NEW BOSTON LANDFILL
BOWIE COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 576C

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT D7
LINER QUALITY CONTROL PLANS

Prepared for

Waste Management of Texas, Inc.

July 2013

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
7/8/2013

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TEXAS BOARD OF PROFESSIONAL ENGINEERS
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TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

NEW BOSTON LANDFILL
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TCEQ PERMIT APPLICATION NO. MSW 576C

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PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT D7A
NORTH DISPOSAL AREA LINER QUALITY CONTROL PLAN

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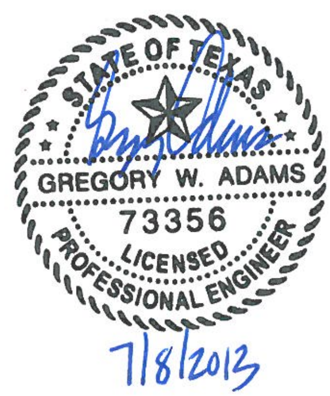

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STATE OF TEXAS
GREGORY W. ADAMS
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TABLES

1 INTRODUCTION

30 TAC §330.339

1.1 Purpose

The West and North Disposal Areas will accept both Type I and Type IV municipal solid waste. All liners and leachate collection systems in the West Disposal Area have been constructed and approved under MSW Permit No. 576B. Details of the existing liners are documented in the SLERs and GLERs. Approval dates are provided on Attachment D1 – Site Layout Plans, Drawing D1.3.

This Liner Quality Control Plan (LQCP) has been prepared in accordance with 30 TAC §330.339 to establish procedures for the design, construction, testing, and documentation of the liner and leachate collection system for the North Disposal Area.

1.2 Definitions

Specific terms and acronyms that are used in this LQCP are defined below.

ASTM – American Society for Testing and Material

BER – Ballast Evaluation Report

Construction Quality Assurance (CQA) – CQA is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes the observations, evaluations, and testing necessary to assess and document the quality of the constructed facility. CQA includes measures taken by the CQA organization to assess whether the work is in compliance with the plans, specifications, and permit requirements for a project.

GLER – Geomembrane Liner Evaluation Report

Geotechnical Professional (GP) – The GP is the authorized representative of the operator who is responsible for all CQA activities for the project. The GP must be registered as a Professional Engineer in Texas. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, construction quality assurance and quality control testing, and hydrogeology. The GP must also have competency and experience in certifying similar projects.

The GP may also be known in applicable regulations and guidelines as the CQA engineer, resident project representative, geotechnical quality control/quality assurance professional (GQCP), or professional of record (POR).

CQA Monitors – CQA monitors are representatives of the GP who work under direct supervision of the GP. The CQA monitor is responsible for quality assurance monitoring and performing on-site tests and observations. The CQA monitor must be NICET-certified at Level 2 for soils and geosynthetics, an engineering technician with a minimum of four years directly related experience, or a graduate engineer or geologist with one year of directly related experience.

Quality Assurance – Quality assurance is a planned program that is designed to assure that the work meets the requirements of the plans, specifications, and permit for a project. Quality assurance includes procedures, quality control activities, and documentation that are performed by the GP and CQA monitor.

Quality Control – Quality control includes the activities that implement the quality assurance program. The GP, CQA monitor, and contractor will perform quality control.

Seasonal High Water Table – The seasonal high water table is the highest measured water level within the construction area.

SLER – Soil Liner Evaluation Report

1.3 Sequence of Construction Activities

Construction of lined areas in the North Disposal Area at the New Boston Landfill will generally proceed in the following sequence of activities:

- The area will be excavated to the proposed subgrade elevations.
- A temporary dewatering system, if required, will be installed as described in Section 3.3.
- The subgrade elevations will be verified.
- The compacted soil liner will be constructed, tested, and verified in accordance with Section 4.
- The geomembrane liner will be constructed, tested, and verified in accordance with Section 5.
- The leachate collection system will be constructed and verified in accordance with Section 6. All soil testing and evaluation of constructed soil liners will be complete prior to installing the leachate collection system.
- The protective cover will be constructed and verified in accordance with Section 7.
- The Soils and Liner Evaluation Report will be submitted to the TCEQ.
- The Geomembrane Liner Evaluation Report will be submitted to the TCEQ.

2 LINER SYSTEM

30 TAC §330.331

2.1 Composite Liner and Leachate Collection Systems

The components of the composite liner system are listed from top to bottom in Table D7A-1. Details of the composite liner system are provided in Attachment D3 – Construction Design Details.

Table D7A-1
New Boston Landfill
Components of the Composite Liner System

Liner System Component	Description	Minimum Thickness
Protective Cover	General earthfill	24 inches
Leachate Collection Layer	Single-sided geocomposite on floor Double-sided geocomposite on side slopes	0.25 inches nominal 0.20 inches nominal
Geomembrane Liner	Smooth HDPE geomembrane on floor Textured HDPE geomembrane on side slopes	60 mil nominal 60 mil nominal
Compacted Soil Liner	Compacted soil with a coefficient of permeability less than or equal to 1×10^{-7} cm/sec	24 inches

The leachate collection layer will be graded to drain to a collection trench along the centerline of each cell. The leachate collection trench will consist of perforated HDPE pipe encased in aggregate. The leachate collection trench will convey leachate to a sump located along the toe of the side slope. A description of the leachate collection system is provided in Attachment D6 – Leachate and Contaminated Water Management Plan, and details of the leachate collection system are provided in Attachment D3.

2.2 Construction Monitoring

Continuous on-site monitoring is necessary to confirm that the components of the liner system are constructed in accordance with this LQCP. In accordance with 30 TAC §330.339(a)(2), the CQA monitor shall provide continuous on-site observation and field sampling and testing as required during the following construction activities:

- Temporary dewatering system installation
- Subgrade preparation
- Compacted soil liner placement, processing, compaction, and testing

- Geomembrane liner deployment, trial welds, seaming, testing, and repairing
- Leachate collection layer deployment and seaming
- Anchor trench backfill
- Protective cover layer placement
- Any work that could damage the installed components of the liner system

The GP will document and certify that the liner system was constructed in accordance with this LQCP. The GP shall make sufficient site visits to observe critical construction activities and to verify that the construction and quality assurance activities are performed in accordance with this LQCP.

3 EARTHWORK

30 TAC §§330.337, 330.339

3.1 General

The proposed grading plan for the North Disposal Area (Attachment D3, Drawing D3.1) provides for the landfill floor to slope at one percent to the perimeter sidewalls, which will slope at 3H:1V. The fill area will be divided into cells, each of which has a two percent cross slope to a leachate collection trench along the centerline of the cell. Collection trenches will slope to sumps located along the perimeter of the landfill. Earthwork activities and testing will be documented in the SLER in accordance with Section 9.2.

3.2 Materials

The following material classifications will be encountered in excavations or will be required for landfill construction.

General Fill

General fill consists of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than four inches in diameter.

Compacted Soil Liner

Compacted soil liner materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 4.2.

Protective Cover

Protective cover materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 7.2.

Leachate Aggregate

Drainage aggregate consists of natural or manufactured granular material that meets the requirements of Section 6.2.4.

Anchor Trench Backfill

Anchor trench backfill consists of general fill that is free of particles larger than one inch in diameter.

Daily and Intermediate Cover

Daily and intermediate cover materials consist of soil that has not been previously mixed with solid waste.

Topsoil

Topsoil consists of soil that is capable of sustaining vegetation and is free of debris, rubbish, and solid waste.

Unsuitable Materials

Unsuitable materials consist of any material that is determined by the GP to not be suitable for use as classified above.

3.3 Construction Below Groundwater

3.3.1 Highest Measured Water Elevations

The highest measured water elevations will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water elevations will be adjusted upward.

3.3.2 Temporary Dewatering

As shown in Attachment D3, Drawing D3.7, the excavations will extend below the highest recorded groundwater elevations in Sectors 1 through 5. Areas where the liner is to be constructed below the highest measured groundwater elevations will be dewatered during and after construction by a temporary dewatering system. The temporary dewatering system will be a network of underdrains consisting of HDPE panel-shaped pipe wrapped in geotextile encased in sand-filled trenches. The underdrains will discharge into open sumps beyond the lined areas or closed sumps beneath the lined areas. The groundwater will be pumped from the sumps into the perimeter drainage system. Automated submersible pumps will be installed in closed sumps. The pumps will be equipped with pressure transducers to monitor the groundwater level and level controls to turn the pumps on when the water reaches the top of the sump and turn the pumps off when the water reaches the lower operational limit of the pumps. The temporary dewatering system will be operated until sufficient ballast has been placed over the liner system to offset the hydrostatic forces and the ballast has been documented in the BER.

The design procedures and typical details of the temporary dewatering system are provided in Attachment D7A, Appendix D7A-B. Design and installation of the temporary dewatering system will be documented in the SLER in accordance with Section 9.2. The facility will submit a BER to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations.

3.4 Excavation

A description of the materials that will be encountered in the excavations is provided in Attachment D5 – Geotechnical Design.

The slope stability analyses are provided in Attachment D5, Appendix D5-B – Slope Stability Analyses. The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the excavation plan, dewatering system, ballast system, liner system, final cover system, or landfill completion plan will necessitate that the slope stability analyses be revised to reflect the actual conditions. Interim 3H:1V waste slopes shall not exceed 155 feet in height. Temporary construction slopes shall not be steeper than the interim slopes and concentrated loadings such as heavy equipment and soil stockpiles should not be placed near the crest of slopes unless additional slope stability analyses are performed.

4 COMPACTED SOIL LINER

30 TAC §330.339

4.1 General

The compacted soil liner component of the composite liner system consists of a 24-inch-thick layer of compacted, relatively homogeneous, cohesive material. The CQA monitor shall provide continuous on-site observation during compacted soil liner placement, compaction, and testing in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during compacted soil liner construction to document the construction activities, testing, and thickness verification in the SLER, in accordance with Section 9.2.

4.2 Materials

Compacted soil liner material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material. The required compacted soil liner material properties are summarized in Table D7A-2.

Table D7A-2
New Boston Landfill
Compacted Soil Liner Material Properties

Test	Standard	Required Property
Plasticity Index	ASTM D 4318	15 or greater
Liquid Limit	ASTM D 4318	30 or greater
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	30 or greater
Percent Passing 1-inch Sieve	ASTM D 422	100
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1×10^{-7} cm/sec or less

Preconstruction testing procedures and frequencies for compacted soil liner materials are listed in Section 4.8.1.

4.3 Subgrade Preparation

Prior to placing soil liner material, the subgrade should be proof-rolled with heavy, rubber-tired construction equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling operation. Soft areas should be undercut to firm material, then backfilled with compacted general fill. The GP will observe the subgrade for groundwater seepage and take appropriate actions when necessary.

The subgrade elevations shall be verified in accordance with the requirements of Section 4.8.3 prior to the placement of compacted soil liner.

4.4 Placement and Processing

The compacted soil subgrade and surface of each lift should be roughened prior to placement of the next lift of compacted soil liner. The soil liner material should be placed in maximum 8-inch loose lifts to produce compacted lift thickness of approximately six inches. The material should be processed to a maximum particle size of one inch or less before water is added. Rocks and clods less than one inch in diameter should not total more than 10 percent by weight. The surface of the top lift shall contain no material larger than 3/8 inch.

If additional water is necessary to adjust the moisture content, it should be applied after initial processing, but prior to compaction. Water should be applied evenly across the lift and worked into the material. Water used for the soil liner compaction must not be contaminated by waste or any objectionable material.

4.5 Compaction

The soil liner shall be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to bond the lifts, to distribute the water, and to blend the soil matrix through kneading action. Soil liner shall not be compacted with a bulldozer, rubber-tired roller, flat-wheel roller, scraper, truck, or any track equipment unless it is used to pull a footed roller. The compactor should weigh at least 40,000 pounds. The lift thickness shall be controlled to achieve penetration into the top of the previously compacted lift; therefore, the lift thickness should not be greater than the pad or prong length. Cleaning devices on the roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration.

The compactor should make approximately four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content at or above optimum moisture. Areas with failing tests shall be reworked, recompacted, and retested, and passing tests must be achieved before another lift is added.

After a lift is compacted, it must be watered to prevent drying and desiccation until the next lift can be placed. If desiccation occurs, the GP must determine if the lift can be rehydrated by surface application of water or if the lift must be scarified, watered, and recompacted. Following compaction and fine grading of the final lift, the surface of the compacted soil liner shall be smooth drum rolled.

4.6 Protection

The completed compacted soil liner must be protected from drying, desiccation, rutting, erosion, and ponded water until the geomembrane is installed. Areas that undergo excessive desiccation or damage shall be reworked, recompacted, and retested as directed by the GP.

4.7 Tie in to Existing Liners

The edge of existing compacted soil liners shall be cut back on either a slope or steps to prevent the formation of a vertical joint. Details of the existing liner tie-in are shown in Attachment D3.

4.8 Testing and Verification

4.8.1 Preconstruction Testing

Table D7A-3 lists the minimum testing required for material proposed for use as compacted soil liner.

Table D7A-3
New Boston Landfill
Compacted Soil Liner Material Preconstruction Tests

Test	Standard	Frequency
Plasticity Index	ASTM D 4318	1 per material type
Liquid Limit	ASTM D 4318	1 per material type
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per material type
Percent Passing 1-inch Sieve	ASTM D 422	1 per material type
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII or ASTM D 5093	1 per material type

After the moisture density relationship has been determined for a material type, a soil sample should be remolded to about 95 percent of the maximum dry density at the optimum moisture content. This sample will be tested to determine if the soil can be compacted to achieve the required coefficient of permeability. Either falling head or constant head laboratory permeability tests may be performed to determine the coefficient of permeability. The permeant fluid for testing must be tap water or 0.005N calcium sulfate solution. Distilled or deionized water shall not be used as the permeant fluid.

4.8.2 Construction Testing

All quality control testing will be performed during construction of the liner, except for testing that is required after individual lifts are constructed. Table D7A-4 lists the minimum testing required for material used as compacted soil liner.

Table D7A-4
New Boston Landfill
Compacted Soil Liner Material Construction Tests

Test	Standard	Frequency
Field Density	ASTM D 2922	1/8,000 sf per 6-inch lift
Plasticity Index	ASTM D 4318	1/100,000 sf per 6-inch lift
Liquid Limit	ASTM D 4318	1/100,000 sf per 6-inch lift
Percent Passing 1-inch and No. 200 Sieve	ASTM D 1140 ASTM D 422	1/100,000 sf per 6-inch lift
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII or ASTM D 5093[1]	1/100,000 sf per 6-inch lift
Moisture Content	ASTM D 2216	1/100,000 sf per 6-inch lift

[1] In the event that field permeability testing procedures are alternatively used for construction testing, field permeability tests will be performed in accordance with ASTM D5093 for those soil liners that are in the floor of the excavation and a variation of the Boutwell STEI Field Permeability Test approved by the executive director for the sidewalls or in accordance with guidance furnished by the executive director.

The Atterberg limits of the in-place compacted soil liner must be compared to the Atterberg limits of the Proctor curve sample to assure that the Proctor curve represents the in-place material. Any variance of more than 10 points between the liquid limit or plasticity index of the in-place soil and those of the Proctor curve sample will require that a new Proctor curve be developed. Permeability testing will be performed on undisturbed samples from the compacted soil liner as described in Section 4.8.1 and all test data will be reported.

4.8.3 Thickness Verification

The as-built thickness of the compacted soil liner shall be determined by standard survey methods. Prior to the placement of liner material, the subgrade elevations will be determined at a minimum rate of one survey point per 5,000 sf of lined area. After the compacted soil liner is completed, the top of the liner elevations will be determined at the same locations as the subgrade elevations.

5 GEOMEMBRANE LINER

30 TAC §§330.331, 330.339

5.1 General

The geomembrane liner (GM) component of the composite liner system consists of a 60-mil-thick HDPE geomembrane placed over the compacted soil liner. Smooth GM will be placed on the floor liner and GM that is textured on both sides will be placed over the sidewall liner. The CQA monitor shall provide continuous on-site observation during GM deployment, trial welds, seaming, testing, and repairing in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during the GM installation to document the installation and testing in the GLER, in accordance with Section 9.3.

5.2 Materials

5.2.1 Properties

GM shall consist of smooth and textured high-density polyethylene (HDPE) geomembrane produced from virgin raw materials. Recycled materials are not acceptable. The GM shall not be manufactured from resin from differing suppliers. The GM shall meet the requirements in the most current revision of the Geosynthetics Research Institute (GRI) Standard GM13. A copy of GRI-GM13 is included in Attachment D7A, Appendix D7A-E.

Manufacturer quality control testing procedures and frequencies for GM are listed in Section 5.5.1. Third party conformance testing procedures and frequencies for GM are listed in Section 5.5.2.

5.2.2 Delivery and Storage

GM shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site.

Upon delivery of the geomembrane, the CQA monitor will observe that:

- Equipment used to unload and store the rolls or pallets does not damage the geomembrane.
- The geomembrane is stored in an acceptable location and not stacked more than five rolls high.
- The geomembrane is protected from puncture, dirt, grease, water, moisture, and excessive heat, or other damage.

- All manufacturing documentation required by the specifications has been received and reviewed for compliance with the specifications.

- The geomembrane receipt log form has been completed for all materials received.

Damaged geomembrane may be rejected and removed from the site or stored at a location separate from accepted geomembrane.

5.3 Preparation

The surface of the compacted soil liner shall be protected in accordance with Section 4.6 until the GM is installed. Prior to installation of the GM, the compacted soil liner shall be tested and verified in accordance with Section 4.8, and the GP or CQA monitor and geosynthetics installer shall inspect the surface of the soil liner to verify that:

- The soil liner surface has been smooth drum rolled.

- The soil liner surface is free of irregularities, soft areas, or loose soil.

- The soil liner surface is free of stones, protrusions, or objects that could damage the GM.

The geosynthetics installer must accept the condition of the compacted soil liner and sign a subgrade acceptance form prior to the installation of the GM.

5.4 Installation

5.4.1 Deployment and Placement

The following activities must take place prior to GM deployment:

- The manufacturer's quality control and third party conformance tests should be completed and approved by the GP in accordance with the requirements of Section 5.5.

- The GP or CQA monitor and geosynthetics installer shall approve the subgrade in accordance with the requirements of Section 5.3.

- The geosynthetics installer shall sign the subgrade acceptance form.

GM shall be deployed by equipment that will unroll the GM without damaging, crimping, or stretching it and deployment equipment must not damage the underlying compacted soil liner. GM must not be deployed during periods of rain or high winds and shall not be deployed on top of frozen subgrade. The installer must only deploy the amount of GM that can be seamed on the same day. The GM shall be installed in direct and uniform contact with the compacted soil liner.

Upon deployment, each panel shall be assigned a unique identification number. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and wearing shoes that could damage the GM shall not be permitted on the GM, and only low-ground pressure supporting equipment shall be allowed on the GM. Textured GM shall be placed on side slopes and shall extend to a minimum of 5 feet beyond the toe of the slope.

During GM placement, the CQA monitor must:

- Provide full time observation.
- Record panel numbers, panel dimensions, and roll numbers.
- Record weather conditions.
- Observe the condition of the subgrade and note any deficiencies. All deficiencies shall be repaired and be approved by the CQA monitor.
- Observe the condition of the GM and note any defects. All defects must be repaired in accordance with the requirements of Section 5.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the deployment method minimizes wrinkles and that the GM is anchored to prevent movement from wind.
- Observe that no more panels are deployed than can be seamed on the same day.
- Observe that there are no horizontal seams on side slopes and that the textured material extends a minimum of 5 feet past the toe of the slope.

Any panels that are not deployed in accordance with this section shall be marked by the CQA monitor and be repaired in accordance with Section 5.4.4 or be removed and replaced by the installer.

5.4.2 Seaming

Only welding apparatus and operators that have completed approved trial welds in accordance with Section 5.5.3 shall be allowed to weld panel seams. Each seam shall be assigned a unique number, which is preferably consistent with the panel numbering system. Sidewall seams shall be oriented downslope. Prior to welding, the proper panel overlap shall be provided; dirt, grease, and free moisture shall be cleaned from the panel contact area; and wrinkles shall be removed as much as practical. For extrusion welds, oxidation shall be ground from the seam area within one hour of the welding operation and the extrudiate shall be purged from the extrusion welding apparatus. Seaming operations shall not be allowed when the ambient temperature is below 40°F or above

104°F unless trial welds have demonstrated that adequate welds can be achieved outside these limits.

During GM seaming operations, the CQA monitor must:

- Provide full time observation.
- Record seam numbers.
- Record weather conditions.
- Observe that only approved welding apparatus and operators are allowed to weld seams.
- Observe the condition of the seams and note any defects. All defects must be repaired in accordance with the requirements of Section 5.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the seams are free of grease, dirt, moisture, and wrinkles.
- Observe that welding operations take place within the approved ambient temperature range.
- Observe that seam grinding has been completed less than one hour before extrusion welding and the extrudiate has been purged from extrusion welders.
- Observe that there are no horizontal seams on side slopes and that the textured material extends a minimum of five feet past the toe of the slope.

5.4.3 Anchor Trenches

The GM anchor trench shall be left open until the seaming is completed. Expansion and contraction of the GM should be accounted for during deployment. The top corner of the anchor trenches shall be rounded to prevent crimping the GM. The bottom of the anchor trench shall be dry, stable and be free of loose particles and rocks. Anchor trenches shall be backfilled with compacted general fill that is free of particles larger than one inch in diameter. The anchor trenches shall be backfilled and compacted in a manner that does not damage or induce stress to the GM.

5.4.4 Repairs

Defects in the GM, defects in seams, failing destructive tests, failing nondestructive tests, holes from nondestructive tests, and destructive test sample locations shall be repaired by one of the following repair techniques:

- Patching - used to repair large holes, tears, large GM defects, and destructive test locations.

- Extrusion - used to repair small GM defects, cuts, holes from nondestructive tests, and seam defects less than ½-inch long.
- Capping - used to repair failed seams or seams where nondestructive tests cannot be performed.
- Removal - used to replace areas with large defects where other repair techniques are not appropriate.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one hour prior to the repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least six inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least three inches. Bevel the top edges of patches prior to extrusion welding.

Destructive and non-destructive testing will be performed on all repairs in accordance with Section 5.5.4.

5.5 Testing and Verification

5.5.1 Manufacturer's Quality Control Testing

The GM manufacturer shall test the geomembrane and raw materials in accordance with GRI Standard GM13 to assure the quality of the GM.

5.5.2 Conformance Testing

Conformance samples of the GM shall be cut across the full width of selected rolls in accordance with the test frequency specified in Table D7A-5. Conformance samples may be taken at the manufacturing plant or at the project site and will be forwarded to a third party laboratory for testing. Material property requirements are provided in Section 5.2.1. Minimum conformance testing requirements are provided in Table D7A-5.

Table D7A-5
New Boston Landfill
GM Conformance Tests

Test	Standard	Frequency
Sheet Thickness	ASTM D 5199, 1593, or 5994	1 per 50,000 sf and every resin lot (1)
Specific Gravity	ASTM D 1505	1 per 100,000 sf and every resin lot
Carbon Black Content	ASTM D 1603	1 per 100,000 sf and every resin lot
Carbon Black Dispersion	ASTM D 3015 or 5596	1 per 100,000 sf and every resin lot
Tensile Properties	ASTM D 638	1 per 100,000 sf and every resin lot

(1) Additional thickness testing at laboratory performed in lieu of field thickness testing.

5.5.3 Trial Welds

Each operator and welding apparatus must be tested to verify that seam welds that meet the specifications can be achieved under the site conditions. Trial welds must be performed at the beginning and midpoint of each day for each operator and apparatus used that day. If welding continues past 6:00 p.m., additional trial welds may be required.

The trial weld samples shall be three feet long and twelve inches wide, with the seam centered lengthwise. At least four one-inch-wide coupons will be cut from each trial weld sample. Two coupons from each sample will be tested for shear and two samples will be tested for peel. Peel test coupons for dual-track welds shall be tested on both sides of the air channel. Each coupon must meet the minimum strength requirements listed in Table D7A-6 and exhibit a Film Tear Bond (FTB). If the trial weld fails, two more trial seams must be welded and tested. This process will continue until passing trial welds are achieved.

The CQA monitor must observe the trial welding operations and document the operator's initials, apparatus number, time, date, air temperature, apparatus temperature, and peel and shear test results. If the CQA monitor believes that an operator or apparatus is not functioning properly, or if the weather conditions have substantially changed since the trial welds were performed, new trial welds must be performed.

5.5.4 Construction Testing

Nondestructive Tests

Nondestructive seam tests include vacuum testing and air pressure testing. Nondestructive testing shall be performed for the entire length of each seam by the GM installer.

Vacuum testing shall be used to test extrusion-welded seams and fusion-welded seams that cannot be tested by air pressure methods. The vacuum box shall be placed over a seam section that has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom of the vacuum box must seal against the GM to prevent leaks. The vacuum box pressure shall be reduced to about three to five inches of Hg. Soap bubbles will indicate the presence of holes or non-bonded seams. The vacuum box dwell time shall be at least 10 seconds.

Air pressure testing shall be used to test fusion-welded seams that have an air channel. Both ends of the air channel shall be sealed and air shall be pumped into the channel to at least 30 psi or ½ psi per mil of thickness, whichever is greater. The air channel must sustain the pressure for at least five minutes, without more than a 4-psi pressure drop. Following a passing pressure test, the pressure shall be released from the end of the seam that is opposite of the pressure gauge. The pressure gauge must return to zero; if it does not, the seam is probably blocked. After the blockage has been located, the seam shall be pressure tested on both sides of the blockage. All penetration holes shall be sealed after the air pressure testing is completed.

During the nondestructive testing, the CQA monitor must:

- Observe that equipment and operators perform the tests properly.
- Observe that the entire length of each seam is tested and record the results of the test.
- Identify failed seams and inform the installer of any required repairs.
- Record all completed and tested repairs on the repair log.

Destructive Tests

Destructive testing shall be performed at a frequency of one stratified test location per 500 linear feet of seam. Repairs over 10 feet long shall be included in the total seam length. Destructive test samples should be 45 inches long by 12 inches wide with the seam centered along the length of the sample.

Two coupons should be cut from each end of the sample and the installer must test these coupons with a tensiometer capable of measuring the seam strength. The installer shall test two coupons in shear and two coupons in peel. For double wedge-welded seams, both sides of the air channel shall be tested in peel. The CQA monitor must observe the tests and record the results on the destructive testing log. The minimum requirements for destructive testing are provided in Table D7A-6. If one of the coupons fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations, or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established.

If the field test results are satisfactory, the remaining sample shall be divided into three parts: one-third for the installer, one-third for third party laboratory testing, and one-third for the owner to archive. The laboratory shall test five coupons from each sample in shear and test five coupons from each sample in peel (10 when testing both inner and outer welds of dual-track fusion welds). The minimum requirements for destructive testing are provided in Table D7A-6. If the laboratory test fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations, or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established. All seams shall be bracketed by passing laboratory tests; field tests results shall not be used for final acceptance.

Table D7A-6
New Boston Landfill
GM Seam Properties

Test	Standard	Frequency	Minimum Criteria
Shear	ASTM D 4437	1 sample per 500 feet of seam	Four of five specimens from each sample must have a shear strength greater than or equal to 95% of sheet strength but not less than 120 ppi. The average shear strength value of all five specimens must be greater than or equal to 95% of sheet strength but not less than 120 ppi.
Peel	ASTM D 4437	1 sample per 500 feet of seam	Four of five specimens from each sample must have a peel strength greater than or equal to 62% of sheet strength but not less than 78 ppi. The average peel strength value of all five specimens must be greater than or equal to 62% of sheet strength but not less than 78 ppi. Both sides of dual track seams shall meet the minimum criteria. Each track is considered a separate sample. All specimens shall exhibit Film Tear Bond.

During destructive seam testing, the CQA monitor must:

- Select sample locations and observe sample cutting.
- Assign sample numbers and label samples.
- Observe installer-performed tests.
- Record sample locations, sample number, sample purpose, and field test results.

5.5.5 Thickness Verification

The CQA monitor shall perform thickness verification tests on each panel unless thickness conformance tests are performed at a frequency of one per 50,000 sf. If field thickness testing is required, thickness verification shall be performed with a micrometer at a minimum of one measurement per five feet along the leading edge of the panel. A minimum of five tests is required for each panel. No measurement may be less than 90 percent of the nominal panel thickness. The CQA monitor shall record panel numbers, panel dimensions, roll numbers destructive test numbers, and repair numbers.

6 LEACHATE COLLECTION SYSTEM

30 TAC §330.333

6.1 General

The leachate collection system consists of the collection layer, collection trenches, piping, and sumps. Details of the leachate collection system design are provided in Attachment D3. The design capacity calculations are provided in Attachment D6. Material properties are described in Section 6.2. The CQA monitor shall provide on-site observation during leachate collection layer and piping installation in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during the leachate collection system installation to document the installation in the GLER, in accordance with Section 9.3.

6.2 Materials

6.2.1 Geocomposite

The leachate collection layer consists of geocomposite drainage net installed above the GM. Single-sided geocomposite (nonwoven geotextile bonded to the top of HDPE drainage net) will be installed on the floor, and double-sided geocomposite (nonwoven geotextile bonded to the top and bottom of HDPE drainage net) will be installed on the sidewalls. The geocomposite shall have the minimum properties listed in Table D7A-7.

Table D7A-7
New Boston Landfill
Geocomposite Properties

Material	Test	Standard	Required Property
Geotextile	Material		Nonwoven polypropylene or polyester
	Apparent Opening Size	ASTM D 4751	70 sieve maximum
	Unit Weight	ASTM D 5261	6 oz/yd^2
	Grab Strength	ASTM D 4632	150 lb
	Puncture Strength	ASTM D 4833	80 lb
HDPE Drainage Net	Specific Gravity	ASTM D 1505	0.93 g/cm^3
	Thickness	ASTM D 5199	0.20 inch
	Carbon Black	ASTM D 1603	Minimum 2%, maximum 3%
	Tensile Strength	ASTM D 5035	40 lb/in
Floor Geocomposite	Transmissivity	ASTM D 4716	4 x 10^{-4} m^2/sec
Sidewall Geocomposite	Transmissivity	ASTM D 4716	3 x 10^{-5} m^2/sec

Manufacturer quality control testing procedures and frequencies for geocomposite are listed in Section 6.5.1.

6.2.2 Geotextile

The leachate 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 D7A-8.

Table D7A-8
New Boston Landfill
Geotextile Properties

Test	Standard	Required Property
Material		Nonwoven polypropylene or polyester
Apparent Opening Size	ASTM D 4751	70 sieve maximum
Unit Weight	ASTM D 5261	6 oz/yd^2
Grab Strength	ASTM D 4632	150 lb
Tear Strength	ASTM D 4533	60 lb
Puncture Strength	ASTM D 4833	80 lb

Manufacturer quality control testing procedures and frequencies for geotextile are listed in Section 6.5.1.

6.2.3 Leachate Pipe

The leachate piping includes perforated collection trench pipes and the solid sidewall riser pipes. The leachate piping shall meet the cell classification PE345434C in accordance with ASTM D 3350. The pipe shall have the minimum SDR rating and perforation schedule shown on the plans and specifications.

6.2.4 Leachate Aggregate

Leachate aggregate will be placed in the collection trenches and in the sumps. The aggregate shall consist of manufactured or natural materials having the properties listed in Table D7A-9. Alternate gradations may be approved by the GP.

Table D7A-9
New Boston Landfill
Leachate Aggregate Properties

Test	Standard	Required Property	
Gradation	ASTM D 422	Sieve 1 1/2" 1/2" 3/8"	% Passing 90-100 20-50 0-15
Hydraulic Conductivity	ASTM D 2434	$\geq 1 \times 10^{-2}$ cm/sec	
Carbonate Content	JLT-S-105-89 or ASTM D 3042[a]	Maximum 15% loss	

[a] Use an HCL solution having a pH of 5 or lower.

Conformance testing procedures and frequencies for leachate aggregate are listed in Section 6.5.2.

6.2.5 Delivery and Storage

Geocomposite and geotextile shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected. Pipe shall be shipped in bundles labeled with the manufacturer's name and cell classification number.

The geocomposite, geotextile, and pipe shall be unloaded and handled with equipment that does not cause damage. Rolls should not be pushed, slid, or dragged to the storage location. The geocomposite and geotextile must not be stored on wet, soft, or rocky subgrade but must be stored on a stable subgrade. Geocomposite and geotextile must not be stacked more than five rolls high to avoid crushing the roll cores. The stored geocomposite, geotextile, and pipe must be protected from puncture, grease, dirt, excessive heat, or other damage.

6.3 Preparation

Prior to installation of the leachate collection layer the soil liner and GM shall be tested and verified in accordance with Sections 4.8 and 5.5. The CQA monitor shall observe that the surface to receive the geocomposite is free of debris, stones, and dirt and verify that the geocomposite conformance documentation has been submitted and approved.

6.4 Installation

6.4.1 Geocomposite

Double-sided geocomposite shall be installed on sidewalls and single-sided geocomposite shall be installed on the floor. Geocomposite shall be deployed by equipment that will unroll the geocomposite without damaging, crimping, or stretching it and deployment equipment must not damage the underlying GM. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and wearing shoes that could damage the geocomposite or GM shall not be permitted on the geocomposite and only low-ground pressure supporting equipment shall be allowed on the geocomposite or GM. Adjacent rolls of geocomposite shall be securely tied through the drainage net with plastic fasteners every five feet along the length of the panel and every six inches along the ends of the panels. The top geotextile of adjacent rolls shall be overlapped and be sewn or heat bonded together. Additional geotextile will be used at end seams to cover holes made by installation of the plastic fasteners. This material shall be sewn or heat bonded to the geotextile on the geocomposite. The installer shall take precautions to prevent burning holes in the geotextile when using heat bonding techniques.

During geocomposite placement, the CQA monitor must:

- Provide full time observation.
- Record weather conditions.
- Observe the condition of the geocomposite and note any defects. All defects must be repaired or replaced.
- Observe that people working on the geocomposite or GM do not smoke, wear shoes that could damage the geocomposite or GM, or engage in activities that could damage the geocomposite or GM.
- Observe that the deployment method minimizes wrinkles in the geocomposite and GM.
- Observe that the geocomposite panels have been properly tied and seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

6.4.2 Geotextile

Geotextile shall be placed around the leachate aggregate in the collection trenches and the sumps in accordance with the plans. Geotextile shall be deployed by equipment that will unroll the geocomposite without damaging or stretching it, and deployment equipment must not damage the underlying geosynthetics. Smoking and wearing shoes that could damage the geotextile, geocomposite, or GM shall not be permitted on the geotextile and only low-ground pressure supporting equipment shall be allowed on the geotextile, geocomposite, or GM. Adjacent rolls shall be overlapped and sewn or heat bonded together. The installer shall take precautions to prevent burning holes in the geotextile when using heat bonding techniques.

During geotextile placement, the CQA monitor must:

- Provide full time observation.

- Observe the condition of the geotextile and note any defects. All defects must be repaired or replaced.

- Observe that people working on the geotextile, geocomposite, or GM do not smoke, wear shoes that could damage the geotextile, geocomposite, or GM, or engage in activities that could damage the geotextile, geocomposite, or GM.

- Observe that the deployment method minimizes wrinkles in the geotextile, geocomposite, and GM.

- Observe that the geotextile panels have been properly seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

6.4.3 Pipe

Leachate pipe shall be placed to the lines and grades shown on the plans. The pipe shall be joined in accordance with the manufacturer's recommendations and the project specifications.

Construction equipment shall not be allowed to travel directly over the leachate pipes to prevent crushing or excessive deflection until aggregates and protective cover have been placed. Minimum equipment separation distances listed in Section 7.4, Table D7A-13 shall be observed.

During leachate pipe placement, the CQA monitor must:

- Provide full time observation.

- Observe the condition of the pipes and note any defects. All defective pipes must be replaced.

- Observe that people working on the geotextile, geocomposite, or GM do not smoke, wear shoes that could damage the geotextile, geocomposite, or GM, or engage in activities that could damage the geotextile, geocomposite, or GM.

- Observe that construction equipment does not damage pipes, geotextile, geocomposite, or GM.

- Observe that the perforations and pipe orientation are in accordance with the plans and specifications.

- Observe that the pipes and fittings are joined in accordance with the project specifications and the manufacturer's recommendations.

Any pipes that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

6.4.4 Leachate Aggregate

Leachate aggregate shall be placed in the collection trenches and sumps to the lines and grades shown on the plans. During leachate aggregate placement, the CQA monitor must:

- Observe that leachate aggregate is placed in accordance with the plans and specifications.
- Observe that the leachate aggregate is consistent with the conformance test samples.
- Observe that leachate aggregate placement activities do not dislodge or damage leachate pipes or underlying geosynthetics.

6.5 Testing and Verification

6.5.1 Manufacturer's Testing

The geocomposite manufacturer shall test the geocomposite to assure the quality of the geocomposite. Material property requirements are provided in Section 6.2.1. Minimum manufacturer's testing requirements are provided in Table D7A-10. The manufacturer's testing shall be conducted at a minimum frequency of one test per 100,000 sf of material.

Table D7A-10
New Boston Landfill
Geocomposite Manufacturer's Tests

Material	Test	Standard
Geotextile	Weight	ASTM D 5261
	Apparent Opening Size	ASTM D 4751
	Grab Strength	ASTM D 4632
	Puncture Strength	ASTM D 4833
HDPE Drainage Net	Specific Gravity	ASTM D 1505
	Thickness	ASTM D 5199
	Carbon Black	ASTM D 1603
Geocomposite	Transmissivity[1]	ASTM D 4716

[1] GP shall specify transmissivity test boundary conditions to approximate anticipated field conditions.

The geotextile manufacturer shall test the geotextile to assure the quality of the geotextile. Material property requirements are provided in Section 6.2.2. Minimum manufacturer's testing requirements are provided in Table D7A-11. The manufacturer's testing shall be conducted at a minimum frequency of 1 test per 100,000 sf of material.

Table D7A-11
New Boston Landfill
Geotextile Manufacturer's Tests

Test	Standard
Weight	ASTM D 5261
Apparent Opening Size	ASTM D 4751
Grab Strength	ASTM D 4632
Tear Strength	ASTM D 4533
Puncture Strength	ASTM D 4833

The leachate piping manufacturer shall provide a certification that the pipe meets the cell classification PE345434C in accordance with ASTM D 3350, and the minimum SDR rating and perforation schedule shown on the plans and specifications.

6.5.2 Construction Testing

The leachate aggregate shall be tested to assure that the aggregate meets the specifications. Material property requirements are provided in Section 6.2.4. Minimum construction testing requirements are provided in Table D7A-12.

Table D7A-12
New Boston Landfill
Leachate Aggregate Construction Tests

Test	Standard	Frequency
Gradation	ASTM D 422	1 per 3,000 cy
Hydraulic Conductivity	ASTM D 2434	1 per 3,000 cy
Carbonate Content	JLT-S-105-89 or ASTM D 3042[a]	1 per 3,000 cy

[a] Use an HCL solution having a pH of 5 or lower.

6.5.3 Verification

The as-built location of the leachate piping shall be determined and reported in the GLER. All components of the leachate collection system shall be verified and documented in the GLER in accordance with Section 9.3.

7 PROTECTIVE COVER

30 TAC §330.339

7.1 General

The protective cover component of the composite liner system consists of a 24-inch-thick layer of soils placed over the leachate collection layer. The drainage aggregate around the leachate collection pipes will extend through the protective cover to form a chimney drain for the leachate collection system. The CQA monitor shall provide continuous on-site observation during protective cover placement to assure that protective cover placement does not damage underlying geosynthetics in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during protective cover placement to document the construction activities, testing, and thickness verification in the GLER in accordance with Section 9.3.

7.2 Materials

Protective cover material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material, or any material that could damage the underlying geosynthetics. Since drainage aggregate chimneys will be provided above the LCS trenches, there are no permeability requirements for protective cover materials.

7.3 Preparation

Prior to placing the protective cover material, the top of compacted soil liner elevations shall be verified in accordance with the requirements of Section 4.8.3 and all testing on the underlying geosynthetics shall be completed.

7.4 Placement

The protective cover shall be placed in a manner that minimizes the potential to damage the underlying geosynthetics. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect the underlying geosynthetics. The protective cover shall be dumped from the haul road and spread by low ground pressure equipment in a manner that minimizes wrinkles and stress in the geosynthetics. On sidewalls, protective cover shall be placed from the bottom to the top, not across or down. The minimum separation distances between construction equipment and the geosynthetics are listed in Table D7A-13.

Table D7A-13
New Boston Landfill
Minimum Separation Distance

Equipment Ground Pressure (psi)	Minimum Separation Distance (in)
< 4	12
4 - 8	18
8 - 16	24
> 16	36

Any geosynthetic material that, in the opinion of the CQA monitor, has been damaged by the protective cover placement must be repaired and retested in accordance with Sections 5.4 and 6.4.

7.5 Testing and Verification

7.5.1 Testing

If the protective cover is counted as ballast against hydrostatic forces, the field density of the in-place protective cover shall be determined at a rate of one test per 10,000 sf. The in-place field density will be determined for information only, and there is no minimum compaction requirement for protective cover.

7.5.2 Thickness Verification

The as-built thickness of the protective cover shall be determined by standard survey methods. Prior to the placement of protective cover, the top of compacted soil liner elevations will be determined at a minimum rate of one survey point per 5,000 sf of lined area. After the protective cover is completed, the top of the protective cover elevations will be determined at the same locations as the top of compacted soil liner elevations.

8 BALLAST

30 TAC §330.337

8.1 General

The highest measured water elevations are presented in Attachment D7A, Appendix D7A-A and represent the highest groundwater elevations that have been encountered at the site. The highest measured water elevations will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water elevations must be adjusted upward. Lined areas will be dewatered during and after construction using a temporary dewatering system as described in Section 3.3.2.

Long-term hydrostatic uplift pressures will be resisted by the weight of the materials placed above the geomembrane liner in accordance with §330.337. Ballast includes the weight of the leachate collection system, protective cover, compacted waste, and final cover. The ballast will be documented in the BER in accordance with Section 9.4.

8.2 Ballast Geometry

For each new lined area, the GP will prepare calculations to determine the geometry of the ballast that is required to prevent hydrostatic uplift of the liner system with a minimum factor of safety of 1.5. Procedures for calculating the height of compacted waste or additional protective cover soil above the liner system needed to ballast hydrostatic pressure are provided in Attachment D7A, along with example calculations.

8.3 Ballast Materials

Ballast will consist of protective cover, leachate aggregate, infiltration layer, erosion layer, and solid waste. Material properties for protective cover are listed in Section 7.2 and material properties for leachate aggregate are listed in Section 6.2.4. Solid waste ballast will consist of waste accepted at the site in accordance with Part IV – Site Operating Plan. Large, bulky items must be excluded from the initial five feet of waste ballast.

8.4 Ballast Placement

Landfill personnel will be on site full time during the placement of the first five feet of waste over the liner system. They will verify and document that the initial five feet of waste does not contain large, bulky items which could damage the liner system or which cannot be compacted to the required density. Waste ballast must be compacted to a density of not less than 1,200 lb/cy or 44 pcf. The site manager will document that the waste used for ballast has been compacted with multiple passes of a wheeled compactor that weighs in excess of 40,000 pounds. The form to be used by the landfill manager is included in Attachment D7A, Appendix D7A-D. This documentation will be placed in the site operating record and attached to the BER.

8.5 Testing and Verification

Where protective cover is used as ballast, it will be tested in accordance with Section 7.5.1 and test results will be used to calculate the required ballast thickness. Where protective cover is not tested, the protective cover will be assumed to have a density of 90 percent of the maximum dry density of the material. Waste ballast compaction will be verified by the site manager and documented on the Waste-for-Ballast Placement Record. The GP will verify that the temporary dewatering system prevented uplift forces on the liner during construction of the liner. The verification will include observations of water levels in the dewatering sumps or survey data as deemed appropriate by the GP. The site manager will document that the dewatering system remained operational until ballast was placed. The documentation will be placed in the site operating record.

Once the calculated height of compacted waste has been achieved for each cell area, the temporary dewatering system no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. Before submittal of the BER, the GP will review compaction information and density of material used as ballast, and the thickness of all materials used in Ballast Calculations. A BER must be submitted to the TCEQ in accordance with Section 9.4 to document that adequate ballast height has been achieved and to request that the temporary dewatering system operations be discontinued.

9 DOCUMENTATION

30 TAC §330.341

9.1 Reports

Each report shall be submitted in triplicate to the TCEQ and shall be prepared in accordance with the methods and procedures contained in this LQCP. The evaluated area should not be used for the receipt of solid waste until acceptance is received from the executive director. The executive director may respond to the permittee either verbally or in writing within 14 days from the date on which the document is date-stamped by the TCEQ. Verbal acceptance may be obtained from the executive director, which will be followed by written concurrence. If no response, either written or verbal, is received within 14 days, the SLER or GLER shall be considered accepted and the owner or operator may continue facility construction or operations. Each report must be signed and, where applicable, sealed by the individual performing the evaluation and countersigned by the site operator or his authorized representative.

Markers will be placed to identify all disposal areas for which a SLER has been submitted and accepted by the executive director. These markers shall be located so that they are not destroyed during operations.

The surface of a liner should be covered with a layer of solid waste within a period of six months to mitigate the effects of surface erosion and rutting due to traffic. Liner surfaces not covered with waste within six months shall be checked by the SLER evaluator, who shall then submit a letter report on his findings to the executive director. Any required repairs shall be performed properly. An addendum to the SLER shall be submitted for all liners that need repair due to damage.

9.2 Soils and Liner Evaluation Report

After construction of the compacted soil liner, the GP will submit a SLER to the TCEQ on behalf of the owner. Preparation and submission of the SLER shall be in accordance with TCEQ MSWR. The purpose of the SLER is to document that the construction methods and test procedures are consistent with this LQCP, the TCEQ MSWR, and the project specifications.

At a minimum, the SLER will contain the following:

- TCEQ SLER form
- A summary of all construction activities
- A summary of all laboratory and field test results
- Sampling and testing location drawings

- A description of significant construction problems and the resolution of these problems
- Record drawings
- A statement of compliance with the LQCP
- An updated seasonal high water table map
- A detailed description of the temporary dewatering system
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act

9.3 Geomembrane Liner Evaluation Report

After construction of the geosynthetics portion of the liner, the GP will submit a GLER to the TCEQ on behalf of the owner. Preparation and submission of the GLER shall be in accordance with TCEQ MSWR. The purpose of the GLER is to document that the construction methods and test procedures are consistent with this LQCP, the TCEQ MSWR, and the project specifications.

At a minimum, the GLER will contain the following:

- TCEQ GLER form
- A summary of all construction activities
- A summary of all laboratory and field test results
- Sampling and testing location
- A description of significant construction problems and the resolution of these problems
- Record drawings
- A statement of compliance with the LQCP
- An updated seasonal high water table map
- A brief description of the temporary dewatering system
- Calculations for the required ballast thickness
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act

9.4 Ballast Evaluation Report

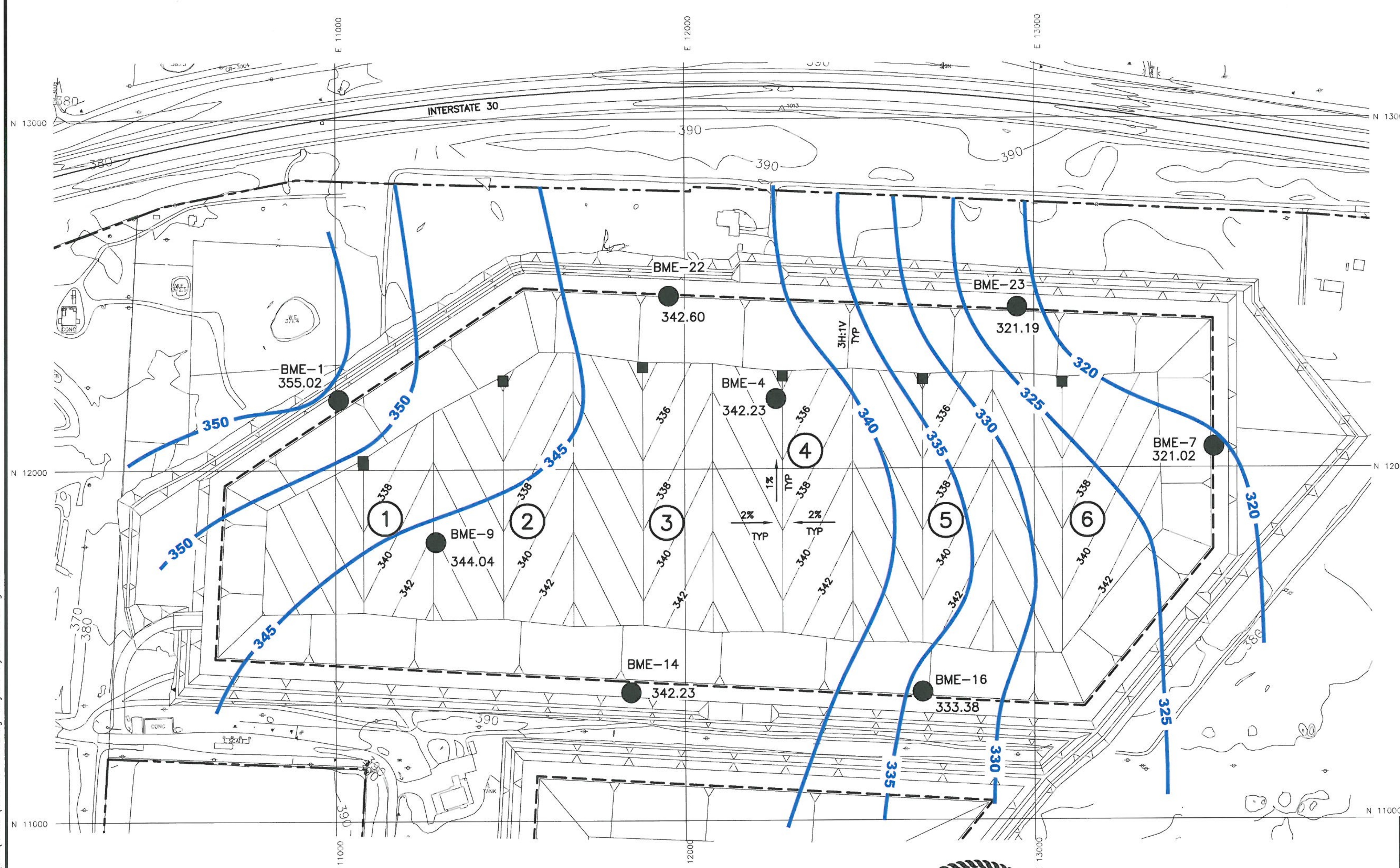
For areas where waste is used for ballast, a BER will be completed and submitted to the TCEQ. The purpose of the BER is to document that sufficient ballast has been placed to offset the potential long-term hydrostatic uplift forces that may exist below the liner system. The BER will provide documentation that the temporary groundwater control system is no longer required. The BER shall include the following information:

- Names and phone numbers of contact persons.
- Evaluation by the GP documenting that detrimental uplift has not occurred within the liner system. The evaluation shall include survey data as deemed pertinent by the GP.
- Certification from the owner of the type of waste placed in the lower 5 feet and documentation of the compaction from the Site Operating Record (see form in Attachment D7A, Appendix D7A-D).
- Survey of the top of waste to document that the required thickness has been placed.
- Documentation that any dewatering system used to lower the groundwater level during liner construction was in effect throughout the completion of the ballast placement.
- Documentation that the seasonal high water elevation has not increased from that presented in Attachment D7A, Appendix D7A-A or that additional ballast has been provided to compensate for upward changes in the high water table during ballast placement.
- The signature and seal of the registered professional engineer performing the evaluation and the signature of the owner's authorized representative.

If adequate ballast is placed on a liner as part of the construction process it will be documented in the GLER. If it is documented in the GLER that adequate ballast is present to counteract any hydrostatic uplift, a separate BER will not be required or submitted for that particular liner installation.

NEW BOSTON LANDFILL

APPENDIX D7A-A
HIGHEST MEASURED WATER LEVELS NORTH DISPOSAL AREA



LEGEND

- PERMIT BOUNDARY
- LANDFILL FOOTPRINT
- EXISTING CONTOUR (250)
- SITE GRID (N 11000)
- PROPOSED CONTOUR (338)
- HIGHEST MEASURED GROUNDWATER (340)
- SUMP
- SECTOR DESIGNATION (6)

NOTES:

1. EXISTING CONTOURS COMPILED BY AIR SURVEY FROM AERIAL SURVEY DATED MARCH 5, 2012.
2. PERMIT BOUNDARY PROVIDED BY MTG ENGINEERS AND SURVEYORS, INC.
3. PROPOSED CONTOURS DEPICT LINER SUBGRADE (EXCAVATION) GRADES.
4. ELEVATION OF DEEPEST EXCAVATION AT THE BOTTOM OF CELL 3 SUMP = 330 FT. MSL.
5. THE HIGHEST MEASURED GROUNDWATER CONTOURS DO NOT REPRESENT AN OBSERVED POTENTIOMETRIC SURFACE.

STATE OF TEXAS
GREGORY W. ADAMS
73356
REGISTERED PROFESSIONAL ENGINEER
7/8/2013

ISSUED FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
REVISIONS						

HIGHEST MEASURED WATER LEVELS NORTH DISPOSAL AREA

WASTE MANAGEMENT OF TEXAS, INC. NEW BOSTON LANDFILL PERMIT AMENDMENT APPLICATION

BIGGS & MATHEWS ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD ◆ WICHITA FALLS
817-563-1144

TBPE FIRM NO. F-256		TBPG FIRM NO. 50222
DSN. GWA	DATE : 6/13	DRAWING
DWN. GLW	SCALE : GRAPHIC	D7A–A.1
CHK. GWA	DWG : D7.A–A1–HMGW.dwg	

J:\101\05\112\Att D7\D7.A–A1–HMGW.dwg Layout: Layout1 User: gwhite

NEW BOSTON LANDFILL

APPENDIX D7A-B
TEMPORARY DEWATERING SYSTEM

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
7/8/2013

Includes pages D7A-B-1 through D7A-B-6

New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Required: Determine the inflow rate to the underdrain.

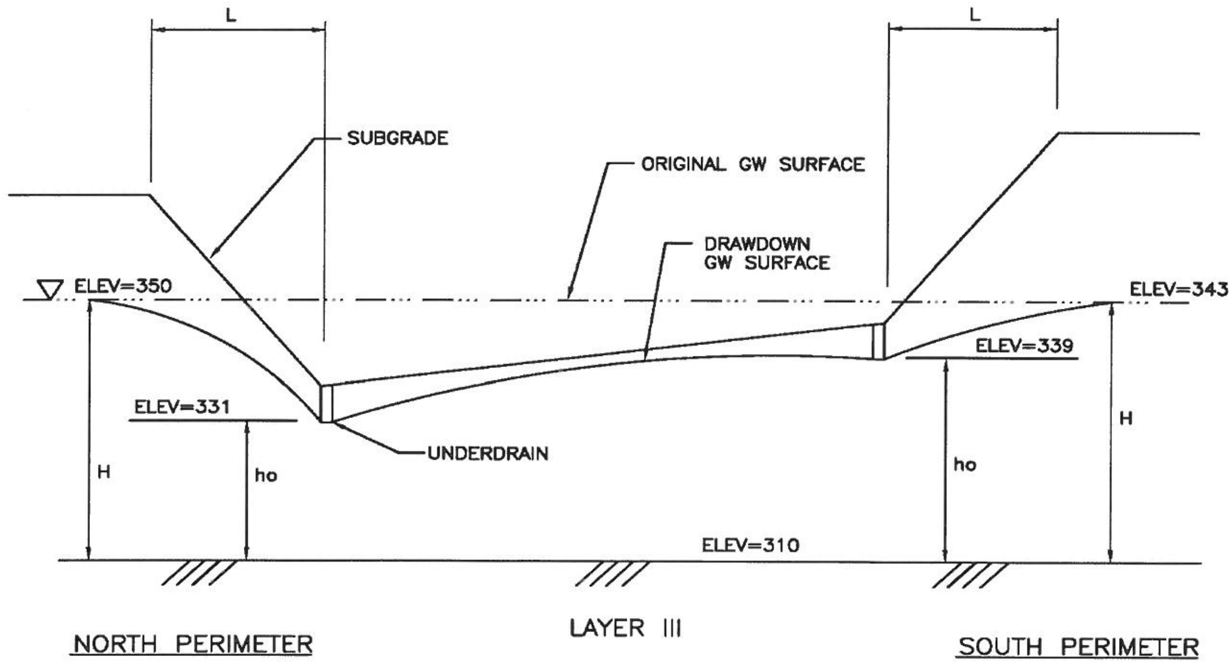
References: 1) *Dewatering and Groundwater Control*, UFC 3-220-05, January 2004 (replaces TM 5-818-5).

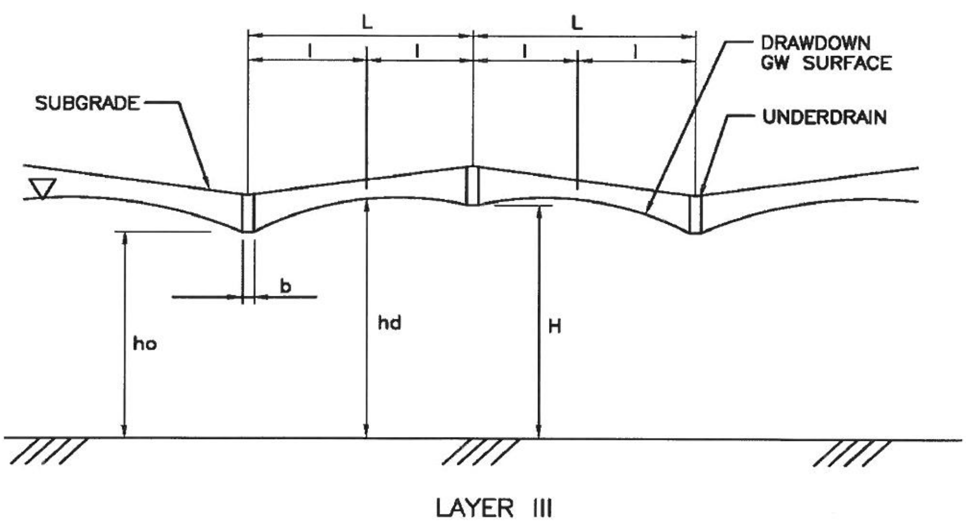
Assumptions:
1) The temporary dewatering system will be designed for the highest recorded water levels (see Drawing D7A-A.1).
2) The dewatering system plan and details are shown on Drawings D3.7 And D3.9.
3) The boundary of the uppermost ground water bearing unit (GWBU) is at the top of Layer III.

Solution:

Typical Sections

The underdrain consists of a network of composites drains in sand filled trenches that discharge into open or closed sumps. The typical underdrain sections are shown below.

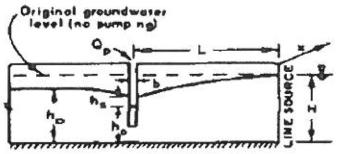




New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Determine the inflow of the underdrain from the methods presented in Reference 1 for partially penetrating slots.

Figure 4-3. Flow and head for partially penetrating line slot; single-line source; artesian, gravity, and combined flows.



h_s IS OBTAINED FROM FIG. 4-2

(c)

FLOW

$$Q_p = \left(0.73 + 0.27\frac{H - h_o}{H}\right)\frac{kx}{2L}(H^2 - h_o^2) \quad (3)$$

WHERE $L \geq 3H$

MAX RESIDUAL HEAD DOWNSTREAM OF SLOT

$$h_D = h_o\left[\frac{1.48}{L}(H - h_o) + 1\right] \quad (4)$$

GRAVITY FLOW

(Modified from "Foundation Engineering," G. A. Leonards, ed., 1962. McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.)

North Perimeter Underdrain

inflow:	$Q = [0.73 + 0.27(H - h_o)/H](Kx/2L)(H^2 - h_o^2)$		Ref 1, Fig. 4-3, Eq. 3.
where:	Q = inflow		
	H = design water elevation =		40.0 ft
	h_o = height of water at underdrain =		21.0 ft
	K = hydraulic conductivity of GWBU =		7.84E-06 fps
	x = unit length of underdrain =		1.0 ft
	L = length of drawdown =		200.0 ft
		Q =	**1.95E-05 cfs/ft**

West Perimeter Underdrain

inflow:	$Q = [0.73 + 0.27(H - h_o)/H](Kx/2L)(H^2 - h_o^2)$		Ref 1, Fig. 4-3, Eq. 3.
where:	Q = inflow		
	H = design water height =		36.0 ft
	h_o = height of water at underdrain =		31.0 ft
	K = hydraulic conductivity of GWBU =		7.84E-06 fps
	x = unit length of underdrain =		1.0 ft
	L = length of drawdown =		200.0 ft
		Q =	**5.04E-06 cfs/ft**

South Perimeter Underdrain

inflow:	$Q = [0.73 + 0.27(H - h_o)/H](Kx/2L)(H^2 - h_o^2)$		Ref 1, Fig. 4-3, Eq. 3.
where:	Q = inflow		
	H = design water elevation =		33.0 ft
	h_o = height of water at underdrain =		29.0 ft
	K = hydraulic conductivity of GWBU =		7.84E-06 fps
	x = unit length of underdrain =		1.0 ft
	L = length of drawdown =		200.0 ft
		Q =	**3.71E-06 cfs/ft**

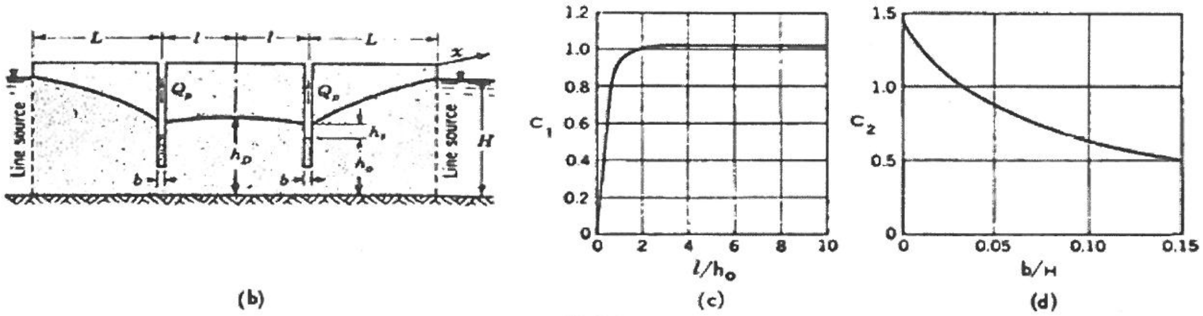
Interior Underdrain

inflow:	$Q = [0.73 + 0.27(H - h_o)/H](Kx/2L)(H^2 - h_o^2)$		Ref 1, Fig. 4-3, Eq. 3.
where:	Q = inflow		
	H = design water elevation =		29.0 ft
	h_o = height of water at underdrain =		25.0 ft
	K = hydraulic conductivity of GWBU =		7.84E-06 fps
	x = unit length of underdrain =		1.0 ft
	L = length of drawdown =		200.0 ft
		Q =	**3.25E-06 cfs/ft**

New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Determine the residual head (rebound) between the underdrains from the methods presented in Reference 1 for partially penetrating slots.

Figure 4-5. Flow and head (midway) for twopartially penetrating slots; two-line source; artesian and gravity flows,



FLOW

FLOW TO EACH SLOT APPROXIMATELY THAT ONE SLOT WITH ONE LINE SOURCE. EQ 3. FIG. 4-3.

h_D† — † MAXIMUM RESIDUAL HEAD MIDWAY BETWEEN THE TWO SLOTS.

$$h_D = h_o\left[\frac{C_1C_2}{L}(H - h_o) + 1\right]$$

WHERE C_1 AND C_2 ARE OBTAINED FROM FIG. (c) AND (d) ABOVE..

(Modified from "Foundation Engineering," G. A. Leonards, ed., 1962, McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.)

rebound: $h_d = h_o[((C_1C_2/L)(H - h_o) + 1)]$ — Ref 1, Fig. 4-5, Eq. 1.

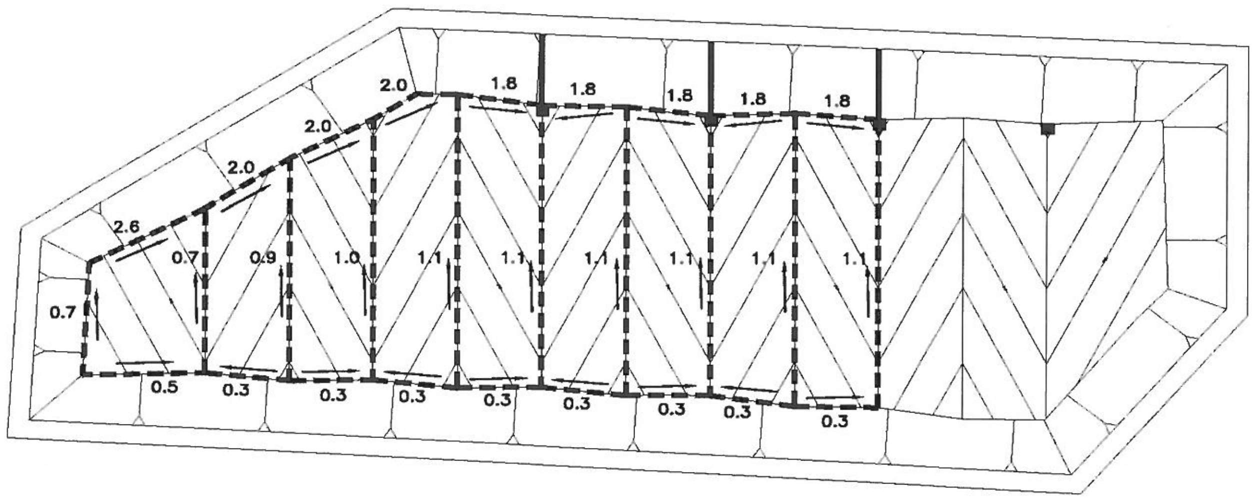
where: h_d = height at midpoint between drains

H = height of water surface =	29.0	ft
h_o = height of water at underdrain =	25.0	ft
L = length of drawdown =	200.0	ft
l = distance to midpoint of underdrains =	100.0	ft
b = width of underdrains =	1.0	ft
l/h_o =	4.0	
b/H =	0.03	
C_1 = coefficient from chart (c) =	1.0	
C_2 = coefficient from chart (d) =	1.0	

h_d = 25.5 ft

New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Determine the flow for each segment of the underdrain system by multiplying the inflow rate by the underdrain length.



ALL QUANTITIES IN GPM

New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Required: Size the following elements of the temporary dewatering system:
1) Composite Drains
2) Pumps

References: 1) *KTC-97-5, SPR-92-143, "Performance and Cost Effectiveness of Pavement Edge Drains",* L. John Fleckenstein, Kentucky Transportation Center, 1997.

Assumptions:
1) The dewatering system plan and details are shown on Drawings D3.7 And D3.9.
2) Flow rates are from the inflow rate calculations.

Solution

1) Maximum flowrate to a single underdrain occur at the north perimeter of Cell 3.

Maximum combined flow rate =	16.2	gpm
Flow capacity of 12" ADS Composite Drain =	39.0	gpm
Factor of Safety =	**2.4**	

2) Size pumps for 1.5 times the maximum flowrate

Flowrate to Cell 3 sump =	19.4	gpm
Cell 3 pump capacity =	**29.1**	**gpm**
Flowrate to Cell 4 sump =	6.4	gpm
Cell 4 pump capacity =	**9.6**	**gpm**
Flowrate to Cell 5 sump =	4.3	gpm
Cell 5 pump capacity =	**6.5**	**gpm**

New Boston Landfill
North Disposal Area Underdrdain Inflow Rate

Required: Determine the minimum geosynthetic properties for temporary dewatering system:
1) Geotextile for the composite drain.

References: 1) *Designing with Geosynthetics,* Fourth Edition; Robert M. Koerner.

Assumptions: 1) The adjacent soils will have at least 50% finer than the No. 200 sieve.

Solution: Calculate the required permittivity from the equation:

$$\Psi_{req} = q / \Delta hA$$

where:

Ψ_{req} = permittivity		
q = peak inflow rate to an underdrain =	1.95E-05	cfs/ft
Δh = maximum allowable head =	1.0	ft
L = trench unit length =	1.0	ft
H = drain height =	1.0	ft
A = inflow area = $L \times 2H$ =	2.0	sf

Substitute and solve for required permittivity = 9.75E-06 sec^{-1}

Calculate the allowabe permittivity from Reference 1, Equation 2.25.

$$\Psi_{req} = \Psi_{all} \; (1 / RF_{SCB} \; X \; RF_{CR} \; X \; RF_{IN} \; X \; RF_{CC} \; X \; RF_{BC})$$

where:

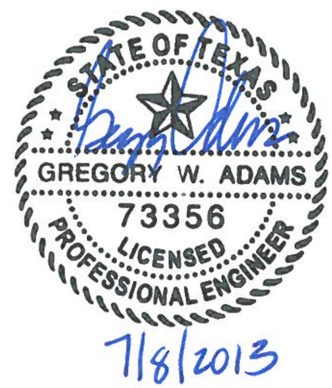
RF_{SCB} = soil clogging/binding reduction factor =	7.0	(Ref. 1, Table 2.12)
RF_{CR} = creep reduction factor =	1.5	(Ref. 1, Table 2.12)
RF_{IN} = intrusion reduction factor =	1.2	(Ref. 1, Table 2.12)
RF_{CC} = chemical clogging reduction factor =	1.0	(Ref. 1, Table 2.12)
RF_{BC} = biological clogging reduction factor =	1.0	(Ref. 1, Table 2.12)

Substitute and solve for allowable permittivity = 1.2E-04 sec^{-1}

For fine-grained, non-dispersive soils the AOS must be less than 0.21mm (Reference 1, Figure 2.4

NEW BOSTON LANDFILL

APPENDIX D7A-C
BALLAST CALCULATIONS



Includes pages D7A-C-1 through D7A-C-6

LINER BALLAST CALCULATIONS

The required ballast thickness shall be calculated by the GP and included in the GLER. The ballast calculation shall be based on the as-built conditions and the updated highest groundwater elevations. The required ballast thickness shall be calculated as follows:

A. Review and update, as necessary, the water level elevations (see Attachment D7A, Appendix D7A-A – Highest Measured Water Levels). Adjust the seasonal high water table upward, if necessary, across the area being lined using the highest measured water levels derived from the most recent piezometer water level readings. Determine the design water level for the area being analyzed. The lined area may be subdivided into more than one area as appropriate for changes in groundwater table elevations and/or subgrade elevations across the lined area.

B. Determine the hydrostatic uplift pressure on the base of the bottom and sidewall liner system including normal, vertical, and horizontal components of the uplift pressure as follows:

   1. Bottom Liner: Determine the maximum hydrostatic uplift pressures acting normal to the base of the bottom liner system using the unit weight of water, γ_W, times the vertical distance from the excavation to the design water level, H.

$$P_N = \gamma_W H$$

   2. Sidewall Liner: Determine the maximum hydrostatic uplift pressures acting normal, vertical, and horizontal to the base of the sidewall liner system using the following steps.

      (a) Determine the maximum normal uplift pressure on the sidewall liner using the unit weight of water times the vertical distance from the base of the layer to the design water level, H.

$$P_N = \gamma_W H$$

      (b) Determine the maximum vertical uplift pressure on the sidewall liner using the normal uplift pressure times the cosine of the slope angle.

$$P_V = P_N \cos \beta$$

      (c) Determine the maximum horizontal uplift pressure on the sidewall liner using the normal uplift pressure times the sine of the slope angle.

$$P_H = P_N \sin \beta$$

C. Determine the resisting pressure against uplift of the bottom and sidewall liner system including normal, vertical, and horizontal components of the resisting pressures as follows:

1. Bottom Liner: Determine the normal resisting pressure at the GM using the unit weight of the protective cover times the thickness of the protective cover.

$$R_N = (\gamma_{pc} \, T_{pc})$$

Where: γ_{pc} = Wet unit weight of the protective cover
T_{pc} = Thickness of the protective cover

The unit weight of the protective cover shall be determined from field measured unit weights.

2. Sidewall Liner:

(a) Determine the vertical resisting pressure of the sidewall liner using the unit weight of the protective cover material times the vertical thickness of the protective cover layer. This is equal to the normal resisting pressure divided by the cosine of the slope angle.

$$R_v = R_N / \cos \beta$$

(b) Determine the horizontal resisting pressure of the sidewall liner using the coefficient of at-rest earth pressure of the liner system components times the vertical resisting pressure.

$$R_H = K_O \, R_V$$

The coefficient of at-rest earth pressure, K_O, is based on the assumed angle of internal friction, ϕ, of the material resisting hydrostatic pressures (compacted soil).

(c) Determine the normal resisting pressure of the sidewall liner system using the normal components of the horizontal and vertical resisting pressures calculated in steps (a) and (b) above.

$$R_N = R_H \sin \beta + R_V \cos \beta$$

D. Evaluate the factor of safety against uplift of the bottom and sidewall liner system due to hydrostatic pressures.

1. Bottom Liner: Determine the factor of safety against uplift of the bottom liner system due to hydrostatic forces acting normal to the base of the bottom liner system.

$$FS = R_N / P_N$$

If the factor of safety is greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic uplift forces.

If the factor of safety is less than 1.2, additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional ballast.

2. Sidewall Liner:

Determine the factor of safety against uplift of the sidewall liner system due to hydrostatic pressures acting normal, vertical, and horizontal to the sidewall liner system.

$$FS_N = R_N / P_N$$

$$FS_V = R_V / P_V$$

$$FS_H = R_H / P_H$$

If the factors of safety are greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic forces.

If the factor of safety is less than 1.2 for any of the components (normal, vertical, or horizontal), additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional soil ballast.

E. Use a factor of safety of 1.5 against uplift of the liner and ballast system for solid waste ballast and a factor of safety of 1.2 for soil ballast.

Assume a unit weight of 44 pcf for solid waste and a unit weight of 100 pcf for soil if field measurements are not available, or if conditions indicate the field measurements are no longer applicable.

1. Bottom Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

$$FS = (R_N + B_N) / P_N$$

Where R_N = Normal protective cover pressure
B_N = Normal ballast pressure
B_N = $H * \gamma$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_N - R_N) / \gamma$$

2. Sidewall Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

(a) $FS = (R_V + B_V) / P_V$

Where R_V = Vertical protective cover pressure
B_V = Vertical ballast pressure
B_V = $H * \gamma$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_V - R_V) / \gamma$$

(b) $FS = (R_H + B_H) / P_H$

Where R_H = Horizontal protective cover pressure
B_H = Horizontal ballast pressure
B_H = $B_V * K_0$
B_H = $H * \gamma * 0.7$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_H - R_H) / \gamma * k_0$$

Example calculations are provided on pages D7A-C-5 through D7A-C-6.

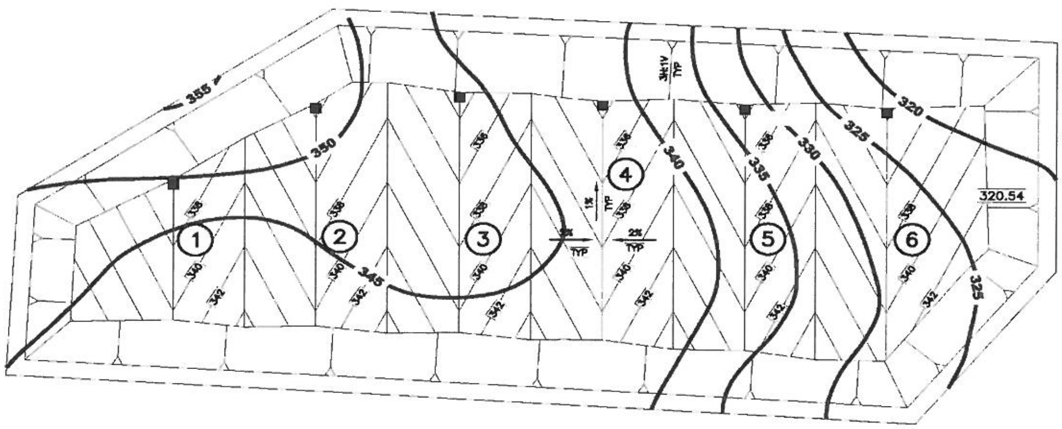
New Boston Landfill
North Disposal Area Ballast Design

Required: Evaluate the long-term hydrostatic uplift pressures on the liner system and determine the ballast requirements.

References: 1) *Guidance Handbook for Liners Constructed Below the Groundwater Table,* TNRCC, 1995.

Assumptions:
1) The design water elevations are shown on Drawing D7A-A.1.
2) All cells must be re-evaluated based on updated groundwater data prior to construction.
3) Assume normal and vertical forces to be the same in the bottom, and design for normal forces.
4) Uplift is evaluated at the soil liner geomembrane interface.

Solution: Calculations are shown for the toe of Cell 2 where the groundwater elevation is highest. The results for other locations are provided in the table at the end of the calculations.



The forces acting upon the liner system are:

P_N = normal pressure	R_N = normal resistance
P_V = vertical pressure	R_V = vertical resistance
P_H = horizontal pressure	R_H = horizontal resistance

1) Determine the uplift pressure upon the FML at the bottom and at the toe of the slopes.

γ_w = unit weight of water =	62.4 pcf
H = design water level above liner =	15 ft
b = sidewall slope =	18.43 deg

Bottom	$P_N = H\gamma_w =$	936.0 psf
Slope	$P_N = H\gamma_w =$	936.0 psf
	$P_H = P_N \sin\beta =$	295.9 psf
	$P_V = P_N \cos\beta =$	888.0 psf

2) Determine the resistance pressure at the bottom and on the slope.

Protective cover:

γ = density =	112.0 pcf
T_N = normal thickness =	2.0 ft
T_V = vertical thickness =	2.1 ft
ϕ = angle of internal friction =	17.0 deg

New Boston Landfill
North Disposal Area Ballast Design

Waste:

γ_{waste} = density =	44.0	pcf
T_V = vertical thickness =	95.0	ft

Infiltration:

γ = density (95% std proctor or field data) =	125.0	pcf
T_V = vertical thickness =	1.5	ft

Erosion:

γ = density=	112.0	pcf
T_V = vertical thickness =	2.0	ft

Bottom $R_N = \Sigma T_N \gamma =$ 4815.5 psf

Slope
$R_H = k_o R_V =$ 2413.8 psf
$R_V = \Sigma T_V \gamma =$ 4827.6 psf
$R_N = R_V \cos\beta + R_H \sin\beta =$ 5343.1 psf

3) Determine the factors of safety against uplift and evaluate the need for additional ballast.

Bottom $FS_N = R_N / P_N =$ 5.1

Slope
$FS_H = R_H / P_H =$ 8.2
$FS_V = R_V / P_V =$ 5.4
$FS_N = R_N / P_N =$ 5.7

4) Based on the above calculation, the critical condition occurs in the bottom of the lined area. Evaluate the normal factor of safety for other points on the liner. The normal resistance provided by the protective cover and final cover system is the same for all points in the lined area.

R_N (floor) = 635.5 psf

Cell	GM EL	GW EL	H	Hwaste	R_N	P_N	FS
1	338.0	350.0	12.0	85.0	4375.5	748.8	5.8
2	336.0	351.0	15.0	95.0	4815.5	936.0	5.1
3	336.0	346.0	10.0	95.0	4815.5	624.0	7.7
4	336.0	342.0	6.0	95.0	4815.5	374.4	12.9
5	338.0	340.0	2.0	95.0	4815.5	124.8	38.6

5) Check the height of waste in each cell when the underdrain will no longer be needed. The normal resistance provided by the protective cover is the same for all points in the lined area.

R_N (floor) = 224 psf

Cell	GM EL	GW EL	H	FS	P_N	R_N	Hwaste [1]
1	338.0	350.0	12.0	1.5	748.8	1123.2	20.4
2	336.0	351.0	15.0	1.5	936.0	1404.0	26.8
3	336.0	346.0	10.0	1.5	624.0	936.0	16.2
4	336.0	342.0	6.0	1.5	374.4	561.6	7.7
5	338.0	340.0	2.0	1.5	124.8	187.2	-0.8

(1) The height of waste is specific to the evaluation point, not the landfill floor. A Ballast Evaluation Report will be submitted to the TCEQ prior to decomissioning the underdrain system.

NEW BOSTON LANDFILL

APPENDIX D7A-D
WASTE-FOR-BALLAST PLACEMENT RECORD

WASTE-FOR-BALLAST PLACEMENT RECORD

This form is to be completed by the landfill manager for all landfilled areas requiring waste-for-ballast. One form will be developed for each area as addressed in a Soil and Liner Evaluation Report (SLER). The Professional of Record (POR) may reference this form in order to certify that the placement of ballast is in compliance with the LQCP.

GENERAL INFORMATION

Area documented by this record (provide site grid coordinates of each corner):

____

____

____

____

SLER approval date for this area: ________________

Date of initial waste placement: ________________

Date of completion of first five feet of waste in place over entire area: ________________

Total required waste-for-ballast thickness for this area:
(Note: Calculations for determining the required thickness of waste-as-ballast will be included with the SLER for this area.) ________________

Date when minimum required thickness of waste was achieved: ________________

Actual waste-for-ballast thickness demonstrated by this record: ________________

WASTE EQUIPMENT USED

- ☐ 40,000-pound minimum gross weight wheeled compactor.
  Specify equipment used:________________________________

FIRST LIFT CONSIDERATIONS

- ☐ No brush, large, bulky, elongated or other waste items which could damage the underlying liner system have been placed within the first five feet of waste above the top of the protective cover.

- ☐ A five-foot lift of loose waste (acceptable waste defined above) has been maintained between the waste compaction equipment and the top of the liner protective cover in all fill areas to allow uniform compaction of the waste material.

- ☐ Describe type(s) of waste placed in the first five feet of waste over the top of the liner protective cover.

  ____

  ____

WASTE COMPACTION METHODS FOR THE TOTAL WASTE-FOR-BALLAST THICKNESS

- ☐ Loose waste layer thickness was less than two-feet-thick prior to compaction to allow uniform compaction of the acceptable waste material (i.e., no brush, large bulky items).
- ☐ Compaction was achieved over the entire area evaluated using a minimum of three passes of at least one track for each loose waste layer.
- ☐ The slope of the compacted waste layers was less than (flatter) 4 horizontal to 1 vertical.

SIGNATURE OF PERMITTEE

The waste overlying the area described in this record has been placed and compacted as described in this record and in accordance with the site Soils and Liner Quality Control Plan and Site Operating Plan.

____
Signature

Waste Management of Texas, Inc.

____
Typed or Printed Name

____
Title

____
Date Signed

Note: This completed form will be placed in the Operating Record and will be available for TCEQ review.

NEW BOSTON LANDFILL

APPENDIX D7A-E
GRI-GM13

Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

Revision 10: April 11, 2011
Revision schedule on pg. 11

GRI Test Method GM13*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version.

values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792	Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004	Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
D 1603	Test Method for Carbon Black in Olefin Plastics
D 3895	Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218	Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397	Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596	Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721	Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885	Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994	Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370	Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693	Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7466	Test Method for Measuring the Asperity Height of Textured Geomembranes

2.2 GRI Standards

GM10	Specification for the Stress Crack Resistance of Geomembrane Sheet
GM 11	Accelerated Weathering of Geomembranes using a Fluorescent UVA-Condensation Exposure Device

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation, n - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)
- Trouser Tear (see Note 7)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: There is a GRI test currently included in this standard. Since this topic is not covered in ASTM standards, this is necessary. It is the following:

- UV Fluorescent Light Exposure

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.)	D5199	nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Per roll
• lowest individual of 10 values		-10%	-10%	-10%	-10%	-10%	-10%	-10%	
Density mg/l (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693 Type IV								20,000 lb
• yield strength		63 lb/in.	84 lb/in.	105 lb/in.	126 lb/in.	168 lb/in.	210 lb/in.	252 lb/in.	
• break strength		114 lb/in.	152 lb/in.	190 lb/in.	228 lb/in.	304 lb/in.	380 lb/in.	456 lb/in.	
• yield elongation		12%	12%	12%	12%	12%	12%	12%	
• break elongation		700%	700%	700%	700%	700%	700%	700%	
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	54 lb	72 lb	90 lb	108 lb	144 lb	180 lb	216 lb	45,000 lb
Stress Crack Resistance *(2)*	D5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI-GM10
Carbon Black Content (range)	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT	D 3895	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	100 min.	
— or —									
(b) High Pressure OIT	D 5885	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	400 min.	
Oven Aging at 85°C *(5), (6)*	D 5721								per each formulation
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55%	55%	55%	55%	55%	55%	55%	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80%	80%	80%	80%	80%	80%	80%	
UV Resistance *(7)*	GM 11								per each formulation
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50%	50%	50%	50%	50%	50%	50%	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - mils (min. ave.) • lowest individual of 10 values	D5199	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	nom. (mil) -10%	per roll
Density (min.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	 11 kN/m 20 kN/m 12% 700%	 15 kN/m 27 kN/m 12% 700%	 18 kN/m 33 kN/m 12% 700%	 22 kN/m 40 kN/m 12% 700%	 29 kN/m 53 kN/m 12% 700%	 37 kN/m 67 kN/m 12% 700%	 44 kN/m 80 kN/m 12% 700%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	240 N	320 N	400 N	480 N	640 N	800 N	960 N	20,000 kg
Stress Crack Resistance *(2)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM-10
Carbon Black Content - %	D 4218 *(3)*	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	2.0-3.0%	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	 100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	 55% 80%	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	 D 3895 D 5885	 N. R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	 N.R. *(8)* 50%	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm
(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 45 lb/in. 12% 100%	84 lb/in. 60 lb/in. 12% 100%	105 lb/in. 75 lb/in. 12% 100%	126 lb/in. 90 lb/in. 12% 100%	168 lb/in. 120 lb/in. 12% 100%	210 lb/in. 150 lb/in. 12% 100%	252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7), (8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 6.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches
(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	0.25 mm	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	90,000 kg
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	11 kN/m 8 kN/m 12% 100%	15 kN/m 10 kN/m 12% 100%	18 kN/m 13 kN/m 12% 100%	22 kN/m 16 kN/m 12% 100%	29 kN/m 21 kN/m 12% 100%	37 kN/m 26 kN/m 12% 100%	44 kN/m 32 kN/m 12% 100%	9,000 kg
Tear Resistance (min. ave.)	D 1004	93 N	125 N	156 N	187 N	249 N	311 N	374 N	20,000 kg
Puncture Resistance (min. ave.)	D 4833	200N	267 N	333 N	400 N	534 N	667 N	800 N	20,000 kg
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	9,000 kg
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	90,000 kg
Oven Aging at 85°C *(7)*, *(8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 0.18 mm, and lowest individual reading must be ≥ 0.13 mm; also see Note 6.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm
(4) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods

NEW BOSTON LANDFILL
BOWIE COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 576C

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT D7B
SOUTH DISPOSAL AREA LINER QUALITY CONTROL PLAN

Prepared for

Waste Management of Texas, Inc.

July 2013

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
7/8/2013

Prepared by

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TEXAS BOARD OF PROFESSIONAL ENGINEERS
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STATE OF TEXAS
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73356
LICENSED
PROFESSIONAL ENGINEER
7/8/2013

CONTENTS

30 TAC §§330.63(d)(4)(G), 330.331, 330.337, 330.339, 330.341

STATE OF TEXAS
GREGORY W. ADAMS
73356
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PROFESSIONAL ENGINEER
7/8/2013

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TABLES

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1 INTRODUCTION

30 TAC §330.339

1.1 Purpose

The South Disposal Area of the New Boston Landfill will accept only Type IV municipal solid waste.

This Liner Quality Control Plan (LQCP) has been prepared in accordance with 30 TAC §330.339 to establish procedures for the design, construction, testing, and documentation of the liner system for the South Disposal Area.

1.2 Definitions

Specific terms and acronyms that are used in this LQCP are defined below.

ASTM – American Society for Testing and Material

BER – Ballast Evaluation Report

Construction Quality Assurance (CQA) – CQA is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes the observations, evaluations, and testing necessary to assess and document the quality of the constructed facility. CQA includes measures taken by the CQA organization to assess whether the work is in compliance with the plans, specifications, and permit requirements for a project.

Geotechnical Professional (GP) – The GP is the authorized representative of the operator who is responsible for all CQA activities for the project. The GP must be registered as a Professional Engineer in Texas. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, construction quality assurance and quality control testing, and hydrogeology. The GP must also have competency and experience in certifying similar projects.

The GP may also be known in applicable regulations and guidelines as the CQA engineer, resident project representative, geotechnical quality control/quality assurance professional (GQCP), or professional of record (POR).

CQA Monitors – CQA monitors are representatives of the GP who work under direct supervision of the GP. The CQA monitor is responsible for quality assurance monitoring and performing on-site tests and observations. The CQA monitor must be NICET-certified at Level 2 for soils and geosynthetics, an engineering technician with a minimum of four years directly related experience, or a graduate engineer or geologist with one year of directly related experience.

Quality Assurance – Quality assurance is a planned program that is designed to assure that the work meets the requirements of the plans, specifications, and permit for a project. Quality assurance includes procedures, quality control activities, and documentation that are performed by the GP and CQA monitor.

Quality Control – Quality control includes the activities that implement the quality assurance program. The GP, CQA monitor, and contractor will perform quality control.

Seasonal High Water Table – The seasonal high water table is the highest measured water level within the construction area.

SLER – Soil Liner Evaluation Report

1.3 Sequence of Construction Activities

Generally construction of lined areas in the South Disposal Area will proceed in the following sequence of activities:

- The area will be excavated to the proposed subgrade elevations.
- A temporary dewatering system, if required, will be installed as described in Section 3.3.
- The subgrade elevations will be verified.
- The compacted soil liner will be constructed, tested, and verified in accordance with Section 4.
- The protective cover will be constructed and verified in accordance with Section 5.
- The Soils and Liner Evaluation Report will be submitted to the TCEQ.

2 LINER SYSTEM

30 TAC §330.331

2.1 Type IV Liner System

The components of the Type IV liner system are listed from top to bottom in Table D7B-1. Details of the Type IV liner system are provided in Attachment D3 – Construction Design Details.

Table D7B-1
New Boston Landfill
Components of the Type IV Liner System

Liner System Component	Description	Thickness
Protective Cover	General earthfill	12 inches minimum
Compacted Soil Liner	Compacted soil with a coefficient of permeability less than or equal to 1 x 10^{-7} cm/sec	36 inches minimum

2.2 Construction Monitoring

Continuous on-site monitoring is necessary to confirm that the components of the liner system are constructed in accordance with this LQCP. In accordance with 30 TAC §330.339(a)(2), the CQA monitor shall provide continuous on-site observation and field sampling and testing as required during the following construction activities:

- Temporary dewatering system installation
- Subgrade preparation
- Compacted soil liner placement, processing, compaction, and testing
- Protective cover layer placement
- Any work that could damage the installed components of the liner system

The GP will document and certify that the liner system was constructed in accordance with this LQCP. The GP shall make sufficient site visits to observe critical construction activities and to verify that the construction and quality assurance activities are performed in accordance with this LQCP.

3 EARTHWORK

30 TAC §§330.337, 330.339

3.1 General

The proposed grading plan for the South Disposal Area at the New Boston Landfill (Attachment D3, Drawing D3.2) provides for the landfill floor subgrade to be at elevation 340 ft-msl and the sidewalls to have a 3H:1V slope. Earthwork activities and testing will be documented in the SLER in accordance with Section 7.2.

3.2 Materials

The following material classifications will be encountered in excavations or will be required for landfill construction.

General Fill

General fill consists of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than four inches in diameter.

Compacted Soil Liner

Compacted soil liner materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 4.2.

Protective Cover

Protective cover materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 5.2.

Weekly and Intermediate Cover

Weekly and intermediate cover materials consist of soil that has not been previously mixed with solid waste.

Topsoil

Topsoil consists of soil that is capable of sustaining vegetation and is free of debris, rubbish, and solid waste.

Unsuitable Materials

Unsuitable materials consist of any material that is determined by the GP to not be suitable for use as classified above.

3.3 Construction Below Groundwater

3.3.1 Highest Measured Water Elevations

The highest measured water elevations will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water elevations will be adjusted upward.

3.3.2 Temporary Dewatering

As shown in Attachment D3, Drawing D3.8, the excavations will extend below the highest recorded groundwater elevations in the western 3/4 of the landfill. Areas where the liner is to be constructed below the highest measured groundwater elevations will be dewatered during and after construction by a temporary dewatering system. The temporary dewatering system will be a network of underdrains consisting of HDPE panel-shaped pipe, wrapped in geotextile, encased in sand-filled trenches. The underdrains will discharge into open sumps beyond the lined areas or a closed sump beneath the lined areas. The groundwater will be pumped from the sumps into the perimeter drainage system. An automated submersible pump will be installed in the closed sump. The pump will be equipped with a pressure transducer to monitor the groundwater level and level controls to turn the pump on when the water reaches the top of the sump and turn the pump off when the water reaches the lower operational limit of the pump. The temporary dewatering system will be operated until sufficient ballast has been placed over the liner system to offset the hydrostatic forces and the ballast has been documented in the BER.

The design procedures and typical details of the temporary dewatering system are provided in Attachment D7B, Appendix D7B-B. Design and installation of the temporary dewatering system will be documented in the SLER in accordance with Section 7.2. The facility will submit a BER to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations.

3.4 Excavation

A description of the materials that will be encountered in the excavations is provided in Attachment D5 – Geotechnical Design.

The slope stability analyses are provided in Attachment D5, Appendix D5-B – Slope Stability Analyses. The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the excavation plan, dewatering system, ballast system, liner system, final cover system, or landfill completion plan will necessitate that the slope stability analyses be revised to reflect the actual conditions. Interim 3H:1V waste slopes shall not exceed 100 feet in height. Temporary construction slopes shall not be steeper than the interim slopes and concentrated loadings such as heavy equipment and soil stockpiles should not be placed near the crest of slopes unless additional slope stability analyses are performed.

4 COMPACTED SOIL LINER

30 TAC §330.339

4.1 General

The compacted soil liner component of the Type IV liner system consists of a 36-inch-thick layer of compacted, relatively homogeneous, cohesive material. The CQA monitor shall provide continuous on-site observation during compacted soil liner placement, compaction, and testing in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during compacted soil liner construction to document the construction activities, testing, and thickness verification in the SLER, in accordance with Section 7.2.

4.2 Materials

Compacted soil liner material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material. The required compacted soil liner material properties are summarized in Table D7B-2.

Table D7B-2
New Boston Landfill
Compacted Soil Liner Material Properties

Test	Standard	Required Property
Plasticity Index	ASTM D 4318	15 or greater
Liquid Limit	ASTM D 4318	30 or greater
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	30 or greater
Percent Passing 1-inch Sieve	ASTM D 422	100
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1×10^{-7} cm/sec or less

Preconstruction testing procedures and frequencies for compacted soil liner materials are listed in Section 4.8.1.

4.3 Subgrade Preparation

Prior to placing soil liner material, the subgrade should be proof-rolled with heavy, rubber-tired construction equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling operation. Soft areas should be undercut to firm material, then backfilled with compacted general fill. The GP will observe the subgrade for groundwater seepage and take appropriate actions when necessary.

The subgrade elevations shall be verified in accordance with the requirements of Section 4.8.3 prior to the placement of compacted soil liner.

4.4 Placement and Processing

The compacted soil subgrade and surface of each lift should be roughened prior to placement of the next lift of compacted soil liner. The soil liner material should be placed in maximum 8-inch loose lifts to produce compacted lift thickness of approximately 6 inches. The material should be processed to a maximum particle size of 1 inch or less before water is added. Rocks and clods less than 1 inch in diameter should not total more than 10 percent by weight. The surface of the top lift shall contain no material larger than 3/8 inch.

If additional water is necessary to adjust the moisture content, it should be applied after initial processing, but prior to compaction. Water should be applied evenly across the lift and worked into the material. Water used for the soil liner compaction must not be contaminated by waste or any objectionable material.

4.5 Compaction

The soil liner shall be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to bond the lifts, to distribute the water, and to blend the soil matrix through kneading action. Soil liner shall not be compacted with a bulldozer, rubber-tired roller, flat-wheel roller, scraper, truck, or any track equipment unless it is used to pull a footed roller. The compactor should weigh at least 40,000 pounds. The lift thickness shall be controlled to achieve penetration into the top of the previously compacted lift; therefore, the lift thickness should not be greater than the pad or prong length. Cleaning devices on the roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration.

The compactor should make approximately four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content at or above optimum moisture. Areas with failing tests shall be reworked, recompacted, and retested, and passing tests must be achieved before another lift is added.

After a lift is compacted, it must be watered to prevent drying and desiccation until the next lift can be placed. If desiccation occurs, the GP must determine if the lift can be rehydrated by surface application of water or if the lift must be scarified, watered, and recompacted. Following compaction and fine grading of the final lift, the surface of the compacted soil liner shall be smooth drum rolled.

4.6 Protection

The completed compacted soil liner must be protected from drying, desiccation, rutting, erosion, and ponded water until the protective cover is installed. Areas that undergo excessive desiccation or damage shall be reworked, recompacted, and retested as directed by the GP.

4.7 Tie in to Existing Liners

The edge of existing compacted soil liners shall be cut back on either a slope or steps to prevent the formation of a vertical joint. Details of the existing liner tie-in are shown in Attachment D3.

4.8 Testing and Verification

4.8.1 Preconstruction Testing

Table D7B-3 lists the minimum testing required for material proposed for use as compacted soil liner.

Table D7B-3
New Boston Landfill
Compacted Soil Liner Material Preconstruction Tests

Test	Standard	Frequency
Plasticity Index	ASTM D 4318	1 per material type
Liquid Limit	ASTM D 4318	1 per material type
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per material type
Percent Passing 1-inch Sieve	ASTM D 422	1 per material type
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1 per material type

After the moisture density relationship has been determined for a material type, a soil sample should be remolded to about 95 percent of the maximum dry density at the optimum moisture content. This sample will be tested to determine if the soil can be compacted to achieve the required coefficient of permeability. Either falling head or constant head laboratory permeability tests may be performed to determine the coefficient of permeability. The permeant fluid for testing must be tap water or 0.005N calcium sulfate solution. Distilled or deionized water shall not be used as the permeant fluid.

4.8.2 Construction Testing

All quality control testing will be performed during construction of the liner, except for testing that is required after individual lifts are constructed. Table D7B-4 lists the minimum testing required for material used as compacted soil liner.

Table D7B-4
New Boston Landfill
Compacted Soil Liner Material Construction Tests

Test	Standard	Frequency
Field Density	ASTM D 2922	1/8,000 sf per 6-inch lift
Plasticity Index	ASTM D 4318	1/100,000 sf per 6-inch lift
Liquid Limit	ASTM D 4318	1/100,000 sf per 6-inch lift
Percent Passing 1-inch and No. 200 Sieve	ASTM D 1140 ASTM D 422	1/100,000 sf per 6-inch lift
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII or ASTM D 5093[1]	1/100,000 sf per 6-inch lift
Moisture Content	ASTM D 2216	1/100,000 sf per 6-inch lift

[1] In the event that field permeability testing procedures are alternatively used for construction testing, field permeability tests will be performed in accordance with ASTM D5093 for soil liners that are in the floor of the excavation and a variation of the Boutwell STEI Field Permeability Test approved by the executive director for the sidewalls, or in accordance with guidance furnished by the executive director.

The Atterberg limits of the in-place compacted soil liner must be compared to the Atterberg limits of the Proctor curve sample to assure that the Proctor curve represents the in-place material. Any variance of more than 10 points between the liquid limit or plasticity index of the in-place soil and those of the Proctor curve sample will require that a new Proctor curve be developed. Permeability testing will be performed on undisturbed samples from the compacted soil liner as described in Section 4.8.1 and all test data will be reported.

4.8.3 Thickness Verification

The as-built thickness of the compacted soil liner shall be determined by standard survey methods. Prior to the placement of liner material, the subgrade elevations will be determined at a minimum rate of one survey point per 5,000 sf of lined area. After the compacted soil liner is completed, the top of the liner elevations will be determined at the same locations as the subgrade elevations.

5 PROTECTIVE COVER

30 TAC §330.339

5.1 General

The protective cover component of the Type IV liner system consists of a 12-inch-thick layer of soils placed over the compacted soil liner. The CQA monitor shall provide continuous on-site observation during protective cover placement to assure that protective cover placement does not damage compacted soil liner in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during protective cover placement to document the construction activities, testing, and thickness verification in the SLER in accordance with Section 7.2.

5.2 Materials

Protective cover material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material, or any material that could damage the compacted soil liner.

5.3 Preparation

Prior to placing the protective cover material, the top of compacted soil liner elevations shall be verified in accordance with the requirements of Section 4.8.3 and all testing on the compacted soil liner shall be completed.

5.4 Placement

The protective cover shall be placed in a manner that minimizes the potential to damage the compacted soil liner. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect the compacted soil liner. The protective cover shall be dumped from the haul road and spread by low ground pressure equipment. The minimum separation distances between construction equipment and the geosynthetics are listed in Table D7B-5.

Table D7B-5
New Boston Landfill
Minimum Separation Distance

Equipment Ground Pressure (psi)	Minimum Separation Distance (in)
< 4	12
4 - 8	18
8 - 16	24
> 16	36

Any compacted soil liner that, in the opinion of the CQA monitor, has been damaged by the protective cover placement must be repaired and retested in accordance with Section 4.8.

5.5 Testing and Verification

5.5.1 Testing

If the protective cover is counted as ballast against hydrostatic forces, the field density of the in-place protective cover shall be determined at a rate of one test per 10,000 sf. The in-place field density will be determined for information only, and there is no minimum compaction requirement for protective cover.

5.5.2 Thickness Verification

The as-built thickness of the protective cover shall be determined by standard survey methods. Prior to the placement of protective cover, the top of compacted soil liner elevations will be determined at a minimum rate of one survey point per 5,000 sf of lined area. After the protective cover is completed, the top of the protective cover elevations will be determined at the same locations as the top of compacted soil liner elevations.

6 BALLAST

30 TAC §330.337

6.1 General

The highest measured water elevations are presented in Attachment D7B, Appendix D7B-A and represent the highest groundwater elevations that have been encountered at the site. The highest measured water elevations will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water elevations must be adjusted upward. Lined areas will be dewatered during and after construction using a temporary dewatering system as described in Section 3.3.2.

Long-term hydrostatic uplift pressures will be resisted by the weight of the materials placed above the liner subgrade in accordance with §330.337. Ballast can include the weight of the compacted soil liner, protective cover, and compacted waste. The ballast will be documented in the BER in accordance with Section 7.3.

6.2 Ballast Geometry

For each new lined area, the GP will prepare calculations to determine the geometry of the ballast that is required to prevent hydrostatic uplift of the liner system with a minimum factor of safety of 1.5. Procedures for calculating the height of compacted waste or additional protective cover soil above the liner system needed to ballast hydrostatic pressure are provided in Attachment D7B, Appendix D7B-C along with example calculations.

6.3 Ballast Materials

Ballast will consist of compacted soil liner protective cover, infiltration layer, erosion layer, and solid waste. If needed, solid waste ballast will consist of waste accepted at the site in accordance with Part IV – Site Operating Plan. Large, bulky items must be excluded from the initial 5 feet of waste ballast.

6.4 Ballast Placement

If solid waste ballast is required, landfill personnel will be on site full time during the placement of the first five feet of waste over the liner system. They will verify and document that the initial five feet of waste does not contain large, bulky items which could damage the liner system or which cannot be compacted to the required density. Waste ballast must be compacted to a density of not less than 1,200 lb/cy or 44 pcf. The site manager will document that the waste used for ballast has been compacted with multiple passes of a wheeled compactor that weighs in excess of 40,000 pounds. The form to be used by the landfill manager is included in Attachment D7B,

Appendix D7B-D . This documentation will be placed in the site operating record and attached to the BER.

6.5 Testing and Verification

Where compacted soil liner and protective cover is used as ballast, it will be tested in accordance with Sections 4 and 5 and test results will be used to calculate the required ballast thickness. Where protective cover is not tested, the protective cover will be assumed to have a density of 90 percent of the maximum dry density of the material. If used, waste ballast compaction will be verified by the site manager and documented on the Waste-for-Ballast Placement Record. The GP will verify that the temporary dewatering system prevented uplift forces on the liner during construction of the liner. The verification will include observations of water levels in the dewatering sumps or survey data as deemed appropriate by the GP. The site manager will document that the dewatering system remained operational until ballast was placed. The documentation will be placed in the site operating record.

Once the calculated height of compacted waste has been achieved for each cell area, the temporary dewatering system no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. Before submittal of the BER, the GP will review compaction information and density of material used as ballast, and the thickness of all materials used in Ballast Calculations. A BER must be submitted to the TCEQ in accordance with Section 7.3 to document that adequate ballast height has been achieved and to request that the temporary dewatering system operations be discontinued.

7 DOCUMENTATION

30 TAC §330.341

7.1 Reports

Each report shall be submitted in triplicate to the Municipal Solid Waste Division and shall be prepared in accordance with the methods and procedures contained in this LQCP. The evaluated area should not be used for the receipt of solid waste until acceptance is received from the executive director. The executive director may respond to the permittee either verbally or in writing within 14 days from the date on which the SLER document is date-stamped by the Municipal Solid Waste Division. Verbal acceptance may be obtained from the executive director, which will be followed by written concurrence. If no response, either written or verbal, is received within 14 days, the SLER shall be considered accepted and the owner or operator may continue facility construction or operations. Each report must be signed and, where applicable, sealed by the individual performing the evaluation and countersigned by the site operator or his authorized representative.

Markers will be placed to identify all disposal areas for which a SLER has been submitted and accepted by the executive director. These markers shall be located so that they are not destroyed during operations.

The surface of a liner should be covered with a layer of solid waste within a period of six months to mitigate the effects of surface erosion and rutting due to traffic. Liner surfaces not covered with waste within six months shall be checked by the SLER evaluator, who shall then submit a letter report on his findings to the executive director. Any required repairs shall be performed properly. A new SLER shall be submitted on the new construction for all liners that need repair due to damage.

7.2 Soils and Liner Evaluation Report

After construction of the compacted soil liner, the GP will submit a SLER to the TCEQ on behalf of the owner. Preparation and submission of the SLER shall be in accordance with TCEQ MSWR. The purpose of the SLER is to document that the construction methods and test procedures are consistent with this LQCP, the TCEQ MSWR, and the project specifications.

At a minimum, the SLER will contain the following:

- TCEQ SLER form
- A summary of all construction activities
- A summary of all laboratory and field test results
- Sampling and testing location drawings

- A description of significant construction problems and the resolution of these problems
- Record drawings
- A statement of compliance with the LQCP
- An updated seasonal high water table map
- A detailed description of the temporary dewatering system
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act

7.3 Ballast Evaluation Report

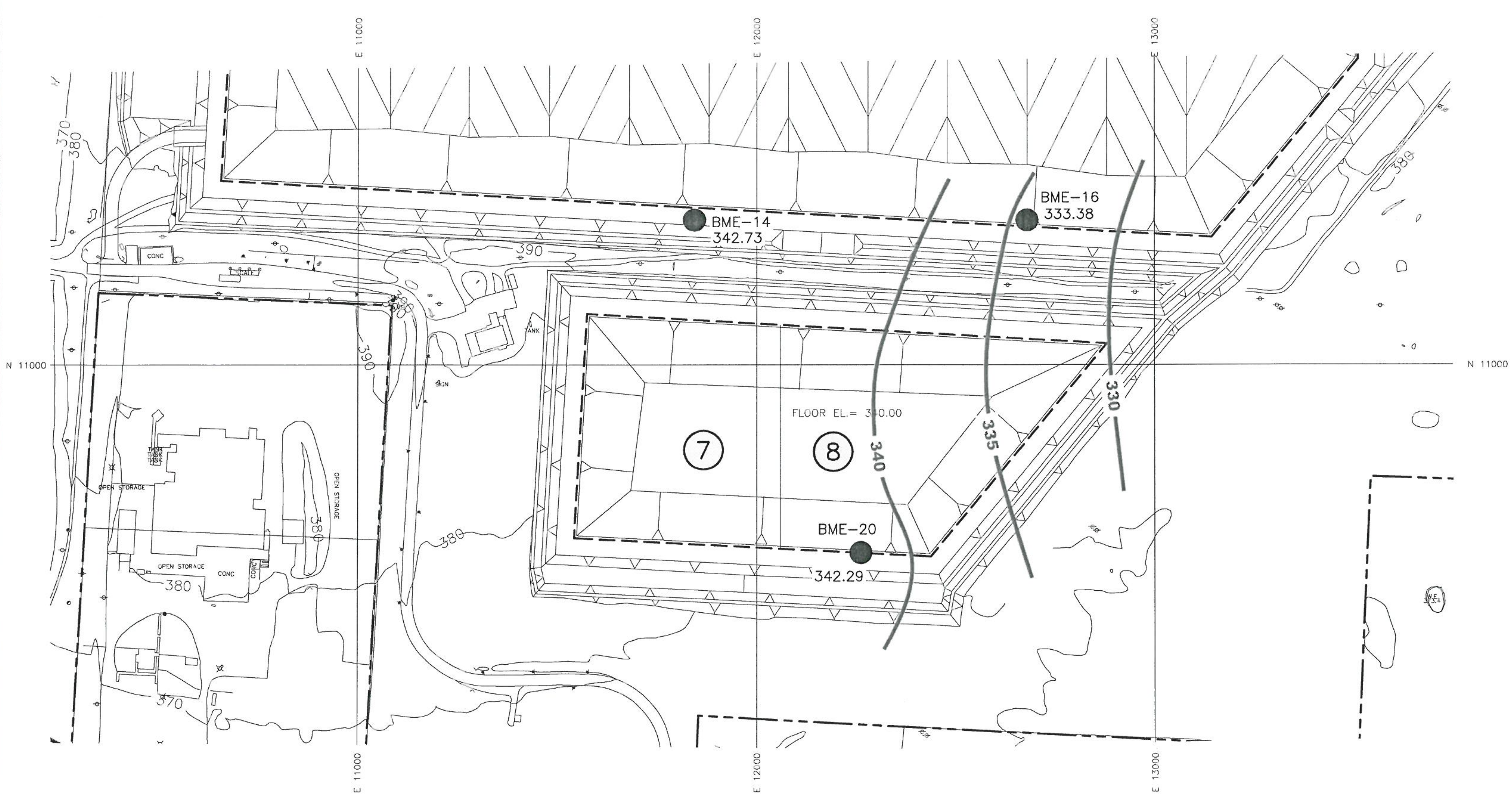
For areas where waste is used for ballast, a BER will be completed and submitted to the TCEQ. The purpose of the BER is to document that sufficient ballast has been placed to offset the potential long-term hydrostatic uplift forces that may exist below the liner system. The BER will provide documentation that the temporary groundwater control system is no longer required. The BER shall include the following information:

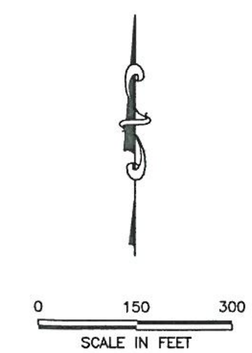
- Names and phone numbers of contact persons.
- Evaluation by the GP documenting that detrimental uplift has not occurred within the liner system. The evaluation shall include survey data as deemed pertinent by the GP.
- Certification from the owner of the type of waste placed in the lower five feet and documentation of the compaction from the Site Operating Record (see form in Attachment D7B, Appendix D7B-D).
- Survey of the top of waste to document that the required thickness has been placed.
- Documentation that any dewatering system used to lower the groundwater level during liner construction was in effect throughout the completion of the ballast placement.
- Documentation that the seasonal high water elevation has not increased from that presented in Attachment D7B, Appendix D7B-A or that additional ballast has been provided to compensate for upward changes in the high water table during ballast placement.
- The signature and seal of the registered professional engineer performing the evaluation and the signature of the owner's authorized representative.

If adequate ballast is placed on a liner as part of the construction process it will be documented in the SLER. If it is documented in the SLER that adequate ballast is present to counteract any hydrostatic uplift, a separate BER will not be required or submitted for that particular liner installation.

NEW BOSTON LANDFILL

APPENDIX D7B-A
HIGHEST MEASURED WATER LEVELS SOUTH DISPOSAL AREA





LEGEND

- PERMIT BOUNDARY
- LANDFILL FOOTPRINT
- 250 EXISTING CONTOUR
- N 11000 SITE GRID
- 338 PROPOSED CONTOUR
- 340 HIGHEST MEASURED GROUNDWATER
- 6 SECTOR DESIGNATION

NOTES:

1. EXISTING CONTOURS COMPILED BY AIR SURVEY FROM AERIAL SURVEY DATED MARCH 5, 2012.
2. PERMIT BOUNDARY PROVIDED BY MTG ENGINEERS AND SURVEYORS, INC.
3. PROPOSED CONTOURS DEPICT LINER SUBGRADE (EXCAVATION) GRADES.
4. ELEVATION OF DEEPEST EXCAVATION AT THE BOTTOM OF SECTORS 7 AND 8 = 340 FT. MSL.
5. THE HIGHEST MEASURED GROUNDWATER CONTOURS DO NOT REPRESENT AN OBSERVED POTENTIOMETRIC SURFACE.

STATE OF TEXAS
GREGORY W. ADAMS
73356
REGISTERED PROFESSIONAL ENGINEER
7/8/2013

ISSUED FOR PERMITTING PURPOSES ONLY

HIGHEST MEASURED WATER LEVEL SOUTH DISPOSAL AREA

WASTE MANAGEMENT OF TEXAS, INC. NEW BOSTON LANDFILL PERMIT AMENDMENT APPLICATION

BIGGS & MATHEWS ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD • WICHITA FALLS
817-563-1144

TBPE FIRM NO. F-256 | TBPG FIRM NO. 50222

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
		~~DATE~~				

REVISIONS

DSN. GWA	DATE : 6/13	DRAWING
DWN. GLW	SCALE : GRAPHIC	D7B-A.1
CHK. GWA	DWG : D7.B-A.1HMGW.dwg	

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NEW BOSTON LANDFILL

APPENDIX D7B-B
TEMPORARY DEWATERING SYSTEM

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
7/8/2013

Includes pages D7B-B-1 through D7B-B-5

New Boston Landfill
South Disposal Area Underdrdain Inflow Rate

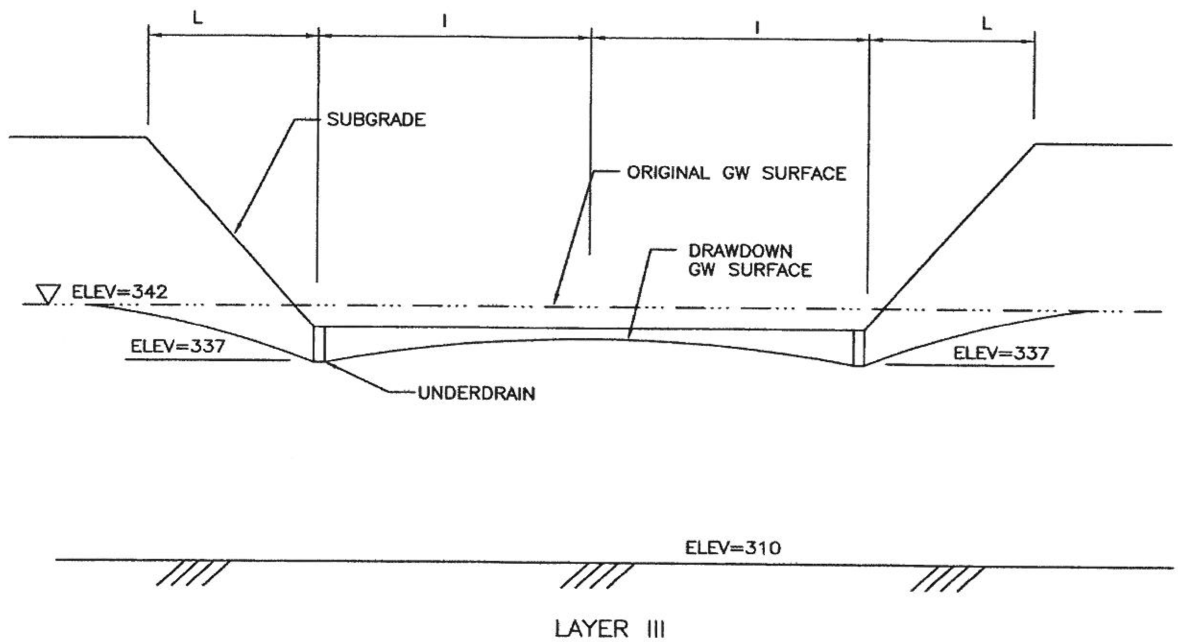
Required: Determine the inflow rate to the underdrain.

References: 1) *Dewatering and Groundwater Control*, UFC 3-220-05, January 2004 (replaces TM 5-818-5).

Assumptions:
1) The temporary dewatering system will be designed for the highest recorded water levels (see Drawing D7A-A.1).
2) The dewatering system plan and details are shown on Drawings D3.8 And D3.9.
3) The boundary of the uppermost ground water bearing unit (GWBU) is at the top of Layer III.

Solution: ***Typical Section***

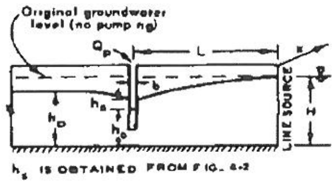
The underdrain consists of a network of composites drains in sand filled trenches that discharge into open or closed sumps. The typical underdrain section is shown below.



New Boston Landfill
South Disposal Area Underdrdain Inflow Rate

Determine the inflow of the underdrain from the methods presented in Reference 1 for partially penetrating slots.

Figure 4-3. Flow and head for partially penetrating line slot; single-line source; artesian, gravity, and combined flows.



(c)

FLOW

$$Q_p = \left(0.73 + 0.27\frac{H - h_o}{H}\right)\frac{Kx}{2L}(H^2 - h_o^2) \quad (3)$$

WHERE $L \geq 3H$

MAX RESIDUAL HEAD DOWNSTREAM OF SLOT

$$h_D = h_o\left[\frac{1.48}{L}(H - h_o) + 1\right] \quad (4)$$

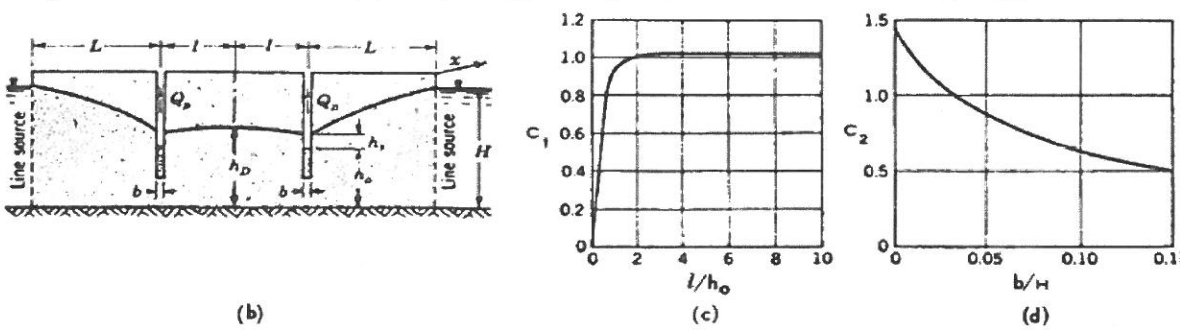
GRAVITY FLOW

(Modified from "Foundation Engineering," G. A. Leonards, ed., 1962. McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.)

inflow:	$Q = [0.73 + 0.27(H - h_o)/H](Kx/2L)(H^2 - h_o^2)$	Ref 1, Fig. 4-3, Eq. 3.
where:	Q = inflow	
	H = design water elevation =	32.0 ft
	h_o = height of water at underdrain =	27.0 ft
	K = hydraulic conductivity of GWBU =	7.84E-06 fps
	x = unit length of underdrain =	1.0 ft
	L = length of drawdown =	200.0 ft
	Q =	**4.46E-06 cfs/ft**

Determine the residual head (rebound) between the underdrains from the methods presented in Reference 1 for partially penetrating slots.

Figure 4-5. Flow and head (midway) for twopartially penetrating slots; two-line source; artesian and gravity flows,



FLOW

FLOW TO EACH SLOT APPROXIMATELY THAT ONE SLOT WITH ONE LINE SOURCE, EQ 3, FIG. 4-3.

h_D †   † MAXIMUM RESIDUAL HEAD MIDWAY BETWEEN THE TWO SLOTS.

$$h_D = h_o\left[\frac{C_1 C_2}{L}(H - h_o) + 1\right]$$

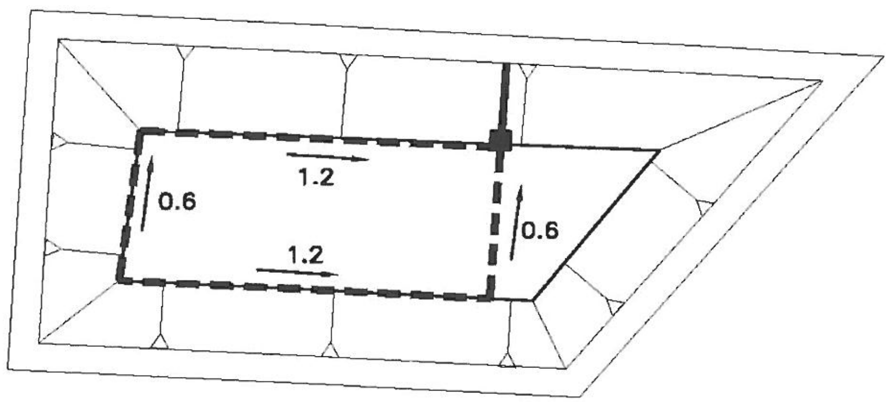
WHERE C_1 AND C_2 ARE OBTAINED FROM FIG. (c) AND (d) ABOVE..

(Modified from "Foundation Engineering," G. A. Leonards, ed., 1962, McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.)

New Boston Landfill
South Disposal Area Underdrdain Inflow Rate

rebound:	$h_d = h_o[((C_1 C_2/L)(H - h_o) + 1)]$		Ref 1, Fig. 4-5, Eq. 1.
where:	h_d = height at midpoint between drains		
	H = height of water surface =	32.0 ft	
	h_o = height of water at underdrain =	27.0 ft	
	L = length of drawdown =	200.0 ft	
	l = distance to midpoint of underdrains =	137.0 ft	
	b = width of underdrains =	1.0 ft	
	l/h_o =	5.1	
	b/H =	0.03	
	C_1 = coefficient from chart (c) =	1.0	
	C_2 = coefficient from chart (d) =	1.0	
	h_d =	**27.7 ft**	

Determine the flow for each segment of the underdrain system by multiplying the inflow rate by the underdrain length.



ALL QUANTITIES IN GPM

New Boston Landfill
South Disposal Area Underdrain Design

Required: Size the following elements of the temporary dewatering system:
1) Composite Drains
2) Pumps

References: 1) *KTC-97-5, SPR-92-143, "Performance and Cost Effectiveness of Pavement Edge Drains",* L. John Fleckenstein, Kentucky Transportation Center, 1997.

Assumptions:
1) The dewatering system plan and details are shown on Drawings D3.8 And D3.9.
2) Flow rates are from the inflow rate calculations.

Solution
1) Maximum flowrate to a single underdrain occur at the north perimeter.

Maximum combined flow rate =	1.8	gpm
Flow capacity of 12" ADS Composite Drain =	39.0	gpm
Factor of Safety =	**21.7**	

2) Size pumps for 1.5 times the maximum flowrate

Flowrate to sump =	3.6	gpm
Pump capacity =	**5.4**	**gpm**

New Boston Landfill
South Disposal Area Underdrain Geotextile Design

Required: Determine the minimum geosynthetic properties for temporary dewatering system:
1) Geotextile for the composite drain.

References: 1) *Designing with Geosynthetics,* Fourth Edition; Robert M. Koerner.

Assumptions: 1) The adjacent soils will have at least 50% finer than the No. 200 sieve.

Solution:

Calculate the required permittivity from the equation:

$$\Psi_{req} = q / \Delta hA$$

where:

Ψ_{req} = permittivity		
q = peak inflow rate to an underdrain =	4.46E-06	cfs/ft
Δh = maximum allowable head =	1.0	ft
L = trench unit length =	1.0	ft
H = drain height =	1.0	ft
A = inflow area = L x 2H =	2.0	sf

Substitute and solve for required permittivity = 2.23E-06 sec^{-1}

Calculate the allowabe permittivity from Reference 1, Equation 2.25.

$$\Psi_{req} = \Psi_{all} \ (1 / RF_{SCB} \ X \ RF_{CR} \ X \ RF_{IN} \ X \ RF_{CC} \ X \ RF_{BC})$$

where:

RF_{SCB} = soil clogging/binding reduction factor =	7.0	(Ref. 1, Table 2.12)
RF_{CR} = creep reduction factor =	1.5	(Ref. 1, Table 2.12)
RF_{IN} = intrusion reduction factor =	1.2	(Ref. 1, Table 2.12)
RF_{CC} = chemical clogging reduction factor =	1.0	(Ref. 1, Table 2.12)
RF_{BC} = biological clogging reduction factor =	1.0	(Ref. 1, Table 2.12)

Substitute and solve for allowable permittivity = 2.8E-05 sec^{-1}

For fine-grained, non-dispersive soils the AOS must be less than 0.21mm (Reference 1, Figure 2.4)

NEW BOSTON LANDFILL

APPENDIX D7B-C
BALLAST CALCULATIONS

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

7/8/2013

Includes pages D7B-C-1 through D7B-C-6

LINER BALLAST CALCULATIONS

The required ballast thickness shall be calculated by the GP and included in the GLER. The ballast calculation shall be based on the as-built conditions and the updated highest groundwater elevations. The required ballast thickness shall be calculated as follows:

A. Review and update, as necessary, the water level elevations (see Attachment D7B, Appendix D7B-A – Highest Measured Water Levels). Adjust the seasonal high water table upward, if necessary, across the area being lined using the highest measured water levels derived from the most recent piezometer water level readings. Determine the design water level for the area being analyzed. The lined area may be subdivided into more than one area as appropriate for changes in groundwater table elevations and/or subgrade elevations across the lined area.

B. Determine the hydrostatic uplift pressure on the base of the bottom and sidewall liner system including normal, vertical, and horizontal components of the uplift pressure as follows:

1. Bottom Liner: Determine the maximum hydrostatic uplift pressures acting normal to the base of the bottom liner system using the unit weight of water, γ_W, times the vertical distance from the excavation to the design water level, H.

$$P_N = \gamma_W H$$

2. Sidewall Liner: Determine the maximum hydrostatic uplift pressures acting normal, vertical, and horizontal to the base of the sidewall liner system using the following steps.

(a) Determine the maximum normal uplift pressure on the sidewall liner using the unit weight of water times the vertical distance from the base of the layer to the design water level, H.

$$P_N = \gamma_W H$$

(b) Determine the maximum vertical uplift pressure on the sidewall liner using the normal uplift pressure times the cosine of the slope angle.

$$P_V = P_N \cos \beta$$

(c) Determine the maximum horizontal uplift pressure on the sidewall liner using the normal uplift pressure times the sine of the slope angle.

$$P_H = P_N \sin \beta$$

C. Determine the resisting pressure against uplift of the bottom and sidewall liner system including normal, vertical, and horizontal components of the resisting pressures as follows:

1. Bottom Liner: Determine the normal resisting pressure at the GM using the unit weight of the protective cover times the thickness of the protective cover.

$$R_N = (\gamma_{pc} T_{pc})$$

Where: γ_{pc} = Wet unit weight of the protective cover
T_{pc} = Thickness of the protective cover

The unit weight of the protective cover shall be determined from field measured unit weights.

2. Sidewall Liner:

(a) Determine the vertical resisting pressure of the sidewall liner using the unit weight of the protective cover material times the vertical thickness of the protective cover layer. This is equal to the normal resisting pressure divided by the cosine of the slope angle.

$$R_v = R_N / \cos\beta$$

(b) Determine the horizontal resisting pressure of the sidewall liner using the coefficient of at-rest earth pressure of the liner system components times the vertical resisting pressure.

$$R_H = K_O R_V$$

The coefficient of at-rest earth pressure, K_O, is based on the assumed angle of internal friction, ϕ, of the material resisting hydrostatic pressures (compacted soil).

(c) Determine the normal resisting pressure of the sidewall liner system using the normal components of the horizontal and vertical resisting pressures calculated in steps (a) and (b) above.

$$R_N = R_H \sin\beta + R_V \cos\beta$$

D. Evaluate the factor of safety against uplift of the bottom and sidewall liner system due to hydrostatic pressures.

1. Bottom Liner: Determine the factor of safety against uplift of the bottom liner system due to hydrostatic forces acting normal to the base of the bottom liner system.

$$FS = R_N / P_N$$

If the factor of safety is greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic uplift forces.

If the factor of safety is less than 1.2, additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional ballast.

2. Sidewall Liner:

Determine the factor of safety against uplift of the sidewall liner system due to hydrostatic pressures acting normal, vertical, and horizontal to the sidewall liner system.

$$FS_N = R_N / P_N$$

$$FS_V = R_V / P_V$$

$$FS_H = R_H / P_H$$

If the factors of safety are greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic forces.

If the factor of safety is less than 1.2 for any of the components (normal, vertical, or horizontal), additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional soil ballast.

E. Use a factor of safety of 1.5 against uplift of the liner and ballast system for solid waste ballast and a factor of safety of 1.2 for soil ballast.

Assume a unit weight of 44 pcf for solid waste and a unit weight of 100 pcf for soil if field measurements are not available, or if conditions indicate the field measurements are no longer applicable.

1. Bottom Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

$$FS = (R_N + B_N) / P_N$$

Where R_N = Normal protective cover pressure
B_N = Normal ballast pressure
B_N = $H * \gamma$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_N - R_N) / \gamma$$

2. Sidewall Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

(a) $FS = (R_V + B_V) / P_V$

Where R_V = Vertical protective cover pressure
B_V = Vertical ballast pressure
B_V = $H * \gamma$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_V - R_V) / \gamma$$

(b) $FS = (R_H + B_H) / P_H$

Where R_H = Horizontal protective cover pressure
B_H = Horizontal ballast pressure
B_H = $B_V * K_0$
B_H = $H * \gamma * 0.7$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_H - R_H) / \gamma * k_0$$

Example calculations are provided on pages D7B-C-5 through D7B-C-6.

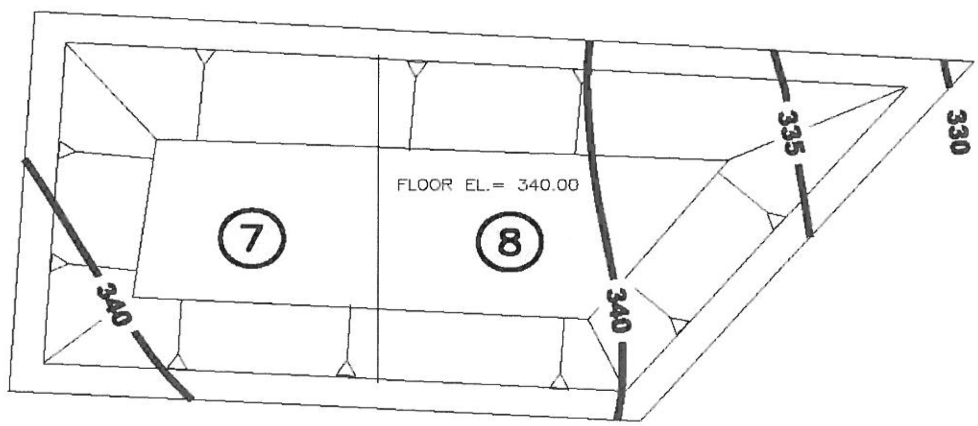
New Boston Landfill
South Disposal Area Ballast Design

Required: Evaluate the long-term hydrostatic uplift pressures on the liner system and determine the ballast requirements.

References: 1) *Guidance Handbook for Liners Constructed Below the Groundwater Table,* TNRCC, 1995.

Assumptions:
1) The design water elevations are shown on Drawing D7B-A.1.
2) All cells must be re-evaluated based on updated groundwater data prior to construction.
3) Assume normal and vertical forces to be the same in the bottom, and design for normal forces.
4) Uplift is evaluated at the bottom of the soil liner.

Solution: Calculations are shown for the toe of Cell 7 where the groundwater elevation is highest.



The forces acting upon the liner system are:

P_N = normal pressure	R_N = normal resistance
P_V = vertical pressure	R_V = vertical resistance
P_H = horizontal pressure	R_H = horizontal resistance

1) Determine the uplift pressure upon the FML at the bottom and at the toe of the slopes.

γ_w = unit weight of water =	62.4 pcf
H = design water level above liner =	2 ft
b = sidewall slope =	18.43 deg

Bottom	$P_N = H\gamma_w =$	124.8 psf
Slope	$P_N = H\gamma_w =$	124.8 psf
	$P_H = P_N \sin\beta =$	39.5 psf
	$P_V = P_N \cos\beta =$	118.4 psf

2) Determine the resistance pressure at the bottom and on the slope.

Compacted Soil Liner

	γ = density =		125.0 pcf
	T_N = normal thickness =		3.0 ft
	T_V = vertical thickness =		3.2 ft
	ϕ = angle of internal friction =		17.0 deg

Protective Cover

	γ = density =		112.0 pcf
	T_N = normal thickness =		1.0 ft
	T_V = vertical thickness =		1.1 ft
	ϕ = angle of internal friction =		17.0 deg
Bottom	$R_N = \Sigma T_N \gamma$ =	487.0 psf	
Slope	$R_H = k_o R_V$ =	256.7 psf	
	$R_V = \Sigma T_V \gamma$ =	513.3 psf	
	$R_N = R_V \cos\beta + R_H \sin\beta$ =	568.1 psf	

3) Determine the factors of safety against uplift and evaluate the need for additional ballast.

Bottom	$FS_N = R_N / P_N$ =	3.9
Slope	$FS_H = R_H / P_H$ =	6.5
	$FS_V = R_V / P_V$ =	4.3
	$FS_N = R_N / P_N$ =	4.6

Since the Factor of Safety is greater than 1.5 additional ballast will not be required.

NEW BOSTON LANDFILL

APPENDIX D7B-D
WASTE-FOR-BALLAST PLACEMENT RECORD

WASTE-FOR-BALLAST PLACEMENT RECORD

This form is to be completed by the landfill manager for all landfilled areas requiring waste-for-ballast. One form will be developed for each area as addressed in a Soil and Liner Evaluation Report (SLER). The Professional of Record (POR) may reference this form in order to certify that the placement of ballast is in compliance with the LQCP.

GENERAL INFORMATION

Area documented by this record (provide site grid coordinates of each corner):

____

____

____

____

SLER approval date for this area: ________________

Date of initial waste placement: ________________

Date of completion of first five feet of waste in place over entire area: ________________

Total required waste-for-ballast thickness for this area:
(Note: Calculations for determining the required thickness of waste-as-ballast will be included with the SLER for this area.) ________________

Date when minimum required thickness of waste was achieved: ________________

Actual waste-for-ballast thickness demonstrated by this record: ________________

WASTE EQUIPMENT USED

☐ 40,000-pound minimum gross weight wheeled compactor.
Specify equipment used:____

FIRST LIFT CONSIDERATIONS

☐ No brush, large, bulky, elongated or other waste items which could damage the underlying liner system have been placed within the first five feet of waste above the top of the protective cover.

☐ A 5-foot lift of loose waste (acceptable waste defined above) has been maintained between the waste compaction equipment and the top of the liner protective cover in all fill areas to allow uniform compaction of the waste material.

☐ Describe type(s) of waste placed in the first 5 feet of waste over the top of the liner protective cover.

____

____

WASTE COMPACTION METHODS FOR THE TOTAL WASTE-FOR-BALLAST THICKNESS

- ☐ Loose waste layer thickness was less than 2-feet-thick prior to compaction to allow uniform compaction of the acceptable waste material (i.e., no brush, large bulky items).
- ☐ Compaction was achieved over the entire area evaluated using a minimum of three passes of at least one track for each loose waste layer.
- ☐ The slope of the compacted waste layers was less than (flatter) 4 horizontal to 1 vertical.

SIGNATURE OF PERMITTEE

The waste overlying the area described in this record has been placed and compacted as described in this record and in accordance with the site Soils and Liner Quality Control Plan and Site Operating Plan.

Waste Management of Texas, Inc.

____
Signature

____
Typed or Printed Name

____
Title

____
Date Signed

Note: This completed form will be placed in the Operating Record and will be available for TCEQ review.