	ft^3/s	Historic Rational Method calculation
Acceleration due to gravity, g	g = 32.2	ft/s^2	
Gabion Mattress Thickness, Mt	Mt = 1.50	ft	
Mean Rock Size, D_{50}	$D_{50} =$ 0.75	ft	
Reynolds Number (Re) = $(gdS_0)^{1/2} \times D_{50} / 1.217$	Re = 62,790.13		
Rock Unit Weight, γ_s	$\gamma_s =$ 170	lb/ft^3	
Channel Normal Depth, d	d = 0.41	ft	
Cross-sectional Area of Flow Prism, $A = Bd + Zd^2$	A = 6.49	ft^2	See Reference 1-2
Wetted Perimeter of Flow Prism, $P = B + 2d\,(Z^2 + 1)^{1/2}$	P = 16.83	ft	See Reference 1-2
Hydraulic Radius, R = A/P	R = 0.39	ft	
Channel Top Width (water surface), T = B + 2dz	T = 16.64	ft	See Reference 1-2
Flow Velocity, V = Q / A	V = 17.42	ft/s	
Average Depth of Flow, $d_a = A / T$	$d_a =$ 0.390	ft	
Relative Depth Ratio, d_a / D_{50}	$d_a / D_{50} =$ 0.520		
Mannings Roughness Coefficient, n			
$d_a/D_{50} < 1.5$, therefore $n = (1.49\, d_a^{1/6}) / g^{1/2}$ f(Fr) f(REG) f(GC)	n = 0.024		See Reference 1-1
Froude Number, $Fr = V / (g\, d_a)^{1/2}$	Fr = 4.92		See Reference 1-3
function-Froude Number, $f(Fr) = (0.28Fr / b)^{\log(0.755 / b)}$	f(Fr) = 4.086		See Reference 1-1
function-Roughness Element Geometry, $f(REG) = 13.343\,(T/D_{50})^{0.492}\, b^{1.025(T/D50)^{\wedge}}$	f(REG) = 4.282		See Reference 1-1
function-Channel Geometry, $f(GC) = (T / d_a)^{-b}$	f(GC) = 0.540		See Reference 1-1
Roughness Concentration Parameter, $b = 1.14\,(D_{50} / T)^{0.453}\,(d_a / D_{50})^{0.814}$	b = 0.16		See Reference 1-1
Calculate Flowrate using Manning's Equation, $Q_c = (1.49/n)\, A\, R^{2/3}\, S^{1/2}$	$Q_c =$ 107.6		See Reference 1-4
Q_c within 5% of Q	OK		
Specific weight of water, γ	$\gamma =$ 62.4	lb/ft^3	See Reference 1-5
Shields' Parameter, F	F = 0.10		See Reference 1-6
Thickness Constant, Mt_c	$Mt_c =$ 4.07	ft	See Reference 1-6
Permissible Shear Stress, $\tau_p = F\,(\gamma_s - \gamma)\, D_{50}$	$\tau_p =$ 8.07	lb/ft^2	See Reference 1-7
Permissible Shear Stress for mattress thickness, $\tau_p = 0.0091\,(\gamma_s - \gamma)\,(Mt + Mt_c)$	$\tau_p =$ 5.45	lb/ft^2	See Reference 1-6
Controlling Permissible Shear Stress, τ_p	$\tau_p =$ 8.07	lb/ft^2	
Actual Shear Stress, $\tau_d = \gamma\, d\, S_o$	$\tau_d =$ 6.40	lb/ft^2	See Reference 1-8
Safety Factor, SF	SF = 1.25		See Reference 1-6
$t_p > SF*t_d$	OK		

Publication No. FHWA-NHI-05-114
September 2005

U.S. Department of Transportation

Federal Highway Administration

Hydraulic Engineering Circular No. 15, Third Edition

Design of Roadside Channels with Flexible Linings

National Highway Institute

Some channels may experience conditions below the lower end of this range where protrusion of individual riprap elements into the flow field significantly changes the roughness relationship. This condition may be experienced on steep channels, but also occurs on moderate slopes. The relationship described by Bathurst (1991) addresses these conditions and can be written as follows (See Appendix D for the original form of the equation):

$$n = \frac{\alpha\, d_a^{1/6}}{\sqrt{g}\, f(Fr)\, f(REG)\, f(CG)} \tag{6.2}$$

where,

- d_a = average flow depth in the channel, m (ft)
- g = acceleration due to gravity, 9.81 m/s^2 (32.2 ft/s^2)
- Fr = Froude number
- REG = roughness element geometry
- CG = channel geometry
- α = unit conversion constant, 1.0 (SI) and 1.49 (CU)

Equation 6.2 is a semi-empirical relationship applicable for the range of conditions where $0.3<d_a/D_{50}<8.0$. The three terms in the denominator represent functions of Froude number, roughness element geometry, and channel geometry given by the following equations:

$$f(Fr) = \left(\frac{0.28Fr}{b}\right)^{\log(0.755/b)} \tag{6.3}$$

$$f(REG) = 13.434\left(\frac{T}{D_{50}}\right)^{0.492} b^{1.025(T/D_{50})^{0.118}} \tag{6.4}$$

$$f(CG) = \left(\frac{T}{d_a}\right)^{-b} \tag{6.5}$$

where,

- T = channel top width, m (ft)
- b = parameter describing the effective roughness concentration.

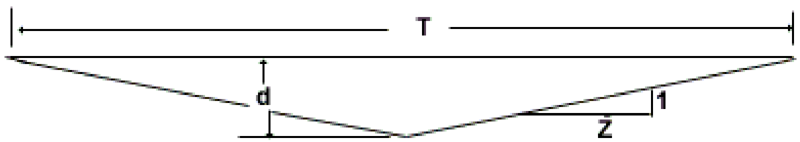
The parameter b describes the relationship between effective roughness concentration and relative submergence of the roughness bed. This relationship is given by:

$$b = 1.14\left(\frac{D_{50}}{T}\right)^{0.453}\left(\frac{d_a}{D_{50}}\right)^{0.814} \tag{6.6}$$

Equations 6.1 and 6.2 both apply in the overlapping range of $1.5 \le d_a/D_{50} \le 8$. For consistency and ease of application over the widest range of potential design situations, use of the Blodgett equation (6.1) is recommended when $1.5 \le d_a/D_{50}$. The Bathurst equation (6.2) is recommended for $0.3<d_a/D_{50}<1.5$.

APPENDIX B: CHANNEL GEOMETRY EQUATIONS

V- SHAPE

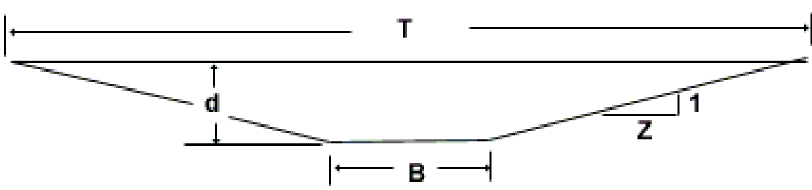


$A = Zd^2$

$p = 2d\sqrt{Z^2 + 1}$

$T = 2dZ$

TRAPEZOIDAL

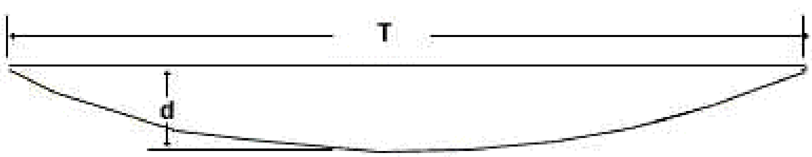


$A = Bd + Zd^2$

$P = B + 2d\sqrt{z^2 + 1}$

$T = B + 2dZ$

PARABOLIC



$$A = \frac{2}{3}Td$$

$$P = \frac{1}{2}\sqrt{16d^2 + T^2} + \left(\frac{T^2}{8d}\right)\ln_e\left(\frac{4d + \sqrt{16d^2 + T^2}}{T}\right)$$

$$T = 1.5\frac{A}{d}$$

Water cannot completely expand to fill the section between the wingwalls in an abrupt expansion. The majority of the flow will stay within an area whose boundaries are defined by:

$$\theta = \tan^{-1}(Fr / 3) \tag{4.3}$$

where,

θ = optimum flare angle

The downstream width of the apron, W_2, is given by:

$$W_2 = W_o + 2L \tan\theta_w \tag{4.4}$$

where,

W_2 = width of apron at length, L, downstream from the culvert outlet, m (ft)

L = distance downstream from culvert outlet, m (ft)

θ_w = wingwall flare angle

If $\theta_w > \theta$ then the designer should consider reducing θ_w to θ. As shown in Figure 4.2 flaring the wingwall more than 1/3Fr (for example 45°) provides unused space which is not completely filled with water.

The design procedure for an abrupt expansion may be summarized in the following steps:

Step 1. Determine the flow conditions at the culvert outlet: V_o and y_o (see Chapter 3).

Step 2. Calculate the Froude number: $\boxed{Fr = V_o /(g\ y_o)^{0.5}}$ at the culvert outlet.

Step 3. Find the optimum flare angle, θ, using Equation 4.3. If the chosen wingwall flare, θ_w, is greater than θ, consider reducing θ_w to θ.

Step 4. Find the average depth on the apron. For boxes, use Figure 4.3. For pipes, use Figure 4.4. The ratio y_A/y_o is obtained knowing the Froude number (Fr) and the desired distance downstream, L.

Step 5. Find average velocity on the apron, V_A, using Equation 4.1 or Equation 4.2. $V_A = V_2$.

Step 6. Calculate the downstream width, W_2, using Equation 4.4.

Step 7. Calculate downstream depth, y_2.

If θ was used in Equation 4.4, calculate $y_2 = Q/(V_A W_2)$. This depth will be larger than y_A since the flow prism is now laterally confined.

If θ_w was used in Equation 4.4, calculate $y_2 = y_A$. However, estimate the average flow width, W_A, $= Q/(V_A y_A)$. Check that $W_A < W_2$. If it is not, then $y_2 = Q/(V_A W_2)$.

<u>Design Example: Abrupt Expansion Transition (SI)</u>

Find the flow conditions (y_2 and V_2) at end of a 3.1 m apron. Assume negligible tailwater. Given:

RCB = 1524 mm x 1524 mm

Wingwall flare $\theta_w = 45°$

Culvert length = 61 m

CHAPTER 2: DESIGN CONCEPTS

The design method presented in this circular is based on the concept of maximum permissible tractive force. The method has two parts, computation of the flow conditions for a given design discharge and determination of the degree of erosion protection required. The flow conditions are a function of the channel geometry, design discharge, channel roughness, channel alignment and channel slope. The erosion protection required can be determined by computing the shear stress on the channel lining (and underlying soil, if applicable) at the design discharge and comparing that stress to the permissible value for the type of lining/soil that makes up the channel boundary.

2.1 OPEN CHANNEL FLOW

2.1.1 Type of Flow

For design purposes in roadside channels, hydraulic conditions are usually assumed to be uniform and steady. This means that the energy slope is approximately equal to average ditch slope, and that the flow rate changes gradually over time. This allows the flow conditions to be estimated using a flow resistance equation to determine the so-called normal flow depth. Flow conditions can be either mild (subcritical) or steep (supercritical). Supercritical flow may create surface waves whose height approaches the depth of flow. For very steep channel gradients, the flow may splash and surge in a violent manner and special considerations for freeboard are required.

More technically, open-channel flow can be classified according to three general conditions:

- uniform or non-uniform flow
- steady or unsteady flow
- subcritical or supercritical flow.

In uniform flow, the depth and discharge remain constant along the channel. In steady flow, no change in discharge occurs over time. Most natural flows are unsteady and are described by runoff hydrographs. It can be assumed in most cases that the flow will vary gradually and can be described as steady, uniform flow for short periods of time. Subcritical flow is distinguished from supercritical flow by a dimensionless number called the Froude number (Fr), which is defined as the ratio of inertial forces to gravitational forces in the system. Subcritical flow (Fr < 1.0) is characterized as tranquil and has deeper, slower velocity flow. In a small channel, subcritical flow can be observed when a shallow wave moves in both the upstream and downstream direction. Supercritical flow (Fr > 1.0) is characterized as rapid and has shallow, high velocity flow. At critical and supercritical flow, a shallow wave only moves in the downstream direction.

2.1.2 Normal Flow Depth

The condition of uniform flow in a channel at a known discharge is computed using the Manning's equation combined with the continuity equation:

$$\boxed{Q = \frac{\alpha}{n} A R^{2/3} S_f^{1/2}} \qquad (2.1)$$

static equilibrium, remaining basically unchanged during all stages of flow. Principles of rigid boundary hydraulics can be applied to evaluate this type of system.

In a dynamic system, some change in the channel bed and/or banks is to be expected due to transport of the sediments that comprise the channel boundary. Stability in a dynamic system is attained when the incoming supply of sediment equals the sediment transport rate. This condition, where sediment supply equals sediment transport, is referred to as dynamic equilibrium. Although some detachment and transport of bed and/or bank sediments occurs, this does not preclude attainment of a channel configuration that is basically stable. A dynamic system can be considered stable so long as the net change does not exceed acceptable levels. Because of the need for reliability, static equilibrium conditions and use of linings to achieve a stable condition is usually preferable to using dynamic equilibrium concepts.

Two methods have been developed and are commonly applied to determine if a channel is stable in the sense that the boundaries are basically immobile (static equilibrium): 1) the permissible velocity approach and 2) the permissible tractive force (shear stress) approach. Under the permissible velocity approach the channel is assumed stable if the mean velocity is lower than the maximum permissible velocity. The tractive force (boundary shear stress) approach focuses on stresses developed at the interface between flowing water and materials forming the channel boundary. By Chow's definition, permissible tractive force is the maximum unit tractive force that will not cause serious erosion of channel bed material from a level channel bed (Chow, 1979).

Permissible velocity procedures were first developed around the 1920's. In the 1950's, permissible tractive force procedures became recognized, based on research investigations conducted by the U.S. Bureau of Reclamation. Procedures for design of vegetated channels using the permissible velocity approach were developed by the SCS and have remained in common use.

In spite of the empirical nature of permissible velocity approaches, the methodology has been employed to design numerous stable channels in the United States and throughout the world. However, considering actual physical processes occurring in open-channel flow, a more realistic model of detachment and erosion processes is based on permissible tractive force which is the method recommended in this publication.

2.2.2 Applied Shear Stress

The hydrodynamic force of water flowing in a channel is known as the tractive force. The basis for stable channel design with flexible lining materials is that flow-induced tractive force should not exceed the permissible or critical shear stress of the lining materials. In a uniform flow, the tractive force is equal to the effective component of the drag force acting on the body of water, parallel to the channel bottom (Chow, 1959). The mean boundary shear stress applied to the wetted perimeter is equal to:

$$\tau_o = \gamma RS_o \tag{2.3}$$

where,

τ_o = mean boundary shear stress, N/m^2 (lb/ft^2)

γ = unit weight of water, 9810 N/m^3 (62.4 lb/ft^3)

R = hydraulic radius, m (ft)

S_o = average bottom slope (equal to energy slope for uniform flow), m/m (ft/ft) where,

τ_p = permissible shear stress, N/m^2 (lb/ft^2)
F_* = Shields' parameter, dimensionless
D_{50} = median stone size, m (ft)

In the tests reported by Simons, et al. (1984), the Shields' parameter for use in Equation 7.1 was found to be equal to 0.10.

A second equation provides for permissible shear stress based on mattress thickness (Simons, et al., 1984). It is applicable for a range of mattress thickness from 0.152 to 0.457 m (0.5 to 1.5 ft).

$$\boxed{\tau_p = 0.0091(\gamma_s - \gamma)(MT + MT_c)} \qquad (7.2)$$

where,

MT = gabion mattress thickness, m (ft)
MT_C = thickness constant, 1.24 m (4.07 ft)

The limits on Equations 7.1 and 7.2 are based on the range of laboratory data from which they are derived. Rock sizes within mattresses typically range from 0.076 to 0.152 m (0.25 to 0.5 ft) rock in the 0.152 m (0.5 ft) thick mattresses to 0.116 to 0.305 m (0.33 to 1 ft) rock in the 0.457 m (1.5 ft) thick mattresses.

When comparing, the permissible shear for gabions with the calculated shear on the channel, a safety factor, SF is required for Equation 3.2. The guidance found in Table 6.1 is applicable to gabions. Since, the Shields parameter in Equation 7.1 is 0.10, the appropriate corresponding safety factor is 1.25. Alternatively, the designer may compute the particle Reynolds number and, using Table 6.1, determine both a Shields' parameter and SF corresponding to the Reynolds number.

7.3 DESIGN PROCEDURE

The design procedure for gabions is as follows. It uses the same roughness relationships developed for riprap.

Step 1. Determine channel slope, channel shape, and design discharge.

Step 2. Select a trial (initial) mattress thickness and fill rock D_{50}, perhaps based on available sizes for the project. (Also, determine specific weight of proposed stone.)

Step 3. Estimate the depth. For the first iteration, select a channel depth, d_i. For subsequent iterations, a new depth can be estimated from the following equation or any other appropriate method.

$$d_{i+1} = d_i \left(\frac{Q}{Q_i}\right)^{0.4}$$

Determine the average flow depth, d_a in the channel. $d_a = A/T$

Step 4. Calculate the relative depth ratio, d_a/D_{50}. If d_a/D_{50} is greater than or equal to 1.5, use Equation 6.1 to calculate Manning's n. If d_a/D_{50} is less than 1.5 use Equation 6.2 to calculate Manning's n. Calculate the discharge using Manning's equation.

CHAPTER 7: GABION LINING DESIGN

Gabions (rock filled wire containers) represent an approach for using smaller rock size than would be required by riprap. The smaller rock is enclosed in larger wire units in the form of mattresses or baskets. Gabion baskets are individual rectangular wire mesh containers filled with rock and frequently applied for grade control structures and retaining walls. Gabion mattresses are also rock filled wire mesh containers. The mattresses are composed of a series of integrated cells that hold the rock allowing for a greater spatial extent in each unit. Potential roadside applications for the gabion mattress include steep channels and rundowns.

The thickness of the gabion mattress may be less than the thickness of an equivalently stable riprap lining. Therefore, gabion mattresses represent a trade-off between less and smaller rock versus the costs of providing and installing the wire enclosures. Gabion mattresses are rarely cost effective on mildly sloped channels.

7.1 MANNING'S ROUGHNESS

Roughness characteristics of gabion mattresses are governed by the size of the rock in the baskets and the wire mesh enclosing the rock. For practical purposes, the effect of the mesh can be neglected. Therefore, Manning's roughness should be determined using the D_{50} of the basket rock as applied to the relationships provided for riprap and gravel linings. (See Section 6.1.)

7.2 PERMISSIBLE SHEAR STRESS

Values for permissible shear stress for gabion mattresses are based on research conducted at laboratory facilities and in the field. However, reports from these studies are difficult to reconcile. Simons, et al. (1984) reported permissible shear stresses in the range of 140 to 190 N/m^2 (3 to 4 lb/ft^2) while Clopper and Chen (1988) reported values approaching 1700 N/m^2 (35 lb/ft^2). Simons, et al. tested mattresses ranging in depth from 152 to 457 mm (6 to 18 in) and on slopes of up to 2 percent. Since the objective was to test embankment overtopping, Clopper and Chen tested 152 mm (6 in) mattresses on 25 and 33 percent slopes.

The difference in reported permissible shear stresses may be partly due to the definition of failure. In the Clopper and Chen report, failure was noted after rocks within the basket had shifted to the downstream end of the baskets and an undulating surface was formed leaving part of the embankment exposed. Although this may be an appropriate definition for a rare embankment-overtopping event, such failure is not appropriate for the more frequently occurring roadside design event. For this reason as well as to provide for conservative guidance, the Simons et al. results are emphasized in this guidance.

Permissible shear stress for gabions may be estimated based on the size of the rock fill or based on gabion mattress thickness. Both estimates are determined and the largest value is taken as the permissible shear stress.

Equation 7.1 provides a relationship for permissible shear stress based on rock fill size (Simons, et al., 1984). This shear stress exceeds that of loose riprap because of the added stability provided by the wire mesh. The equation is valid for a range of D_{50} from 0.076 to 0.457 m (0.25 to 1.5 ft)

$$\boxed{\tau_p = F_*(\gamma_s - \gamma)D_{50}} \tag{7.1}$$

Shear stress in channels is not uniformly distributed along the wetted perimeter (USBR, 1951; Olsen and Florey, 1952; Chow, 1959; Anderson, et al., 1970). A typical distribution of shear stress in a prismatic channel is shown in Figure 2.1. The shear stress is zero at the water surface and reaches a maximum on the centerline of the channel. The maximum for the side slopes occurs at about the lower third of the side.

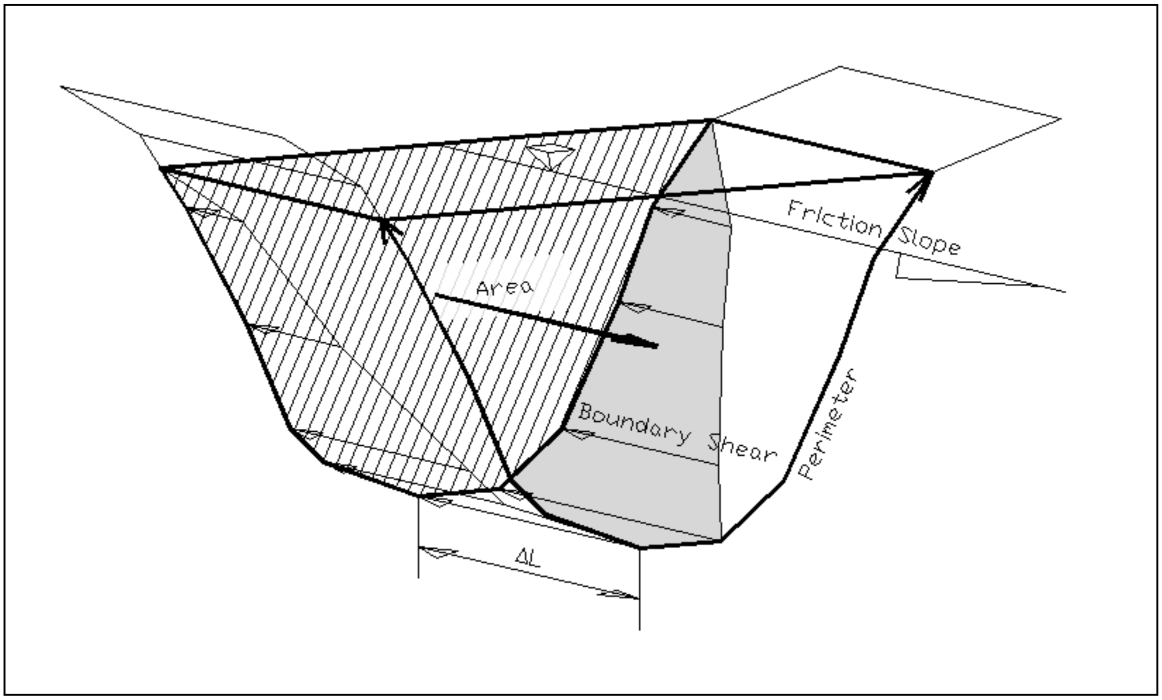


Figure 2.1. Typical Distribution of Shear Stress

The maximum shear stress on a channel bottom, τ_d, and on the channel side, τ_s, in a straight channel depends on the channel shape. To simplify the design process, the maximum channel bottom shear stress is taken as:

$$\boxed{\tau_d = \gamma \, dS_o} \tag{2.4}$$

where,

τ_d = shear stress in channel at maximum depth, N/m^2 (lb/ft^2)

d = maximum depth of flow in the channel for the design discharge, m (ft)

For trapezoidal channels where the ratio of bottom width to flow depth (B/d) is greater than 4, Equation 2.4 provides an appropriate design value for shear stress on a channel bottom. Most roadside channels are characterized by this relatively shallow flow compared to channel width. For trapezoidal channels with a B/d ratio less than 4, Equation 2.4 is conservative. For example, for a B/d ratio of 3, Equation 2.4 overestimates actual bottom shear stress by 3 to 5 percent for side slope values (Z) of 6 to 1.5, respectively. For a B/d ratio of 1, Equation 2.5 overestimates actual bottom shear stress by 24 to 35 percent for the same side slope values of 6 to 1.5, respectively. In general, Equation 2.4 overestimates in cases of relatively narrow channels with steep side slopes.

Publication No. FHWA-NHI-06-086
July 2006

U.S. Department of Transportation

Federal Highway Administration

Hydraulic Engineering Circular No. 14, Third Edition

Hydraulic Design of Energy Dissipators for Culverts and Channels

National Highway Institute

useful for design and were eliminated. An additional 69 runs where $h_s/D_{50}<2$ were also eliminated by the authors of this edition of HEC 14. These runs were not considered reliable for design, especially those with $h_s = 0$. Therefore, the final design development used 149 runs from the study. Of these, 106 were for pipe culverts and 43 were for box culverts. Based on these data, two design relationships are presented here: an envelope design and a best fit design.

To balance the need for avoiding an underdesigned basin against the costs of oversizing a basin, an envelope design relationship in the form of Equation 10.1 and Equation 10.2 was developed. These equations provide a design envelope for the experimental data equivalent to the design figure (Figure XI-2) provided in the previous edition of HEC 14 (Corry, et al., 1983). Equations 10.1 and 10.2, however, improve the fit to the experimental data reducing the root-mean-square (RMS) error from 1.24 to 0.83.

$$\boxed{\frac{h_s}{y_e} = 0.86\left(\frac{D_{50}}{y_e}\right)^{-0.55}\left(\frac{V_o}{\sqrt{g y_e}}\right) - C_o} \qquad (10.1)$$

where,

h_s = dissipator pool depth, m (ft)
y_e = equivalent brink (outlet) depth, m (ft)
D_{50} = median rock size by weight, m (ft)
C_o = tailwater parameter

The tailwater parameter, C_o, is defined as:

$$\begin{array}{ll} C_o = 1.4 & TW/y_e < 0.75 \\ C_o = 4.0(TW/y_e) - 1.6 & 0.75 < TW/y_e < 1.0 \\ C_o = 2.4 & 1.0 < TW/y_e \end{array} \qquad (10.2)$$

A best fit design relationship that minimizes the RMS error when applied to the experimental data was also developed. Equation 10.1 still applies, but the description of the tailwater parameter, C_o, is defined in Equation 10.3. The best fit relationship for Equations 10.1 and 10.3 exhibits a RMS error on the experimental data of 0.56.

$$\begin{array}{ll} C_o = 2.0 & TW/y_e < 0.75 \\ C_o = 4.0(TW/y_e) - 1.0 & 0.75 < TW/y_e < 1.0 \\ C_o = 3.0 & 1.0 < TW/y_e \end{array} \qquad (10.3)$$

Use of the envelope design relationship (Equations 10.1 and 10.2) is recommended when the consequences of failure at or near the design flow are severe. Use of the best fit design relationship (Equations 10.1 and 10.3) is recommended when basin failure may easily be addressed as part of routine maintenance. Intermediate risk levels can be adopted by the use of intermediate values of C_o.

10.1.2 Basin Length

Frequency tables for both box culvert data and pipe culvert data of relative length of scour hole ($L_s/h_s < 6$, $6 < L_s/h_s < 7$, $7 < L_s/h_s < 8$ . . . $25 < L_s/h_s < 30$), with relative tailwater depth TW/y_e in increments of 0.03 m (0.1 ft) as a third variable, were constructed using data from 346

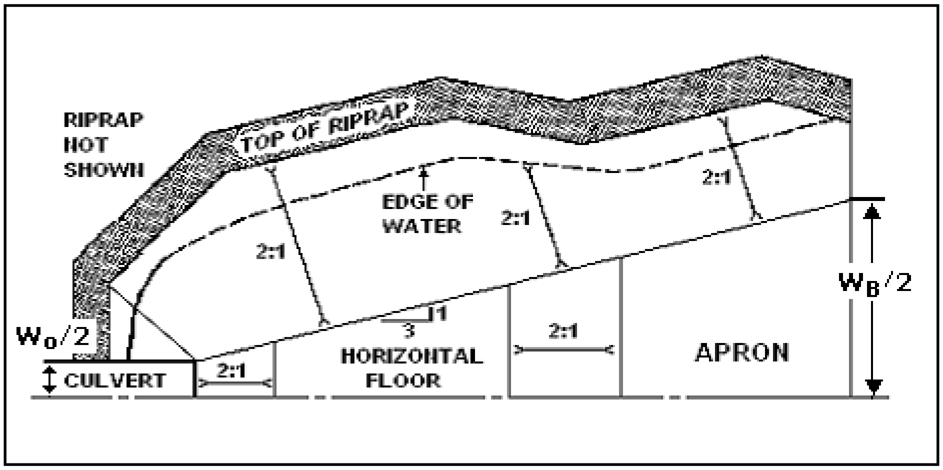


Figure 10.2. Half Plan of Riprap Basin

10.1.1 Design Development

Tests were conducted with pipes from 152 mm (6 in) to 914 mm (24 in) and 152 mm (6 in) high model box culverts from 305 mm (12 in) to 610 mm (24 in) in width. Discharges ranged from 0.003 to 2.8 m^3/s (0.1 to 100 ft^3/s). Both angular and rounded rock with an average size, D_{50}, ranging from 6 mm (1.4 in) to 177 mm (7 in) and gradation coefficients ranging from 1.05 to 2.66 were tested. Two pipe slopes were considered, 0 and 3.75%. In all, 459 model basins were studied. The following conclusions were drawn from an analysis of the experimental data and observed operating characteristics:

- The scour hole depth, h_s; length, L_s; and width, W_s, are related to the size of riprap, D_{50}; discharge, Q; brink depth, y_o; and tailwater depth, TW.
- Rounded material performs approximately the same as angular rock.
- For low tailwater ($TW/y_o < 0.75$), the scour hole functions well as an energy dissipator if $h_s/D_{50} > 2$. The flow at the culvert brink plunges into the hole, a jump forms and flow is generally well dispersed.
- For high tailwater ($TW/y_o > 0.75$), the high velocity core of water passes through the basin and diffuses downstream. As a result, the scour hole is shallower and longer.
- The mound of material that forms downstream contributes to the dissipation of energy and reduces the size of the scour hole. If the mound is removed, the scour hole enlarges somewhat.

Plots were constructed of h_s/y_e versus $V_o/(gy_e)^{1/2}$ with D_{50}/y_e as the third variable. Equivalent brink depth, y_e, is defined to permit use of the same design relationships for rectangular and circular culverts. For rectangular culverts, $y_e = y_o$ (culvert brink depth). For circular culverts, $y_e = (A/2)^{1/2}$, where A is the brink area.

Anticipating that standard or modified end sections would not likely be used when a riprap basin is located at a culvert outlet, the data with these configurations were not used to develop the design relationships. This assumption reduced the number of applicable runs to 346. A total of 128 runs had a D_{50}/y_e of less than 0.1. These data did not exhibit relationships that appeared

CHAPTER 10: RIPRAP BASINS AND APRONS

Riprap is a material that has long been used to protect against the forces of water. The material can be pit-run (as provided by the supplier) or specified (standard or special). State DOTs have standard specifications for a number of classes (sizes or gradations) of riprap. Suppliers maintain an inventory of frequently used classes. Special gradations of riprap are produced on-demand and are therefore more expensive than both pit-run and standard classes.

This chapter includes discussion of both riprap aprons and riprap basin energy dissipators. Both can be used at the outlet of a culvert or chute (channel) by themselves or at the exit of a stilling basin or other energy dissipator to protect against erosion downstream. Section 10.1 provides a design procedure for the riprap basin energy dissipator that is based on armoring a pre-formed scour hole. The riprap for this basin is a special gradation. Section 10.2 includes discussion of riprap aprons that provide a flat armored surface as the only dissipator or as additional protection at the exit of other dissipators. The riprap for these aprons is generally from State DOT standard classes. Section 10.3 provides additional discussion of riprap placement downstream of energy dissipators.

10.1 RIPRAP BASIN

The design procedure for the riprap basin is based on research conducted at Colorado State University (Simons, et al., 1970; Stevens and Simons, 1971) that was sponsored by the Wyoming Highway Department. The recommended riprap basin that is shown on Figure 10.1 and Figure 10.2 has the following features:

- The basin is pre-shaped and lined with riprap that is at least $2D_{50}$ thick.
- The riprap floor is constructed at the approximate depth of scour, h_s, that would occur in a thick pad of riprap. The h_s/D_{50} of the material should be greater than 2.
- The length of the energy dissipating pool, L_s, is $10h_s$, but no less than $3W_o$; the length of the apron, L_A, is $5h_s$, but no less than W_o. The overall length of the basin (pool plus apron), L_B, is $15h_s$, but no less than $4W_o$.
- A riprap cutoff wall or sloping apron can be constructed if downstream channel degradation is anticipated as shown in Figure 10.1.

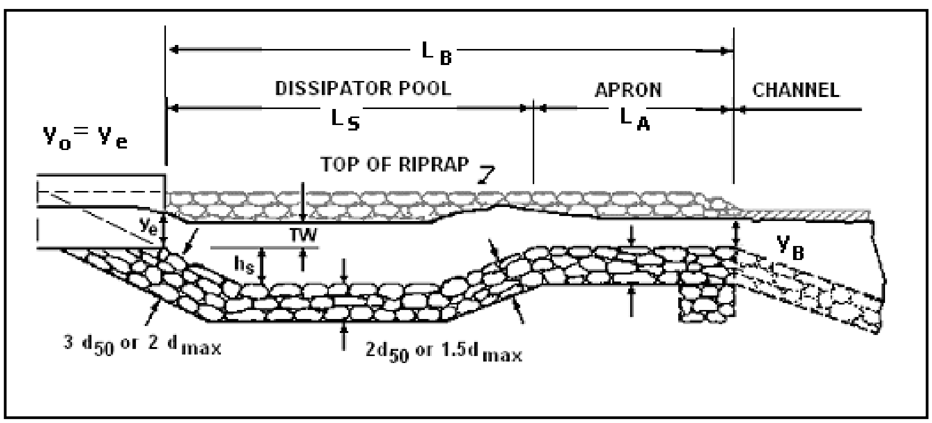


Figure 10.1. Profile of Riprap Basin

10.1.5 Design Procedure

The design procedure for a riprap basin is as follows:

Step 1. Compute the culvert outlet velocity, V_o, and depth, y_o.

For subcritical flow (culvert on mild or horizontal slope), use Figure 3.3 or Figure 3.4 to obtain y_o/D, then obtain V_o by dividing Q by the wetted area associated with y_o. D is the height of a box culvert or diameter of a circular culvert.

For supercritical flow (culvert on a steep slope), V_o will be the normal velocity obtained by using the Manning's Equation for appropriate slope, section, and discharge.

Compute the Froude number, Fr, for brink conditions using brink depth for box culverts (y_e=y_o) and equivalent depth ($y_e = (A/2)^{1/2}$) for non-rectangular sections.

Step 2. Select D_{50} appropriate for locally available riprap. Determine C_o from Equation 10.2 or 10.3 and obtain h_s/y_e from Equation 10.1. Check to see that $h_s/D_{50} \geq 2$ and $D_{50}/y_e \geq 0.1$. If h_s/D_{50} or D_{50}/y_e is out of this range, try a different riprap size. (Basins sized where h_s/D_{50} is greater than, but close to, 2 are often the most economical choice.)

Step 3. Determine the length of the dissipation pool (scour hole), L_s, total basin length, L_B, and basin width at the basin exit, W_B, as shown in Figures 10.1 and 10.2. The walls and apron of the basin should be warped (or transitioned) so that the cross section of the basin at the exit conforms to the cross section of the natural channel. Abrupt transition of surfaces should be avoided to minimize separation zones and resultant eddies.

Step 4. Determine the basin exit depth, $y_B = y_c$, and exit velocity, $V_B = V_c$ and compare with the allowable exit velocity, V_{allow}. The allowable exit velocity may be taken as the estimated normal velocity in the tailwater channel or a velocity specified based on stability criteria, whichever is larger. Critical depth at the basin exit may be determined iteratively using Equation 7.14:

$Q^2/g = (A_c)^3/T_c = [y_c(W_B + zy_c)]^3/ (W_B + 2zy_c)$ by trial and success to determine y_B.

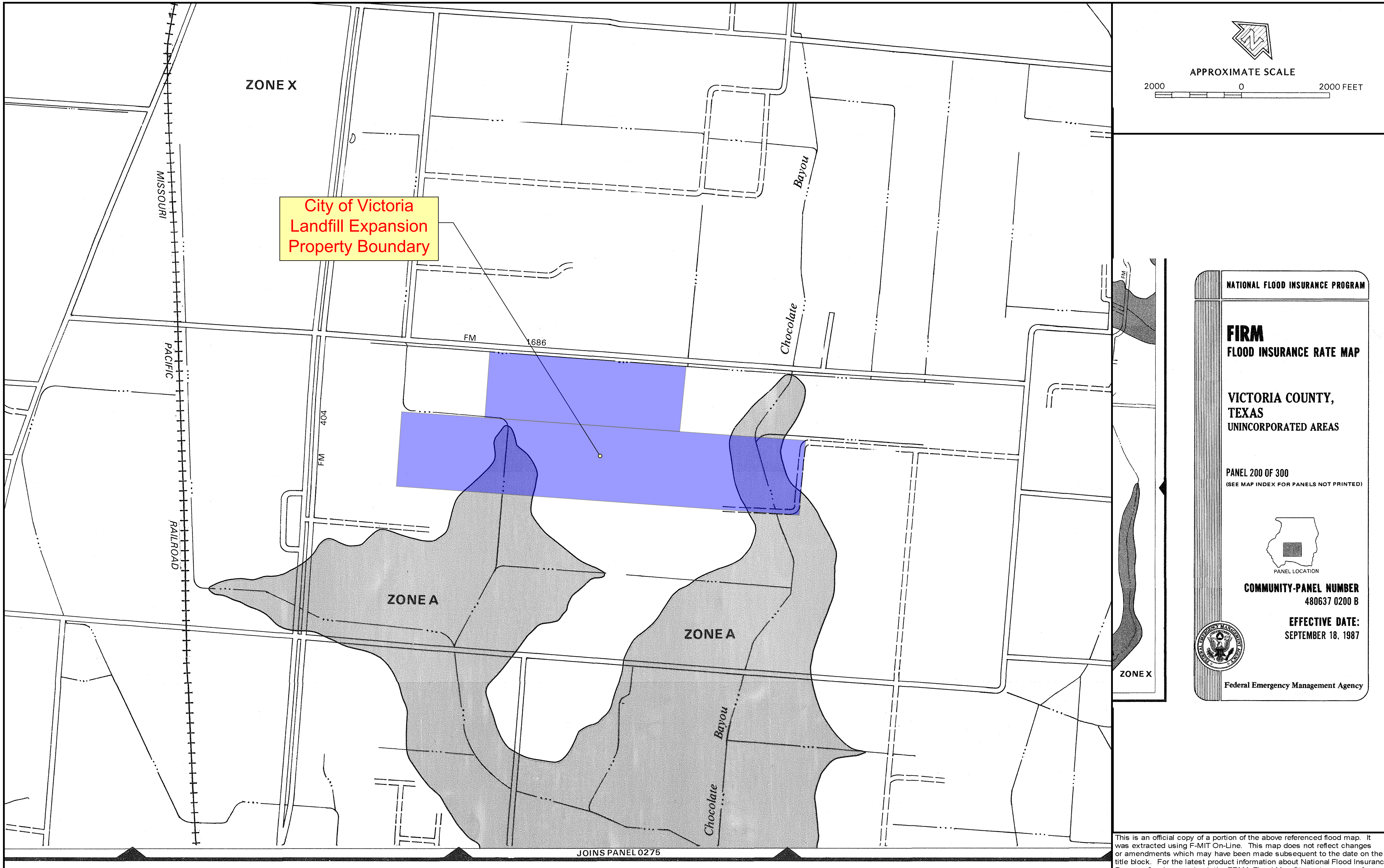
$V_c = Q/A_c$

z = basin side slope, z:1 (H:V)

If $V_c \leq V_{allow}$, the basin dimensions developed in step 3 are acceptable. However, it may be possible to reduce the size of the dissipator pool and/or the apron with a larger riprap size. It may also be possible to maintain the dissipator pool, but reduce the flare on the apron to reduce the exit width to better fit the downstream channel. Steps 2 through 4 are repeated to evaluate alternative dissipator designs.

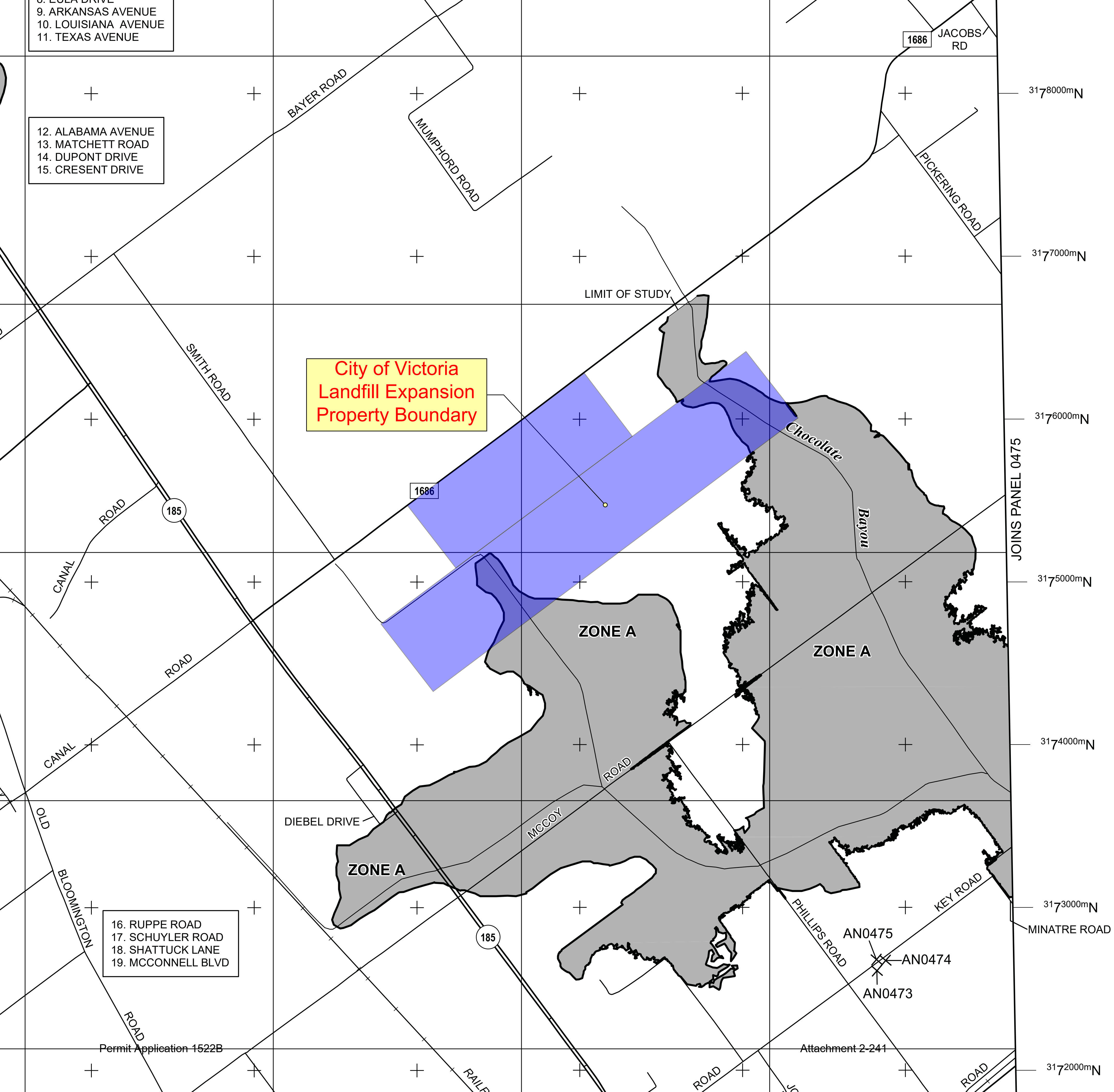
Step 5. Assess need for additional riprap downstream of the dissipator exit. If $TW/y_o \leq 0.75$, no additional riprap is needed. With high tailwater ($TW/y_o \geq 0.75$), estimate centerline velocity at a series of downstream cross sections using Figure 10.3 to determine the size and extent of additional protection. The riprap design details should be in accordance with specifications in HEC 11 (Brown and Clyde, 1989) or similar highway department specifications.

APPENDIX I – FIRM PANEL NUMBER 4806370500B



City of Victoria
Landfill Expansion
Property Boundary
ZONE X
ZONE A
ZONE A
MISSOURI
PACIFIC
RAILROAD
FM
1686
FM
404
Chocolate
Bayou
Chocolate
Bayou
JOINS PANEL 0275
APPROXIMATE SCALE
2000
0
2000 FEET
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
VICTORIA COUNTY, TEXAS
UNINCORPORATED AREAS
PANEL 200 OF 300
(SEE MAP INDEX FOR PANELS NOT PRINTED)
PANEL LOCATION
COMMUNITY-PANEL NUMBER
480637 0200 B
EFFECTIVE DATE:
SEPTEMBER 18, 1987
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX J – FIRM PANEL NUMBER 48469C0450H



For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0450H

FIRM

FLOOD INSURANCE RATE MAP

VICTORIA COUNTY, TEXAS

AND INCORPORATED AREAS

PANEL 450 OF 625

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
VICTORIA COUNTY, UNINCORPORATED AREAS	480637	0450	H

REVISED PRELIMINARY
APRIL 30, 2020

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48469C0450H

EFFECTIVE DATE

Federal Emergency Management Agency

APPENDIX K – ANNOTATED FIRM

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map was Texas State Plane South Central Zone (FIPS 4204). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at https://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit their website at https://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from multiple sources. Base map files were provided in digital format by the U.S. Geological Survey (USGS 1989), National Geodetic Survey (NGS 2004), U.S. Census Bureau TIGER files 2019, Texas Natural Resources Information System (TNRIS 2019), and the City of Victoria (2020).

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **FEMA Map Service Center** (MSC) website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at https://www.fema.gov/national-flood-insurance-program.

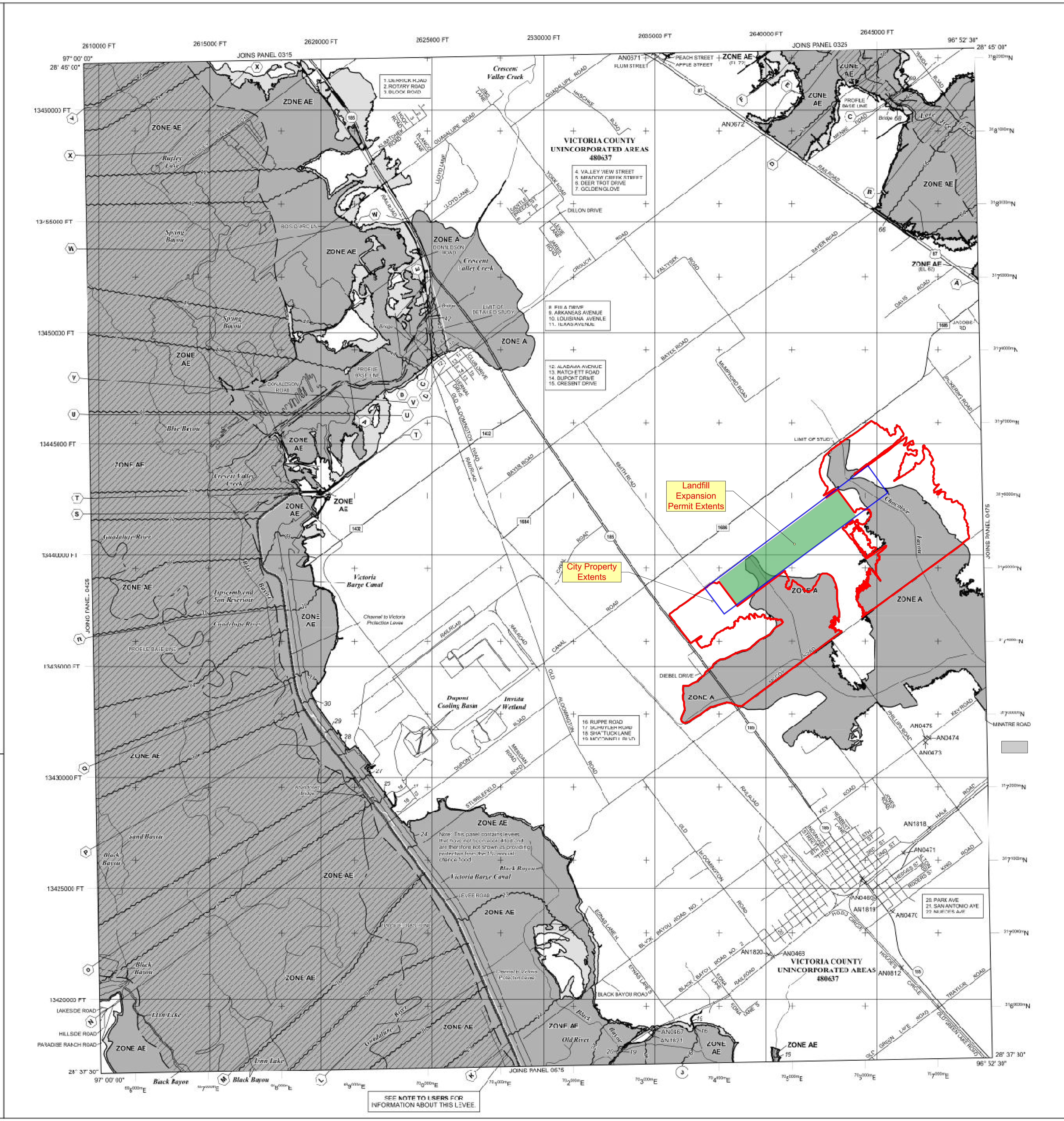
NOTE TO USERS

Non-Accredited Levee Note: This levee system does not meet the minimum requirements of Section 65.10 of the NFIP Regulations, and therefore flood hazard boundaries were determined by the methods which were coordinated and reviewed with impact communities and other stakeholders.

Annotated Legend

Proposed Zone A 1% Annual Chance Floodplain

Effective "Preliminary" Zone A Floodplain



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary
0.2% Annual Chance Floodplain Boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
513 Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line
23 - - - 23 Transect line
45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
$^{48}89^{000m}$ N 1000-meter Universal Transverse Mercator grid values, zone 0101
DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0450H

FIRM
FLOOD INSURANCE RATE MAP
VICTORIA COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 450 OF 625
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
VICTORIA COUNTY, UNINCORPORATED AREAS	480637	0450	H

REVISED PRELIMINARY APRIL 30, 2020

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 48469C0450H

EFFECTIVE DATE

Federal Emergency Management Agency

APPENDIX L – CLOMR COVER LETTER

Federal Emergency Management Agency

Washington, D.C. 20472

November 25, 2020

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 20-06-2477R

The Honorable Ben Zeller
Victoria County Judge
101 North Bridge Street, Room 102
Victoria, TX 77901

Community Name: Victoria County, TX
Community No.: 480637

104

Dear Judge Zeller:

We are providing our comments with the enclosed Conditional Letter of Map Revision (CLOMR) on a proposed project within your community that, if constructed as proposed, could revise the effective Flood Insurance Rate Map (FIRM) for your community.

If you have any questions regarding the floodplain management regulations for your community, the National Flood Insurance Program (NFIP) in general, or technical questions regarding this CLOMR, please contact the Director, Mitigation Division of the Federal Emergency Management Agency (FEMA) Regional Office in Denton, Texas, at (940) 898-5127, or the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP). Additional information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Sincerely,

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Enclosure:
Conditional Letter of Map Revision Comment Document

cc: Mr. John Johnston, P.E., CFM
County Engineer and Floodplain Administrator
Victoria County

Mr. Darryl Lesak
Director of Environmental Services
City of Victoria

Mr. Leon Staab, P.E.
Project Manager
Burns & McDonnell Engineering Company, Inc.

APPENDIX M – FEMA CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT

COMMUNITY INFORMATION		PROPOSED PROJECT DESCRIPTION	BASIS OF CONDITIONAL REQUEST
COMMUNITY	Victoria County Texas (Unincorporated Areas) COMMUNITY NO.: 480637	FILL CHANNEL RELOCATION	HYDROLOGIC ANALYSIS HYDRAULIC ANALYSIS UPDATED TOPOGRAPHIC DATA
IDENTIFIER	City of Victoria Solid Waste Landfill Expansion	APPROXIMATE LATITUDE & LONGITUDE: 28.682, -96.913 SOURCE: USGS QUADRANGLE DATUM: NAD 83	

AFFECTED MAP PANELS			
TYPE: FIRM*	NO.: 4806370200B	DATE: September 18, 1987	* FIRM - Flood Insurance Rate Map

FLOODING SOURCES AND REACH DESCRIPTION

See Page 2 for Additional Flooding Sources

Chocolate Bayou – From the upstream side of McCoy Road to the downstream side of FM 1686

PROPOSED PROJECT DESCRIPTION

Flooding Source	Proposed Project	Location of Proposed Project
Chocolate Bayou	Fill Placement	From approximately 3,310 feet downstream of FM 1686 to approximately 1,970 feet downstream of FM 1686

SUMMARY OF IMPACTS TO FLOOD HAZARD DATA

Flooding Source	Effective Flooding	Proposed Flooding	Increases	Decreases
Chocolate Bayou	Zone A	Zone A	Yes	Yes

COMMENT

This document provides the Federal Emergency Management Agency's (FEMA's) comment regarding a request for a CLOMR for the project described above. This document is not a final determination; it only provides our comment on the proposed project in relation to the flood hazard information shown on the effective National Flood Insurance Program (NFIP) map. We reviewed the submitted data and the data used to prepare the effective flood hazard information for your community and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. Your community is responsible for approving all floodplain development and for ensuring that all permits required by Federal or State/Commonwealth law have been received. State/Commonwealth, county, and community officials, based on their knowledge of local conditions and in the interest of safety, may set higher standards for construction in the Special Flood Hazard Area (SFHA), the area subject to inundation by the base flood). If the State/Commonwealth, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these criteria take precedence over the minimum NFIP criteria.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

ADDITIONAL FLOODING SOURCES AFFECTED BY THIS CONDITIONAL REQUEST

FLOODING SOURCES AND REACH DESCRIPTION

Unnamed Tributary to Chocolate Bayou – From approximately 2,070 feet upstream of McCoy Road to approximately 1,620 feet downstream of FM 1686

PROPOSED PROJECT DESCRIPTION

Flooding Source	Proposed Project	Location of Proposed Project
Unnamed Tributary to Chocolate Bayou	Fill Placement	From approximately 3,270 feet downstream of FM 1686 to approximately 1,710 feet downstream of FM 1686
	Channel Relocation	From approximately 3,740 feet upstream of McCoy Road to approximately 1,660 feet downstream of FM 1686

SUMMARY OF IMPACTS TO FLOOD HAZARD DATA

Flooding Source	Effective Flooding	Proposed Flooding	Increases	Decreases
Unnamed Tributary to Chocolate Bayou	Zone A	Zone A	Yes	Yes

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

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Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

To determine the changes in flood hazards that will be caused by the proposed project, we compared the hydraulic modeling reflecting the proposed project (referred to as the proposed conditions model) to the hydraulic modeling reflecting the existing conditions.

The table below shows the changes in the base flood water-surface elevations (WSELs).

Base Flood WSEL Comparison Table

Flooding Source: Chocolate Bayou		Base Flood WSEL Change (feet)	Location of maximum change
Proposed vs. Existing	Maximum increase	None	N/A
	Maximum decrease	0.01	Approximately 730 feet downstream of FM 1686

Flooding Source: Unnamed Tributary to Chocolate Bayou		Base Flood WSEL Change (feet)	Location of maximum change
Proposed vs. Existing	Maximum increase	0.1	Approximately 2,920 feet downstream of FM 1686
	Maximum decrease	0.1	Approximately 1,900 feet downstream of FM 1686

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR

Upon completion of the project, your community must submit the data listed below and request that we make a final determination on revising the effective FIRM. If the project is built as proposed and the data below are received, a revision to the FIRM would be warranted.

• Detailed application and certification forms must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview and Concurrence Form," must be included. A copy of this form may be accessed at https://www.fema.gov/flood-maps/change-your-flood-zone/paper-application-forms/mt-2.

• The detailed application and certification forms listed below may be required if as-built conditions differ from the proposed plans. If required, please submit new forms, which may be accessed at https://www.fema.gov/flood-maps/change-your-flood-zone/paper-application forms/mt-2, or annotated copies of the previously submitted forms showing the revised information.

Form 2, entitled "Riverine Hydrology and Hydraulics Form." Hydraulic analyses for as-built conditions of the base flood must be submitted with Form 2.

Form 3, entitled "Riverine Structures Form."

• A certified topographic work map showing the revised and effective base floodplain boundaries. Please ensure that the revised information ties in with the current effective information at the downstream and upstream ends of the revised reach.

• An annotated copy of the FIRM, at the scale of the effective FIRM, that shows the revised base floodplain boundary delineations shown on the submitted work map and how they tie-in to the base floodplain boundary delineations shown on the current effective FIRM at the downstream and upstream ends of the revised reach.

• As-built plans, certified by a registered Professional Engineer, of all proposed project elements.

• Documentation of the individual legal notices sent to property owners who will be affected by any widening or shifting of the base floodplain along Chocolate Bayou and Unnamed Tributary to Chocolate Bayou.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR (continued)

• FEMA's fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps may be accessed at https://www.fema.gov/flood-maps/change-your-flood-zone/status/flood-map-related-fees. The fee at the time of the map revision submittal must be received before we can begin processing the request. Payment of this fee can be made through a check or money order, made payable in U.S. funds to the National Flood Insurance Program, or by credit card (Visa or MasterCard only). Please either forward the payment, along with the revision application, to the following address:

LOMC Clearinghouse
Attention: LOMR Manager
3601 Eisenhower Avenue, Suite 500
Alexandria, Virginia 22304-6426

or submit the LOMR using the Online LOMC portal at: https://hazards.fema.gov/femaportal/onlinelomc/signin

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report. Because the flood hazard information (i.e., SFHAs and/or zone designations) will change as a result of the project, a 90-day appeal period will be initiated for the revision, during which community officials and interested persons may appeal the revised flood hazard information based on scientific or technical data.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

COMMUNITY REMINDERS

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Sandy Keefe
Director, Mitigation Division
Federal Emergency Management Agency, Region VI
Federal Regional Center, Room 202
800 North Loop 288
Denton, TX 76209
(940) 898-5127

A preliminary study is being conducted for Victoria County, Texas and Incorporated Areas. Preliminary copies of the revised FIRM and FIS report were submitted to your community for review on April 30, 2020, and may become effective before the revision request following this CLOMR is submitted. Please ensure that the data submitted for the revision ties into the data effective at the time of the submittal.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

APPENDIX N – PROPERTY OWNER NOTIFICATIONS


20315203
37320
20385135
37442
20385133
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37382
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20387594
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61129
61128
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1,600 800 0 1,600 Feet
Legend
Permitted Waste Boundary
Existing Landfill
Landfill Expansion
CLOMR Property Notifications
FEMA Zone A

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 28764

TO: Hroch, Jerome & Susan
2763 McCoy Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 3, ACRES 104.354

Environmental Services

City of Victoria

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Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 28816

TO: Hroch, Jerome & Susan
2763 McCoy Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 10, ACRES 100.0

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P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 20387594

TO: Hroch, Jerome & Susan
2763 McCoy Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 18, ACRES 120.0

Environmental Services

City of Victoria

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March 26, 2020

Property ID No. 28768

TO: Chavana, Amedeo S Jr
10621 FM 185
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 48, ACRES .25, PT OF A .873 AC TR

Environmental Services

City of Victoria

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Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 61130

TO: Chavana, Amedeo S Jr
10621 FM 185
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
SUNSET ACRES, BLOCK 1, LOT 4, PT OF A .873 AC TR, ACRES .3100

Environmental Services

City of Victoria

Established in 1824

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March 26, 2020

Property ID No. 61131

TO: Chavana, Amedeo S Jr
10621 FM 185
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
SUNSET ACRES, BLOCK 1, LOT 5, PT OF A .873 AC TR, ACRES .31

Environmental Services

City of Victoria

Established in 1824

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Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 28772

TO: Carlson, Roland J
PO Box 2335
Victoria, TX 77902

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 4, ACRES 72.62

Environmental Services

March 26, 2020

Property ID No. 28779

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

TO: Dziadek, Ernest ET AL
678 Haschke Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 2, ACRES 166.09

Environmental Services

City of Victoria

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Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 28781

TO: Daniel, Anthony
PO Box 181
Tivoli, TX 77990

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 1, ACRES 78.47

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 37382

TO: Daniel, Anthony & Dorothy
PO Box 181
Tivoli, TX 77990

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03850 W B TRAYLOR ABST 385, TRACT 1, ACRES 214.75

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 37439

TO: Daniel, Anthony & Dorothy
PO Box 181
Tivoli, TX 77990

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 5, ACRES 100.0

Environmental Services

City of Victoria

Established in 1824

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March 26, 2020

Property ID No. 28786

TO: Clark, Cheryl L & Kaiser, Colette G ET AL
4606 Hanselman Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 5, ACRES 107.33

Environmental Services

City of Victoria

Established in 1824

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Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 28807

TO: Stafford Interests LTD
1502 Augusta Dr. Ste 415
Houston, TX 77057

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

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An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
00170 POLITO CASTILLO ABST 17, TRACT 9, ACRES 100.0

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 37320

TO: Hempel, Donnie D & Lisa
1712 Menke Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03810 WINN TRAYLOR ABST 381, TRACT 10, ACRES 8.4

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 37442

TO: Hempel, Donnie D & Lisa
1712 Menke Rd
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 4, ACRES 300.9

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 61128

TO: Berry, Milton J & Betty A
10715 State Hwy 185
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
SUNSET ACRES LOT 1 & LOT 2 BLOCK 1

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 61129

TO: Guerrero, Jose Roberto Lopez
10675 State Hwy 185
Victoria, TX 77905

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
SUNSET ACRES .253 AC IN A-17 AND .3098 AC OF LOT 3 BLOCK 1

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 61132

TO: Garcia, Pedro
1908 Lone Tree Rd
Victoria, TX 77901

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
SUNSET ACRES LOT 6 BLOCK 1

Environmental Services

City of Victoria

Established in 1824

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March 26, 2020

Property ID No. 61133

TO: Garcia, Pedro ET AL
1908 Lone Tree Rd
Victoria, TX 77901

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
SUNSET ACRES LOT 7 BLOCK 1

Environmental Services

City of Victoria

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March 26, 2020

Property ID No. 20315203

TO: Sterne, Houston P ET AL
2506 E Mockingbird
Victoria, TX 77904

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 3, ACRES 103.4, UNDIVIDED INTEREST (PARENT)

Environmental Services

City of Victoria

Established in 1824

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Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 20315203

TO: O'Connor Martin Ranch Ltd
PO Box 2549
Victoria, TX 77902

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 3, ACRES 103.4, UNDIVIDED INTEREST (PARENT)

Environmental Services

City of Victoria

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Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

March 26, 2020

Property ID No. 20385133

TO: Meischen Family Limited Partnership
1522 Woods Rd
Yorktown, TX 78164

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 1 & 2, ACRES 106.1, UNDIVIDED INTEREST

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 20385133

TO: CDJ Ranches Ltd
6034 N State Hwy 119
Yorktown, TX 78164

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03880 SA & MG RR CO ABST 388, TRACT 1 & 2, ACRES 106.1, UNDIVIDED INTEREST

Environmental Services

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Phone: (361) 485-3230
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www.victoriatx.org

March 26, 2020

Property ID No. 20385135

TO: Meischen Family Limited Partnership
1522 Woods Rd
Yorktown, TX 78164

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Legal Description:
03810 WINN TRAYLOR ABST 381, TRACT 8 & 9, ACRES 10.4

Environmental Services

City of Victoria

Established in 1824

Environmental Services is dedicated to delivering quality services to residents that improve the beauty and livability of Victoria.

March 26, 2020

Property ID No. 20385135

TO: CDJ Ranches Ltd
6034 N State Hwy 119
Yorktown, TX 78164

RE: Notification of proposed revision to FEMA's 1-percent annual chance flood hazard map

Dear Property Owner,

The Flood Insurance Rate Map (FIRM) for a community depicts the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA), the area determined to be subject to a 1-percent or greater chance of flooding in any given year. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

The City of Victoria is applying to FEMA for a Conditional Letter of Map Revision (CLOMR) to revise FIRM Panel 4806370200B, effectively dated September 18, 1987 for Victoria County, Texas along the Chocolate Bayou and an unnamed tributary ditch west of the Chocolate Bayou. The City of Victoria is proposing to revise the extents of the FEMA Zone A floodplain as part of a necessary expansion of the City's existing non-hazardous, municipal solid waste landfill.

A Zone A floodplain is a SFHA that has been approximated by FEMA without a detailed hydraulic analysis and no base flood water surface elevations have been determined. As part of the City's analysis to determine the impacts of the proposed landfill expansion upon the 1-percent annual chance floodplain, a more detailed flooding analysis has been completed per FEMA's requirements of floodplain management. This analysis showed significant differences (notably a much wider floodplain) between the existing conditions floodplain and what is currently shown on the FEMA FIRM, partially signifying the technological limitations of FEMA floodplain mapping from over 30 years ago. However, although this analysis determined the pre-project floodplain to be significantly different from FEMA's mapping, it is important to note that our post-project analysis showed that construction of the landfill expansion as currently proposed will have no further adverse floodplain impact to your property, with no additional widening of the floodplain or increase in water surface elevations. This analysis also does not show any structures, buildings or houses to be inundated by the 1-percent annual chance flood.

A CLOMR is only a conditional comment from FEMA on whether a project, if constructed, would meet FEMA standards. The floodplain cannot officially be revised until the project has been completed and a Letter of Map Revision (LOMR) requested from FEMA that would officially revise the FIRM along the Chocolate Bayou and adjacent tributary ditch. For the Victoria landfill expansion, project completion would be many years into the future. This letter is to inform you of the proposed project and the potential changes to the effective flood hazard limits on your property in the future if a LOMR request is submitted to FEMA upon completion of the landfill expansion.

An annotated FEMA floodplain map is attached to this letter. This map shows the floodplain currently depicted on FEMA's map and details what the current existing condition and post-landfill project floodplain boundary would look like if revised. If you have questions about the project regarding the floodplain on your property, you may contact our Consultant, Jon Parker with Burns & McDonnell Engineering at (816) 995-9270. If you have additional questions or concerns about the proposed project or its effect on your property, you may contact me at (361) 485-3230.

Thank you for your cooperation,

Darryl Lesak, Director

Environmental Services Office:

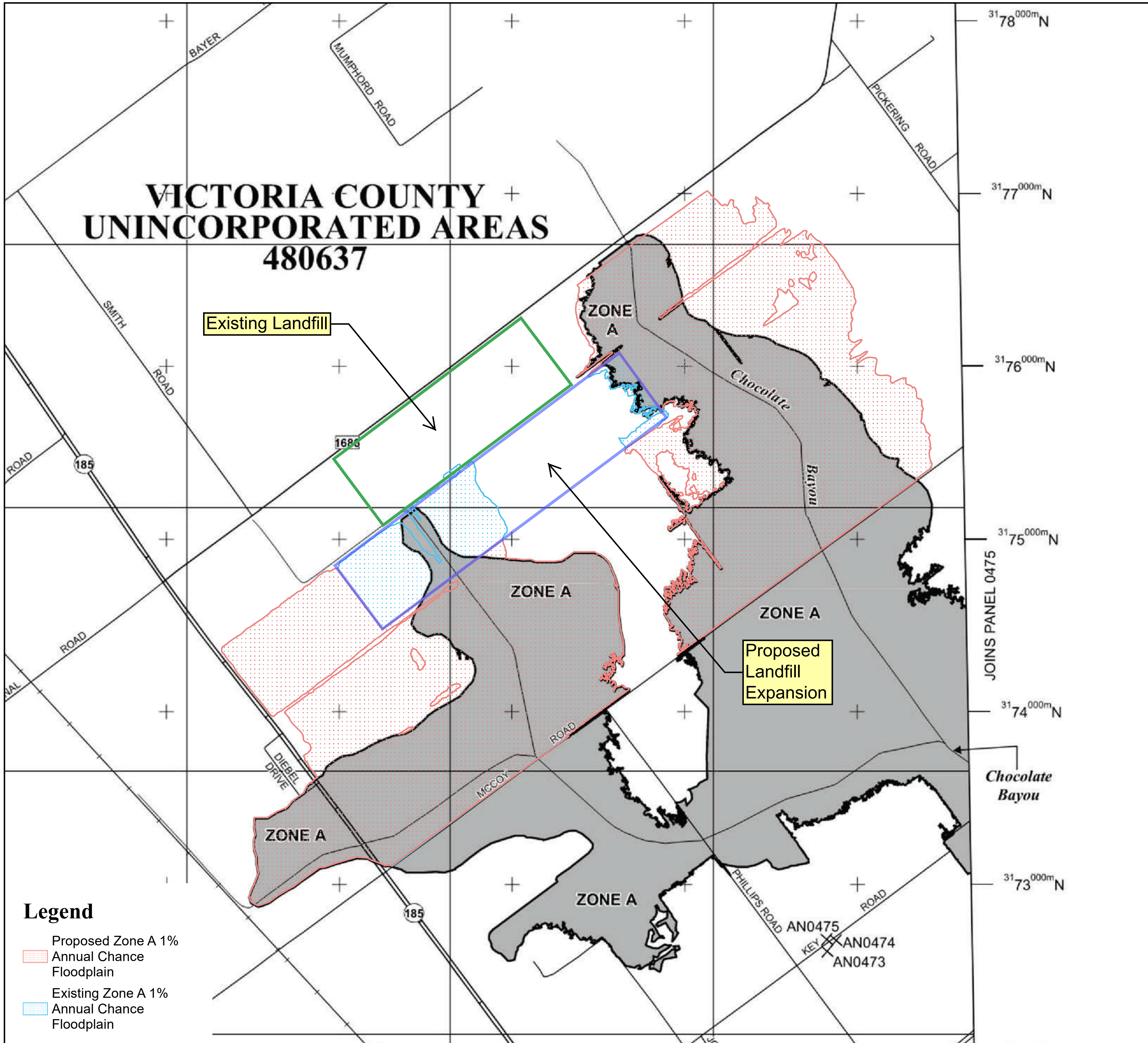
700 Main Center, Ste. 124

P.O. Box 1758
Victoria, Texas 77902
Phone: (361) 485-3230
Fax: (361) 485-3226
www.victoriatx.org

Legal Description:
03810 WINN TRAYLOR ABST 381, TRACT 8 & 9, ACRES 10.4

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



MAP SCALE 1" = 2000'

1000	0	2000	4000	FEET
600	0	600	1200	METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0450H

FIRM
FLOOD INSURANCE RATE MAP
VICTORIA COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 450 OF 625

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
VICTORIA COUNTY, UNINCORPORATED AREAS	480637	0450	H

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
48469C0450H

EFFECTIVE DATE

Federal Emergency Management Agency

Revision 0, March 28, 2022

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Daniel, Anthony & Dorothy
PO Box 181
Tivoli, TX 77990

9590 9402 4192 8121 7077 81

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8442

COMPLETE THIS SECTION ON DELIVERY

A. Signature X Anthony Daniel ☐ Agent ☐ Addressee

B. Received by (Printed Name) C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

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PS Form 3811, July 2015 PSN 7530-02-000-9053 Domestic Return Receipt

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1. Article Addressed to:

CDJ Ranches Ltd
6034 N State Hwy 119
Yorktown, TX 78164

9590 9402 4192 8121 7076 20

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8541

COMPLETE THIS SECTION ON DELIVERY

A. Signature X Carolyn ☐ Agent ☑ Addressee

B. Received by (Printed Name) Carolyn Dohse C. Date of Delivery 4/13/20

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

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1. Article Addressed to:

O'Connor Martin Ranch Ltd
PO Box 2549
Victoria, TX 77902

9590 9402 4192 8121 7076 44

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8527

COMPLETE THIS SECTION ON DELIVERY

A. Signature X Brenda Bridges ☐ Agent ☐ Addressee

B. Received by (Printed Name) Brenda Bridges C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

MAIN POST OFFICE
APR 13 2020
VICTORIA TX 77901

3. Service Type
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1. Article Addressed to:

Hroch, Jerome & Susan
2763 McCoy Rd
Victoria, TX 77905

9590 9402 4192 8121 7078 28

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8411

COMPLETE THIS SECTION ON DELIVERY

A. Signature X JH ☐ Agent ☐ Addressee

B. Received by (Printed Name) (W) 4-13-20 C. Date of Delivery CV19

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
☐ Insured Mail Restricted Delivery (over $500)
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1. Article Addressed to:

Dziadek, Ernest ET AL
678 Haschke Rd
Victoria, TX 77905

9590 9402 4192 8121 7078 04

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8435

COMPLETE THIS SECTION ON DELIVERY

A. Signature X E.D. - LP. ☑ Agent ☐ Addressee

B. Received by (Printed Name) (LP) CV19 C. Date of Delivery 4-10-20

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
☐ Insured Mail Restricted Delivery (over $500)
☐ Priority Mail Express®
☐ Registered Mail™
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1. Article Addressed to:

Berry, Milton J & Betty A
10715 State Hwy 185
Victoria, TX 77905

9590 9402 4192 8121 7076 82

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8480

COMPLETE THIS SECTION ON DELIVERY

A. Signature X M.B. ☑ Agent ☐ Addressee

B. Received by (Printed Name) (WD) CV19 C. Date of Delivery 4-10-20

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

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☐ Certified Mail®
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1. Article Addressed to:

Garcia, Pedro ET AL
1908 Lone Tree Rd
Victoria, TX 77901

9590 9402 4192 8121 7076 68

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8510

COMPLETE THIS SECTION ON DELIVERY

A. Signature X P. Garcia ☐ Agent ☐ Addressee

B. Received by (Printed Name) JS/C4/CV19 C. Date of Delivery 4-10

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
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1. Article Addressed to:

Chavana, Amedeo S Jr
10621 FM 185
Victoria, TX 77905

9590 9402 4192 8121 7078 42

2. Article Number (Transfer from service label)

7018 0360 0002 2038 8404

COMPLETE THIS SECTION ON DELIVERY

A. Signature X ASC, Jr. ☑ Agent ☐ Addressee

B. Received by (Printed Name) (WD) 4-10-20 C. Date of Delivery CV19

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
☐ Insured Mail Restricted Delivery (over $500)
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1. Article Addressed to:

Hempel, Donnie D & Lisa
1712 Menke Rd
Victoria, TX 77905

9590 9402 4192 8121 7076 99

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8473

COMPLETE THIS SECTION ON DELIVERY

A. Signature X T.S. ☒ Agent ☐ Addressee

B. Received by *(Printed Name)* CK KO2

C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
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☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
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77905-572417

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1. Article Addressed to:

Meischen Family Limited Partnership
1522 Woods Rd
Yorktown, TX 78164

9590 9402 4192 8121 7076 37

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8534

COMPLETE THIS SECTION ON DELIVERY

A. Signature X Marilyn Meischen ☐ Agent ☒ Addressee

B. Received by *(Printed Name)* Marilyn Meischen

C. Date of Delivery 4/10/2020

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

APR 2020 YORKTOWN, TX

3. Service Type
☐ Adult Signature
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☐ Collect on Delivery Restricted Delivery
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- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Clark, Cheryl L & Kaiser, Colette G ET AL
4606 Hanselman Rd
Victoria, TX 77905

9590 9402 4192 8121 7077 05

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8459

COMPLETE THIS SECTION ON DELIVERY

A. Signature X C.K covid 19 ☐ Agent ☐ Addressee

B. Received by *(Printed Name)* AF KRLE

C. Date of Delivery 4

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

4606 Hanselman Rd

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
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- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Carlson, Roland J
PO Box 2335
Victoria, TX 77902

9590 9402 4192 8121 7078 11

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8428

COMPLETE THIS SECTION ON DELIVERY

A. Signature X ☐ Agent ☒ Addressee

B. Received by *(Printed Name)* Ro... Carlson

C. Date of Delivery

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☒ No

MAIN POST OFFICE MAR 04 2020 VICTORIA TX 77901

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
☐ Insured Mail Restricted Delivery (over $500)
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1. Article Addressed to:

Stafford Interests LTD
1502 Augusta Dr. Ste 415
Houston, TX 77057

9590 9402 4192 8121 7077 12

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8466

COMPLETE THIS SECTION ON DELIVERY

A. Signature X DW 5460 C-19 ☒ Agent ☐ Addressee

B. Received by *(Printed Name)*

C. Date of Delivery 4/10/20

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
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☐ Collect on Delivery Restricted Delivery
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1. Article Addressed to:

Guerrero, Jose Roberto Lopez
10675 State Hwy 185
Victoria, TX 77905

9590 9402 4192 8121 7076 75

2. Article Number *(Transfer from service label)*

7018 0360 0002 2038 8497

COMPLETE THIS SECTION ON DELIVERY

A. Signature X JRLG ☐ Agent ☐ Addressee

B. Received by *(Printed Name)* (WD) C.V.19

C. Date of Delivery 4-10-20

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☐ Adult Signature
☐ Adult Signature Restricted Delivery
☐ Certified Mail®
☐ Certified Mail Restricted Delivery
☐ Collect on Delivery
☐ Collect on Delivery Restricted Delivery
☐ Insured Mail
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USPS Tracking®

Track Another Package +

Track Packages Anytime, Anywhere Get the free Informed automated notificatio

Tracking Number: 70180360000220388503

Your item was delivered at 3:41 pm on April 13, 2020 in VICTORIA, TX 77904.

Status

Delivered

April 13, 2020 at 3:41 pm
Delivered
VICTORIA, TX 77904

Get Updates

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Burns & McDonnell Engineering Company, Inc.
8911 Capital of Texas Highway \ Building 3, Suite 3100
Austin, TX 78759
O 512-872-7130
F 512-872-7127
www.burnsmcd.com

ATTACHMENT 3 – LEACHATE AND CONTAMINATED WATER PLAN

Part III, Attachment 3
Leachate and Contaminated Water Plan
TCEQ MSW Permit No. 1522B

City of Victoria, Texas

City of Victoria
City of Victoria Landfill Lateral and Vertical Expansion
Project No. 107608

Revision 0, March 28, 2022

Attachment 3
Leachate and Contaminated Water Plan
TCEQ MSW Permit No. 1522B

prepared for

City of Victoria, Texas
City of Victoria
City of Victoria Landfill Lateral and Vertical Expansion
Victoria County, Texas

Project No. 107608

Revision 0, March 28, 2022

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

prepared by

Burns & McDonnell Engineering Company, Inc.
8911 N Capital of Texas Hwy, Building 3, Suite 3100
Austin, Texas 78759
Texas Firm Registration No. F-845

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Page No.

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER

Scott Martin
4/5/2022

1.0 INTRODUCTION

This Leachate and Contaminated Water Management Plan, prepared in accordance with 30 TAC §330.65(c), 330.117, 330.207, 330.227, 330.331(a)(2), 330.333 and 330.337(d), provides the details of the collection, storage, treatment, and disposal of contaminated water (as defined in §330.3(36)), leachate (as defined in 330.3(80)), and gas condensate (as defined §330.3(57)) at the City of Victoria landfill.

This Leachate and Contaminated Water Management Plan addresses the anticipated quantities of leachate and contaminated water and the management approach during the active and postclosure periods of the landfill for the collection, storage, treatment and disposal of leachate and contaminated water.

2.0 LEACHATE MANAGEMENT

This section addresses leachate generation and system design, addressing the requirements of 30 TAC §330.227, §330.331, §330.333, §330.337(b).

2.1 Leachate Generation

Leachate is generated as water infiltrates and percolates through layers of solid waste and the field capacity is exceeded. Leachate generation is dependent on factors such as climate, rainfall, site topography, operating procedures, cover type, and waste types. The Hydraulic Evaluation of Landfill Performance (HELP) Model Version 4.0.1 was used in the design and evaluation of the leachate management system. The HELP model is a hydrologic model of water movement across, into, through, and out of landfills. Landfill leachate generation was estimated based on local climatic factors, soil, and design data in a daily sequential analysis that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, percolation, soil moisture storage, and lateral drainage. A description of the HELP modeling is provided in Appendix 3B and results output are provided in Appendix 3C.

The previously submitted permit design calculations and details for leachate management for the Existing Area (previously Attachments 15A, 15B, 15C, and 15F) can be found Appendix 3A of this report "Historical Leachate and Contaminated Water Report and Attachments."

2.2 Leachate Collection

The leachate collection system (LCS) design for the post-Subtitle D cells in the existing area is described in Appendix 3A with details shown for the liner, leachate collection sumps, collector drains and leachate header/laterals installed for the constructed cells in the Existing Area originally approved by TCEQ August 29, 1997. Within the Expansion Area, the leachate collection system (LCS) design consists of:

- A geocomposite collection layer over the liner system
- Leachate collection trenches, chimney drains, and piping
- Leachate collection sumps and pumps

A base grade at two percent slope toward the leachate collection system piping and leachate collection piping at one-half percent minimum slope facilitate leachate drainage to sumps in both the Existing Area and the vertical and lateral expansion areas. In the Existing area, Trench 5 and 11 are sloped to drain to the south, as shown in Appendix 3A drawing 15A (as prepared by JFK Group, Inc.); while Trenches 6, 7, 8, 9, and 10 are designed to drain to the North, as shown in Appendix 3A drawing 1C (as prepared by SCS Engineers).

Leachate collection chimney drains, used to collect leachate from above-grade MSW disposed above areas with below-grade Class 1 disposal in the Expansion Area will have a maximum spacing of 200 feet.

2.2.1 Design Criteria

The liner and leachate collection system is designed and operated to collect and remove leachate from each cell, adequately protect groundwater, and effectively manage the storage and disposal of leachate.

The LCS is designed in accordance with §330.331(a)(2) to maintain less than a 30-centimeter (approximately one-foot) depth of leachate over the liner throughout the landfill life and post-closure care period (see Appendix 3B).

Consistent with §330.333(1), the LCS is designed of materials that are chemically resistant to the leachate expected to be generated and of materials that are inert to leachates typically produced. Specifically, drainage nets and pipes are high-density polyethylene (HDPE); aggregates will be resistant to carbonate loss; geotextile design factors of safety account for potential clogging.

Consistent with §330.333(2), the LCS is of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill (see Attachment 7 for stability analyses).

Consistent with §330.333(3)(A-G), the LCS is designed to operate through the scheduled closure and post-closure care period of the landfill considering the following required factors:

- Estimated rate of leachate removal;
- Capacity of sumps;
- Pipe material and strength, if used;
- Pipe network spacing and grading, if used;
- Collection sump materials and strength;
- Drainage media specifications and performance; and
- Demonstration that pipes and perforations will be resistant to clogging and can be cleaned.

2.2.2 Leachate Collection Layer

The leachate collection layer consists of a double-sided geocomposite installed above the geomembrane, which consists of an HDPE drainage net with a geotextile bonded to both sides. The geotextile will be of suitable materials consistent with §330.333 and will be rot resistant. The geotextile properties are provided in Part III-Attachment 4, Soil Liner Quality Control Plan.

Leachate collection layer design calculation are presented in Appendix 3B, including anticipated peak flow and hydraulic head on the leachate collection layer.

2.2.3 Drainage Media

Drainage media will be placed in the trenches and sump and will help facilitate leachate collection. Detailed specifications for drainage media and thicknesses and placement around the leachate collection pipes, can be found in Part III-Attachment 4, Soil Liner Quality Control Plan.

Leachate aggregate placed in the collection trenches and sumps will consist of natural or manufactured materials as described in Part III-Attachment 4, Soil Liner Quality Control Plan.

2.2.4 Leachate Collection Pipe System

The leachate collection pipe system consists of perforated collection trench pipes and solid sidewall riser pipes. Sidewall risers will extent to the top of the perimeter perm to provide access for cleaning the leachate collection pipes and sump risers. Details are shown in Part III-Attachment 1. Leachate piping will meet the criteria listed in Part III-Attachment 4 Liner Quality Control Plan.

Chimney drains will be installed above the leachate collection pipes to better facilitate drainage and will extend through the protective cover. Details illustrating the design of the chimney drains are included in Part III-Attachment 1. For cells constructed for below-grade Class 1 disposal within the lateral expansion area, chimney drains will be used to facilitate the collection of leachate from above-grade MSW. Details are shown in Part III-Attachment 1. Chimney drains will be spaced every 200 feet at the interface of above-grade MSW and below-grade Class 1 waste to convey leachate into the collection trench.

Collection trenches consist of a six-inch diameter perforated leachate collection pipe surrounded by drainage aggregate, used to convey leachate to the sumps. Leachate collection pipe design calculations are provided in **Error! Reference source not found.** of this report. Details are shown in Part III-Attachment 1.

2.2.5 Leachate Sumps

Details of the leachate sumps are shown in Part III-Attachment 1. Leachate will be transferred from the sumps by submersible pumps, operated to limit the leachate level to the top of the sump and to control the allowable maximum leachate head on the liner. The exact allowable leachate head will be based on the asbuild conditions of the leachate sump. Leachate sump material requirements are provided in Part III-Attachment 4 Liner Quality Control Plan.

2.2.6 Leachate Storage

Initial leachate storage occurs in the leachate sumps located within each trench in the northern portion of the landfill and shared between two cells in the lateral expansion area. Leachate will be pumped from the sumps directly through a leachate force main to leachate evaporation ponds, storage tanks, or temporary storage facility.

Currently, onsite storage tanks are used for leachate storage. Cells in the Existing Area of the landfill are sloped to drain to the north. Leachate collected in these areas is conveyed to the on-site leachate storage tank area in the north of the site. As shown in Part III-Appendix A Historical Permit Drawings- Drawing 15G-1B, this area is designed and previously permitted for two leachate storage tanks. Currently, one 64,000-gallon tank has been constructed and is used for leachate storage. The storage tank is emptied, as needed, to maintain capacity for the leachate currently generated at the site.

Most of the lined cells in the Existing Area have been constructed, and a single tank continues to provide sufficient leachate storage capacity though previously permitted to double storage capacity for full buildout of the Existing Area and with previously permitted option for two leachate storage tanks (doubling capacity) should continue to be sufficient as increasing slopes in Trenches 7 and 8 will reduce infiltration and increases to the waste column will reduce peak leachate production.

The lateral expansion area (Cells A1 through I2) are sloped to drain to the south, and leachate collected in these areas will be conveyed to an on-site leachate storage tank area on the east portion of the site. The proposed east storage tank area consists of four 64,000-gallon storage tanks, which have been designed to provide with a safety factor to provide enough storage capacity for the leachate expected to be generated within the lateral expansion area prior to hauling for off-site disposal. Leachate storage capacity calculations for the lateral expansion area are provided Appendix 3D.

Tanks will be equipped with a liquid-level sensor and alarm to prevent overfill and alert personnel of the high level in the tank who will take appropriate actions to reduce the leachate level in the tank. Additionally, the alarm will activate an electronic signal that will shut down leachate sump pumps until the issue is resolved.

Leachate storage tanks for the lateral expansion area will be located within a secondary containment area consisting of a concrete enclosure designed to prevent run-on from the 100-year, 24-hour storm event.

The top of the enclosure's concrete walls will be at elevation 66.4 ft amsl, which provides 3 feet of freeboard above the 100-year flood elevation. The capacity of the secondary containment area shall be adequate for holding the volume of the largest tank in the event of a release, plus the rainfall volume of a 25-year, 24-hour storm event that would be contained within the enclosure. Design calculations for the leachate tanks secondary containment area are provided in Appendix 3D.

Leachate storage tank secondary containment facilities will feature a low point where water collected during storm events, or leachate accumulated from a potential release inside the tank area can be removed with a portable or dedicated pump. If the water is suspected to be leachate from a release, will be pumped back into the storage tank.

2.2.7 Leachate Disposal

Leachate removed from the sumps will be evaporated, solidified, treated and discharged, recirculated/sprayed within the waste fill, or transported off-site for treatment and disposal. The volume of leachate removed from the sumps will be recorded on a continuing basis. The results of any periodic analyses of leachate will also be placed in the Operating Record.

The primary disposal for leachate is off-site through a publicly owned treatment works. A copy of the original approval letter from the Guadalupe-Blanco River Authority Loop 175 Wastewater Treatment Plant for the off-site disposal of leachate is included in Attachment A. Consistent with §330.177, there is no regulatory requirement to characterize leachate and gas condensate sent to publicly owned treatment works for disposal; and leachate sampling and analysis will be performed in accordance with the treatment plant requirements.

Consistent with §330.177, recirculation of leachate and gas condensate may occur only on areas designed and constructed with a leachate collection system and composite liner. If utilized, procedures for recirculation may include:

- Discharge to trenches containing perforated pipes or prefabricated infiltration units spaced at regular horizontal and vertical intervals throughout the waste;
- Discharge to open trenches temporarily excavated into the waste which are then backfilled with waste and covered in accordance with §330.133;
- Spray application of leachate to working face or daily cover.

3.0 CONTAMINATED WATER MANAGEMENT

Surface water that comes into contact with leachate, gas condensate, and/or waste will be considered contaminated water. Contaminated water will be managed consistent with §330.207. Contaminated water generation will be minimized through the use of best management practices:

- The active face shall be maintained to prevent run on flow and to prevent runoff from leaving the landfill boundary after contacting exposed waste.
- The active face shall be enclosed within a of temporary soil diversion berms.
- The active face will typically have minimal slopes, as to limit runoff and provide means for rainfall to percolate through the waste.
- The active face will be as narrow as possible to minimize the exposed area and reduce contaminated stormwater runoff.
- Sufficient daily and intermediate cover will be used over filled areas to minimize exposed waste. Cover placement procedures are provided in Part IV Site Operating Plan.

If waste is exposed in areas where daily or intermediate cover has been previously placed, runoff from these areas will be considered contaminated water.

3.1 Contaminated Water Collection, Containment and Disposal

Soil diversion berms will be constructed as needed around the active face to collect and contain surface water that has come into contact with waste. In addition to the planned berms around the active face, temporary containment berms will be constructed wherever needed to collect contaminated water. The design calculations and typical details for containment berms for a 25-year, 24-hour storm event are presented in Appendix 3E. Primary contaminated water storage will be provided by the containment berms, which will provide storage for the 25-year, 24-hour storm event.

Containment berms will be maintained until the contaminated water is pumped to the evaporation pond or temporary storage area. Contaminated water shall be disposed of in a manner that will not cause surface water or groundwater pollution, in accordance with §330.207.

4.0 GAS CONDENSATE MANAGEMENT

4.1 Gas Condensate Management

Per §330.3(57), gas condensate is the liquid generated as the result of any gas recovery process at a municipal solid waste facility. Gas condensate is collected in the landfill gas collection and control system (GCCS) as shown in Part III Attachment 1. Gas condensate will be delivered from the GCCS to the on-site leachate storage systems, or may be recirculated back into the landfill in accordance with §330.177.

APPENDIX 3A - HISTORICAL LEACHATE MANAGEMENT PLAN

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REPORT ON

GEOTECHNICAL EVALUATION FOR VERTICAL EXPANSION PERMIT AMENDMENT CITY OF VICTORIA LANDFILL MSW PERMIT NO. 1522

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April 1996

963-4318

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1.0 INTRODUCTION

Golder Associates was retained by Browning-Ferris, Inc. (BFI) to perform geotechnical analyses in support of a permit amendment for the City of Victoria Landfill in Victoria County, Texas (MSW Permit No. 1522). This report contains the results of stability analyses performed to evaluate the stability of the landfill during various stages of development, settlement analyses intended to evaluate the effect of waste loading, and both hydraulic and structural analyses of the proposed leachate collection system.

The following sections describe the different categories of analyses performed. Supporting documentation and summaries of results of analyses are presented in appendices to this report.

2.0 STABILITY ANALYSES

2.1 Methodology of Analyses

Stability analyses were performed to evaluate the waste fill and composite liner and cover systems both during the active life of the facility and after the facility has been closed. The most widely used method for analyzing the stability of natural and manmade slopes is the limit equilibrium method of analysis. The basic premise of the method is that the potential failure mass, that is, the material above a potential failure surface, acts as a rigid body and the shear strength of the material is fully developed at all points along the failure surface at the moment of incipient failure. A failure criterion is adopted and the conditions for static equilibrium are applied to the analysis of the problem. The method assumes that no strains take place until the failure condition is fulfilled. The results of the analyses are expressed in terms of a safety factor in the form of a ratio of the available shear strength (resisting force) along the failure surface to the downslope forces - a component of the weight of the failure mass - (driving forces). This method has traditionally been used to analyze the stability of both soil and rock slopes, and has been extended to the analysis of waste fills and the interfaces between soil or waste and the geosynthetics used in landfill construction. The facility is not located in a seismic risk zone, and therefore, earthquake loading is not taken into account in the analyses.

Potential failure surfaces are governed by the stress-strain properties of the materials in both the waste fill and foundation. Actual failure surfaces are extremely complex and can never be known in advance. However, investigations into the behavior of earthen materials have yielded methods of analyses that can be applied to some general surfaces for the purpose of estimating field behavior of the materials. The potential failure surfaces commonly analyzed are categorized as either circular or noncircular. The wedge and sliding block analyses presented in this report fall into the noncircular category while the Simplified Bishop Method of Slices method of analysis assumes a circular failure surface. Both methods have been used to evaluate the stability of the City of Victoria Landfill.

2.2 Strength Criteria

A conventional Mohr-Coulomb strength envelope was used to model the soils in the foundation, the geosynthetics interface, and the waste fill. The highly variable nature of the material in the waste fill, along with the relative size of various components in the fill, makes it difficult to determine strength properties of the municipal solid waste to a high degree of certainty. Therefore, several analyses were performed with different assumed waste properties. Strength (and weight) values used for these analyses are consistent with the profession's current understanding of the performance of waste fills and are presented in Table 1. For all practical purposes the parameters for the waste can be considered as effective stress parameters.

TABLE 1

PARAMETERS USED IN THE STABILITY ANALYSES

MATERIAL	STRENGTH PARAMETERS	UNIT WEIGHT (pcf)
Refuse	$\phi = 35°$, c = 0 $\phi = 25°$, c = 2 psi	55 and 70 55 and 70
Textured Geomembrane/Sand Interface	$\phi = 28°$, c = 0	N/A
Smooth Geomembrane/Sand Interface	$\phi = 8°$, c = 0	N/A
Foundation	$\phi = 25°$, c = 3 psi	125

2.3 Failure Surfaces Evaluated

The presence of geosynthetics in landfills introduces a surface along which potential movement can occur. In most landfills the geosynthetics lie flat along the bottom of the waste pile. Nontextured geomembrane provides a smooth surface along its contact between the underlying clay liner and the overlying protective soil cover or drainage layer, and the frictional resistance along these surfaces is typically quite low. Furthermore, this surface (landfill floor) is typically slightly inclined. For these reasons the interface between the geomembrane and the soil, or between adjacent geosynthetic components of a liner and drainage system, constitutes a surface along which the waste fill could potentially move. To fully and accurately model the stability of the waste fill it is necessary that this interface be appropriately considered in the analyses. For the City of Victoria Landfill, the stability of the waste fill was analyzed using both sliding block analyses and circular analyses.

2.4 Analyses

Several cases were analyzed to define relationships between the height of refuse and associated safety factor against sliding for various combinations of floor slope, strength of refuse and slope of the active face of the landfill. General cases considered in the analyses are illustrated in Figures A-1 through A-4, and the results of these analyses are included on Table 2. Details of the method and the specific cases that yielded the minimum values are provided in Appendix A.

The results of the stability analyses illustrate that the factor of safety calculated varies for different assumed waste parameters and for different assumed failure planes. The following general conclusions can be drawn from the analyses:

- It is advantageous in terms of stability to keep 5 to 10 feet of refuse over the cell floor at least 30 feet beyond (ahead of) the toe of the active waste slope. It is recognized that this may not be possible in all locations or at all times.

- It is desirable for waste placement to proceed in a direction parallel to the ridge line (or low line) of the cell floor and to proceed upslope, i.e. from the sump area towards the middle of the landfill.

- The slope of the active waste fill should not exceed 4H:1V where it contracts any temporary berm or side wall, and the vertical waste fill height should not exceed approximately 50 feet unless a 50-foot wide bench is provided.

- Active waste slopes in the interior of the facility may approach 3H:1V as long as a 50-foot wide bench is provided in the active waste fill slope face approximately 50-feet above the floor.

For the assumptions made in the analyses, the results indicate that a waste fill slope of 4H:1V should typically provide a safety factor greater than 1.5 irrespective of the direction of waste fill placement for depths of waste up to approximately 50 feet. Nevertheless, in light of the uncertainties inherent in the analyses it is always prudent to maintain as flat a slope as possible for the active waste slopes.

Slope stability analyses were also performed to determine the safety factor for the landfill slopes at the time of landfill closure, i.e. the final closed configuration. For this case, both circular and noncircular potential failure surfaces were also investigated. CSLOPE (a software program) was used to analyze circular surfaces. The particular method of analysis used was the Simplified Bishop Method of Slices. The analyses focused on potential failure surfaces in the waste fill and underlying foundation. Several potential circular surfaces were analyzed. Figures A-1 through A-4 illustrate where the cross sections were taken for the analyses. The results of these analyses are summarized in Table 2. Each case analyzed is included in Appendix A.

Engineering calculations were also performed to evaluate the stability, on the sidewalls of the landfill, of the compacted clay liner, geosynthetic liner, and protective soil cover/drain. These calculations confirm the integrity of these components of the landfill liner system and are also presented in Appendix A.

Table 2 which is a summary of the results of the stability analyses includes individual analysis cases that have calculated factors of safety less than 1.5. These cases are included in Table 2, as they are analyses that were performed to evaluate the stability of a potential landfilling on loading condition at the City of Victoria Landfill. The potential landfilling conditions represented by the individual cases that have calculated factors of safety less than 1.5 are not considered optimal and should be avoided during operation of the facility.

TABLE 2

SUMMARY OF STABILITY ANALYSES

CASE	SURFACE TYPE	REFUSE WEIGHT	REFUSE PARAMETERS	MINIMUM FACTOR OF SAFETY
1A	Noncircular	55 pcf	$\phi = 25°$, c = 2 psi	1.81
1B	Noncircular	55 pcf	$\phi = 25°$, c = 2 psi	1.80
1C	Noncircular	55 pcf	$\phi = 35°$, c = 0	1.83
1D	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.77
1E	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.81
1F	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.71
1G	Noncircular	55 pcf	$\phi = 3°$, c = 0	1.90
1H	Circular	55 pcf	$\phi = 25°$, c = 2 psi	3.51
1I	Circular	55 pcf	$\phi = 35°$, c = 0	2.92
1J	Circular	70 pcf	$\phi = 25°$, c = 2 psi	3.29
1K	Planar	N/A	N/A	1.50
2A	Noncircular	55 pcf	$\phi = 35°$, c = 0	1.36
2B	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.45
2C	Noncircular	55 pcf	$\phi = 35°$, c = 0	1.53
2D	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.49
2E	Noncircular	55 pcf	$\phi = 35°$, c = 0	1.57
2F	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.52
2G	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.53
2H	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.52
2I	Circular	55 pcf	$\phi = 25°$, c = 2 psi	3.07
2J	Circular	55 pcf	$\phi = 35°$, c = 0	2.14
2K	Circular	70 pcf	$\phi = 25°$, c = 2 psi	2.73
2L	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.32
2M	Noncircular	70 pcf	$\phi = 25°$, c = 2 psi	1.47
2N	Circular	55 pcf	$\phi = 25°$, c = 2 psi	2.88
2O	Circular	55 pcf	$\phi = 35°$, c = 0	2.14
2P	Circular	70 pcf	$\phi = 25°$, c = 2 psi	2.69
2Q	Noncircular	55 pcf	$\phi = 35°$, c = 0	1.82
2R	Planar	N/A	N/A	1.60

3.0 SETTLEMENT ANALYSES

Golder Associates has performed settlement analyses to determine computed settlements for selected points at the base of the facility after the landfill is filled to the proposed final grades. The selected points correspond to the upstream and downstream ends of an existing leachate collection line in the southwestern end of the landfill and a typical leachate collection line proposed for the northeastern end of the site. The intent of the analyses is to determine the magnitude of differential settlement beneath the landfill footprint. In the extreme, such differential settlements may impact the effectiveness of the leachate collection system by flattening or reversing the pipe grades. Settlement analyses are provided in Appendix B and described below.

3.1 Contributions to Settlement

Computed settlements are a function of load geometry and magnitude, soil stratigraphy and initial stress conditions. The computed movements are presumed to result from the combination of upward heave due to excavation of the landfill cell and downward settlement due to waste filling. The loads are modeled as flexible rectangular foundations with dimensions of approximately landfill width by landfill length. The soil stratigraphy used in our analyses is based on published regional geology for Victoria County and surrounding counties. It should be noted that the depth of influence for a foundation is typically taken as twice the width (2B), which results in considerable depths for landfills with short side dimensions on the order of 2,000 feet. Published regional geology provides a means for obtaining stratigraphies which extend to the required depths (several thousand feet). The initial stress conditions used in the analyses reflect the existing overburden stress and presume that the soil has been previously consolidated to a stress slightly (2,000 pounds per square foot) greater than the current overburden stress.

3.2 Settlement Model

Geometry. The existing grade prior to construction was taken as 63.5 feet above Mean Sea Level (ft.-MSL). An average base elevation of 45 feet above Mean Sea Level (ft.-MSL) was used to model unloading due to excavation. The dimensions of the unloading are approximately those for the toe of the below-grade landfill slope. Final cover grades extending up at a slope of

4H:1V from grade level to elevation 134 ft.-MSL were used to model subsequent reloading due to liner construction and waste placement.. The dimension of the reloading are approximately those for the lateral extent of the final cover at half-height. The dimensions used in the analysis represent the average of the unloading dimensions and the reloading dimensions.

The geometry of the loading used to model the City of Victoria Landfill is shown on Figures B-1 and B-2 in Appendix B.

Stratigraphy, stress distribution and settlement. The soils underlying the City of Victoria Landfill may be characterized as generally consisting of sand from the ground surface to approximately 2000 feet below grade and clay from approximately 2000 feet below grade to at least 4500 feet below grade. The interpreted stratigraphy for the soils underlying the City of Victoria Landfill is presented on Figure B-3 in Appendix B. An excerpt of the published source for the interpreted stratigraphy is included at the end of Appendix B.

Stress distributions in the soils below the landfill were computed using Boussinesq theory for stresses in an elastic half-space. Analyses were taken to a depth equal to twice the loading width. Elastic settlement in sand layers was computed using the strain influence factor defined by Schmertmann's 2B-0.6 distribution. Consolidation settlement in clay layers was computed using consolidation theory as defined by Terzaghi.

Settlement points. The four selected points (I, II, III, and IV) represent the ends of an existing leachate collection line (I and II) and the ends of a typical proposed leachate collection line (III and IV). Both lines are graded at 0.5 percent and run for approximately 1,000 feet. In both cases the upstream ends (II and III) near the interior of the facility are anticipated to undergo greater settlement than the downstream ends (I and IV) that are near the perimeter of the facility.

3.3 Computed Settlements

A criteria for computed settlements is that computed differential settlements should not result in grade reversal along leachate collection pipes. The computed differential settlement may be expressed in percent for comparison with the original design grading plan.

Existing leachate collection line. The existing leachate collection line in the western portion of the landfill is computed to undergo settlements of 19 to 29 inches at the upstream end (Point II) and 13 to 19 inches at the downstream end (Point I). This is equivalent to a differential settlement of 6 to 10 inches which may be taken over the 1,000 foot pipe length to yield a computed decrease in grade of approximately 0.08 percent. This is significantly less than the original design grading of 0.5 percent.

Proposed leachate collection line. A typical proposed leachate collection line in the eastern half of the landfill is computed to undergo settlements of 19 to 29 inches at the upstream end (Point III) and 10 to 15 inches at the downstream end (Point IV). This is equivalent to a differential settlement of 9 to 14 inches which may be taken over the 1,000 foot pipe length to yield a computed decrease in grade of approximately 0.1 percent. This is significantly less than the original design grading of 0.5 percent.

The differential settlements calculated between two sets of points that were chosen to model the extreme (highest and lowest) loading conditions, are not considered to be excessive or detrimental to the immediate or long term functioning of the City of Victoria Landfill leachate collection system.

4.0 LEACHATE COLLECTION SYSTEM DESIGN

The proposed extension of the northeast end of the landfill consists of 6 cells ranging in size from approximately 11.7 to 12.7 acres. The components of the leachate collection system have been designed on the basis of the largest (12.7 acre) cell and the results of the analyses are applicable to the remaining cells. Specific analyses were performed to determine:

- maximum spacing between leachate collection lateral pipes,
- estimated leachate production on a daily, biweekly and annual basis,
- structural stability of the proposed leachate collection pipes;
- leachate impingement rates for sizing leachate collection system pipes, pumps, and force mains, and
- design capacities of typical leachate collection system pumps with respect to discharge rate and discharge head.

4.1 HELP Modeling

The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3, was used to calculate leachate generation rate and leachate head on the liner system as a function of applied rainfall over time. The landfill stratigraphy was selected to reflect a typical operating condition and consisted of the following components, taken from top to bottom:

- 12 inches of cover soil;
- 20 feet of solid waste;
- 12 inches of protective cover;
- 12 inches of drainage sand;
- an 0.060 inch thick geomembrane liner; and
- 24 inches of compacted clay.

Physical characteristics for each layer are shown in the HELP printout in Appendix C. The applied rainfall was based on recorded precipitation data for Victoria, Texas, as obtained from the Southern

Regional Climate Center (Baton Rouge, Louisiana). Data was obtained for the period 1961 through 1993 and a five year interval (1968 through 1972) was selected on the basis of exhibiting the highest annual rainfalls. A daily rainfall record reflecting the data obtained for 1968 through 1972 was used in the HELP analyses on the grounds that a similar sequence of events could take place during a five year period of landfill operation. Daily rainfall totals for the 5 year period used are illustrated on Figure C-1, and the same period shown on Figure C-2 in the context of the complete 30 year period.

4.2 Leachate Pipe Spacing

A HELP analysis was performed to determine the maximum spacing between leachate collection system laterals. Each cell in the lateral expansion is proposed to have a single leachate collection header running the length of the center of the cell at 0.5 percent slope and leachate collection laterals oriented perpendicular to the header and graded at 2 percent slope. The complete system of pipes will be embedded in geotextile wrapped gravel, and the complete floor of the cell will be covered with 1 foot of sand (1×10^{-2} cm/sec) overlain by 1 foot of protective cover soil (1×10^{-4} cm/sec).

A criteria for leachate collection system performance is that the leachate head on the geomembrane liner must be limited to one foot or less. A maximum spacing between leachate collection system laterals of 140 feet results in a maximum daily head on the liner of less than 12 inches for the five years of rainfall applied. This configuration was modeled by using an equivalent drainage length of 70 feet and an equivalent floor slope of 0 percent.

The average daily head computed per month by the HELP model is shown on Figure C-3 and the designed leachate collection system pipe layout is shown on Figure C-4. The HELP analysis for the configuration shown on Figure C-4 is provided in Appendix C.

4.3 Leachate Volumes

The leachate volumes generated per day are shown on Figure C-5, as determined from the HELP analysis. Cumulative volumes for moving two week intervals are shown on Figure C-6. These volumes represent a tool for estimating required temporary leachate storage volume. The greatest two week volume obtained during rainfall corresponding to the five wettest years of obtained data is approximately 200,000 gallons for a 13 acre cell.

The leachate volumes generated per year are shown on Figure C-7, as determined from the HELP analysis. These volumes are considered conservative, i.e. larger than expected, in that a relatively severe precipitation was assumed, and no temporary fill sector divider berms were assumed. The actual amount of leachate generated over any two week period may be significantly less than those calculated.

4.4 Leachate Recirculation

A HELP analysis was performed to determine what percentage of the leachate generated during landfill operations could be recirculated without increasing the maximum leachate head on the liner beyond the one foot limitation. The same landfill stratigraphy used for the design of the leachate collection system was used to model leachate recirculation. The recirculation was presumed to be sprayed or otherwise distributed across the top of the soil cover overlying the 20 feet of waste. By successive variation of recirculated leachate volume, expressed as a percentage of leachate generation, it was determined that approximately 10 percent of the generated leachate could be recirculated without raising the peak daily head on the liner beyond 1 foot. The HELP analysis for 9 percent leachate recirculation is provided in Appendix C.

It should be noted that this corresponds to a continuous 9 percent during the course of a five year period with rainfall equal to the wettest five years of data provided. Recirculation percentage could presumably be higher both during dry periods within the five years modeled and during years which are drier than the five years modeled.

4.5 Pipe Sizing

Required properties for leachate collection laterals and headers were determined based on the leachate generation data from the HELP analysis used to define the maximum spacing between laterals.

The peak daily impingement rate on the leachate collection system sand layer is 0.106 inches of leachate per day (1.02×10^{-7} feet per second). This corresponds to a required capacity of less than 0.01 cubic feet per second (2 gallons per minute) for a lateral pipe draining an area of 140 feet by 350 feet, and a required capacity of 0.06 cubic feet per second (25 gallons per minute) for a header pipe draining an area of 12.7 acres.

The pipe proposed for the leachate collection system is SDR 17 HDPE pipe. The laterals and headers are proposed to be 6 inch nominal diameter with 3/8 inch perforations spaced at 6-inches in two rows, as shown on Figure C-4. The upslope risers are proposed to be 18 inch minimum nominal diameter with 3/8 inch perforations spaced at 6-inch intervals in rows 6 inches apart. Structural analyses indicating the suitability of SDR 17 HDPE pipe for these applications are provided in Appendix. The computed factors of safety for the proposed pipes are:

- greater than 3.5 for wall crushing;
- greater than 2.4 for wall buckling; and
- greater than 2.6 for ring deflection.

These analyses are based on depths of waste fill between 48 and 89 feet and a unit weight of 80 pounds per cubic foot for the waste and cover soil combination.

The discharge capacity for gravity flow in a full 6-inch diameter lateral pipe with a 2 percent bottom slope is 3.7 cubic feet per second and the discharge capacity for gravity flow in a full 6-inch diameter header pipe with a 0.5 percent bottom slope is 1.8 cubic feet per second. These values both exceed the highest required flows of 0.06 cubic feet per second. Analyses of discharge capacity for lateral and header pipes are provided in Appendix C.

The minimum required capacity for a leachate collection system pump represents a combination of discharge volume and discharge head. Discharge volume is a function of the leachate generation rate determined with the HELP model. Discharge head is a combination of the vertical height between the sump and grade level, the vertical height between grade level and the liquid in a full leachate storage tank, and the friction losses incurred by pumping through the length of a force main. The configuration of the lateral expansion area results in a peak discharge of 0.06 cubic feet per second (25 gallons per minute), a vertical height of 40 feet, and friction losses related to 5,200 feet of HDPE force main.

A typical leachate collection system pump in the lateral expansion area will require the capacity to discharge 25 gallons per minute against 71 feet of head if 2 inch inner diameter force main is used. A typical leachate collection system pump in the lateral expansion area will require the capacity to discharge 25 gallons per minute against 50 feet of head if 3 inch inner diameter force main is used. It should be noted that even if friction losses are eliminated by shortening the length of the force main, a pump will still require the capacity to discharge against the roughly 40 feet of head corresponding to the elevation difference between the sump and the leachate level in a full leachate storage tank. Analyses of the head requirements associated with 5,200 feet of 2 or 3 inch diameter HDPE force main are provided in Appendix C.

5.0 SUMMARY AND CONCLUSIONS

Stability analyses have been performed to show that the planned final filled landfill configuration has a calculated factor of safety greater than 1.5. Stability analyses have also been performed to show recommended and stable waste filling configurations during the active waste filling phase of the facility.

Settlement analyses have been performed which indicate that computed differential settlements will not adversely affect existing or proposed leachate collection lines during the landfill active life and post-closure care period.

The leachate collection system has been modeled using HELP Version 3, and the results of the analysis indicate that computed maximum leachate head on the liner will be below 1 foot based on available rainfall data. Structural analyses have been performed to verify that the proposed leachate collection system piping exhibits suitable factors of safety against crushing, buckling, or deflection in the proposed application. The results of the HELP analysis have been used to size the piping and pumps of the leachate collection system.

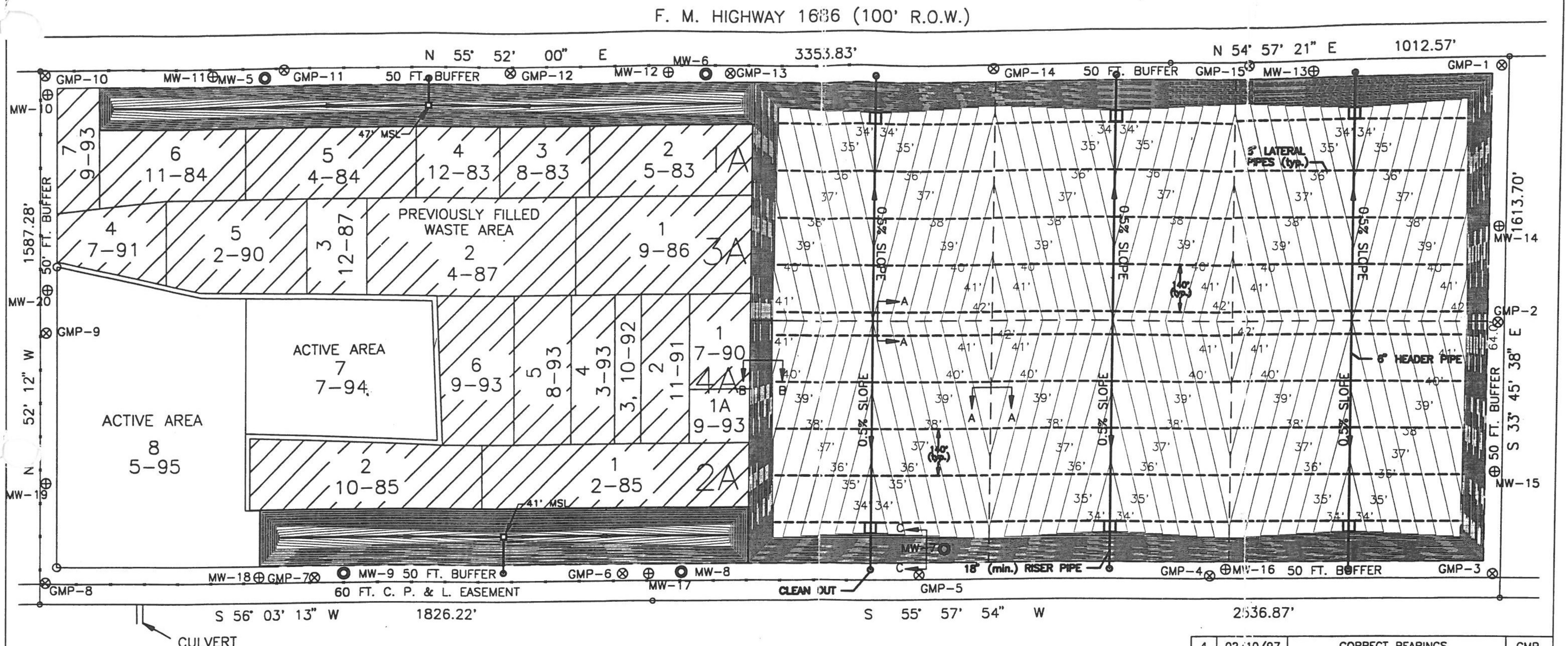
Information contained in this report was prepared either by or under the direct supervision of a professional engineer registered in the State of Texas. Drawings contained in this report are prepared for permitting use by BFI as facility operator and the City of Victoria as facility owner of the City of Victoria Landfill. The analyses and results presented in this report are site-specific and should not be considered applicable to other sites.

We appreciate the opportunity to provide our engineering services to BFI and would be pleased to further discuss the results of our work should comments or questions arise.

Very truly yours,
GOLDER ASSOCIATES INC.

Mark R. Funkhouser, P.E.	Robert C. Pedersen, P.E.	Charles G. Dominguez
Associate	Project Engineer	Staff Engineer

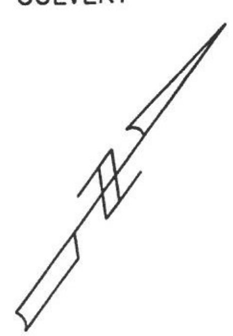
PERMIT DRAWING



NOTES:

- MONITORING WELLS TO BE PLUGGED AND ABANDONED
- GAS MONITORING PROBES
- GROUNDWATER MONITORING WELLS

ALL EXCAVATION GRADES ARE ABOVE MEAN SEA LEVEL



GRAPHIC SCALE

STATE OF TEXAS
J. FLETCHER KELLY
61815
REGISTERED PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DOCUMENT WAS AUTHORIZED BY J. FLETCHER KELLY TEXAS P.E. NO. 61815 (NOT VALID UNLESS SIGNED) ON 2-10-97

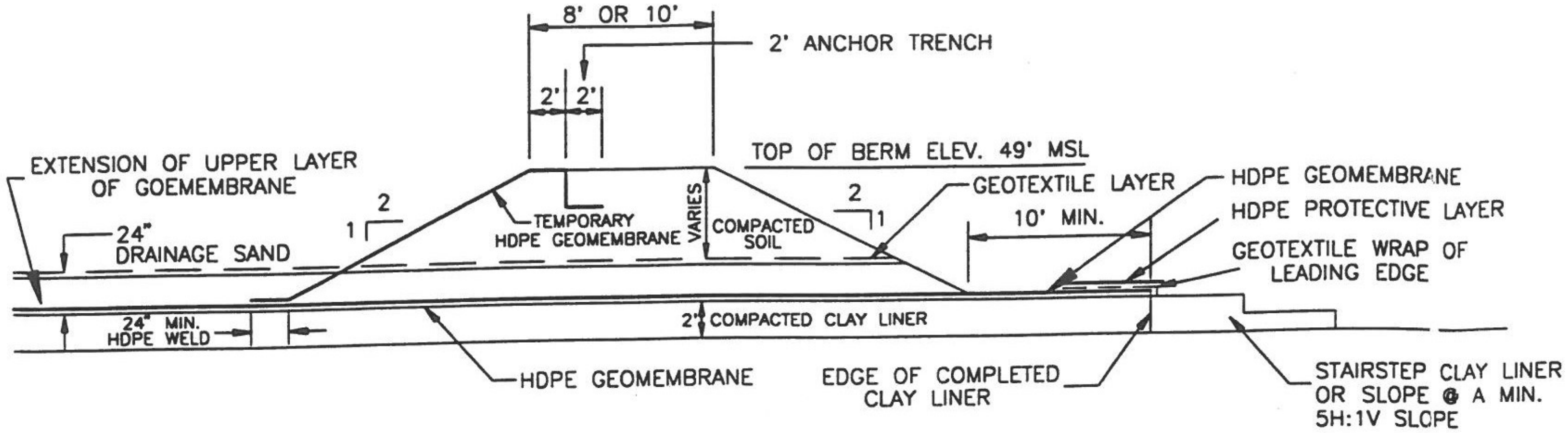
NO.	DATE	REVISIONS	BY
4	02/10/97	CORRECT BEARINGS	CMP
3	01/13/97	RENAME PIEZOMETERS	CMP
2	12/20/96	GENERAL REVISION	CMP
1	09/18/96	ADD LCS DESIGN	CMP

SDP ATTACHMENT 15A
EXCAVATION PLAN
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.
201 EAST SINTON STREET P.O. BOX 460, SINTON, TEXAS 78387

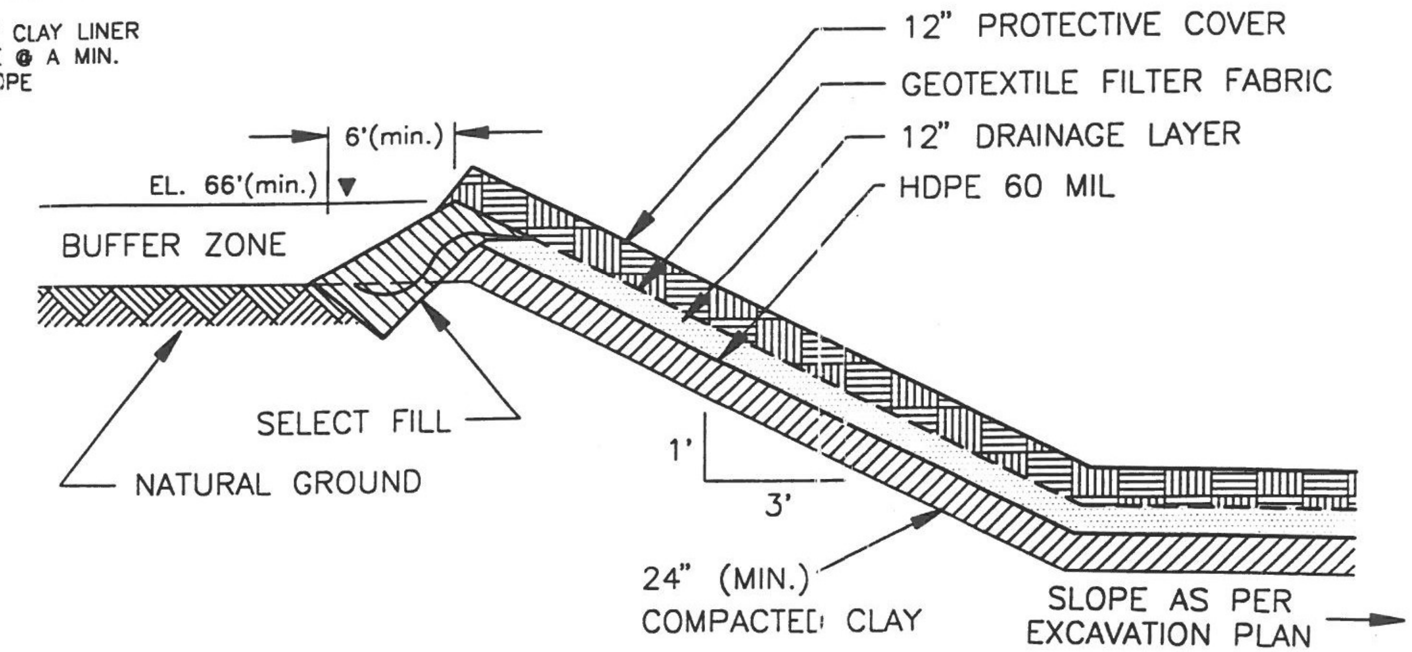
DRAWN BY: CMP	SCALE:	PAGE NO.
APPV'D. BY: JFK	DATE: 05-01-96	1 OF 3
F:\JOBS\549N\LINER2.DWG		

CROSS-SECTION A-A

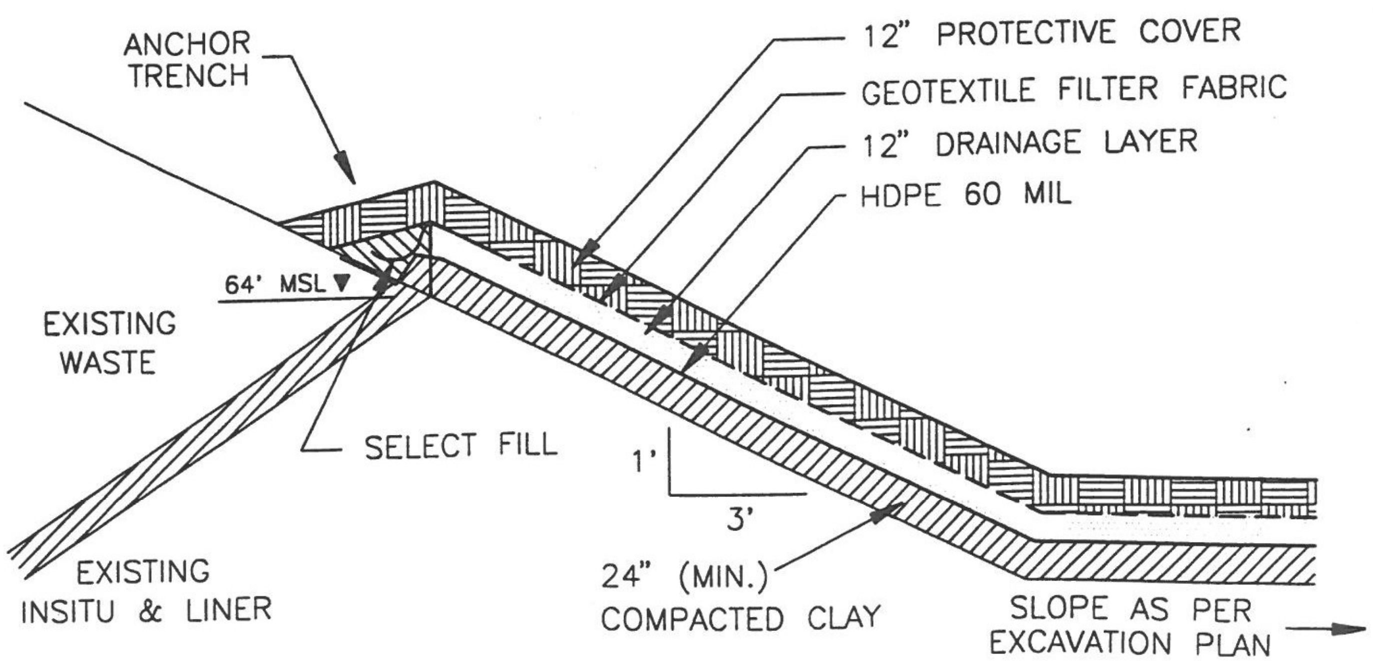


NOTES:
1) THE SAND LAYER IS SEPARATED BY 60 MIL HDPE GEOMEMBRANE ON WASTE SIDE OF BERM TO TEMPORARILY PREVENT LEACHATE FROM TRAVELING UNDER THE BERM. THIS TEMPORARILY HDPE GEOMEMBRANE WILL BE REMOVED UPON COMPLETION OF THE NEXT CELL.
2) ALL TEMPORARY BERM DIMENSION ARE TYPICAL

CROSS-SECTION C-C
HDPE LINER ANCHOR DETAIL AT NATURAL GRADE



CROSS-SECTION B-B
SIDE SLOPE TIE-IN WITH EXISTING INSITU LINERS



STATE OF TEXAS
J. FLETCHER KELLY
61815
REGISTERED PROFESSIONAL ENGINEER

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ON 2-10-97

NO.	DATE	REVISIONS	BY
3			
2			
1	02/10/97	ADD DIMENSIONS	CMP

SDP ATTACHMENT 15B
LINER DETAIL
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.
201 EAST SINTON STREET P.O. BOX 460, SINTON, TEXAS 78387

DRAWN BY: JMP	SCALE	SHEET NO.
APPV'D. BY: JFK	DATE: 09-11-96	2 OF 3
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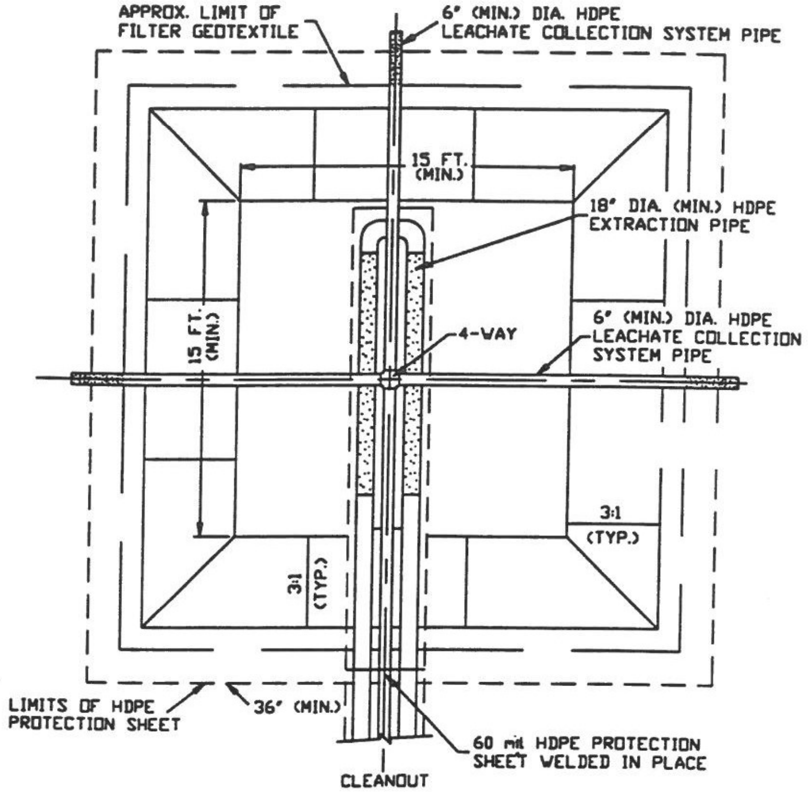
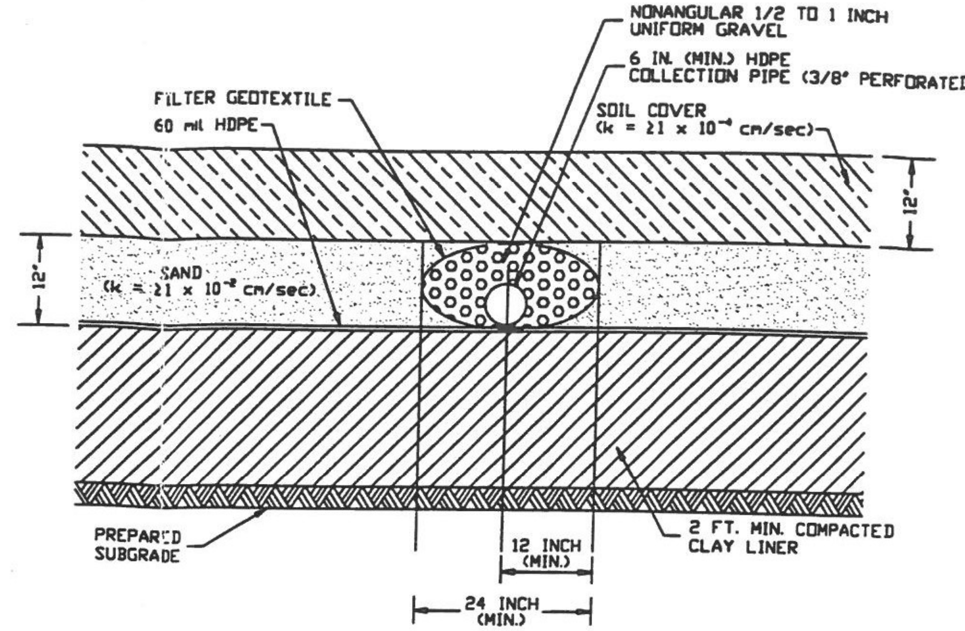


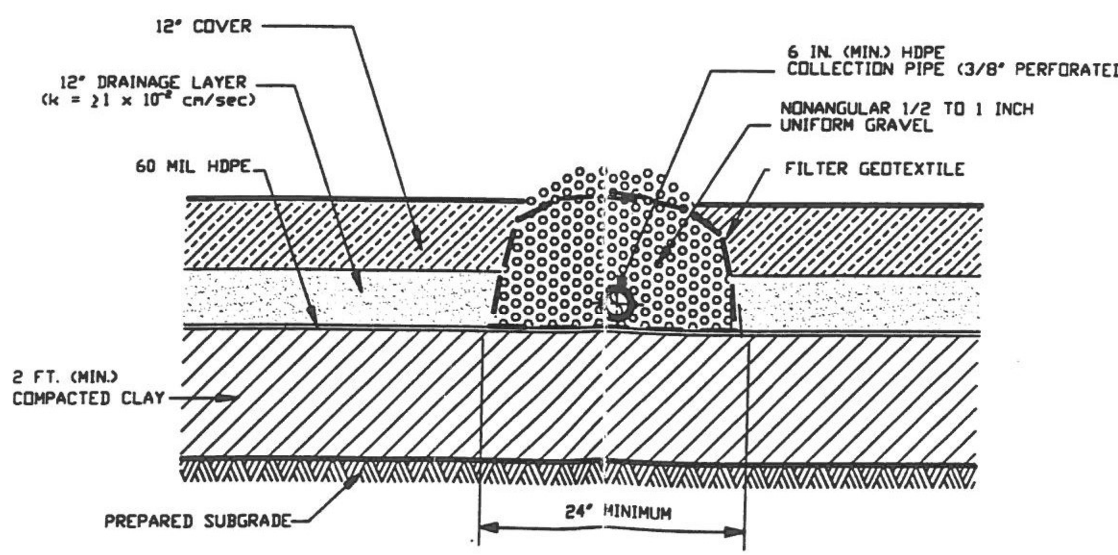
NOTES: 1. PERFORATIONS STOP AT LIMITS OF FILTER GEOTEXTILE (LEACHATE COLLECTION SYSTEM PIPE)

2. SECOND EXTRACTION PIPE IS OPTIONAL

LEACHATE COLLECTION SUMP



COLLECTOR DRAIN DETAIL AND LEACHATE HEADER/LATERAL



OPTIONAL COLLECTOR DRAIN DETAIL AND LEACHATE HEADER/LATERAL

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NO.	DATE	REVISIONS	APP.
3			
2	01/13/97	ADD OPTIONAL DETAIL	CMP
1	12/10/96	GENERAL REVISION	CMP

SDP ATTACHMENT 15C
DETAILED LEACHATE COLLECTION SUMP AND COLLECTOR DRAIN DETAIL
CITY OF VICTORIA LANDFILL
TNRCC PERMIT NO. 1522

JFK GROUP, INC.
201 EAST SINTON STREET P.O. BOX 460, SINTON, TEXAS 78387

DRAWN BY: JMP	SCALE:	SHEET NO.
APPV'D. BY: JFK	DATE: 10-16-96	3 OF 3
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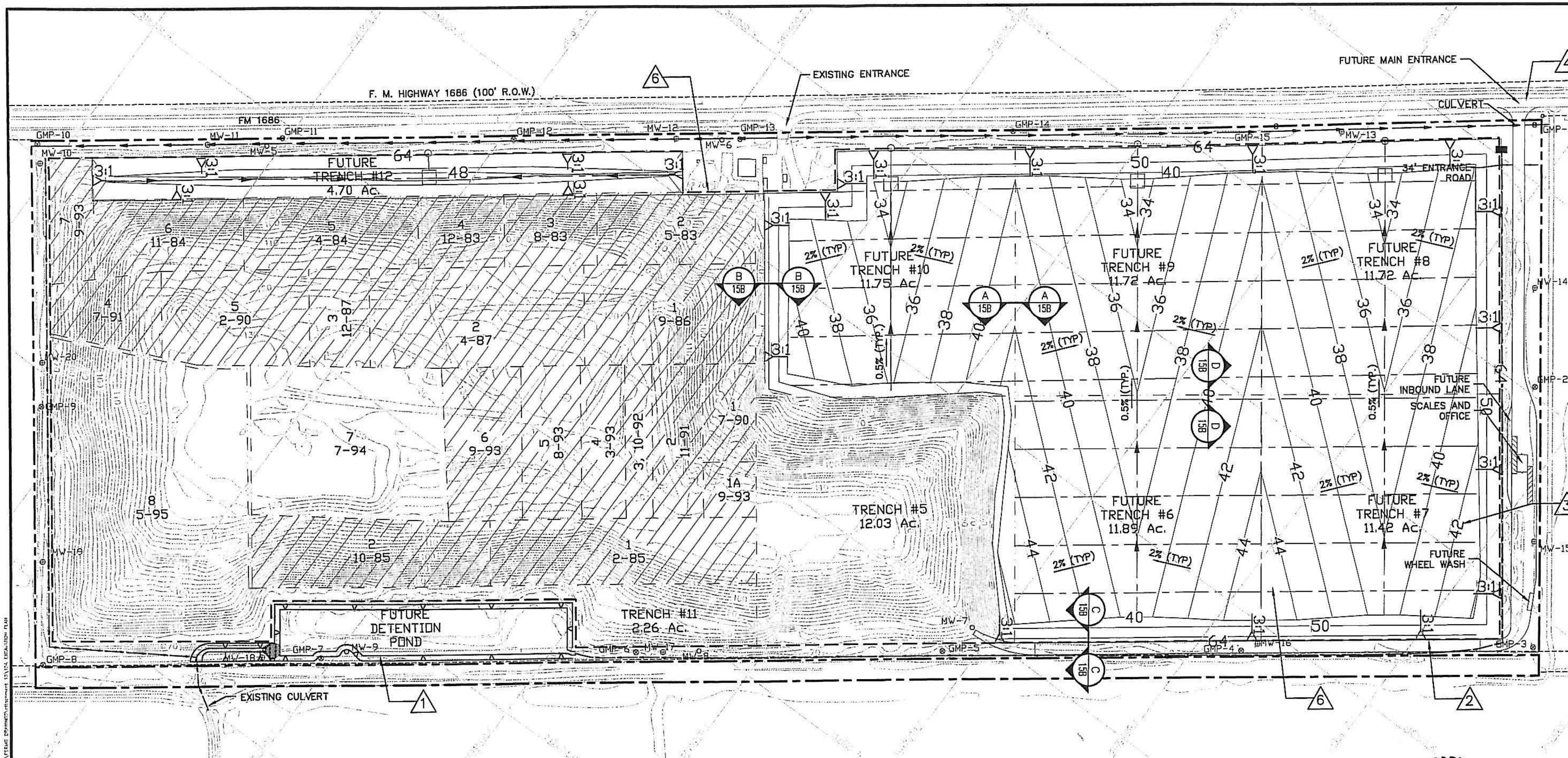

LEGEND

PERMIT BOUNDARY	
PROPERTY LINE	
LIMITS OF WASTE	
STATE PLANE COORDINATE	
EXISTING CONTOUR	
EXCAVATION CONTOUR	
PROPOSED ROAD SPOT ELEVATION	
LCS PIPE (8")	
LCS LATERAL PIPE (6")	
LCS SUMP AND SUMP RISER	
MW-8	MONITORING WELLS TO BE PLUGGED AND ABANDONED
GMP-6	GAS MONITORING PROBES
MW-17	GROUNDWATER MONITORING WELLS
	PERIMETER CHANNEL FLOWLINE
1	INDICATES REVISION
	PRE-SUBTITLE D CELLS 5

0 150 300
SCALE IN FEET

NOTE:

1. THE EXISTING CONTOURS AND ELEVATIONS COMPILED BY DALLAS AERIAL, FROM AERIAL PHOTOGRAPHY FLOWN APRIL 8, 2008.
2. ALL EXCAVATION GRADES ARE ABOVE MEAN SEA LEVEL.
3. IF A GEOSYNTHETIC DRAINAGE LAYER IS USED FOR THE LEACHATE COLLECTION SYSTEM IN LIEU OF THE GRANULAR DRAINAGE LAYER. THE LCS LATERAL PIPES MAY BE OMITTED IN THOSE AREAS.

STATE OF TEXAS
JAMES R. MURRAY III
73860
REGISTERED PROFESSIONAL ENGINEER
3/29/09

THIS ATTACHMENT WAS INCLUDED IN A PERMIT MODIFICATION, AS PREPARED BY JFK GROUP, AND SIGNED AND SEALED BY JEFFREY P. YOUNG (TEXAS P.E. 79809) ON MARCH 8, 2006. SCS ENGINEERS IS CERTIFYING, BY ENGINEERING SEAL, ONLY THE REVISIONS SHOWN DATED NOVEMBER 2008 AND MARCH 2009.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	03/2009	ADDED WASTE FILL AREA AND ADDED DETENTION POND	
2	03/2009	REDUCED WASTE FOOTPRINT	
3	03/2009	REVISED EXCAVATION PLAN	
4	03/2009	UPDATED ENTRANCE LOCATION	
5	11/2008	REVISED LEACHATE COLLECTION SYSTEM NOTE	JR
6	03/2009	REVISED EXCAVATION PLAN AND WASTE FOOTPRINT	JR

DRAWING TITLE: EXCAVATION PLAN

PROJECT TITLE: PERMIT MODIFICATION

CLIENT: REPUBLIC WASTE SERVICES
CITY OF VICTORIA LANDFILL
18545 F.M. 1686
VICTORIA, TEXAS 77905

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST DR, SUITE 250, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16208541 | DWN. BY: RJ | Q/A RVW BY: DJM
CHK. BY: DJM | APP. BY: JRM

CADD FILE: 15A EXCAVATION PLAN

DATE: 11/2008

SCALE: AS SHOWN

ATTACHMENT **15A**

APPENDIX 3B – HELP MODELING

1.0 APPENDIX B- HELP MODELING

1.1 INTRODUCTION

The following analyses were developed utilizing the Hydraulic Evaluation of Landfill Performance (HELP) Model Version 4.0.1. Environmental Laboratory United States Army Corps of Engineers (USACE) Experiment Station developed this model for the United States Environmental Protection Agency (USEPA) Risk Reduction Engineering Laboratory in October of 2020. The HELP model is a hydrologic model of water movement across, into, through, and out of landfills. The model uses climatologic, soil, and design data in a daily sequential analysis that accounts for the effects of surface storage, runoff, infiltration, evapotranspiration, percolation, soil moisture storage, and lateral drainage.

The HELP Model was used to estimate amounts of leachate generation and maximum daily head on the liner system that may be expected during various stages of landfill development for the lateral expansion in the Expansion Area of the City of Victoria Landfill (Landfill). The lateral expansion (Cells A1-I2) were simulated for the initial, intermediate, and final conditions.

The simulations were conducted on a per acre basis and were then multiplied each Cell's respective area to quantify volumes associated with leachate generation and collection over the life of the Landfill.

1.2 WEATHER DATA

The HELP Model Version 4.0.1 allows for location-specific weather data to be simulated based on latitude and longitude on a 0.25 x 0.25 degree grid across the continental U.S. Daily precipitation, temperature, and solar radiation data were simulated based on the Landfill site coordinates for the Expansion Area (28.69 degrees latitude; -96.90 degrees longitude). Location-specific parameters for wind speed and relative humidity were imported for the Landfill site using the National Solar Radiation Data Base (NSRDB).

The initial and intermediate models were simulated over a five-year period with a 24-hour 25-year storm event (9.77 inches) manually added to September 23 of Year 3, resulting in an average annual precipitation of 41.26 inches. The final condition was simulated over a 30-year period, and a 24-hour 100-year storm event (13.4 inches) was manually added to September 23 of Year 3 resulting in annual average precipitation of 38.61 inches.

The number of growing days (282 days) was determined based on 30% probability using 1981-2010 Climate Normals for the nearest climate station (Victoria Regional Airport) beginning on day 40 of the year and ending on day 345 of the year. The maximum leaf area index (5.0 LAI) was determined based on the geographic distribution of max LAI provided in Appendix F of the HELP model guidance documentation.

1.3 LANDFILL DESIGN AND WASTE PARAMETERS

The Landfill final cover system and liner system design consists of the following layers from top to bottom, based on the requirements for the inclusion of sub-grade Class 1 industrial solid wastes (per 30 TAC §330.331(e)(1)) and above-grade MSW wastes (per 30 TAC §330.457). The landfill design was modeled based on the design option for below-grade Class 1 disposal in the lateral expansion.

Final Cover:

- Twelve inches of soil and native vegetation;
- 200-mil double-sided geocomposite drainage layer;
- 40-mil of low-density polyethylene (LDPE) textured geomembrane; and
- 18 inches of compacted clay soil liner.

Landfill Liner:

- 24 inches of protective cover;
- 200-mil double-sided geocomposite drainage layer;
- 60-mil high-density polyethylene (HDPE) textured geomembrane; and
- 36 inches of compacted clay soil liner with a hydraulic conductivity no more than 1 x 10^{-7} cm/sec.

1.3.1 Final Cover

The final cover components were simulated as follows:

- 12 inches of soil using HELP Model Material #10, a sandy clay loam similar to soils commonly found in the vicinity of the Landfill;
- 200-mil geocomposite using HELP Model Material #20, a 0.5 cm drainage net;
- 40-mil LDPE geomembrane using HELP Model Material #36, a low-density polyethylene; and
- 18 inches of custom prescriptive clay using HELP Model Material #44, for a barrier soil.

Geomembrane parameters were modeled consistent with prior modeling for the site, with an assumed pinhole density of one hole per acre, installation defects of four holes per acre, and “good” placement quality. A transmissivity of one cm^2/sec was manually input into the program for the geocomposite.

1.3.2 Intermediate Cover

The 12 inches of intermediate cover was simulated using HELP Model Material #13, which corresponds to a clayey sand that reflects the type of soils commonly found in the vicinity of the Landfill..

1.3.3 Protective Cover

The 24 inches of protective cover was simulated based on HELP Model Material #13, with hydraulic conductivity adjusted to meet the permeability requirement of 1.0×10^{-4}.

1.3.4 Liner Drainage Layer

The drainage layer is composed of a 200-mil geocomposite drainage geonet which is simulated using a 200-mil drainage net (HELP Model Material #20). The HELP Model Version 4.0 default hydraulic conductivity for the drainage net was employed for all simulations as published hydraulic conductivity data for geocomposite is not available. A transmissivity of 1 cm^2/sec was manually input into the program for the geocomposite, based on the manufacturer’s products specifications.

1.3.5 Geomembrane

The 60-mil HDPE geomembrane was simulated using HELP Model Material #35, which is identified as ‘High Density Polyethylene’. A layer thickness of 60-mil was manually input into the program. Geomembrane parameters were modeled consistent with prior modeling for the site, with an assumed pinhole density of one holes per acre, installation defects of four holes per acre, and “good” placement quality.

1.3.6 Compacted Soil Liner

The compacted soil liner was simulated using HELP Material #16 (‘barrier soil’), which corresponds to the prescriptive three feet of compacted soil liner. As described in Part III, the final design includes the use of a geosynthetic clay liner (GCL) only within the sump area of each cell and/or trench to maintain required groundwater separation and increase available airspace within the Landfill.

1.3.7 Waste Parameters

The waste mass was simulated using HELP Material #18 ('municipal waste'), for two primary reasons:

1. The default initial soil water content of 29.2 percent is near field capacity for most soils and generates a conservatively high initial moisture content for the waste mass.

2. The permeability coefficient of $1x10^{-3}$ cm/sec appears to be conservatively high based upon observed waste characteristics and reported in-place waste densities. This limits the amount of water storage capacity within the waste mass and maximizes leachate generation.

1.4 HELP MODELING SCENARIOS

A description of the initial, intermediate, and final condition results are provided in the sections herein and maximum head on the liner, peak daily leachate generated per acre, and average annual leachate generated per acre for all conditions are presented below in Table 1-1.

1.4.1 Initial Condition

The initial condition simulated leachate generation after an initial 10-foot waste column was placed in the cell with 6 inches of daily cover. The area where runoff is possible was assumed to be 0 percent based on drainage conditions associated with the slopes of the first lift and the overland drainage slope was assumed to be 1 percent, as it is the minimum value that can be selected. The maximum surface slope length is assumed to be 806 feet based on the longest overland drainage path over daily cover. The input evaporative zone depth was set at 6 inches. The leaf area index (LAI) was set at zero, based upon the assumption that the soil cover would be bare (i.e., no vegetation).

1.4.2 Intermediate Condition

The intermediate condition simulated leachate generation with an average 50-foot waste column. The area where runoff is possible was assumed to be 100 percent due to drainage conditions associated with the addition of intermediate cover material over the waste. The overland drainage scope is conservatively 3 percent and the maximum slope length assumed to be fifteen-hundred (1500) feet based on intermediate cover grades. The input evaporative zone depth was conservatively set at 10 inches, which is within the 12-inch intermediate cover layer. The use of the more conservative evaporative zone depth (1) serves to reduce the evaporation that actually would occur and (2) maximizes the infiltration that will occur in the HELP Model output. The LAI was set at one, based upon the assumption that the intermediate cover would have some vegetation established on the sideslopes of the Landfill.

The intermediate condition was simulated without leachate recirculation and with varied percentages, ranging from 30 to 100 percent of the leachate being collected in the drainage layer and recirculated into the waste layer. The leachate would be recirculated through land application to the open face of the Landfill and not over the areas of intermediate cover.

1.4.3 Final Condition

The final cover condition simulated leachate generation with an average 100-foot waste column. The area where runoff is possible was assumed to be 100 percent based on drainage conditions associated with the slopes at final grades. The overland drainage scope is assumed to be 15 percent and the maximum slope length assumed to be eight-hundred six (806) feet based on final cover top grades (2 percent). This slope assumption maximizes infiltration and leachate generation quantities for the final condition.

The input evaporative zone depth was 12 inches based on the assumed depth of the suitable plant growth material. The LAI was set at 2, based upon the assumption that the soil cover would have a fair stand of vegetation established on the side slopes and the top surface of the Landfill.

1.5 HELP MODEL RESULTS

The maximum head on the liner, peak daily leachate collected, and average annual leachate generation was calculated based on a per acre basis for each simulation. The HELP Model results demonstrate that the Landfill will conform to the design standards described in 30 TAC §330.331(a)(2) for MSW cells and §335.590(24)(B) for cells also accepting Class 1 waste, which requires the leachate removal system to maintain less than thirty (30) centimeters (approximately twelve [12] inches) of head above the liner. The HELP Model output files are presented in Appendix C.

STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER
Scott Martin
4/5/2022

Table 1-1: HELP Model Output

Development Stage	Maximum Head on the Liner (in)	Peak Daily Leachate Collected Per Acre[1] (gal)	Average Annual Leachate Collected Per Acre[1] (gal)
Initial Condition	0.1016	4,230.77	141,807.00
Intermediate Condition: No Recirculation	0.1074	4,473.78	123,862.96
Intermediate Condition with 30% Recirculation	0.0897	3,890.54	195,135.76
Intermediate Condition with 75% Recirculation	0.100	4,152.19	529,484.91
Intermediate Condition with 100% Recirculation	0.200	8,344.37	947,501.78
Final Condition	0.009	0.28	0.31

1. Leachate collection values include quantity of leachate recirculated

The Landfill phasing plan and the area of each phase were used to simulate average monthly and annual leachate generation values over the life of the Landfill. Leachate from cells A1-I2 will be collected and stored in leachate tanks prior to hauling for disposal. Peak daily drainage was used to specify the operation and design of the leachate collection system, based on the peak drainage scenario shown in Table 1-2.

Table 1-2: Peak Daily Leachate Generation to Leachate Pond

Cell	Condition	Total Cell Peak Daily Drainage Collected (gal)
A1	Intermediate	47,408
A2	Final	50
B1	Final	50
B2	Final	50
C1	Final	52
C2	Final	52
D1	Final	52
D2	Final	52
E1	Final	52
E2	Final	50
F1	Final	55

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PROFESSIONAL ENGINEER
Scott Martin
4/5/2022

F2	Final	57
G1	Final	57
G2	Final	58
H1	Final	57
H2	Intermediate	43,761
I1	Intermediate	43,761
I2	Initial	53,308
Total		**188,983**

Scott Martin
4/5/2022

Burns & McDonnell Engineering Company, Inc.
8911 Capital of Texas Highway \ Building 3, Suite 3100
Kansas City, MO 64114
O 512-872-7130
F 512-872-7127
www.burnsmcd.com

APPENDIX 3C – HELP MODEL OUTPUT

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: INITIAL 806 ft w. runoff **Simulated On:** 3/11/2021 14:05

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SC - Sandy Clay
Material Texture Number 13

Thickness	=	6	inches
Porosity	=	0.43	vol/vol
Field Capacity	=	0.321	vol/vol
Wilting Point	=	0.221	vol/vol
Initial Soil Water Content	=	0.2788	vol/vol
Effective Sat. Hyd. Conductivity	=	3.30E-05	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	120	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.2935	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.2651	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04	cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)

Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0444	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	2	%
Drainage Length	=	372	ft

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	95.1	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	1.673	inches
Upper Limit of Evaporative Storage	=	2.58	inches
Lower Limit of Evaporative Storage	=	1.326	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	58.63	inches
Total Initial Water	=	58.63	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	28.69	Degrees
Maximum Leaf Area Index	=	5	
Start of Growing Season (Julian Date)	=	40	days
End of Growing Season (Julian Date)	=	345	days
Average Wind Speed	=	10	mph
Average 1st Quarter Relative Humidity	=	75	%
Average 2nd Quarter Relative Humidity	=	77	%
Average 3rd Quarter Relative Humidity	=	75	%
Average 4th Quarter Relative Humidity	=	76	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.743102	2.061257	2.611492	2.579621	4.322587	4.866009
4.663412	2.050707	5.755203	4.001707	3.033373	2.572099

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.69/-96.9

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
60.9	63.3	71.9	76.3	84.7	90.3
93.4	91.3	86.8	84.3	71.1	74.2

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.69/-96.9
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.69/-96.9

Average Annual Totals Summary

Title: INITIAL 806 ft w. runoff
Simulated on: 3/11/2021 14:06

	Average Annual Totals for Years 1 - 5*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.26	[1.79]	149,775.9	100.00
Runoff	8.823	[2.669]	32,026.7	21.38
Evapotranspiration	27.275	[1.933]	99,007.7	66.10
Subprofile1				
Lateral drainage collected from Layer 4	5.2223	[0.4055]	18,956.9	12.66
Percolation/leakage through Layer 6	0.000010	[0.000001]	0.0346	0.00
Average Head on Top of Layer 5	0.0047	[0.0004]	---	---
Water storage				
Change in water storage	-0.0594	[0.2552]	-215.5	-0.14

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: INITIAL 806 ft w. runoff
Simulated on: 3/11/2021 14:06

	Peak Values for Years 1 - 5*		
	(inches)		(cubic feet)
Precipitation	9.77		35,465.1
Runoff	8.423		30,574.0
Subprofile1			
Drainage collected from Layer 4	0.1558		565.6
Percolation/leakage through Layer 6	0.000000		0.0007
Average head on Layer 5	0.0511		---
Maximum head on Layer 5	0.1016		---
Location of maximum head in Layer 4	2.31	(feet from drain)	
Other Parameters			
Snow water	0.8084		2,934.7
Maximum vegetation soil water	0.3557	(vol/vol)	
Minimum vegetation soil water	0.2210	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: INITIAL 806 ft w. runoff
Simulated on: 3/11/2021 14:06
Simulation period: 5 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.3261	0.2210
2	35.0399	0.2920
3	6.5841	0.2743
4	0.0116	0.0578
5	0.0000	0.0000
6	15.3720	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: INTER-806-W.30 RECIRC **Simulated On:** 2/1/2021 11:07

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SC - Sandy Clay
Material Texture Number 13

Thickness	=	12	inches
Porosity	=	0.43	vol/vol
Field Capacity	=	0.321	vol/vol
Wilting Point	=	0.221	vol/vol
Initial Soil Water Content	=	0.3107	vol/vol
Effective Sat. Hyd. Conductivity	=	3.30E-05	cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	600	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Note: 30% of drainage collected from Layer 4 is recirculated into this layer.

Layer 3

Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04	cm/sec

Layer 4

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)

Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	2	%
Drainage Length	=	372	ft

Note: 30% of drainage collected from this layer is recirculated into Layer 2.

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.5	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	10	inches
Initial Water in Evaporative Zone	=	3.086	inches
Upper Limit of Evaporative Storage	=	4.3	inches
Lower Limit of Evaporative Storage	=	2.21	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	200.158	inches
Total Initial Water	=	200.158	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	28.8	Degrees
Maximum Leaf Area Index	=	5	
Start of Growing Season (Julian Date)	=	40	days
End of Growing Season (Julian Date)	=	345	days
Average Wind Speed	=	10.8	mph
Average 1st Quarter Relative Humidity	=	66	%
Average 2nd Quarter Relative Humidity	=	68	%
Average 3rd Quarter Relative Humidity	=	63	%
Average 4th Quarter Relative Humidity	=	66	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.455864	1.450525	3.130764	5.571163	4.384472	4.149132
2.581692	1.853833	6.542828	3.04153	3.144775	2.849654

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
63.4	66.4	65.7	73.2	86	91.6
94.4	91.2	87.5	78.9	69.4	67.4

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Average Annual Totals Summary

Title: INTER-806-W.30 RECIRC
Simulated on: 2/1/2021 11:08

	Average Annual Totals for Years 1 - 5*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.16	[7.22]	149,397.1	100.00
Runoff	5.538	[4.557]	20,103.2	13.46
Evapotranspiration	31.100	[2.567]	112,894.0	75.57
Subprofile1				
Recirculation into Layer 2	1.9231	[0.7578]	6,980.7	4.67
Lateral drainage collected from Layer 4	4.4872	[1.7681]	16,288.4	10.90
Drainage recirculated from Layer 4	1.9231	[0.7578]	6,980.7	4.67
Percolation/leakage through Layer 6	0.000011	[0.000003]	0.0399	0.00
Average Head on Top of Layer 5	0.0058	[0.0023]	---	---
Water storage				
Change in water storage	0.0293	[1.2198]	106.2	0.07

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: INTER-806-W.30 RECIRC
Simulated on: 2/1/2021 11:08

	Peak Values for Years 1 - 5*	
	(inches)	(cubic feet)
Precipitation	9.77	35,465.1
Runoff	7.571	27,481.7
Subprofile1		
Drainage Recirculated into Layer 2	0.0412	149.7
Drainage collected from Layer 4	0.0962	349.4
Drainage recirculated from Layer 4	0.0412	149.7
Percolation/leakage through Layer 6	0.000000	0.0006
Average head on Layer 5	0.0451	---
Maximum head on Layer 5	0.0897	---
Location of maximum head in Layer 4	2.07 (feet from drain)	
Other Parameters		
Snow water	1.0110	3,669.8
Maximum vegetation soil water	0.4165 (vol/vol)	
Minimum vegetation soil water	0.2210 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: INTER-806-W.30 RECIRC
Simulated on: 2/1/2021 11:08
Simulation period: 5 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.1357	0.2613
2	175.2000	0.2920
3	6.5881	0.2745
4	0.0085	0.0427
5	0.0000	0.0000
6	15.3720	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title:	INTER-806-RECIRC75	**Simulated On:**	2/1/2021 17:12

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SC - Sandy Clay
Material Texture Number 13

Thickness	=	12	inches
Porosity	=	0.43	vol/vol
Field Capacity	=	0.321	vol/vol
Wilting Point	=	0.221	vol/vol
Initial Soil Water Content	=	0.3107	vol/vol
Effective Sat. Hyd. Conductivity	=	3.30E-05	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	600	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Note: 75% of drainage collected from Layer 4 is recirculated into this layer.

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.266	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04	cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)

Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0246	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	2	%
Drainage Length	=	372	ft

Note: 75% of drainage collected from this layer is recirculated into Layer 2.

Layer 5

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.5	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	10	inches
Initial Water in Evaporative Zone	=	3.086	inches
Upper Limit of Evaporative Storage	=	4.3	inches
Lower Limit of Evaporative Storage	=	2.21	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	200.689	inches
Total Initial Water	=	200.689	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	28.8	Degrees
Maximum Leaf Area Index	=	5	
Start of Growing Season (Julian Date)	=	40	days
End of Growing Season (Julian Date)	=	345	days
Average Wind Speed	=	10.8	mph
Average 1st Quarter Relative Humidity	=	66	%
Average 2nd Quarter Relative Humidity	=	68	%
Average 3rd Quarter Relative Humidity	=	63	%
Average 4th Quarter Relative Humidity	=	66	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.455864	1.450525	3.130764	5.571163	4.384472	4.149132
2.581692	1.853833	6.542828	3.04153	3.144775	2.849654

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
63.4	66.4	65.7	73.2	86	91.6
94.4	91.2	87.5	78.9	69.4	67.4

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Average Annual Totals Summary

Title: INTER-806-RECIRC75
Simulated on: 2/1/2021 17:13

	Average Annual Totals for Years 1 - 5*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.16	[7.22]	149,397.1	100.00
Runoff	5.538	[4.557]	20,103.2	13.46
Evapotranspiration	31.100	[2.567]	112,894.0	75.57
Subprofile1				
Recirculation into Layer 2	12.5530	[3.8877]	45,567.5	30.50
Lateral drainage collected from Layer 4	4.1843	[1.2959]	15,189.2	10.17
Drainage recirculated from Layer 4	12.5530	[3.8877]	45,567.5	30.50
Percolation/leakage through Layer 6	0.000024	[0.000006]	0.0876	0.00
Average Head on Top of Layer 5	0.0150	[0.0047]	---	---
Water storage				
Change in water storage	0.3268	[1.047]	1,186.1	0.79

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: INTER-806-RECIRC75
Simulated on: 2/1/2021 17:13

	Peak Values for Years 1 - 5*	
	(inches)	(cubic feet)
Precipitation	9.77	35,465.1
Runoff	7.571	27,481.7
Subprofile1		
Drainage Recirculated into Layer 2	0.1007	365.6
Drainage collected from Layer 4	0.0336	121.9
Drainage recirculated from Layer 4	0.1007	365.6
Percolation/leakage through Layer 6	0.000000	0.0006
Average head on Layer 5	0.0441	---
Maximum head on Layer 5	0.0876	---
Location of maximum head in Layer 4	2.03 (feet from drain)	
Other Parameters		
Snow water	1.0110	3,669.8
Maximum vegetation soil water	0.4165 (vol/vol)	
Minimum vegetation soil water	0.2210 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: INTER-806-RECIRC75
Simulated on: 2/1/2021 17:13
Simulation period: 5 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.1357	0.2613
2	176.5167	0.2942
3	7.2810	0.3034
4	0.0177	0.0886
5	0.0000	0.0000
6	15.3720	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: INTER-MSW w. 100% RECIRC **Simulated On:** 1/21/2021 13:37

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SC - Sandy Clay
Material Texture Number 13

Thickness	=	12	inches
Porosity	=	0.43	vol/vol
Field Capacity	=	0.321	vol/vol
Wilting Point	=	0.221	vol/vol
Initial Soil Water Content	=	0.3107	vol/vol
Effective Sat. Hyd. Conductivity	=	3.30E-05	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	600	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.2964	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Note: 100% of drainage collected from Layer 4 is recirculated into this layer.

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.2946	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04	cm/sec

Layer 4
Type 2 - Lateral Drainage Layer

Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0796	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	2	%
Drainage Length	=	372	ft

Note: 100% of drainage collected from this layer is recirculated into Layer 2.

Layer 5

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	91.5	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	10	inches
Initial Water in Evaporative Zone	=	3.086	inches
Upper Limit of Evaporative Storage	=	4.3	inches

Lower Limit of Evaporative Storage	=	2.21	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	204.022	inches
Total Initial Water	=	204.022	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	28.8	Degrees
Maximum Leaf Area Index	=	5	
Start of Growing Season (Julian Date)	=	40	days
End of Growing Season (Julian Date)	=	345	days
Average Wind Speed	=	10.8	mph
Average 1st Quarter Relative Humidity	=	66	%
Average 2nd Quarter Relative Humidity	=	68	%
Average 3rd Quarter Relative Humidity	=	63	%
Average 4th Quarter Relative Humidity	=	66	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.455864	1.450525	3.130764	5.571163	4.384472	4.149132
2.581692	1.853833	6.542828	3.04153	3.144775	2.849654

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
63.4	66.4	65.7	73.2	86	91.6
94.4	91.2	87.5	78.9	69.4	67.4

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Average Annual Totals Summary

Title: INTER-MSW w. 100% RECIRC
Simulated on: 1/21/2021 13:38

	Average Annual Totals for Years 1 - 5*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	41.16	[7.22]	149,397.1	100.00
Runoff	5.538	[4.557]	20,103.2	13.46
Evapotranspiration	31.100	[2.567]	112,894.0	75.57
Subprofile1				
Recirculation into Layer 2	32.5965	[10.3422]	118,325.3	79.20
Lateral drainage collected from Layer 4	0.0000	[0]	0.0000	0.00
Drainage recirculated from Layer 4	32.5965	[10.3422]	118,325.3	79.20
Percolation/leakage through Layer 6	0.000042	[0.000011]	0.1523	0.00
Average Head on Top of Layer 5	0.0293	[0.0093]	---	---
Water storage				
Change in water storage	4.4854	[0.8451]	16,282.0	10.90

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: INTER-MSW w. 100% RECIRC
Simulated on: 1/21/2021 13:39

	Peak Values for Years 1 - 5*	
	(inches)	(cubic feet)
Precipitation	9.77	35,465.1
Runoff	7.571	27,481.7
Subprofile1		
Drainage Recirculated into Layer 2	0.2889	1,048.8
Drainage collected from Layer 4	0.0000	0.0000
Drainage recirculated from Layer 4	0.2889	1,048.8
Percolation/leakage through Layer 6	0.000000	0.0012
Average head on Layer 5	0.0948	---
Maximum head on Layer 5	0.1876	---
Location of maximum head in Layer 4	3.93 (feet from drain)	
Other Parameters		
Snow water	1.0110	3,669.8
Maximum vegetation soil water	0.4165 (vol/vol)	
Minimum vegetation soil water	0.2210 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: INTER-MSW w. 100% RECIRC
Simulated on: 1/21/2021 13:39
Simulation period: 5 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.1357	0.2613
2	200.2494	0.3337
3	7.6342	0.3181
4	0.0580	0.2899
5	0.0000	0.0000
6	15.3720	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: FINAL-200mil-806-15pct-LL **Simulated On:** 11/15/2021 12:41

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
SCL - Sandy Clay Loam
Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.1583	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 2
Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	15	%
Drainage Length	=	806	ft

Layer 3
Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04	inches
Effective Sat. Hyd. Conductivity	=	4.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 4
Type 3 - Barrier Soil Liner

Custom Prescriptive Clay

Material Texture Number 44

Thickness	=	18	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	9.99E-06	cm/sec

Layer 5

Type 1 - Vertical Percolation Layer

SCL - Sandy Clay Loam

Material Texture Number 10

Thickness	=	12	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.20E-04	cm/sec

Layer 6

Type 1 - Vertical Percolation Layer (Waste)

Municipal Solid Waste (MSW) (900 pcy)

Material Texture Number 18

Thickness	=	1200	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.292	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 7

Type 1 - Vertical Percolation Layer

Custom Soil 1

Material Texture Number 43

Thickness	=	24	inches
Porosity	=	0.398	vol/vol
Field Capacity	=	0.244	vol/vol
Wilting Point	=	0.136	vol/vol
Initial Soil Water Content	=	0.244	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04	cm/sec

Layer 8

Type 2 - Lateral Drainage Layer

Drainage Net (0.5 cm)
Material Texture Number 20

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.01	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E+01	cm/sec
Slope	=	2	%
Drainage Length	=	370	ft

Layer 9

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 10

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	36	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	85.7	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	1.899	inches
Upper Limit of Evaporative Storage	=	4.776	inches
Lower Limit of Evaporative Storage	=	1.632	inches

Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	384.145	inches
Total Initial Water	=	384.145	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	28.8	Degrees
Maximum Leaf Area Index	=	5	
Start of Growing Season (Julian Date)	=	40	days
End of Growing Season (Julian Date)	=	345	days
Average Wind Speed	=	10.8	mph
Average 1st Quarter Relative Humidity	=	66	%
Average 2nd Quarter Relative Humidity	=	68	%
Average 3rd Quarter Relative Humidity	=	63	%
Average 4th Quarter Relative Humidity	=	66	%

Note: Evapotranspiration data was obtained for ,

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.253277	1.768531	2.607794	3.161907	3.777098	3.760645
3.51597	2.51198	4.818605	2.837665	2.687022	1.902475

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
64.2	65.3	71.4	79.3	85.8	90.3
93.1	91.9	85.9	78	68.9	65.1

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 28.8/-97.03

Average Annual Totals Summary

Title: FINAL-200mil-806-15pct-LL
Simulated on: 11/15/2021 12:42

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.60	[5.74]	129,238.8	100.00
Runoff	1.405	[1.986]	5,101.1	3.95
Evapotranspiration	31.631	[4.025]	114,821.0	88.84
Subprofile1				
Lateral drainage collected from Layer 2	2.5707	[1.5427]	9,331.6	7.22
Percolation/leakage through Layer 4	0.000058	[0.000069]	0.2094	0.00
Average Head on Top of Layer 3	0.0017	[0.0026]	---	---
Subprofile2				
Lateral drainage collected from Layer 8	0.0001	[0.0001]	0.2079	0.00
Percolation/leakage through Layer 10	0.000000	[0]	0.0015	0.00
Average Head on Top of Layer 9	0.0000	[0]	---	---
Water storage				
Change in water storage	-0.0042	[0.5155]	-15.1	-0.01

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: FINAL-200mil-806-15pct-LL
Simulated on: 11/15/2021 12:42

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	13.40	48,642.0
Runoff	9.634	34,971.1
Subprofile1		
Drainage collected from Layer 2	1.2548	4,554.9
Percolation/leakage through Layer 4	0.000153	0.5564
Average head on Layer 3	2.1989	---
Maximum head on Layer 3	2.6502	---
Location of maximum head in Layer 2	0.00 (feet from drain)	
Subprofile2		
Drainage collected from Layer 8	0.0002	0.5529
Percolation/leakage through Layer 10	0.000000	0.0000
Average head on Layer 9	0.0000	---
Maximum head on Layer 9	0.0001	---
Location of maximum head in Layer 8	0.00 (feet from drain)	
Other Parameters		
Snow water	2.1094	7,657.2
Maximum vegetation soil water	0.3626 (vol/vol)	
Minimum vegetation soil water	0.1360 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: FINAL-200mil-806-15pct-LL
Simulated on: 11/15/2021 12:42
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.7743	0.1479
2	0.0020	0.0100
3	0.0000	0.0000
4	7.6860	0.4270
5	2.9280	0.2440
6	350.4000	0.2920
7	5.8560	0.2440
8	0.0020	0.0100
9	0.0000	0.0000
10	15.3720	0.4270
Snow water	0.0000	---

APPENDIX 3D – LEACHATE TANK CONTAINMENT CALCULATIONS

Leachate Tank Sizing Calculations
Victoria Landfill Permit Amendment

Step 1: Determine existing tank volume

Tank Diameter (ft)	Tank Area (ft^2)	Heigh of Tank (ft)	Tank Volume (ft^3)	Tank Volume (gal)
26.0	530.93	16.0	8494.9	63,546

Step 2: Determine the number of tanks needed to store peak daily leachate generation

Total Daily Drainage Collected (gal)	Tank Volume (gal)	Number of Tanks Needed	Number of Tanks Needed w/ Safety Factor
188,983	63545.8	3	4

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4/5/2022

Leachate Tank Containment Structure Calculations
Victoria Landfill Permit Amendment

Step 1: Determine containment volume displaced by the tanks.

Tank ID	Tank Diameter (ft)	Tank Area (ft^2)	Base Elevation at Tank[a]	Berm Overflow Elevation[b]	Displaced Tank Volume (ft^3)
1522B-1	26.0	530.93	64.0	66.4	1,274
1522B-2	26.0	530.93	64.0	66.4	1,274
1522B-3	26.0	530.93	64.0	66.4	1,274
1522B-4	26.0	530.93	64.0	66.4	0[c]

Step 2: Determine the volume available for containment of tank contents and stormwater.

Containment Area	Containment Overflow Elevation	Approximate Containment Area (ft2)	Total Vol. to Overflow Elevation (ft^3)	Displacement of All Tanks(ft^3)	Net Volume (ft^3)	Net Volume to Overflow Elevation (gal)
Combined	66.4	8,470	20,328	3,823	16,505	123,460

Step 3: Determine storm event volume and evaluate containment structure capacity for stormwater and contents of the largest tank.

Containment Area[d] (sf)	25-yr, 24-hr Storm Event precipitation (ft)
9,070	0.82

Largest Tank in Containment Area ft^3	Largest Tank in Containment Area gallons	Containment Surplus (gallons)	Volume of 25-yr Storm Event (ft^3)	Volume of 25-yr Storm Event (gal)	Containment Surplus following Storm Event (gallons)	**Is containment adequate for Largest Tank +25yr Storm Event?**
21,390	64,000	59,460	7,392	55,293	4,167	**YES**

Notes:

[a] - All tank dimensions rounded to nearest 1.0ft

[b] - This elevation is 3' above the 100-year flood elevation

[c] - Displacement volume of largest tank removed from calculation

[d] - Containment area includes area inside of walls and the loadout pad that slopes toward the containment.

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Leachate Tank Containment Structure Calculations
Victoria Landfill Permit Amendment

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Percent Containment
103%

APPENDIX 3E – DIVERSION BERM DESIGN CALCULATIONS

Victoria Landfill
CONTAMINATED WATER CONTAINMENT AND DIVERSION BERM CALCULATION

BURNS & McDONNELL

PROJECT	Victoria Landfill Permit Amendment 1522B
SUBJECT	Contaminated Water Containment and Diversion Berms
PROJECT NUMBER	1076078
DATE	11/2/2021

Purpose: The purpose of this calculation is to determine the height of the contaminated water containment berm at the downstream edge of the active face and the height of the diversion berm controlling stormwater run-on to the active face.

Methodology: These calculations are organized into two parts: those pertaining to the containment berm and those pertaining to the diversion berm. First, the containment berm height was calculated by estimating the volume of runoff within the active area, then solving for the required height based on this volume, the length of the berm and the geometry of the v-shaped water cross-section. Second, the diversion berm height was calculated using the Rational Method to estimate the peak flow from a typical run-on drainage basin and Mannings Equation to size the v-shaped swale. Runoff peak flows and volumes were calculated using the 25-year, 24-hour storm event for Victoria, TX.

Assumptions:
1. Runoff coefficient for the active face is determined according to exposed waste at 3% slopes.
2. The average weekly waste placement rate, used to size the active face was determined using the 2019 annual disposal tonnage, a 666 lb/cy factor, and a compaction ratio of 2:1 (volume in truck:volume in landfill)
3. The lift thickness, used to size the active face, is 10 feet. This is typical for landfill operations.
4. The active face is square-shaped.
5. The active face has a slope of 3%.
6. The containment/diversion berms shall have 2:1 slopes and no minimum top width.
7. Time of concentration is assumed to be 10 min.
8. Runoff coefficient for the run-on basin is determined according to interim cover material at 3:1 slopes that extend to touch the flowine of the berm.
9. Area of the run-on basin is 4 acres. This is equivalent to approximately 14 former active faces.
10. A 0.5% flowline slope was used to design the run-on berm. Actual slopes at time of installation should be 1.0%. This accounts for settlement.

References:
1. Texas DOT Hydraulic Design Manual, 2019
2. NOAA Atlas 14, Volume 11, Version 2 Estimates for Victoria, TX
3. Rainfall Intensity-Duration-Frequency Coefficients for Texas Version 2.1, 2015
4. Hydraflow Express Extension Output

7222 = Data Input Cell
7222 = Calculated and/or Referenced

Conclusions: 2-foot containment and diversion berms with 2:1 side slopes shall be installed around the active face. The diversion portion of the berm, along the upstream edge of the active face, shall have a flowline of at least 0.5% for the duration of the active face.

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Prepared By:	T. Schmidt	Date:	11/2/2021
Checked By:	D. Kantner	Date:	11/8/2021
Approved By:	S. Martin	Date:	11/12/2021

Scott Martin
4/5/2022

Victoria Landfill
CONTAMINATED WATER CONTAINMENT CALCULATION

Calculation by: TJS   Date: 11/2/2021

Reference

1) PEAK VOLUME OF CONTMINATED WATER

MSW Runoff Coefficient, C

					Reference
Watershed Relief Component, Cr		**Cr =**	0.09		Reference 1, Assumption 1
Soil Infiltration Component, Ci		**Ci =**	0.06		Reference 1, Assumption 1
Vegetal Cover Component, Cv		**Cv =**	0.16		Reference 1, Assumption 1
Surface Type Component, Cs		**Cs =**	0.04		Reference 1, Assumption 1
Overall Runoff Coefficient, C = Cr + Ci + Cv + Cs		**C =**	0.35		Reference 1

25-year, 24-hour Rainfall Depth, D

Rainfall Depth		**D =**	9.78	in	Reference 2
			0.82	ft	

Area, A

In-place waste volume per year, Wyear		$\mathbf{W_{year}}$ =	232,733	CY	Assumption 2
In-place waste volume per week	$\mathbf{W = W_{year} / 52}$	**W =**	4,476	CY	Assumption 2
			120,842	ft^3	
Lift Thickness, T		**T =**	10	ft	Assumption 3
Contact Water Area	**A = W/T**	**A =**	12,084	ft^2	
			0.28	acres	

Contaminated Water Volume, V

V = Total Contaminated Water = C x D x A	**V =**	3,447	ft^3	

2) REQUIRED CONTAINMENT BERM HEIGHT

Downstream Berm Length, L	$\mathbf{L = A^{0.5}}$	**L =**	109.93	ft	Assumption 4
Required Cross-Sectional Area	$\mathbf{A_x = V/L}$	$\mathbf{A_x}$ =	31.36	ft^2	
Slope of Active Area (inside edge of triangular cross-sectional area, A		$\mathbf{S_1}$ =	0.03	ft/ft	Assumption 5
Slope of Berm (outside edge of triangular cross-sectional area, Ax)		$\mathbf{S_2}$ =	0.50	ft/ft	Assumption 6
Height of Contaminated Water	$\mathbf{H_W = (2Ax / [(1/S_2)+(1/S_1)])^{0.5}}$	$\mathbf{H_W}$ =	1.33	ft	
Height of Containment Berm	$\mathbf{H_B = H_W + 6\ inches\ freeboard}$	$\mathbf{H_B}$ =	1.83	ft	

Use a berm height of 2 feet.

NOTE:
Areas and Lengths calculated using AutoCAD Civil3D 2020

Victoria Landfill

ACTIVE FACE RUN-ON DIVERSION CALCULATION

Calculation by: TJS Date: 11/2/2021

1) PEAK FLOW OF RUN-ON WATER

Runoff Coefficient, C

				Reference
Watershed Relief Component, Cr	**Cr =**	0.30		Reference 1, Assumption 8
Soil Infiltration Component, Ci	**Ci =**	0.08		Reference 1, Assumption 8
Vegetal Cover Component, Cv	**Cv =**	0.12		Reference 1, Assumption 8
Surface Type Component, Cs	**Cs =**	0.08		Reference 1, Assumption 8
Overall Runoff Coefficient, C = Cr + Ci + Cv + Cs		**0.58**		

Average Rainfall Intensity, I

Time of Concentration, T	**T_c =**	10.0	min	Assumption 7
25- Year Intensity-Frequency-Duration Coefficient, e	**e =**	0.7734		Reference 3
25- Year Intensity-Frequency-Duration Coefficient, b	**b =**	97.500	in	Reference 3
25- Year Intensity-Frequency-Duration Coefficient, d	**d =**	10.440	min	Reference 3
Average Rainfall Intensity, $I = b/(T_c + d)^e$	**I =**	**9.451**	in/hr	Reference 3

Drainage Area, A

Drainage Area, A	**A =**	4.00	Ac	Assumption 9

Peak Flow, Q

Q= Total Discharge from Watershed = C x I x A	**Q =**	**21.9**	**cfs**	

2) REQUIRED DIVERSION BERM HEIGHT

Slope of Run-on Basin (inside edge of triangular cross-sectional area)	**S =**	0.33	ft/ft	Assumption 8
Slope of Berm (outside edge of triangular cross-sectional area)	**S =**	0.50	ft/ft	Assumption 6
Slope of Swale Flowline	**S =**	0.50	%	Assumption 10
Mannings Roughness Coefficient, n	**n =**	0.018		Reference 1
Depth of Flow	**H_W =**	1.420	ft	Reference 4
Height of Diversion Berm **$H_B = H_W$ + 6 inches freeboard**	**H_B =**	**1.92**	ft	

Use a berm height of 2 feet.

NOTE:

Areas and Lengths calculated using AutoCAD Civil3D 2020

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4/5/2022

Reference 1
Texas DOT Hydraulic Design Manual, 2019

Hydraulic Design Manual

Revised September 2019

Table 4-11: Runoff Coefficients for Rural Watersheds

Watershed characteristic	Extreme	High	Normal	Low
Relief - C_r	0.28-0.35 Steep, rugged terrain with average slopes above 30%	0.20-0.28 Hilly, with average slopes of 10-30%	0.14-0.20 Rolling, with average slopes of 5-10%	0.08-0.14 Relatively flat land, with average slopes of 0-5%
Soil infiltration - C_i	0.12-0.16 No effective soil cover; either rock or thin soil mantle of negligible infiltration capacity	0.08-0.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity or poorly drained	0.06-0.08 Normal; well drained light or medium textured soils, sandy loams	0.04-0.06 Deep sand or other soil that takes up water readily; very light, well-drained soils
Vegetal cover - C_v	0.12-0.16 No effective plant cover, bare or very sparse cover	0.08-0.12 Poor to fair; clean cultivation, crops or poor natural cover, less than 20% of drainage area has good cover	0.06-0.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	0.04-0.06 Good to excellent; about 90% of drainage area in good grassland, woodland, or equivalent cover
Surface Storage - C_s	0.10-0.12 Negligible; surface depressions few and shallow, drainageways steep and small, no marshes	0.08-0.10 Well-defined system of small drainageways, no ponds or marshes	0.06-0.08 Normal; considerable surface depression, e.g., storage lakes and ponds and marshes	0.04-0.06 Much surface storage, drainage system not sharply defined; large floodplain storage, large number of ponds or marshes
Table 4-11 note: The total runoff coefficient based on the 4 runoff components is $C = C_r + C_i + C_v + C_s$				

While this approach was developed for application to rural watersheds, it can be used as a check against mixed-use runoff coefficients computed using other methods. In so doing, the designer would use judgment, primarily in specifying C_s, to account for partially developed conditions within the watershed.

Mixed Land Use

For areas with a mixture of land uses, a composite runoff coefficient should be used. The composite runoff coefficient is weighted based on the area of each respective land use and can be calculated as:

Table 4-10: Runoff Coefficients for Urban Watersheds

Type of drainage area	Runoff coefficient
Heavy soil, steep 7%	0.25-0.35
Streets:	
Asphaltic	0.85-0.95
Concrete	0.90-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.95
Roofs	0.75-0.95

Rural and Mixed-Use Watershed

Table 4-11 shows an alternate, systematic approach for developing the runoff coefficient. This table applies to rural watersheds only, addressing the watershed as a series of aspects. For each of four aspects, the designer makes a systematic assignment of a runoff coefficient "component." Using Equation 4-22, the four assigned components are added to form an overall runoff coefficient for the specific watershed segment.

The runoff coefficient for rural watersheds is given by:

$$C = C_r + C_i + C_v + C_s$$

Equation 4-22.

Where:

C = runoff coefficient for rural watershed

C_r = component of coefficient accounting for watershed relief

C_i = component of coefficient accounting for soil infiltration

C_v = component of coefficient accounting for vegetal cover

C_s = component of coefficient accounting for surface type

The designer selects the most appropriate values for C_r, C_i, C_v, and C_s from Table 4-11.

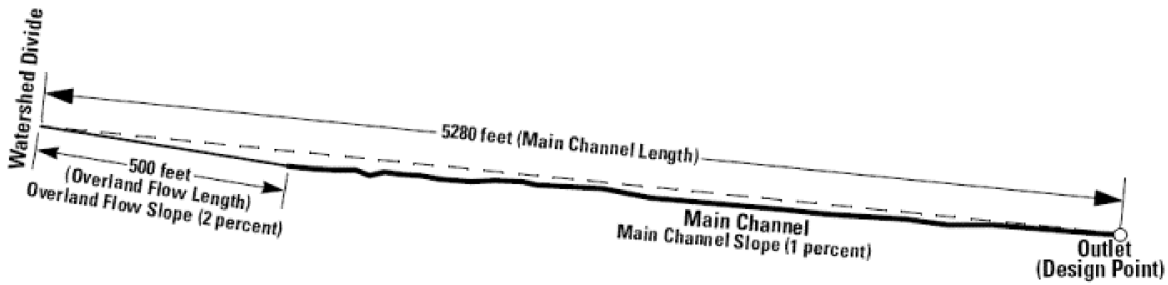

Figure 4-7. Example application of Kerby-Kirpich method

Natural Resources Conservation Service (NRCS) Method for Estimating t_c

The NRCS method for estimating t_c is applicable for small watersheds, in which the majority of flow is overland flow such that timing of the peak flow is not significantly affected by the contribution flow routed through underground storm drain systems. With the NRCS method:

$$t_c = t_{sh} + t_{sc} + t_{ch}$$

Equation 4-16.

Where:

t_{sh} = sheet flow travel time

t_{sc} = shallow concentrated flow travel time

t_{ch} = channel flow travel time

NRCS 1986 provides the following descriptions of these flow components:

Sheet flow is flow over plane surfaces, usually occurring in the headwater of streams. With sheet flow, the friction value 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.

Sheet flow usually becomes shallow concentrated flow after around 100 feet.

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 USGS quadrangle sheets.

For open channel flow, consider the uniform flow velocity based on bank-full flow conditions. That is, the main channel is flowing full without flow in the overbanks. This assumption avoids the significant iteration associated with rainfall intensity or discharges (because rainfall intensity and discharge are dependent on time of concentration).

For conduit flow, in a proposed storm drain system, compute the velocity at uniform depth based on the computed discharge at the upstream. Otherwise, if the conduit is in existence, determine full capacity flow in the conduit, and determine the velocity at capacity flow. You may need to compare this velocity later with the velocity calculated during conduit analysis. If there is a significant difference and the conduit is a relatively large component of the total travel path, recompute the time of concentration using the latter velocity estimate.

If it is determined that a low slope condition or a transitional slope condition exists, the user should consider using an adjusted slope in calculating the time of concentration. See Time of Concentration.

Sheet Flow Time Calculation

Sheet flow travel time is computed as:

$$t_{sh} = \frac{0.007(n_{ol}L_{sh})^{0.8}}{(P_2)^{0.5}S_{sh}^{0.4}}$$

Equation 4-17.

Where:

t_{sh} = sheet flow travel time (hr.)

n_{ol} = overland flow roughness coefficient (provided in Table 4-6)

L_{sh} = sheet flow length (ft) (100 ft. maximum)

P_2 = 2-year, 24-h rainfall depth (in.) (provided in - NOAA's Precipitation Frequency Data Server for Atlas 14)

S_{sh} = sheet flow slope (ft/ft)

Table 4-6: Overland Flow Roughness Coefficients for Use in NRCS Method in Calculating Sheet Flow Travel Time (NRCS 1986)

Surface description		n_{ol}
Smooth surfaces (concrete, asphalt, gravel, or bare soil)		0.011
Fallow (no residue)		0.05
Cultivated soils:	Residue $cover \le 20\,\%$	0.06
	Residue cover > 20%	0.17
Grass:	Short grass prairie	0.15
	Dense grasses	0.24
	Bermuda	0.41

Table 4-6: Overland Flow Roughness Coefficients for Use in NRCS Method in Calculating Sheet Flow Travel Time (NRCS 1986)

Surface description		n_{ol}
Range (natural):		0.13
Woods:	Light underbrush	0.40
	Dense underbrush	0.80

NOTE: 'n' values for overland flows (nol) are not to be used in other channel or floodplain applications.

Shallow Concentrated Flow

Shallow concentrated flow travel time is computed as:

$$t_{sc} = \frac{L_{sc}}{3600KS_{sc}^{0.5}}$$

Equation 4-18.

Where:

t_{sc} = shallow concentrated flow time (hr.)

L_{sc} = shallow concentrated flow length (ft)

K = 16.13 for unpaved surface, 20.32 for paved surface

S_{sc} = shallow concentrated flow slope (ft/ft)

Channel Flow

Channel flow travel time is computed by dividing the channel distance by the flow rate obtained from Manning's equation. This can be written as:

$$t_{ch} = L_{ch} \Big/ \left((3600 \frac{1.49}{n} R^{\frac{2}{3}} S_{ch}^{\frac{1}{2}}) \right)$$

Equation 4-19.

Where:

t_{ch} = channel flow time (hr.)

L_{ch} = channel flow length (ft)

S_{ch} = channel flow slope (ft/ft)

n = Manning's roughness coefficient

R = channel hydraulic radius (ft), and is equal to $\frac{a}{p_w}$, where: a = cross sectional area (ft^2) and p_w = wetted perimeter (ft), consider the uniform flow velocity based on bank-full flow conditions. That is, the main channel is flowing full without flow in the overbanks. This assumption avoids the significant iteration associated with other methods that employ rainfall intensity or discharges (because rainfall intensity and discharge are dependent on time of concentration).

Manning's Roughness Coefficient Values

Manning's roughness coefficients are used to calculate flows using Manning's equation. Values from American Society of Civil Engineers (ASCE) 1992, FHWA 2001, and Chow 1959 are reproduced in Table 4-7, Table 4-8, and Table 4-9.

Table 4-7: Manning's Roughness Coefficients for Open Channels

Type of channel	Manning's n
A. Natural streams	
1. Minor streams (top width at flood stage < 100 ft)	
a. Clean, straight, full, no rifts or deep pools	0.025-0.033
b. Same as a, but more stones and weeds	0.030-0.040
c. Clean, winding, some pools and shoals	0.033-0.045
d. Same as c, but some weeds and stones	0.035-0.050
e. Same as d, lower stages, more ineffective	0.040-0.055
f. Same as d, more stones	0.045-0.060
g. Sluggish reaches, weedy, deep pools	0.050-0.080
h. Very weedy, heavy stand of timber and underbrush	0.075-0.150
i. Mountain streams with gravel and cobbles, few boulders on bottom	0.030-0.050
j. Mountain streams with cobbles and large boulders on bottom	0.040-0.070
2. Floodplains	
a. Pasture, no brush, short grass	0.025-0.035
b. Pasture, no brush, high grass	0.030-0.050
c. Cultivated areas, no crop	0.020-0.040
d. Cultivated areas, mature row crops	0.025-0.045
e. Cultivated areas, mature field crops	0.030-0.050
f. Scattered brush, heavy weeds	0.035-0.070
g. Light brush and trees in winter	0.035-0.060
h. Light brush and trees in summer	0.040-0.080

Table 4-7: Manning's Roughness Coefficients for Open Channels

Type of channel	Manning's n
i. Medium to dense brush in winter	0.045-0.110
j. Medium to dense brush in summer	0.070-0.160
k. Trees, dense willows summer, straight	0.110-0.200
l. Trees, cleared land with tree stumps, no sprouts	0.030-0.050
m. Trees, cleared land with tree stumps, with sprouts	0.050-0.080
n. Trees, heavy stand of timber, few down trees, flood stage below branches	0.080-0.120
o. Trees, heavy stand of timber, few down trees, flood stage reaching branches	0.100-0.160
3. Major streams (top width at flood stage > 100 ft)	
a. Regular section with no boulders or brush	0.025-0.060
b. Irregular rough section	0.035-0.100
B. Excavated or dredged channels	
1. Earth, straight and uniform	
a. Clean, recently completed	0.016-0.020
b. Clean, after weathering	0.018-0.025
c. Gravel, uniform section, clean	0.022-0.030
d. With short grass, few weeds	0.022-0.033
2. Earth, winding and sluggish	
a. No vegetation	0.023-0.030
b. Grass, some weeds	0.025-0.033
c. Deep weeds or aquatic plants in deep channels	0.030-0.040
d. Earth bottom and rubble sides	0.028-0.035
e. Stony bottom and weedy banks	0.025-0.040
f. Cobble bottom and clean sides	0.030-0.050
g. Winding, sluggish, stony bottom, weedy banks	0.025-0.040
h. Dense weeds as high as flow depth	0.050-0.120
3. Dragline-excavated or dredged	
a. No vegetation	0.025-0.033
b. Light brush on banks	0.035-0.060
4. Rock cuts	

Procedure for using the Rational Method

The rational formula estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration. The rational formula is:

$$Q = \frac{CIA}{Z}$$

Equation 4-20.

Where*:*

Q = maximum rate of runoff (cfs or m^3/sec.)

C = runoff coefficient

I = average rainfall intensity (in./hr. or mm/hr.)

A = drainage area (ac or ha)

Z = conversion factor, 1 for English, 360 for metric

Rainfall Intensity

The rainfall intensity (I) is the average rainfall rate in in./hr. for a specific rainfall duration and a selected frequency. The duration is assumed to be equal to the time of concentration. For drainage areas in Texas, you may compute the rainfall intensity using Equation 4-21, which is known as a rainfall intensity-duration-frequency (IDF) relationship (power-law model).

$$I = \frac{b}{(t_c + d)^e}$$

Equation 4-21.

Where:

I = design rainfall intensity (in./hr.)

t_c = time of concentration (min) as discussed in Section 11

e, b, d = coefficients based on rainfall IDF data.

In September 2018, the National Oceanic and Atmospheric Administration (NOAA) released updated precipitation frequency estimates for Texas. These estimates are available through NOAA's Precipitation Frequency Data Server (PFDS) website and the report documenting the approach is also available at the same website - NOAA Atlas 14, Volume 11: Precipitation-Frequency Atlas of the United States. This new rainfall data is considered best available data and should be used for all projects. Tabular IDF data are available from the PFDS, but linear interpolation or curve generation is needed to obtain intensity values between tabular durations. Ongoing TxDOT research will produce future e, b, d coefficients to better automate intensity calculations. However, barring significant project implementation concerns, Atlas 14 IDF data should be used. Exceptions must be approved by the DHE or DES HYD and noted on the plans or drainage report.

Currently, the coefficients in Equation 4-21 can be found in the EBDLKUP-2015v2.1.xlsx spreadsheet lookup tool (developed by Cleveland et al. 2015) for specific frequencies listed by county (See video/tutorial on the use of the EBDLKUP-2015v2.1.xlsx spreadsheet tool). This spreadsheet is based on prior rainfall frequency-duration data contained in the Atlas of Depth-Duration Frequency (DDF) of Precipitation of Annual Maxima for Texas (TxDOT 5-1301-01-1).

If a project is approved to use the older values from the EBDLKUP-2015v2.1.xlsx spreadsheet lookup tool or from existing functionality in design software like GEOPAK, they should still evaluate the new NOAA rainfall changes for their project area and, if there are increases for the design frequency, estimate an appropriate level of freeboard for use. The freeboard amount and a description of how it was generated should be noted in both the plans and the drainage report. Software that facilitates Rational Method calculations often has IDF curves from rainfall data embedded into the software. Location-specific IDF from the new NOAA rainfall data can be imported for each project into the software.

TxDOT is currently working with Texas Transportation Institute (TTI) staff, as part of research project 0-6980, to update the IDF curve relationships for the state of Texas based on the 2018 NOAA rainfall data. This work will include an update of the EBDLKUP-2015v2.1.xlsx file linked above and planned for inclusion in the next HDM update.

The general shape of a rainfall IDF curve is shown in Figure 4-9. As rainfall duration approaches zero, the rainfall intensity tends towards infinity. Because the rainfall intensity/duration relationship is assessed by assuming that the duration is equal to the time of concentration, small areas with exceedingly short times of concentration could result in design rainfall intensities that are unrealistically high. To minimize this likelihood, use a minimum time of concentration of 10 minutes. As the duration tends to infinity, the design rainfall tends towards zero. Usually, the area limitation of 200 acres for Rational Method calculations should result in rainfall intensities that are not unrealistically low. However, if the estimated time of concentration is

Reference 2
NOAA Atlas 14, Volume 11, Version 2 Estimates for Victoria, TX

NOAA Atlas 14, Volume 11, Version 2
Location name: Victoria, Texas, USA*
Latitude: 28.7371°, Longitude: -96.9737°
Elevation: 29.61 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.497 (0.376-0.657)	0.571 (0.436-0.748)	0.692 (0.527-0.910)	0.792 (0.595-1.06)	0.930 (0.678-1.27)	1.04 (0.735-1.45)	1.14 (0.788-1.64)	1.25 (0.838-1.83)	1.38 (0.897-2.09)	1.48 (0.937-2.29)
10-min	0.790 (0.598-1.04)	0.909 (0.694-1.19)	1.10 (0.839-1.45)	1.26 (0.948-1.68)	1.49 (1.08-2.04)	1.66 (1.18-2.33)	1.83 (1.26-2.62)	1.99 (1.33-2.91)	2.18 (1.42-3.30)	2.32 (1.47-3.60)
15-min	1.00 (0.757-1.32)	1.15 (0.875-1.50)	1.39 (1.06-1.82)	1.58 (1.19-2.11)	1.86 (1.35-2.54)	2.07 (1.46-2.89)	2.27 (1.57-3.26)	2.48 (1.66-3.63)	2.74 (1.78-4.14)	2.93 (1.86-4.54)
30-min	1.42 (1.08-1.88)	1.62 (1.24-2.13)	1.96 (1.49-2.57)	2.23 (1.67-2.97)	2.60 (1.89-3.56)	2.89 (2.05-4.05)	3.18 (2.19-4.56)	3.47 (2.33-5.09)	3.85 (2.50-5.83)	4.14 (2.62-6.42)
60-min	1.87 (1.42-2.47)	2.15 (1.64-2.82)	2.60 (1.98-3.42)	2.98 (2.24-3.97)	3.50 (2.54-4.78)	3.90 (2.76-5.45)	4.30 (2.97-6.17)	4.72 (3.17-6.94)	5.30 (3.44-8.03)	5.74 (3.64-8.90)
2-hr	2.32 (1.77-3.03)	2.71 (2.08-3.50)	3.35 (2.57-4.36)	3.89 (2.94-5.13)	4.65 (3.41-6.29)	5.25 (3.74-7.27)	5.87 (4.07-8.32)	6.54 (4.42-9.48)	7.47 (4.88-11.2)	8.22 (5.22-12.6)
3-hr	2.57 (1.97-3.34)	3.06 (2.35-3.91)	3.82 (2.95-4.94)	4.48 (3.41-5.88)	5.43 (4.00-7.30)	6.18 (4.42-8.51)	6.98 (4.86-9.83)	7.85 (5.32-11.3)	9.07 (5.93-13.5)	10.1 (6.40-15.2)
6-hr	2.98 (2.31-3.84)	3.63 (2.81-4.58)	4.64 (3.60-5.93)	5.53 (4.24-7.17)	6.82 (5.06-9.08)	7.87 (5.67-10.7)	9.00 (6.31-12.5)	10.2 (6.98-14.6)	12.0 (7.89-17.6)	13.5 (8.60-20.1)
12-hr	3.32 (2.59-4.24)	4.16 (3.23-5.15)	5.42 (4.24-6.84)	6.55 (5.07-8.42)	8.23 (6.16-10.9)	9.62 (6.99-13.0)	11.2 (7.86-15.3)	12.8 (8.78-18.0)	15.3 (10.1-22.0)	17.3 (11.1-25.4)
24-hr	3.65 (2.88-4.61)	4.70 (3.67-5.73)	6.26 (4.94-7.82)	7.68 (5.99-9.76)	9.78 (7.38-12.8)	11.5 (8.45-15.4)	13.5 (9.55-18.3)	15.6 (10.7-21.6)	18.7 (12.4-26.6)	21.2 (13.7-30.8)
2-day	3.97 (3.15-4.96)	5.28 (4.17-6.39)	7.27 (5.80-9.00)	9.06 (7.13-11.4)	11.7 (8.87-15.1)	13.8 (10.2-18.2)	16.2 (11.5-21.7)	18.7 (12.9-25.5)	22.3 (14.8-31.3)	25.2 (16.3-36.1)
3-day	4.25 (3.40-5.28)	5.69 (4.54-6.88)	7.91 (6.36-9.74)	9.87 (7.80-12.3)	12.7 (9.68-16.3)	15.0 (11.1-19.6)	17.5 (12.5-23.2)	20.2 (14.0-27.3)	24.0 (16.0-33.4)	27.1 (17.6-38.4)
4-day	4.56 (3.66-5.64)	6.04 (4.85-7.29)	8.34 (6.73-10.2)	10.4 (8.22-12.9)	13.2 (10.1-16.9)	15.6 (11.5-20.2)	18.1 (13.0-23.9)	20.8 (14.5-28.1)	24.8 (16.6-34.3)	28.1 (18.2-39.5)
7-day	5.39 (4.35-6.61)	6.88 (5.57-8.27)	9.21 (7.49-11.2)	11.2 (8.98-13.9)	14.1 (10.9-17.8)	16.5 (12.2-21.1)	19.0 (13.7-24.8)	21.8 (15.3-29.1)	26.0 (17.5-35.6)	29.6 (19.2-41.1)
10-day	6.05 (4.91-7.39)	7.56 (6.17-9.07)	9.93 (8.11-12.0)	12.0 (9.63-14.7)	14.9 (11.5-18.6)	17.2 (12.8-22.0)	19.7 (14.3-25.7)	22.6 (15.9-30.0)	26.9 (18.1-36.6)	30.6 (19.9-42.1)
20-day	7.87 (6.45-9.52)	9.52 (7.90-11.4)	12.2 (10.1-14.7)	14.4 (11.7-17.6)	17.5 (13.6-21.6)	19.8 (14.9-24.9)	22.3 (16.2-28.6)	25.1 (17.7-32.8)	29.2 (19.8-39.1)	32.7 (21.4-44.4)
30-day	9.33 (7.69-11.2)	11.1 (9.31-13.3)	14.1 (11.7-16.9)	16.5 (13.4-19.9)	19.7 (15.3-24.1)	22.1 (16.6-27.5)	24.5 (17.9-31.2)	27.2 (19.3-35.3)	31.2 (21.1-41.3)	34.4 (22.6-46.3)
45-day	11.3 (9.39-13.5)	13.3 (11.3-15.9)	16.7 (14.0-19.9)	19.4 (15.9-23.3)	22.9 (17.9-27.9)	25.5 (19.2-31.5)	28.0 (20.5-35.4)	30.8 (21.8-39.5)	34.6 (23.5-45.4)	37.6 (24.7-50.1)
60-day	13.1 (10.9-15.6)	15.3 (13.0-18.2)	19.0 (16.0-22.6)	22.0 (18.1-26.2)	25.8 (20.3-31.3)	28.6 (21.7-35.2)	31.3 (23.0-39.3)	34.1 (24.3-43.5)	37.9 (25.8-49.4)	40.7 (26.8-53.9)

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

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

Please refer to NOAA Atlas 14 document for more information.

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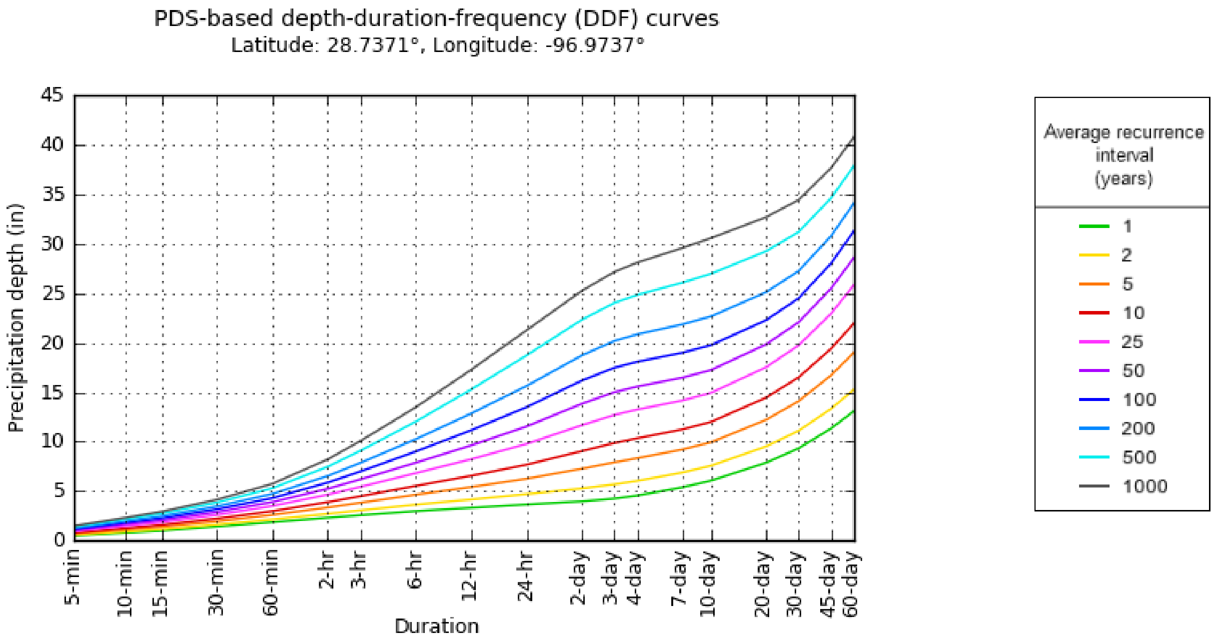
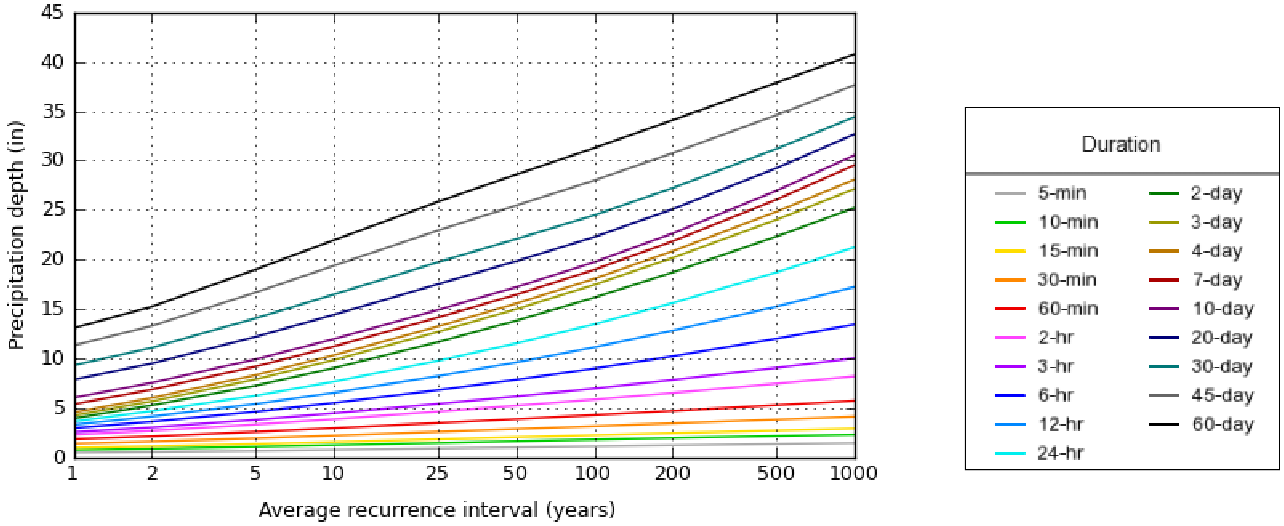
PF graphical





NOAA Atlas 14, Volume 11, Version 2

Created (GMT): Tue Jan 12 23:52:12 2021

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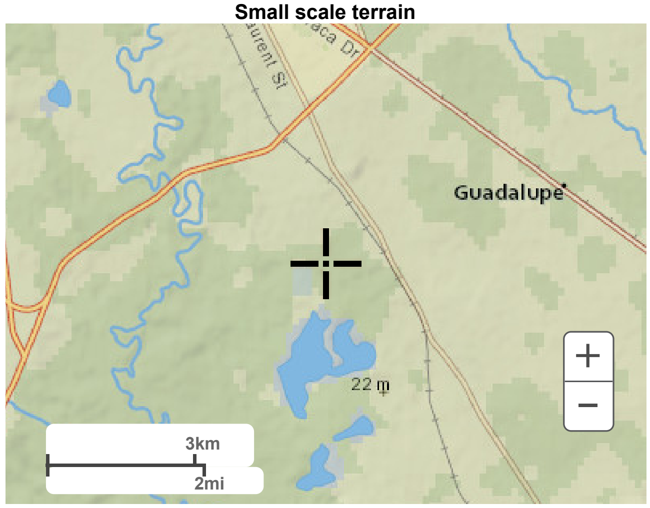
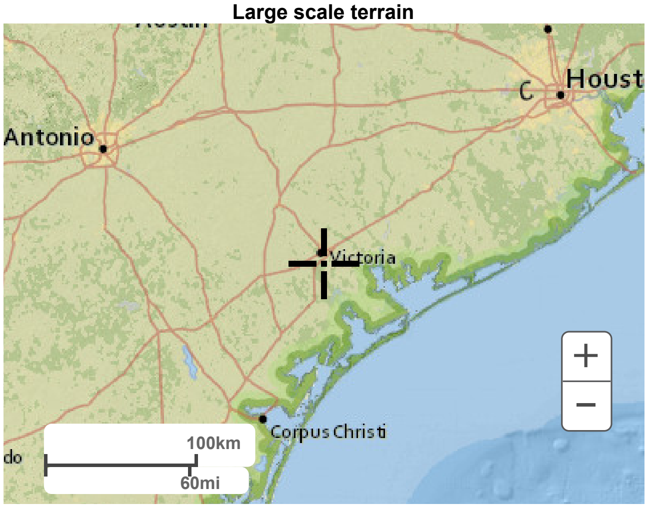
Maps & aerials

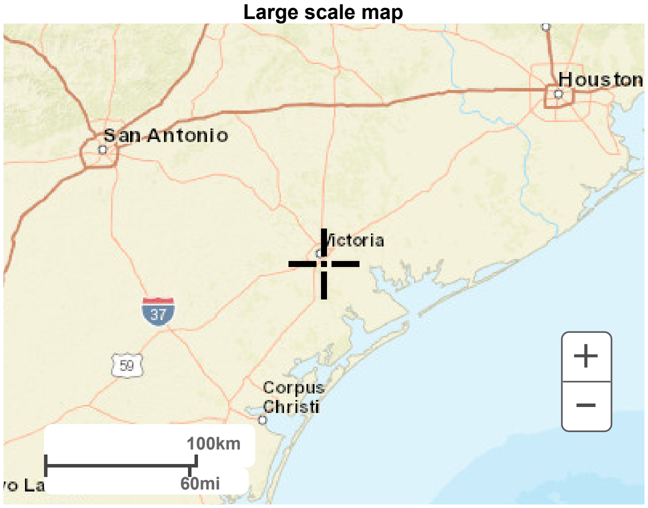
Small scale terrain



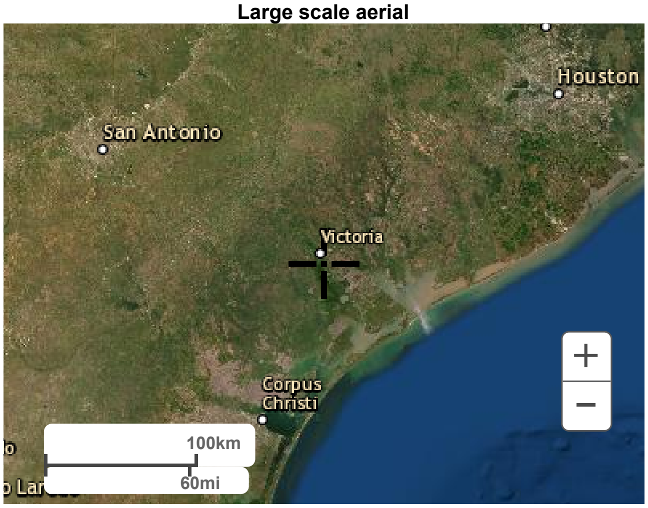
Large scale terrain



Large scale map



Large scale aerial



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Reference 3
Rainfall Intensity-Duration-Frequency Coefficients for Texas Version 2.1, 2015

Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units

English

2. Select or Enter a County

Victoria

3. Enter a Time of Conc.
Select Units

- | min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.8068	0.7918	0.7807	0.7734	0.774	0.7749
b (in.)	60.55	75.30	85.33	97.50	112.80	131.49
d (min)	10.01	10.15	10.16	10.44	11.09	11.87
Intensity (in./hr)	~~#VALUE!~~	~~#VALUE!~~	~~#VALUE!~~	~~#VALUE!~~	~~#VALUE!~~	~~#VALUE!~~

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

Reference 4
Hydraflow Express Extension Output for AutoCAD Civil 3D

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Friday, Nov 12 2021

Reference 4 - Channel Calculation for Diversion Berm

Triangular

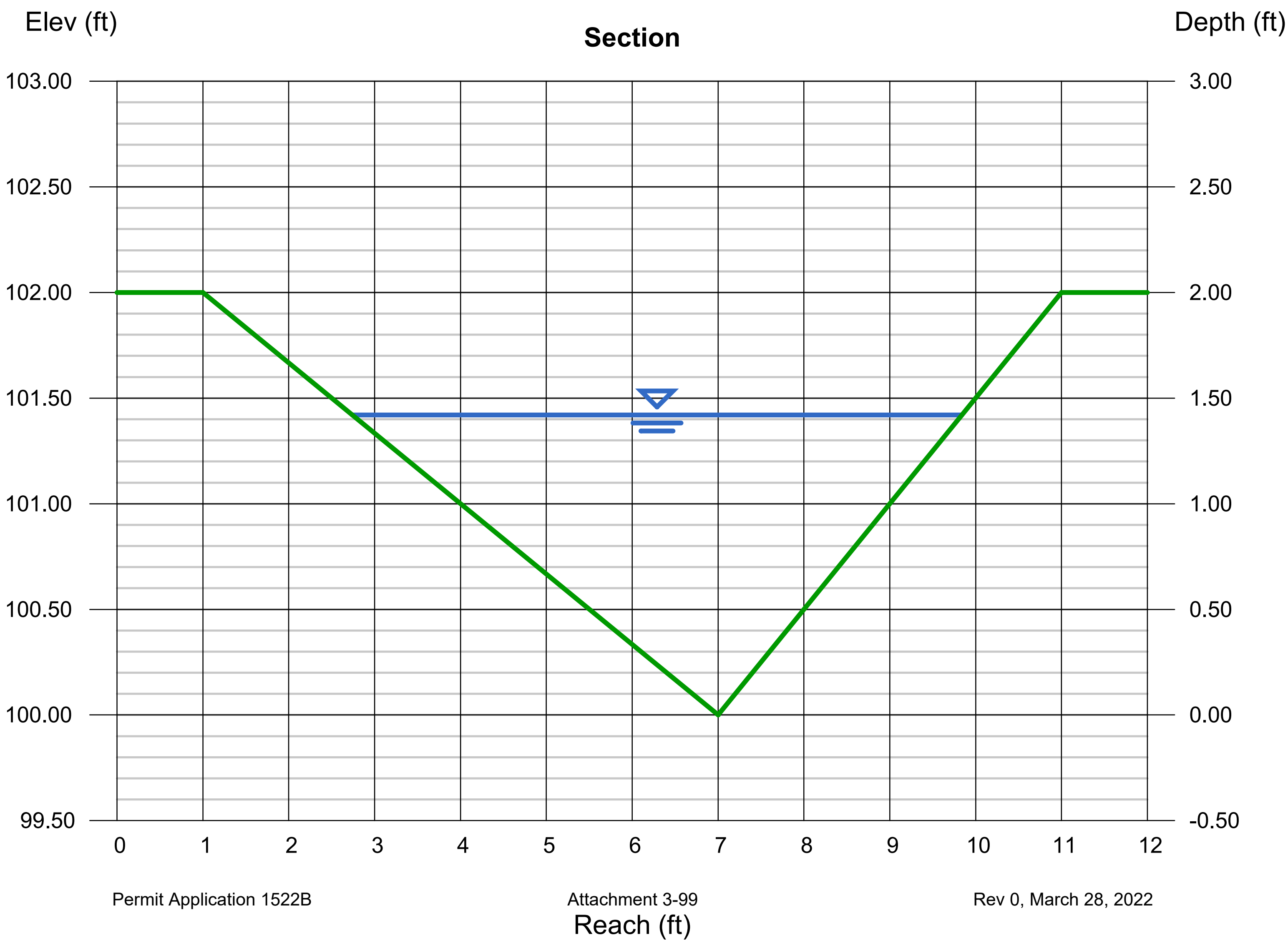
Side Slopes (z:1)	= 3.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 0.50
N-Value	= 0.018

Calculations

Compute by:	Known Q
Known Q (cfs)	= 21.90

Highlighted

Depth (ft)	= 1.42
Q (cfs)	= 21.90
Area (sqft)	= 5.04
Velocity (ft/s)	= 4.34
Wetted Perim (ft)	= 7.67
Crit Depth, Yc (ft)	= 1.37
Top Width (ft)	= 7.10
EGL (ft)	= 1.71



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ATTACHMENT 4 – SOIL LINER QUALITY CONTROL PLAN

Part III, Attachment 4 – Soil and Liner Quality Control Plan
TCEQ MSW Permit No. 1522B

City of Victoria, Texas
Landfill Lateral and Vertical Expansion
Victoria County, Texas

City of Victoria Landfill Lateral and Vertical Expansion
Project No. 107608

Revision 0, March 28, 2022

Part III, Attachment 4 – Soil and Liner Quality Control Plan TCEQ MSW Permit No. 1522B

prepared for

City of Victoria, Texas
Landfill Lateral and Vertical Expansion
Victoria County, Texas

Project No. 107608

Revision 0, March 28, 2022
3/28/2022

prepared by

Burns & McDonnell Engineering Company, Inc.
Austin, Texas
Texas Firm Registration No. F-845

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STATE OF TEXAS
SCOTT MARTIN
120819
LICENSED
PROFESSIONAL ENGINEER
Scott Martin
4/5/2022

LIST OF TABLES

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
ASTM	American Society for Testing and Materials
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
FMLER	Flexible Membrane Liner Evaluation
FTB	Film Tear Bond
GCQP	Geotechnical Quality Control Professional
HDPE	High Density Polyethylene
IGL	Independent Geosynthetics Laboratory
OMC	Optimum Moisture Content
psf	Pounds per square foot
SLER	Soil Liner Evaluation Report
SLQCP	Soil Liner Quality Control Plan
TCEQ	Texas Commission for Environmental Quality

1.0 INTRODUCTION

The Soils and Liner Quality Control Plan (SLQCP) is used to provide installers with adequate procedural guidance and material requirements for assuring that the landfill liner system is constructed as designed and permitted.

The SLQCP includes specifying materials, equipment, and construction methods for the compaction of soil liners, detailing installation methods and quality control testing and reporting for any geomembrane which may be used, providing guidance necessary for testing and reporting evaluation procedures to the professional preparing the Soil Liner Evaluation Report (SLER) and/or Flexible Membrane Liner Evaluation Report (FMLER), and describing the necessary procedures for implementation. Detailed Subtitle D liner drawings can be found in Part III, Attachment 11.

1.1 Definitions

The following list of definitions pertinent to the SLQCP is provided for reference:

<u>Atterberg Limits</u>: The liquid limit and plastic limit (ASTM D4318-84). The water content when the soil behavior changes from the liquid to the plastic state is the liquid limit; from the plastic to the semi-solid state is the plastic limit.

<u>Classification System</u>: The soil classification system shall be in accordance with the standard test method for classification of soils for engineering purposes (ASTM D2487-83).

<u>Compaction</u>: The process of increasing the density or unit weight of soil by rolling, tamping, vibrating, or other mechanical means.

<u>Density</u>: Mass density of a soil is its weight per unit volume; usually reported in pounds per cubic foot.

<u>Extrusion Weld</u>: A bond between two high density polyethylene (HDPE) materials which is achieved by extruding a bead of HDPE over the leading edge of the seam between the upper and lower sheet using a handheld apparatus. Extrusion welds shall be used for patch repairs, destructive repairs and in some tie-ins.

<u>Flexible membrane liner (geomembrane):</u> A relatively impermeable thin sheet of high-density polyethylene used as a barrier liner or cover to prevent liquid or vapor migration into or from liquid or solid storage facilities.

<u>Fusion Weld</u>: A bond between two high density polyethylene (HDPE) materials which is achieved by fusing both HDPE surfaces in a homogeneous bond of the two surfaces using a power-driven apparatus capable of heating and compressing the overlapped portions of the geomembrane sheets.

<u>GCQP:</u> Geotechnical Professional Engineer registered in the state of Texas or a certified Engineering Geologist providing monitoring of construction, construction surveillance, testing services, and surveying services or technical oversight of testing and surveying services; responsible for the implementation of the SLQCP and for certification that construction is in accordance with the SLQCP, and specifications outlined herein. While the Registered Professional Engineer or Certified Engineering Geologist is the certifying professional, within this document GCQP collectively refers to the certifying professional, their firm, or staff and technicians working under their direct supervision.

<u>Independent Geosynthetics Laboratory (IGL):</u> A qualified geosynthetics testing laboratory not affiliated with either the manufacturer or the owner.

<u>In-Situ:</u> "As Is", or as it exists in place naturally.

<u>Moisture Content:</u> Ratio of quantity of water in the soil (by weight) to the weight of the soil solids (dry soil), expressed in percentage; also referred to as water content.

<u>OMC:</u> Moisture content corresponding to maximum dry density as determined in standard Proctor test (ASTM 0698) or modified Proctor (ASTM 01557).

<u>Permeability</u>: Ability of pore fluid to travel through a soil mass via interconnected voids. "High" permeability indicates relatively rapid flow of pore fluid and vice versa. Rates of permeability are generally reported in centimeters per second.

<u>Plasticity</u>: Ability of soil to be remolded without raveling or breaking apart. The plasticity index, numerically equal to the difference between the liquid and plastic limit, is a comparative number which describes the range of moisture contents over which a soil behavior is plastic.

<u>Project Representative</u>: The on-site or designated representative of the City or its operator.

<u>Secondary Structure</u>: The macrostructure of geologic stratum. Structural features in a soil or rock deposit which can be seen with little or no magnification, to include, but not limited to, pockets, lenses, layers, seams, or partings of varying soil types, slickensided fissures, laminated structure, and/or mineral concretions or staining.

2.0 SOIL LINER REQUIREMENTS

All liners shall have continuous on-site inspection during construction by the GQCP or a technician under their direct supervision. All field sampling and testing, both during construction and after completion of the liner construction, shall be performed by the GQCP or a technician under their supervision. The QCA monitor shall provide continues on-site observation during compacted soil liner placement, compaction, and testing in accordance with 30 TAC §330.339(a)(2).

Engineered subgrade for Class 1 material shall meet all requirements of soil liner as discussed in this document.

Compacted soil materials shall be free from debris, rubbish, frozen materials, foreign objects, and organic material. The requirements for constructed soil liner and soil liner materials are provided in Table 2-1.

Table 2-1: Requirements for Constructed Soil Liner and Soil Liner Materials

Test	Method	Required Value
Sieve Analysis[1]	ASTM D6913. ASTM D422	100% (nominal) passing 1" screen
Sieve Analysis	ASTM D1140	30% passing #200 sieve
Atterberg Limits	ASTM D4318	Plasticity index equal to or greater than 15 Liquid limit equal to or greater than 30
Permeability[2]	ASTM D5084; or Corp of Engineers EM 1110-2-1906, Appen. VII	K $\leq 1\text{x}10^{-7}$ cm/sec for soil liner k $\leq 1\text{x}10^{-8}$ cm/sec for Class 1 engineered subgrade
Soil Classification	ASTM D2487	N/A
Moisture Content	ASTM D2216	N/A
Standard Proctor	ASTM D698	Compaction curve for reference
Thickness of constructed liner	Survey methods	Minimum 2' thick with geomembrane liner

Notes:
[1]ASTM D422 is specified in §330.339(c)(4)(B) but has been discontinued. ASTM D6913 provides a Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
[2]Permeability tests for proving the suitability of soils to be used in constructing clay liners shall be performed in the laboratory. Preconstruction testing procedures and frequencies are listed in Section 3.0.

3.0 PRECONSTRUCTION TESTING – SOIL LINERS

After identifying a potential soil liner material, characteristic tests will be conducted on representative samples of the material as directed below.

3.1 Characteristic Testing

Sieve analysis, Atterberg limits and soil classification will be conducted to determine if the soil meets the criteria outlined in Table 2-1. If the results of these tests indicate acceptable source material, a Proctor compaction test will be conducted to determine the maximum dry density and optimum moisture content. The type of ASTM Proctor compaction test, standard or modified, will be determined by the certifying engineer based on types of heavy equipment to be used in the field. If a modified Proctor is to be used, equipment capable of providing 56,000 ft-lb/ft^3 or greater compaction will be used.

Using the results from the standard Proctor test, a permeability test sample will be prepared at no less than 95 percent maximum dry density and optimum moisture content. If modified Proctor test is used as a reference, a permeability test sample will be prepared at no less than 90 percent of maximum dry density and optimum moisture content.

Permeability tests will be conducted per the specified test method using tap water or 0.005Ncalcium sulfate solution as the permeant fluid. Distilled or deionized water is not acceptable for use as permeant fluid. The permeant fluid shall be deaired.

If the permeability is 1 x 10^{-8} cm/sec or less, soil liner construction may begin with that soil material.

If the permeability test for the sample prepared at 95 percent maximum dry density and optimum moisture content does not satisfy the required permeability of 1 x 10^{-8} cm/sec or less, permeability test(s) with increased dry density and/or increased moisture content will be required if the soil material is to be used for liner construction. Using systematic increases in compaction effort and moisture content, additional permeability test sample(s) shall be prepared and tested.

The minimum acceptable compaction criteria for soil liner construction will be based on the criteria used in the permeability test which met the permeability requirement of 1 x 10^{-8} cm/sec or less.

All permeability test data on soil materials which are used for soil liner must be submitted regardless of test method used or test result.

If materials vary by more than 10 points in either the liquid limit or plasticity index from previous evaluated materials, a separate preconstruction evaluation shall be conducted.

If multiple borrow sources are to be used, a separate preconstruction evaluation will be made for the different sources. If different soil layers or types are encountered in the same borrow area, a separate preconstruction evaluation will be performed for the different materials under consideration for use as soil liner.

A moisture-density compaction curve must be established prior to field testing. The moisture-density compaction curve shall include a zero air voids line. It is required that the specific gravity used for the zero air voids line be included, but it may be estimated.

4.0 SOIL LINER SPECIFICATIONS

4.1 Subgrade Preparation

Prior to placing soil liner materials, the subgrade should be proof-rolled with heavy, rubber-tired equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling, and identified soft areas should be undercut to firm material and then backfilled with compacted general fill.

The subgrade elevations and be verified in accordance with the requirements prior to placement of the compacted soil liner. The excavation surface will be surveyed prior to liner construction for documentation.

After excavation surveying but prior to soil liner material placement, the excavation or subgrade surface shall be scarified to provide bonding between the compacted soil liner and the underlying surface.

Soil liner construction shall be sequenced in such a manner as to maintain drainage and minimize the potential effects of precipitation on the construction.

Continuous and repeated visual inspection of the materials being used will be performed to ensure proper soils are being used. The GCQP shall inspect soils to ensure debris such as large rocks, sticks, etc., or soils that the GCQP suspects as not conforming to the specifications established in the pre-construction testing are not included in the liner. Any such soils found to be unsuitable for liner construction shall be rejected by the GCQP. The GCQP shall note any such rejections of soils for any reason in the daily logs of the GCQP.

4.2 Placement

Soil liner material will not be placed or compacted during sustained periods of temperatures below 30°F. Soil liner material may be placed during early morning freezing temperatures with warming trends during the day.

If necessary, the soil material will be screened, processed, disced, or worked to reduce dry clod size to approximately one inch or less prior to compaction. The maximum clod size shall be approximately one inch in diameter prior to initiating compaction.

Approved soil liner (or GCL) material will be placed in uniform layers not exceeding nine inches (loose lift). If the pads of the compactor to be used will not penetrate a nine-inch loose lift, the thickness of the loose lift will be reduced to allow for full penetration by the compactor pads. Compaction equipment will be maintained to avoid clogging of liner soil around the compactor pads. In constructing a two foot thick soil liner, a minimum of four lifts will be used.

Prior to compaction, representative samples shall be tested for moisture content. If moisture content is at or wet of optimum or within the range specified by preconstruction testing, compaction may begin. If the moisture content is outside the specified ranges, the soil liner material shall be wetted or dried and reworked accordingly.

If the moisture content is outside the acceptable range, the soil will be wetted or dried and reworked accordingly. The soil shall be sprinkled or sprayed with water and dozed, wind-rowed, disc-plowed or processed to uniformly increase the moisture content of the soil if the material is below the specified moisture content. The soil shall be dozed, wind-rowed, disc-plowed or processed if the moisture content is too high.

If water is to be added to soil liner material, it shall be sprinkled or sprayed uniformly and worked to provide a relatively uniform moisture content within the soil liner material to be compacted.

Contaminated water will not be used in the construction of soil liner.

4.3 Compaction

As each lift (approximate six inch compacted thickness) of liner (or GCL) has been completed, field density and moisture content tests will be performed at the frequency outlined.

Minimum field compaction criteria for constructed soil liner (or GCL) is 95 percent of the maximum dry density at determined by standard Proctor (ASTM D698) at a moisture content at or above optimum moisture content.

Compaction of soil liner (or GCL) material loose lifts shall be performed with an appropriately heavy, properly ballasted, penetrating foot compactor such as a pad foot, prong-foot, or sheepsfoot compactor similar to a CAT compactor series 815 or equivalent.

A minimum of four passes are required, with a pass being defined as two applications of the compacting roller (i.e., for a one roller compactor, a pass is a trip forward and back, for a two roller compactor, a pass is a trip forward). Additional passes may be required to achieve compaction requirements.

Dozer or scraper equipment shall not be used for primary compactive effort except as follows:

An initial lift of soil liner (or GCL) placed upon an underdrain system or an underlying geosynthetic layer shall be compacted to the specified density and moisture content with a standard track-width dozer or equivalent track equipment capable of providing equal or greater bearing pressure (1,100 psf).

Penetrating foot compactors shall not be used above an underdrain system or geosynthetic layer until the overlying soil thickness is equal to or greater than 1.5 times the length of the penetrating foot.

Within a construction area, each lift shall be thoroughly compacted and satisfy moisture and density controls through field testing prior to placement of subsequent lifts.

4.4 Lift Bonding

Previously compacted lifts will be thoroughly scarified prior to placement of subsequent lifts to promote bonding between lifts.

During construction, finished lifts or sections may be sprinkled with water as needed to prevent drying and desiccation.

If desiccation and crusting of a lift surface occurs before placement of the next lift, the area shall be sprinkled with water, scarified, and tested for acceptable moisture content prior to placement of a subsequent lift.

Completed lifts or sections of compacted soil liner shall be sealed by rolling with a rubber tired or smooth drum roller and sprinkled with water as needed.

Prior to placing subsequent lifts, the surface of the previous lift shall be scarified, and moisture conditioned to provide bonding between lifts. The length of the compactor pads shall be sufficient to penetrate the subsequent loose lift and the lift interface to provide bonding between lifts.

4.5 Liner Protection

Tie-ins to existing liner areas will be made using a stair step approach. Within the leading edge of the liner construction (minimum 10 feet for two foot-thick liner and 15 feet for three foot-thick liner), lifts of compacted soil liner will terminate in a stair step manner. When additional liner is to be constructed, this leading edge will be scarified, and the new liner tied into the existing liner. This intent of this method of construction is to prevent a vertical joint through the constructed liner.

All sampling or testing locations shall be backfilled with bentonite pellets or a hand tamped soil liner material and bentonite mixture. These locations include field density test locations, material sample locations and tube sample locations, as well as any other liner penetration.

Ponded water on constructed soil liner and protective cover shall be removed in a timely manner.

For soil liners which will not be overlain with a flexible membrane liner, protective cover will be placed a minimum one foot thick over the constructed soil liner. Compaction of protective cover is not required.

For soil liners which will be overlain with a flexible membrane liner, the compacted soil liner shall be smooth drum rolled in preparation for geomembrane placement.

SLER markers will be provided at the limits of constructed soil liner and will remain in-place during active disposal operations within that area. To facilitate operations, SLER markers may be removed upon approval of subsequent disposal areas. The SLER markers must be tied into the master site grid system for reference and shall not be placed through the constructed liner.

Soil liner construction will be conducted in a systematic and timely fashion. A construction period of 60 days or less will be targeted for each given area. For construction periods exceeding 60 days for a given area, explanations for the delayed construction and the methods to be used to ensure liner integrity will be provided in the SLER.

4.6 Field Testing - Soil Liner

Minimum requirements for field testing during construction of soil liner using parallel lifts are as follows:

- A field density and moisture content test will be conducted per every 8,000 square feet for each six-inch compacted lift. For areas less than 15,000 square feet, a minimum of three field density tests will be conducted per six-inch lift.
- Sieve analysis will be performed at a frequency of one test per every 100,000 square feet or major fraction thereof. A minimum of one test per six-inch compacted lift is required.
- Atterberg limits will be determined at a frequency of one test per every 100,000 square feet or major fraction thereof. A minimum of one test per six-inch compacted lift is required.
- Permeability tests will be performed at a frequency of one test per every 100,000 square feet or major fraction thereof. A minimum of one permeability test per each six-inch compacted lift is required.

- Thickness verification will be performed by survey methods. A minimum of one verification point per 5,000 square feet of surface area is required. If the construction area is under 5,000 square feet, a minimum of two verification points will be required.
- Sidewall liners constructed using parallel lifts will be constructed monolithically with the floor liner. Sidewall liner evaluation will be performed using the same criteria and rate of testing as the bottom liner evaluation.

Minimum requirements for field testing during construction of soil liner using horizontal lifts are as follows:

- A field density and moisture content test will be conducted for every 100 lineal feet for each 12-inch compacted thickness.
- Sieve analysis will be performed at a frequency of one test per every 2,000 lineal feet or major fraction thereof. A minimum of one test per 12-inch compacted thickness is required.
- Atterberg limits will be determined at a frequency of one test per every 2,000 lineal feet or major fraction thereof. A minimum of one test per 12-inch compacted thickness is required.
- Permeability tests will be performed at a frequency of one test per every 2,000 lineal feet. A minimum of one permeability test per 12-inch compacted thickness and a minimum of six permeability tests per entire sidewall liner is required.
- Thickness verification will be performed by survey methods. A minimum of one verification point per 5,000 square feet of surface area is required. If the construction area is under 5,000 square feet, a minimum of two verification points will be required.

When sampling for permeability tests, two Shelby tubes/drive cylinders shall be retrieved. One tube/cylinder shall serve at the primary test sample. The second tube/cylinder shall serve as the backup sample in case of damage or sample disturbance in the first tube, or in case of a non-conforming permeability test.

Care will be taken to reference field density tests to the correct Proctor curve for the material being used in construction.

An increase in the frequency of field density testing does not require a corresponding increase in sieve analysis, Atterberg limits or permeability testing.

If the frequency of field density testing is increased, the frequency of the other tests remains one test per 100,000 square feet per six-inch compacted lift or major fraction thereof for parallel lifts.

If the frequency of field density/moisture tests for horizontal lifts on sidewall liners is increased, the frequency of sieve analysis, Atterberg limits and permeability tests will remain one test per every 2,000 lineal feet of sidewall per twelve-inch lift or major fraction thereof.

Throughout construction of soil liner, test results will be reviewed. If the liquid limit or plasticity index of the soil varies more than 10 points from the limits determined during preconstruction testing, a compaction test will be performed on the varying material. A laboratory permeability test will be performed on the varying material to ensure a permeability of 1×10^{-7}·cm/sec or less will be achieved using the construction compaction criteria. For the engineered subgrade, a permeability of 1×10^{-8}·cm/sec or less must be achieved using the construction compaction criteria.

Sand cone tests, rubber balloon tests, or drive cylinder samples may be used to correlate dry density and moisture content measurements with those of the nuclear gauge. The results of these tests shall be documented and reviewed to determine if re-calibration of the nuclear density gauge is necessary.

All sampling or testing locations shall be backfilled with bentonite pellets or a hand tamped soil liner material and bentonite mixture. These locations include field density test locations, material sample locations and tube sample locations, as well as any other liner penetration.

If used, field permeability testing of in-situ soils or constructed soil liner shall be in accordance with ASTM D5093 or the Boutwell STEI two-stage field permeability test. Field permeability testing shall be used only with the prior consent of the TCEQ.

All test results shall be reported. In case of non-conforming test results, the steps taken to correct the nonconformity shall be explained in the SLER following procedures outlined below.

4.7 Non-Conforming Tests - Soil Liner Field Density and Moisture Tests

Sections of compacted soil liner (or GCL) which do not meet the density and moisture content requirements may be reworked and retested until the section does pass the criteria or the section of compacted soil liner may be removed and replaced to passing standards.

In the event of a failed moisture-density test, it is necessary to isolate the non-conforming area. Additional tests will be performed approximately half-way between the failed test and the nearest adjacent passing test locations. If the additional tests pass, the area bounded by passing tests will be reworked and retested. If the additional tests fail, a second set of additional tests will be performed between the failing additional tests and surrounding passing tests. This process will be repeated until the non-conforming area is defined. Once the non-conforming area is defined, it will be reworked and retested until compaction and moisture criteria are met.

In lieu of additional tests to define the non-conforming area, it is acceptable to rework entire area bounded by the initial surrounding passing tests.

If reworking consistently fails and the section does not pass the criteria, the non-conforming area shall be removed and replaced.

All reworked areas shall be tested and confirmed to satisfy the compaction criteria. The reporting of retests shall clearing indicate the number and location of the non-conforming test and the subsequent conforming retest. Retests shall be taken near the location of the original non-conforming test.

4.8 Permeability Tests

In the event of a non-conforming permeability test, the test procedures and test sample shall be reviewed for inconsistency in test procedure or flaw in the permeability test sample. A review of the associated soil characteristic tests and field density/moisture content tests shall be performed to confirm that the appropriate compaction criteria were used.

A permeability sample shall be prepared from the backup drive cylinder or Shelby tube sample and an additional permeability test shall be performed on the backup sample.

If the backup sample provides an acceptable permeability result, the results of the first sample will be disregarded if it is determined that the first sample or test procedure was flawed. If the backup sample does not provide an acceptable permeability, a review of the required compaction criteria will be performed to determine if the compaction criteria require revision.

Additional permeability test samples will be retrieved between the non-conforming permeability location and the surrounding passing permeability test locations. The results from these additional permeability tests will be used to bound the area requiring rework or removal and replacement. The area to be reworked or removed and replaced will be bounded by passing permeability tests. In lieu of additional testing to define the nonconforming area, the area between the initial passing permeability tests may be reworked or removed and replaced.

If reworking consistently fails and the section does not pass the criteria, the non-conforming area will be removed and replaced. All reworked areas shall be tested and confirmed to satisfy the permeability criteria. The reporting of retests shall clearly indicate the number and location of the non-conforming test and the subsequent conforming retest. Retests shall be taken near the location of the original non-conforming test.

All soil testing and evaluation of in-situ soil or constructed soil liners shall be completed prior to installing the leachate collection system.

4.9 Survey Control

The as-built thickness of the soil liner shall be determined by survey methods.

Prior to the placement of soil liner, the excavation surface shall be surveyed once per 5,000 square feet on a pre-established grid.

Upon completion of the soil liner, and prior to the installation of subsequent elements, the top of the soil liner shall be surveyed to ensure the specified thickness of soil liner has been achieved.

Upon completion of the protective cover/leachate collection system, the top of the layer shall be surveyed to ensure the specified thickness has been placed.

4.10 Documentation

A Soil Liner Evaluation Report (SLER) will be completed and filed with the TCEQ documenting the soil liner construction. A cover letter will preface the SLER giving names and telephone numbers of contact personnel. In addition, at a minimum, the information listed below will be included with the SLER.

A scaled plot will be made for each six-inch compacted lift. This plot will contain locations and identification number for all the tests conducted on a particular lift and sample locations. For clarity, multiple plots for the same six-inch compacted lift may be provided (i.e., one plot for field density/moisture tests and another plot for soils characteristics and permeability test sample locations). The locations of all soils tests (passing and failing) will be recorded. The site grid system will be overlain onto the plot. North arrows and bar scales will be provided. Side liners constructed using horizontal lifts may submit, in lieu of multiple plan views, an elevation view showing the location of all tests and samples.

Summary tables will be provided for test results. At a minimum, test and/or sample number, location, and result will be reported. Where appropriate, laboratory test numbers will cross-reference corresponding field density/moisture tests. Cross-references will be provided between non-conforming tests and subsequent passing retests.

In addition to reporting the results of permeability tests, test data calculations will be included for all permeability tests. Summary tables will be provided for all test results.

A site layout plan will be included indicating area of liner construction covered by the submittal, filled areas, active area, site grid plan, graphic scale, north arrow, and other pertinent site information. This site layout will show the location of areas covered by previous submittals as well as the approval dates.

Reference locations will be noted on a drawing of the area evaluated. All elevation calculations necessary for thickness determination shall be attached as part of the supporting documentation to the SLER.

A listing of the quality control personnel and their respective days on-site will be included in the submittal.

A construction log will be provided which indicated dates, stages of construction, and weather conditions.

4.11 Reporting Procedures

At least three copies of each SLER shall be submitted to TCEQ.

Each SLER must be signed and where applicable sealed by the individual performing the evaluation and countersigned by the site operator or their authorized representative.

When the individual trench method of filling is used, the dividing area between individual trenches will be lined prior to placement of aerial fill overlying the filled trench area.

Prior to disposal of solid waste in any trench or on any area, excavation, or unprotected surface, a SLER and FMLER shall be submitted to the executive director for review and approval. If no response, either written or verbal, is received within 14 days after the SLER/FMLER was received at the Municipal Solid Waste Division of TCEQ, the SLER shall be considered approved. Waste may be placed in the area only after notification to the Groundwater Protection Team of the Compliance and Enforcement Section of the Municipal Solid Waste Division of TCEQ by telephone of the intent to place waste on the area. In areas requiring a leachate collection system and/or protective cover, documentation of such construction must also be submitted to the TCEQ prior to waste disposal on the area.

5.0 FLEXIBLE MEMBRANE LINER

5.1 Material Requirements

Geomembrane liner shall be made of 60 mil smooth (for cell bottoms only) or textured (for both cell bottoms and side slopes), high density polyethylene (HDPE). No more than one percent of the material may be additives and no recycled or reclaimed material shall be used by manufacturer. No more than two percent regrind material will be allowed. The CQA monitor shall provide continuous on-site observation during GM deployment, trial welds, seaming, testing, and repairing in accordance with §330.339(a)(2). The GP shall make sufficient site visits during GM installation to document the installation and testing in the required GLER.

Geomembrane liner shall be shipped rolled. Rolls shall be stored on site in stacks of five rolls or less.

The geomembrane liner shall be installed as soon as practical after completion and approval of the SLER. Each sequential section of liner shall be secured in an anchor trench and continuously welded to the adjacent sections.

The geomembrane used shall meet, at a minimum, the standards of GRI-GM13.

Resin documentation, including density, carbon black content, carbon black dispersion, oxidative induction time, and melt flow index shall be submitted for resins used.

5.2 Preconstruction Testing

All geomembrane rolls will be tested and evaluated in accordance with GRI-GM13 prior to acceptance. In general, testing of the rolls will be conducted by the manufacturer.

Test results shall be submitted to the GQCP, who will review and confirm the HDPE material meets specifications prior to installation of a HDPE roll.

Environmental Stress Crack (ASTM 01693) test results shall be submitted to the Project Representative within 75 days of material shipment.

6.0 FLEXIBLE MEMBRANE LINER SPECIFICATIONS

All liners shall have continuous on-site inspection during construction by the GQCP or a technician under their direct supervision. All field sampling and testing, both during construction and after completion of the liner construction, shall be performed under the observation of the GQCP or a technician under their supervision.

6.1 Preparation

Areas to receive liner installation shall be relatively smooth and even, and free of rocks which may damage the membrane, desiccation cracks which may affect the integrity of the clay liner, ruts, voids, etc. Prior to geomembrane installation, the condition of the subgrade must be deemed suitable for geomembrane installation by the GQCP and the installer.

An anchor trench will be required at the liner perimeter to secure the geomembrane. Loose soil underlying the geomembrane in the anchor trench shall be minimized.

6.2 Placement

Installation of the geomembrane shall be as follows:

- Follow all manufacturer's recommendations. Install in direct and uniform contact with the compacted soil component or approved alternate liner.
- Unroll only those sections which are to be seamed together or anchored in one day. Panels shall not be placed in inclement weather such as rain or high winds. Panels shall be positioned with the overlap recommended by the manufacturer, but not less than three inches. The edge of the upslope sheet shall be positioned above the edge of the downslope sheet. The geomembrane liner sections will be placed in an anchor trench which is then backfilled with soil compacted to a 90 percent of the maximum dry density as determined by the Standard Proctor Compaction Tests (ASTM 0698).
- After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges which are to be bonded as smooth and free of wrinkles as possible. The number of rolls deployed ahead of seaming operations will be at the discretion of the Installer.

6.3 Trial Seams

Testing of trial seams will be conducted by the Installer under observation by the GQCP.

The Installer shall maintain and use equipment and personnel at the site to perform testing of test seams.

A test seam will be made for each seaming apparatus to be used in field seaming. If more than one seaming technician uses the same apparatus, a separate test seam will be made for each apparatus/technician combination that will perform field welding. Test seams will be made each day prior to commencing field seaming. These seams will be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The texture(s) of the geomembrane pieces selected for the trial seams should represent any geomembrane interfaces to be seamed together in the field. Time, tip temperature, and seamer name will be recorded for each trial seam. For extrusion welding, test the welder and the machine for each new trial seam. For fusion welding, test the machine only for each new trial seam (since the machine is not operator dependent).

Such test seams will be made at the beginning of each seaming period, such as morning start-up and after mid-day or lunch break. At the GQCP's discretion, additional trial seams may be required. Each seamer will make at least one test seam each day.

The test seam sample will be at least 0.9m (3 ft) long by 0.3m (1 ft) wide with the seam centered lengthwise. Four (six when possible if using dual track fusion welding) adjoining specimens 25mm (1 in) wide each will be die cut from the test seam sample. These specimens will be tested in the field with a tensiometer for both shear (two specimens) and peel (two specimens, four when possible if testing both inner and outer welds for dual track fusion welding). Whenever possible, peel specimens will be tested on the interior track and peel specimens will be tested on the exterior track.

Test seams will be tested by the Installer under observation of the GQCP. The specimens shall not fail in the weld.

A passing fusion or extrusion welded test seam will be achieved when the criteria described in GRI-GM19 are satisfied with the exclusion of any strain requirements.

If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel. Field welding will not begin, for the machine or welder (if applicable), until all test seams pass.

6.4 Field Seaming

All foreign matter (dirt, water oil, etc.) shall be removed from the edges to be bonded. No solvents shall be used to clean the geomembrane liner.

The Installer shall provide the Owner's Representative and CQA Officer with a panel layout drawing. This drawing may be modified, with the approval of the CQA Officer, to meet job site conditions. The Installer will maintain record drawings that shall be updated by the Installer on a regular basis.

A seam numbering system shall be agreed to by the CQA Officer and Installer prior to the start of seaming operations. One methodology is to identify the seam by adjacent panels. For example, the seam located between Panel 306 and 401 would be Seam No. 306/401.

Prior to seaming, trial welds for each operator and seaming apparatus (welder) shall be tested in accordance with the geomembrane specification to determine if the equipment and operator are functioning properly. The CQA Officer shall observe welding operations and the testing of the trial welds. Trial weld results shall be recorded by the CQC Manager and on the forms provided by the Installer. All trial welds are to be completed under conditions similar to those existing when the panel shall be seamed. Trial welds shall be completed at the beginning of each morning and afternoon shift, and also at any time the CQA Officer believes that an operator or seaming apparatus is not functioning properly. If there are large changes in temperature, humidity, or wind speed, the test weld is to be repeated.

During seaming operations, the CQA Officer shall verify that the following conditions exist:

- The Installer has the number of welders and spare parts agreed to in the pre-construction meeting
- Equipment used for seaming does not damage the geomembrane
- The extruder is purged prior to beginning a seam until all the heat-degraded extruder is removed (extrusion welding only)
- Seam grinding has been completed less than 30 minutes before seam welding (extrusion welding only)
- Seam edges are beveled and grind marks are perpendicular to the seam (extrusion welding only)
- Grind marks do not extend more than 1/4 inch from edge of weld
- The ambient temperature measured within 6 inches of the geomembrane surface is between 32 degrees and 105 degrees Fahrenheit, unless approved otherwise by the CQA Officer
- The end of old welds, more than five minutes old, are ground to expose new material before restarting a weld (extrusion welding only)

- The weld is free of dust, dirt, moisture, or other contaminants
- The seams overlap a minimum of three inches for extrusion welding and four inches for fusion welding, or in accordance with manufacturer's recommendations
- No solvents or adhesives are present in the seam area
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing
- The panels are seamed in accordance with the plans and specifications

6.5 Field Testing - Flexible Membrane Liner

All geomembrane seams will be tested and evaluated prior to acceptance. The GQCP will observe all production seam field test procedures. Testing of the seams will be conducted by the Installer under observation by the GQCP. At their discretion, the GQCP may have additional testing performed to verify that the HDPE seams meet the specifications.

Non-Destructive Testing - Production seams will be tested by the Contractor continuously using non-destructive techniques. Requirements for non-destructive testing are as follows:

Single Weld Seams - the Installer shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams. The system shall be capable of applying a vacuum of at least three psi. The vacuum shall be held for a minimum of 15 seconds for each section of seam.

Double Weld Seams - The Installer shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall be capable of applying a pressure of at least 30 psi for not less than five minutes. The Installer shall perform all pressure and vacuum testing under the supervision of the GQCP. Following two-minute pressurized stabilization period pressure losses over a measurement period of five minutes shall not exceed the following: 40 mil - 4 psi, 60 mil - 3 psi, 80 mil - 2 psi. When the test is complete, the Installer shall release pressure from the seam end opposite of the pressure gauge to verify that the entire seam was pressurized.

6.5.1 Construction Testing

Two nondestructive testing procedures shall be utilized, depending on the type of welding procedure used. For extrusion welded seams the vacuum box method shall be employed for the full seam length. A vacuum of at least three- pounds per square inch (psi) shall be maintained for at least ten seconds. For the dual wedge (hot shoe) fusion welded seam, the air channel shall be pressurized to a maximum pressure of

30-psi (GRI Test Method GM6). The air channel shall be pressurized for at least five minutes. If the loss of pressure exceeds two psi or pressure does not stabilize after five minutes, the defective area shall be located and repaired.

6.6 Destructive Testing

Destructive testing will be performed at least once within each 500 linear feet of production seam. The locations will be selected by the GQCP in such a manner as to representatively sample the geomembrane seam quality for the entire installation. Individual repairs of leaks or failed seams greater than 10 feet in length must be counted in determining the total seam length for testing. At a minimum, a destructive test will be performed for each welding machine used. Sufficient samples will be obtained by the Installer to provide one sample to the archive, one sample to the GCQP for laboratory testing, and two samples to be retained by the Installer for both field and laboratory testing.

The Installer shall initially field test the seam using a calibrated tensiometer. Field testing shall include at least two peel tests (four, when possible, for testing both track on dual-track fusion welds.) No strain measurements from field tests of production seams will be measured. Field tests will be evaluated for the criteria described in GRI-GM19a with the exclusion of any strain requirements.

If the field test indicates an acceptable seam, the samples for laboratory testing will be delivered to the laboratories and tested for both strength and strain requirements.

Laboratory tested fusion and extrusion welded seams must meet the requirements provided in Tables 1(a) and 1(b) of GRI-GM14.

Testing shall include the shear and peel test (ASTM D6392). At least five specimens shall be tested in peel and five specimens in shear. All of the five specimens tested by the Testing Laboratory using each method must meet the minimum test values presented in the Project Documents. The Testing Laboratory shall provide test results within 24 hours in writing or via telephone with the CQA Officer. Certified test results are to be provided within 5 days. The Contractor or Installer shall immediately notify the CQA Officer and Engineer in the event of a failed test. No areas (except as necessary to provide temporary wind protection or to temporarily prevent water from getting under the geomembrane) are to be covered prior to receiving the laboratory test results.

If unresolved discrepancies exist between the GQCP's and installer’s test results, the archived sample may be tested by the GQCP.

6.7 Non-Conforming Test Results

Samples which do not pass the shear and peel tests will be re-sampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples will continue to be obtained until the questionable seam area is defined.

If desired, it is acceptable to cap strip the non-conforming seam length with the cap strip extending the entire length between two passing seam tests.

Damaged and sample coupon areas of geomembrane shall be repaired by the Installer by construction of a cap strip. The cap strip will extend a minimum of six inches in all direction from the area of concern. The cap strip will be completely seamed by extrusion welding to the parent geomembrane.

No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by fusion or extrusion methods. Spot welding and extrusion beads may be used to repair surface flaws or irregularity.

Repaired areas will be non-destructive tested for seam integrity. At the discretion of the GQCP, destructive tests may be conducted on the repaired areas.

6.8 Liner Protection

At the end of each day or installation segment all unseamed edges shall be anchored by rope, sandbags, or other approved device. Sandbags securing the geomembrane on the side slopes shall be connected by rope fastened at the top of the slope section by a temporary anchor. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the geomembrane.

Only low ground pressure support equipment approved by the Project Representative may be allowed on the geomembrane. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in any activity which damages the geomembrane. Small equipment, such as generators, will be placed on scrap liner material (rub sheets) placed over the geomembrane liner.

Between construction of partial sections of the geomembrane liner, leading edges of the geomembrane may be exposed or buried for extended periods of time prior to their joining to adjacent subsequent geomembrane sections. It is necessary to protect leading edges in high activity areas.

6.9 Completion

The anchor trench will be backfilled with soil and compacted.

Care shall be taken when backfilling the trench to prevent any damage to the geomembrane. Anchor trench spoil shall be used as backfill material, wherever possible.

6.10 Survey Control

The coordinates and elevations of the boundary of the flexible membrane liner system (interior upper edge of the anchor trench) shall be documented by survey methods.

The documentation survey may be performed separately or in conjunction with the protective cover/leachate collection system survey.

6.11 Documentation

A Flexible Membrane Liner Evaluation Report (FMLER) will be completed and filed with the TCEQ documenting the flexible membrane liner construction. A cover letter will preface the FMLER giving names and telephone numbers of contact personnel. In addition, at a minimum, the information listed below will be included with the FMLER.

- A scaled plot will be made indicating the panel layout, seam locations and number, repair locations, and destructive test locations. This plot will contain locations and identification number for all the tests conducted. If necessary, multiple plots may be provided. The site grid system will be overlain onto the plot. North arrows and bar scales will be provided.
- Manufacturer quality control test results and conformance test results will be submitted.
- Documentation tables will be provided for trial test welds, non-destructive tests, and destructive test results. At a minimum, test and/or sample number, location, and result will be reported. Cross-references will be provided between non-conforming tests and subsequent passing retests.
- Whenever appropriate, summary tables will be provided for test results.
- A site layout plan will be included indicating area of flexible membrane liner construction covered by the submittal, filled areas, active area, site grid plan, graphic scale, north arrow, and other pertinent site information. This site layout will show the location of areas covered by previous submittals as well as the approval dates.
- Survey locations indicating the extent of flexible membrane liner installation will be included.
- All subgrade acceptance documentation will be submitted.
- A construction log will be provided which indicates dates, stage of construction, and weather conditions.

6.12 Reporting Procedures

At least three copies of each FMLER shall be submitted to TCEQ.

Each FMLER must be signed and where applicable sealed by the individual performing the evaluation and countersigned by the site operator or their authorized representative.

Prior to disposal of solid waste in any trench or on any area, excavation, or unprotected surface, a FMLER shall be submitted to the executive director for review and approval. If no response, either written or verbal, is received within 14 days after the SLER/FMLER was received at the Municipal Solid Waste Division of TCEQ, the FMLER shall be considered approved. Waste may be placed on the area only after notification to the Ground-Water Protection Team of the Compliance and Enforcement Section of the Municipal Solid Waste Division of TCEQ by telephone of the intent to place waste on the area. In areas requiring a leachate collection system and/or protective cover, documentation of such construction must also be supplied to the TCEQ prior to waste disposal on the area.

6.13 Fusion Welded Seams

Peel Requirements:

- Testing method: ASTM D4437
- Ultimate strength meeting the requirements of GRI-GM19a
- Separation percentage meeting the requirements of GRI-GM19a

Shear Requirements:

- Testing method: ASTM D4437
- Ultimate strength meeting the requirements of GRI-GM19a
- Elongation at break meeting the requirements of GRI-GM19a

6.14 Extrusion Welded Seams

Peel Requirements:

- Testing method: ASTM D4437
- Ultimate strength meeting the requirements of GRI-GM19a
- Separation percentage meeting the requirements of GRI-GM19a

Shear Requirements:

- Testing method: ASTM D4437
- Ultimate strength meeting the requirements of GRI-GM19a
- Elongation at break meeting the requirements of GRI-GM19a

* A failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area.

6.14.1 Repairs

Portions of the geomembrane with flaws or that fail a nondestructive or destructive test shall be repaired in accordance with the specifications and manufacturer's recommendations.

- Patching is used to repair large holes, tears, large panel defects, and destructive testing sample locations.
- Extrusion is used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than 3/8 inch in the largest dimension.
- Capping is used to repair failed welds or to cover seams where welds cannot be nondestructively tested.
- Removal is used to replace areas with large defects where the preceding methods are not appropriate. Removal is also used to remove excess material (wrinkles) from the installed geomembrane.

6.14.2 Wrinkles

Placing soil cover or drainage materials over the geomembrane, temperature changes, or creep may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over shall be repaired either by cutting out excess material or, if possible, allowing the liner to contract due to temperature reduction. In no case shall material be placed over the geomembrane that could result in the geomembrane folding.

6.14.3 Bridging

Unless approved by the CQA Officer, bridging must be removed and repaired at no cost to Owner.

6.14.4 Folded Material

All folded HDPE geomembrane shall be removed and repaired at no cost to Owner.

6.14.5 Geomembrane Acceptance

The Installer shall retain all ownership and responsibility for the geomembrane until acceptance by the Owner. In the event the Installer is responsible for placing a protective cover over the geomembrane, the Installer shall retain ownership and responsibility for the geomembrane until the protective cover is placed.

The CQA Officer shall accept the geomembrane when the following activities have occurred:

- The installation is finished
- All seams have been inspected and approved
- All required laboratory tests have been completed and approved
- Signed QC certificates for each roll of geomembrane have been supplied by the Installer and approved by the CQA Officer. Certificates shall include resin identification, roll number, date of production, and test results for density, melt index, and tensile strength (ASTM D638)
- All record drawings have been completed and approved
- All documentation required by the specification has been received

6.15 Geotextile

6.15.1 Delivery and Handling

The CQA Officer shall verify the following activities:

- Equipment used to unload the rolls does not damage the geotextile
- Care is used to unload the rolls
- All documentation required by specifications has been received
- Geotextile rolls are not dragged across ground surface
- Heavy construction equipment is not operated directly on the geotextile

At the CQA Officer’s discretion, damaged rolls may be rejected and removed from the site or stored at a location separate from accepted rolls designated by the Owner’s Representative. All rolls without proper manufacturer’s documentation shall be rejected.

6.15.2 On-Site Storage

The CQA Officer shall verify that the geotextile rolls are protected from moisture, sunlight, and snow.

6.15.3 Conformance Testing

6.15.3.1 Tests

Installation shall be in accordance with the "Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities" by the United States Environmental Protection Agency (EPA). Prior to delivery, the Geosynthetics Manufacturer shall obtain one geotextile sample per 50,000 square feet of geotextile material. The samples shall be forwarded to the Testing Laboratory and at a minimum, the following tests are required to be performed:

- Mass per unit area
- Thickness
- Grab tensile strength
- Permittivity (ASTM D4491, if material is used as a filter layer)
- Apparent opening size, AOS (if material is used as a filter layer)

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA Officer shall review all test results and report any nonconformance to the Owner's Representative and the Installer.

6.15.3.2 Sampling Procedure

Samples shall be taken across the entire roll width and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. The CQA Officer or authorized representative shall mark on the sample:

- The manufacturer's identification number
- Machine number
- Date

6.15.4 Geotextile Installation

Prior to geotextile installation, the CQA Officer shall verify that the following conditions exist:

- All lines and subgrades have been verified by a qualified surveyor
- The subgrade has been prepared in accordance with the earthwork specification
- If the geotextile is to be placed over a geomembrane, the portion of the geomembrane installation to be covered by the geotextile, including all required documentation, has been completed

- The supporting surface does not contain stones or other material that could damage the geotextile or, where applicable, an underlying geomembrane
- There are no excessively soft areas that could result in damage to an overlying geomembrane
- All construction stakes and hubs have been removed and holes filled with soil placed to the minimum requirements for the adjacent soil

During panel placement the CQA Officer shall perform the following activities:

- Observe the geotextile as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geotextile by handling, trafficking, leakage of hydrocarbons, or other means.
- Verify that the people working on the geotextile do not smoke, wear shoes, or engage in other activities that could damage the geotextile.
- Verify that the geotextile is anchored to prevent movement by the wind. If geotextile is to be placed above a geomembrane, this must be done using sandbags or other similar means that shall not damage the covered geomembrane in any way.

The CQA Officer shall inform the Installer and Owner’s Representative if any of the above conditions are not met.

During geotextile placement, the CQA Officer shall verify the following activities are completed:

- The seams are overlapped as required by the specifications
- Any thread used to sew the panels of geotextile together meets specification requirements
- The geotextile panels are joined in accordance with the plans and specifications

Repair procedures include the following activities:

- Patching is used to repair holes, tears, and defects
- Removal is used to replace areas with large defects where the preceding method is not appropriate. Specific repair procedures are outlined in the specification.

6.16 Geocomposite

6.16.1 Delivery and Handling

The CQA Officer shall verify that the following activities are completed:

- Equipment used to unload the rolls shall not damage the geocomposite
- Care is used to unload the rolls
- The label containing product identification, roll number, and roll dimensions has been supplied by the Installer and been approved by the CQA Officer
- The geocomposite is covered to minimize contact with dirt and other contaminants
- Geocomposite rolls are not dragged across ground surface
- Heavy construction equipment is not operated directly on the geocomposite

At the CQA Officer's discretion, damaged rolls may be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the Owner's Representative. All rolls without proper manufacturer's documentation shall be rejected.

6.16.2 Conformance Testing

6.16.2.1 Tests

Before delivery, the Geosynthetics Manufacturer shall obtain one geocomposite sample per 50,000 square feet of geocomposite. The samples shall be forwarded to the Testing laboratory for the following tests:

- Carbon Black
- Transmissivity
- Thickness
- Tensile Properties
- Density
- Adhesion of Geotextile to Geonet

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA Officer shall review all test results and report any nonconformance to the Owner's Representative and the Installer.

6.16.2.2 Sampling Procedure

Samples shall be taken across the entire roll width and shall not include the first three feet unless otherwise specified, samples shall be three feet long by the roll width. The CQA Officer or authorized representative shall tag the sample with the manufacturer's roll identification number and the date sampled.

6.16.3 Geocomposite Installation

Prior to geocomposite installation, the CQA Officer shall verify that the following conditions exist:

- The geocomposite installation, including all required documentation, has been completed
- The geocomposite surface is clean

During panel placement, the CQA Officer shall perform the following activities:

- Observe the geocomposite as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications
- Verify that equipment used does not damage the geocomposite or underlying geomembrane by handling, trafficking, leakage of hydrocarbons, or other means
- Verify that people working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite or underlying geomembrane
- Verify that the geocomposite is anchored to prevent movement by the wind (the Installer is responsible for any damage resulting to or from windblown geocomposite)
- Verify that the geocomposite remains free of contaminants such as soil, grease, fuel, etc.

The CQA Officer shall inform the Installer and Owner's Representative if the above conditions are not met.

During geocomposite placement, the CQA Officer shall verify that the following conditions exist:

- Adjacent edges along the length of the geocomposite roll shall be overlapped a minimum of four inches, or as recommended by the Manufacturer.
- The overlapped edges shall be joined in accordance with the plans and specifications.
- Adjoining rolls across the roll width should be shingled down in the direction of the slope and joined together in accordance with the plans and specifications.
- Repair procedures include the following activities:
  - Patching is used to repair holes, breaks, tears, and defects
  - Removal is used to replace areas with large defects where patching is not appropriate.

7.0 LEACHATE COLLECTION SYSTEM

7.1 Placement

Because of the intimate contact with the liner system, leachate collection placement shall have continuous on-site inspection by the GQCP. All field sampling and testing shall be performed under the observation of the GQCP.

The drainage layer for the leachate collection system shall consist of a geosynthetic drainage layer (i.e. geocomposite, geonet, and geotextiles).

Typical specifications for the geosynthetic drainage layer are presented on Table 3 Part III, Attachment 3 in the Leachate and Contaminated Water Plan shall be referenced in determining the suitability of the proposed material. Double-sided heated bonded geonet/geotextile drainage composite will be utilized in the slopes and single- sided (may be separated, or heat bonded) drainage composite will be used on floors.

Geosynthetic drainage materials and filter geotextile will be anchored in an anchor trench. Geotextile panels used in the geosynthetic drainage layer or placed above the leachate collection system shall be overlapped and either heat bonded, or field sewn. Only low ground pressure support equipment approved by the Project Representative may be allowed on the geosynthetic drainage materials or geotextile. Personnel working on the geosynthetic drainage materials or geotextile shall not smoke, wear damaging shoes, or engage in any activity which damages the geomembrane.

The GQCP will inspect leachate collection pipe placement and pipe connections and will review manufacturers certification information. Pipe locations will be documented by survey methods at the sump and at the terminating end of the collection pipe, as well as at points where the slope changes and at 200-foot intervals along the pipe.

The coarse aggregate materials to be used around the leachate collection pipes shall be tested for graduation (ASTM D 422) and permeability (ASTM D 2434) at the source at a minimum frequency of one test per 3,000 cubic yards or one test per construction event, whichever is greater. At the discretion of the GQCP, additional testing may be performed on the coarse aggregate material. The material shall have a particle size of greater than one-half inch and less than one inch and shall have less than three percent by weight passing the No. 200 sieve. The material shall have a maximum calcium carbonate content of 15% (ASTM D 3042). The material shall meet or exceed the specifications as described in this SLQCP and in Part III, Attachment 3 Leachate and Contaminated Water Plan.

Test results, including manufacturer's certifications and test data for the filter geotextile will be submitted to the TCEQ in the FMLER with documentation to be at least one test per 100,000 square feet and not less than one per resin lot. Survey documentation for the leachate collection system will be submitted to the TCEQ in the FMLER. Reference locations will be provided for the thickness verification points. All elevation calculations necessary for thickness determination shall be attached as supporting documentation.

7.2 HDPE Pipe Installation

The piping (including the side slope riser sumps) associated with the leachate collection system shall consist of materials in accordance with the project construction drawings and specifications. All pipe materials shall be delivered, handled, and stored in accordance with the manufacturer’s recommendations to avoid damage to the materials. Pipe installation shall be along the lines and grades as specified in the project construction drawings and specifications, and final location of all piping shall be surveyed and provided to the Owner on a scaled drawing. Pipe joining, welding, and testing of the installed pipe materials shall be in accordance with the manufacturer’s recommendations as well as the project documents. CQA Officer shall visually observe pipe placement activities and notify the Installer and Owner's Representative if the above conditions are not met. Any repairs to the installed piping shall be in accordance with the project construction drawings and specifications and shall be observed by the CQA Officer. All piping and installation defects shall be repaired or replaced prior to putting the leachate line in service.

7.3 Protective Cover

Because of the intimate contact with the liner system, protective cover placement shall have continuous on-site inspection during construction by the GQCP. All field sampling and testing shall be performed under the observation of the GQCP.

The protective cover layer shall be 24-inches thick, or as otherwise approved by the TCEQ.

Protective cover material shall be placed in layers at least 12-inches thick with low ground pressure equipment (less than five psi contact pressure.)

Protective cover material shall be soil or other materials (including select waste) as approved by the TCEQ. Protective cover must have chimney drains keyed into the underlying leachate collection layer. The physical characteristics of the protective cover shall be monitored throughout material placement.

The thickness of the protective cover shall be verified with survey procedures or direct measurement on the same grid used for the soil liner, at a minimum confirmation of one point per 5,000 square feet.

Test results and survey documentation for the protective cover layer will be submitted to the TCEQ. Reference locations will be provided for the thickness verification points. All elevation calculations necessary for thickness determination shall be attached as supporting documentation.

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