CITY OF EDINBURG SOLID WASTE MANAGEMENT

PERMIT AMENDMENT APPLICATION

Part III, Attachment 3

WASTE MANAGEMENT UNIT DESIGN

Edinburg Regional Disposal Facility

Edinburg, Hidalgo County, Texas

TCEQ Permit MSW-956C

Submitted To: City of Edinburg
Department of Solid Waste Management
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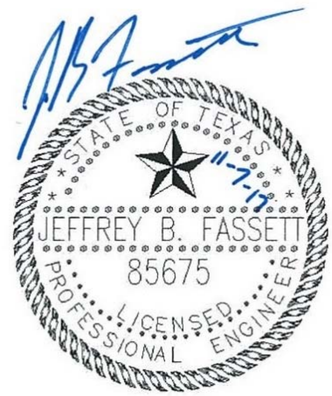

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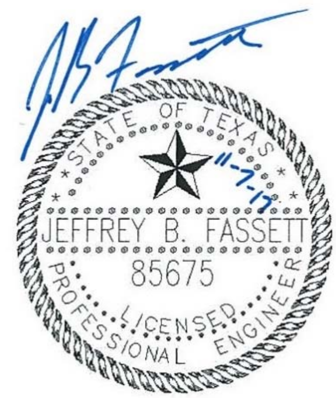

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EXECUTIVE SUMMARY

30 TAC §330.63(d)(4)(G)

This Waste Management Unit Design Report including a Liner Quality Control Plan is prepared under the direction of a licensed professional engineer in accordance with 30 TAC §330.63(d)(4), and applicable sections of 30 TAC, Chapter 330, Subchapter H "Liner System Design and Operation." The Edinburg Regional Disposal Facility (facility) has been designed to safeguard the health, welfare, and physical property of the people and the environment through various design considerations, which include volume and site life calculations, geotechnical analyses, liner design, leachate management, all-weather access, and other operational considerations.

1.0 LANDFILL UNITS

1.1 All-Weather Operation

30 TAC §30 TAC §330.63(d)(4)(A)

The facility makes provisions for all-weather operation and regularly maintain all-weather roads constructed for access to unloading areas designated for wet-weather operations.

1.1.1 Publicly Owned Routes to the Facility

The facility entrance is located at 8601 Jasman Rd north of FM 2812 and is shared with the City's Type IV Landfill TCEQ Permit MSW-2302. Access to the facility entrance from US Hwy 281 is eastbound on FM 2812 and north onto Jasman Rd. Access roads to the facility entrance are constructed with an asphaltic concrete pavement surface overlaying a limed caliche base.

1.1.2 Facility Entrance to Unloading Areas and Interior Access Roads

Access roads from the gatehouse and scales at the facility entrance to unloading areas and interior access roads are characteristically surfaced with caliche. Other all-weather road building materials such as compacted gravel, crushed stone, asphalt, or concrete may be used by the facility. Interior road locations are depicted on Figure III3-1, Facility Layout Plan.

1.1.3 Tracking of Mud Minimization

As discussed in §4.16.2, Tracking of Mud Minimization of Part IV, Site Operating Plan, the tracking of mud onto public roadways from the facility will be minimized. Traffic leaving the facility will travel southbound on Jasman Road for a quarter-mile to FM 2812. Mud at the facility entrance road and interior access roads will be removed by spraying water from the site water truck, scraping with a site bulldozer or maintainer, using a rotary broom street sweeper, or otherwise deploying site personnel with appropriate on-site materials, tools and equipment. Jasman Road, an asphaltic-concrete-paved road, will be inspected for any tracked mud and associated debris daily. As necessary, mud will be removed from Jasman Road in a similar manner to control the further tracking of mud onto FM 2812. The SM will have authority to implement additional measures (e.g., wheel shakers, wheel washes, etc.) if the preceding measures are not reasonably effective.

1.2 Landfill Method

30 TAC §330.63(d)(4)(B)

The pattern of waste disposal will be governed by the area fill disposal method. Landfilling will occur below grade and above grade, depending on the stage of operational development and operational considerations. Initially, filling will occur above grade over the existing constructed fill areas to attain the design top of waste grades. New landfill cells will be developed adjacent to existing filled areas and waste placement operations will continue below grade.

1.3 Landfill Unit Elevations

30 TAC §330.63(d)(4)(C)

Figure III3-1, Facility Layout Plan illustrates an outline of the solid waste management units. Waste within Pre-Subtitle D Units 1-4 will either be relocated for development of Unit 8 or an Overliner- will be constructed for vertical expansion. Figure III3-2A, Subgrade Layout Plan – Overliner Option depicts the subgrade elevations of the lateral expansion cells within Unit 7 and Overliner. Likewise Figure III3-2B, Subgrade Layout Plan –Unit 8 Option, depicts the subgrade elevations of the lateral expansion cells within Unit 7 and Unit 8. The elevation of deepest excavation (EDE) for the facility is 70 ft-msl located at the bottom of leachate collection sumps for each cell within Units 6, 7, and 8 as depicted on Figures III3-2A and III3-2B.

Figure III3-3, Final Contour Map depicts the maximum final cover elevation of approximately 398 ft-msl. The maximum waste elevation is the final cover elevation minus the thickness of final cover and is dependent on thickness of the final cover lining option used. Part III7, Closure Plan details final cover lining options.

1.4 Estimated Rate of Solid Waste Deposition and Operating Life

30 TAC §330.63(d)(4)(D)

Disposal capacity as referenced in 30 TAC §330 Subchapter P is amount of waste that a facility can dispose. Similarly, the EPA defines landfill capacity as the amount of airspace volume. The maximum total disposal capacity of the facility is 87,301,156 cubic yards, and the maximum remaining disposal capacity will be 76,304,934 cubic yards of waste and daily cover, based on the FY 2016 MSW Annual Report. It is anticipated that the rate of waste disposal will reach approximately 1,500,000 tons per year and that the facility will have a site life of approximately 63.5 years. The total disposal capacity and operational life calculations are provided in Appendix III3A, Volume and Site Life Calculations.

As population, economic conditions, and available landfill disposal capacity change within the region, the volume of incoming waste could vary considerably. The facility will maintain quarterly records to document waste acceptance rates. If the rate exceeds the estimated rate and is not due to a temporary occurrence, the City will file a permit modification application consistent with 30 TAC §330.125(h). As provided by rule, the estimated waste acceptance rate is not a limiting parameter of the permit.

1.5 Landfill Unit Cross-Sections

30 TAC §330.63(d)(4)(E) & (F)

Figure III3-4A, Fill Cross-Sections Location Map is a map showing a sufficient number of cross-sections across the facility, both latitudinally and longitudinally, so as to accurately depict the existing and proposed depths of all fill areas within the site. These fill cross-sections go through or very near soil borings where boring logs obtained from Part III4B, Soil Boring Logs are shown on the plan profiles, Figures III3-4B – III3-4E, Fill Cross-Sections. These plan profile figures provide an inset key map of the fill cross-section plan and clearly show the following content provided in Table III3-1, Fill Cross-Section Figures III3-4B – III3-4E.

Table III3-1: Fill Cross-Section Figures III3-4B – III3-4E

Plan Profile Content	A – A'	B – B'	C – C'	D – D'
Plan Inset Key Map	✓	✓	✓	✓
Boring Logs	✓	✓	✓	✓
Top of Levee	✓	✓	✓	✓
Top of Proposed Fill (Top of Final Cover)	✓	✓	✓	✓
Maximum Elevation of Proposed Fill	✓	✓	✓	✓
Top of the Wastes	✓	✓	✓	✓
Existing Ground	✓	✓	✓	✓
Bottom of the Excavations (Subgrade)	✓	✓	✓	✓
Side Slopes of Trenches and Fill Areas	✓	✓	✓	✓
Gas Vents or Wells	✓		✓	
Groundwater Monitoring Wells	✓	✓	✓	✓
Initial and Static Levels of Any Water Encountered	✓	✓	✓	✓
Compacted Perimeter Berms	✓	✓	✓	✓

Notes: 1. Items not checked are not applicable.
2. Perimeter berm design dimensions shown on figures.

2.0 WASTE MANAGEMENT UNIT ENGINEERING ANALYSES

Analyses were performed to assess the performance of the landfill with respect to settlement and slope stability. Each of these analyses is described in detail in the following sections.

2.1 Settlement Analysis

Facility floor settlement will occur in Strata I through III. Review of the excavation plan indicates that much of Stratum I will be removed prior to construction of the liner system and that much of the Edinburg Regional Disposal Facility floor will be founded on a thin layer of remaining Stratum I. For this analysis, settlement critical cross-sections are cut through a section of the Edinburg Regional Disposal Facility with the thickest waste above and the most critical subsurface conditions. Intermittent points along the critical cross-section are analyzed for settlement and post-settlement to define slopes. The cross-section location is referred to as Line A, located in Unit 7, Cell 2A and 2B on a north-south direction. The cross-section begins at the facility perimeter and progress toward the facility center where the proposed final elevation is highest.

The settlement analyses indicate that the minimum total settlement will be approximately 4 feet and the minimum post-settlement grade on the floor will be 0.6%. The post-settlement grade was used in the leachate header pipe sizing calculations (Appendix III3D-3A).

The post-settlement floor grades will maintain positive drainage and allow the leachate to drain towards the leachate collection system under the conditions analyzed. The results of the settlement analysis are presented in Appendix III3B-1, Settlement Analysis.

2.2 Stability Analysis

The results of the stability analyses indicate that the proposed slopes are stable under the conditions analyzed. For each condition analyzed, the minimum calculated factor of safety exceeds the recommended factor of safety.

Based on the Corps of Engineers "Design and Construction of Levees" manual (EM 1110-2-1913), the recommended factors of safety are 1.3 for short-term and 1.5 for long-term conditions, respectively. Short term conditions include:

- Excavated slopes (undrained conditions);
- Sideslopes; and
- Interior waste slopes.

All other conditions are long-term.

Slope stability analyses were performed using limit equilibrium methods to assess the stability of the proposed landfill. In particular, stability of the proposed excavated landfill sideslopes, stability of the protective cover on landfill sideslopes, stability of the interior waste slopes, overall stability of the final filled landfill, and stability of the final cover system were evaluated.

In general, the analyses consist of the following:

- Characterization of the critical cross-section (e.g., the geometry, geology, geosynthetic interfaces, and groundwater conditions).
- Selection of appropriate strength parameters.
- Analysis under anticipated critical conditions.

The analyses are summarized in the following sections.

2.2.1 Stability Analysis of Excavated Slopes

A stability analysis was performed to consider potential failure surfaces for excavation of waste management units. The excavation is a 3H:1V slope with a crest elevation of 95 ft-msl and the minimum excavation elevation is 70 ft-msl.

Potential failure surfaces were analyzed and the minimum factor of safety was computed based on limit equilibrium methods following Spencer's and GLE/Morgenstern-Price methods of analysis using SLIDE Version 7.0, an integrated slope stability analysis program for personal computers.

Results from the method providing the least factor of safety is presented Appendix III3B-2A. The factor of safety is 4.2 for the total stress condition and 2.0 for the effective stress condition. These values indicate the excavation slopes will be stable.

2.2.2 Stability of Sideslope Liner

A stability analysis was performed to consider potential veneer failure of the sideslope liner. The sideslope is a 3H:1V slope with a crest elevation of 95 ft-msl, a minimum elevation of 70 ft-msl, and a maximum length of 75 ft.

The critical interface on the slope was analyzed and the minimum factor of safety was computed using an infinite slope analysis. Based on a review of the literature and unpublished data on similar materials under similar loading conditions, the critical interface shear strength within the sideslope alternative liner system was estimated to be 24 degrees. According to Appendix III3B-2B-2, the maximum head over the geomembrane is less than the thickness of the geocomposite drainage layer because the double-sided geocomposite drainage layer will have a transmissivity adequate to convey water infiltrating through the protective cover over the maximum sideslope length.

Results from the analysis is presented Appendix III3B-2B. The factor of safety for veneer slope stability is 1.34 with the use of conservative parameters in the analysis. This value indicates the sideslope liner will be stable.

2.2.3 Stability of the Interior Waste Slopes

Interior waste slope stability analyses were performed using the limit equilibrium slope stability method to determine the factor of safety against sliding along the liner. Based on a review of the floor grades and filling sequence, it was identified that the interior waste slope in Unit 7, Cells 6B through 9B is the most critical case, where the filling and floor slope occur in the same direction with no buttress effect from existing waste or the floor gradient.

Potential failure surfaces were analyzed and the minimum factor of safety was computed based on limit equilibrium methods following Spencer's and GLE/Morgenstern-Price methods of analysis using SLIDE

Version 7.0, an integrated slope stability analysis program. Two possible waste filling slopes were considered; a continuous 3H:1V temporary waste slope with no benches, and a 3H:1V temporary waste slope with one bench at the middle of the slope. The maximum waste height is conservatively assumed at 400 ft-msl which is greater than the proposed waste thickness. The strength parameters were either conservatively chosen from published studies or based on test results for similar conditions.

Results from the method providing the least factor of safety are presented in Appendix III3B-2C. Under the assumed conservative scenarios, results indicate that the interior waste slope at 3H:1V may be filled up to the final elevation with an acceptable factor of safety. However, to facilitate site operations and to account for any operational uncertainties, a 100-foot wide bench at the midpoint of the 3H:1V interior slope is advised. Slope stability analyses for this condition are also presented in Appendix III3B-2C.

2.2.4 Stability of Final Filled Configuration

Final filled configuration stability analyses were performed using limit equilibrium methods to determine the factors of safety against sliding or failure. Based on a review of the design grades, two reasonable worst-case configurations were considered: a section along Unit 7, Cell 2, having 3H:1V excavation sideslopes and 4H:1V final cover slopes to a crest elevation at 400 feet msl; and a section along Unit 7 with similar slopes running west to east along Cells 1B through 5A.

Potential failure surfaces were analyzed and the minimum factor of safety was computed based on limit equilibrium methods following Spencer's and GLE/Morgenstern-Price methods of analysis using SLIDE Version 7.0, an integrated slope stability analysis program for personal computers. The strength parameters are conservatively estimated or based on test results for similar conditions, and the reasonable worst case configuration.

Results from the method providing the least factor of safety are presented in Appendix III3B-2D. Along Section A the factor of safety is 1.9 for block sliding and 2.9 for circular failure. The corresponded factor of safety for Section B is 2.0 for block sliding and 2.9 for circular failure. These values indicate the final-filled configuration will be stable.

2.2.5 Stability of Final Cover System

A stability analysis of the final cover liner system was performed using an infinite slope analysis to estimate the potential for sliding to occur following closure of the landfill cells. A worst-case section, consisting of a 1,200-foot long, 25% slope was analyzed. Based on a review of the literature and unpublished data on similar materials under similar loading conditions, the critical interface shear strength within the final cover liner system was estimated to be 21 degrees.

The analyses are included in Appendix III3B-2E and indicate that, provided the geocomposite drainage layer is adequate to convey drainage without building up pore water pressures in the geocomposite, the factor of safety against sliding will be approximately 1.5.

Additional analyses (also included in Appendix III3B-2E) were performed to determine the geocomposite drainage layer transmissivity required to adequately convey surface water infiltration over the maximum final cover slope length. If the minimum measured transmissivity value reported in Appendix III3-2E is not met, the maximum flow length must be reduced (i.e., the geocomposite drainage layer must be "daylighted") in direct proportion to the ratio of the actual measured transmissivity and the required measured transmissivity. A detail depicting "daylighting" is included as detail 4 in Attachment 7, Closure Plan, Figure III7-3A, Conventional Composite Final Cover Details.

2.3 Overliner

Waste within Pre-Subtitle D Units 1 – 4 will either be relocated for development of Unit 8 or an overliner will be constructed for vertical expansion. The subgrade of the overliner will be the in-place final cover grades previously permitted and extend to Unit 6 as depicted on Figure III3-9A, Overliner Subgrade Layout. Details of the overliner design are presented on Figures III3-7A, III3-9C, and III3-9D. Overliner design analyses are included in Appendix IIIB-3, Overliner.

2.3.1 Settlement

Appendix III3B-3A, Settlement Analysis demonstrates positive drainage is maintained for the leachate collection and removal system.

Settlement for the overliner system will primarily be the result of compression of the underlying old waste and, to a lesser extent, consolidation of the foundation soil layers due to increased loads from the new waste and final cover placement. Old waste settlement consists of two components: 1) time-dependent secondary compression (or creep), and 2) primary settlement caused by the stress increase from new waste and final cover. Secondary compression within the foundation material will be very small; therefore, only consolidation settlement was evaluated below the landfill.

Settlement below the overliner was estimated and used to determine the post-settlement grades of the overliner. The minimum post-settlement grade in the direction of leachate flow is approximately 0.4 percent; therefore, positive drainage will remain at the end of the 30-year post-closure period.

2.3.2 Strain Analysis

Appendix III3B-3B, Strain Analysis demonstrates the induced tensile strain due to differential settlement of existing waste and the formation of a localized depression beneath the liner system is below the minimum allowable strain of the liner components.

Using settlement results, the difference in liner length between prior and post settlement was analyzed. The evaluation showed the liner will mainly be under compression with liner shortening. A very limited portion will experience a lengthening with a strain of 0.3 percent, well below the allowable strain of 5 percent.

An evaluation of strain in the overliner due to localized depressions (subsidence) near the surface of the old waste was performed, and is included as Appendix III3B-3B, Strain Analysis. A parametric analysis, comparing the diameter of the subsidence area and depth at its center to the allowable strain of the overliner components, indicates that the ratio of depth to diameter is approximately 0.14 for 5 percent strain and 0.20 for 10 percent strain.

Depressions of this magnitude would only be expected if voids or highly compressible material are present immediately below the overliner. To reduce the potential for subsidence below the overliner system, the existing waste will be surcharged by placing at least 20 feet of soil for a minimum 3-month period. The surcharge will collapse voids and compress the underlying material.

2.3.3 Stability Analysis

Final filled configuration stability analyses were performed using limit equilibrium methods to determine the factors of safety against sliding or failure. Based on a review of the design grades, the reasonable worst-case configuration was assumed to consist of a section along the western side of Units 3 and 4, having 4H:1V final cover slopes to a crest and maximum fill elevation of approximately 312.6 ft-msl. Compared to other sections through the pre-Subtitle D area, the chosen section exhibits thicker existing waste. Additionally, the toe of the future waste along the chosen section is less supported by the perimeter berm.

Potential failure surfaces were analyzed and the minimum factor of safety was computed based on limit equilibrium methods following Spencer's and GLE/Morgenstern-Price methods of analysis using SLIDE Version 7.0, an integrated slope stability analysis program for personal computers. The strength parameters are conservatively estimated or based on test results for similar conditions, and the reasonable worst case configuration.

The results from the method providing the least factor of safety is presented Appendix III3B-3C. The factor of safety is 2.0 for block sliding and 3.0 for circular failure. These values indicate the final-filled configuration will be stable.

3.0 LINER DESIGN CRITERIA

30 TAC §§330.331(a)(2) & 330.331(b)

The Pre-Subtitle D Units 1 – 4 consist of cells extending to a depth of approximately 15 feet below original ground surface. Some of the cells are reported to include a single geomembrane liner. None of the cells include a leachate collection system. The approximate grades of the Pre-Subtitle D cells are shown on Figure III3B-3A-1.

The liner design for the facility is not composed of “composite liner” components defined by 30 TAC §330.331(b); consisting of at least a 2-foot layer of re-compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ cm/s and a 60-mil high density polyethylene (HDPE) geomembrane liner component.

An alternative liner design is currently approved under permit TCEQ Permit MSW-956B for remaining Subtitle D construction and is the liner design to be used for expansion cells in Unit 7 and Unit 8. The alternative liner design consists of, from bottom up, a geosynthetic clay liner (GCL), a 60-mil high-density polyethylene (HDPE) geomembrane liner, double-side geocomposite composed of a geonet bonded to geotextile on both sides, and 2 feet of protective cover soil. The overliner design discussed in §2.3, Overliner will use 60-mil linear low-density polyethylene (LLDPE) instead of HDPE because its elastic properties are better suited for potential waste settlement. Alternative liner details are included on Figure III3-7, Alternative Liner System Details. Overliner design details and cross-sections are shown on Figures III3-9B, III3-9C, and III3-9D.

As discussed in §4.0, Leachate Collection and Removal System (LCRS) is designed to maintain less than a 30-centimeter depth of leachate over the alternative liner system.

Portions of the landfill excavation extend below the seasonal high water table. Consistent with current practice at the site, toe drains and a geocomposite underdrain along the sideslopes will be installed to control groundwater. The underdrain will be maintained and operated until sufficient ballast is in place to resist the uplift pressures below the liner system. The underdrain analyses are included in Appendix III3E-2. The underdrain system layout and details are shown on Figures III3-6A, III3-6B, and III3-8.

3.1 Alternative Liner Design

30 TAC §330.335

Alternative liner designs, which must include a leachate management system, may be authorized by the TCEQ if a demonstration by computerized design modeling that the maximum contaminant levels detailed in 30 TAC §330.331, Table 1 will not be exceeded at the point of compliance. At the discretion of the TCEQ, a field demonstration may be required to prove the practicality and performance capabilities of an alternative liner design.

3.2 Point of Compliance Demonstration

30 TAC §330.331(a)(1)

The liner design ensures the concentration values listed in Table 1 of 30 TAC §330.331(a)(1) will not be exceeded in the uppermost aquifer at the point of compliance, as determined in 30 TAC §330.403. The alternative liner design was evaluated to demonstrate that it provides a level of groundwater protection that is greater than or equal to the level of protection provided by a "composite liner" system. The evaluation presented in Appendix III3C-1, Point of Compliance Demonstration indicates that substituting the clay component with a geosynthetic clay liner (GCL) will provide a greater or equivalent level of groundwater protection at the facility. In addition, fate and transport modeling performed on the alternative liner system demonstrates that the maximum contaminant levels detailed in 30 TAC §330.331(a)(1) will not be exceeded at the point of compliance as a result of hypothetical leakage through the liner system.

3.3 Constructed of Chemically Resistant Materials

30 TAC §330.333(1)

The alternative liner system will be constructed of materials including HDPE (or LLDPE for the overliner system) and polyester or polypropylene are chemically resistant to leachate characteristically generated by municipal solid waste facilities. HDPE or LLDPE materials are used for the geomembrane and polyester or polypropylene materials are used in the geotextile component of the GCL and geocomposite drainage layer.

3.4 Liner Design Considerations

30 TAC §330.331(c)

When approving an alternative liner design that ensures the concentration values listed in Table 1 of 30 TAC §330.331(a)(1) will not be exceeded in the uppermost aquifer at the point of compliance, as determined in 30 TAC §330.403, the TCEQ may consider, but is not limited to, the following factors:

- 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 proximity and withdrawal rate of the groundwater users;
- the availability of alternative drinking water supplies;
- the existing quality of the groundwater, including other sources of contamination and their cumulative impacts on the groundwater and whether groundwater is currently used or reasonably expected to be used for drinking water;
- public health, safety, and welfare effects; and
- practicable capability of the owner or operator.

The alternative liner design is currently approved under permit TCEQ Permit MSW-956B. The aforementioned factors and any factors not addressed in this application shall be provided to the TCEQ upon request to aid in considerations.

4.0 LEACHATE COLLECTION AND REMOVAL SYSTEM

30 TAC §§330.331(a)(2) & 330.333

The leachate collection and removal system (LCRS) is designed and constructed to maintain less than a 30-centimeter depth of leachate over the alternative liner system and eliminate potential migration of landfill leachate into groundwater and to meet the requirements of 30 TAC §330.333. The LCRS will collect and remove leachate from the top of the alternative liner, channel leachate to designated leachate collection sumps, and pump leachate from the leachate collection sump into a leachate force main for disposal.

The LCRS drainage layer is comprised of a double-sided geocomposite: a high density polyethylene (HDPE) geonet bonded with geotextile on both sides. The leachate collection system details are presented on Figure III3-8, Leachate Collection and Removal System and Underdrain Details. Leachate is collected from the drainage layers into a leachate collection trench constructed of perforated HDPE piping encased by a drainage aggregate and wrapped in a geotextile filter. The leachate collection trench discharges into leachate collection sumps likewise constructed of drainage aggregate and wrapped in geotextile filter. From with the leachate collection sumps, an HDPE upslope riser pipe houses a pump that removes accumulated leachate from within the leachate collection sumps into a leachate force main for discharge to the public sewer system as depicted on Figures III3-5A and III3-5B.

The LCRS is designed and operated to function through the scheduled closure and post-closure care period of the landfill considering the following factors:

- constructed of materials that are chemically resistant to the leachate expected to be generated
- 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
- 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.

4.1 Groundwater Inflow

30 TAC §330.337(d)

The LCRS is designed to handle both the leachate generated and the groundwater inflow from materials beneath and lateral to the liner system. Appendix III3D-2, Groundwater Inflow demonstrates the calculated maximum volume of groundwater inflow based on determination of the permeability and potentiometric conditions of the alternative liner system and of the materials surrounding the liner system. Groundwater inflow into the leachate collection system using the alternative liner system is negligible relative to leachate production rates.

4.2 Rate of Leachate Removal

30 TAC §330.333(3)(A)

The estimated rate of leachate removal is operationally equivalent to the leachate production rate. The HELP Model (Hydraulic Evaluation of Landfill Performance, US Army Corps of Engineers, Waterways Experiment Station, Version 3.07, November, 1997) was used to determine the leachate production rate (impingement rate) for various conditions during the life of the landfill. A summary of HELP model results is provided in Appendix III3D-1, HELP Model Evaluations. The maximum rate of leachate removal is 962 cf/ac/day.

4.3 Drainage Media Specifications and Performance

30 TAC §330.333(F)

Drainage media used in the LCRS include double-sided geocomposite and perforated HDPE header piping encased by a drainage aggregate wrapped in a filter geotextile. Evaluations of performance and required specifications of drainage media are provided in Appendix III3D-3, Drainage Media Specifications and Performance.

4.3.1 Constructed of Chemically Resistant Materials

30 TAC §330.333(1)

The LCRS will be constructed of materials including HDPE, polyester or polypropylene, and drainage aggregate that are chemically resistant to the leachate expected to be generated by municipal solid waste facilities. HDPE materials are used in the geonet component of the double-sided geocomposite drainage layer and piping within the leachate collection trench and leachate collection sump. Drainage material used within the leachate collection trench and leachate collection sump is required to be resistant to carbonate loss. The geotextile component of the double-sided geocomposite drainage layer, leachate collection trench, and leachate collection sump utilize 100-percent continuous-filament polyester or polypropylene.

4.3.2 Double-sided Geocomposite Drainage Layer

The double-sided geocomposite drainage media is a high density polyethylene (HDPE) geonet bonded with geotextile on both sides. Appendix III3D-1, HELP Model Evaluation demonstrates the design transmissivity using the impingement rate under the worst case scenario and the maximum lengths and slopes from the subgrade layout plan presented in Figures III3-2A and III3-2B. Also provided are transmissivity specification requirements for the double-sided geocomposite to be used; reduction factors were applied to consider potential long-term creep, chemical clogging, biological clogging, and intrusion of geotextile into the geonet component.

4.3.3 Leachate Collection Trench Header Pipe Sizing

The leachate collection trench is a perforated HDPE header pipe encased by a drainage aggregate wrapped in a filter geotextile. Appendix III3D-3A, Header Pipe Sizing evaluates the size of header pipe required to convey the maximum anticipated leachate generated using the maximum impingement rate from the worst case scenario provided by Appendix III3D-1, Help Model Evaluation, the slope of header pipe post-settlement provided by Appendix III3B-1, Settlement, and the maximum contributing area from the subgrade layout plan presented in Figures III3-2A and III3-2B. The header pipe sizing is more than adequate for the maximum leachate generated.

4.3.4 Leachate Collection Trench Header Pipe Perforations

Appendix III3D-3B, Header Pipe Perforations evaluates the perforation size required to convey the maximum leachate generated using the maximum leachate generation rate from the worst case scenario provided by Appendix III3D-1, Help Model Evaluation. The inflow rates into the header pipe perforations exceeds the maximum leachate generated.

4.3.5 Pipe Material and Strength

30 TAC §§330.333(3)(C) & 330.333(3)(E)

Pipes used in the LCRS are of HDPE material. Appendix III3D-3C, HDPE Pipe Structural Design evaluates the structural integrity of the leachate collection trench header pipes and sump riser pipes to withstand maximum overburden pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill.

The vertical pressures were determined for overburden pressures of the overlying wastes and waste cover materials and for equipment loading over the pipe with 5 feet of waste and 2 feet of protective cover. Overburden pressures were greater than that of equipment loading, thus overburden was used for analysis of structural integrity of the designed HDPE header pipe and sump riser pipe which include wall crushing, wall buckling and ring deflection.

Review of the results shows that both pipes have satisfactory factors of safety against wall crushing and buckling and pipe deflections are lower than the allowable. Therefore the HDPE pipes can withstand the vertical pressure exerted.

4.3.6 Sufficient Strength and Thickness

30 TAC §330.333(2)

The leachate collection and removal system (LCRS) will be 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. As previously discussed in the §4.3.5, the HDPE header and riser pipes are of sufficient strength and thickness. The double-sided geocomposite drainage layer and drainage aggregate used in the LCRS have a compressive strength much greater than the vertical pressures calculated in Appendix III3D-3D, HDPE Pipe Structural Design.

4.3.7 Drainage Aggregate

Drainage aggregate wrapped in a filter geotextile is used in both the leachate collection trenches and leachate collection sumps. The aggregate used shall consist of durable particles of crushed stone, natural gravel, or light weight aggregate free of silt, clay, or other unsuitable materials and shall have a loss mass due to calcium carbonate of less than 15 percent. To prevent potential clogging of aggregate into the header pipe perforations, the gradation of aggregate shall be such that the ratio of 85 percent size of aggregate to the header pipe perforation size is greater than 1.7.

4.3.8 Pipe Perforations Resistant to Clogging

30 TAC §330.33(G)

Pipe perforations will be resistant to clogging because leachate collection pipes are encased by a drainage aggregate with a gradation sizing described in §4.3.4 wrapped in a filter geotextile. The longest length of leachate collection trench as shown on the subgrade layout plans presented in Figures III3-2A and III3-2B is approximately 1900 ft. According to industry standard, the current practice of hydro-jetting can clean header pipes to a distance greater than 2000 ft.

4.3.9 Leachate Collection Trench Spacing and Grading

30 TAC §330.333(3)(D)

Leachate collection trenches are graded at 1% along subgrade low lines created from the convergence of 2% floors as shown on the subgrade layout plans presented in Figures III3-2A and III3-2B.

4.3.10 Leachate Collection Sump Capacity

30 TAC §330.333(3)(B)

Appendix III3D-4, Sump Capacity Calculations utilizes typical sump dimensions and porosity of the drainage aggregate to determine leachate capacity. The maximum leachate generated, based on the maximum contributing area and the maximum leachate generation rate provided by Appendix III3D-1, Help Model Evaluation was compared to the sump leachate capacity to determine an estimated time to fill the sump. Based on results, the leachate collection sump design provides adequate capacity and cycle time for leachate pumping.

5.0 BALLAST AND DEWATERING SYSTEM

30 TAC §330.337(e)

Waste management unit excavations extend below the seasonal high water table resulting in upward or inward hydrostatic forces on the alternative liner. The alternative liner and the waste placed above it will provide the ballast (weight) to protect the liner system from uplift forces from groundwater. To offset hydrostatic uplift during construction, an active dewatering system will be constructed and operated until sufficient ballast is in place.

5.1 Ballast

30 TAC §330.337(b)(1)

To offset hydrostatic uplift, the weight of the alternative liner and the waste placed above it will provide the ballast (weight) to protect the liner system from uplift forces from groundwater. The ballast counteracting the hydrostatic forces include the soil materials from the leachate collection system components, the protective cover, waste above the liner and leachate collection system, and the soil materials from the interim cover. The weight of the geosynthetic components of the leachate collection system and any geosynthetic components of the interim cover is considered negligible. Appendix III3E-1, Ballast Calculations demonstrate that the ballast, including waste, offset hydrostatic uplift by a factor greater than 1.5. A Ballast Evaluation Report (BER) must be submitted to the TCEQ when the ballast verification demonstrates that further ballasting or dewatering is no longer necessary as outlined in Appendix III3F §8.3, Ballast Evaluation Report.

5.2 Dewatering System

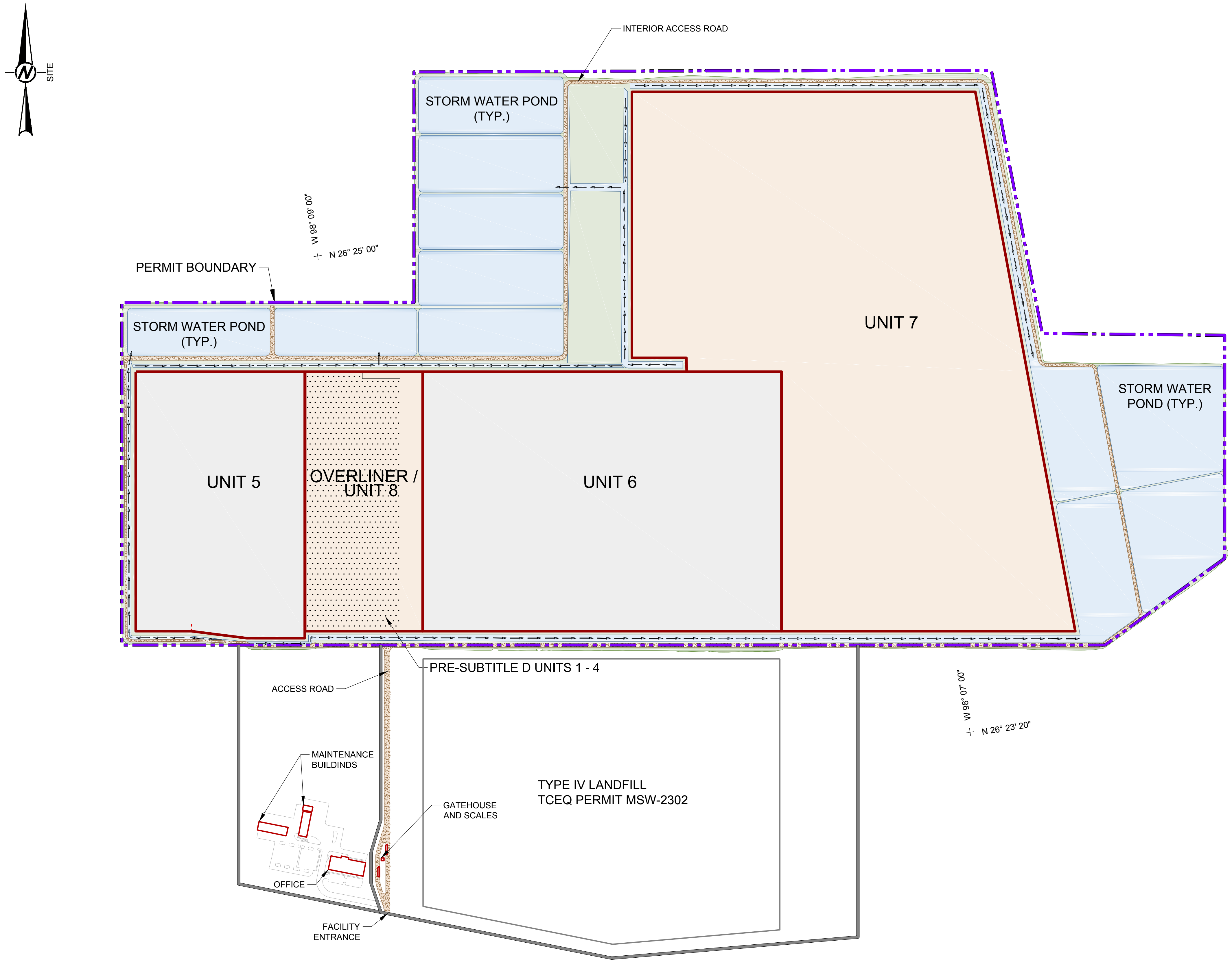
30 TAC §330.337(b)(2)

During construction of the alternative liner, groundwater will be controlled by installing an active dewatering system, which includes an underdrain composed of toe drains, a geocomposite along the sideslopes, and an underdrain sump where removed groundwater will be pumped into adjacent drainage perimeter channel. Appendix III3E-2, Dewatering System Calculations estimates groundwater flow into the underdrain using SEEP/W, a 2-dimensional finite element analysis program, using the worst-case scenario and designs the underdrain system to reduce upward or inward hydrostatic forces on the alternative liner to achieve factor of safety greater than 1.2 against uplift. Figures III3-6A, III3-6B, and III3-8 present design layout and details of the dewatering system.

6.0 LINER QUALITY CONTROL PLAN

30 TAC §330.339(a)

Appendix III3F, Liner Quality Control Plan (LQCP), is prepared under the direction of a licensed professional engineer by a Professional Engineer, and it shall be the basis for the type and rate of quality control testing performance and reported in the geosynthetic liner evaluation report (GLER) as required in §30 TAC §330.341. The plan provides operating personnel adequate procedural guidance for assuring continuous compliance with groundwater protection requirements. The plan specifies construction methods employing good engineering practices for installation and testing of components of the alternative liner including geosynthetic clay liner (GCL), geomembrane (GM), leachate collection and removal system (LCRS), and protective cover soil. As discussed in §3.1, the alternative liner design does not include at least a 2-foot layer of re-compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ cm/s; therefore, liner quality control testing procedures for a compacted clay liner are not provided within the LQCP in accordance with 30 TAC §330.339. Also included within the LQCP are special considerations for excavations below the seasonal high groundwater table.



LEGEND

- PERMIT BOUNDARY
- UNIT BOUNDARY
- EXISTING PRE-SUBTITLE D UNITS 1 - 4
- ROADS
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION

NOTE(S)

1. ACCESS ROADS FROM THE GATEHOUSE AND SCALES AT FACILITY ENTRANCE TO THE UNLOADING AREAS AND OTHER INTERIOR ACCESS ROADS ARE CHARACTERISTILY SURFACED WITH THE CALICHE.
2. INTERIOR ACCESS ROAD WILL BE EITHER SOIL SURFACED OR SURFACED WITH CALICHE.
3. OTHER ALL-WEATHER ROAD BUILDING MATERIALS SUCH AS COMPACTED GRAVEL, CRUSHED STONE, ASPHALT, OR CONCRETE MAY BE USED BY THE FACILITY.
4. ALL-WEATHER ROADS WILL BE CONSTRUCTED FOR ACCESS TO UNLOADING AREAS DESIGNATED FOR WET-WEATHER OPERATIONS.

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0 300 600
1" = 600' FEET

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1	2017-11-07	RESPONSE TO TCEQ FIRST NOD	CEI	TNB	MX	JBF
0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	CEI	TDS	MX	JBF

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
FACILITY LAYOUT PLAN

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	1 of 19	III3-1

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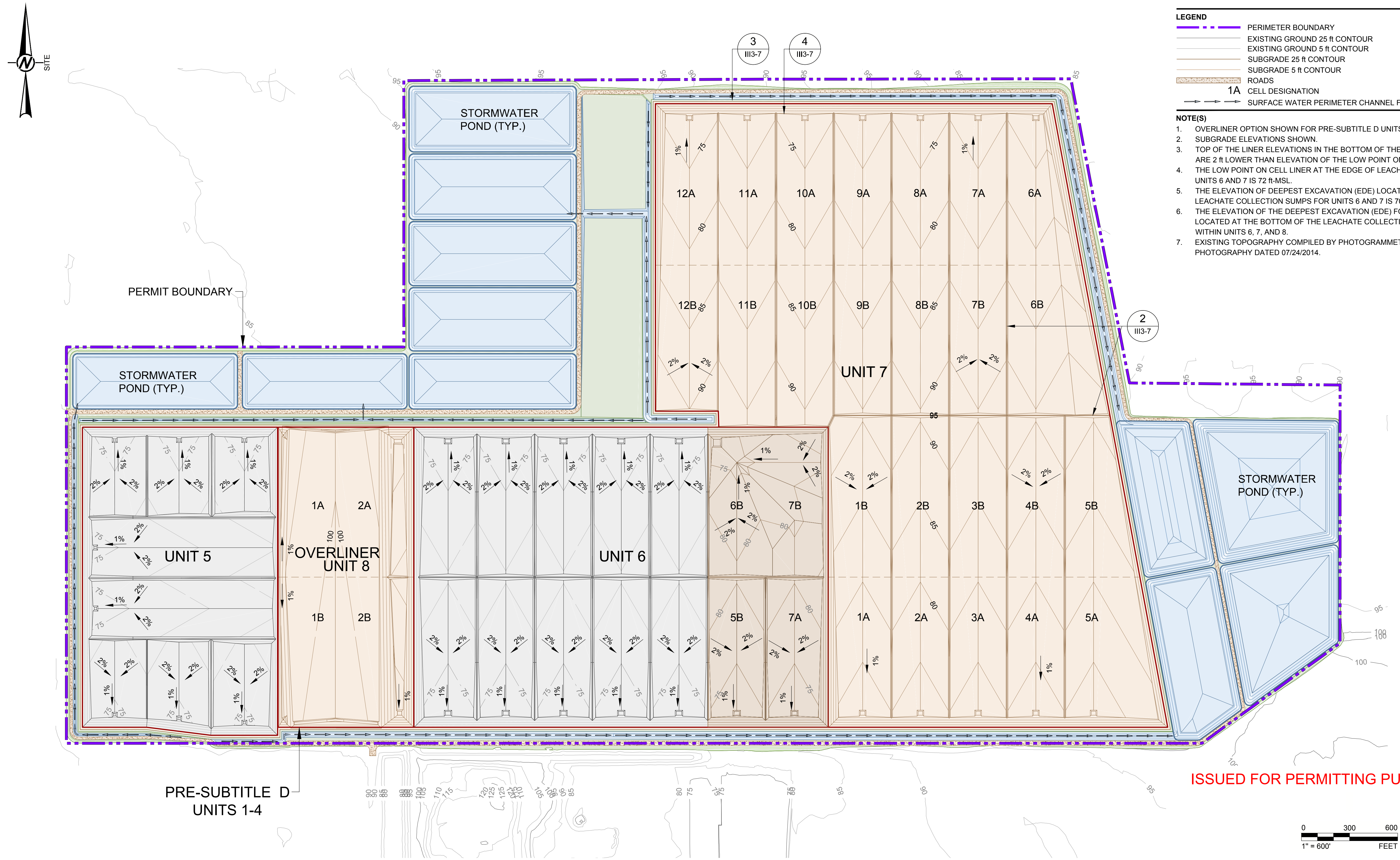
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B



LEGEND

- PERIMETER BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- ROADS
- 1A CELL DESIGNATION
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION

NOTE(S)

1. OVERLINER OPTION SHOWN FOR PRE-SUBTITLE D UNITS 1-4.
2. SUBGRADE ELEVATIONS SHOWN.
3. TOP OF THE LINER ELEVATIONS IN THE BOTTOM OF THE LEACHATE COLLECTION SUMPS ARE 2 ft LOWER THAN ELEVATION OF THE LOW POINT ON THE LINER.
4. THE LOW POINT ON CELL LINER AT THE EDGE OF LEACHATE COLLECTION SUMP FOR UNITS 6 AND 7 IS 72 ft-MSL.
5. THE ELEVATION OF DEEPEST EXCAVATION (EDE) LOCATED IN THE BOTTOM OF THE LEACHATE COLLECTION SUMPS FOR UNITS 6 AND 7 IS 70 ft-MSL.
6. THE ELEVATION OF THE DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 70 ft-msl LOCATED AT THE BOTTOM OF THE LEACHATE COLLECTION SUMPS FOR EACH CELL WITHIN UNITS 6, 7, AND 8.
7. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	CEI	AA	MX	JBF

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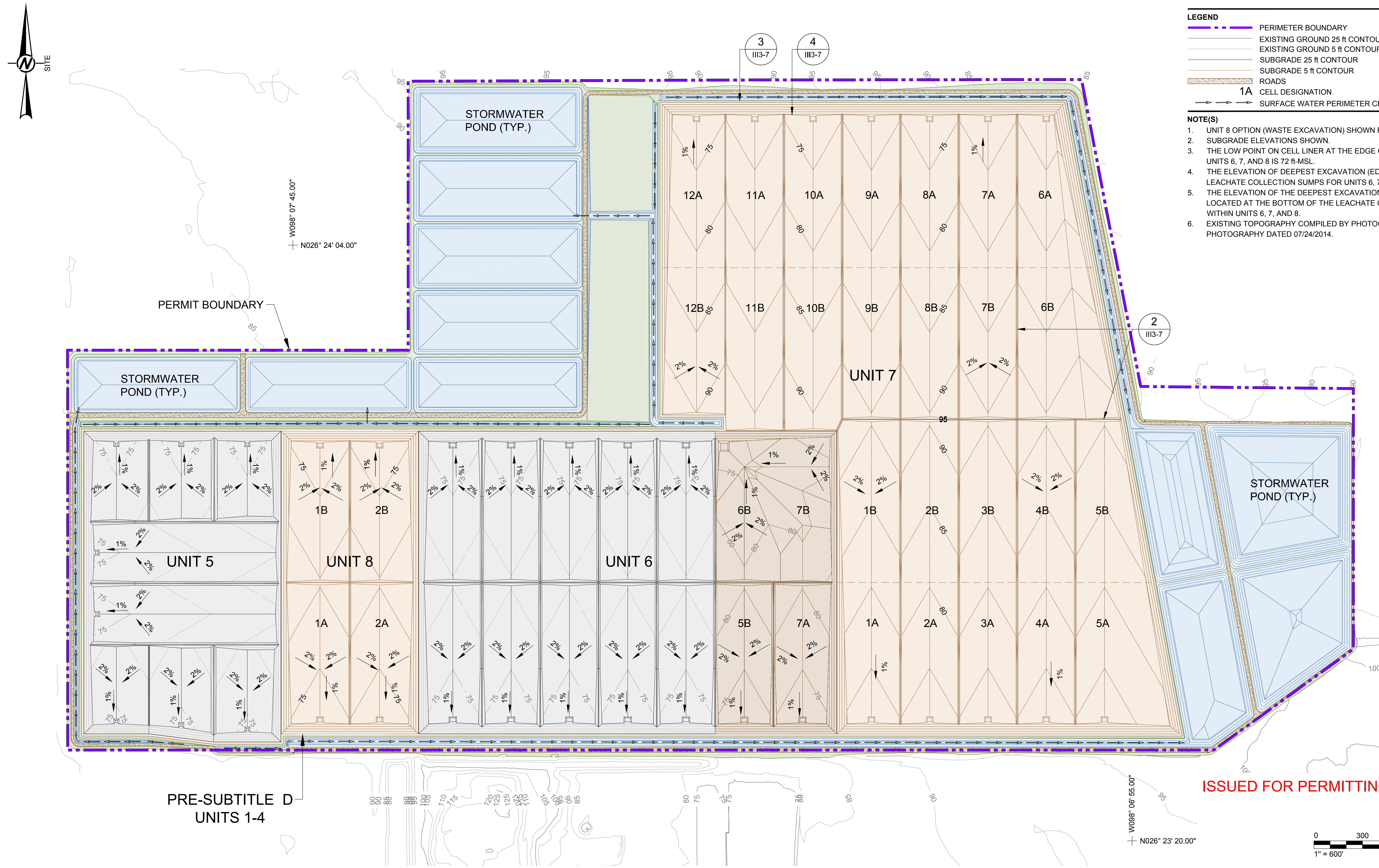
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
SUBGRADE LAYOUT PLAN
OVERLINER OPTION

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	2 of 19	III3-2A



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LEGEND

- PERIMETER BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- ROADS
- 1A CELL DESIGNATION
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION

NOTE(S)

1. UNIT 8 OPTION (WASTE EXCAVATION) SHOWN FOR PRE-SUBTITLE D UNITS 1-4.
2. SUBGRADE ELEVATIONS SHOWN.
3. THE LOW POINT ON CELL LINER AT THE EDGE OF LEACHATE COLLECTION SUMP FOR UNITS 6, 7, AND 8 IS 72 ft-MSL.
4. THE ELEVATION OF DEEPEST EXCAVATION (EDE) LOCATED IN THE BOTTOM OF THE LEACHATE COLLECTION SUMPS FOR UNITS 6, 7, AND 8 IS 70 ft-MSL.
5. THE ELEVATION OF THE DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 70 ft-msl LOCATED AT THE BOTTOM OF THE LEACHATE COLLECTION SUMPS FOR EACH CELL WITHIN UNITS 6, 7, AND 8.
6. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.

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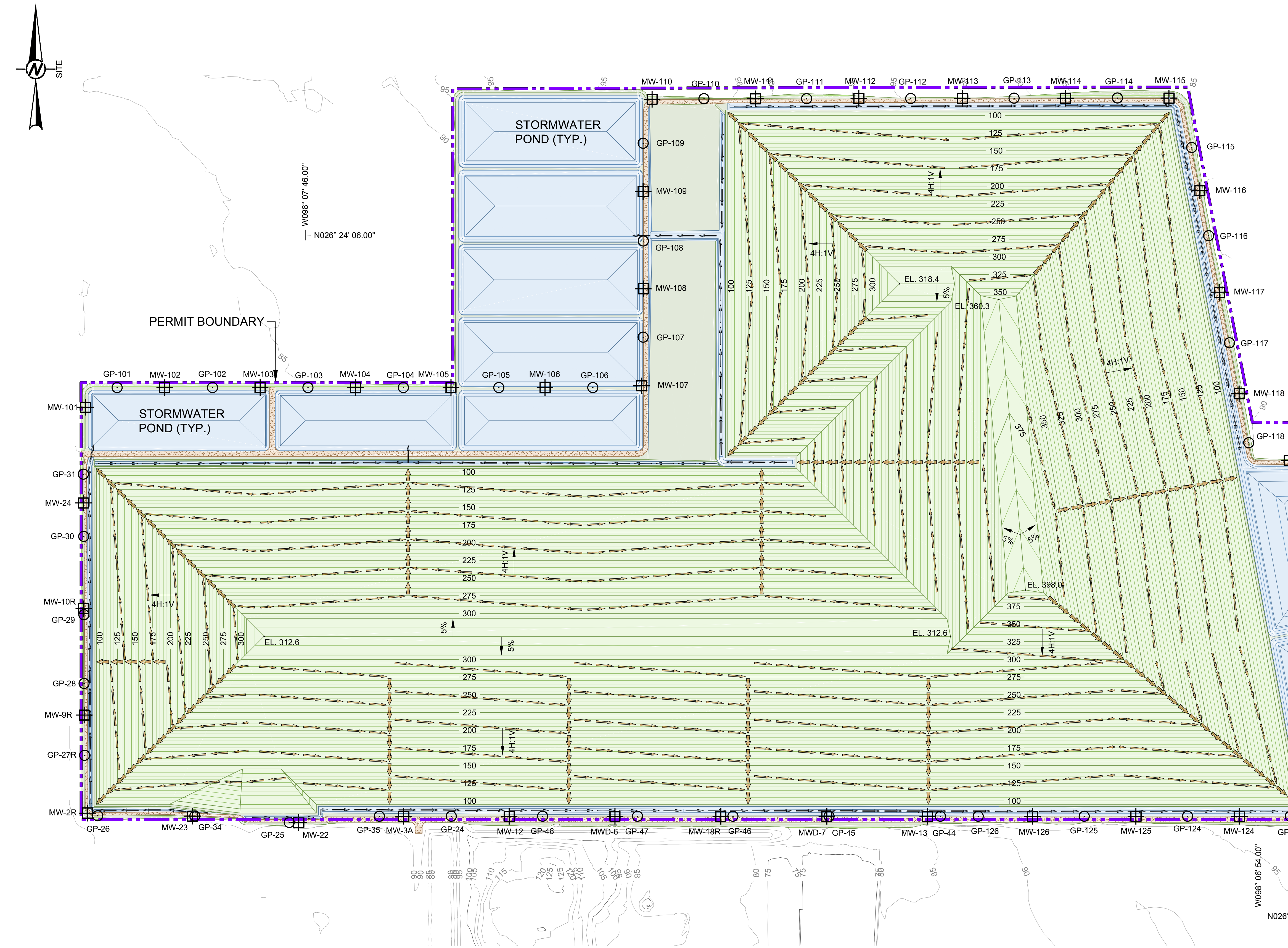
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
SUBGRADE LAYOUT PLAN
UNIT 8 OPTION

PROJECT NO.	APPLICATION SECTION	REV.	3 of 19	FIGURE
1401491	III3	1		III3-2B



ISSUED FOR PERMITTING PURPOSES ONLY

0 300 600
1" = 600' FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- FINAL COVER 25 ft CONTOUR
- FINAL COVER 5 ft CONTOUR
- ACCESS ROADS
- GP-107 GAS PROBE
- MW-107 GROUNDWATER MONITORING WELL
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- ADD-ON BERMS FLOW DIRECTION
- DOWNCHUTE FLOW DIRECTION

NOTE(S)

1. TOP OF FINAL COVER GRADES ARE SHOWN ON THIS SHEET.
2. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.
3. SEE PART III2, SURFACE WATER DRAINAGE REPORT, FOR DETAILS OF STORMWATER MANAGEMENT FEATURES.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
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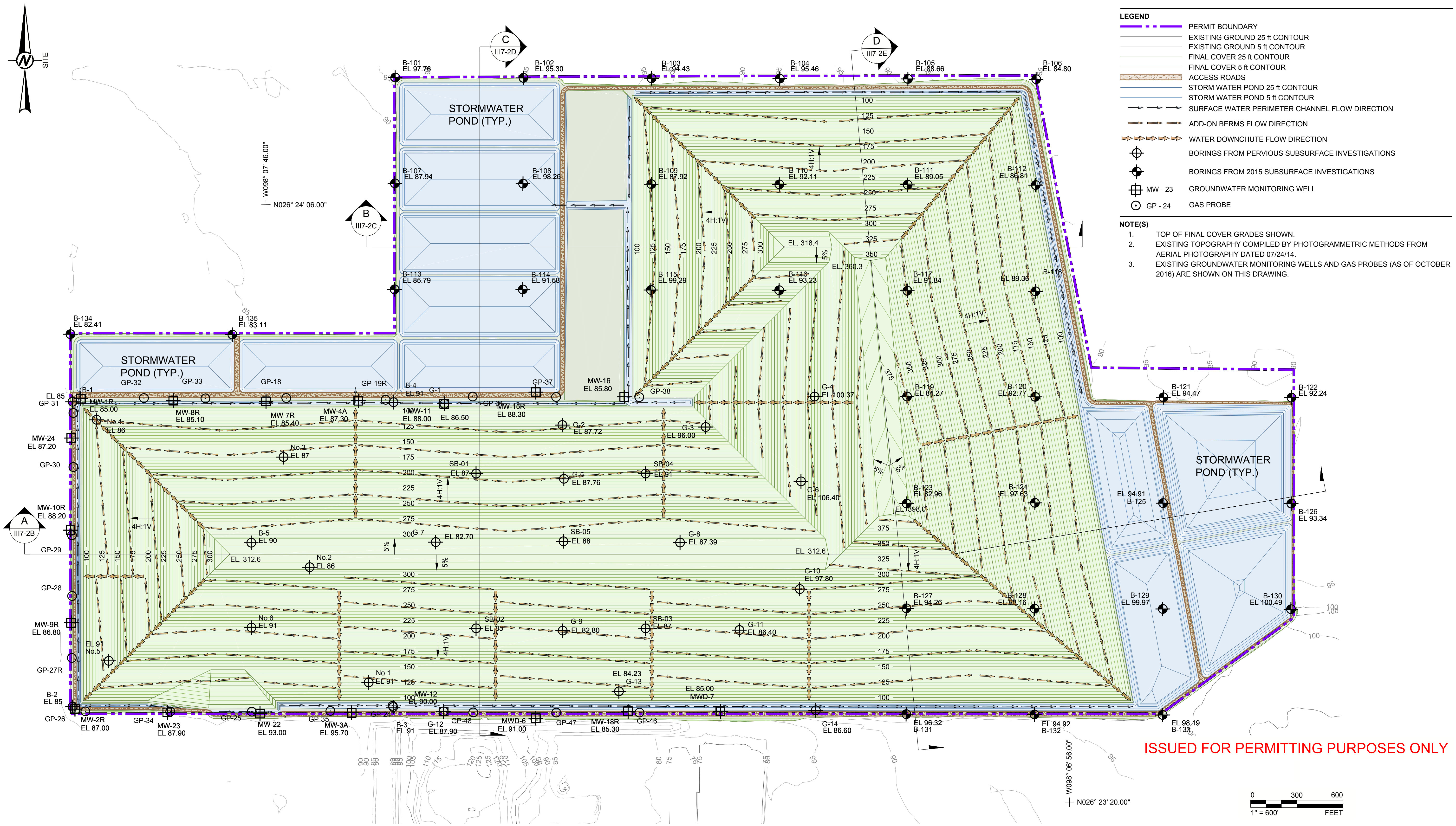
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
FINAL CONTOUR MAP

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	4 of 19	III3-3



LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- FINAL COVER 25 ft CONTOUR
- FINAL COVER 5 ft CONTOUR
- ACCESS ROADS
- STORM WATER POND 25 ft CONTOUR
- STORM WATER POND 5 ft CONTOUR
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- ADD-ON BERMS FLOW DIRECTION
- WATER DOWNCHUTE FLOW DIRECTION
- BORINGS FROM PERVIOUS SUBSURFACE INVESTIGATIONS
- BORINGS FROM 2015 SUBSURFACE INVESTIGATIONS
- MW - 23 GROUNDWATER MONITORING WELL
- GP - 24 GAS PROBE

NOTE(S)

1. TOP OF FINAL COVER GRADES SHOWN.
2. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/14.
3. EXISTING GROUNDWATER MONITORING WELLS AND GAS PROBES (AS OF OCTOBER 2016) ARE SHOWN ON THIS DRAWING.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOD	CEI	TNB	JBF	JBF
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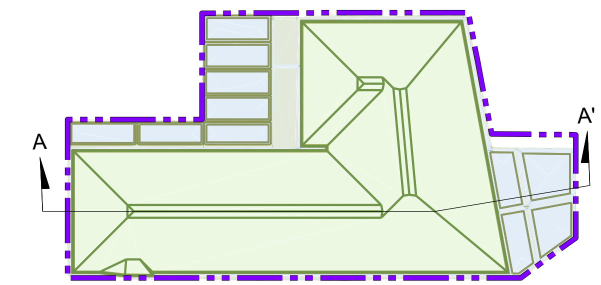
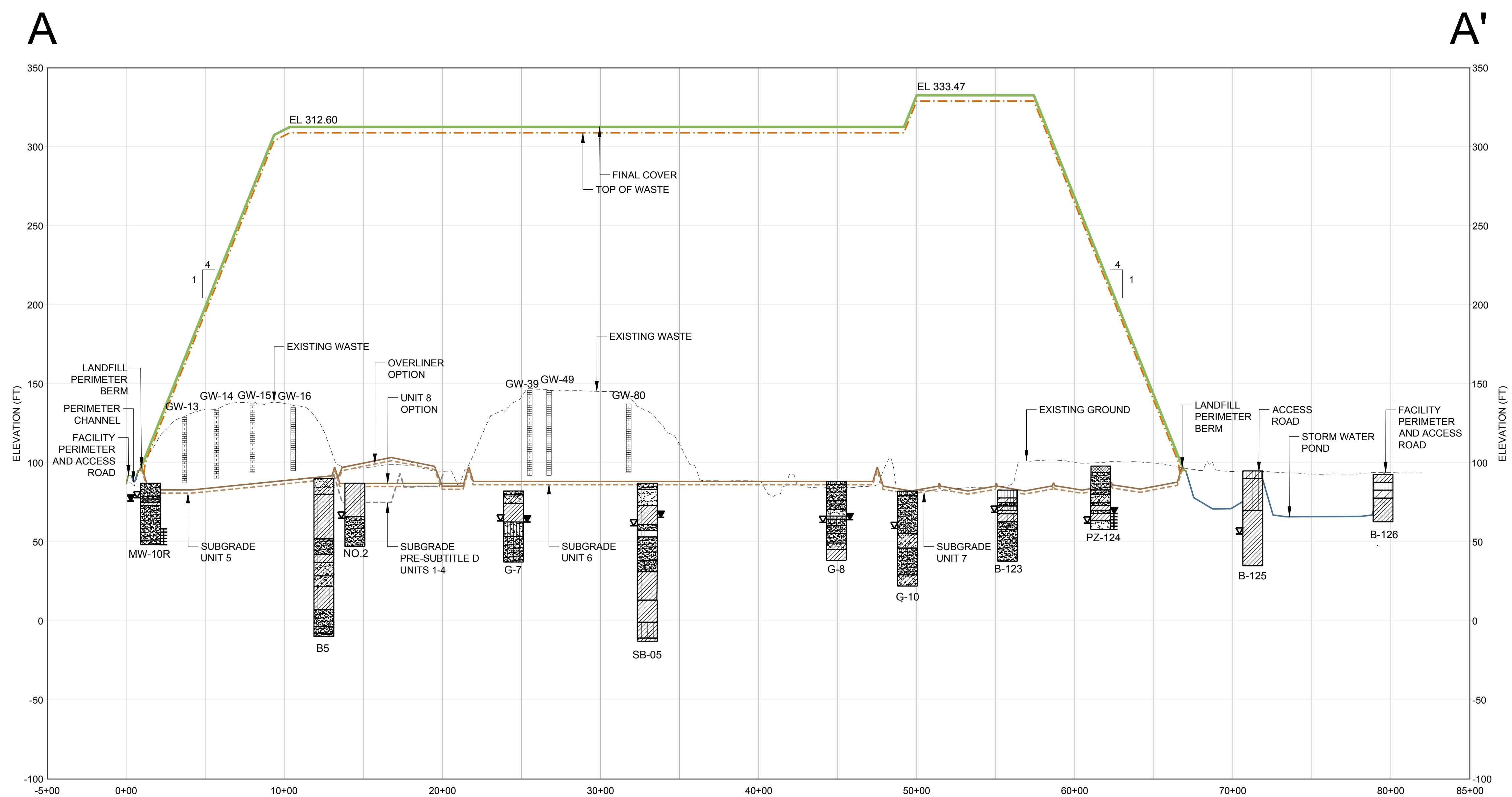
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
FILL CROSS-SECTIONS LOCATION MAP

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	5 of 19	III3-4A

KEY MAP





SCALE 1" = 800'
VERT. SCALE 1" = 80'

A
III3-4B

FILL CROSS-SECTION A

LEGEND

- FINAL COVER
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- EXISTING SUBGRADE
- STORM WATER POND AND DITCH

- SILT
- SAND
- CLAY
- SILTY SAND
- SILTY CLAY
- SANDY SILT
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL
- SANDY CLAY
- CLAYEY SAND
- CLAYEY SILT
- SANDY SILTY CLAY
- SILTY CLAYEY SAND

NOTE(S)

1. GAS WELL DATA BASED ON INFORMATION FROM DESIGN AND AS BUILT DRAWINGS.
2. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHTOGRAPHY DATED 07/24/2014.
3. THERE ARE NO INITIAL WATER LEVEL DTATA FOR THE BORINGS SHOWN ON THIS CROSS-SECTION. THE INITIAL WATER LEVEL IS THAT LEVEL AT THE TIME OF DRILLING AS REPORTED ON THE BORING LOG. THE STATIC WATER LEVEL IS THAT LEVEL SOMETIME AFTER DRILLING AS REPORTED ON THE BORING LOG.
4. THE SIDESLOPES SHOWN ARE NOMINAL; THE ACTUAL SIDESLOPES ON THESE CROSS-SECTIONS WILL VARY DUE TO THE ANGULAR PROJECTION OF THE SECTIONS.
5. GAS WELL LOCATIONS ARE SHOWN ON III6, LANDFILL GAS MANAGEMENT PLAN, FIGURE III6-3
6. MONITORING WELL LOCATIONS ARE SHOWN ON III3, FILL CROSS-SECTION LOCATION MAP, FIGURE III3-4A.
7. SECTION SHOWN FOR UNIT 8 OPTION IS THROUGH THE INTERCELL BERM.

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0 400 800
1" = 800' FEET

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0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	CEI	AA	MX	JBF

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
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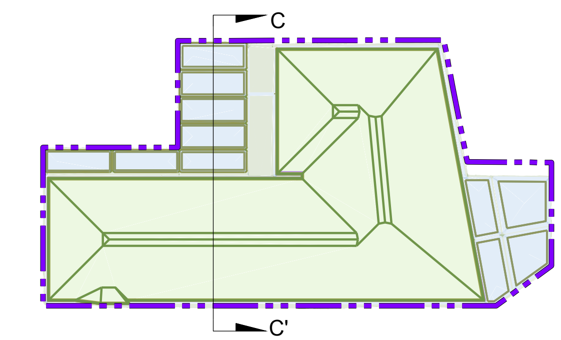
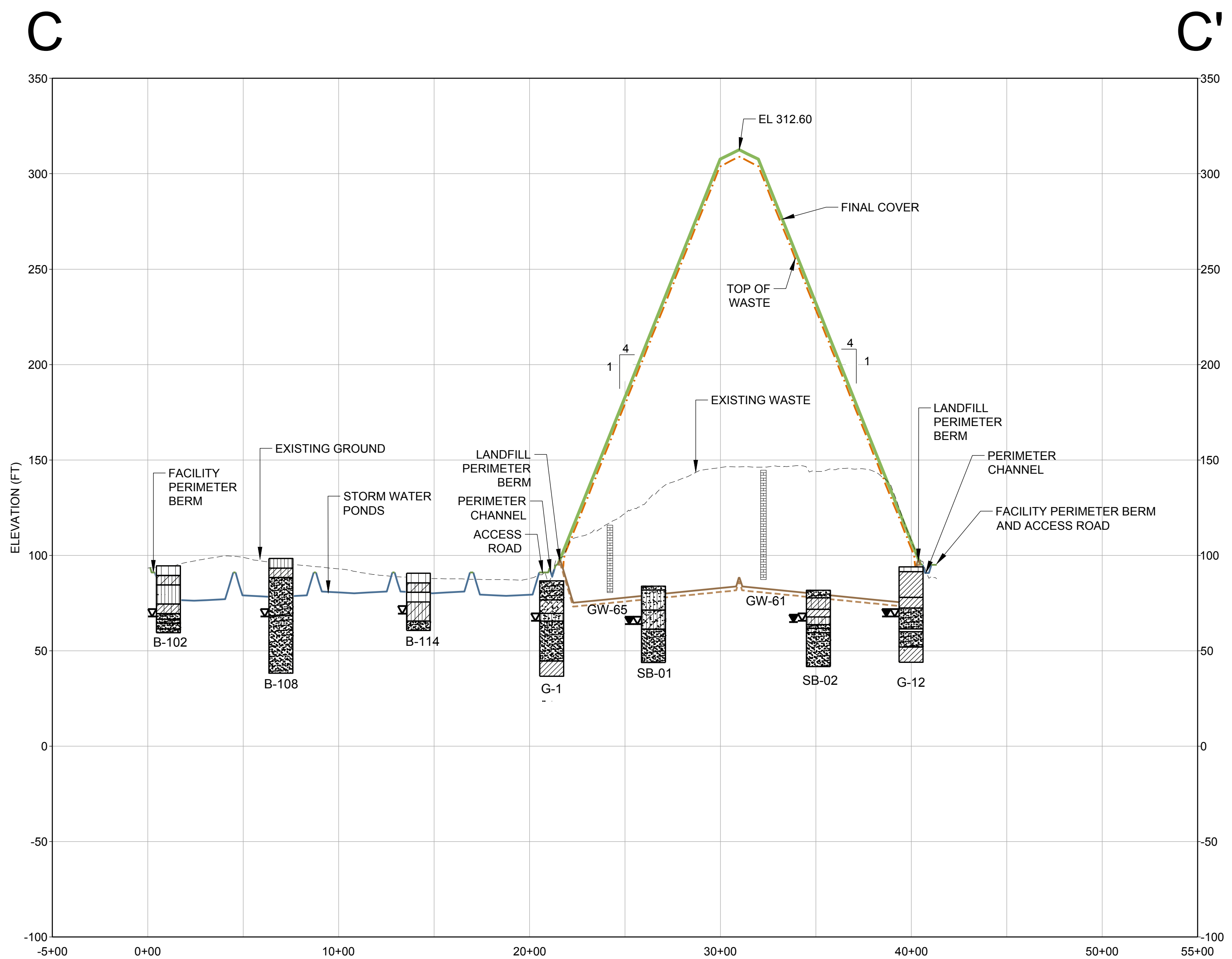
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
FILL CROSS-SECTION A

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	6 of 19	III3-4B

KEY MAP





SCALE 1" = 800'
VERT. SCALE 1" = 80'
C
III3-4D
FILL CROSS-SECTION C

LEGEND

- FINAL COVER
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- STORM WATER POND AND DITCH

- SILT
- SAND
- CLAY
- SILTY SAND
- SILTY CLAY
- SANDY SILT
- SANDY CLAY
- CLAYEY SAND
- CLAYEY SILT
- SANDY SILTY CLAY
- SILTY CLAYEY SAND
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL

NOTE(S)

1. GAS WELL DATA BASED ON INFORMATION FROM DESIGN AND AS BUILT DRAWINGS.
2. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHTOGRAPHY DATED 07/24/2014.
3. THERE ARE NO INITIAL WATER LEVEL DTATA FOR THE BORINGS SHOWN ON THIS CROSS-SECTION. THE INITIAL WATER LEVEL IS THAT LEVEL AT THE TIME OF DRILLING AS REPORTED ON THE BORING LOG. THE STATIC WATER LEVEL IS THAT LEVEL SOMETIME AFTER DRILLING AS REPORTED ON THE BORING LOG.
4. THE SIDESLOPES SHOWN ARE NOMINAL; THE ACTUAL SIDESLOPES ON THESE CROSS-SECTIONS WILL VARY DUE TO THE ANGULAR PROJECTION OF THE SECTIONS.
5. GAS WELL LOCATIONS ARE SHOWN ON III6, LANDFILL GAS MANAGEMENT PLAN, FIGURE III6-3
6. MONITORING WELL LOCATIONS ARE SHOWN ON III3, FILL CROSS-SECTION LOCATION, FIGURE III3-4A.

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0 400 800
1" = 800' FEET

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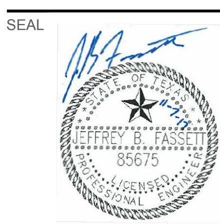
1	2017-11-07	RESPONSE TO TCEQ FIRST NOD	CEI	TNB	JBF	JBF
0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	CEI	AA	MX	JBF

SEAL



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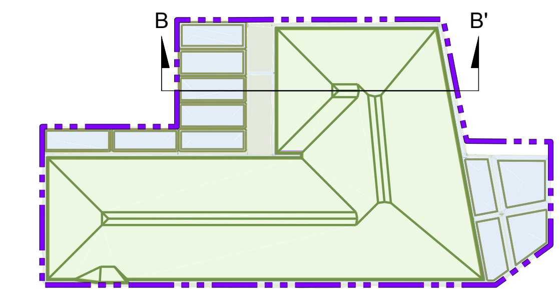
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

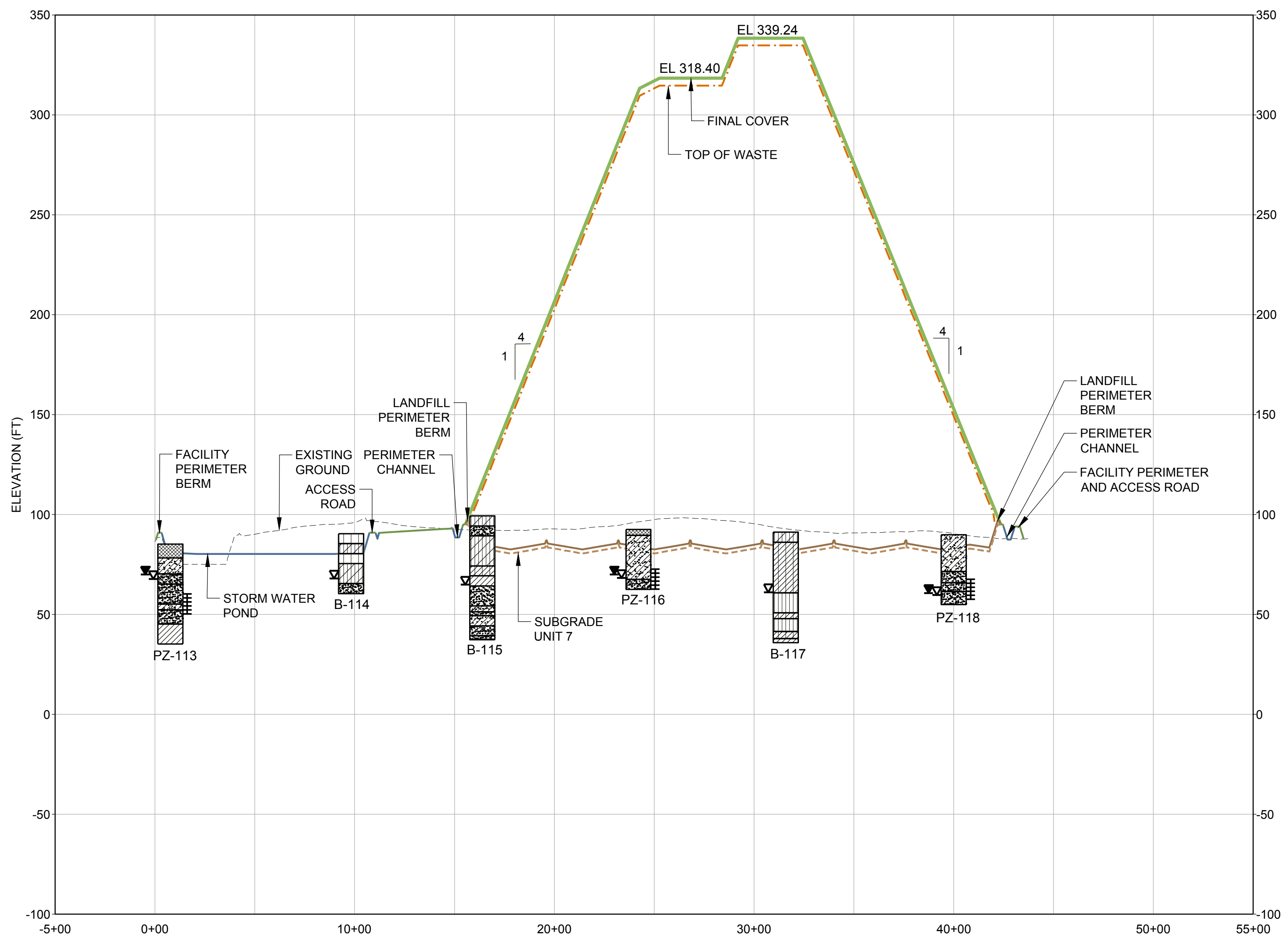
TITLE
FILL CROSS SECTION C

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	8 of 19	III3-4D

KEY MAP



B B'



SCALE 1" = 800' (B / III3-4C) FILL CROSS-SECTION B
VERT. SCALE 1" = 80'

LEGEND

- FINAL COVER
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- STORM WATER POND AND DITCH

SILT	SANDY CLAY
SAND	CLAYEY SAND
CLAY	CLAYEY SILT
SILTY SAND	SANDY SILTY CLAY
SILTY CLAY	SILTY CLAYEY SAND
SANDY SILT	

- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL

NOTE(S)

1. GAS WELL DATA BASED ON INFORMATION FROM DESIGN AND AS BUILT DRAWINGS.
2. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.
3. THERE ARE NO INITIAL WATER LEVEL DTATA FOR THE BORINGS SHOWN ON THIS CROSS-SECTION. THE INITIAL WATER LEVEL IS THAT LEVEL AT THE TIME OF DRILLING AS REPORTED ON THE BORING LOG. THE STATIC WATER LEVEL IS THAT LEVEL SOMETIME AFTER DRILLING AS REPORTED ON THE BORING LOG.
4. THE SIDESLOPES SHOWN ARE NOMINAL; THE ACTUAL SIDESLOPES ON THESE CROSS-SECTIONS WILL VARY DUE TO THE ANGULAR PROJECTION OF THE SECTIONS.
5. GAS WELL LOCATIONS ARE SHOWN ON III6, LANDFILL GAS MANAGEMENT PLAN, FIGURE III6-3
6. MONITORING WELL LOCATIONS ARE SHOWN ON III3, FILL CROSS-SECTION LOCATION MAP, FIGURE III3-4A.

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0 400 800
1" = 800' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOD	CEI	TNB	JBF	JBF
0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	CEI	AA	MX	JBF

SEAL
STATE OF TEXAS
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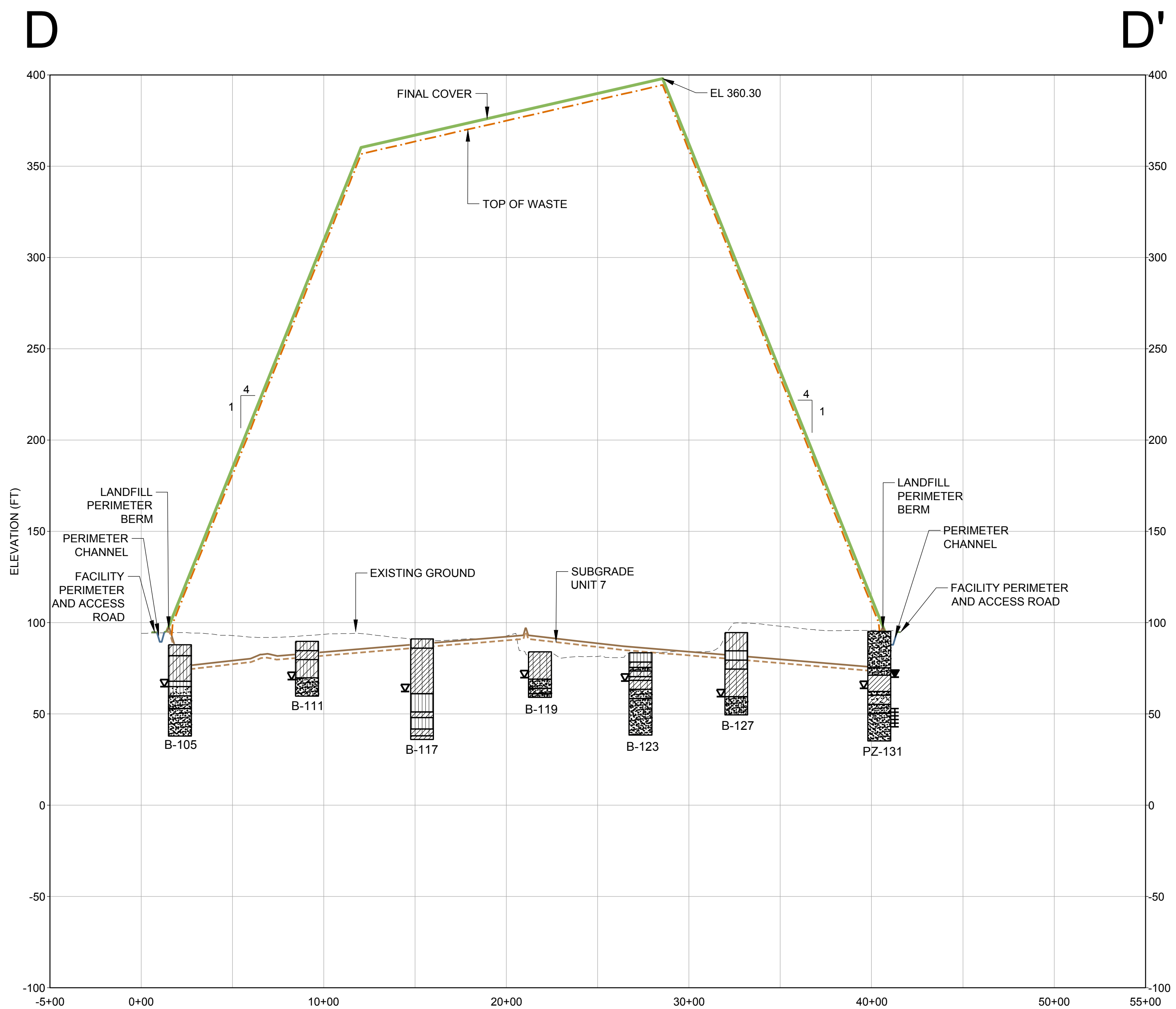
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

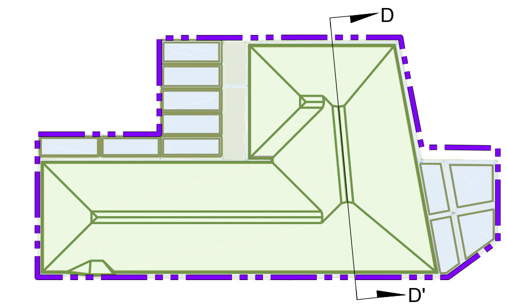
TITLE
FILL CROSS-SECTION B

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	7 of 19	III3-4C



SCALE 1" = 800' VERT. SCALE 1" = 80' D III3-4E FILL CROSS-SECTION D

KEY MAP



LEGEND

- FINAL COVER
- TOP OF WASTE
- EXISTING GRADE
- SUBGRADE
- STORM WATER POND AND DITCH

- SILT
- SAND
- CLAY
- SILTY SAND
- SILTY CLAY
- SANDY SILT
- SANDY CLAY
- CLAYEY SAND
- CLAYEY SILT
- SANDY SILTY CLAY
- SILTY CLAYEY SAND
- STATIC WATER LEVEL
- INITIAL WATER LEVEL
- SCREENED INTERVAL

NOTE(S)

1. GAS WELL DATA BASED ON INFORMATION FROM DESIGN AND AS BUILT DRAWINGS.
2. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHTOGRAPHY DATED 07/24/2014.
3. THERE ARE NO INITIAL WATER LEVEL DTATA FOR THE BORINGS SHOWN ON THIS CROSS-SECTION. THE INITIAL WATER LEVEL IS THAT LEVEL AT THE TIME OF DRILLING AS REPORTED ON THE BORING LOG. THE STATIC WATER LEVEL IS THAT LEVEL SOMETIME AFTER DRILLING AS REPORTED ON THE BORING LOG.
4. THE SIDESLOPES SHOWN ARE NOMINAL; THE ACTUAL SIDESLOPES ON THESE CROSS-SECTIONS WILL VARY DUE TO THE ANGULAR PROJECTION OF THE SECTIONS.
5. GAS WELL LOCATIONS ARE SHOWN ON III6, LANDFILL GAS MANAGEMENT PLAN, FIGURE III6-3
6. MONITORING WELL LOCATIONS ARE SHOWN ON III3, FILL CROSS-SECTION MAP, FIGURE III3-4A.

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
FILL CROSS-SECTION D

PROJECT NO.	APPLICATION SECTION	REV.	9 of 19	FIGURE
1401491	III3	1		III3-4E

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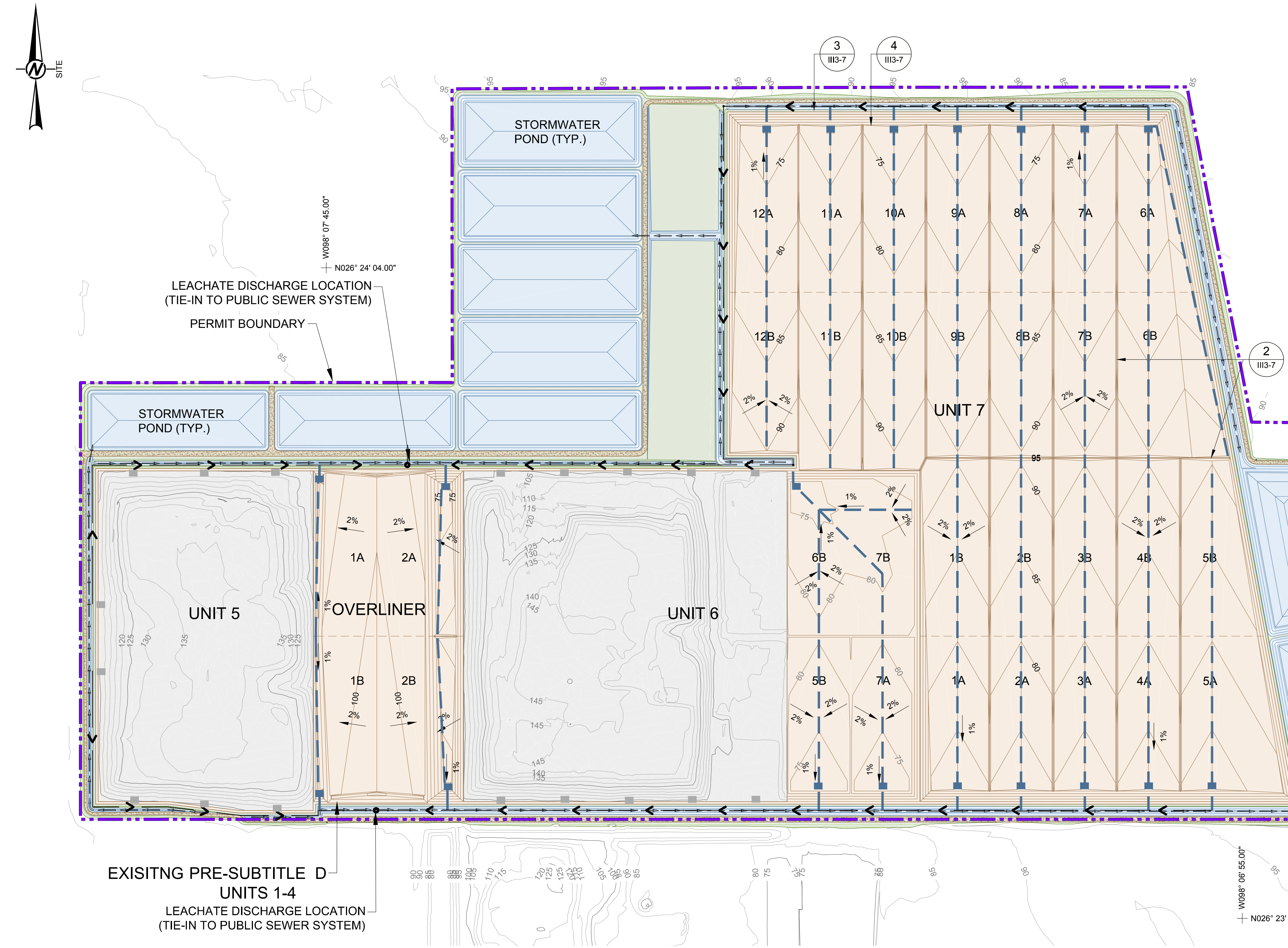

LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- DIKE 25 ft CONTOUR
- DIKE 5 ft CONTOUR
- STORM WATER POND 25 ft CONTOUR
- STORM WATER POND 5 ft CONTOUR
- ROADS
- LEACHATE COLLECTION PIPES
- LEACHATE COLLECTION FORCEMAIN AND FLOW DIRECTION
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- LEACHATE DISCHARGE TIE-IN TO PUBLIC SEWER SYSTEM
- FUTURE TOP OF UPSLOPE RISER PIPE
- EXISTING TOP OF UPSLOPE RISER PIPE

NOTE(S)

1. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.
2. OVERLINER OPTION SHOWN FOR PRE-SUBTITLE D UNITS 1-4.
3. THE LEACHATE FORCEMAIN WILL BE EXTENDED INCREMENTALLY AS FUTURE CELLS ARE CONSTRUCTED
4. THE LOCATIONS OF THE LEACHATE FORCEMAINS SHOWN ARE APPROXIMATE. THE ACTUAL LOCATIONS WILL BE DETERMINED BASED ON FIELD CONDITIONS

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
LEACHATE COLLECTION SYSTEM DISCHARGE PLAN
OVERLINER OPTION

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	10 of 19	III3-5A

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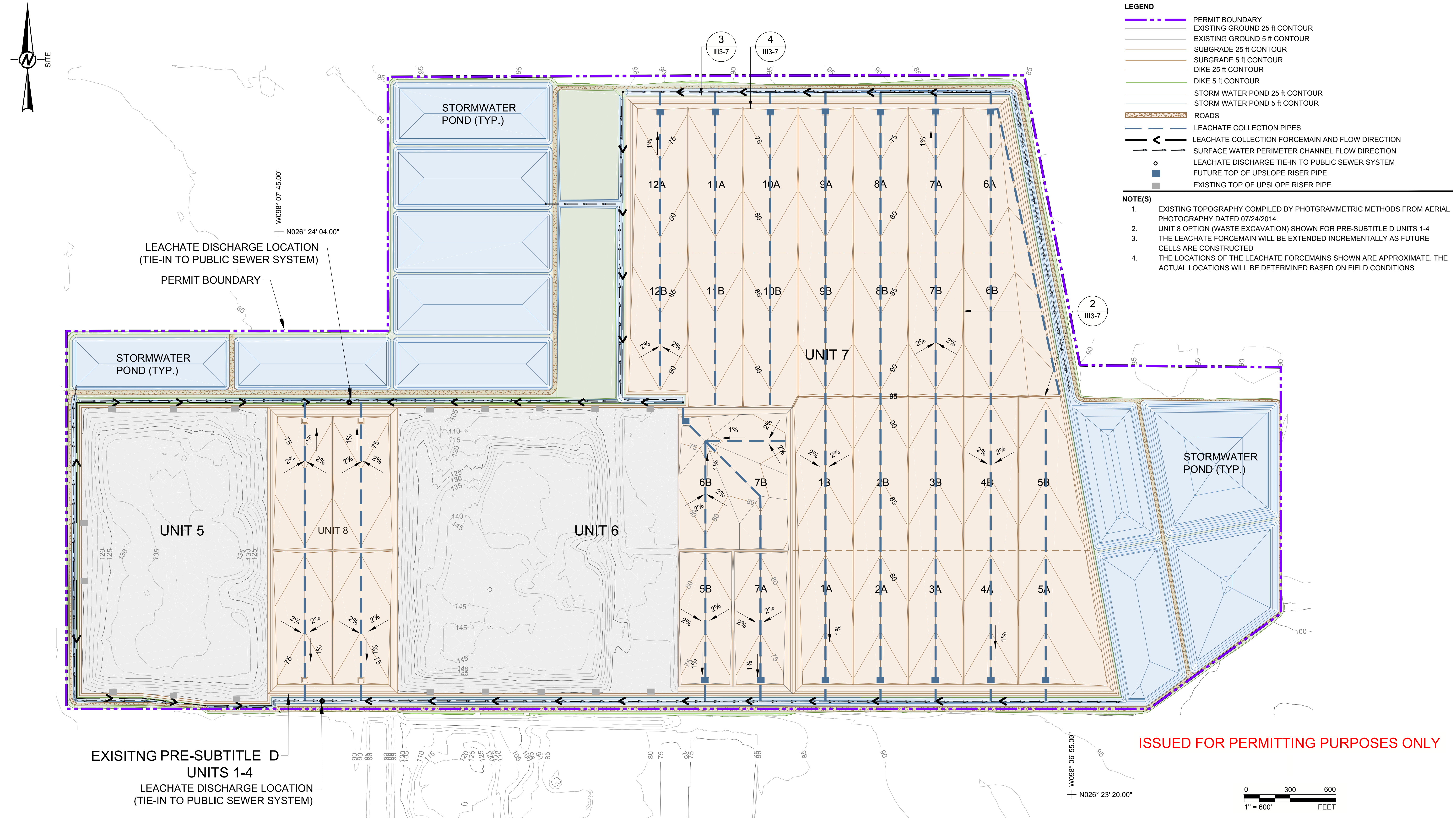

LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- DIKE 25 ft CONTOUR
- DIKE 5 ft CONTOUR
- STORM WATER POND 25 ft CONTOUR
- STORM WATER POND 5 ft CONTOUR
- ROADS
- LEACHATE COLLECTION PIPES
- LEACHATE COLLECTION FORCEMAIN AND FLOW DIRECTION
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- LEACHATE DISCHARGE TIE-IN TO PUBLIC SEWER SYSTEM
- FUTURE TOP OF UPSLOPE RISER PIPE
- EXISTING TOP OF UPSLOPE RISER PIPE

NOTE(S)

1. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.
2. UNIT 8 OPTION (WASTE EXCAVATION) SHOWN FOR PRE-SUBTITLE D UNITS 1-4
3. THE LEACHATE FORCEMAIN WILL BE EXTENDED INCREMENTALLY AS FUTURE CELLS ARE CONSTRUCTED
4. THE LOCATIONS OF THE LEACHATE FORCEMAINS SHOWN ARE APPROXIMATE. THE ACTUAL LOCATIONS WILL BE DETERMINED BASED ON FIELD CONDITIONS

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
LEACHATE COLLECTION SYSTEM DISCHARGE PLAN
UNIT 8 OPTION

PROJECT NO.	APPLICATION SECTION	REV.	11 of 19	FIGURE
1401491	III3	1		III3-5B

LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- DIKE 25 ft CONTOUR
- DIKE 5 ft CONTOUR
- STORM WATER POND 25 ft CONTOUR
- STORM WATER POND 5 ft CONTOUR
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- ROADS
- TOE DRAIN UNDERDRAIN (SEE FIGURE III3F-5 FOR DETAILS)
- DEWATERING SUMP
- 1A CELL DESIGNATION

NOTE(S)

1. OVERLINER OPTION SHOWN FOR PRE-SUBTITLE D UNITS 1-4
2. SUBGRADE ELEVATIONS SHOWN
3. TOP OF THE LINER ELEVATIONS IN THE BOTTOM OF THE LEACHATE COLLECTION SUMPS ARE 2 ft LOWER THAN ELEVATION OF THE LOW POINT ON THE LINER.
4. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
UNDERDRAIN SYSTEM LAYOUT
OVERLINER OPTION

PROJECT NO.	APPLICATION SECTION	REV.	12 of 19	FIGURE
1401491	III3	1		III3-6A

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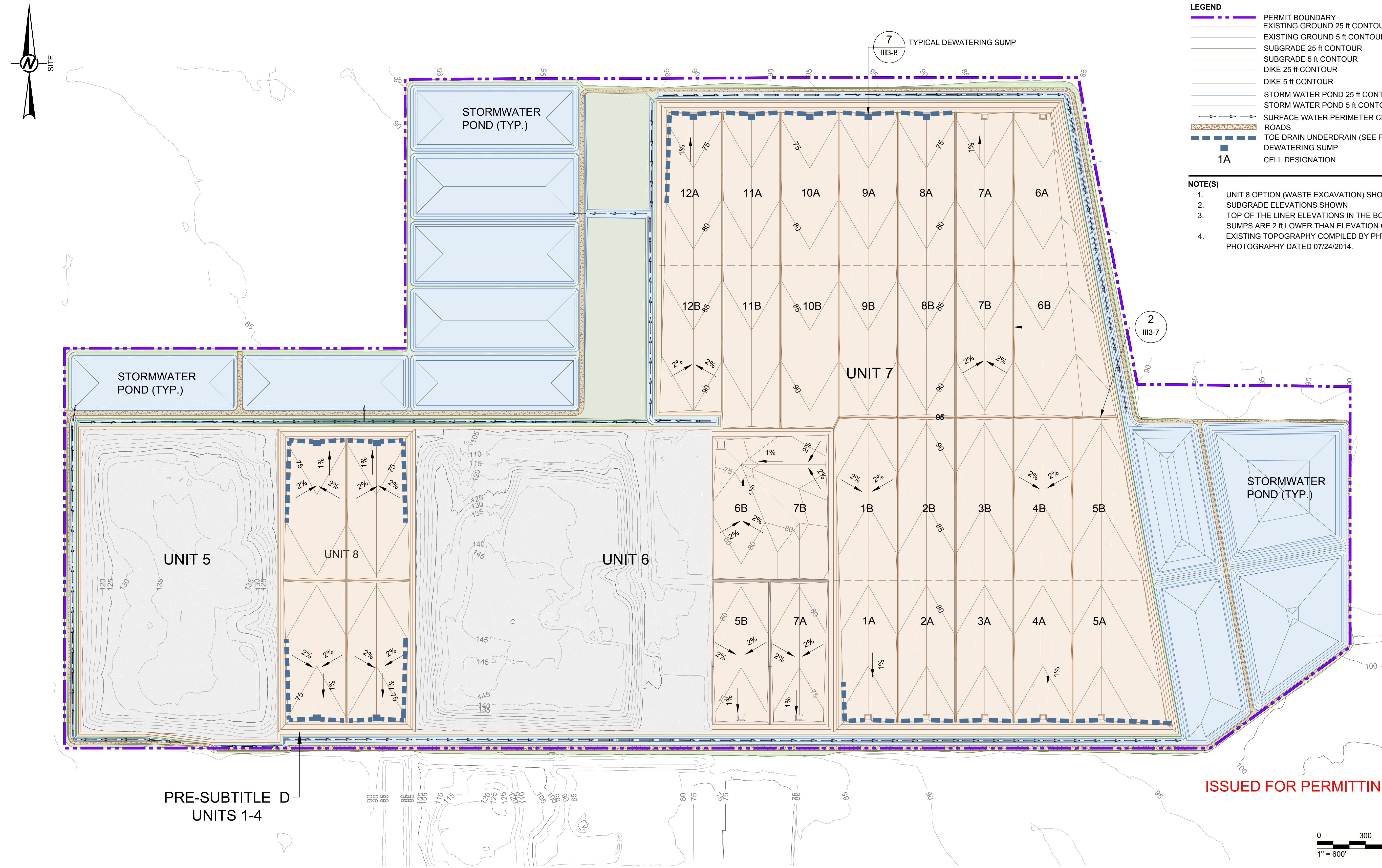

LEGEND

- PERMIT BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- DIKE 25 ft CONTOUR
- DIKE 5 ft CONTOUR
- STORM WATER POND 25 ft CONTOUR
- STORM WATER POND 5 ft CONTOUR
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION
- ROADS
- TOE DRAIN UNDERDRAIN (SEE FIGURE III3F-5 FOR DETAILS)
- DEWATERING SUMP
- 1A CELL DESIGNATION

NOTE(S)

1. UNIT 8 OPTION (WASTE EXCAVATION) SHOWN FOR PRE-SUBTITLE D UNITS 1-4
2. SUBGRADE ELEVATIONS SHOWN
3. TOP OF THE LINER ELEVATIONS IN THE BOTTOM OF THE LEACHATE COLLECTION SUMPS ARE 2 ft LOWER THAN ELEVATION OF THE LOW POINT ON THE LINER.
4. EXISTING TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 07/24/2014.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2017-11-07	RESPONSE TO TCEQ FIRST NOD	CEI	TNB	MX	JBF
0	2017-07-21	PERMIT AMENDMENT APPLICATION SUBMITTAL	AA	AA	MX	JBF

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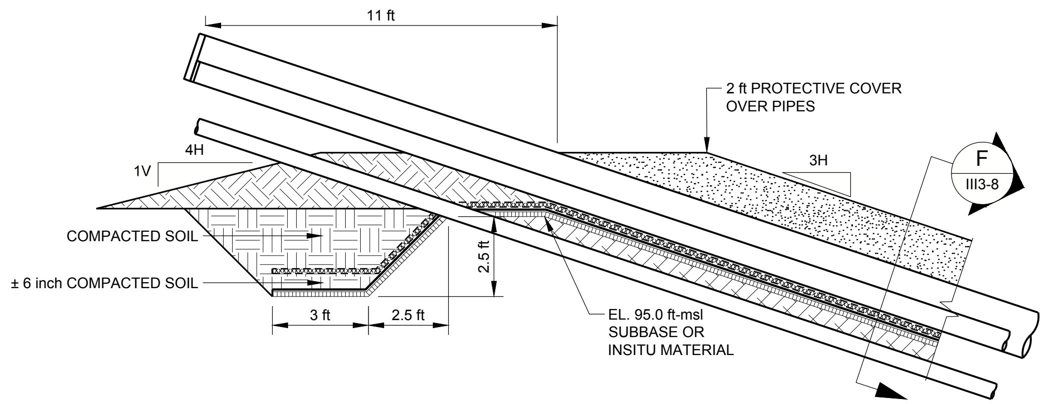
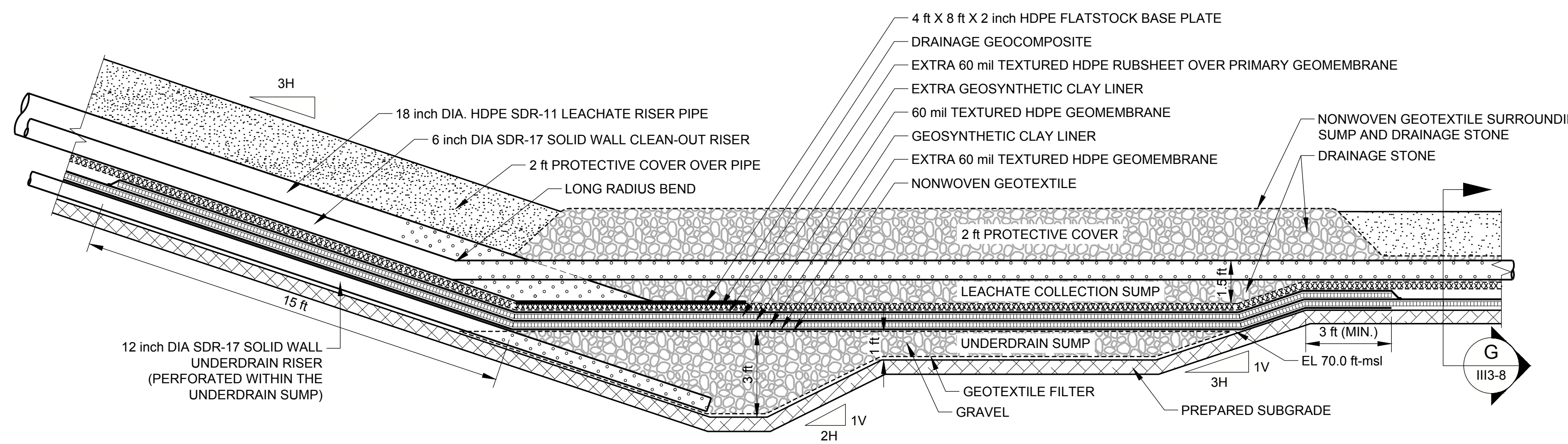
PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

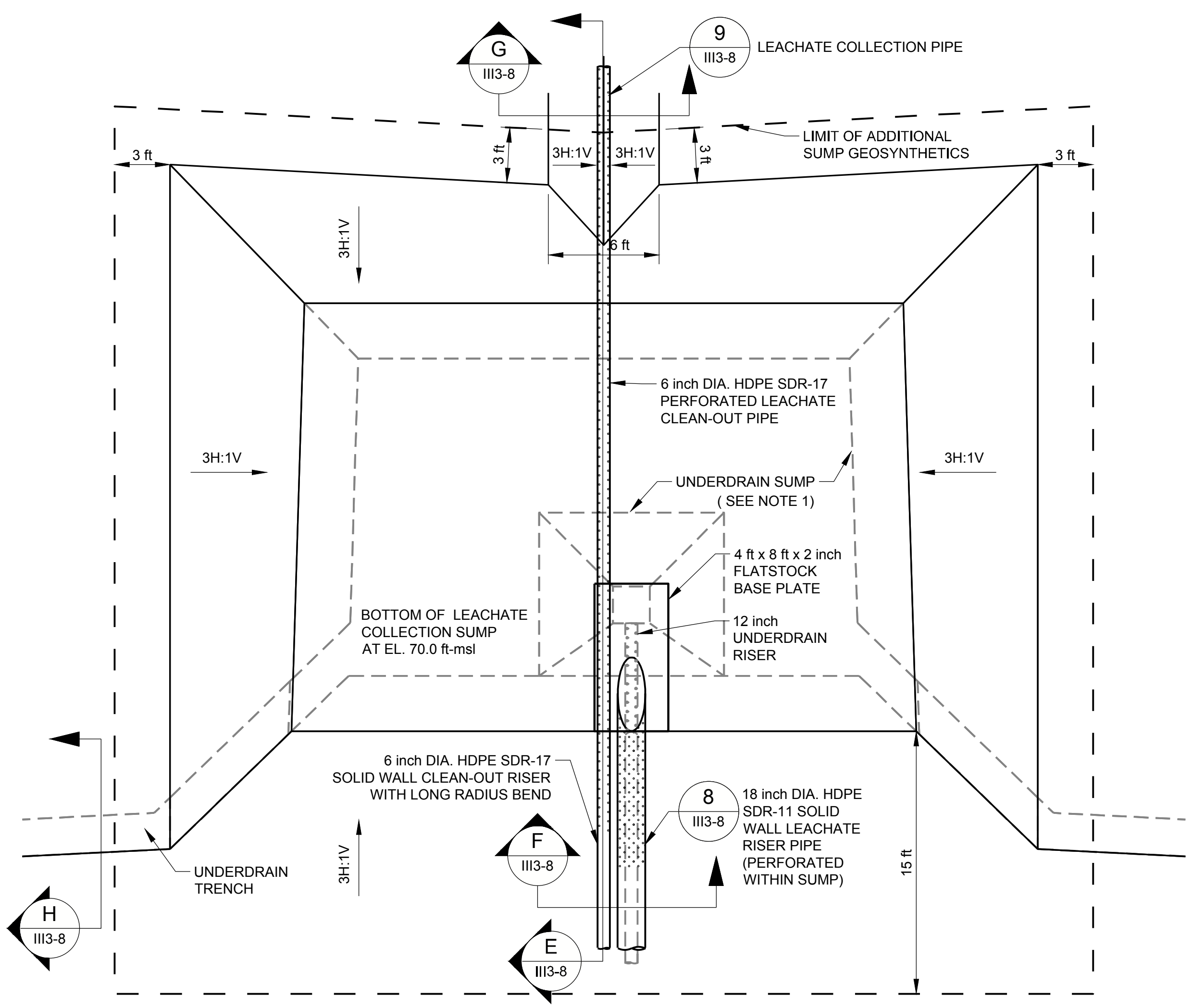
TITLE
UNDERDRAIN SYSTEM LAYOUT
UNIT 8 OPTION

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	13 of 19	III3-6B

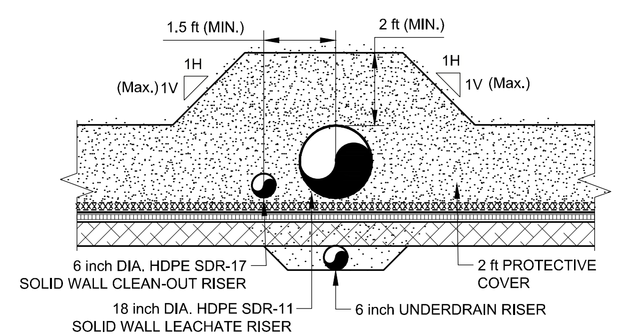




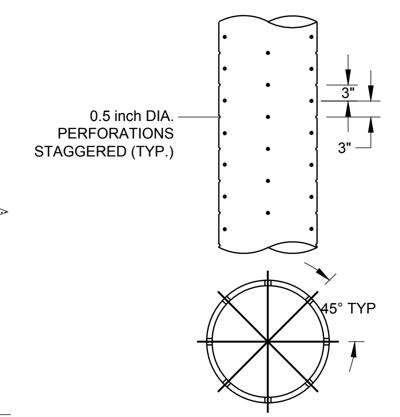
SCALE 1" = 6' E III3-8 LEACHATE COLLECTION AND UNDERDRAIN SUMPS



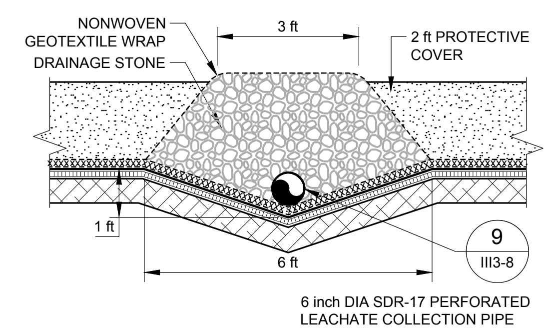
SCALE 1" = 10' 7 III3-8 LEACHATE COLLECTION AND DEWATERING SUMPS



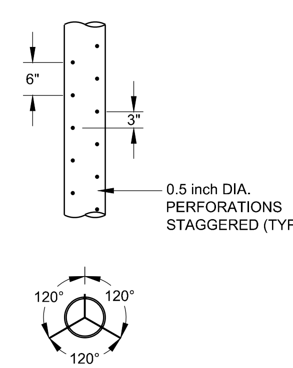
SCALE 1" = 4' F III3-8 SIDESLOPE RISER PIPES



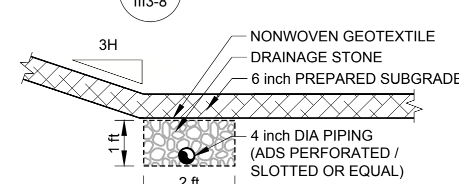
SCALE 1" = 3' 8 III3-8 LEACHATE COLLECTION SUMP RISER PIPE PERFORATION



SCALE 1" = 4' G III3-8 LEACHATE COLLECTION TRENCH



SCALE 1" = 3' 9 III3-8 LEACHATE COLLECTION PIPE PERFORATION



SCALE 1" = 4' H III3-8 DEWATERING TRENCH

NOTE(S)

1. DEWATERING SUMP EXISTS ONLY IN CELLS WITH DEWATERING TOE DRAIN.

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0 2 4 — 1" = 4' FEET

0 2 4 — 1" = 4' FEET

0 3 6 — 1" = 6' FEET

0 0.5 10 — 1" = 10' FEET

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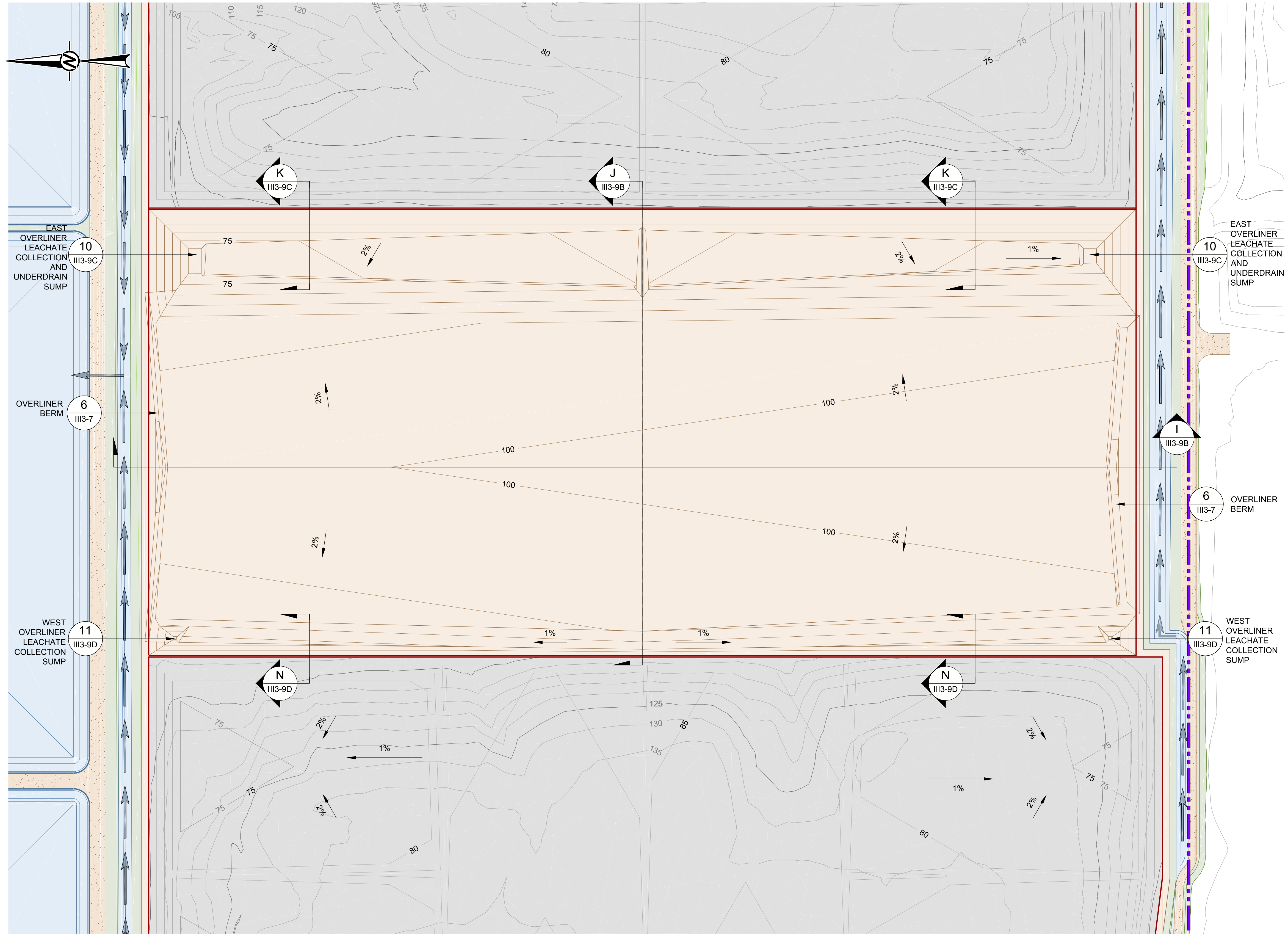
PROJECT

EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE

LEACHATE COLLECTION AND REMOVAL SYSTEM AND UNDERDRAIN DETAILS

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	15 of 19	III3-8



LEGEND

- PERIMETER BOUNDARY
- EXISTING GROUND 25 ft CONTOUR
- EXISTING GROUND 5 ft CONTOUR
- SUBGRADE 25 ft CONTOUR
- SUBGRADE 5 ft CONTOUR
- ROADS
- SURFACE WATER PERIMETER CHANNEL FLOW DIRECTION

NOTE(S)

1. OVERLINER OPTION SHOWN FOR PRE-SUBTITLE D UNITS 1-4.
2. SUBGRADE ELEVATIONS SHOWN.
3. THE ELEVATION OF DEEPEST EXCAVATION (EDE) FOR OVERLINER EAST AT THE BOTTOM OF SUMP IS 70 ft-msl AND THE (EDE) OVERLINER WEST AT THE BOTTOM OF SUMP IS 79.50 ft-msl.

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0 100 200
1" = 200' FEET

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PROJECT
EDINBURG REGIONAL DISPOSAL FACILITY
PERMIT AMENDMENT APPLICATION TCEQ PERMIT MSW-956C
EDINBURG, HIDALGO COUNTY, TEXAS

TITLE
OVERLINER SUBGRADE LAYOUT PLAN

PROJECT NO.	APPLICATION SECTION	REV.		FIGURE
1401491	III3	1	16 of 19	III3-9A

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APPENDIX III3A-1

VOLUME CALCULATIONS

VOLUME CALCULATIONS

Made by: JCW
Checked by: CEI
Reviewed by: JBF

1.0 SUMMARY

The table below summarizes total disposal capacity (i.e. airspace) for each cover option for the landfill expansion.

Total Airspace (CY)		**Construction Options**	
		Overliner	*Unit 8*
Final Cover Options	*Standard*	84,997,400	84,831,321
	Alternative	85,981,680	85,815,599
	Closure Turf	87,301,156	87,135,076

GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

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2.0 OBJECTIVE

To determine the airpsace gained from the expansion of Edinburg Regional Disposal Facilty for two options for the Pre-Subtitle D Units 1 through 4: construction of an overliner above existing Units 1 - 4, and relocation of existing Pre-Subtitle D waste and construction of Unit 8. In addition, three final cover options outlined in Part III7, Closure Plan are considered in the volume calculation.

3.0 GIVEN

Approved TCEQ Permit MSW-956B final cover grades and composite lining system grades, expansion design top of waste grades and top of composite lining system grades, and total airspace for approved TCEQ Permits MSW-956A and MSW-956B.

4.0 METHOD

Use AutoCAD Civil 3D, a civil engineering software, to compare the expansion top of waste grades to the top of permitted waste grades combined with expansion top of composite lining system grades.

5.0 CALCULATIONS

5.1 Previously Approved Airspace Capacities

Permit	Capacity (CY)	Description
956A	1,027,858	Pre-Subtitle D Units 1-4
956B	16,734,913	Addition of Units 5 and 6

5.2 Expansion Airspace Gained

To determine the expansion volume gained, two surface models are compared: bottom of waste surface developed by combining top of approved TCEQ Permit MSW-956B waste surfaces with expansion top of protective cover surface, and expansion top of waste surfaces.

5.2.1 Construction of Overliner option

Comparison of developed bottom of waste surface (combination of expansion protective cover grades including Overliner with TCEQ Permit MSW-956B waste grades) to expansion top of waste grades (developed from expansion final cover grades and thicknesses of the final cover options).

Final Cover	**Thickness (ft)**	**Capacity (CY)**
Standard	3.5	68,262,487
Alternative	2	69,246,767
Closure Turf	0	70,566,243

5.2.2 Relocation of Pre-Subtitle D waste and construction of Unit 8 option

Comparison of developed bottom of waste surface (combination of expansion protective cover grades including Unit 8 with TCEQ Permit MSW-956B waste grades) to expansion top of waste grades (developed from expansion final cover grades and thicknesses of the final cover options). Please note that airspace gained will be reduced by volume of relocated Pre-Subtile D waste.

Final Cover	**Thickness (ft)**	**Volume (CY)**	**Capacity (CY)**
Standard	3.5	69,124,266	68,096,408
Alternative	2	70,108,544	69,080,686
Closure Turf	0	71,428,021	70,400,163

6.0 CONCLUSION

The total airspace capacity is the sum of TCEQ Permit MSW-956B and expansion airspace gained.

Total Airspace (CY)		**Construction Options**	
		Overliner	*Unit 8*
Final Cover Options	*Standard*	84,997,400	84,831,321
	Alternative	85,981,680	85,815,599
	Closure Turf	87,301,156	87,135,076

APPENDIX III3A-2

SITE LIFE CALCULATIONS

SITE LIFE CALCULATIONS

Made by: CEI
Checked by: MX
Reviewed by: JBF

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1.0 SUMMARY

The site life is: 63.5 yrs or until Feb 2080

2.0 OBJECTIVE

To determine the anticipated site life based on airspace volume calculations, current disposal capacity (i.e. airspace) consumed, estimated waste receipts, and projected growth rates.

3.0 GIVEN

FY 2015 Annual Report MSW-956B	**Date 8/31/2016**
Current annual waste receipt	494,319 tons
Compacted waste density	1215 lbs/CY
Total Airspace	16,734,913 CY
Remaining Capacity	5,738,691 CY
Airspace Consumed	10,996,222 CY

Total Airspace		**Construction Options**	
		Overliner	*Unit 8*
Final Cover Options	*Prescriptive*	84,997,400	84,831,321
	Alternate	85,981,680	85,815,599
	Closure Turf	87,301,156	87,135,076

4.0 ASSUMPTIONS

Growth Rate	1.75%
Compacted in-place waste density	1,500 lbs/CY

5.0 CALCULATIONS

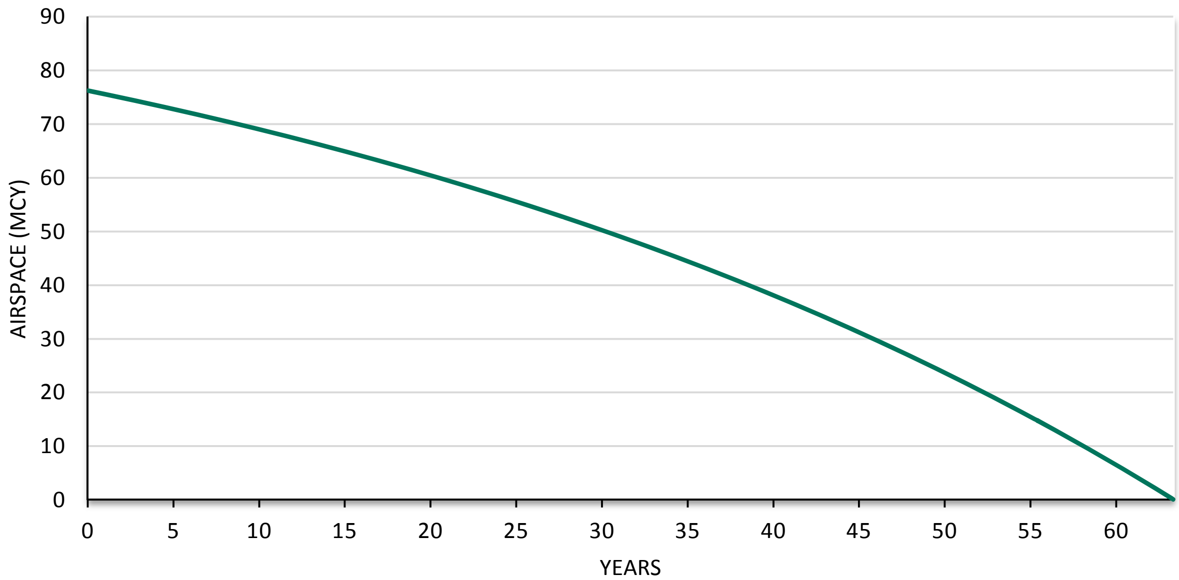
The site life, number of years to consume total airspace, can be determined by solving the following equation:

$$A_T = \sum_n A_C (1+R)^n$$

where

A_T =	Total remaining airspace	A_T =	76,304,934 CY
A_C =	Initial annual airspace consumed	A_C =	659,092 CY/yr
R =	Growth Rate	R =	1.0175
n =	Site life in years	n =	**63.5** years

SITE LIFE


90
80
70
60
50
40
30
20
10
0
AIRSPACE (MCY)
0
5
10
15
20
25
30
35
40
45
50
55
60
YEARS

APPENDIX III3B-2E-1

FINAL COVER SYSTEM STABILITY

FINAL COVER SYSTEM STABILITY CALCULATION

Made by: JCW
Checked by: CEI
Reviewed by: JBF

1.0 OBJECTIVE

Evaluate the stability of the final cover liner system.

2.0 GIVEN

The maximum head over the geomembrane is less than the thickness of the geocomposite drainage layer as demonstrated in Appendix III3B-2E-2, Final Cover Drainage Layer Capacity.

Final cover slopes are 4H:1V with a maximum length of 1200 ft.

The failure mechanism will be sliding along one of the liner interfaces. The final cover system consists of (from top to bottom):

24-inch Soil Cover consisting of on-site soils
Double-sided Geocomposite Drainage Layer
40-mil LLDPE textured Geomembrane
Geosynthetic Clay Liner (GCL)

OR

18-inch Soil Cover consisting of on-site soils
Double-sided Geocomposite Drainage Layer
40-mil LLDPE textured Geomembrane
18-inch Clay Liner

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Based on a review of available data at low normal stresses, the following parameters were assigned to the materials.

Table III3B-2E-1: Final Cover Component Interface Unit Weight and Strength Parameters

Soil	Unit Weight (pcf)		Strength Parameters		Reference
	Moist	Saturated	ϕ degrees	c (psf)	
Soil Cover	115	132	28	0	Estimate
Soil Cover / Geocomposite	–	–	28	0	Golder*
Geocomposite/Textured Geomembrane**	–	–	21	0	Golder*
Textured Geomembrane/GCL	–	–	24	0	Golder*
GCL/Clay Liner	–	–	35	0	Golder*

* Based on unpublished data from tests performed in Golder's laboratory, on similar geosynthetic materials. Strength parameters were conservatively assigned to be equal to or a percentage of the peak strength (lower bound) to account for testing material variability (see pages 3 and 4).

**The data indicates a lower-bound angle of 24°, but since the final cover pertains to a long-term condition a conservative angle of 21° is assumed for the calculation.

Based on the shear strength parameters, the critical interface occurs along the geocomposite/ textured geomembrane interface; this interface was assigned a conservative friction angle of 21 degrees.

4.0 METHOD

Create a model representing the sideslope situation and use it in conjunction with limit equilibrium concepts to determine the minimum factor of safety against a sliding block failure along the critical interface.

Infinite Slope Analysis

$$FS = \frac{c + (\gamma b \cos\beta - \gamma_w d \cos\beta)\tan\phi}{\gamma b \sin\beta}$$

Sliding at Geocomposite-Textured Geomembrane Interface

ϕ =	21	interface friction angle
β =	14.0	slope angle (degrees)
c =	0	adhesion (psf)
γ =	115	unit weight of soil (pcf)
b =	2.0	thickness (ft)
d =	0	water depth in cover (ft)
γ_w =	62.4	unit weight of water (pcf)
FS =	**1.54**	

Based on the Corps of Engineers "Design and Constuction of Levees" manual (EM 1110-2-1913) and the "EPA Guilde to Technical Resources for the Design of Land Disposal Facilities", the recommended factor of safety is 1.5 for the veneer slope stabiltiy of the final cover.

5.0 RESULTS

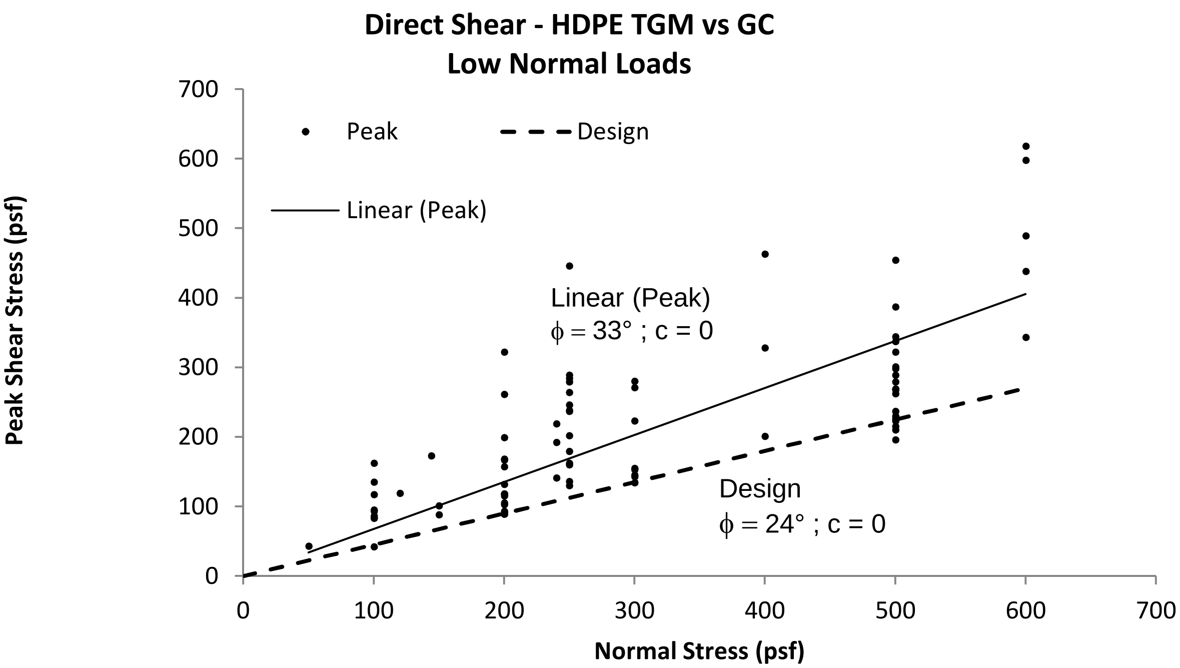
Using the Golder Associates interface friction angle database as a guide, the most critical internal friction angle of the final cover liner system was conservatively assumed to be 21 degrees. The resulting minimum factor of safety was calculated to be 1.54

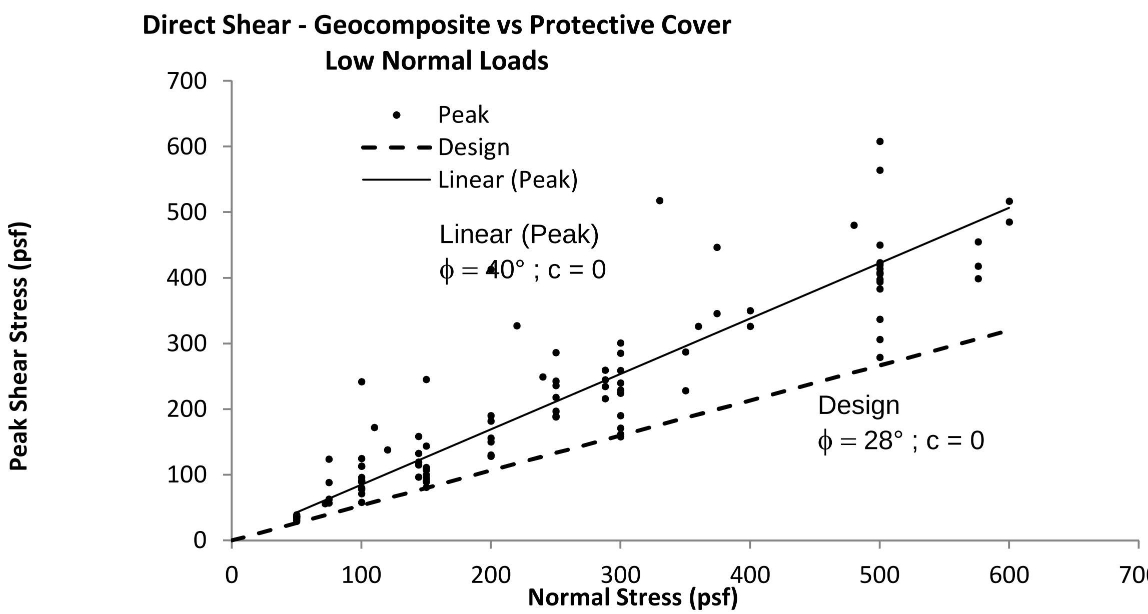
6.0 CONCLUSION

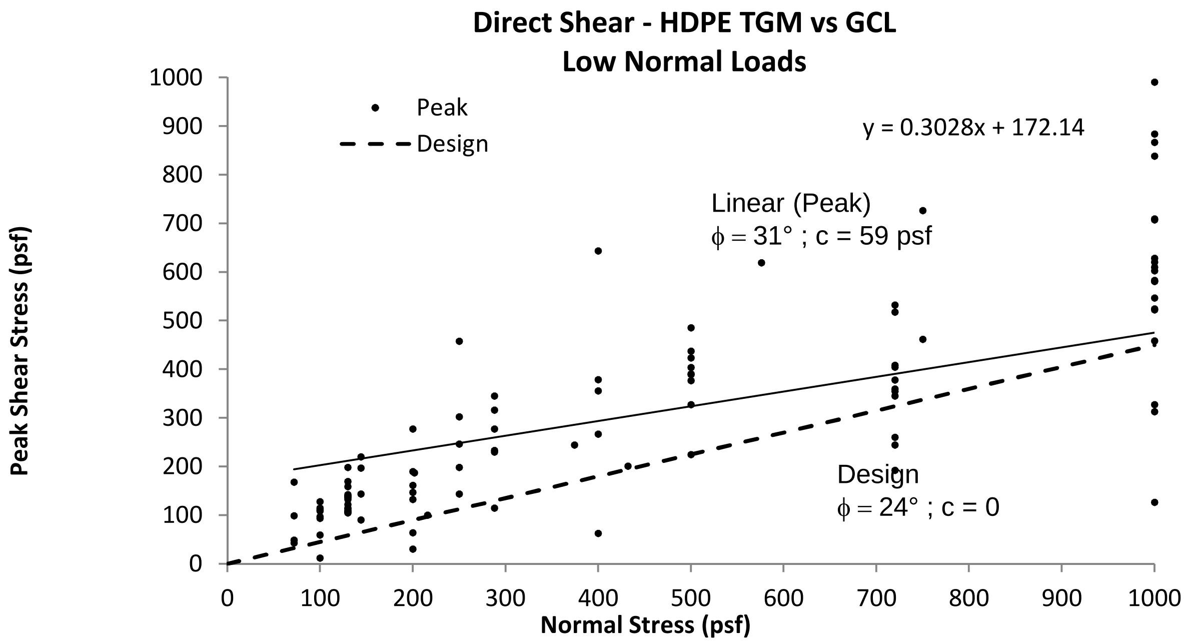
The slope stability analysis indicates that the final cover slope is stable.

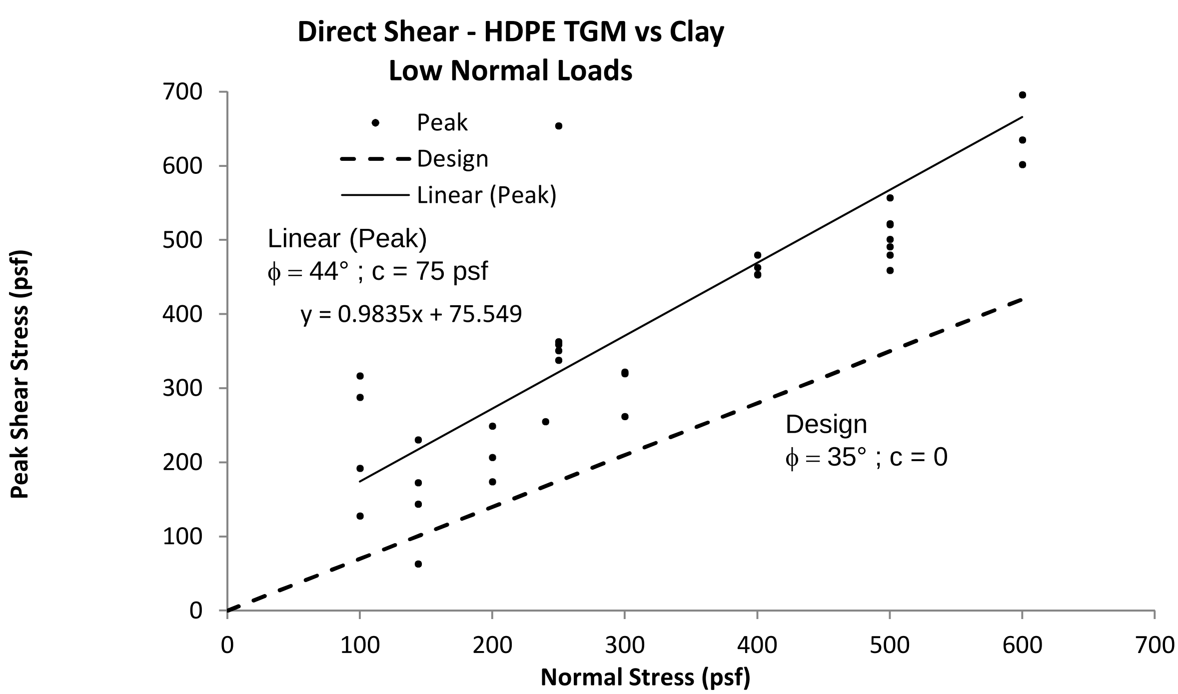
7.0 REFERENCES

Shear-Normal plots from unpublished data from tests performed in Golder's laboratory.






Direct Shear - HDPE TGM vs GCL
Low Normal Loads
Peak
Design
y = 0.3028x + 172.14
Linear (Peak)
ϕ = 31° ; c = 59 psf
Design
ϕ = 24° ; c = 0
Peak Shear Stress (psf)
Normal Stress (psf)
0
100
200
300
400
500
600
700
800
900
1000


Direct Shear - HDPE TGM vs Clay
Low Normal Loads
Peak
Design
Linear (Peak)
Linear (Peak)
ϕ = 44° ; c = 75 psf
y = 0.9835x + 75.549
Design
ϕ = 35° ; c = 0
Peak Shear Stress (psf)
Normal Stress (psf)
0
100
200
300
400
500
600
700

APPENDIX III3D-4

LEACHATE COLLECTION SUMP CAPACITY

LEACHATE COLLECTION SUMP CAPACITY

Made by: CEI
Checked by: MX
Reviewed by: JBF

1.0 OBJECTIVE

Calculate the volume and capacity of a typical leachate collection sump and, with this quantity, estimate the sump cycle time.

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2.0 GIVEN

The typical dimensions for the lateral expansion sumps are provided below. Because sumps for the overliner option are larger in size, their capacities are not evaluated for the purpose of this calculation.

Sump base dimensions:	30	ft long
	24	ft wide
	2	ft deep
Sideslopes in sump:	3	:1 (horizontal:vertical)
Sump gravel porosity:	0.3	

Typically, the transducer and control panel is set to shut down the pump with 1 foot of leachate left in the sump to keep the pump from overheating. Likewise, to maintain less than 30 cm of leachate above the liner system, the transducer and control panel is set to turn on at 0 ft to a maximum of 1 ft above liner. To be conservative the for the sump cycle calculations, 0 ft above liner is used.

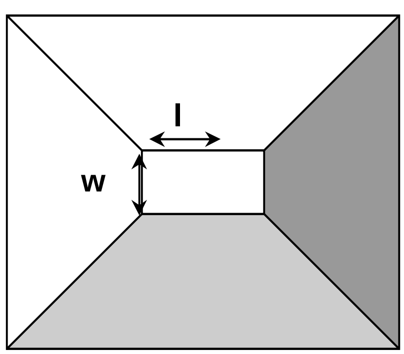
Tranducer Start/Stop Elevations from bottom of sump:	2	ft (start level)
	1	ft (stop level)

3.0 CALCULATIONS

3.1 Total Sump Volume & Sump Capacity

$V = 1/3\ (A_1+A_2+(A1A2)^{1/2})\ D$ where

A_1 = area at base of sump
A_2 = area at top of sump
D = depth of sump



Plan View

Profile View

Sump Capacity=Gravel Porosity * Total Sump Volume

Assuming leachate remains at the base of the sump at the set tranducer elevation, the remaining void volume in the sump is:

Base Area	Top Area	Depth	Total Vol.	Sump Capacity	
(ft^2)	(ft^2)	(ft)	(ft^3)	(ft^3)	gallons
1,080	1,512	1	1,290	387	2,895

3.2 Time to Fill Sump, Worst-case Conditions

The time it takes to fill the sump when leachate remains at the sump base and worst-case conditions exist is:

q_{max}	$Area_{max}$	Maximum flow into sump			Time to fill sump		
ft^3/acre/day	acre	ft^3/day	gal/day	gal/min	day	hr	min
956	20.9	19,980	149,453	104	0.02	0.5	28

The maximum leachate generation rate was computed by the HELP model to be 956 ft^3/acre/day.

The maximum contributing area is Cell 12A of 20.9 acres.

3.3 Time to Fill Sump, Typical Conditions

The time it takes to fill the sump when leachate remains at the sump base and typical conditions exist is:

q_{ave}	$Area_{max}$	Average flow into sump			Time to fill sump		
ft^3/acre/yr	acre	ft^3/day	gal/day	gal/min	day	hr	min
12,494	20.9	715	5,351	4	0.15	3.5	209

The maximum average annual leachate generation rate was computed by the HELP model to be 12,494 ft^3/acre/yr.

The maximum contributing area is Cell 12A of 20.9 acres.

3.4 Sump Cycle Times

Sump cycles times should be greater than 15 minutes or number of cycles should not be greater than 100 cycles per day to prevent overheating and complete failure. The cycle time is the time to remove two sump volumes.

Worse-case Condition			Typical Condition		
min	day	cycles/day	min	day	cycles/day
56	0.04	26	418	0.29	3

4.0 CONCLUSION

Each sump will have a capacity of approximately 2,895 gallons. Under worst-case conditions, leachate will reach the crest of the sump approximately 0.5 hours after pumping. Under typical conditions, leachate will reach the crest of the sump approximately 3.5 hours after pumping. Therefore, the sump design will provide adequate time for sump cycling.

APPENDIX III3E-1

SUFFICIENT BALLAST CALCULATIONS

SUFFICIENT BALLAST CALCULATIONS

Made by: CEI
Checked by: MX
Reviewed by: JBF

1.0 OBJECTIVE

Provide ballast calculations in accordance with Appendix III3F, Liner Quality Control Plan (LQCP).

2.0 APPROACH

The factor of safety against hydrostatic uplift is defined as the sum of the resisting forces provided by the ballast (weight) of overlying materials including protective soil cover, waste, and final cover, divided by the hydrostatic uplift forces acting at the base of the geomembrane liner. As described in the LQCP, a factor of safety of 1.5 is required when waste is being used as the ballast material.

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3.0 EXAMPLE BALLAST CALCULATIONS

Provided below are example calculations demonstrating the factor of safety in the final fill condition and the waste thickness required to achieve a factor of safety of 1.5.

Final-Filled Condition		**Ballast Offset (lb)**			**Hydrostatic Force (lb)**	
Slope of Alternative Liner at Evaluation Point	3 H:1V	*Final Cover*	*Waste*	*Protective Cover*	*Alternate Liner*	*Ground-water*
Top Elevation (ft-msl)		120.0	116.5	74.0	72.0	75.8
Thickness (ft)		3.5	42.5	2.0	-	3.8
Unit Weight (pcf)		115.0	44.0	105.0	-	62.4
Hydrostatic Offset Factor	**9.4**	2234.3			237.1	

Waste Thickness Required		**Ballast Offset (lb)**		**Hydrostatic Force (lb)**	
Slope of Alternative Liner at Evaluation Point	3 H:1V	*Waste*	*Protective Cover*	*Alternate Liner*	*Ground-water*
Top Elevation (ft-msl)		79.9	74.0	72.0	76.5
Thickness (ft)		**5.9**	2.0	-	4.5
Unit Weight (pcf)		44.0	105.0	-	62.4
Hydrostatic Offset Factor	**1.5**	421.2		280.8	

4.0 CALCULATIONS AND RESULTS

Final filled condition and waste thickness required ballast calculations for each evaluation point within the lateral expansion area of Units 7 and 8 as well as remaining cell construction in Unit 6 as depicted in Figure III3E-1-1 is summarized in the tables below. The evaluation points provided represent the worse-case locations for each unit cell. The final cover, protective cover, and alternate liner elevations are the same for each ballast evaluation point. In addition, the final cover and protective cover thickness as well as associated unit weight is assumed to be the same as the sample calculation provided above.

Final-Filled Condition	Factor of Safety	Component Elevations				
		Final Cover	*Waste*	*Protective Cover*	*Alternate Liner*	*Ground-water*
Point 1 - Unit 7, Cell 1	**8.5**	120.0	116.5	74.0	72.0	76.2
Point 2 - Unit 7, Cell 2	**8.7**	120.0	116.5	74.0	72.0	76.1
Point 3 - Unit 7, Cell 3	**9.4**	120.0	116.5	74.0	72.0	75.8
Point 4 - Unit 7, Cell 4	**9.2**	120.0	116.5	74.0	72.0	75.9
Point 5 - Unit 7, Cell 5	**8.5**	120.0	116.5	74.0	72.0	76.2
Point 6 - Unit 7, Cell 6	**NA**	120.0	116.5	74.0	72.0	70.2
Point 7 - Unit 7, Cell 7	**NA**	120.0	116.5	74.0	72.0	71.8
Point 8 - Unit 7, Cell 8	**19.9**	120.0	116.5	74.0	72.0	73.8
Point 9 - Unit 7, Cell 9	**10.9**	120.0	116.5	74.0	72.0	75.3
Point 10 - Unit 7, Cell 10	**9.2**	120.0	116.5	74.0	72.0	75.9
Point 11 - Unit 7, Cell 11	**8.3**	120.0	116.5	74.0	72.0	76.3
Point 12 - Unit 7, Cell 12	**8.0**	120.0	116.5	74.0	72.0	76.5
Point 13 - Unit 8, Cell 1A	**6.8**	120.0	116.5	74.0	72.0	77.3
Point 14 - Unit 8, Cell 1B	**5.3**	120.0	116.5	74.0	72.0	78.7
Point 15 - Unit 8, Cell 2A*	**7.0**	120.0	116.5	74.0	72.0	77.1
Point 16 - Unit 8, Cell 2B*	**6.1**	120.0	116.5	74.0	72.0	77.9
Point 17 - Unit 6, Cell 5B	**7.2**	120.0	116.5	74.0	72.0	77.0
Point 18 - Unit 6, Cell 7A	**7.6**	120.0	116.5	74.0	72.0	76.7
Point 19 - Unit 6, Cell 6B	**7.5**	120.0	116.5	74.0	72.0	76.8

NA: Groundwater elevation is below liner elevation.

* Unit 8 evaluation point similar to that of overliner option.

Waste Thickness Required	Waste Thickness	*Factor of Safety*	Component Elevations			
			Waste	*Protective Cover*	*Alternate Liner*	*Ground-water*
Point 1 - Unit 7, Cell 1	**5.2**	1.5	79.2	74.0	72.0	76.2
Point 2 - Unit 7, Cell 2	**4.9**	1.5	78.9	74.0	72.0	76.1
Point 3 - Unit 7, Cell 3	**4.2**	1.5	78.2	74.0	72.0	75.8
Point 4 - Unit 7, Cell 4	**4.4**	1.5	78.4	74.0	72.0	75.9
Point 5 - Unit 7, Cell 5	**5.2**	1.5	79.2	74.0	72.0	76.2
Point 6 - Unit 7, Cell 6	**0.0**	1.5	74.0	74.0	72.0	70.2
Point 7 - Unit 7, Cell 7	**0.0**	1.5	74.0	74.0	72.0	71.8
Point 8 - Unit 7, Cell 8	**0.0**	1.5	74.0	74.0	72.0	73.8
Point 9 - Unit 7, Cell 9	**3.0**	1.5	77.0	74.0	72.0	75.3
Point 10 - Unit 7, Cell 10	**4.4**	1.5	78.4	74.0	72.0	75.9
Point 11 - Unit 7, Cell 11	**5.4**	1.5	79.4	74.0	72.0	76.3
Point 12 - Unit 7, Cell 12	**5.9**	1.5	79.9	74.0	72.0	76.5
Point 13 - Unit 8, Cell 1A	**7.8**	1.5	81.8	74.0	72.0	77.3
Point 14 - Unit 8, Cell 1B	**11.1**	1.5	85.1	74.0	72.0	78.7
Point 15 - Unit 8, Cell 2A*	**7.3**	1.5	81.3	74.0	72.0	77.1
Point 16 - Unit 8, Cell 2B*	**9.2**	1.5	83.2	74.0	72.0	77.9
Point 17 - Unit 6, Cell 5B	**7.0**	1.5	81.0	74.0	72.0	77.0
Point 18 - Unit 6, Cell 7A	**6.3**	1.5	80.3	74.0	72.0	76.7
Point 19 - Unit 6, Cell 6B	**6.6**	1.5	80.6	74.0	72.0	76.8

* Unit 8 evaluation point similar to that of overliner option.

5.0 CONCLUSION

A ballast calculation was performed at each evaluation point depicted on Figure III3E-1-1 within the lateral expansion area of Unit 7. The evaluation point number 12 selected within Cell 12 where the difference between the seasonal high groundwater surface and the design basegrade is the greatest is the worst-case scenario. The final filled condition has a factor of safety of 8.0 and 5.9 ft is the thickness of waste required to achieve a factor of safety of 1.5. Review of the results indicate that long-term ballast is adequate for the proposed design.

APPENDIX III3E-2A

UNDERDRAIN SEEPAGE CALCULATION

UNDERDRAIN SEEPAGE CALCULATION

Made by: JX
Checked by: MX
Reviewed by: JBF

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1.0 OBJECTIVE

Use finite element analyses to model seepage and estimate the potential seepage flow under the Edinburg Regional Disposal Facility expansion area liner system. Design the underdrain system to limit build-up of water pressure under the most critical seepage conditions.

2.0 DISCUSSION

2.1 Site Conditions

The subsurface stratigraphy of the site includes three units, Stratum I, II, and III. These units are comprised of: sandy clays/clayey sands (Stratum I); silty fine sand and sand (Stratum II); and high plasticity, hard, dry clay (Stratum III). Based upon an evaluation of the soil boring and groundwater data from site investigations, Stratum II is the uppermost water bearing layer. Stratum I in general acts as a confining layer for Stratum II. Stratum I is underlain by Stratum II at an approximate elevation of 65 ft msl (mean sea level) in the northern cells and 55 ft msl in the southern cells. Stratum II is underlain by Stratum III at an approximate elevation of 45 ft msl in the northern cells and 35 ft msl in the southern cells. Cell excavation in the expansion area will be within Stratum I.

Seasonal high groundwater elevations, based on historical groundwater measurements, are shown on Figures III3E-2A-1.

The cell liner system for the facility includes a geosynthetic clay liner (GCL), a geomembrane liner and 2 feet of protective cover soil.

2.3 Underdrain Design

In cell areas where the subgrade elevation will be lower than the seasonal high groundwater elevation, an underdrain system will be installed. The proposed underdrain design includes a toe drain (consisting of a perforated pipe in a gravel filled trench), a geocomposite drainage layer on the cell sideslope, and a sump at the end of the cell (underneath the leachate sump). The underdrain is designed to reduce the hydrostatic uplifting forces on the liner system.

3.0 METHOD

Use SEEP/W, a 2-Dimensional finite element analysis program, to estimate flow into the underdrain based on a generalized subsurface stratigraphy. For conservative purposes, the worst-case scenario is used to calculate the anticipated flow and design the underdrain capacity.

4.0 INPUT PARAMETERS

4.1 Soil Parameters

Permeability parameters were determined by measuring the hydraulic conductivity of the soils with a flexible wall permeameter (ASTM Test Method D5084). The horizontal hydraulic conductivity of Stratum II was based on field slug test data. Details on Edinburg Regional Disposal Facility soil stratum properties are available in the Geology Report in Part III4, Geology Report.

Stratum Number	Horizontal Permeability K_x (cm/s)	Horizontal Permeability K_x (ft/s)	Vertical Permeability K_y (cm/s)	Vertical Permeability K_y (ft/s)	K_y/K_x Ratio
I	1.75E-06	5.74E-08	2.18E-07	7.15E-09	0.125
II	1.65E-04	5.41E-06	1.91E-04	6.27E-06	1.158
III	1.63E-07	5.35E-09	8.84E-09	2.90E-10	0.054

Due to the pockets of sand found in Stratum I, the models were conservatively designed such that the material properties of Stratum I actually reflect permeability of Stratum II. This would result in a greater flow into the underdrain, which in turn will produce a conservative underdrain design.

4.2 Critical Cross Sections

The critical cross-section will occur along portions of the Edinburg Regional Disposal Facility Unit 7 that have the highest seasonal groundwater level underlying the liner system (geosynthetic clay liner, geomembrane liner, and 2 feet of protective cover soil). Three cross-sections were selected to represent the most critical conditions. All cross-sections were modeled assuming Stratum II layer is a consistent 20 ft thickness. Two cross-sections are on the north side of the expansion, one in Cell 12A and the other in Cells 10A and 11A. On the south side of the expansion, a cross-section was selected in Cell 1. The cross-sections align with the groundwater flow directions. Locations of the cross-sections are shown on Figures III3E-2A-1.

4.3 Boundary Conditions

4.3.1 Sideslope Underdrain and Liner System

A geocomposite underdrain layer will be placed along the sideslope to intercept, collect, and transmit groundwater to the toe of the slope. The sideslope underdrain was modeled as a seepage face; i.e. a free draining surface with no positive pore pressures. The liner system was modeled as an impenetrable boundary.

4.3.2 Total Head

Total head boundaries were set to represent hydrostatic groundwater conditions below existing grade.

For North Cross-Section 1, the highest seasonal groundwater elevations ranged from 78 ft msl at the western boundary of Cell 12A to 76 ft msl at the northern boundary of Cell 12A.

For North Cross-Section 2, the highest seasonal groundwater elevation ranged from 77.5 ft msl at the western boundary of Cell11A to 75.5 ft msl at the northern boundary of Cell 10A.

For the South Cross-Section, the highest seasonal groundwater elevation ranged from 76.5 ft msl at the southern boundary of the expansion area to 75 ft msl at the northern point of Cell 1.

4.3.3 Toe Drain

The toe drain was designed to be 2 feet wide by 2 feet deep and modeled as a sink (a node assigned zero pressure). A sink models a condition in which all water seeping into it is removed before creating a pressure condition.

5.0 RESULTS

SEEP/W output figure, showing analysis configurations, boundary conditions, phreatic surface, total head contours, etc., are attached. As discussed above, three cross-sections were modeled in the SEEP/W analyses, two for the generalized north cell orientation and one for the generalized south cell oritentation. Section 5.1 presents the groundwater flows and Section 5.2 addresses the pore water pressure head on the liner.

5.1 Groundwater Flow Summary

Steady-state flow rate of groundwater into each toe-drain was calculated.

North cross-section 1, west toe drain =	1.15E-06	ft^3/sec/ft
North cross-section 1, north toe drain =	1.42E-05	ft^3/sec/ft
North cross-section 2, toe drain =	2.47E-05	ft^3/sec/ft
South cross-section, toe drain =	1.60E-05	ft^3/sec/ft
Maximum flow rate into the toe drain=	2.47E-05	ft^3/sec/ft

Evaluation of the sideslope underdrain geocomposite calculation is presented in Appendix III3E-2C.

5.2 Pore Water Pressure on The Liner

The analysis shows that the toe drains draw down the phreatic surface to below the liner elevations in the north cross-section 2 and south cross-section. In north cross-section 1, i.e. where the seasonal high groundwater elevation is the highest, the maximum pressure head exerted on the liner (GCL, geomembrane, and 2 feet protective cover soil) is 1.5 feet The factor of safety against hydrostatic uplift is calculated as follows:

Maximum Pore Water Pressure =	93.6 psf (1.5 feet of water head at 62.4 pcf)
Ballast Pressure =	210 psf (2 feet of protective cover at 105 pcf)
Factor of Safety =	2.2 >1.2 OKAY

Since the factor of safety is above 1.2, the liner will exert enough pressure to offset the hydostatic uplift from groundwater.

6.0 CONCLUSION

Based on the landfill's cross-sectional geometry, seasonal high groundwater table, subsurface soil properties and conservative assumptions listed above, the analysis shows that the maximum anticipated steady-state flow of groundwater to the proposed underdrain system is 2.47E-05 ft^3/sec/ft. The maximum calculated steady-state flow of groundwater into the toe drain will not exceed the capacity of the underdrain collection pipe, as shown in the underdrain pipe sizing calculation in Appendix III-3E-2B. Additionally, the maximum pore water pressure head along the liner system is 1.5 feet; therefore, the hydrostatic pressure exerted on the liner by the groundwater can be offset over the short-term by the 2-ft thick protective cover soil with a factor of safety greater than 1.2. Long term ballast will be achieved with a combination of soil and overlying waste with a factor of safety greater than 1.5 as shown in Appendix III-3E-1.

APPENDIX III3F

LINER QUALITY CONTROL PLAN

CITY OF EDINBURG SOLID WASTE MANAGEMENT

PERMIT AMENDMENT APPLICATION

Part III, Attachment 3, Appendix F

LINER QUALITY CONTROL PLAN

Edinburg Regional Disposal Facility

Edinburg, Hidalgo County, Texas

TCEQ Permit MSW-956C

GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

INTENDED FOR PERMITTING PURPOSES ONLY

Submitted To: City of Edinburg
Department of Solid Waste Management
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July 2017
Revised: November 2017

Project No. 1401491

Golder Associates

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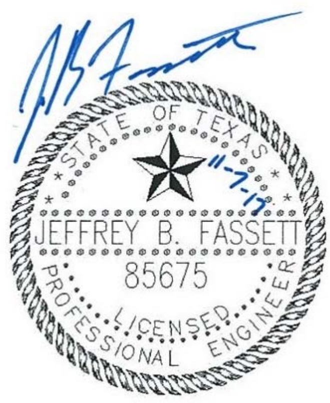

GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

INTENDED FOR PERMITTING PURPOSES ONLY

1.0 PURPOSE

1.1 Purpose

30 TAC §330.339(a)

This Liner Quality Control Plan (LQCP), is prepared under the direction of a licensed professional engineer, and it is the basis for the type and rate of quality control testing performance and reported in the liner evaluation report (LER) as required in §30 TAC §330.341. The plan provides operating personnel adequate procedural guidance for assuring continuous compliance with groundwater protection requirements. The plan specifies construction methods employing good engineering practices for installation and testing of components of the alternative liner including geosynthetic clay liner (GCL), geomembrane (GM), leachate collection and removal system (LCRS), and protective cover soil. In addition, dewatering plans are included.

1.2 Liner Quality Control Testing Procedures

30 TAC §330.339(a)(2)

The liner quality control testing procedures, including sampling frequency, are provided in this LQCP. All field sampling and testing, both during construction and after completion, shall be performed by a person acting in compliance with the provisions of the Texas Engineering Practice Act and other applicable state laws and regulations. The professional of record who signs the LER or his representative should be on site during all liner construction. Quality control of construction and quality assurance sampling and testing procedures should follow the latest technical guidelines of the TCEQ.

2.0 GEOSYNTHETIC CLAY LINER

This section presents general procedures, quality control testing requirements, and installation procedures for geosynthetic clay liner (GCL) construction. The GCL approved for use at the site consists of sodium bentonite encapsulated between two geotextile layers, needle-punched or stitched-bonded together.

2.1 Pre-Installation Material Evaluation

2.1.1 Manufacturer's Quality Control Certificates

Prior to the installation of the GCL, the manufacturer or installer shall provide the POR with quality control certificates signed by a responsible party employed by the manufacturer. The manufacturer must provide documentation certifying the material was continuously inspected for broken needles, and is needle free. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in accordance with project-specific testing methods and subject to the minimum testing frequency shown in Table III3F-1, GCL QC Submittal Frequency & Material Specifications. The owner may require more frequent testing at his discretion.

The quality control testing may be performed in the manufacturing plant. The POR shall review the test results prior to accepting the GCL to ensure that the certified minimum properties meet the values presented in Table III3F-1, GCL QC Submittal Frequency & Material Specifications.

2.1.2 Conformance Testing

In addition to the manufacturer's quality control certificates, samples of rolls of GCL will be obtained for conformance testing. The samples shall be tested by an independent third party laboratory in accordance with Table III3F-2, GCL Conformance Test Schedule. The POR shall review the test results to ensure that they meet the values presented in Table III3F-1, GCL QC Submittal Frequency & Material Specifications.

The POR shall compare measured shear strength values to those used in the stability analyses included in Appendix III3B-2B, III3B-2C, and III3B-2D. If the measured interface shear strength is less than the values used in the analyses, the stability of the liner system shall be reassessed and revised calculations shall be included in the Liner Evaluation Report (LER).

2.1.3 Shipping and Unloading

In order to prevent premature hydration, the GCL rolls shall be shipped in plastic wrapping that shall remain intact until material installation. Rolls shall be labeled with the manufacturers name, product identification, roll and lot number, roll dimensions, weight and any other information to trace the quality assurance documentation. Upon delivery of the GCL, storage and handling procedures shall be documented. The rolls will be stacked, stored above ground, covered, and handled in accordance with ASTM D5888 or manufacturer's recommendations. If any rolls is damaged during shipping, unloading or storage or if the outer portion becomes partially hydrated, the damaged portion shall be removed before the roll is deployed.

Table III3F-1: GCL QC Submittal Frequency & Material Specifications

Bentonite					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Fluid Loss	max.	ml	18	ASTM D5891	1 per 50 tons or every truck or railcar
Free Swell	min.	ml	24	ASTM D5890	
Geotextile					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Mass per Unit Area	—	g/cc	—	ASTM D5261	1 per 200,000 ft^2
Tensile Properties:	—	lb	—	ASTM D4632	
GCL Product					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Bentonite Mass	min.	lb/ft^2	0.8	ASTM D5993	1 per 40,000 ft^2
Bentonite Moisture Content	—	%	—	ASTM D5993	
Grab Tensile Strength	—	lb	—	ASTM D6768	1 per 200,000 ft^2
Hydraulic Flux	max.	m^3/m^2-s	1×10^{-8}	ASTM D5887	1 per week for each production line(2)
Lap Joint Permeability	Max	cm/sec	1×10^{-8}	Flow Box or other suitable device	1 per material and lap type

Notes:
1. Updated methods may be implemented based on a review by the POR.
2. Report last 20 test values, ending on production date of supplied GCL.
3. For those properties that do not indicate a value, the GCL material must meet the manufacturer's minimum specification.

Table III3F-2: GCL Conformance Test Schedule

TEST	**METHOD(1)**	**FREQUENCY**
Bentonite Mass/Unit Area	ASTM D5993	Not less than 1 test per 100,000 ft^2
Hydraulic Flux	ASTM D5887	
Direct Shear(2)(3)	ASTM D6243	1 test per GCL/adjoining material

Notes:
1. Updated methods may be implemented based on a review by the POR.
2. Direct shear testing shall be performed on the GCL/geomembrane/geocomposite sandwich. Soak interface and apply normal stresses of 1000, 5000, and 18,000 psf for at least 1 hour prior to shearing at a displacement rate of 0.04 in/min.
3. The testing results shall be compared to the values used in the stability analyses included in the Appendix III3B-3B. If the measured interface shear strength is less than the values used in the analyses, the stability of the liner system shall be reassessed and revised calculations shall be included in the GLER.
4. Test results from materials used during one construction event may be used in subsequent events provided the materials used are the same and approved by the POR.

2.2 Installation Procedures

2.2.1 GCL Subgrade Preparation

Surfaces to be lined should be smooth and free of all rocks greater than 0.75-inch diameter (or as recommended by the manufacturer, if less than 0.75 inches), sharp/angular objects, sticks, roots, or debris of any kind. The surface should provide a firm, unyielding foundation for the GCL with no sudden, sharp, or abrupt changes or break in grade. The subgrade surface shall be prepared by rolling with a smooth-drum roller to minimize the roughness and press down protruding soil or rock particles prior to GCL deployment. Loose rocks and/or dry soil particles that could damage the GCL shall be removed. Excessive voids or dimples shall be filled with soil.

Standing water or excessive moisture on the subgrade will not be allowed. The subgrade shall be maintained in a smooth, uniform, and drained condition.

2.2.2 Anchor Trench Construction

The anchor trench shall be constructed according to the project plans and specifications, and the excavation and backfilling operations shall be documented. If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of anchor trench open at any time should be minimized. The inside edge of the trench shall be rounded so as to avoid stresses from sharp bends in the GCL. The GCL will not be placed into the anchor trench on top of any rocks greater than 0.75-inch diameter, sharp/angular objects, sticks, roots, or debris of any kind. The anchor trench shall be adequately drained to prevent ponding or hydration of the GCL while the trench is open. The anchor trench shall be backfilled and compacted according to the project plans and specifications; however, backfilling shall be performed, at a minimum, with ordinary compaction as deemed suitable by the POR.

2.2.3 GCL Deployment

Equipment used to deploy GCL must not cause excessive rutting of the subgrade. Deployed GCL panels should contain no folds or excessive slack. Installation personnel must not smoke or wear damaging shoes on GCL. GCL should not be placed during excessive winds. Sand bags should be used to anchor deployed GCL when necessary. In general, only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the GCL. If the POR or CQA monitor observes any potential damage done to the liner by the support equipment, use of the equipment will cease and the damage will be repaired. Generators, gasoline or solvent cans, tools, or supplies must not be stored directly on the GCL. GCL must be rolled into position, not drug across the subgrade. Deployed GCL must not be used as a work area without adequate protection such as a rub sheet.

Panels should be overlapped and seamed, as recommended by the manufacturer. End-to-end seams on sideslopes are not allowed. Care must be taken to assure the GCL is installed with the proper side up.

GCL deployment shall be limited to the amount that can be covered with the overlying geomembrane liner the same day. GCL deployment shall not be undertaken during precipitation or when there is an impending threat of precipitation. GCL deployed on 5H:IV or steeper slopes shall be rolled down the slopes, not cross slope.

Following deployment, the CQA monitor shall visually examine the entire surface of the GCL for even bentonite distribution, thin spots, or other panel defects. All defects will be recorded and repaired in accordance with this LQCP. The QA/QC representative shall also verify the following:

- Proper overlap during deployment
- Seams between GCL panels are constructed per manufacturer's recommendations
- Defects are patched and overlapped properly
- The bentonite has not become excessively hydrated
- No stones, tools, cutting blades or other objects that could damage the GCL are present on the GCL.

Excessively hydrated GCL shall be removed and replaced with new material. Geomembrane shall not be placed on hydrated GCL.

GCL panels shall be given an identification code, mapped, and logged to record relevant installation information.

2.2.4 GCL Repairs

Torn or otherwise damaged geosynthetic facing must be patched with the same type of geosynthetic. The geosynthetic patch must extend at least 12 inches beyond the damaged area and must be heat bonded, or otherwise attached to the main GCL to avoid shifting during placement of overlying geosynthetics. If the GCL damage includes loss of bentonite, the patch must consist of full GCL extending at least 12 inches beyond the damaged area. Lapping procedures must be the same as specified for original laps of GCL panels.

2.2.5 GCL Protection

The overlying geosynthetics and soil layers shall be deployed in such a manner as to ensure that the GCL is not damaged. Textured geomembranes shall not be dragged across previously installed GCL. A smooth rubsheet shall be placed between the GCL and textured geomembrane to prevent damage. The rubsheet will be removed when the geomembrane is in position. Other methods may be employed at the POR's discretion.

To avoid local bentonite displacement, and the possible impact on the hydraulic performance of a GCL, the protective cover soil of suitable thickness should be placed over the geomembrane and geocomposite overlying the GCL as soon as practicable following completion of the geomembrane and leachate collection system construction.

3.0 GEOMEMBRANE LINER

This section presents general procedures, quality control testing requirements, and construction specifications for geomembrane liner construction. The alternative liner design includes the use of a 60-mil high-density polyethylene (HDPE) geomembrane liner with an exception for the overliner option which includes the use of a 60-mil linear low-density polyethylene (LLDPE) because its elastic properties are better suited for potential waste settlement.

3.1 Pre-installation Material Evaluation

3.1.1 Manufacturer's Quality Control Certificates

Prior to the installation of any geomembrane, the manufacturer or installer shall provide the POR with quality control certificates signed by a responsible party employed by the manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in the manufacturing plant using the test methods and frequencies listed in the most recent version of the Geosynthetic Research Institute (GRI) test method GM13 for HDPE geomembrane and GM17 for LLDPE geomembrane. Recycled or reclaimed materials must not be used in the manufacturing process. The owner may require more frequent testing at his/her discretion.

The POR shall review the test results prior to accepting the geomembrane to assure that the certified minimum properties meet the minimum values for textured geomembranes, as determined by the most recent GRI test method GM13 or GM17. The current versions of the GRI test methods are included in Appendix III3F-1.

Resumes of the installer's supervisor(s) or Master Seamer(s) shall be obtained to verify that adequate seaming experience will be utilized on the project. The installer’s supervisor or Master Seamer shall have had experience totaling a minimum of 2,000,000 square feet of geomembrane installation.

3.1.2 Conformance Testing

In addition to the manufacturer's quality control certificates, samples of the geomembrane will be obtained either at the manufacturing facility or upon delivery to the site for conformance testing. The test samples shall be obtained for conformance testing in accordance with the testing schedule shown in Table III3F-3, Geomembrane Conformance Test Schedule. Testing must be performed by an independent third party laboratory.

The POR shall review the test results to ensure that they meet the values presented in Table III3F-3, Geomembrane Conformance Test Schedule.

TABLE III3F-3: Geomembrane Conformance Test Schedule

TEST	METHOD(1)	FREQUENCY
Thickness (laboratory measurement)	ASTM D5994 (Textured)	Not less than 1 test per 50,000 ft^2 and every resin lot.
Density	ASTM D1505 or D792	Not less than 1 test per 100,000 ft^2 with not less than 1 per resin lot
Carbon black content	ASTM D4218	
Carbon black dispersion	ASTM D5596	
Tensile properties	ASTM D6693, Type IV	

Notes:

1. Updated ASTM or GRI methods may be implemented based on a review by the POR.

3.1.3 Shipping and Storage

Each roll shall be labeled with the manufacturing name, product identification, roll and lot number, dimensions, weight and any other informantion to trace quality assurance documentation. Upon delivery, storage and handling procedures shall be documented. Rolls shall be stacked, stored and handled in accordance with ASTM D5888 or the manufacturers recommendations. As a general rule, rolls should not be stacked more than four rolls high, and must be handled in a manner that does not damage the material. If any roll is observed to be damaged during shipping, unloading or storage, the damaged portion shall be removed before the roll is deployed.

The rolls delivered to the site shall be inventoried, recording the manufacturer's name and product identification, and the roll thickness, number, and dimensions. Manufacturer's certificates should be cross-referenced to rolls delivered on-site.

3.2 Installation Procedures

3.2.1 Geomembrane Deployment

The geomembrane shall be installed in direct and uniform contact with the GCL. The geomembrane shall not be placed during inclement weather, such as high winds or rain. Deployment of the geomembrane must not damage the underlying GCL. Geomembrane shall be unrolled, not drug across the GCL.

Geomembrane seaming should generally not take place when ambient temperatures are below 32 degrees Fahrenheit (°F), unless preheating is used. For extrusion welding, preheating will be required if the temperature is below 32°F and follow the procedures in the Geosynthetic Research Institute (GRI) Test Method GM-9. For fusion welding, preheating may be waived if the installer demonstrates that quality welds may be obtained without preheating. Seaming shall not be permitted at ambient temperatures above 104°F, unless the installer can demonstrate that seam quality is not compromised.

In general, only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the geomembrane or GCL. If the POR observes any potential damage done to the liner by the support equipment, use of the equipment will cease and the damage will be repaired. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in any other activity likely to damage the geomembrane. Only those sections that are to be placed and seamed in one day should be unrolled. Panels left unseamed should be anchored with sandbags or other suitable weights. In general, seams should be oriented parallel to the line of maximum slope (i.e., oriented up and down, not across the slope). In corners and odd-shaped geometric locations, the number of field seams should be minimized. If end seams are necessary on the sideslope, locate them in the lower half of the slope. Seams that join the side slope panels to the floor should be located at least 5 feet from the toe of the slope.

Panels should be overlapped, as recommended by the manufacturer, as appropriate for the type of seam welding to be performed; however, overlapping shall be no less than 3 inches and shall be verified by the POR or the CQA monitor. Field seaming shall only be performed by the method(s) approved by the manufacturer, either by extrusion welding or double-tracked fusion welding. No seaming shall take place without the installer's supervisor or Master Seamer and CQA monitor being present. Fishmouths, or wrinkles at the seam overlap, shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut shall be seamed and/or patched. Seams shall extend to the outside edge of panels placed in the anchor trench.

Panel layout and field seams shall be given an identification code, mapped, and logged to record relevant installation information. Inspection and testing records shall be logged as well as repair and retest data. Section 7.0 includes a thorough list of items to be documented during geomembrane construction and testing.

3.3 Installation Monitoring and Testing

3.3.1 Trial Seams

Each day prior to commencing field seaming, trial seams shall be made on pieces of geomembrane material to verify that conditions are adequate for production seaming. Trial seams shall be made at the beginning of each seaming period and shift (generally, at least twice each day) for each combination of production seaming machine and operator to be used that day. The trial test seam shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Four 1-inch wide specimens shall be die-cut from the trial seam sample using a calibration field extensometer. Two specimens shall be tested in the field for shear and two for peel (test both inner and outer welds for dual track fusion welding) and shall be compared to the minimum seam strength requirements specified in the most current version of the Geosynthetic Research Institute, GRI Test Method GM19. The current versions of the GRI test methods are included in Appendix III3F-1. A copy of the current calibration certificate for the extensometer must be provided by the installer.

If any of the trial seam specimens fail, the entire trial seam operation shall be repeated. If an additional specimen fails during the second trial seam, the seaming machine and seamer shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. Additional trial seams shall be performed if frequent field seaming problems are experienced or if power to the seaming machines is interrupted sufficiently long to require rewarming.

3.3.2 Non-Destructive Testing

Continuous, non-destructive testing shall be performed on all seams by the installer. All leaks must be isolated and repaired by following the procedures described in this LQCP.

Air Pressure Testing – ASTM D5820. The ends of the air channel of the dual-track fusion weld must be sealed and pressured to approximately 30 pounds per square inch (psi), if possible. The air pump must then be shut off and the air pressure observed after 5 minutes. A loss of less than 4 psi is acceptable if it is determined that the air channel is not blocked between the sealed ends. A loss greater or equal to 4 psi indicates the presence of a seam leak that must then be isolated and repaired by following the procedures described in this LQCP. The POR or his/her qualified representative must observe and record all pressure gauge readings.

Vacuum-Box Testing – ASTM D5641. Apply a vacuum of approximately 4 to 8 psi to all extrusion welded seams that can be tested in this manner. The seam must be observed for leaks for at least 10 seconds while subjected to this vacuum. The POR or his/her qualified representative must observe 100% of this testing.

Other Testing. Other non-destructive testing must have prior written approval from the TCEQ.

3.3.3 Destructive Seam Testing

Destructive samples shall be taken at a minimum frequency of one test location, selected randomly, within each 500 linear feet of seam length, inclusive of both primary longitudinal and cross seams, cap strips, and repairs 20 square feet or larger. Each test sample should be of sufficient length and 12 inches wide with the seam located in the middle. Test specimens, approximately 1 inch wide, shall be cut from both ends of the sample for field testing (peel and shear). The remaining sample should be cut into three parts (one for quality assurance laboratory testing, one for installer quality control laboratory testing, and one for archive storage to be maintained at a location selected by the owner).

The field tests shall be conducted on a certified calibrated extensometer capable of maintaining a constant extension rate of 2 inches per minute. If one of the field test specimens from the ends of the destructive sample fails, then the seam will be considered to have failed, and repairs shall be initiated as described below. If both specimens pass, then a sample for laboratory testing will be sent to the quality assurance laboratory for testing in both peel and shear. Seam strengths for HDPE geomembranes shall meet the minimum values specified in the most current version of the Geosynthetic Research Institute, GRI Test Method GM19 "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes".

Destructive test results for both field and laboratory tests shall include qualitative data, including the location of the failure and locus-of-break code, as described in ASTM D6392. Peel tests on double-tracked fusion welds shall be performed on both inside and outside tracks of the weld. Seam break classifications for extrusion and fusion welds are shown on Figures III3F-1 and III3F-2, respectively.

At a minimum, a destructive test must be done for each welding machine used for seaming or repairs. A sufficient amount of the seam must be removed to conduct field testing, independent laboratory testing, and archiving of enough material to retest the seam when necessary. Destructive seam testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. Additional destructive test samples may be taken if deemed necessary by the POR or his/her qualified representative.

> Weld Acceptance Criteria: For HDPE seams, the minimum passing criteria for destructive seam testing are described in the Geosynthetic Institute, GRI Test Method GM19. The POR must use the most current version of GM19 when evaluating welded seams.
>
> Seam Failure Delineation: When a sample fails a destructive test, the installer shall trace the welding path to an intermediate location at least 10 feet in each direction, or a distance determined by the POR, from the point of the failed test and take 1-inch wide specimens for an additional set of field tests. If these additional samples pass the tests, then two laboratory destructive samples shall be taken adjacent to the intermediate locations or at locations determined by the POR or his/her representative. If these laboratory samples pass the tests, then the seam shall be repaired between these locations. If either sample fails, then the process shall be repeated to establish a zone where the seam should be repaired. All acceptable repaired seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.
>
> Seam Failure Repairs: Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired. Repair methods may include spot welding (extrusion) for minor flaws and punctures; patches for larger holes and tears; capping for large lengths of failed seams or panel damage; and extrusion welding of outer flap to repair an inadequate fusion seam (less than 100-feet cumulative length) that has an exposed edge.

For any repair method, the following provisions shall be satisfied:

- Surfaces of the geomembrane that are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair.
- All surfaces shall be clean and dry at the time of repair.
- Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches.
- All repairs shall be non-destructively tested, as previously described.
- All seaming equipment, personnel, and operation procedures used in repair work shall meet the same requirements as for new seaming operations.

The POR or his/her qualified representative shall observe all non-destructive testing of repairs and shall record the number of each repair, type, date, and test outcome. Repairs that pass the non-destructive tests shall be taken as an indication of an adequate repair. Repairs more than 150 feet long shall also be required to have a destructive test performed. Repairs that fail the initial retest shall be redone and retested until a passing test results. All work and testing of repairs shall be fully documented in a repair log.

When placing overlying material on the geomembrane, effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. In no case shall the geomembrane be allowed to fold over on itself.

4.0 LEACHATE COLLECTION SYSTEM

4.1 Leachate Collection System and Drainage Materials

The leachate collection trenches and sumps shall be constructed in conjunction with liner construction. All GCL and geomembrane testing shall be completed prior to installing the leachate collection system on the area under evaluation. The locations of the trenches and sumps and design details are shown on the Figures III3-2A, III3-2B, III3-6A, III3-6B, and III3-8. The installation of the leachate collection system and protective cover system will have continuous inspection by the POR or his/her qualified representative(s). Quality assurance monitoring shall consist of measuring the dimensions of the excavated trenches and sumps, and documenting that the pipe, geotextile filters, bedding materials and drainage layers have been placed in accordance with the design details. All data and observations regarding construction of the leachate collection system shall be documented in the Liner Evaluation Report (LER).

Materials selected for use in the leachate collection system and drainage layers shall be verified by the POR to comply with this section of the LQCP.

4.1.1 Double-sided Geocomposite Drainage Layer

Geosynthetic drainage material shall conform to the material and performance properties specified in Table III3F-4, Geosynthetic Drainage Layer Specifications. Manufacturers' certificates of material and performance characteristics shall be obtained and documented at the minimum frequency shown on Table III3F-4, Geosynthetic Drainage Layer Specifications, with not less than one per resin lot. Geosynthetic drainage material conformance testing will consist of transmissivity testing on each material type using the test set-up described in Table III3F-4, Geosynthetic Drainage Layer Specifications.

The drainage layer for the leachate collection system will consist of a geosynthetic drainage layer over both the floor and sideslopes of the landfill cells. The geosynthetic drainage layer shall consist of a geonet with a nonwoven geotextile heat-bonded to both sides. The geosynthetic drainage layer shall be anchored in an anchor trench at the crest of the sideslopes.

Geotextile panels placed in the leachate collection system shall be overlapped and either heat-bonded or field sewn. Only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the geotextile. Personnel working on the geotextile shall not smoke, wear damaging shoes, or engage in any activity that damages the geotextile, or underlying geosynthetics.

TABLE III3F-4: Geosynthetic Drainage Layer Specifications

Test Category	Product	Test[a]	Test Method[b]	Testing Frequency
Manufacturer	Resin (Geonet)	Density	ASTM D792 or D1505	One test per 100,000 ft^2 and every resin lot
		Melt Flow Index	ASTM D1238	
Manufacturer	Geonet	Density	ASTM D792 or D1505	One test per 100,000 ft^2 and every resin lot
		Nass / Area	ASTM D5261	
		Thickness	ASTM D5199	
		Compression	ASTM D1621	
		Transmissivity	ASTM D4716	
Manufacturer	Geotextile	Mass/Area	ASTM D5261	One test per 100,000 ft^2 and every resin lot
		Grab Tensile Strength	AASTM D4632	
		Trapezoidal Tear Strength	ASTM D4533	
		Burst Strength	ASTM D3786	
		Puncture Strength	ASTN D4833	
		Thickness	ASTM D5199	
		Apparent Opening Size	ASTM D4751	
		Permittivity	ASTM D4491	
Independent Laboratory	Geocomposite Product	Transmissivity	ASTM D4716	One test per product type
		Interface Shear or Ply Adhesion	ASTM D5321 OR D413	One test per project

[a] Adapted from EPA/600/R-93/182, September 1993, and *Designing with Geosynthetics*, 6th ed.
[b] The POR may propose equivalent or better tests.

4.1.2 Filter Geotextile

The leachate drainage aggregate that is placed in the collection trenches and sumps shall be wrapped in a geotextile filter fabric. The geotextile shall have the minimum properties listed in Table III3F-5, Nonwoven Filter Geotextile Specifications .

Table III3F-5: Nonwoven Filter Geotextile Specifications

Property	Qualifier	Unit	Value	Test Method	Frequency
Mass per Unit Area	MARV	oz/yd^2	7.5	ASTM D5261	100,000 sf
AOS		US Sieve (mm)	80 (0.15)	ASTM D4751	550,000 sf

Property	Qualifier	Unit	Value	Test Method	Frequency
Puncture Resistance		lb	550	ASTM D6241	550,000 sf
Grab Tensile Strength		lb	205	ASTM D4632	100,000 sf

4.1.3 Leachate Pipe

The leachate piping includes perforated collection trench pipes and solid sideslope riser pipes. The leachate piping shall conform to ASTM D3350 with a minimum cell classification value of 345464C. The pipe shall have the minimum SDR rating and perforation schedule shown on the plans and specifications.

4.1.4 Drainage Material

Granular drainage materials, to be used in the underdrains, along the leachate collection lines, and in the sumps. At least one set of pre-construction tests shall be conducted for each drainage medium from each proposed source and a minimum of one per each 3000 cy. Pre-construction tests shall include a complete grain-size analysis, including minus No. 200 Sieve (ASTM D422) and calcium carbonate content (ASTM D3042 modified to use hydrochloric acid with a pH of 5 or the J&L method). The grain-size analysis will be used to determine if the material is compatible with the perforations in the leachate collection pipes and if the material is expected to achieve a minimum permeability of 1 x 10^{-2} cm/sec. The measured calcium carbonate content must not exceed 15 percent.

Granular drainage materials selected for use shall be tested at regular intervals for conformance during construction. Minimum testing frequency shall include one grain-size analysis for every 3,000 cubic yards, or portion thereof, for each material being used.

4.2 Protective Cover Material

Protective cover materials shall be free of deleterious materials that could puncture the synthetic lining system. The protective cover material shall be selected and placed so as not to harm the geomembrane or other geosynthetic layers. The installation of the leachate collection system and protective cover system will have continuous inspection by the POR or his/her qualified representative(s).

Visual observations shall be made to verify that no deleterious materials are present in the protective cover that could damage the lining and leachate collection systems or impede their performance as designed.

Alternate protective cover material, such as shredded tire chips, may only be used when overlying a protective layer of sufficient puncture resistance to prevent penetration of steel belting fragments or other deleterious materials through the geosynthetic drainage layers or geomembrane. Prior to use of an alternate protective cover material, written approval will be obtained from the TCEQ.

Protective cover does not require compaction control; however, it should be stable for construction and disposal traffic. Care shall be exercised in placement so as not to shift, wrinkle, or damage the underlying geosynthetic layers, and the placement methods shall be documented. Protective cover placement should be conducted at the coolest part of the day to minimize the development of wrinkles in the geosynthetic materials.

The protective cover shall be placed such that the top surface, while spreading, is at least 2 feet above the geosynthetic layers at all times unless low ground pressure dozers are used (i.e., track pressure less than 5 psi). A greater thickness shall be maintained to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires, quick stops, or sharp turns.

The final thickness of the protective cover shall be a minimum 24 inches above a geosynthetic drainage layer. The required thickness of protective cover shall be verified by survey methods on an established grid system with not less than one verification point per 5,000 square feet of surface area.

5.0 DEWATERING SYSTEM

Waste management unit excavations extend below the seasonal high water table resulting in upward or inward hydrostatic forces on the alternative liner. Measures will be taken to protect the liner and leachate collection system during construction below the seasonal high groundwater table. During construction of the alternative liner, groundwater will be controlled by installing an active dewatering system which includes an underdrain composed of toe drains, a geocomposite along the sideslopes, and an underdrain sump.

5.1 Foundation Evaluation

Prior to excavating any waste management unit below the seasonal high water table, a preliminary foundation evaluation considering stability, settlement, and constructability shall be performed. This evaluation has been performed and is provided in Appendix III3B, Waste Management Unit Design Analyses.

5.2 Excavation

Excavations below the water table can result in the excessive influx of groundwater and excavated bottom or slope instability. Since soil is typically excavated gradually for use as daily cover, groundwater influx can be controlled by allowing the seepage to drain away from the cell excavation area, thus temporarily lowering the groundwater level. If this approach is not effective or practical, other means, such as well-points may be used to lower the surrounding groundwater table.

5.3 Underdrain Construction

Once excavated to design subgrade, an underdrain shall be installed. The underdrain consists of a double-sided geocomposite installed along the excavated sideslope and toe drains. Toe drains are 2-foot wide by 2-foot deep trenches installed along the toe of excavation with a 4-inch ADS N-12 corrugated HDPE (or equal) perforated pipe surrounded by drainage material, wrapped with filter geotextile. The toe drains will direct groundwater to an underdrain sump located directly beneath the leachate collection sump. Pumps sized to accommodate the designed groundwater flows from the underdrain system will be installed within a riser pipe with controls to allow automatic operation. The underdrain sump riser pipe shall exit the cell in such a manner so as not to penetrate the alternative liner within the planned limits of the waste disposal. Underdrain material specifcations shall be that of materials used in the leachate collection system.

5.4 Alternative Liner Stability During Construction

30 TAC §330.337(f)(1)

The dewatering system will prevent excessive pressure head from developing beneath the alternative liner during construction because the double-sided geocomposite and toe drains have been designed to accommodate the maximum anticipated inflow of groundwater as presented in Appendix III3E-2, Dewatering System Calculations. During construction activities, the POR shall evaluate the groundwater level and confirm the underdrain design.

The POR shall observe the liner subgrade, liner, and leachate collection system materials for the presence of groundwater seepage during construction to verify the subgrade is suitable for liner system construction. The entire subgrade shall be observed during excavation, and the occurrence of the following shall be noted:

- Groundwater seepage within the subgrade.
- Softening of the subgrade surface resulting from groundwater seepage.
- Softness or sheen in the secondary features resulting from groundwater seepage.

In each GLER, observations and subgrade evaluations performed by the POR will be presented to verify that the subgrade soils are suitable for liner system construction.

5.5 Alternative Liner Stability During Filling and Operation

30 TAC §330.337(c)

After the waste management unit is constructed and approved to receive waste, landfill operators shall ensure the stability of the alternative liner by maintaining continuous operation of the dewatering system. The underdrain will be in operation until sufficient ballast is in place to offset hydrostatic uplift.

6.0 BALLAST REQUIREMENTS

To offset hydrostatic uplift, the weight of the alternative liner and the waste placed above it will provide the ballast (weight) to protect the liner system from uplift forces from groundwater. The ballast counteracting the hydrostatic forces include the soil materials from the leachate collection system components, the protective cover, waste above the liner and leachate collection system, and the soil materials from the final cover. The weight of the geosynthetic components of the leachate collection system and any geosynthetic components of the final cover is considered negligible.

6.1 Seasonal High Groundwater Table

30 TAC §330.337(i)

To evaluate the ballast required to offset hydrostatic uplift, groundwater levels within the waste management unit must be assessed. Groundwater level data are presented in Appendix III3F-2. Using groundwater level data provided in III4E, Historic Groundwater Levels. Figures III3F-3A and III3F-3B present the seasonal high groundwater contours elevations.

For each new increment of liner construction, the POR shall reevaluate the seasonal high groundwater table for the construction area as part of the Geosynthetic Liner Evaluation Report (GLER) submittal. The seasonal high water table shall be adjusted upward, if necessary, as additional groundwater elevation data become available.

6.2 Ballast Thickness Calculations

The required ballast thickness will be calculated using the following procedures:

1. Determine the hydrostatic uplift pressure, P, acting on the alternative liner from the assumed seasonal high groundwater table, and the resistance provided by the ballast:

   Determine the maximum hydrostatic uplift pressure, P, acting on the geomembrane component of the alternative liner using the unit weight of water, γ_w, times the vertical distance from the base of the alternative liner to the seasonal high water table, H_{wt}.

   $$P = \gamma_w H_{wt}$$

   The resisting pressure, R_N, provided by the ballast is equal to the normal component of the sum of the unit weights of each ballast component, γ_i, times their respective vertical thickness, T_i, as shown in the following equation:

   $$R_N = \Sigma(\gamma_i T_i)\cos^2 \beta$$

   Where β is the angle between the slope of alternative liner and horizontal.

2. The equations for *R* and *P* are solved for equilibrium to find the thickness of ballast required to counteract the calculated water pressure.

   The safety factors indicated in the regulations, either 1.2 or 1.5 depending on the type and configuration of ballast used, are incorporated into the above referenced equations by multiplying by the appropriate factor. If only soil ballast is used, a factor of 1.2 is used in the equation, and if some combination of soil layers and waste is used as ballast, a factor of 1.5 is used.

$$1.2P = R \qquad or \qquad 1.5P = R$$

   When the equations for *R* and *P* are input, the required waste thickness, and/or required ballast thickness, is then determined. The equations can be solved for any location within or near an excavation where the piezometric profile is known or can be estimated.

The example ballast calculation are presented in Appendix III3E-1, Sufficient Ballast Calculations.

In each GLER, waste for ballast calculations will be provided to determine the minimum amount of waste needed, if any, to offset the hydrostatic uplift from the seasonal high water table.

6.3 Ballast Verification

30 TAC §330.337(f)(2)

When the operator determines that adequate ballast is in place, the amount of ballast must be verified to be sufficient to offset hydrostatic uplift on the alternative liner by a factor of 1.5 per Appendix III3E-1, Sufficient Ballast Calculations. The measures and tests used to verify that any ballast including waste are sufficient to meet the established ballast criteria include surveyed elevations to determine component thickness and density to determine component weight. In addition, the seasonal high water table shall be adjusted upward, if necessary, as additional groundwater elevation data become available.

7.0 MARKING AND IDENTIFYING EVALUATED AREAS

In accordance with 30 TAC §330.143(b)(1) and (6), markers shall be placed so that all areas for which the GLER have been submitted and approved by the TCEQ are readily identifiable. Such markers are to provide site workers with immediate knowledge of the extent of approved disposal areas and shall be placed in accordance with the Site Operating Plan.

Markers shall be metal, wooden, or recycled posts and shall extend at least 6 feet above ground level. Markers shall not be obscured by vegetation and shall be placed so that they are not destroyed during operations. Sufficient intermediate markers shall be installed to show the required boundary. Lost markers shall be promptly replaced. Limits of the evaluated area shall be referenced to the site grid system. Markers shall not be placed inside the evaluated area. Markers shall be color coded in accordance with 30 TAC §330.143(b)(1). GLER markers shall be red in color.

8.0 DOCUMENTATION AND REPORTING

The use of applicable TCEQ forms is required. Forms for liners and leachate collection systems and forms for excavation dewatering and liner ballast is posted on the TCEQ website.

8.1 Geosythentic Liner Evaluation Report

30 TAC §330.341

A Geosynthetic Liner Evaluation Report (GLER) includes documentation of cell construction including geosynthetic clay liner installation, geomembrane installation, and leachate collection system installation including protective cover soil. Prior to the disposal of solid waste in any cell, or on any area, excavation, or unprotected surface, a GLER shall be submitted to the TCEQ.

Each GLER shall be submitted in triplicate (including all attachments) to the executive director and shall be prepared in accordance with the methods and procedures contained in this LQCP. If the executive director provides no response, either written or verbal, within 14 days of receipt, the owner or operator may continue facility construction or operation.

If the executive director determines that a report is incomplete or that the test data provided are insufficient to support the evaluation conclusions, additional test data or other information may be required, and use of the cell or disposal area will not be allowed until such additional data are received, reviewed, and accepted. Each report must be signed and, where applicable, sealed by the POR performing the evaluation and counter-signed by the facility operator or an authorized representative.

The construction documentation provided in the GLER will contain a narrative describing the work conducted and testing programs required by the LQCP, "as-built" or record drawings, and appendices of field and laboratory data. The GLER will contain or discuss the information included in Table III3F-6, GLER Content at a minimum.

Table III3F-6: GLER Content

Geosynthetic Clay Liner	Roll shipment and receipt information
	Manufacturer's quality control certificates and results
	Storage and handling information
	Conformance test sampling and test results
	Subgrade acceptance
	Anchor trench preparation and backfilling
	Panel deployment, identification, and placement
	Equipment placed or operated on GCL
	100 percent visual inspection for defects, damage, etc.
	Seaming methods

	Repairs, including patch size and shape
Geomembrane Liner	Roll shipment and receipt information
	Manufacturer's quality control certificates and results
	Storage and handling information
	Conformance test sampling and test results
	Seamer's names and resumes of experience and qualifications
	Subgrade acceptance
	Anchor trench preparation and backfilling
	Panel deployment, identification, and placement
	Seam preparation, orientation, and identification
	Equipment placed or operated on geomembrane
	100 percent visual inspection for defects, damage, etc.
	Trial seam tests for each combination of seaming equipment and personnel
	Seaming methods, times, temperature, and equipment shutdowns and startups
	Continuous 100 percent non-destructive seam testing, methods, criteria, and results
	Destructive testing methods, criteria, and results
	Repairs, including preparation and procedures, failure delineation, patch size and shape, and retesting
	Material properties and placement of drainage materials and protective cover
Record Drawings	Phase layout plan
	Location of the subject cell with GLER markers
	Previous filled and active areas
	As-built GCL panel layout drawings, showing locations of patches and repairs
	As-built geomembrane panel layout drawings showing location of destructive test samples, patches, and repairs
	As-built drawings showing elevations of protective cover to confirm its thickness
Ballast Evaluation	Waste for ballast calculations will be provided to determine the minimum amount of waste needed, if any, to offset the hydrostatic uplift from the seasonal high water table.

8.2 Interim Status Report

An Interim Status Report (ISR) should be provided to the TCEQ for portions of a liner system that remain uncovered with waste for more than six months from the date that the protective cover was applied, and the area shall be reevaluated by a POR.

8.3 Ballast Evaluation Report

30 TAC §330.337(j)

A Ballast Evaluation Report (BER) must be submitted to the TCEQ when the ballast verification demonstrates that further ballasting or dewatering is no longer necessary. If the TCEQ provides no response within 14 days of the date of receipt, dewatering or further ballasting operations may be discontinued. The BER shall include a statement verifying the alternative liner did not undergo uplift during construction, certification that ballast met the criteria established in this LQCP, and signed and sealed by an independent licensed professional engineer performing the evaluation and signature of the facility operator or his authorized representative. The following information will be included, as applicable, with the BER.

- A summary of in-place density measurements will be presented verifying that the weight of the leachate collection system, protective cover, ballast (if any), and cover required as ballast complied with the calculations.
- The top of protective cover will be surveyed after installation to assure that the liner and leachate collection system did not undergo uplift prior to waste placement.
- Water level measurements obtained from appropriate site piezometer and monitor wells near each excavation area will be presented verifying that the groundwater levels do not exceed the design seasonal high water table. If the observed water levels exceed the design seasonal high water level, the ballast calculations will be adjusted accordingly.
- A TCEQ Waste-as-Ballast Placement Record form completed by the landfill manager or designated representative will be presented confirming that the waste material in the first 5 feet of waste was free of brush and large bulky items, daily operations of the pressure relief/underdrain system (if required) were completed, and a wheeled trash compactor having a minimum weight of 40,000 pounds was used to place waste.