Attachment D

Landfill Operation Plan

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D. LANDFILL OPERATION PLAN

D-1 Containers

This section is not applicable.

D-2 Tank Systems

This section is not applicable. Wastes are not stored in tanks for longer than 90 days.

D-3 Waste Piles

This section is not applicable.

D-4 Surface Impoundments

This section is not applicable.

D-5 Incinerators

This section is not applicable.

D-6 Landfills

D-6a List of Wastes

The list of wastes that may be placed in the Greenbelt II Landfill is provided in Section C-1d of Attachment C.

Sludge placed in the Greenbelt II Landfill will be solidified with fly ash and/or lime kiln dust and pass the strength testing outlined in the Construction Quality Assurance Plan (QA/QC Manual) provided in **Appendix D-1**.

During solidification events, F006 is staged within the active portion of the landfill. The active portion of the landfill is graded to minimize ponding of surface water and contact run-off is collected within the leachate collection system. Loads of F006 are placed around the perimeter of a slag pad to minimize potential for truck wheels to contact waste material. The slag pad is large enough for trucks to off-load the ash. General dimensions of the pad are 50 feet by 100 feet by 6 inches thick. Fly ash and/or lime kiln dust are delivered as needed for use during solidification activities. Generally, only the amount of fly ash or lime kiln dust expected to be needed for each day of mixing is delivered. If however, solidification mixing is shut down due to high wind or inclement weather, fly ash or lime kiln dust delivered prior to the shutdown will temporarily remain in the mixing area until solidification activities start up again (e.g. the following work day). Solidification activities will not be performed during periods of heavy precipitation.

Fly ash or lime kiln dust is delivered and unloaded near the mixing area within the waste boundary. Waste is solidified by mixing either fly ash or lime kiln dust with the F006 material using a front end loader or excavator bucket. The equipment repeatedly scoops/dumps materials until the solidification agent is blended with the F006 material. Once mixed, the solidified material is stockpiled. The solidified material is then placed using a bulldozer and spread in lifts across the working face of the landfill. Upon completion of placing the solidified waste, the area is graded and sloped to drain toward the leachate collection system to minimize the potential for standing water from rainfall.

D-6b Liner System Exemption Requests

No liner system exemption is being proposed for the Greenbelt II Landfill; therefore, this section does not apply.

D-6c Liner System, General Items

D-6c(1) Liner System Description

The Greenbelt II Landfill has been designed to comply with the minimum technology requirements (MTR) (RCRA Attachment 3004(o)) for landfills so that flow of liquids into and through the liners will be minimized.

The landfill liner system selected is a double liner system consisting of, in ascending order, a minimum of 3 feet of recompacted clay, a 60 mil High Density Polyethylene (HDPE) liner, an HDPE geonet leachate detection layer, another 60 mil HDPE liner, a 12-ounce polyethylene geotextile, a 15-inch thick stone leachate collection layer, and a 5-inch thick compacted stone operational/protection layer.

This combination of layers satisfies the two liner, leachate collection, and leak detection requirements of RCRA Sections 3004(o)(1)(A)(i), 3004(o)(4)(A), and 3004(o)(4)(B)(i).

The liner system is sloped from the middle of the landfill to the north and south at 2.19 percent as shown on Sheets 6, 7, 10, and 11 of the Permit.

D-6c(2) Liner System Location Relative to High Water Table

Two previously installed piezometers (MW-G7A and MW-G8A) are located immediately upgradient (south) of the Greenbelt II Landfill. Additional monitoring wells have also been installed around the borders of existing Cells A, B and C of the Greenbelt II Landfill. As shown in **Appendices E-1** through **E-4** of the Permit, these wells (plus piezometers installed in December 1992 as part of the design process) have been monitored to evaluate the elevation and direction of groundwater flow beneath the Greenbelt II Landfill.

Relative to the groundwater level, the liner system is above the water, except the clay key area at Vault No. 1 at the south end of the landfill. At this location, the 5.25 foot thick clay key way under the vault is approximately three feet (elev. 596.0 - elev. 592.90) beneath the water table during seasonally high water level periods.

As shown in **Appendices E-1** through **E-4** of the Permit, the water table fluctuates with high precipitation periods. This type of fluctuation is typical for unconfined aquifers in continental climates (i.e., four seasons). Continental climates typically exhibit two seasonally high precipitation periods in the early spring and fall. Therefore, the bottom of the liner system may occasionally be in contact with the water table at this one area. Other areas of the landfill liner are 3.0 to 9.0 feet above the water table. Waste is a minimum of 7.5 feet above the seasonal high water table.

The pressure exerted by the water level onto the clay liner is minimal and will not create stresses which could cause failure of the liner system or adversely affect the leak detection system. As shown on calculations in **Appendix D-5** of the Permit, the pressure exerted by the water is 1.33 psi; the resisting force (i.e., weight) of the clay liner alone is 3.79 psi; yielding a minimum factor of safety of 2.8 against uplift. After waste is deposited in the cell around this area, the resisting force increases to as much as 14 psi yielding a factor of safety of 10 against uplift.

Furthermore, water is known to seek “the path of least resistance”. This path will be the pores of the surrounding sand because it is more porous and hence less resistant to flow.

D-6c(3) Loads on Liner System

Loads exerted on the system will include the solidified waste and the final cover. Because the cover extends beyond the waste limit, the loads on a square foot unit area will vary from 610 pounds (two feet of clay = 105 pounds per cubic foot (pcf), four feet of sand = 100 pcf) to 8730 pounds (two feet clay, four feet sand, 70 feet of waste). These loads consider: static and dynamic loads; stresses due to construction and installation; stresses resulting from operating equipment; stresses due to the maximum quantity of waste, cover, and proposed post-closure land use; stresses resulting from settlement, subsidence, or uplift; and internal and external pressure gradients.

Calculations concerning the liner's ability to support these loads are presented in **Appendix D-5** of the Permit. Foundation analyses are also discussed in detail in Section D-6d(4).

D-6c(4) Liner System Coverage

The extent of the secondary composite liner and the primary liner are shown on Sheets 6, 7, 8, and 9 of the Permit. As shown on Section G-G' of Sheet 13 in the primary liner extends 17.25 feet beyond the waste limit and the secondary composite liner extends 14.25 feet beyond the waste limit on the sidewalls of the landfill. The extent of the leachate detection geonet drainage layer and protective geotextile are shown on Sheets 24 and 25 of the Permit.

Temporary liner anchors will be used until all four of the cells are constructed. The cell phasing is shown on Sheets 4 and 5 of the Permit. Temporary liner anchors are used to secure the synthetic liners until the adjacent cell is constructed. The temporary anchors are shown on Sheet 18 of the Permit.

In summary, the entire liner system at a temporary anchor extends 34.0 to 67.0 feet beyond the waste limit. The temporary termination of the liner is also raised six feet above its normal position. This elevated anchor makes it easy to locate and inspect the temporary anchor and provides excess area to construct and join the adjacent cell liner. Also, the elevated anchor provides a double-lined holding area for landfill runoff in the event the storm water drain is plugged. The temporary liner anchors are a complete part of the cell they serve. The contact water accumulated by the temporary liner anchor system is double contained and routed to the sump areas. The temporary liner anchor, east/west trend (for Cell A) routes contact water south through the primary drainage layer to the sump. The temporary liner anchor, north/south trend (for Cell A) routes contact water along the east overflow area thus traveling south to the storm water sump.

When connection to an adjacent cell is required, the compacted sand extending under the temporary anchor (and above compacted clay) shall be re-excavated. As the synthetic liners are exposed, they will temporarily be folded back towards the operating cell. The extent of the compacted clay liner in this area (11.5 feet; see Sheet 18 of the Permit) was determined by evaluating safe temporary slopes and the operating clearance that a clay compactor would need to ensure that the connection of additional clay liner can be performed in a quality manner.

As shown on Sheet 18 of the Permit, the re-excavation limit will allow sufficient space to tie in the clay liners, discard exposed synthetic liners, and connect new synthetic liners and drainage nets. No special procedures are necessary at these locations. The connection will be a fusion weld as shown in Detail 4, Sheet 19 of the Permit.

D-6c(5) Liner System Exposure Prevention

Installation specifications regarding liner exposure prevention are discussed in detail in the Project QA/QC Manual included as **Appendix D-1**. In general, the HDPE liner installations will comply with the following to reduce liner exposure to sunlight:

1. Roll stock of HDPE liners stored on site will remain covered with the protective sheeting provided by the liner manufacturer or will be covered on site using a dark colored, plastic tarp.
2. Placement of earthen cover over the liners will commence immediately after the liner installation is approved by the Project QA/QC Officer.
3. Only that amount of liner which is reasonably expected to be completed on any given work day should be rolled out. In case of inclement weather suspending liner installation for an extended period, the liner should be protected by placing sacrificial geotextile over the top of the exposed liner or rolled out liner will be re-rolled and covered.
4. As shown on Section G-G’ of Sheet 13 and Detail 6 of Sheet 20 of the Permit, approximately 20 linear feet of the final soil cover will be installed immediately after the permanent liner anchoring is completed to reduce exposure of the liners in those areas.
5. At the temporary liner anchor locations, the liner will be covered with native sand or general soil and the length of the liner exposed will be trimmed off and discarded when joined with the adjacent cell liner (see note 3 of Sheet 18 of the Permit).

Wind uplift calculations, which evaluate sand bag spacing during installation of the synthetic liner, are presented in **Appendix D-7** of the Permit. In short, the calculations estimate that bags spaced at 5 to 6 foot intervals along the edges of the exposed liner will be required until the granular drainage layer is installed.

D-6d Liner System, Foundation

D-6d(1) <u>Foundation Description</u>

The soils underlying the Greenbelt II Landfill are classified in the Unified Soil Classification System as predominately loose to medium dense brown fine sands. This sand extends approximately 30 feet below existing ground surface (G.S.) (22 feet below bottom of liner). Underlying this unit is approximately 40 feet of dense to very dense brownish-gray fine sand with trace amounts of silt, which is in turn underlain by approximately 25 feet (75 to 100 feet below G.S.) of stiff to very stiff gray silty clay. For a detailed subsurface description, refer to **Appendices E-1** through **E-4** of the Permit.

During the subsurface investigation of the foundation soils underlying the Greenbelt II Landfill, an area of buried waste was discovered. Under the provisions of the previous Greenbelt II permit, this area was defined as a Solid Waste Management Unit (SWMU) and is subject to RCRA Corrective Action regulations. This area has been identified as the Eastside SWMU. SWMU materials were relocated from the Greenbelt II footprint and the Eastside SWMU was closed in-place in 2010-2011 and post-construction activities are on-going as of 2018.

D-6d(2) <u>Subsurface Exploration Data</u>

Eight borings were performed in the early 1990s within the Greenbelt II Landfill to characterize the subsurface and supplement existing data. The location of the borings and boring logs are presented in **Appendix E-1** of the Permit. General subsurface profiles are presented on Sheet 11, Plates 3 through 6 of **Appendix E-1**, and Plate 8 of **Appendix E-2** of the Permit. The depth of the borings varied from 90 feet to 125 feet (82 feet to 117 feet below the liner bottom). In addition, a series of borings were advanced prior to construction of Cells A, B, and C of the Greenbelt II Landfill. The purpose of these borings was to install groundwater monitoring wells around the perimeters of Cells A, B, and C. Boring logs for these borings are presented in **Appendix E-2**, **E-3**, and **E-4** of the Permit.

Split-spoon samples were obtained on a continuous basis in each of the borings. Additional subsurface data was obtained from eight borings performed by ATEC Associates, Inc. (ATEC) in 1990 and from monitoring wells installed for the Greenbelt I Landfill.

More comprehensive discussions of the subsurface geology and hydrogeology are contained in **Appendices E-1** through **E-4** of the Permit.

D-6d(3) Laboratory Testing Data

Laboratory testing data on the soils underlying the Greenbelt II Landfill is presented in **Appendix D-4** of the Permit. The frequency of testing was selected to comply with guidance documents from the IDEM. In general, a grain size was performed on granular units at a frequency of every ten feet or less for each boring. Additional laboratory testing from soils obtained in the vicinity of the Greenbelt II Landfill are presented in **Appendices E-3** and **E-4** of the Permit.

D-6d(4) Engineering Analyses

Indiana is not listed in the active seismic zones as shown in Appendix VI of 40 C.F.R. Part 264. In addition, Northwest Indiana is not characterized as a "karstic terrain." The Indiana Department of Natural Resources' Special Report #11, Environmental Geology of Lake and Porter Counties, Indiana, An Aid to Planning, shows the uppermost bedrock unit to be the Devonian Age Antrim Shale member of the Maquoketa Formation. Also, on page 7 of this report it is stated that: "The bedrock should not present construction related problems because of the thickness of the glacial materials . . . and the limited extent of previously mentioned solution features." Therefore, concerns related to seismic, subsidence, or sinkhole issues at this site is minimal.

D-6d(4)(a) Settlement Potential

The settlement potential of the solidified waste and the foundation soils has been evaluated. The maximum settlement of the solidified waste has been calculated from the data obtained from a consolidation test performed on the solidified waste in the Greenbelt I Landfill. At the approximate landfill height of 70 feet, approximately three inches of waste settlement was calculated. This relatively low settlement potential is because of the solid brick-like structure of the waste. The monolithic, solidified structure has an inherently large shear strength and no biodegradable fraction.

The settlement potential of the foundation soils has been evaluated with the use of SETTLG, a settlement computer model by Geosoft, Inc. The landfill was divided into 17 discrete sections to evaluate the differential settlement induced by variation of load from the different waste heights. This model predicts 7.44 inches of differential settlement across the facility. The amount of settlement is not sufficient to shear the soil or geomembrane liners or adversely impact the leachate collection system. The settlement analysis is in **Appendix I-2** of the Permit.

The landfill bottom slope has been designed to account for this load induced settlement and still maintain a minimum 2 percent slope towards the leachate collection pipes. The construction grade will be 2.19 percent and the resultant post settlement grade will be approximately 2.1 percent.

D-6d(4)(b) Bearing Capacity

Four separate bearing capacity failure modes were evaluated and are presented in **Appendix D-5** of the Permit. Two conservative deep (to bedrock) failure modes were evaluated in drained and undrained conditions. The third failure mode represents a shear or punching failure case of a 3.25 foot thick clay liner and the fourth case evaluates the synthetic liner's ability to support the leachate collection vault loads. The calculations indicate a safety factor in excess of 1.2 to 1.6 desired for dynamic (earthquake) loads on large embankments.

D-6d(4)(c) Stability of Landfill Slopes

The Greenbelt II Landfill has a 3:1 slope from road elevations of 608.0 to 616.0 up to the permanent road bench at elevation 648.0 and 4:1 slopes from 648.0 to 678.0. The top of the landfill is then crowned at a 5 percent slope to maintain positive drainage. As shown in **Appendix D-2** of the Permit, stability analyses were performed to demonstrate the structural integrity of the slopes and foundation soils. The stability analyses were performed by using the simplified Bishop Method on the PCSTABL4 computer program developed by Purdue University. Seven cases were analyzed: static deep rotational failure, dynamic deep rotational failure, shallow rotational failure in sand, static and dynamic deep rotational failure of solidified sludge, sliding block failure of saturated cover with and without a PVC geomembrane, and sliding block failure of unsaturated cover without a geomembrane. The analyses, soil properties, and slopes are discussed in detail, along with the model results, in **Appendix D-2** of the Permit.

D-6d(4)(d) Potential for Excess Hydrostatic or Gas Pressure

The potential for excess gas pressure at this facility is minimal. Given the straightforward site geology and the small percentage of degradable biochemical sludges, there are no known natural sources of gas in the area and if gas were generated, the preferential path of migration would be through the surrounding sand soils, minimizing the potential for pressure build-up under the liner.

The pressure exerted by the water level onto the clay liner is minimal and will not create stresses that could cause failure of the liner system or adversely affect the leak detection system. As shown on calculations in **Appendix D-5** of the Permit, the pressure exerted by the water is 1.33 psi; the resisting force (i.e., weight) of the clay liner alone is 3.79 psi; yielding a minimum factor of safety of 2.8 against uplift. After waste is deposited in the cell around this area, the resisting force will increase to as much as 14 psi yielding a factor of safety of 10 against uplift.

Furthermore, water is known to seek "the path of least resistance". This path will be the pores of the surrounding sand because it is more porous and hence less resistant to flow.

D-6e Liner System, Liners

D-6e(1) Synthetic Liners

Two 60-mil HDPE liners have been selected for use in the liner system installed at the Greenbelt II Landfill. This liner system is one of two acceptable designs as defined in the federal EPA's final rule entitled "Liners and Leak Detection Systems for Hazardous Waste Land Disposal Units" and Minimum Technology Guidance. In the selected design, the secondary lower 60-mil HDPE liner is combined with a minimum of three feet of clay to form a "composite liner". The primary HDPE liner is placed inside the composite liner between the two drainage layers.

The HDPE flexible membrane liners will be manufactured by Poly-Flex, Inc. of Grand Prairie, Texas or an approved manufacturer satisfying current Poly-Flex, Inc. specifications. The HDPE geonet and polypropylene geotextile will also be manufactured by Poly-Flex, Inc. or an approved manufacturer satisfying current Poly-Flex, Inc. specifications.

D-6e(1)(a) Synthetic Liner Compatibility Data

A Workplan for implementing liner/waste compatibility testing was previously prepared and approved by the USEPA. A copy of the Approved Workplan and Approval Letter is presented in **Appendix D-6** of the Permit. The purpose of the Workplan was to ensure that the compatibility testing meets the criteria and goals of the Agency. The testing was completed and results were submitted for review prior to construction of the landfill liner for Cell A. The test results demonstrated that the selected HDPE liners, drainage nets and piping and polypropylene geotextiles are compatible with the wastes. This test data will be used to select future use geosynthetics in accordance with USEPA Recommended Practices. If the permittee decides to use geosynthetics of a different chemical structure, the 9090 compatibility testing will be reperformed and an appropriate application for permit modification will be submitted to IDEM for approval. Also, if the future geosynthetics do not match the baseline compatibility test results within 15% during conformance testing, the test will be reperformed.

D-6e(1)(b) Synthetic Liner Strength

To evaluate the physical characteristics of the HDPE liners, two periods of time were examined.

The first period is during and immediately after construction. In **Appendix D-7** of the Permit are several calculations illustrating that the Greenbelt II Landfill design grades, slopes and selected earthen materials are appropriate for use with a 60 mil HDPE liner meeting the former NSF 54 strength requirements or the latest industry standard test methods and specifications provided by the Geosynthetic Research Institute (GRI), whichever is more stringent.

The second period when liner strength must be evaluated is long-term. Because the weight of the landfill is placed uniformly on the liner, the overall load does not affect the liner performance. However, localized occurrences may induce strains in a liner. Calculations demonstrating that the liner has been designed to handle strains produced by waste settlement and strains due to subsidence of gravel backfill in the leachate trench are also attached in **Appendix D-7** of the Permit.

D-6e(1)(c) Synthetic Liner Bedding

The secondary flexible membrane liner will be placed directly atop a minimum 3-foot thick recompacted clay barrier layer. The primary flexible membrane liner (FML) will be placed atop the secondary leachate detection layer and covered by a 12-ounce polypropylene geotextile. The liners will be in contact with two types of earthen materials: clay and Indiana #8 gravel aggregate. Typical physical properties of the clays and Indiana #8, including grain size, moisture content, Atterberg limits, moisture/density, relative density, and specific gravity, are presented in **Appendix D-8** of the Permit. The Indiana #8 is relatively coarse and could puncture the primary FML. Therefore, the 12-ounce polypropylene geotextile was selected as a protective cushion between the gravel and liner. The increase in puncture resistance by the addition of a geotextile has been studied and the results were published by Dr. Richard Koerner of the Geosynthetics Research Institute (at Drexel University). His work on this subject is published in the following documents:

1. Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments, Richardson and Koerner, EPA Document 600/2-87/097, 1987, and

2. Puncture Resistance of Geomembranes Using a Truncated Cone Test, Hullings and Koerner, Geosynthetics 1991 Conference, Atlanta, GA.

In summary, a geotextile increases the puncture resistance of a geomembrane by cushioning and, to a lesser extent, by increased tensile strength. Dr. Koerner's work concludes that non-woven needle punched geotextiles provide the greatest protection and that the greater the density of the geotextile, the greater the protection.

As shown in Permit, **Appendix D-7**, Figure 4, the Critical Core Height (CCH), which induces puncture, is increased by a factor of two to almost 2 centimeters (cm). When comparing this CCH (2 cm) to the mean particle size of an Indiana #8 gradation gravel (1.22 cm), it can be seen that the selected 12 ounce geotextile (one of the thickest available) will increase puncture resistance.

Specifications for subgrade preparation, leachate collection trenching and covering the liners are discussed in the Project QA/QC Manual (see **Appendix D-1**).

D-6e(2) <u>Soil Liners</u>

D-6e(2)(a) Material Testing Data

A consolidation test, which subjected a recompacted clay sample (@ 90 percent standard Proctor) to pressures up to 16,000 psf, revealed that the maximum waste load of 8,300 psf will consolidate the clay layer approximately 0.25 feet. Therefore, a minimum thickness of three feet will be maintained throughout the facility life. The consolidation calculations are presented in **Appendix D-5** of the Permit. Soil test data for the clay soils are included in **Appendix D-8** of the Permit.

D-6e(2)(b) Soil Liner Compatibility Data

A USEPA Method 9100 soil/leachate compatibility test has been performed. A Workplan outlining the laboratory procedures was approved by the USEPA, a copy of which is presented in **Appendix D-6** of the Permit.

Upon review of published literature, the permittee does not believe the inorganic wastes to be deposited in the Greenbelt II Landfill will adversely affect the clay liner's properties. In fact, it has been shown that alkaline waters tend to decrease a soil's permeability.

The results of the 9100 compatibility test were submitted and approved prior to construction of the liner.

D-6e(2)(c) Soil Liner Strength

A consolidation test, which subjected a recompacted clay sample (@ 90 percent standard Proctor) to pressures up to 16,000 psf, revealed that the maximum waste load of 8,300 psf will consolidate the clay layer approximately 0.25 feet. Therefore, a minimum thickness of three feet will be maintained throughout the facility life. The consolidation calculations are presented in **Appendix D-5** of the Permit.

According to Geotextile Testing and the Design Engineer, ASTM STP 952, pp. 112-113, a clay liner of finite thickness has a bearing capacity equal to its cohesion (c) times a load relative friction factor (Nc). Cohesion is obtained from one of several laboratory tests and Nc is obtained from calibrated tables.

Because the clay liner was recompacted, a sample for unconfined compression testing was obtained from a proctor mold compacted at 90 percent standard maximum dry density at the soil's optimum moisture content. The maximum dry density used was from an average maximum dry density obtained from Greenbelt I Landfill QA/QC testing. The liner strength is six times the landfill load. The resulting clay liner's strength calculations are provided in **Appendix D-5** of the Permit.

D-6f Liner System, Leachate Collection/Detection Systems

D-6f(1) System Operation and Design

In ascending order, the containment system is comprised of:

1. Approximately 3.25 feet (3.0 feet minimum) of recompacted clay with a hydraulic conductivity of no greater than 1×10^{-7} cm/s;
2. A secondary synthetic 60 mil thick HDPE geomembrane liner;
3. A synthetic HDPE drainage net (geonet) leak detection layer with a transmissivity of greater than $3 \times 10^{-3} m^2/sec$;
4. A primary synthetic 60 mil HDPE geomembrane liner;
5. A 12-ounce polypropylene geotextile cushion;
6. A 15-inch thick (minimum) granular leachate collection layer; and

7. A 5-inch thick (minimum) granular protective/operational layer and graded aggregate filter.

The liner system is sloped at greater than 2 percent from the middle to the north and south ends to promote drainage of accumulated leachate.

Leachate collected in the leachate collection system will flow through the 15-inch thick (minimum) granular layer to 6-inch slotted HDPE SDR 21 collector pipes located at each end of the landfill. The collector pipes run the width of the landfill and are sloped at 0.5 percent toward the middle. From there, the leachate pipes direct the accumulated leachate to one of the two HDPE vaults located at each end of the landfill. From these vaults, leachate from the primary leachate collection system is drained by gravity through an HDPE pipe to the Greenbelt II Pumphouse. The pumphouse, constructed for the Greenbelt II Landfill, senses any incoming liquids and pumps the liquids, via a 6-inch HDPE force main, to the Chrome Treatment Plant. The general locations of the pumphouse, pipeline and vaults are shown on Sheet 14. Specific details of the vaults, manholes and pipes are shown on Sheets 12 through 17 of the Permit.

The small leachate flows in the secondary leachate detection system will gravity drain to the annular shaped sump around Vaults 1 and 2 where the liquids are sensed by a meter and a submersible pump is activated which pumps liquids up through a flow meter into the primary leachate collection system discharge pipe. This process is shown on Sheet 27 of the Permit.

Vault Nos. 1 and 2 are located inside the limits of the landfill double liner system. The secondary and primary FML layers were extended across the sump area prior to the vaults being set in place as shown on Detail 1, Sheet 26 and Detail 3, Sheet 27. Collected leachate in either the leachate collection or detection piping systems is routed through the vaults in solid HDPE pipes. Therefore, leachate within the piping system at the vaults has four separate containment barriers: the pipe, the one-inch thick solid HDPE vault and the two HDPE liners.

The leachate discharge lines, which direct the flows to the Greenbelt II pumphouse, exit the landfill through the side wall composite liner. This is similar to the method described on page 4-17 and 65 of the USEPA Guidance Document 625/4-89/022, Seminar Publication: Requirements for Hazardous Waste Design, Construction and Closure, August 1989. At the exit point, a triple liner boot around the pipe and two anti-seep collars minimize leaks from seals around the pipe.

D-6f(2) Drainage Material

The proposed drainage material is INDOT #8 gravel, with a minimum permeability of 1 x 10^{-2} cm/sec. Permeability data for the proposed gradation is included in **Appendix D-13** of the Permit.

D-6f(3) Grading and Drainage

The liner system is sloped at greater than two percent from the middle to the north and south ends to promote drainage of accumulated leachate.

Leachate collected in the leachate collection system is designed to flow through the 15-inch thick (minimum) granular layer to 6-inch slotted HDPE SDR 21 collector pipes located at each end of the landfill. The collector pipes run the entire width of the landfill and are sloped at 0.5 percent toward the middle. From there, the leachate pipes direct the accumulated leachate to one of the two HDPE vaults located at each end of the landfill. From these vaults, leachate from the primary leachate collection system is drained by gravity through an HDPE pipe to the Greenbelt II Pumphouse. The pumphouse, constructed for the Greenbelt II Landfill, senses incoming liquids and pumps the liquids, via a 6-inch HDPE force main, to the Chrome Treatment Plant. The general locations of the pumphouse, pipeline and vaults are shown on Sheet 14. Specific details of the vaults, manholes and pipes are shown on Sheets 12 through 17. Calculations demonstrating sufficient pipe capacity at the Greenbelt II Landfill are included in **Appendix D-12** of the Permit.

The leachate detection system is also sloped at greater than two percent from the middle to the north and south ends. The small leachate flows in the secondary leachate detection system will gravity drain to the annular shaped sump around Vaults 1 and 2 where the liquids are sensed by a meter and a submersible pump is activated which pumps liquids up through a flow meter into the primary leachate collection system discharge pipe. This process is shown on Sheet 27 of the Permit.

D-6f(4) Maximum Leachate Head

The ability of a given leachate collection system to maintain less than one foot of leachate within the primary drainage system is a function of four variables, including:

1. Quantity of inflow,
2. Permeability of drainage material,

3. Slope of drainage layer, and
4. Leachate pipe spacing.

The quantity of inflow or leachate is predicted by the HELP model. Because of the low permeable nature of the solidified waste, little leachate is generated during the fifty year facility life. Therefore, to illustrate the leachate collection system's ability to operate, a conservative "worst case" scenario is applied.

Appendix D-12 of the Permit presents a conservative scenario where no waste or cover was in place. This would replicate a cell immediately after liner construction was complete and no waste was in place. If a large rainfall occurred during this period, the leachate collection system would be required to collect the infiltration portion of the rainfall (rainfall less runoff). The calculations in **Appendix D-12** demonstrate that the primary leachate collection layer can handle this limited occurrence scenario, while maintaining less than one foot of head.

The truest scenario would fall between the above mentioned two cases. Therefore, the leachate collection system as designed can maintain the less than one-foot requirement.

D-6f(5) <u>System Compatibility</u>

A Workplan for implementing liner/waste compatibility testing was prepared and previously approved by the USEPA. A copy of the Approved Workplan and Approval Letter is presented in **Appendix D-6** of the Permit. The purpose of the Workplan was to ensure that the compatibility testing meets the criteria and goals of the Agency. The testing was completed and results were submitted for review prior to construction of the landfill liner for Cell A (see **Appendix D-6** of the Permit). The test results demonstrated that the selected HDPE liners, drainage nets and piping and polypropylene geotextiles are compatible with the wastes. This test data will be used to select future use geosynthetics in accordance with USEPA Recommended Practices. If the permittee decides to use geosynthetics of a different chemical structure, the 9090 compatibility testing will be reperformed and an appropriate application for permit modification will be submitted to IDEM for approval. Also, if the future geosynthetics do not match the baseline compatibility test results within 15% during conformance testing, the test will be re-performed.

A USEPA Method 9100 soil/leachate compatibility test has been performed for this facility. A Workplan outlining the laboratory procedures was approved by the USEPA, a copy of which is presented in **Appendix D-6** of the Permit. Upon review of published literature, the permittee does not believe the inorganic wastes to be deposited in the Greenbelt II Landfill will adversely affect the clay liner's properties. In fact, it has been shown that alkaline waters tend to decrease a soil's permeability. The results of the 9100 compatibility test were submitted and approved prior to construction of the liner.

The leachate collection system is constructed of gravel aggregate and HDPE pipe. Each material was tested for compatibility with the waste. Method 9100 and 9090 testing was implemented as discussed in the Compatibility Testing Workplan in **Appendix D-6** of the Permit.

D-6f(6) Systems Strength

D-6f(6)(a) Stability of Drainage Layers

Because the Greenbelt II Landfill is essentially an "above ground" facility, sliding stability of the granular primary leachate collection layer is not of concern. The side slopes are flat (5:1) and the side slopes rise only one to six feet above the landfill bottom. A typical angle of repose for the gravel would be above 30 degrees. Comparing the repose angle to the landfill side slope (11.3 degrees) would yield a factor of safety against sliding of approximately three.

Bearing capacity calculations for the landfill are included in **Appendix D-5** of the Permit. In these calculations, a conservative phi value of 25° was used. This value is less than the phi values used in the slope stability calculations in **Appendix D-2** of the Permit; thus the drainage layers are believed to have sufficient strength to support the applied loads.

D-6f(6)(b) Strength of Piping

Appendix D-9 of the Permit presents calculations showing that the selected pipe, Polypipe PE 3408 HDPE SDR 21, can withstand all loads exerted by the Greenbelt II Landfill. Calculations include crushing by truck impact loads and landfill loads, long-term buckling and excessive ring deflection. The pipe strength was also corrected for the loss of strength by pipe slotting.

D-6f(7) Prevention of Clogging

The Indiana #53 aggregate selected for use as the operational layer will also act as a graded filter to control migration of sludge fines into the primary leachate collection layer of Indiana #8 aggregate. The 0.5 inch slot size selected for the leachate collection pipes was also selected based on federal EPA criteria to minimize migration of the Indiana #8 into the pipes. As an additional level of protection, pipe trenches (not pipes) are wrapped in a 12-ounce geotextile. The gradation calculations are presented in **Appendix D-10** of the Permit.

D-6f(8) Liquid Removal

The liner system is sloped at greater than 2 percent from the middle to the north and south ends to promote drainage of accumulated leachate.

Leachate collected in the leachate collection system is designed to flow through the 15-inch thick (minimum) granular layer to 6-inch slotted HDPE SDR 21 collector pipes located at each end of the landfill. The collector pipes run the entire width of the landfill and are sloped at 0.5 percent toward the middle. From there the leachate pipes direct the accumulated leachate to one of the two HDPE vaults located at each end of the landfill. From these vaults, leachate from the primary leachate collection system is drained by gravity through an HDPE pipe to the Greenbelt II Pumphouse. The pumphouse senses incoming liquids and pumps the liquids, via an 6-inch HDPE force main, into the Chrome Treatment Plant. The general locations of the pumphouse, pipeline and vaults are shown on Sheet 14 in the Permit. Specific details of the vaults, manholes and pipes are shown on Sheets 12 through 17. Calculations demonstrating sufficient pipe size at the Greenbelt II Landfill are included in **Appendix D-12** of the Permit.

The small leachate flows in the secondary leachate detection system will gravity drain to the annular shaped sump around Vaults 1 and 2 where the liquids are sensed by a meter and a submersible pump is activated which pumps liquids up through a flow meter into the primary leachate collection system discharge pipe. This process is summarized on Sheet 27 located in the Permit.

D-6f(9) Location Relative to Water Table

Two previously installed piezometers (MW-G7A, MW-G8A) are located immediately upgradient (south) of the Greenbelt II Landfill location. These two piezometers were installed in April 1989. Additional monitoring wells have been installed around the borders of existing Cells A, B and C of the Greenbelt II Landfill. As shown in **Appendices E-1** through **E-4** of the Permit, these wells (plus piezometers installed in December 1992 as part of the design process) have been monitored to evaluate the elevation and direction of groundwater flow beneath the Greenbelt II Landfill.

Relative to the water level, the liner system is entirely above the water table, except the clay key area at Vault No. 1 at the south end of the landfill. At this location, the 5.25 foot thick clay key way under the vault is approximately three feet (elev. 596.0 - elev. 592.90) beneath the water table during seasonally high water level periods.

As shown in **Appendices E-1** through **E-4** of the Permit, the water table fluctuates with high precipitation periods. This type of fluctuation is typical for unconfined aquifers in continental climates (i.e., four seasons). Continental climates typically exhibit two seasonally high precipitation periods in the early spring and fall. Therefore, the bottom of the liner system may occasionally be in contact with the water table in one area. Other areas of the landfill liner are 3.0 to 9.0 feet above the water table. Waste is a minimum 7.5 feet above the seasonal high water table.

The pressure exerted by the water level onto the clay liner is minimal and will not create stresses which could cause failure of the liner system or adversely affect the leak detection system. As shown in calculations in **Appendix D-5** of the Permit, the pressure exerted by the water is 1.33 psi; the resisting force (i.e., weight) of the clay liner alone is 3.79 psi; yielding a minimum factor of safety of 2.8 against uplift. After waste is deposited in the cell around this area, the resisting force will increase to as much as 14 psi, yielding a factor of safety of 10 against uplift.

Furthermore, water is known to seek "the path of least resistance". This path will be the pores of the surrounding sand because it is more porous and hence less resistant to flow.

D-6g Liner System, Construction and Maintenance

D-6g(1) Material Specifications

D-6g(1)(a) Synthetic Liners

Specifications for materials and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**. Maintenance of stored liner materials is also addressed in **Appendix D-1**.

D-6g(1)(b) Soil Liners

Specifications for materials, including borrow material, and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**.

D-6g(1)(c) Leachate Collection/Detection System

Specifications for materials, including borrow material, and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**.

D-6g(2) Construction Specifications

D-6g(2)(a) Liner System Foundation

Specifications for materials, including borrow material, and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**.

D-6g(2)(b) Soil Liner

Specifications for materials, including borrow material, and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**.

D-6g(2)(c) Synthetic Liner

Specifications for materials and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**. Maintenance of stored liner materials is also addressed in **Appendix D-1**. Maintenance of the liner system will be minimal upon completion of construction. However, some maintenance and repair of the liner(s) may be required when the adjacent cells are constructed. Specifics concerning liner maintenance when joining new sections of liner to old sections is addressed in **Appendix D-1** and in the notes on Sheets 8, 9, and 18.

D-6g(2)(d) Leachate Collection/Detection Systems

Specifications for materials, including borrow material, and procedures used during construction are explained in the Construction Quality Assurance Plan presented in **Appendix D-1**.

D-6g(3) Construction Quality Assurance Program

Construction quality assurance will adhere to the Construction Quality Assurance Plan, which is included in **Appendix D-1**. Submittals of the quality assurance documents will be provided at appropriate intervals or as required by the landfill permit. Typically, these submittals would occur within 60-90 days of the completion of large construction activities.

D-6g(4) Maintenance Procedures for Leachate Collection/ Detection System

Maintenance of the Leachate Collection/Detection System consists of routine and non-routine repairs. Non-routine repairs are identified during the landfill inspections and corrections are implemented accordingly. Routine maintenance, consisting of items such as pipe cleaning and sump sediment cleanout, is addressed in the Management, Operations and Maintenance Plan presented in **Appendix D-3**. A Response Action Plan (RAP), including action leakage rates (ALRs), is also presented in **Appendix D-3**.

D-6g(5) Liner Repairs During Operation

Liner repair procedures are included in **Appendix D-1** and Sheet 19 of the Permit.

D-6h Action Leakage Rate

D-6h(1) Determination of Action Leakage Rate

A Response Action Plan (RAP) as required by 40 CFR 265.223 is included in **Appendix D-3**. In summary, the RAP establishes an Action Leakage Rate (ALR) of 182.5 gallons per acre per day. This ALR was established in accordance with numerous guidance documents and the preamble language of the January 29, 1992 final rule entitled "Liners and Leak Detection Systems for Hazardous Waste Land Disposal Units". The preamble states that "units meeting the minimum technological requirements would not require action leakage rates under 100 gpad for landfills and the Agency believes that leak detection systems with greater hydraulic conductivities would have higher action leakage rates." See 57 Fed. Reg. at 3474. Therefore, the permittee believes that an ALR of 182.5 gpad is consistent with Agency requirements. The average leakage observed during operation of the landfill has been significantly lower than the ALR.

D-6h(2) Monitoring of Leakage

The leachate detection system drains into an annular gravel-filled sump surrounding each vault. Within the sump, a cased submersible pump withdraws the water, forces it through a flow meter and discharges it into the leachate collection and contact storm water line. This operation is shown on Sheets 26 and 27.

Metering of the leachate collection and contact storm water will provide historical records of the leachate volumes generated and verification of the effectiveness of the Primary Liner system as required by the USEPA.

D-6i Leakage Response Action Plan

D-6i(1)Response Actions

Response actions are outlined in the Response Action Plan, which is included in **Appendix D-3**.

D-6i(2) Leak and/or Remedial Determinations

Leak and/or remedial determinations are detailed in the Response Action Plan, which is included in **Appendix D-3**.

D-6i(3) Notifications

Notifications are listed in the Response Action Plan, which is included in **Appendix D-3**.

D-6j Run-on and Run-off Control Systems

D-6j(1) Run-on Control Systems

D-6j(1)(a) Design and Performance

Run-on control at the Greenbelt II Landfill is not a large concern. There are no streams or rivers near the facility boundaries and the surficial sands common to the area produce little or no runoff. In addition, the facility is above ground. As shown in Section G-G' on Sheet 13 of the Permit, up to 8 feet of the final interim cap have been constructed to provide cover for the synthetic liner anchors. This cover provides additional run-on protection during the facility operating life. A run-on/run-off berm was constructed as shown on Sheets 3 and 22 of the Permit along the outside of the non-contact storm water retention area.

D-6j(1)(b) Calculation of Peak Flow

Because peak run-on flow is not a large concern as indicated in paragraph (a) above, this section is not applicable.

D-6j(2) Run-off Control System

D-6j(2)(a) Design and Performance

Run-off control is probably the single most important design aspect of the Greenbelt II Landfill because the low permeable nature of the waste produces significant runoff. Runoff is divided into two distinct groups: contact and non-contact runoff. Contact runoff is rainfall which has come into contact with the solidified sludge and must be treated as hazardous. Non-contact runoff is that portion of rainfall that falls onto the cover and is discharged at the toe of the cover.

D-6j(2)(a)(i) Contact Water

The design of the contact water run-off control system is closely related to the phasing of disposal operations during the facility life. The phasing operations are shown on Sheets 4 and 5 of the Permit. Contact runoff on active cell areas is drained to sumps constructed on the working area of the landfill. This method has worked well with minimal maintenance. The location of these sumps is relative to the height of the waste in that cell. The sump acts as a collection point and also as a sediment trap. The sumps are drained by 6-inch perforated pipes, which travel down the interior slopes of the partially constructed landfill, and discharge to a concrete sump located approximately in the center of the landfill. Concrete was selected to line this sump because it will be in operation for many years.

The concrete sump is drained by a 6-inch perforated HDPE pipe, which is connected to the 10-inch HDPE SDR 21 pipe located along the north/south center line of the landfill. The 10-inch pipe rests atop the protective/operational stone layer of the liner and was constructed in its entirety during Cell A construction. The liner is located under the interior north/south road as shown on Sheets 18 and 20 of the Permit. The 10-inch pipe is sloped at the same 2.1 percent as the landfill liner and intersects Vault No. 2 at the south end of the landfill. A similar 10-inch pipe system could be installed to slope to the north and connect to Vault No. 1, if needed during future operations. A 10-inch diameter stub and flange was constructed on the south side of Vault No. 1 for future use.

The above described flow path will convey most of the contact runoff; however, as shown in Detail 6 on Sheet 20 of the Permit, a small side slope area and interior access road would drain away from the main concrete sump. Therefore, smaller sumps may be constructed near Vault Nos. 1 and 2 to drain these small areas into the conveyance system. Sheet 29 presents the current drainage plan and indicates the location of the concrete sump and the interior slopes that drain away from the main concrete sump, toward the vault. Flow arrows are included on the drawing to indicate the current direction of flow for contact water.

Pipe load and strength calculations are presented in **Appendix D-9** of the Permit for the 10-inch line. Pipe flow capacity is presented in **Appendix D-12** of the Permit.

Prevention of overtopping of contact runoff is provided at several points within the landfill if the storm water conveyance system malfunctions. The contact runoff is directed to the NPDES-permitted Greenbelt II pumphouse. The pumphouse has two pumps with a tested capacity of 450 gallons per minute (gpm). In the event of power failure, excess flow, or pump mechanical breakdown, an alarm is triggered that signals the 24-hour plant security station and treatment plant operators. When the valve is shut, the incoming water is held in the transmission lines and sumps. This potential back-up is the reason why all of the piping is “hard plumbed” through the manholes. Because the elevation of the landfill is typically higher than the manholes, the hard plumbing will prevent overtopping at the manholes outside the landfill. As needed, temporary sumps will be constructed on the working face of each operating cell. The temporary sumps are sized to contain up to a 10-year storm event in case of a plugged line or closed valve at the pumphouse. Sizing criteria are shown on Sheet 20 of the Permit.

A 750,000 gallon double walled storm water surge tank has also been installed to temporarily contain excess contact storm water prior to treatment at the Chrome Treatment Plant. When needed, excess storm water is pumped to the surge tank, temporarily held, and then released in a controlled fashion via gravity and routed to the Chrome Treatment Plant for treatment. As a contingency, excess contact storm water may also be temporarily held on the working face of the landfill, consistent with previously permitted language.

As interim waste elevations are achieved, a hydraulic barrier will be constructed to prevent contact water from spilling over the outside edges of the landfill. The hydraulic barrier system is shown on Sheet 21. The hydraulic barrier provides for a holding area more than a 25-year, 24-hour duration storm event as shown in **Appendix D-11**.

The temporary liner anchor design, as shown on Sheet 18, also provides additional double-lined storm water holding capacity. Calculations of this capacity are shown in **Appendix D-11** of the Permit.

D-6j(2)(a)(ii) Non-Contact Water

Non-contact water resulting from low-frequency, high-intensity storms are directed to the outside perimeter of the landfill and collected in standard storm water retention basins. The non-contact water perimeter ponds located south of Cell A and north of Cell C were constructed during the construction of these cells. The location of each of these ponds is identified on Sheet 29. Due to the permeable nature of the native sandy soils, the "ponds" rarely retain noticeable volumes of surface water for extended time periods. The design bottom elevation of the ponds is 604 ft. MSL, which is approximately 6-9 feet above the top of the seasonal high water table. Once beyond the boundary of the landfill, most surface water infiltrates nearly vertically until the water table is intercepted. This non-contact water does not come into contact with waste and is managed as normal storm run-off.

Although the perimeter non-contact water collection pond has been sized to collect the calculated runoff from a 25-year, 24-hour storm, the collected runoff will be allowed to percolate into the subsoils beneath the pond. Mr. Charles Walker of the Porter County Extension of the United States Soil Conservation Service previously indicated that the percolation rate of the natural granular soils has been calculated to be 10-15 minutes per inch (min/in). He also indicated that it is their practice to be conservative and use a percolation rate of 45 min/in in their calculations. Using the conservative value of 45 min/in, the discharge from a 25-year, 24-hour storm into the retention basins would seep into the ground in approximately 3.45 hours. This design maintains similar drainage patterns before, during and after construction, without flooding adjacent property.

The 1997 closure area consisting of approximately 1.75 acres was capped utilizing the originally permitted final cover system (e.g. 2 ft. compacted clay, PVC, and 4 ft. of native sand). Precipitation falls onto the area and is discharged through the drainage and vegetation layer and then to retention basins. Because of the high permeability of the sand, the discharge from the cover is predominantly "interflow"; that is, flow within the sand layer. Little to no surface water is expected to runoff from the 1997 closure area as was demonstrated by HELP Model results presented in **Appendix I-4** of the Permit. The final cover system is designed with a double sided geocomposite. A double sided geocomposite will be installed over the top of the PVC geomembrane and discharge into a slag/gravel toe drain. A HELP Model evaluation was performed for the final cover system which indicates that runoff from the final cover is expected as well as discharge from the underlying double sided geocomposite. Surface runoff and flow from the geocomposite will discharge into the slag/gravel toe drain and flow over the slag perimeter road as non-contact water. HELP Model output data for the final cover system is included in **Appendix I-4**. A detail showing the cross section of the final cover system and the slag/gravel toe drain is included on Sheet 28.

D-6j(2)(b) Calculation of Peak Flow

D-6j(2)(b)(i) Contact Water

The peak flow of contact water is presented in **Appendix D-11** of the Permit. In summary, because of the low permeable nature of the waste, 100 percent runoff is assumed as the peak flow.

D-6j(2)(b)(ii) Non-Contact Water

The peak flow of non-contact water is presented in **Appendix D-14** of the Permit.

D-6j(3) <u>Management of Collection and Holding Units</u>

Management of the various collection and storm water holding units used to convey contact water from the Greenbelt II Landfill are addressed in D-6j(2) above. Construction specifications for the sumps, concrete sumps, manholes, vaults and pipes are presented in the Construction Quality Assurance Plan (**Appendix D-1**) and addressed on several of the drawings. Notes on the drawings also address the maintenance items of these units as does the Management, Operations and Maintenance Plan (**Appendix D-3**). A Response Action Plan (RAP) outlining the management of leachate from the facility during construction and operation is presented in **Appendix D-3**.

D-6j(4) Construction

Construction specifications for the sumps, concrete sumps, manholes, vaults and pipes are presented in the Construction Quality Assurance Plan (**Appendix D-1**) and addressed on several of the drawings.

D-6j(5) Maintenance

Notes on the drawings address the maintenance items of the collection and holding units, as does the Management, Operations and Maintenance Plan (**Appendix D-3**).

D-6k Control of Wind Dispersal

The landfill design uses a sloped sidewall that is capped and because of this slope, the area of the dewatered sludge exposed to the wind is continuously reduced as the dewatered sludge is mounded. Dewatered sludge meeting BDAT LDR treatment standards will be placed there on a regular basis and this continuous placement of sludge will assure higher moisture dewatered sludge at the sludge/air interface. Thus, the material in the landfill will be subject to minimal wind dispersal.

During solidification maintenance, the dry nature of the fly ash combined with movement of heavy equipment may create dusty conditions. To control the fly ash dust, the permittee will perform the procedures described in Section F-2b(6)(b) of Attachment F of this Permit.

D-6l Liquids in Landfills

No liquids, containers, containerized liquids, labpacks or reactive or incompatible wastes are allowed to be deposited in the Greenbelt II Landfill. Procedures for excluding liquids are outlined in Section D-6(a), and in the Construction Quality Assurance Plan (**Appendix D-1**).

D-6m Containerized Wastes

No containerized wastes will be deposited in the Greenbelt II Landfill. Therefore, this section is not applicable.

D-6n Special Waste Management Plan for Landfills Containing Wastes F020. F021, F022, F023, F026 and F027

No F020, F021, F022, F023, F026 or F027 wastes will be deposited in the Greenbelt II Landfill. Therefore, this section is not applicable.

D-7 Land Treatment

No land treatment takes place at the Greenbelt II Landfill. Fly ash and/or lime is added to the sludge at the Greenbelt II Landfill, but this is considered a physical process, and is conducted after it has been demonstrated that the sludge complies with the BDAT treatment standards (see Waste Analysis Plan provided in **Appendix C-2** to this Permit). IDEM has previously recognized that the addition of these materials at the Greenbelt II Landfill is not considered hazardous waste treatment.

D-8 Miscellaneous Units

No hazardous wastes are present within Miscellaneous Units at the permittee's facility. Therefore, this section does not apply.

D-9 Boilers and Industrial Furnaces (BIFs)

The permittee's facility is not a boiler or industrial furnace facility. Therefore, this section does not apply.

D-10 Containment Buildings

No hazardous wastes are stored in containment buildings located at the Greenbelt II Landfill. Therefore, this section does not apply.

APPENDIX D-1

Quality Assurance/Quality Control Plan for Greenbelt II Landfill Construction

See VFC document # 83546904, pages 608 – 713

APPENDIX D-2

Stability Analysis

See VFC document # 83546904, pages 714 - 806

APPENDIX D-3

Response Action Plan and Management, Operations and Maintenance Plan

Response Action Plan

Greenbelt II Landfill

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Response Action Plan (RAP), as required by 40 CFR 264.223, is to address the response actions that will be undertaken should leakages through the primary liner occur at the Greenbelt II Landfill. The following sections will specify the monitoring, inspection and corrective measures that will be implemented if a flow of leachate exceeding the Action Leakage Rate (ALR) occurs in the leak detection system. This plan is based on an assessment of the capability of the total design, construction and operation of the unit as a whole and not the individual capabilities of the components. The leak detection system (LDS), however, can be analyzed in individual grid sections thus providing a means to locate general leak or failed areas.

1.2 Greenbelt II Landfill

The Greenbelt II Landfill will total approximately 20 acres in size and will be divided into 4 cells. The landfill is underlain by a composite liner which includes a leachate collection and recovery system (LCRS) and a leachate detection system (LDS). The sizes of the landfill cells to be used in the RAP calculations prior to total liner bottom completion are:

CELL	DIMENSIONS	CELL SURFACE AREA
Cell A	576.5 ft. x 399 ft.	5.3 acres
Cell A & B	576.5 ft. x 690 ft.	9.1 acres
Cell C	565 ft. x 399 ft.	5.2 acres
Cell C & D	565 ft. x 690 ft.	8.9 acres

The cell sizes when all four are completed are each 4.5 acres. However, the acreages are increased to reflect the additional temporary liner anchors as shown on Sheet 2.

The system is designed to meet or exceed the minimum technological requirements. At the base of the landfill, the LCRS, a 1.25 ft. gravel drainage layer, collects leachate and gravity route it toward the primary header trench and pipe, which is then gravity routed into the HDPE vault. A cross connection inside the vault connects the primary header pipe to the leachate conveyance line, which is then gravity routed to the pumphouse. A geotextile layer has been installed below the gravel to minimize damage to the underlying primary flexible membrane liner (FML).

A synthetic geonet layer, part of the LDS composite, will be placed under the primary FML to gravity route any leachate that permeates, diffuses or leaks through the primary FML towards the secondary collection sump. A secondary FML will lie below the geonet to serve as a barrier against leachate migration into the subsurface soil or groundwater. To further protect against this migration, a 3.25 ft. layer of clay will underlie the secondary FML. Together, these components will further reduce the potential for leachate entering the environment. Calculation 3 has an illustration of the 5.0 ft. thick liner composite which underlies the Greenbelt II Landfill.

The LDS detects leachate that has permeated the primary FML. The liquid that permeates the primary FML is gravity routed through a Poly-Flex FN-3 HDPE geonet to the secondary header pipe. This 6" diameter HDPE header pipe is then gravity routed to the secondary sump which surrounds the HDPE vault. A submersible pump which is located at the sump invert pumps the collected liquid through a 1" diameter discharge line traveling through the HDPE vault and connected into the internal piping network. A flow meter has been installed in the 1" diameter discharge line, allowing measurement of the flow in the LDS sump.

The LDS capacity will effect this RAP in two ways: The action leak rate (ALR) is required to be less than the flow capacity of the LDS and less than the pumping capacity of the LDS sump. The ALR is the site specific level at which the USEPA requires response action. The ALR is based upon calculations of the maximum flow capacity of the LDS so as not to exceed one foot head on the bottom liner.

1.3 Flow Rates

Three benchmark flow rates have been established in this RAP. These benchmarks will be the basis for the monitoring and response action the permittee will take should leakage in the primary FML occur.

The beginning level for leachate leakage is the normal leakage rate (NLR). Flow rates between 0 and 25 gallons per acre per day (gpad) have been established as the NLR. This level of flow is to be expected due to calculated theoretical permeation or diffusion through the primary FML.

The secondary level for leakage is the Watch Level (WL). Flow rates between 25 and 182.2 gpad are categorized as WL. The lower half of the WL flow values indicate the possible existence of a minor breach of integrity or pin sized holes in the primary FML. Flow rates on the upper half of the WL indicates potential problem areas that should be addressed prior to exceeding the Action Leakage Rate.

The third and final level of leakage is the Action Leakage Rate (ALR). This level is calculated using EPA guidelines and is based on the unit design and the potential for liquids to migrate through the primary liner. After entering specific site information into the established EPA equation, the ALR for the Greenbelt II landfill was calculated as 182.2 gpad (Calculations 1 and 2). Flow rates in excess of 182.2 gpad (ALR) indicate a major localized or general failure of the primary FML.

The determination for the NLR and the WL are based on safety and protection. The NLR values are those flow rates which are typical of a landfill due to diffusion through the FML.

The WL represents all values between the NLR and the ALR, that is, values which are above what typically occurs in a landfill but below the level at which EPA has determined a need for response actions. This level has been labeled the Watch Level because monitoring the flow rate becomes more important. Flow rates in this range suggest the need for close observation in order to narrow down the possible causes of the excessive flow rate. Although no immediate action is necessary or required, it may be necessary to take precautionary or response actions to prevent the flow rate from reaching the ALR.

The ALR was calculated using the procedures provided by EPA (see Calculations 1 and 2). As previously stated, the ALR is required to be less than the flow capacity of the LDS. At the Greenbelt II Landfill, the LDS can handle a flow of 364.5 gpad, as determined by the suggested leak scenario formula recommended by the EPA (Calculation 1 and 2). To provide additional conservatism into the system, the safety factor of 2, as recommended by the EPA, was utilized thus yielding a trigger level of 182.2 gpad. Therefore, even though the capacity of the system, using EPA calculations, is 364.5 gpad, the permittee will be required to take response actions at an ALR of 182.2 gpad. As stated in the Federal Register, "The ultimate goal of the liner and leak detection system requirements is to prevent the release of hazardous constituents from the unit, thereby protecting the ground water and surface water. A system in place to detect leaks at the earliest practical time should be complemented by early follow-up actions to effectively minimize the chance for migration of hazardous constituents from the unit" (January 29, 1992). The permittee will accomplish this by responding to flow rates within the WL and taking corrective action if flow rates exceed the ALR.

2.0 SOURCES OF FLUIDS WITHIN THE LDS

2.1 Water Vapor Transmission (WVT) Through the Primary and Secondary FML

Though essentially impermeable (below available scientific method for quantification), water can permeate through an FML. To quantify this movement in a laboratory, though incorrect and extremely conservative, water vapor is substituted for liquid water. This is known as a water vapor transmission test (ASTM E96).

The sources of liquid could be from precipitation, drainage layer moisture, and/or water used to compact the 3.25 foot clay liner during construction. The Poly Flex 60 mil FML has a Water Vapor Transmission of 0.020 g/100 in^2 day (see Attachment V) or 1 x 10^{-5} gal/ft^2 day. This WVT value multiplied by the area under consideration will yield a volume of liquid that has permeated the surface of the FML. Using the equation in Calculation 3 - Case I approximately 0.44 gallons per acre day (gpad) would be expected to permeate through the primary FML. This same volume could also permeate up through the secondary FML, therefore an approximate volume of 0.88 gpad could be detected in the Leak Detection System due to WVT.

2.2 Precipitation Percolation Through the Primary FML

Precipitation percolation represents the flow of liquid through an estimated number of liner deficiencies in the primary FML. The estimated liner deficiencies consist of 0.25 inch diameter holes evenly spaced at 10 holes per acre. These assumptions, which are used to calculate the liner leakage fraction (LLF) for use in the HELP model (see Attachment VII).

As shown in Calculation 3 - Case II a primary liner efficiency of 97.82% was utilized. The summary section in Attachment VII states the average annual percentage of percolation through layer 3 (primary FML) is 2.18%; therefore, yielding a liner efficiency of 97.82%. The percolation through layer 3 is the ratio of Darcian flow through the above referenced 10 holes per acre and the volume of water drained laterally off the top of the primary FML through the primary drainage layer.

It can also be stated the drainage medium directly below the primary FML can influence the liner efficiency. As the hydraulic transmissivity of the drainage layer increases the flow rate through the liner voids can increase. Because Greenbelt II Landfill is designed with a drainage net with a transmissivity of 2 x 10^{-3} m^2/sec., flow through liner deficiencies, (as computed by the HELP Model) will be increased.

Using a liner efficiency of 97.82% and a factor of safety of 3, the flow from leakage through the primary FML would be 23.5 gpad. Therefore a Normal Leakage Rate (NLR) of approximately 25 gpad (23.5 gpad + 0.88 gpad) will be implemented at the Greenbelt II Landfill.

3.0 MONITORING AND RESPONSE ACTIONS BY FLOW RATE

3.1 General

The purpose of this section is to address the monitoring protocol and response actions that will be observed by the permittee at the Greenbelt II Landfill. There were previously two phases in which different protocol were be observed: the Construction Phase and the Continuous Operation Phase. However, because the Construction Phase has been completed, these procedures have been removed and the only applicable procedures are for the Continuous Operation Phase.

The benchmark flow rates (NLR, WL & ALR) are derived from measurements taken at the flow meters in the vaults. Flow rate measurements obtained in total gallons per time period, will be taken at both vaults and analyzed separately because of the east-west drainage divide located in the middle of the landfill. The individual flow rates converted to gallons per acre per day (gpad) will then determine which benchmark category and corresponding monitoring procedures that particular section of the landfill will follow.

A form will be utilized to track and record LDS monitoring. Figure F-3 in Attachment F of the Permit illustrates the tabular format for calculating the flow rate in gpad from the nonresettable flow meter which measures in total gallons.

The leachate collection system will be inspected weekly. Each inspection will require a flow rate calculation sheet to be filled out and logged.

3.2 Continuous Operation Phase Monitoring & Response Actions

The Continuous Operation Phase begins when waste is placed in the landfill and ends with the completion of post closure monitoring of the landfill. This phase represents a broad range of waste lift configuration inside the cell area. The volume and configuration of waste placement in the cell will directly correlate to the types and degrees of response actions applied.

3.2.1 Monitoring NLR During Continuous Operation Phase

If a flow rate between 0 and 25 gpad (the NLR) is detected in the sump during this phase, the permittee will monitor the LDS at normal intervals and calculate an average daily flow rate.

3.2.2. Response Actions to NLR During Continuous Operation Phase

The Normal Leakage Rate (NLR) is the theoretical calculated leakage produced by the landfill. The cause for this leakage is primarily condensation through the primary FML (water vapor transmission) and the estimated 97.82% efficiency of the primary liner. Action will be limited to the monitoring protocol stated in Section 3.2.1.

An illustration of the procedures used for responding to a NLR value during the Continuous Operation Phase is found in Table 1.

3.2.3 Monitoring WL During Continuous Operation Phase

If a flow rate between 25 and 182.2 gpad (the WL) is detected during this phase, the permittee will increase the monitoring frequency to twice per week and calculate an average daily flow rate. This will continue until the flow rate decreases below 25 gpad (the NLR) or exceeds 182.2 gpad (the ALR).

3.2.4 Response Actions to WL During Continuous Operation Phase

The cause for a WL leakage (25 to 182.2 gpad) during the Continuous Operation Phase could be of several origins. The condensation (water vapor transmission) through the primary FML could be a larger amount than theoretically calculated or the liner may have an efficiency less than the 97.82%. Typical problem areas which could result in increased leakage are listed below in Section 3.2.6.

An illustration of the procedures used for responding to a WL flow during the Continuous Operation Phase is found in Table 2.

3.2.5 Monitoring ALR During Continuous Operation Phase

If a flow rate exceeding 182.2 gpad (the ALR) is detected during this phase, the permittee will increase the monitoring of the LDS to daily and calculate a daily flow rate. Also, a sample of the liquids collected from the LDS system will be obtained and submitted for analysis of the groundwater indicator parameters listed in Attachment E of this Permit.

3.2.6 Response Actions to ALR During Continuous Operation Phase

A flow rate in excess of the ALR (182.2 gpad) during the Continuous Operation Phase may indicate a major localized or general failure of the primary FML.

The response to an ALR flow during the Continuous Operation Phase begins with the permittee following the monitoring procedures stated in Section 3.2.5. Next, the permittee will attempt to locate the general leak area. This will be accomplished by accessing the secondary header clean-outs at the landfill vaults in order to verify which landfill cell the leak is originating from. Once this is verified, the LDIs will be used to narrow down the leak area to the grid section of bottom liner they monitor.

Next, the permittee will visually sample the liquid present in the secondary sump. If the sump liquid contains mostly clear liquid, such as rainwater, then the bottom composite liner where no waste is present must be checked for typical problem areas, such as:

- Construction traffic on the bottom composite liner and the 5:1 sideslope that show signs of effecting the integrity of the primary FML.

    (Tire ruts, Construction equipment staging areas, access and haul roads)

- Integrity of the temporary and permanent liner anchor trenches.

    (Evidence of storm water run-on flow, anchor up-lift and visible synthetic liner)

- Ponding after rainfalls that can be correlated with an increase leakage rates during and after rainfall events.

- Secondary cleanouts and the LDI access ports

    (Water tight seals at cover, evidence of ponding near ports and header connection failure)

- Primary liner panel layout record drawings that could give clues to potential problem areas within the synthetic liner system.

    (Pipe boots, patch areas, inclement weather day areas, complex panel geometry, daily start/finish areas and miscellaneous difficult connections).

If the sump liquid contains mostly waste liquid, such as leachate, then the possible problem areas in the bottom composite liner where waste is present must be analyzed. The permittee will first review the primary liner panel layout as-built to determine possible areas within the synthetic liner system which are more susceptible to failure. Areas containing pipe boots, patches, inclement weather days, and complex panel geometry must be located within the general leak area.

The permittee will also correlate the available precipitation records and flow rates at the secondary sump to determine a general idea of when and where the leak occurred. This area may still be located close to the waste working face, thus making response action feasible.

Next, the permittee will locate the specific leak area and review the possible corrective actions. If there is no waste or small waste lifts in the specific leak area, the permittee will carefully uncover the synthetic liner, locate and repair the flaw and retest the area before covering.

If there are large waste lifts in a specific leak area, the permittee will perform the following response actions:

- Decrease the head on the liner by increasing the secondary pump cycles,
- Increase the slope of the working face in order to decrease the travel time of contact water to the temporary sump thus reducing the contact water permeating the waste lift, and
- Partially close the cell unit with a clay cover if all other corrective action have failed.

After repairs are completed, the permittee will perform ALR monitoring requirements until the leakage rate decreases to WL (25 to 182.2 gpad) or NLR (0 to 25 gpad).

The permittee will notify the IDEM within 7 days of the discovery of the flow rate exceeding the ALR. The permittee will submit a preliminary written assessment to the IDEM within 30 days of the initial discovery of an ALR flow. This preliminary assessment will contain information on the amount and the source of the liquid in the sump, the possible size of the defect, the location and cause of the leak, and information and short term actions to be implemented. Within 60 days, the permittee will submit a report to the IDEM detailing the effectiveness of the response actions taken. The permittee will submit quarterly reports to the IDEM as long as the ALR is exceeded.

An illustration of the procedures used for responding to an ALR during the Continuous Operation Phase flow is found in Table 3.

Table 1

Cell Continuous Operation Phase
Response Actions for NLR

Flow Rate (gpad)	Type of Flow	Potential Cause and Response
0-25	Normal Leakage Rate (NLR)	**<u>POTENTIAL CAUSE:</u>** • Condensation Through primary FML (Water Vapor Transmission) • 99.5% liner efficiency (small holes in primary FML) **<u>RESPONSE:</u>** • Follow monitoring schedule

Table 2

Cell Continuous Operation Phase
Response Action for WL

Flow Rate (gpad)	Type of Flow	Potential Cause and Response
25-182.2	Watch Level (WL)	**POTENTIAL CAUSE:** • Condensation through primary FML (Water Vapor Transmission) • Liner efficiency less than 99.5% (more holes in liner than planned) • Incomplete liner installation • Damaged liner from construction activity • Leakage from run-on at liner anchors **RESPONSE:** • Follow monitoring schedule • Review flow rate report log to determine if leakage rate steadily increases, sporadically increases, or fluctuates during and after storm events. • Voluntarily perform any of the ALR response actions listed in Table 3 so that the ALR is not exceeded. • Report results to Environmental Affairs.

Table 3
Cell Continuous Operation Phase
Response Actions for ALR

<table>
<tr><th>Flow Rate (gpad)</th><th>Type of Flow</th><th>Potential Cause and Response</th></tr>
<tr><td>182.2+</td><td>Action Leakage Rate (ALR)</td><td>
<u>POTENTIAL CAUSE</u>:
• Flow rate in excess of the Action Leakage Rate (ALR) indicate a major localized or general failure of the primary FML.

<u>RESPONSE</u>:
1. Follow monitoring schedule:

2. Locate the general leak area:
• Access the secondary header clean-outs at the landfill vaults to verify which landfill cell the leak is originating from.
• Use the LDIs to determine the general leak location within the cell.

3. Visually sample the liquid present in the secondary pump:
3.A. If the sump liquid contains mostly clear liquid (i.e. rain water), visually check the bottom composite liner where no waste is present for the following:

• Signs of construction traffic on bottom composite liner and 5:1 sideslope (Tire rutts, construction equipment staging areas, and access and haul roads)
• Integrity of temporary and permanent liner anchor trenches (evidence of storm water run-on flow, anchor up-lift and visible synthetic liner)
• Note general ponding during and after rainfall that can be correlated with an increase in leakage rate
• Check secondary clean-outs and LDI access ports (water tight seals at cover, evidence of ponding near ports and header connection failure)
• Review primary liner panel layout (as-builts) to determine possible problem areas (pipe boots, patch areas, inclement weather day areas, complex panel geometry, daily start/finish areas and miscellaneous difficult connections)

3.B. If the sump liquid contains mostly waste liquid (i.e. leachate), determine the possible problem areas in the bottom composite liner which is now under waste by:

• Reviewing primary liner panel layout (as-builts) to determine possible problem areas (Pipe boots, patch areas, inclement weather day areas, complex panel geometry, daily start/finish areas and miscellaneous difficult connections).
• Correlating waste placement daily records, precipitation record and flow rates at the secondary sump to determine a general idea of when and where the leak occurred.
• Checking the integrity of the primary liner at the sump area (perform water/dye test at the sump primary clean-outs, note any dye in the secondary sump).
• Inspecting contact water temporary sump for overflow evidence and line failures.
</td></tr>
</table>

Table 3
(Continued)

Flow Rate (gpad)	Type of Flow	Cause and Response
182.2+	Action Leakage Rate (ALR)	**4. Locate specific leak area, review possible corrective actions:** **4.A**. If there are no waste or small waste lifts in the specific leak area: • Carefully uncover the synthetic liner; • Locate and repair flaws; and • Retest before covering; **4.B.** If there are large waste lifts in the specific leak area: • Decrease head on the liner by increasing secondary pump cycles; • Increase slop of working face to decrease travel time of contact water to temporary sump; or • Partially close cell unit with clay cap. **5. Perform ALR Monitoring requirements until leakage rate decreases to Watch Level (WL):** **6. IDEM notification, preliminary assessment, and reports required:** • Notify IDEM within 7 days of exceeding ALR; • Submit a preliminary written assessment to the IDEM within 14 days of initial ALR value with information on the amount and source of liquid in secondary pump, possible size of defect, location and cause of leak, and any immediate and short term actions to be implemented; • Submit report to IDEM within 30 days describing effectiveness of response actions; • Monthly reports to IDEM as long as ALR is exceeded; and . • Submit a final report summarizing all the response actions which have been implemented to reduce the ALR.

WEAVER BOOS CONSULTANTS, INC. CALCULATION I

☐ 520 N. Michigan Avenue, Chicago, IL 60611 • (312) 670-0041
☐ 601 W. Beardsley Avenue, Elkhart, IN 46514 • (219) 294-1830

By MNC Date ____ Subject CALCULATION ACTION LEAKAGE RATE (ALR) FOR GBTT'S RAP Sheet 1 of 2
Chkd By____ Date ____ File No. 92-24.09

REVISED: 8-26-92

ALL CALCULATIONS AND QUOTES ARE REFERENCED FROM THE FEDERAL REGISTER / VOL 57 NO. 19 / WED. 1-29-92 / RULES & REGULATIONS

GENERAL CRITERIA TO CALCULATE (ALR) ACTION LEAKAGE RATE:

1. ALR BASED ON THE MAXIMUM DESIGN LEAKAGE RATE THAT THE LEAK DETECTION SYSTEM CAN REMOVE WITHOUT THE FLUID HEAD ON THE BOTTOM LINER EXCEEDING ONE FOOT (OR WIDTH OF DRAINAGE NET) ∴ ALR SHOULD BE LESS THAN THE FLOW CAPACITY OF THE DRAINAGE LAYER. (THIS APPROACH IS SIMILAR TO THE RAPID AND EXTREMELY LARGE LEAK IN THE MAY 29, 1987 PROPOSAL).
2. ALR SHOULD BE LESS THAN OR EQUAL TO THE PUMPING CAPACITY OF THE LEAK DETECTION SUMP.

CALCULATE MAX FLOW RATE OF DRAINAGE LAYER

AGENCY BELIEVES THE FOLLOWING FORMULA (BASED ON NON-TURBULENT FLOW THROUGH SATURATED MEDIA) IS THE MOST LIKELY LEAK SCENARIO FOR A GEOMEMBRANE LINER

$Q = K \cdot h \cdot \tan\alpha \cdot B$

Q = FLOW RATE IN THE LEAK DETECTION SYSTEM (GEONET)
h = HEAD ON THE BOTTOM LINER
K = HYDRAULIC CONDUCTIVITY OF THE DRAINAGE MEDIUM ($K = T/b$)
α = SLOPE OF THE LEAK DETECTION SYSTEM
B = WIDTH OF FLOW IN THE LEAK DETECTION SYSTEM PERPENDICULAR TO FLOW.
T = HYDRAULIC TRANSMISSIVITY @ 15,000 psf / 2%
b = WIDTH OF DETECTION SYSTEM (GEONET)

GIVEN:

$T = 2\times10^{-3}\ m^2/sec$ -OR- $0.0215\ FT^3/SEC$ (SEE ATTACHMENT I, TRANSMISSIVITY CHART)
b = 0.20 in -OR- 0.0167 FT (SEE ATTACHMENT II, GEONET SPEC SHEET - THICKNESS)
∴ K = 1.29 FT/SEC
h = 0.0167 FT (ASSUME FULL FLOW THROUGH WIDTH OF GEONET)
α = 2.0% -OR- .02 FT/FT (SEE ATTACHMENT III, ILLUSTRATION OF CELL 4)
B = 75 FT (SEE ATTACHMENT III, ILLUSTRATION OF CELL 4)
∴ Q = 1.29 FT/SEC (0.0167 FT)(TAN .02 FT/FT)(75 FT)
Q = $5.6\times10^{-4}\ FT^3/SEC$ -OR- 364.5 GAL/ACRE/DAY
* F.S = 2.0 ∴ Q = 182.2 GAL/ACRE/DAY

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By MNC Date ______ Subject CALCULATION ACTION LEAKAGE RATE (ALR) FOR GR II'S R.A.P Sheet 2 of 3

Ckd By ______ Date ______ File No. 92-24

REVISED 8-26-92

CALCULATE MAXIMUM PUMPING CAPACITY OF LEAK DETECTION SUMP

GIVEN:

- VOLUME OF LEAK DETECTION SUMP = 4,000 GALLONS @ 3.0 FT OPERATING LEVEL
  * (SEE ATTACHMENT VI AND GR II DESIGN DRAWINGS E741-0051 # 52)
- PUMP CAPACITY = 5 GAL/MIN OR 7200 GAL/DAY (SEE ATTACHMENT IV)
- ALR = 182.2 gpad (SEE PREVIOUS PAGE, CALCULATION # 1)

CELL A

ACRES = 5.32

ALR = 182.2 gpad

∴ ALR REACHED IN CELL A WOULD GENERATE 969.5 GALLONS

CELL B

ACRES = 3.86

ALR = 182.2 gpad

∴ ALR REACHED IN CELL B WOULD GENERATE 703.3 GALLONS

CONCLUSIONS:

→ TOTAL LIQUID GENERATED FROM CELL A & B IF ALR IS REACHED = 1,673 GAL/DAY

→ VOLUME OF LEAK DETECTION SUMP (VAULT 1) = 4,000 GALLONS

∴ SUMP VOLUME CAN CONTAIN THE LIQUID PRODUCED FROM AN ALR EVENT

$F.S = 4000/1673$; $F.S = 2.4$

→ PUMP CAPACITY OF SUMP (VAULT 1) (SEE ATTACHMENT IV) = 7,200 GAL/DAY

∴ PUMP CAPACITY EXCEEDS THE VOLUME OF AN ALR EVENT

$F.S = 7{,}200/1673$; $F.S. = 4.3$

* CELLS C & D, WHICH WILL DRAIN TO VAULT 2, ARE APPROXIMATE MIRROR IMAGES OF CELLS A & B ∴ THE SAME ALR RATE WILL BE USED FOR THESE LATER CELL DEVELOPMENTS.

WEAVER BOOS CONSULTANTS, INC. CALCULATION 3

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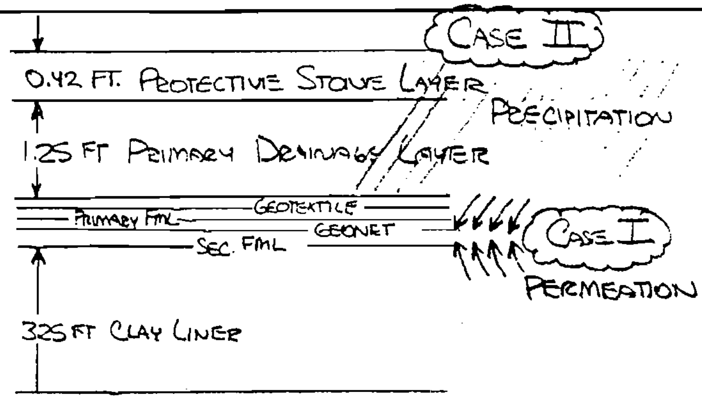
By MMC Date ______ Subject EXPECTED SOURCES & QUANTITIES OF FLUIDS WITHIN THE LDS Sheet 1 of 1
By TB Date ______ File No. 92-24.09



LINER COMPOSITE

SUMMARY

CASE I FLOW RATE = 0.88 gpad
CASE II FLOW RATE = 23.5 gpad
TOTAL = 24.3 gpad
∴ BENCHMARK FLOW RATE TO UTILIZE FOR NORMAL LEAKAGE RATE (NLR) = 25.0 gpad

CASE I WATER VAPOR TRANSMISSION (WVT) THROUGH PRIMARY & SECONDARY FML

GIVEN: - POLY-FLEX 60 MIL HDPE GEOMEMBRANE
- WATER VAPOR TRANSMISSION = 0.020 g/100 IN² · DAY (SEE ATTACHMENT V)

CONVERSION → $\frac{0.020 g}{100 IN^2 \cdot DAY} \times \frac{0.035 oz}{1 g} \times \frac{1 GAL}{128 oz} \times \frac{144 IN^2}{1 FT^2} = 1 \times 10^{-5} GAL/FT^2 \cdot DAY$

CELL A AREA = 232,000 FT² - OR - 5.32 ACRES

∴ $\frac{1 \times 10^{-5} GAL}{FT^2 \cdot DAY} \times \frac{232,000 FT^2}{1} = \frac{2.32 GAL}{CELL A \cdot DAY}$ - OR - $\frac{0.44 GAL}{ACRE \cdot DAY}$

CONCLUSION: - WVT THROUGH PRIMARY FML = 0.44 gpad
- WVT THROUGH SECONDARY FML = 0.44 gpad

TOTAL WVT INTO LDS = 0.88 gpad

CASE II: PRECIPITATION PERCOLATION THROUGH PRIMARY FML

GIVEN: AVERAGE PRECIPITATION = 3.47"/MONTH OR 0.12"/DAY * SEE ATTACHMENT VII

SYSTEM	TIME PERIOD	AVERAGE PREC. PER DAY	CELL A AREA (FT²)	CELL A VOLUME PREC. PER DAY	CELL A AREA (ACRES)	gpad
PRIMARY	DAILY	0.12 IN/DAY (0.01 FT/DAY)	232,000	2,320 FT³/DAY (17,350 GAL/DAY)	5.32	3,261

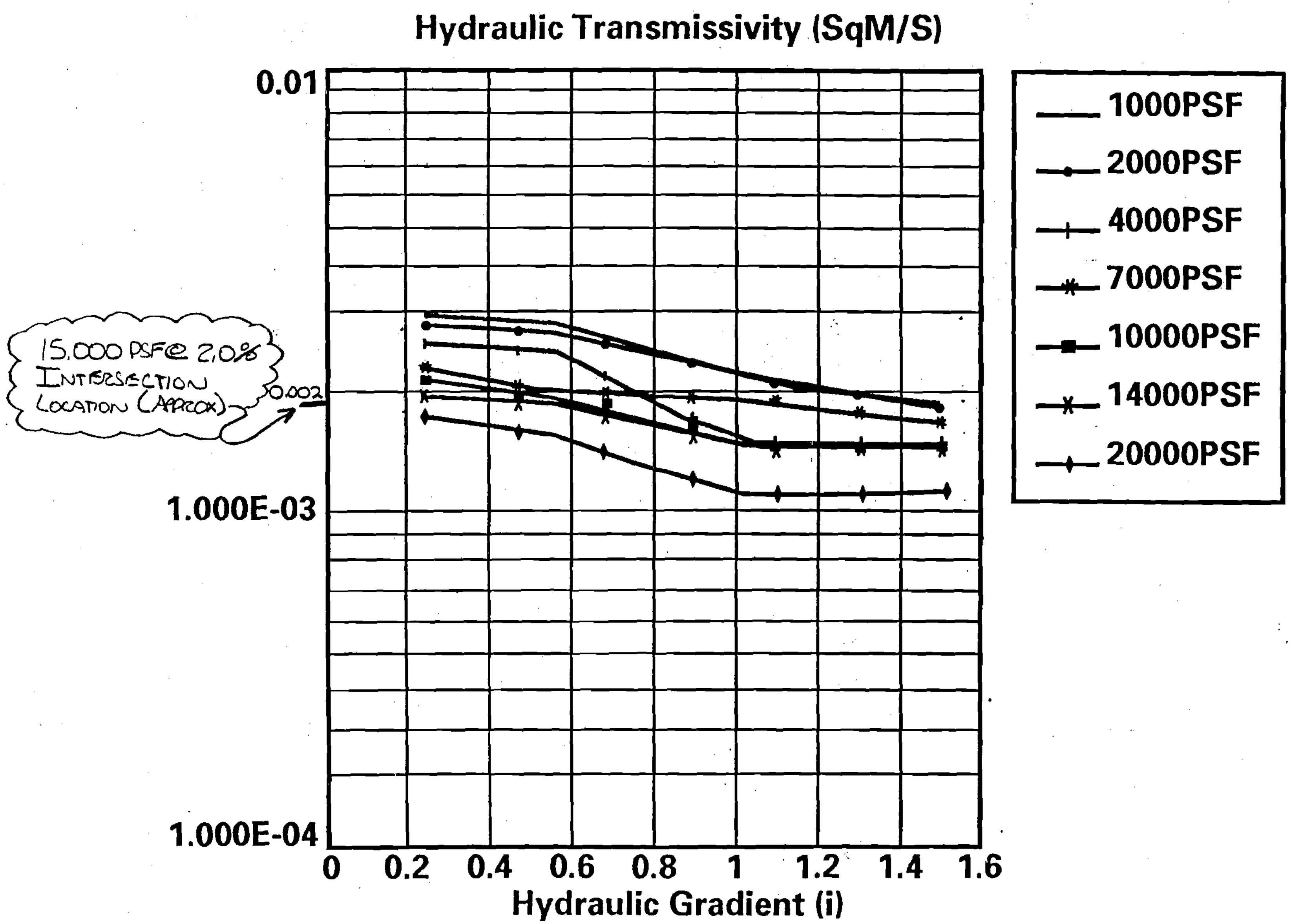
PRIMARY LINER IS APPROXIMATELY 97.82% EFFICIENT (ACCORDING TO HELP MODEL CRITERIA)
∴ 3,261 gpad (IN CONTACT WITH THE PRIMARY LINER) × (100% - 97.82%) = 71.0 gpad

PERCOLATION THROUGH PRIMARY LINER = 71.0 gpad
F.S. OF 3 = 23.5 gpad

(THIS VALUE CLOSE TO VALUE GENERATED BY HELP MODEL → 61.8 gpad)

CONCLUSION: CONSTRUCTION WATER INFILTRATION INTO THE LEAK DETECTION SYSTEM WILL ACCOUNT FOR APPROXIMATELY 23.5 gpad

DRAINAGE NET HYDRAULIC TRANSMISSIVITY
OF POLY-FLEX NET PFN-3



HDPE LINER/PFN-3/HDPE LINER

ATTACHMENT 1

ATTACHMENT II

POLY·FLEX
POLYETHYLENE GEOMEMBRANES

FLEX·NET® SPECIFICATION – Average Roll Values

Raw Material	Test Method	FN-2 Polyethylene	FN-3 Polyethylene
Weight (lbs/ft²)	ASTM D 3776	0.117	0.162
Thickness (inches)	ASTM D 751	0.160	0.200
Density of polymer (g/cm³)	ASTM D 1505	0.940	0.940
Tensile Strength (lb/in)	ASTM D 1682 (modified)	30	42
Porosity (%), Nom.	n/a	83	80
Roll Width (feet), Nom.	n/a	6.0	6.0
Standard Roll Length (feet), Nom.	n/a	150	150
Ft² per Roll, Nom.	n/a	900	900
Carbon Black (%)	ASTM D 1603	2 – 3%	2 – 3%
Transmissivity (m²/s)	ASTM D 4716	1×10^{-3}*	1×10^{-3}*

*Per ASTM D 4716-87. The transmissivity was measured using water @ 20°C (68°F) with a gradient of one, between two steel plates, after one hour.

Values may vary, based on dimensions of the transmissivity specimen and specific laboratory.

Confining Pressures: FN-2 - 2000 psf; FN-3 - 15,000 psf.

POLY·FLEX, INC.
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Grand Prairie, Texas 75051 USA
800-527-3322 214-647-4374
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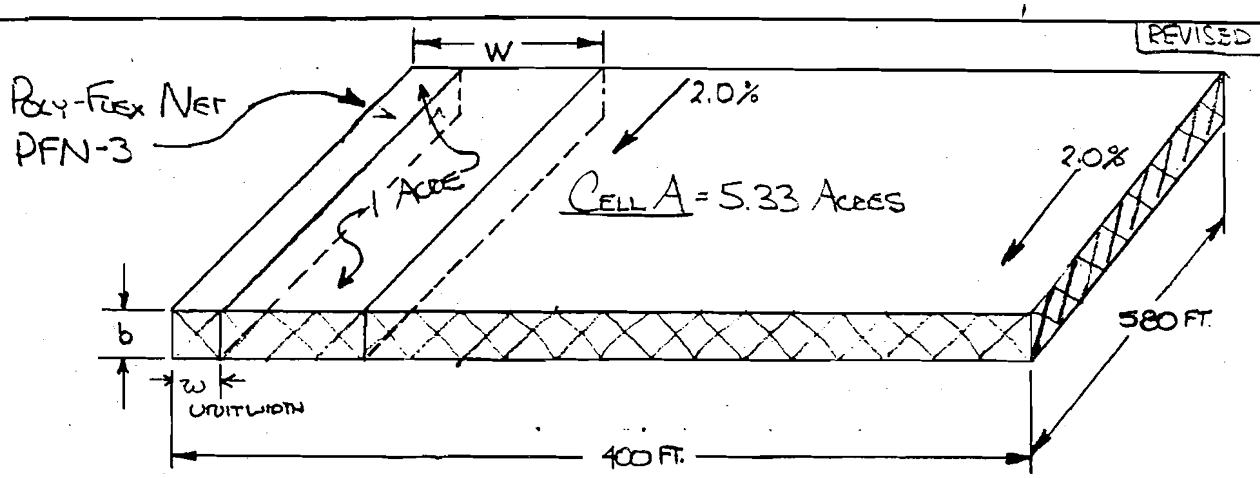
By MMC Date 7/26/92 Subject TOTAL FLOW CAPACITY OF PFN-3 Sheet 1 of 1

Ckd By ______ Date ______ ATTACHMENT III File No. 92-3?

REVISED 8-26-92



GIVEN:

- N POROSITY (%) = 80% SEE ATTACHMENT II
- T HYDRAULIC TRANSMISSIVITY @ 15,000 PSF & 2.0%
  ∴ SEE ATTACHMENT I $T = 2 \times 10^{-3}\ m^2/sec \times \frac{10.76\ ft^2}{1\ m^2} = 0.022\ ft^2/sec$
- b THICKNESS (IN) = 0.200 IN OR 0.0167 FT
- i GRADIENT (%) = 2.0% OR 0.02
- UNIT WIDTH = 1.0 FT

$K = T/b$; $K = \frac{0.022\ ft^2/sec}{0.067\ ft}$; $K = 1.32\ ft/sec$

$Q = KIA$; $Q = 1.32\ ft/sec\,(0.02)(0.0167\ ft \times 1.0\ ft)$

$Q = 0.0004\ ft^3/sec$ OR $4.0 \times 10^{-4}\ ft^3/sec$

UNIT CONVERSION $\frac{0.0004\ ft^3}{sec} \times \frac{7.48\ gal}{1\ ft^3} \times \frac{3600\ sec}{1\ hr} \times \frac{24\ hr}{1\ day} = 284.9\ gal/day$

∴ THE CAPACITY OF THE DRAINAGE NET = 284.9 GAL/DAY/UNIT WIDTH

CONVERT UNIT WIDTH TO ACRE WIDTH:

→ THERE ARE APPROXIMATELY 400 UNIT WIDTHS PERPENDICULAR TO FLOW FROM CELL A ∴ 284.9 GAL/DAY/UNIT WIDTH (400 UNIT WIDTHS) =
= 113,960 GAL/DAY/WIDTH CELL A

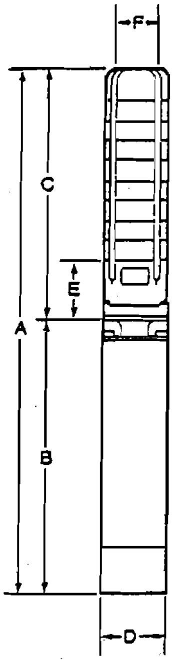
→ FIND ACRE WIDTH OF CELL A → L × W = 43560 FT² OR 580 FT (W) = 43560 FT²
W = 75.1 FT

→ CONVERT TO GAL/ACRE/DAY $\frac{113960}{75}$ = 1517 GAL/DAY/ACRE WIDTH

GRUNDFOS Redi-Flo4

ATTACHMENT IV

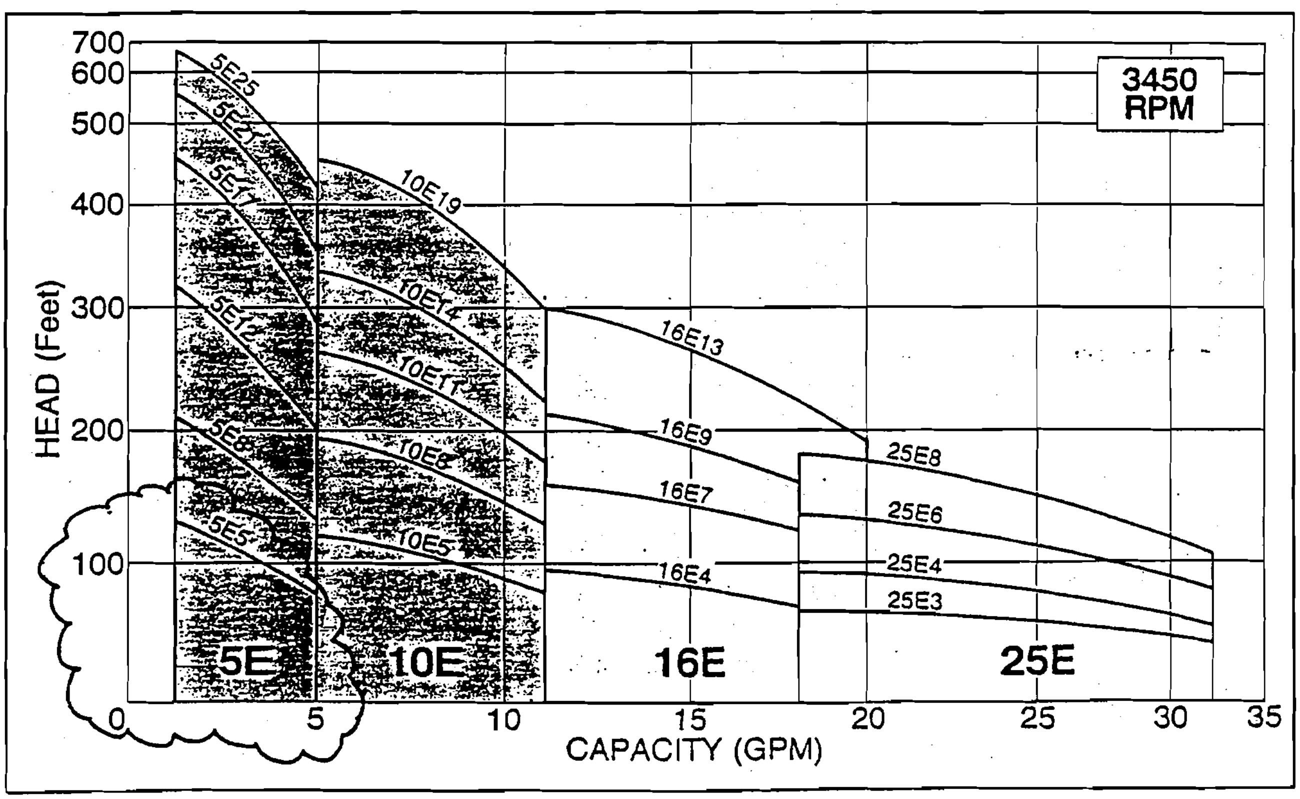
Dimensions



PUMP MODEL	MOTOR HP	MOTOR DIA.	OVERALL A	MOTOR LENGTH B	PUMP END LENGTH C	MAX. DIA. D	INLET E	DISCH. PIPE SIZE F
5E5	⅓	4"	20 5/16"	10"	10 5/16"	3 31/32"	3 ¼"	1" NPT
5E8	⅓	4"	22 ¾	10	12 ¾	3 31/32	3 ¼	1" NPT
5E12	½	4"	26 13/16	10 13/16	16	3 31/32	3 ¼	1" NPT
5E17	¾	4"	31 7/16	12 3/8	20 3/16	3 31/32	3 ¼	1" NPT
5E21	1	4"	35 7/16	12	23 7/16	3 31/32	3 ¼	1" NPT
5E25	1 ½	4"	40 5/16	13 9/16	26 ¾	3 31/32	3 ¼	1" NPT
10E5	⅓	4"	20 5/16	10	10 5/16	3 31/32	3 ¼	1 ¼" NPT
10E8	½	4"	23 9/16	10 13/16	12 ¾	3 31/32	3 ¼	1 ¼" NPT
10E11	¾	4"	26 9/16	11 3/8	15 3/16	3 31/32	3 ¼	1 ¼" NPT
10E14	1	4"	29 11/16	12	17 11/16	3 31/32	3 ¼	1 ¼" NPT
10E19	1 ½	4"	35 3/8	13 9/16	21 13/16	3 31/32	3 ¼	1 ¼" NPT
16E4	½	4"	20 ¼	10 13/16	9 7/16	3 31/32	3 ¼	1 ¼" NPT
16E7	¾	4"	23 ¼	11 3/8	11 7/8	3 31/32	3 ¼	1 ¼" NPT
16E9	1	4"	25 9/16	12	13 9/16	3 31/32	3 ¼	1 ¼" NPT
16E13	1 ½	4"	30 7/16	13 9/16	16 7/8	3 31/32	3 ¼	1 ¼" NPT
25E3	½	4"	19 3/8	10 13/16	8 9/16	3 31/32	3 ¼	1 ½" NPT
25E4	¾	4"	20 13/16	11 3/8	9 7/16	3 31/32	3 ¼	1 ½" NPT
25E6	1	4"	23 1/16	12	11 1/16	3 31/32	3 ¼	1 ½" NPT
25E8	1 ½	4"	26 5/16	13 9/16	12 ¾	3 31/32	3 ¼	1 ½" NPT

NOTE: Dimensions are for single phase motors. Specifications subject to change without notice.

Performance



POLY•FLEX
POLYETHYLENE GEOMEMBRANES

Quality Control & Quality Assurance

ATTACHMENT V

7.1.2
Properties Met By Poly•Flex Geomembrane Rolls

Property	Test Method	Typical Value* 20 mil [0.5mm]	30 mil [0.75mm]	40 mil [1.0mm]	60 mil [1.5mm]	80 mil [2.0mm]	100 mil [2.5mm]
Thickness, mils, minimum	ASTM D 1593	18	27	36	54	72	90
Density (g/cc), minimum	ASTM D 1505	0.94	0.94	0.94	0.94	0.94	0.94
Melt Index (g/10 min., maximum)	ASTM D 1238	0.4	0.4	0.4	0.4	0.4	0.4
Carbon Black content (%)	ASTM D 1603	2 -3	2 -3	2 -3	2 -3	2 -3	2 -3
Carbon Black Dispersion	ASTM D 3015	A-1, A-2, B-1	A-1, A-2, B-1	A-1, A-2, B-1	A-1, A-2, B-1	A-1, A-2, B-1	A-1, A-2, B-1
Tensile Properties	ASTM D 638 Type IV specimen at 2 inches/minute						
1. Tensile Strength at Yield (pounds/inch width)		50	75	100	150	200	250
2. Tensile Strength at Break (pounds/inch width)		85	125	165	250	330	400
3. Elongation at Yield (%)		13	13	13	13	13	13
4. Elongation at Break (%)		750	750	750	750	750	750
5. Modulus of Elasticity (1% secant; pounds/square inch)		90,000	90,000	90,000	90,000	90,000	90,000
Tear Strength (lbs.)	ASTM D 1004 Die C	15	23	31	47	63	79
Puncture Resistance (lbs.)	FTMS 101 C 2031	100	140	180	260	340	420
	FTMS 101 C 2065	40	53	65	90	120	155
Hydrostatic Resistance (lbs./square inch)	ASTM D 751	165	245	330	495	660	800
Low Temperature Brittleness (°F)	ASTM D 746	<-94°	<-94°	<-94°	<-94°	<-94°	<-94°
Dimensional Stability (% change max.)	ASTM D 1204	± 1	± 1	± 1	± 1	± 1	± 1
Volatile Loss (%)	ASTM D 1203	0.1	0.1	0.1	0.1	0.1	0.1
Resistance to Soil Burial (% change max. in orig. value)	ASTM D 3083 type IV specimen at 2 inches/minute						
A. Tensile Strength at Yield & Break		10	10	10	10	10	10
B. Elongation at Yield & Break		10	10	10	10	10	10
Ozone Resistance	ASTM D 1149 7 days, 100 pphm 104 F, bent loop	no cracks	no cracks	no cracks	no cracks	no cracks	no cracks
Environmental Stress Crack (hours)	ASTM D 1693 Condition C (modified NSF 54)	>2000	>2000	>2000	>2000	>2000	>2000
Water Absorption (% change max in original weight)	ASTM D 570	0.1	0.1	0.1	0.1	0.1	0.1
Coefficient of Linear Thermal Expansion (cm/cm °c) x 10^{-4}	ASTM D 696	1.2	1.2	1.2	1.2	1.2	1.2
Moisture Vapor Transmission Rate (g/100 in² · day)	ASTM E 96 100 F, 100% relative humidity	0.040	0.030	0.025	0.020	0.018	0.017
Roll Dimensions							
1. Width (feet):		22.5	22.5	22.5	22.5	22.5	22.5
2. Length (feet):		1000	800	600	400	300	250
3. Area (square feet):		22,500	18,000	13,500	9000	6750	5625
4. Weight (pounds), approx.:		2250	2700	2700	2700	2700	2800

* All values, except when specified as minimum or maximum, represent average lot property values.

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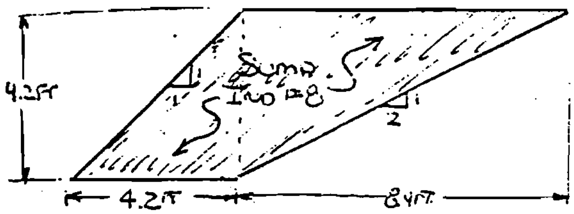
By: MC Date 8/10/92 Subject Sump Volume - Vault 1 or Vault 2 Sheet 1 of 1

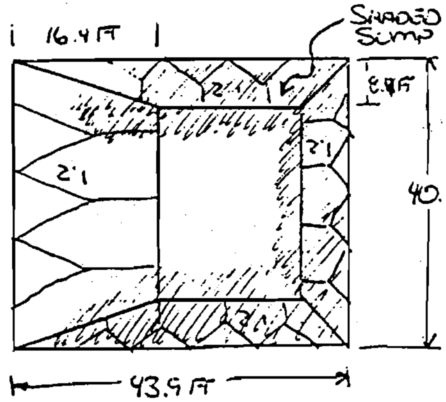
'd By______ Date ______ Attachment VI File No. 92-24.09



Cross Sectional View
Scale 1" = 5.0 FT
* See Dwg E741-0050 - Section B-B

Area = 4.2 FT × 4.2 FT/2 + 8.4 FT × 4.2 FT/2
Area = 8.82 FT + 17.64 FT
Area = 26.5 FT²

* A depth of 3.0 FT. @ sump will yield a total sump volume of 4,000 gal *



Plan View Sump Area
N.T.S.
* See Dwg. E741-0032

Length of Sump

(43.9 FT - 8.2 FT - 4.2 FT) + (40.8 FT - 8.4 FT) + (43.9 FT - 8.2 - 4.2)
Length = 31.5 FT + 32.4 FT + 31.5 FT
Length = 95.4 FT

→ Total Volume of Sump = 95.4 FT × 26.5 FT = 2,528 FT³

Porosity of Gravel = 0.30
∴ V leachate = 2528 FT³ (.30) = 758.43 FT³ or 5,673 Gal

Summary:

→ Volume of Leak Detection Sump @ a 4.2 FT Pump Operating Level (Head) = 5,673 Gallons

→ Volume of Leak Detection Sump @ a 3.0 FT Pump Operating Level (Head) = 4,000 Gallons

ATTACHMENT VII
HELP MODEL

Introduction

To assess the hydrologic effectiveness of the proposed Greenbelt II Landfill, a water budget analysis was performed using the Hydrologic Evaluation of Landfill Performance (HELP) Version 2 computer model. The HELP model was developed by the U.S. Army Corps of Engineers' Waterways Experiment Station for the U.S. Environmental Protection Agency's Office of Solid Waste.

The HELP Model was run to simulate an approximate one year period during the initial stage of Cell A being active, when no appreciable volume waste lifts have been placed. This analysis of the liner system will predict "worst case" leachate volumes for use in prediction of leachate volumes in the leak detection system. Five layers of the liner were included in the analysis. The layers include: 5 inches of Indiana gradation #53 stone; 15 inches of Indiana gradation #8 stone; a 60 mil flexible membrane liner (FML); a 0.25 foot thick geonet drainage media; and a second 60 mil FML overlying 39 inches of compacted clay. Other specific input parameters are identical to those used to run in the post closure landfill simulations (see Appendix I-1).

Unique Cases

Our design specifies using two unique input parameter cases which were only discussed briefly in supporting literature. The two situations included modeling an FML by itself and the use of a geonet as the drainage layer.

FML Modeling

The first case consists of modeling an FML by itself as the upper liner. The HELP Model has input requirements tailored for an FML with a barrier soil liner (clay), but not of an FML alone. The modeling approach is similar, where it is an iterative process, and the liner system is analyzed as if the liner has leaks. Water will flow through the liner as fast as the underlying media will allow it to flow. Specific liner system characteristics such as liner leakage fraction (LLF), hole size, and water standing above the liner (head) are first assumed and changed according to output values.

For this analysis we used a constant hole pattern of 10 holes per acre, as suggested by Dr. Robert Koerner, based on numerous reported field tests, and a 1/4 inch hole size. We also used a LLF of 1 x 10^{-7} (unitless), which is calculated by dividing the total area of holes by the total area of liner. This is a conservative estimate. Comprehensive construction quality assurance monitoring will further decrease the presence of numerous holes in the FML.

Geonet Modeling

To model the geonet it is recommended to treat the geonet as a soil drainage media, and use specific geonet manufacturing characteristics in place of soil input values. Manufacturers data on thickness and transmissivity are used to obtain the saturated hydraulic conductivity, in this case, approximately 30.0 centimeters per second. Other remaining required input values have been estimated as recommended by the model's author, Dr. Paul Schroeder. He recommends using the lowest allowable wilting point value (0.02 vol./vol.), a field capacity value of 0.05 vol./vol. and a porosity of 0.47 vol./vol. From this data, an initial water content of 0.02 vol./vol. is calculated.

Results

The output value of the most interest is the average annual percolation through the primary FML. The model predicted 15,989 cubic feet or approximately 119,959 gallons of fluid will percolate through the FML in one year. This calculates to approximately 61.8 gallons per acre per day (gpad). Of this volume, approximately 118,520 gallons will laterally drain into the leachate collection system during the initial one year period, with the remaining volume stored in the drainage media via primarily surface tension.

The fluid rate of 61.8 gpad represents a worst case situation during the initial development of Cell A, before waste is placed. The volume will be dramatically reduced when waste and cover materials are placed. Thereafter increased runoff, greater evapotranspiration values and greater soil moisture demand will significantly reduce percolation quantities.

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NATIONAL STEEL-MIDWEST DIVISION
GREENBELT II LANDFILL; 1YR WITHOUT WASTE
AUGUST 25, 1992

****
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LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	5.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0220 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.002000000095 CM/SEC

LAYER 2

LATERAL DRAINAGE LAYER

THICKNESS	=	15.00 INCHES
POROSITY	=	0.3500 VOL/VOL
FIELD CAPACITY	=	0.0400 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0220 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	3.000000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	520.0 FEET

LAYER 3

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	2.50 INCHES
POROSITY	=	0.4700 VOL/VOL
FIELD CAPACITY	=	0.0500 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL

```
INITIAL SOIL WATER CONTENT            =        0.0230 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY      =       30.000000000000 CM/SEC
LINER LEAKAGE FRACTION                =        0.00000001


                              LAYER  4
                              --------

                       LATERAL DRAINAGE LAYER
THICKNESS                             =        0.25 INCHES
POROSITY                              =        0.4700 VOL/VOL
FIELD CAPACITY                        =        0.0500 VOL/VOL
WILTING POINT                         =        0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT            =        0.0230 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY      =       30.000000000000 CM/SEC
SLOPE                                 =        2.00 PERCENT
DRAINAGE LENGTH                       =      520.0 FEET


                              LAYER  5
                              --------

         BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER
THICKNESS                             =       39.00 INCHES
POROSITY                              =        0.4150 VOL/VOL
FIELD CAPACITY                        =        0.3610 VOL/VOL
WILTING POINT                         =        0.2850 VOL/VOL
INITIAL SOIL WATER CONTENT            =        0.2900 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY      =        0.000000050000 CM/SEC
LINER LEAKAGE FRACTION                =        0.00000001


                       GENERAL SIMULATION DATA
                       -----------------------

SCS RUNOFF CURVE NUMBER               =        98.00
TOTAL AREA OF COVER                   =    230000. SQ FT
EVAPORATIVE ZONE DEPTH                =        10.00 INCHES
POTENTIAL RUNOFF FRACTION             =         1.000000
UPPER LIMIT VEG. STORAGE              =         3.8350 INCHES
INITIAL VEG. STORAGE                  =         0.2200 INCHES
INITIAL SNOW WATER CONTENT            =         0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN
  SOIL AND WASTE LAYERS               =        11.8132 INCHES

           SOIL WATER CONTENT INITIALIZED BY USER.


                         CLIMATOLOGICAL DATA
                         -------------------

USER SPECIFIED RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
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SOLAR RADIATION FOR CHICAGO ILLINOIS

MAXIMUM LEAF AREA INDEX = 0.00
START OF GROWING SEASON (JULIAN DATE) = 128
END OF GROWING SEASON (JULIAN DATE) = 282

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.80	26.80	36.50	49.10	60.00	69.40
73.40	71.60	65.00	53.50	40.20	28.60

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.00	0.88	2.24	3.32	1.92	3.84
	4.03	5.34	3.73	4.52	3.47	3.94
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.130	0.043	0.399	1.281	0.482	0.882
	1.336	2.385	1.823	2.536	1.439	1.469
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.556	0.883	1.339	1.551	1.625	2.802
	2.306	2.632	1.541	1.602	0.882	0.861
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE FROM LAYER 2						
TOTALS	0.0000	0.0000	0.1139	0.5992	0.0000	0.0763
	0.0109	0.6613	0.3252	0.3239	0.4545	1.4531
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0571	0.0983	0.0000	0.0414

	0.0074	0.1137	0.0448	0.0527	0.1187	0.3001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE FROM LAYER 4

TOTALS	0.0000	0.0000	0.0503	0.1033	0.0000	0.0391
	0.0043	0.1142	0.0448	0.0527	0.1174	0.3006
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

SUMMARY

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	38.23	(0.000)	732742.	100.00
RUNOFF	14.205	(0.000)	272270.	37.16
EVAPOTRANSPIRATION	18.582	(0.000)	356154.	48.61
LATERAL DRAINAGE FROM LAYER 2	4.0182	(0.0000)	77016.	10.51
PERCOLATION FROM LAYER 3	0.8342	(0.0000)	15989.	2.18
LATERAL DRAINAGE FROM LAYER 4	0.8267	(0.0000)	15845.	2.16
PERCOLATION FROM LAYER 5	0.0000	(0.0000)	0.	0.00
CHANGE IN WATER STORAGE	0.598	(0.000)	11457.	1.56

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By DBF Date 8-25-92 Subject Calculation of EFFECTIVE LINER LEAKAGE FRACTION BASED ON HOLE SIZE Sheet 1 of 1

Ckd By_____ Date _____ File No._____

CALCULATE LINER LEAKAGE FRACTION OF FML

GIVEN:
- TOTAL SURFACE AREA OF LINER (FML) FOR CELL A.
  $A_L = 230,000\ FT^2$ (5.3 acres)
- HOLE SIZE (TYPICAL)
  $D_H = \frac{0.25\ in\ (0.021\ FT)}{hole}$
- HOLE SPACING BASED ON AVERAGE VALUES PROVIDED BY DR. ROBERT KOERNER OF GEOSYNTHETIC RESEARCH INSTITUTE DREXEL UNIVERSITY, PHILADELPHIA, PA.
  HS = 10 HOLES / ACRE

FIND: LINER LEAKAGE FRACTION (LLF); THIS IS DERIVED BY DIVIDING TOTAL AREA OF HOLES BY TOTAL AREA OF LINER.

$$\therefore LLF = \frac{A_H}{A_L} \quad \text{where } A_H = \left(\frac{D_H}{2}\right)^2 \cdot \pi \cdot HS \cdot A_L(\text{acre})$$

$$= \left(\frac{.021\ FT}{2}\right)^2 / \text{HOLE} \cdot (\pi) \cdot \frac{10\ \text{HOLE}}{\text{acre}} \cdot \frac{5.3\ \text{acre}}{1}$$

$$= .018\ FT^2$$

$$= \frac{0.018\ FT^2}{230,000\ FT^2}$$

$$= 8 \times 10^{-8}$$

$$= \text{say, } 1 \times 10^{-7}$$

• PUT THIS VALUE INTO HELP MODEL. CAREFULLY MONITORED FML CQA WILL FURTHER DECREASE LEAKAGE FRACTION

Landfill Management Operations and Maintenance Plan

Greenbelt II Landfill

1.0 Personnel Responsible

Various personnel are involved in the operation of the Greenbelt II Landfill. These include:

- Facility employees;
- Construction contractors; and
- Third party engineering consultants and compliance contractors consultants.

The Greenbelt II Landfill is a non-commercial waste disposal facility. Hence, the operations and compliance duties are delegated based on need at the discretion of environmental personnel at facility.

The ultimate responsibility for the facility resides with the plant's Environmental Manager, the landfill owner and operator. The Manager is trained in applicable environmental regulations and provides oversight of the landfill operations. His/her primary duties are to ensure compliance with the landfill permit and delegate and supervise the necessary tasks to maintain compliance.

2.0 Non-Construction Activities

2.1 Access Road Maintenance

The access road is appropriately maintained. Access to the facility is via an asphalt paved road from the mill. Surrounding the landfill is a perimeter road, which allows inspection access without entering the landfill proper. Access to the working area of the landfill is provided by stone/slag interior roads, which connect to the perimeter road at various locations.

The perimeter road is sloped at 1 percent from the intersection with the access road to the midpoints of the sides. The interior roads are designed to a maximum 5 percent slope. Their location is relative to the working area of the landfill. Typical road layouts relative to 10 foot lifts of waste in each cell are shown in the Cell Phasing Sheets 4 and 5.

Unobstructed access to the landfill via these roads will be maintained.

2.2 Security

A six-foot high chain link fence surrounds the entire landfill and restricts access to one double gate. Temporary chain link fencing will be installed until all four cells and the complete circumference permanent fence is installed.

Alternately, the permittee may elect to completely construct the fence during cell construction and selectively remove and replace it to provide construction access on subsequent cells.

2.3 Inspections

Routine inspections of the various landfill operations, monitoring devices and apparatus is provided in accordance with Attachment F of the Permit.

2.4 Spill Control

Because no liquids will be received at the landfill, spill control is directed at sludge spills enroute to the landfill. Nonemergency spill mitigation is implemented under internal spill guidance and reporting procedures maintained by the permittee.

2.5 Vector Control

Potential disease vectors, such as rodents, birds and insects, are not a problem at this facility because of the non-biological nature of the monofilled waste.

2.6 Fire Control

The chance of a fire occurring at the Greenbelt II Landfill is remote due to the non-combustible nature of the waste and the lack of any mechanical or electrical components in or near the landfill. A Contingency Plan has been developed by the permittee to minimize hazards to human health or the environment from fires or explosions involving hazardous waste.

The permittee maintains its own fire fighting force and equipment.

2.7 Leachate Collection System Operation

A leachate collection system is operated at the Greenbelt II Landfill. It will be maintained and inspected in accordance with Attachments D and F of this Permit.

2.8 Leachate/Stormwater Disposal

As described in the Design Summary of the permit, leachate is automatically conveyed to the NPDES-permitted Chromium Treatment Plant (CTP) via the Greenbelt II gravity drained pipelines and the Greenbelt pumphouse/pipeline. The CTP is operated continuously.

Treatment plant operations could only be suspended after complete closure of the entire steel facility was implemented. If such a plant closure were to occur, the permittee would maintain responsibility for the Greenbelt II Landfill and make the appropriate arrangements for leachate disposal and the appropriate permit modifications to allow this to occur.

2.9 Land Ban Disposal: Chemical Analysis

The only hazardous waste disposed at the Greenbelt II Landfill (EPA Hazardous Waste No. F006) is subject to landfill disposal restrictions. The waste must be treated in accordance with the federal EPA mandated Best Demonstrated Available Technology (BDAT) Land Disposal Restriction (LDR) treatment standards. For F006 waste, the BDAT LDR treatment standard is solidification and stabilization. As described in Attachments C and D of the Permit, chemical analysis of the sludge filter cake is performed monthly when the F006 filter cake is transported to the Greenbelt II Landfill.

2.10 Permit

Permit requirements, files and submittals are the responsibility of the Environmental Department. Files are maintained in their offices.

2.11 Non-Construction Health and Safety

The above mentioned routine duties are governed by a Non-Construction Health and Safety Plan (see Appendix D-15). The plan is differentiated from the Construction Health and Safety Plan because of the non-intrusive, short-term nature of the tasks performed by employees. Intrusive activities, such as landfill construction and solidification events, are performed by contractor employees, which are governed by the Construction Health and Safety Plan.

3.0 Construction Activities

3.1 General

Most construction activities at the Greenbelt II Landfill are performed by outside contractors under the guidance of the landfill third party engineering consultant. In general, this section describes these activities. More specific details of the construction activities can be found in the Site Construction Quality Assurance Plan, Construction Health and Safety Plan, Design Summary and Construction Drawings.

3.2 Site Preparation

Site preparation will involve stripping, excavation, construction of the entrance road and facilities, fencing, perimeter drainage control, base clay grade construction, synthetic liner installations, drainage layers and leachate collection systems. Construction will be to the lines and grades shown in the Drawings and will be documented in the form of as-built plans. Quality control for liner construction, synthetic seaming and verification of material quality and quantity will be in accordance with the Site Construction Quality Assurance Plan. A qualified engineer shall inspect construction prior to fill placement to assess that construction conforms to design specifications and permits.

3.3 Surveying

Surveying of construction will be performed throughout landfill construction and operations to provide data for the as-built plans and conformance with applicable permits. Surveying will be provided under the direction of a Registered Land Surveyor or Professional Engineer.

A topographic map will be generated as needed to document progress of filling operations. This map, after review and approval of the landfill third party engineering consultant, will be maintained by the Plant Engineering Department. Survey data concerning lines and grades of filling operations and final cover elevations will be input into a computer software program, such as Earthworks by Civilsoft, Inc., (or similar equivalent) and presented along with any other pertinent QA documentation to the IDEM.

3.4 Solidification

Solidification is the compaction of the wastes that are deposited. Solidification is required to ensure compliance with the required physical strength characteristics. Even though the waste has chemically been stabilized to below land ban levels, the waste needs to be properly compacted to meet the strength requirement of 6,500 psf failure shear strength (see Construction Quality Assurance Plan). This strength is required to ensure slope stability and reduce cover subsidence and maintenance.

Other landfill construction duties, such as cover construction, vegetation, leachate collection system cleanouts, and QA/QC, will be implemented as necessary based upon the inspection results.

3.5 QA/QC Functions

Construction quality assurance will adhere to the Construction Quality Assurance Plan. Submittals of the quality assurance documents will be provided to the Environmental Affairs Department at appropriate intervals or as required by the landfill permit. Typically, these submittals would occur within 60-90 days of large construction activities, such as cell construction, and yearly at other times.

3.6 Construction Health and Safety

A Construction Health and Safety Plan is provided in Appendix D-16 of the Permit.

3.7 Leachate Collection System Cleanout/Maintenance

Cleanout for the leachate collection system will be undertaken if noticeable significant changes in the flow occur.

Cleanout risers have been added to the collection/detection system, as shown on the Drawings, at each end of a collection pipe. If required, the cleanout will be conducted using a water pressure-driven nozzle. This type of power rodding has been utilized for 6-inch pipes for distances of up to 2,000 feet (greater than the 350 feet at the Greenbelt II Landfill). The nozzle will enter the upgradient cleanout location and travel to the leachate collection vaults. The collection pipes have also been designed to be fully accessible by camera, if necessary.

APPENDIX D-4

Soils Lab Testing Data

See VFC document # 83546904, pages 846 – 896

APPENDIX D-5

Geotechnical Calculations

See VFC document # 83546904, pages 897 - 939

APPENDIX D-6

Workplan EPA 9090 and Workplan EPA 9100 Compatibility Testing

See VFC document # 83546904, pages 940 – 955

APPENDIX D-7

Liner Strength and Wind Uplift Calculations, and In-Place Stabilized Waste Strength Testing Program

See VFC document # 83546904, pages 956 - 1006

APPENDIX D-8

Soil Liner Laboratory Properties (Clay and Indiana #8 Stone)

See VFC document # 83546904, pages 1007 – 1045

APPENDIX D-9

Leachate Pipe Load and Strength Calculations

See VFC document # 83546904, pages 1046 - 1083

APPENDIX D-10

Aggregate Filter Calculations

See VFC document # 83546904, pages 1084 - 1094

APPENDIX D-11

Q-Peak Contact Water

See VFC document # 83546904, pages 1095 - 1099

APPENDIX D-12

Stone LCR/LCR Pipe Flow Calculations

See VFC document # 83546904, pages 1100 - 1108

APPENDIX D-13

Leachate Collection Layer Permeability Data

See VFC document # 83546904, pages 1109 - 1110

APPENDIX D-14

Soil Loss/Q-Peak Non-Contact Water

See VFC document # 83546904, pages 1111 - 1139

APPENDIX D-15

Non-Construction Health and Safety Plan

See VFC document # 83546904, pages 1140 - 1157

APPENDIX D-16

Construction Health and Safety Plan

See VFC document # 83546904, pages 1158 - 1238