LEACHATE MANAGEMENT PLAN

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Charles City County Landfill – SWP #531

WASTE MANAGEMENT

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1.0 GENERAL

This Leachate Management Plan has been prepared for the Charles City County Landfill (Facility) located in Charles City, Virginia. The landfill operates as a municipal solid waste landfill under Virginia Solid Waste Permit #531. Golder Associates Inc. (Golder) has prepared this Plan for Waste Management of Virginia, Inc. (Waste Management). Leachate generation estimates were made using the Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.07, as developed by the United States Environmental Protection Agency (USEPA).

The goal of the leachate management system design is effective and efficient leachate minimization, containment, collection, extraction, and storage. The objectives of the leachate management system design for Charles City County Landfill include:

- Efficient collection of leachate by drainage layers and perforated piping system (with gravity flow) engineered leachate extractions points; where leachate sumps, submersible pumps, and side slope risers are located
- Minimize leachate head build-up on the liner system to a maximum of 12 inches under normal operating conditions
- Development of base grade at a minimum post settlement gradient of 2 percent to promote rapid leachate collection
- Phased landfill development and closure capping to minimize leachate generation;
- Hydraulic design of the leachate extraction pumps and forcemain for conveyance of flows to the leachate storage tanks
- Leachate system redundancy as needed to efficiently remove and extract collected leachate

The principal elements of the leachate collection and removal system include the drainage materials, leachate collection pipes, leachate sumps, sideslope risers and associated extraction pumps, and leachate forcemains to the on-site storage tanks.

1.1 Permit Amendment Information

As part of this Major Permit Amendment (May 2017), two alternate final cover systems are being proposed. Waste Management desires to modify the design of the landfill's final cover system to incorporate either a 40-mil linear low-density polyethylene (LLDPE) geomembrane and 275-mil geocomposite or a 50-mil Agru Super Gripnet® geomembrane with a heat-burnished geotextile. These proposed final cover systems are intended for use on the side slope areas of the landfill (final slopes at 4 horizontal to 1 vertical, or 4H:1V); slopes shallower than 4H:1V will receive the prescriptive pre-approved alternate final cover system detailed in 9VAC20-81-160.D.2.d., which contains a geosynthetic clay liner (GCL).

In addition, Waste Management desires to change the base liner system to replace the 18-inch thick low-permeability soil layer with a 12-inch thick controlled subgrade layer. The bottom liner system is discussed in detail in the Design Report. The final grading plan elevations have been altered to account for the revised liner system configuration to prevent a net increase in the permitted disposal capacity of the landfill. Approximately 268.46 acres of the closure cap have been affected by changes due to this permit modification. The peak final grading plan elevations remain at an elevation of 292 feet above mean sea level (ft amsl).

2.0 LEACHATE ESTIMATE

Appendix A presents an estimate of the leachate flow for the life of the landfill based on the modified landfill phasing and HELP Model simulations. The HELP Model, developed by the U.S. Army Engineering Waterways Experiment Station in Vicksburg, Mississippi for the U.S. Environmental Protection Agency, uses climatological, soil, and landfill design information to predict average monthly and annual values of precipitation, runoff, evapotranspiration, lateral drainage, percolation/ leakage, and head on the landfill liner. The HELP Model was used to estimate the total leachate production rates, by conditions, for the Charles City County Landfill during the operation of the landfill. Five different conditions for the proposed landfill development were evaluated which determined the total production rates of leachate throughout the operational phasing of the landfill. Annual average volumes were determined, as well as the anticipated peak annual volume over the life of the facility.

Currently, the Facility generates approximately 12,406,057 gallons of leachate per year from Phases I-IV and Phase V Cell 1. The HELP Model results were used to predict the leachate generation rates for the remainder of the life of the landfill. Attachment 3 of Appendix A shows the estimated leachate flows for the varying conditions anticipated over the life of the landfill based on HELP Model simulation. The peak annual leachate generation rate is 44,543,591 gallons, and occurs in year 45 (2061).

3.0 LEACHATE COLLECTION SYSTEM

3.1 Drainage System Design

The leachate drainage layer will consist of an 18-inch thick layer of granular material with a minimum permeability of 5.0×10^{-2} centimeters per second (cm/s). The leachate collection pipes will consist of 6-inch and 8-inch SDR 11 perforated high density polyethylene (HDPE) leachate collection pipes.

3.1.1 Bearing Capacity of the Leachate Drainage System

A bearing capacity analysis was previously performed to demonstrate that the bearing capacity of the underlying soils and the leachate drainage system will not be exceeded by the expected loading from the landfill.

3.1.2 Slope Stability

Slope stability was evaluated as part of the original permit. The proposed modifications are not expected to significantly decrease the stability of the bottom liner or final grades.

3.1.3 Geotextile Wrap

The VDOT #57 stone in the leachate drainage system will be wrapped with a nonwoven geotextile to provide separation and filtration capacity and minimize the drainage material from migrating into the gravel and the collection pipe. The dimensions of the stone and the geotextile wrap are shown on the liner detail on Drawing 21. The geotextile shall have an Apparent Opening Size (AOS) of US Sieve #30 or smaller. Appendix B provides the calculation for the sizing of the geotextile.

3.1.4 Pipe Protection Design

The leachate collection pipes will consist of 6-inch and 8-inch SDR-11 perforated HDPE. The pipes will be installed in a gravel "burrito wrap" where the pipe is surrounded in VDOT #57 stone, which is wrapped with a nonwoven geotextile to prevent drainage material intrusion. The pipe perforations are 3/8-inch diameter, which is smaller than the d_{50} gradation point for #57 stone, and therefore stone entry into the pipe is not a concern.

3.2 Leachate Collection Pipe

3.2.1 Pipe Capacity

Calculations in Appendix C demonstrate the ability of the proposed leachate collection pipes to convey leachate from the drainage layer to the leachate collection sump. These calculations assume a pipe slope of 3 percent for the leachate headers and 1.4 percent for the laterals. The headers and laterals are sized for the average daily flows from the maximum monthly leachate flow generated through the HELP Model.

These calculations also determine the size, quantity, and spacing of perforations in the leachate collection headers.

The leachate collection pipes will have 3/8-inch diameter perforations spaced every 3 linear inches of pipe as shown on Drawing 21. The perforations are sized to allow sufficient flow while preventing surrounding VDOT #57 stone from entering or plugging the collection line.

The leachate pumps and forcemain should be sized accordingly to manage and adequately convey an average of 60 gpm from each cell over each cell's useful life.

3.2.2 Pipe Strength

The leachate collection pipes were analyzed for compressive ring thrust, ring deflection, and wall buckling. According to the calculations contained in Appendix D, the pipes were found to be structurally stable under high refuse loads (153 feet). Therefore, the drainage layer will protect the leachate collection pipes within the drainage stone against stresses and disturbances from overlying wastes, cover materials, and equipment operations.

3.3 Leachate Collection System Design Standard

The HELP Model was used to determine the maximum head on the base liner system. Based on the open condition model with 10 feet of waste, the maximum head on the base liner system is 11.893 inches, which is less than the maximum 12-inch head design standard.

4.0 LEACHATE REMOVAL SYSTEM

The leachate will be removed from the sumps in the landfill through 24-inch diameter SDR-11 HDPE sideslope risers. This will result in no liner penetrations. Drawings 19 to 22 show the details of the leachate collection sump and riser. The leachate riser pipes will extend through the final cover into a sump house that will be accessible after closure.

Leachate transmission pumps will direct leachate from the sump house to the leachate storage tanks via an 8-inch by 12-inch diameter dual contained leachate forcemain. The leachate forcemain will be installed around the perimeter of the landfill cells, and will be constructed sequentially as each new cell is constructed.

5.0 COLLECTION AND STORAGE UNITS

The seven-day storage volume, included in Attachment 4 of Appendix A, was calculated from the HELP model estimates, and was determined on an annual basis for the life of the facility. The peak seven-day storage requirement is expected to be 571,533 gallons, which occurs from 2059 to 2062. The Facility currently operates with two approximately 250,000-gallon leachate storage tanks. The tanks are capable of managing the seven-day storage requirement until it peaks in 2059.

The leachate collection tanks are located within a lined, recessed secondary containment area which was sized in accordance with 40CFR112. The secondary containment area provides storage for approximately 423,583 gallons, which exceeds the required 250,000-gallon requirement.

6.0 LEACHATE TREATMENT OR DISPOSAL

Leachate from the storage tanks is disposed of off-site by the City of Hopewell, Delaware County Regional Water Quality Control Authority (DELCORA), and Shamrock Environmental Corporation. Leachate is pumped from the tanks into trucks for transportation.

7.0 LEACHATE RECIRCULATION

Leachate recirculation is not currently used to manage leachate and promote the decomposition of waste; however, leachate recirculation can be used in accordance with the Recirculation Notification dated August 1, 1994, or most recent update.

If used, a minimum of 20 feet of waste will be present above the liner system prior to commencing recirculation operations. No leachate will be recirculated within 75 feet of the exterior slope of the landfill to minimize side slope leaks or seeps. Additionally, recirculation will not occur on days with measurable precipitation or within 72 hours of a named storm event. Recirculation will be accomplished using injection trenches, injection wells, and/or conventional water distribution equipment, such as water trucks with spray nozzles. In general, leachate application rates will range from 5 to 10 gallons per square foot of the working face. Leachate will not be allowed to form standing puddles or run-off on the working face.

Appendix A

HELP Model Analysis

1.0 OBJECTIVE

This analysis evaluates the hydraulic performance of the bottom liner design for Phases V-X of the Charles City County Landfill. The maximum drainage length, peak daily heads, average month and year volumes, annual leachate volumes, and the peak leachate volume for the life of the facility were determined through this analysis.

2.0 METHOD

The analysis was performed using The Hydrologic Evaluation of Landfill Performance (HELP) Model (v3.07) for the open, intermediate cover, and closed conditions. The open condition was divided into 10-ft, 60-ft, and 110-ft depths of Municipal Solid Waste (MSW) to model each phase during the filling cycle. The open waste, intermediate cover, and final cover conditions were modeled for 30 years to provide sufficient data to conduct the lifetime leachate volumes analysis.

Each iteration of the HELP model was run for a one-acre area to develop per-acre values that were used for all phases. Each per-acre value was multiplied by the planar area of the proposed phase (e.g., Phase VI multiplied the per-acre value by 24.7). Phases I-IV and Phase V Cell 1 were modeled as a single unit beginning with a partially closed condition to develop a total annual leachate volume for the facility.

To simulate the saturation of waste throughout the life of each phase, the initial moisture contents of the waste and drainage layers were manually adjusted from the default values. The 10 ft open condition's moisture content was developed by the HELP Model for the nearly-steady-state condition of the MSW. Subsequent iterations (60 ft MSW, etc.) were run at intervals of 50 ft waste lift thickness, using the previous iteration's final moisture contents for each waste and drainage layer.

3.0 MODEL INPUTS AND ASSUMPTIONS

Precipitation, temperature, solar radiation, and evapotranspiration data were synthetically generated through the HELP Model for up to 30 years using the default values for Richmond, Virginia and a station latitude of 37.5 degrees. Default values for latitude, start and end of growing season, relative humidity, and average annual wind speed were used. This data is included in Attachments 5-9.

The Leaf Area Index (LAI), a dimensionless coefficient representing the leaf area of actively transpiring vegetation, was assumed to be 0 (bare soil) for open MSW, 2 (fair vegetation) for the intermediate cover condition, and 5 (excellent vegetation) for the closed condition.

The Natural Resource Conservation Service (NRCS) runoff curve numbers were selected based on guidance from Technical Release 55 (TR-55). Curve numbers of 85, 69, and 61 were used for the open waste, intermediate cover, and closed conditions, respectively. Runoff was not allowed for the open waste condition to force the model to treat all liquid as leachate. Alternatively, runoff was allowed for all areas in the intermediate cover and closed conditions.

The High Density Polyethylene (HDPE) geomembrane layers were modeled conservatively, with an upper geomembrane liner pinhole density of 1 per acre to force leachate into the geonet drainage layer and result in a head on the lower geomembrane liner. The lower geomembrane liner installation quality was set to "perfect", and the pinhole density was 0 per acre.

The following tables summarize the landfill layer components used in the HELP Model. In some layers, the default permeability value (k) was replaced to reflect observed laboratory results. The permeability of the bottom drainage layer was set to 5.0 x 10^{-2} cm/s for all conditions based on desired soil constraints (the default value of 1.0 x 10^{1} cm/s was used for the geocomposite drainage layer on the cap). For the 60 ft and 110 ft open waste conditions, the 10-ft open waste condition was modeled with additional 50-ft lifts to evaluate incremental waste depths.

Bottom Liner System – 10-ft MSW

#	Layer ID	Layer Type	Thickness	Porosity	Initial Soil Water Content	Effective Saturated Hydraulic Conductivity
			(in)			(cm/s)
1	MSW Waste	1	120	0.6710	0.3347	1.00E-03
2	Lateral Drainage Layer	2	18	0.4170	0.0666	5.00E-02
3	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
4	Geonet	1	0.25	0.8500	0.0276	1.00E+01
5	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
6	Geosynthetic Clay Liner (GCL)	3	0.4	0.7500	0.7500	1.00E-09
7	Controlled Subgrade	1	12	0.4710	0.2917	4.20E-05

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Intermediate Cover System – 152.5-ft MSW

#	Layer ID	Layer Type	Thickness	Porosity	Initial Soil Water Content	Effective Saturated Hydraulic Conductivity
			(in)			(cm/s)
1	Intermediate Cover	1	12	0.4710	0.2910	4.20E-05
2	MSW Waste	1	510	0.6710	0.2910	1.00E-03
3	MSW Waste	1	600	0.6710	0.2910	1.00E-03
4	MSW Waste	1	600	0.6710	0.2920	1.00E-03
5	MSW Waste	1	120	0.6710	0.2930	1.00E-03
6	Lateral Drainage Layer	2	18	0.4170	0.0940	5.00E-02
7	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
8	Geonet	1	0.25	0.8500	0.8500	1.00E+01
9	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
10	GCL	3	0.4	0.7500	0.7500	1.00E-09
11	Controlled Subgrade	1	12	0.4710	0.2290	4.20E-05

Final Cover System (Geocomposite)– 152.5-ft MSW

#	Layer ID	Layer Type	Thickness	Porosity	Initial Soil Water Content	Effective Saturated Hydraulic Conductivity
			(in)			(cm/s)
1	Vegetative Support Layer	1	6	0.4730	0.1930	5.20E-04
2	Protective Cover Soil	1	18	0.4730	0.2550	5.20E-05
3	275-mil Geocomposite	2	0.28	0.8500	0.0210	1.00E+01
4	40-mil LLDPE Geomembrane	4	0.04	N/A	N/A	4.00E-13
5	GCL	3	0.4	0.7500	0.7500	5.00E-09
6	Intermediate Cover	1	12	0.4710	0.3180	4.20E-05
7	MSW Waste	1	510	0.6710	0.2920	1.00E-03
8	MSW Waste	1	600	0.6710	0.2920	1.00E-03
9	MSW Waste	1	600	0.6710	0.2930	1.00E-03
10	MSW Waste	1	120	0.6710	0.2920	1.00E-03
11	Lateral Drainage Layer	2	18	0.4170	0.0570	5.00E-02
12	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
13	Geonet	1	0.25	0.8500	0.8500	1.00E+01
14	60-mil HDPE Geomembrane	4	0.06	N/A	N/A	2.00E-13
15	GCL	3	0.4	0.7500	0.7500	1.00E-09
16	Controlled Subgrade	1	12	0.4710	0.2260	4.20E-05

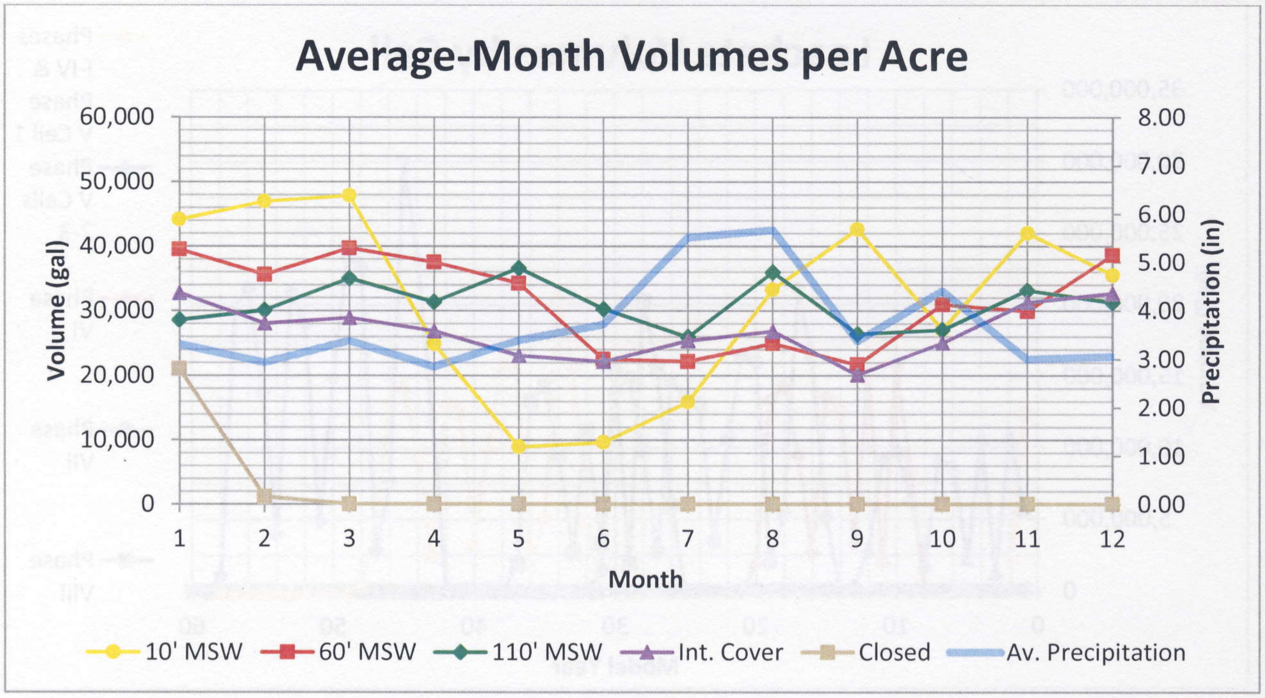
4.0 CALCULATIONS AND RESULTS

4.1 Maximum Drainage Length and Daily Head

Using the HELP Model, a drainage length of 165 ft will yield a maximum daily head of 11.893 inches. This value is less than the maximum allowable head of 12 inches. Pipes were spaced such that the maximum drainage length to a collection pipe is 165 ft.

4.2 Average Month and Average Year Volumes

The average-month volumes were calculated based on the monthly "Lateral Drainage Collected" values from the HELP Model outputs. These values were averaged for each condition and phase for all non-zero volumes. The average-year volumes were calculated by summing the average month volumes for each condition and phase. The average-month and average-year volumes are contained in Attachment 2. The average-month volumes are shown in the graph below.

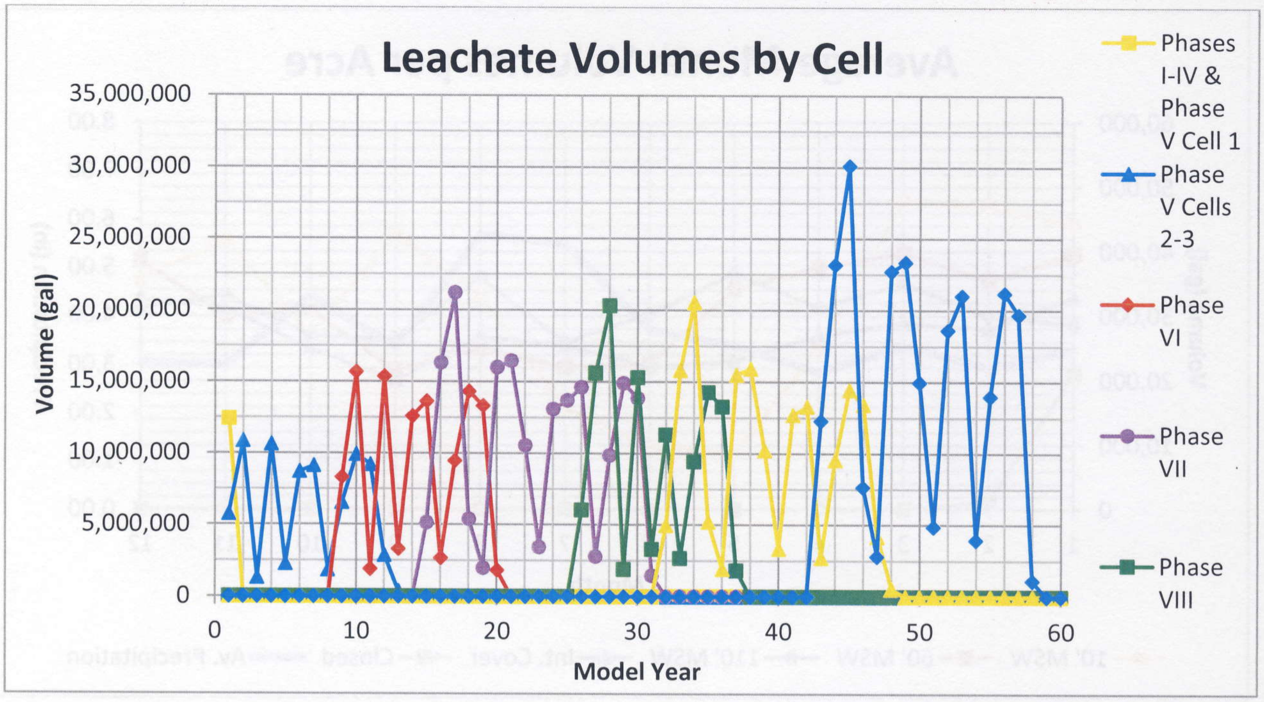


4.3 Annual and Maximum Leachate Volumes

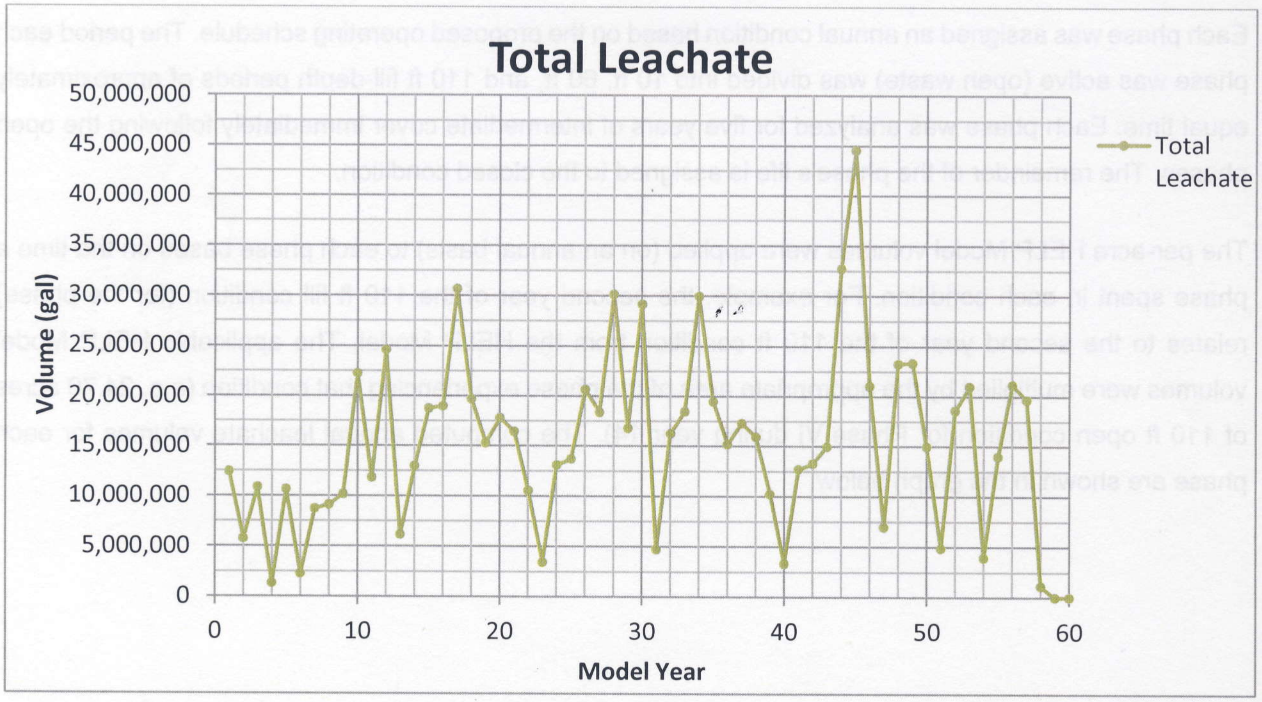
A schedule of leachate volumes was developed (Attachment 3) to show the annual leachate volumes for each phase. This schedule was used to determine the maximum expected leachate volume for the site, based on the proposed operating schedule.

Each phase was assigned an annual condition based on the proposed operating schedule. The period each phase was active (open waste) was divided into 10 ft, 60 ft, and 110 ft fill-depth periods of approximately equal time. Each phase was analyzed for five years of intermediate cover immediately following the open phases. The remainder of the phase's life is assigned to the closed condition.

The per-acre HELP Model volumes were applied (on an annual basis) to each phase based on the time a phase spent in each condition. For example, the second year of the 110 ft fill condition (for the phase) relates to the second year of the 110 ft condition from the HELP Model. The applicable HELP Model volumes were multiplied by the appropriate area of the phase experiencing that condition (e.g. 24.70 acres of 110 ft open condition for Phase VI during year 14). The computed annual leachate volumes for each phase are shown in the graph below.



The annual leachate volume for the site was developed by summing the annual leachate volumes for all phases. Pre-construction phases were considered as having produced no leachate. By comparing the site's annual leachate volumes, the maximum annual leachate volume was identified as 44,543,591 gallons during year 45 (2061). The total annual leachate volumes for the site are shown in the graph below.



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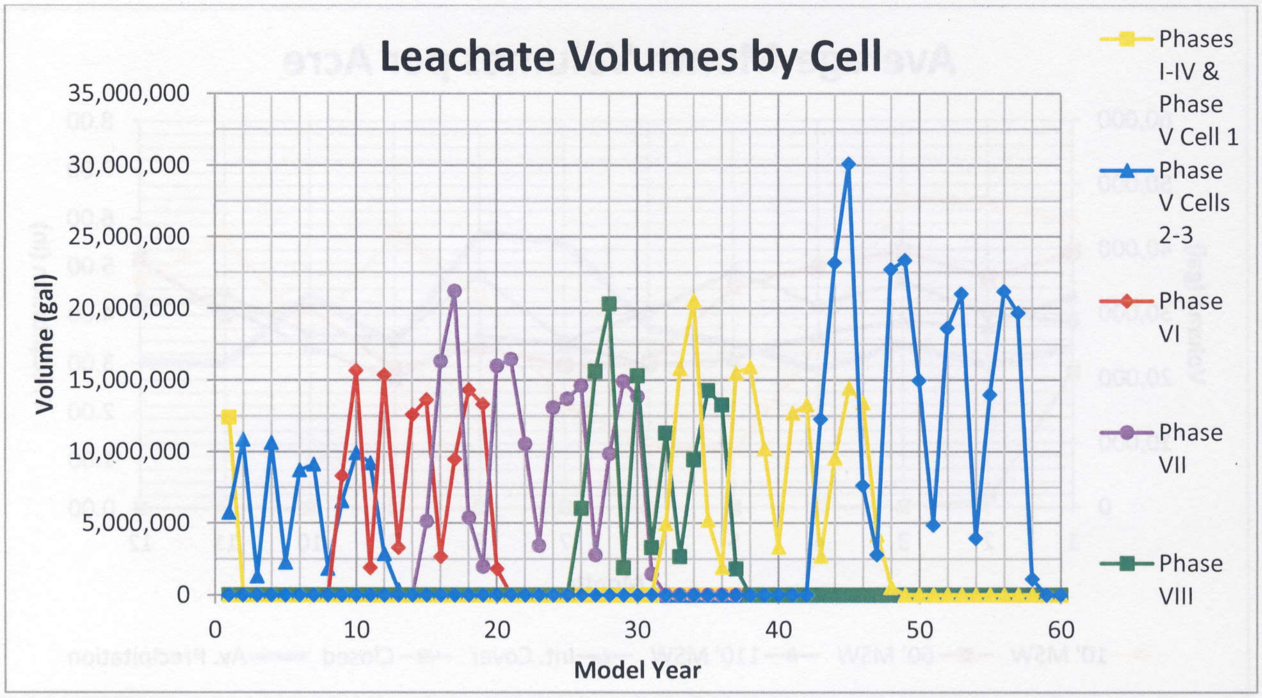

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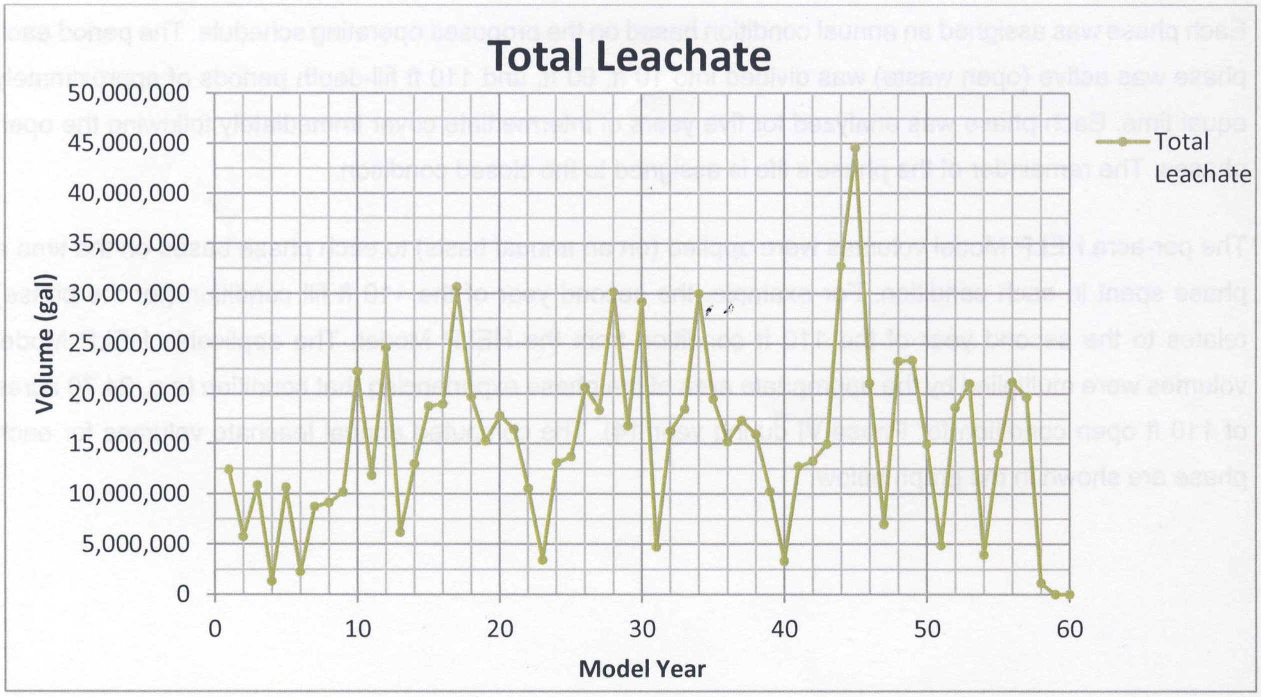

5.0 CONCLUSIONS

Based on the above results, the proposed design will adequately handle the expected leachate volumes. The leachate collection system maintains less than 12 inches of head on the liner with the proposed drainage material and collection pipe spacing.

Attachments

Attachment 1 Monthly Collected Leachate Volumes

Attachment 2 Average Month Leachate Flow

Attachment 3 Annual Leachate Production Under Anticipated Operational Conditions

Attachment 4 Seven-Day Storage Volumes

Attachment 5 HELP Model, 10 ft MSW

Attachment 6 HELP Model, 60 ft MSW

Attachment 7 HELP Model, 110 ft MSW

Attachment 8 HELP Model, Intermediate Cover

Attachment 9 HELP Model, Closed

References

1. Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L. (1994). "Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering Documentation for Version 3," EPA/600/9-94/xxx, U.S. Environmental Protection Agency Risk Reduction Engineering Laboratory, Cincinnati, OH.

2. The Hydrologic Evaluation of Landfill Performance (HELP) Model V3.07, November 1, 1997.