SECTION 2.3
DESIGN
2.3 DESIGN

Introduction

Peoria City/County Landfill No.3 (Landfill No. 3) has been designed by experienced landfill engineers, geologists and scientists based on thorough and comprehensive investigations and analyses of regional and site-specific conditions. These engineers, geologists and scientists have designed numerous landfills that are operating safely, and have reviewed many other landfill facilities on behalf of local governments and large corporations.

Facility History

The City of Peoria and Peoria County jointly own the Peoria City/County Landfill Facility. Two separate permitted disposal units, designated as Landfill No. 1 and Landfill No. 2, are located adjacent to Landfill No. 3. Landfill No. 1 is an approximate 98 acre landfill which was opened in 1976 and was closed in April 1998.

In 1974 the City and County of Peoria jointly applied to the IEPA for a Planning and Implementation Grant for a Joint Solid Waste Sanitary Landfill Disposal Facility. The Peoria City/County Landfill Committee (Committee) was formed in 1975. With the assistance of a consultant, the Committee completed the permitting requirements and design of a publicly owned and operated landfill, which is referred to as Landfill No. 1. Waste began to be accepted in Landfill No. 1 during February 1976.

The Peoria City and County operated Landfill No. 1 until January 1, 1979. Browning Ferris Industries, Inc. (BFI) assumed the role of contract operator at this time. The operating contract was taken over by Peoria City/County Landfill, Inc. (PCCLI), an affiliate of Peoria Disposal Company, in 1982. PCCLI then operated Landfill No. 1 until it was closed in April 1998. Upon the closure of Landfill No. 1, Landfill No. 2 was opened and was operated by Waste Management of Illinois, Inc (WMII). Landfill No. 2 continues to be operated by WMII.

Facility Expansion

In anticipation of the closure of Landfill No. 2 in 2020 (estimated date), the Peoria City/County Landfill Committee (Committee) has opted to expand the landfill in order to continue waste disposal operations. The existing Facility Boundary has been expanded to include Landfill No. 3 waste footprint. The existing scalehouse, facility entrance, haul roads, and miscellaneous facilities currently utilized by the Facility will continue to be used as part of the facility expansion.

The proposed Landfill No. 3 is generally located to the north of Landfill No. 1 and to the east of Landfill No. 2. The topography in this area generally exhibits high topographic relief with several steeply sloped piles of mine spoil, road cuts and embankments, and steeply sloped ravines. The near-surface soil is disturbed due to historic strip mining, grading, and stockpiling activities.
Overview of Landfill No. 3 Design

Landfill No. 3 provides approximately 13.4 million airspace cubic yards (inclusive of daily and intermediate cover, exclusive of final cover) of waste disposal capacity, offering approximately 32 years of extended facility life. The base of the liner/foundation system has been placed within the Carbondale Shale unit, which provides enhanced structural stability to the landfill and is protective of the groundwater due to its extremely low permeability. The leachate collection system and landfill gas collection system will largely operate independently of the other waste disposal units.

Engineered Landfill Design Features

In conjunction with a suitable site location and favorable geologic and hydrogeologic conditions, multiple engineered design features are included to safely contain the waste that is placed in the landfill. These design features, which have been successfully used at the existing landfill and many other modern landfills, have been shown to protect the public health, safety, and welfare, and include the following:

1. **Composite Liner System.** Landfill No. 3 has been designed with a composite liner system consisting of a minimum 3-foot thick compacted cohesive soil liner with a maximum permeability $1 \times 10^{-7}$ cm/sec and a 60-mil high density polyethylene (HDPE) geomembrane. In the leachate drainage trenches and collection sump areas (areas where the leachate is drained to and collected) the composite liner system has been designed to include a geosynthetic clay liner (GCL) sandwiched between two 60-mil HDPE geomembranes, a design that exceeds the federal and state regulations which require only one 60-mil HDPE geomembrane. The composite liner system will effectively prevent the release of potential hazards from the landfill and perform at a level which exceeds state, and federal standards. The liner system has been computer modeled, and the computer analysis demonstrates that the proposed landfill will not impact existing or future groundwater quality.

2. **Geotechnical Analysis.** Landfill No. 3 has been designed to maintain sufficient factors of safety during static (F.S. $\geq 1.5$) and seismic (F.S. $\geq 1.3$) conditions for both long-term and short-term conditions for global mass stability and maximum interim slopes that may be constructed during waste filling prior to the completion of construction. The geotechnical analyses demonstrate that landfill slopes will not fail and that liner and final cover integrity will be maintained over the life of the landfill and beyond.

3. **Leachate Collection System.** The Landfill No. 3 design incorporates a leachate collection system consisting of a one-foot thick permeable granular drainage layer placed above the composite liner on the landfill floor. Along the 3H:1V sideslopes, the leachate collection system consists of a highly transmissive geonet drainage layer overlain by a geotextile filter fabric and a 18-Inch thick select fill layer. The leachate collection layer drains to collection points located along the perimeter of the waste boundary. Leachate will be removed from these collection points and properly managed.

4. **Final Cover System.** The final cover system of the landfill consists of a low-permeability layer to inhibit precipitation from entering the landfill and a protective soil layer used to maintain the long-term integrity of the cap. The
low-permeability layer will include a double-sided textured 40-mil HDPE geomembrane and a 1-foot thick compacted cohesive soil layer with a maximum constructed permeability of $1 \times 10^{-7}$ cm/sec. A double-sided geocomposite drainage net will overlay the geomembrane to drain infiltrated water away from the low-permeability layer. A protective soil cover layer will be placed over the geocomposite and will include a minimum of 2.5 feet of protective cover soil and six inches of vegetative cover soil. The majority of Landfill No. 3 will have a maximum slope of 4H:1V. In order to minimize the potential for erosion, the final slopes of the landfill will be vegetated.

5. **Landfill Gas Collection System.** Landfill No. 3 will have an active landfill gas management system to collect and control gases generated through the natural decomposition of waste. The collected landfill gas will likely be beneficially used once a sufficient amount of landfill gas is available.

**Overview of Expansion Footprint Selection**

An extensive hydrogeologic investigation was completed at the facility prior to developing the landfill expansion design in order to determine the area suitable for landfill development. Due to the known presence of underground coal mines in the vicinity of Landfill No. 3, this effort also included an investigation to ensure that no underground mines are present beneath the proposed landfill expansion footprint.

The investigation found that mine spoil and naturally present shale beneath the site will work in conjunction with the engineered features of the landfill to protect groundwater resources in Peoria County. Additionally, the investigation has determined that no underground coal mines exist beneath Landfill No. 3, based on multiple borings, geophysical surface seismic lines, and other subsurface investigation techniques.

As discussed in Section 2.2, the Landfill No. 3 boundary has been positioned outside the angle-of-draw from geophysical surface seismic lines that ring around the area considered for landfill development. Angle-of-draw is a measurement that describes the potentially-impacted area that could display subsidence if a hypothetical mine were to collapse. Because no mines are located inside the surface seismic lines, offsetting to account for the angle of draw from the seismic lines gives confidence that the landfill will not be impacted by a potential mine collapse outside of the surface seismic line locations. Please see Section 2.2 and Appendix G for further information.

Based on modeling angle-of-draws for nearby underground mines, an angle of draw of between 14 and 20 degrees off of vertical would be expected within the Carbondale Formation from a mine collapse (see Appendix G). The angle of draw through the overlying mine spoil was not modeled, but would not be expected to be greater than 45 degrees. Therefore, no subsidence would occur outside the area defined by these angles of draw originating from the edge of a collapsed mine. The landfill perimeter has been conservatively located well outside the angle of draw along lines demonstrated by the site investigation to be absent of underground mines, as illustrated. It is noted that this distance varies around the perimeter
of Landfill No. 3 area based on the thickness of bedrock and mine spoil above the Springfield (No. 5) Coal.

Blasting is not anticipated to be used during the construction of Landfill No. 3. As part of the site investigation, seismic velocities of the shale were determined between 3,200 and 5,600 ft/sec. This seismic velocity range indicates that the use of a ripper is appropriate for shale removal. Thus, site construction activities are highly unlikely to impact the proximate room and pillar mine shafts. Regardless, Landfill No. 3 has been located with ample setbacks from the mines such that even a complete mine collapse will not affect the safety of Landfill No. 3.

**Design Period**

Landfill No. 3 will provide an approximate additional site life of 32 years and will be constructed and operated to perform safely throughout the entire design period, including a minimum of thirty (30) years of post-closure. The estimated operating life of the Facility may vary due to changes in incoming waste volumes and waste compaction rates.

**Landfill Composite Liner System**

An engineered composite liner system will be constructed at the bottom and sides of the landfill to contain the waste materials and prevent contaminants from leaving the landfill and impacting groundwater. The composite liner will consist of a compacted cohesive soil liner overlain by a geomembrane (plastic) liner. The soil liner will consist of a minimum 3-foot thick layer of recompacted cohesive soil with a maximum permeability of $1 \times 10^{-7}$ cm/sec. The geomembrane will be a 60-mil HDPE liner. Additionally, a geocomposite clay liner and a second 60-mil HDPE geomembrane will be installed in critical areas, namely the leachate drainage trenches and collection sumps. This design configuration is outlined in a Special Condition of Local Siting Approval, as listed in IEPA Form PLC-PA8, provided in Section 1.

The proposed liner system for Landfill No. 3 has been designed to function for the entire design period, pursuant to Section 811.306(c). The low-permeability component of the proposed liner system consists of mine spoil materials with demonstrated performance at Landfills Nos. 1 and 2, and are generally clayey soils that have survived for thousands of years. Long-term laboratory testing of HDPE geomembranes indicate that the service life of geomembranes is several hundred years (see Appendix K). In addition, Appendices J and K provides a demonstration that the proposed liner system will be stable (i.e. will function) under both short-term and long-term conditions. Appendix K includes a demonstration that the composite liner system will perform better than a five-foot clay liner system.
Hydrogeology Considerations

The design of Landfill No. 3 is supplemented by existing geologic and hydrogeologic features to provide a high level of environmental safety. The proposed landfill expansion will be surrounded by a low-permeability cohesive material (Mine Spoil) and underlain by low-permeability (predominantly shale) bedrock of the Carbondale Formation that is hundreds of feet thick beneath the site. Field and laboratory test results and field observations indicate that these materials effectively restrict vertical and horizontal movement of groundwater and will serve as an additional environmental safeguard at Landfill No. 3, since groundwater elevations outside of the proposed landfill will be much higher than the conservatively calculated interior leachate levels, an inward hydraulic gradient is expected. This provides a fail-safe design in that groundwater pressure will prevent leachate from escaping the landfill, even in the unlikely event of a flaw in the liner system. Please refer to Section 2.2 “Site Investigation” for a complete description of the geologic setting of the and to Section 2.7 “Groundwater Impact Assessment,” for the results of contaminant transport modeling of Landfill No. 3. The Environmental Monitoring Program is described within Section 2.8.

Earth Liner

The 3-foot (minimum thickness) Earth Liner will be constructed to exhibit a maximum hydraulic conductivity of $1 \times 10^{-7}$ cm/sec. The Earth Liner will be constructed of mine spoil soils due to the favorable physical properties for construction and low hydraulic conductivity. Mine spoil has been used to construct the earth liner of Landfill No. 2 and has been reviewed and approved by the IEPA. Due to the fact that mine spoil composition may vary based on its initial deposition, unsuitable construction soils will be segregated and not used for construction purposes. Earth Liner material, placement, and compaction standards are provided in Specifications Section 02200 (Earthwork). Construction Quality Assurance (CQA) requirements are described in the CQA Plan, provided in Appendix O of this application.

Geomembrane

The geomembrane liner will be installed above the Earth Liner by personnel experienced in liner installation. The geomembrane liner will consist of panels of 60-mil textured HDPE. Geomembrane materials, installation, seams, and testing will be performed in accordance with Specifications Section 02650 (Geomembranes). CQA activities will be as described in the CQA Plan provided in Appendix O.

The geomembrane panels will be arranged to minimize the number of field seams. It is assumed that the geomembrane panels will be 22.5 feet wide by 400 feet long (panel lengths and widths may vary by manufacturer’s specifications at the time of construction). Drawing No. D7 provides a conceptual geomembrane panel layout for Landfill No. 3. The actual constructed layout of the geomembrane panels will be provided with each cell construction certification report. Penetrations through the geomembrane liner system are not proposed or anticipated.

The geomembrane liner subgrade will be prepared to be smooth and free of rocks, stones, roots, sharp objects or other undesirable debris. In order to maintain stable side slopes, the geomembrane liners will be anchored beyond the limits of the waste into the anchor trenches as shown on Drawing No. D15.
The geomembrane liner will also be protected from sharp items in the waste by the granular drainage blanket which will serve as part of the leachate collection system on the landfill floor, and by 18-inches of select fill on the sideslopes.

Based on current technology, a dual fusion weld wedge weld is generally the preferred seaming method to join panels and will generally be used for areas except at sumps, corners or other irregular areas where an extrusion weld is necessary. Extrusion welds are also highly effective welds and are anticipated to be used to repair destructive sample locations, and any repair areas.

The geomembrane will have sufficient strength and durability to function at Landfill No. 3 for the design period under the maximum expected loading imposed by the waste and equipment and stresses imposed by settlement, temperature, construction, and operation, pursuant to Section 811.306(e). Calculations demonstrating the strength and durability of the HDPE liner are provided in Appendix J. Demonstration that HDPE is compatible with the landfill environment is provided in Appendix K.

**Geosynthetic Clay Liners (GCLs)**

Within each leachate collection "v" notch drain and leachate collection sumps, a GCL will be sandwiched between two 60-mil HDPE geomembranes and placed on top of the 3 foot thick recompacted cohesive soil liner as shown on Design Drawing No. D15. GCL materials and installation will comply with Specifications Section 02660 (Geosynthetic Clay Liner).

**CQA Documentation**

Liner construction, documentation, and certification will be performed in accordance with the CQA Plan contained in Appendix O of this Application. A CQA Officer will supervise and be responsible for all inspections and testing. The CQA Officer will be an independent licensed Professional Engineer. A construction acceptance report will be prepared under the direct supervision of the CQA Officer and submitted to the IEPA after completion of each major phase of construction.

**Geotechnical Analyses**

The following section describes the geotechnical analyses conducted on Landfill No. 3 design in order to verify that the liner and final cover will be stable during construction, operation, and following closure of the landfill. The analyses demonstrate that landfill slopes will not fail and that the structural integrity of the bottom liner and final cover will be maintained over the life of the landfill and beyond. Specifically, this section addresses:

1. **Slope Stability.** This subsection analyzes the slopes of the active face of the waste during interim waste filling operations, as well as the final build-out landform, in order to meet the desired safety factors. In addition, stability of the
bottom and sideslope liner, leachate collection system and final cover systems are analyzed to determine factors of safety against failure.

2. **Foundation and Mass Stability.** This subsection examines the foundation materials below the landfill, ensuring that the foundation will not be compromised by bearing capacity failure.

3. **Landfill Settlement.** This subsection details the anticipated settlement of the foundation and waste within the landfill, and estimates the potential differential settlement at the landfill. Landfill No. 3 has been designed to withstand this settlement while maintaining functional design performance of the engineered systems.

4. **Anchor Trench/Runout Design.** This subsection evaluates whether the anchor trench design provides holding capacity against the self weight of the geomembrane while allowing pull-out of the geomembrane at loads approaching the ultimate material strength of the geomembrane.

5. **Additional Geosynthetic Strength and Protection Considerations.** This subsection includes several calculations such as geomembrane strain, leachate pipe deflection and crushing, wheel loading, wind uplift, and puncture resistance. These evaluations consider additional geosynthetic material considerations as to whether the proposed materials will function as required over the life of each landfill design option.

Supporting documentation and calculations are provided in Appendix J. Geotechnical analyses have been performed under the direct supervision of a licensed professional engineer experienced in geotechnical engineering.

**Slope Stability**

Slope stability analyses were performed for Landfill No. 3. The liner system has sideslopes of 3 Horizontal to 1 Vertical (3H:1V), and the final cover system generally consists of 4H:1V slopes with a plateau of 10H:1V. The peak of the landfill is approximately 804 feet above mean sea level (MSL).

A seismic analysis was performed based on a horizontal acceleration of 0.0652g to demonstrate that the slopes will be stable during seismic events. The design horizontal acceleration corresponds to an earthquake event that has a 10% probability of occurring every 250 years (see Figure 2.2-15).

In general, modern municipal solid waste landfills have performed extremely well during earthquake events¹. A detailed study of southern California landfills demonstrated that all landfills designed in accordance with Subtitle D liner standards that were subject to the strongest shaking of the January 17, 1994 Northridge California earthquake (Magnitude 6.7), performed well with no major slope failures.

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Failure Scenarios

The following slopes and potential failure scenarios were modeled for Landfill No. 3:

1. Final landform conditions with a block failure through the liner system (long and short terms).
2. Final landform conditions with circular failure through the waste (long and short terms).
3. Final landform conditions with circular failure through the foundation (long and short terms).
4. Excavation face with circular failure.
5. Active landfill face conditions with circular failure.

As noted above, both long term (drained) and short-term (undrained) conditions were considered in the slope stability analysis. Under drained conditions, it is assumed that the excess pore water pressures have dissipated. Thus, the drained strength analyses may be used to evaluate long-term stability. For short-term conditions, an undrained strength analysis was performed. Under undrained conditions, it is assumed that excess pore water pressure is positive because the pore water pressure has not had enough time to dissipate.

A cross-section (A-A') through the most critical section of the site was used to determine the global mass stability. The liner design calls for textured 60-mil HDPE geomembrane. The cross section was modeled assuming an excavation slope of 3H:1V. Cross section A-A' utilized a peak final landform elevation of 804 feet MSL with a final cover slope that includes benches and ranges between 4H:1V and 10H:1V. The water table elevation for the evaluation was selected from recent groundwater data available at the time of the analysis. Two dozer loadings were applied to all failure scenarios. Please refer to Appendix J for a detailed description of the slope stability analyses.

Table 2.3-1 demonstrates that the Landfill No. 3 design meets the requirements of 35 Ill. Admin. Code, Section 811.205, which states that all final slopes must achieve a minimum static slope safety factor of 1.5 and a minimum seismic safety factor of 1.3. The supporting model printouts are provided in Appendix J.

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Additionally, a slope stability analysis was conducted to evaluate the stability of the final cover system. A horizontal acceleration of 0.0652g was used for the analysis of seismic conditions.
A double-sided textured geomembrane will be used over the entire final cover. The results of the analysis yielded a static factor of safety greater than 2.0, and a seismic factor of safety greater than 1.6, which exceeds the requirements of 35 Ill. Admin. Code Section 811.304 (d) (1.5 for static and 1.3 for seismic). The supporting calculations are provided in Appendix J.

A stability analysis of the liner/leachate collection system was also performed. The factor of safety against slope failure of the liner/leachate collection system was determined assuming buttressing effects at the bottom of the sideslope. Assuming a granular drainage material, and 3H:1V sideslopes, the factors of safety were calculated to be greater than 1.4 for static conditions and greater than 1.3 for seismic conditions, and therefore conform with the requirements of 35 Ill. Admin. Code Section 811.306 (b) (1.3 static conditions and 1.0 for seismic). The supporting calculations are provided in Appendix J.

**Bearing Capacity Analysis (Foundation and Mass Stability)**

Bearing capacity analyses were performed to demonstrate that the foundation materials beneath Landfill No. 3 exhibits sufficient strength to support anticipated loads. The most critical location across the landfill base was analyzed (maximum waste height of approximately 213 feet). The Carbondale Formation Shale unit occurs immediately beneath the base liner. Terzaghi's bearing capacity equation was used to calculate the ultimate bearing capacity using engineering properties of the Carbondale Formation Shale. The factor of safety is the ratio of the ultimate bearing capacity to the overburden pressures expected to act on the foundation. Using conservative assumptions, factors of safety greater than 2.0 under static conditions and greater than 1.5 under seismic conditions (as required by 35 Ill. Admin. Code Section 811.304) were achieved. The supporting calculations are provided in Appendix J. The calculations contained in Appendix J also demonstrate that the bedding materials of the leachate collection system possess the structural strength to support the maximum loads imposed by the overlying materials and landfill equipment.

**Landfill Settlement**

Settlement at a landfill is generally caused by the weight of the landfill compressing the foundation soils and by decomposition of the waste. Settlement analyses were conducted for the landfill foundation of the proposed design using conservative assumptions. The maximum differential settlement of the foundation soils was calculated between the locations of maximum and minimum load on the base of landfill over the shortest distance. The maximum waste settlement due to compression was estimated between the point of maximum waste height and the edge of the landfill, over the shortest distance.

**Foundation Settlement.** As the landfill is constructed, the weight of the landfill will cause the geological units and low permeability soil liner to consolidate slightly. Consolidation is the settlement due to the reduction of void space. The reduction in void space will have the additional benefit of reducing the hydraulic conductivity of both the liner and underlying soils.

Differential settlement calculations were performed to verify that the leachate collection system will still drain after the landfill foundation settles (refer to Appendix J). Although the slope of the proposed leachate collection system may change over time due to settlement, the resulting slopes will still allow for drainage and meet performance requirements.

**Waste Compression.** The proposed recirculation of leachate of the landfill will accelerate waste decomposition, leading to a significant increase in the magnitude of initial and secondary compression and corresponding settlement. While compression will continue for a similar time period as a conventional landfill, most compression will be completed before
final cover systems are placed as a result of leachate recirculation. As a result, leachate recirculation will reduce long-term maintenance of the final cover system. The maximum differential settlement was calculated to be less than one percent (refer to Appendix J). The final cover system is designed to accommodate the remaining settlement after cover materials are constructed. As a result, differential settlement will have little effect on the performance of the final cover system as demonstrated in calculations provided in Appendix J.

As an additional safeguard, the landfill final cover will be periodically monitored, and maintenance will be performed as necessary. Final cover inspection and maintenance will be performed in accordance with the facility's post-closure care plan contained in Section 2.9 of this Application.

Anchor Trench/Runout Design

It is anticipated that an anchor trench will be used to anchor the geosynthetics. The anchor trench design was evaluated using a veneer analysis, which is provided in Appendix J. The anchor trench was determined to provide holding capacity against the self-weight of the geomembrane, while allowing pull-out of the geomembrane at loads approaching the ultimate material strength of the geomembrane, which minimizes the potential for tearing.

Leachate Management

Overview of Leachate System

Liquid that comes in contact with waste is known as leachate and will be properly managed. Landfill No. 3 will include a leachate collection system to collect and remove leachate for treatment at an off-site facility, solidified and disposed in the landfill, or re-entrained in the waste via leachate recirculation. At this time, on-site treatment or pretreatment of leachate is not planned.

Leachate will flow by gravity into perforated HDPE collection pipes spaced at intervals along the bottom of the landfill. The collection pipes will be sloped sumps located at the base of the landfill sidewall. Access to the sumps will be provided by risers which will be placed on the landfill sidewalls and will extend beyond the waste boundary. Leachate will be removed from the sumps using an appropriate pump. A force main will be used to pipe leachate from the sumps to the leachate recirculation system, "liquid" waste solidification area, and/or leachate storage tank. All leachate piping outside of the waste limits will be dual-walled.

The leachate collection system will consist of perforated HDPE pipe situated within a gravel envelope and surrounded by a minimum one-foot thick granular drainage system, located above the geomembrane liner as shown on Drawing No. D15. If locally available and practical for use, a rounded to sub-rounded washed river rock or similar material is proposed for the granular drainage layer. The granular drainage layer will have a minimum hydraulic conductivity of $2 \times 10^{-2}$ cm/sec. The leachate collection system is capable of supporting the weight of the overlying landfill, as demonstrated in Appendix J.

The leachate management system has been designed to safely handle leachate during routine maintenance and repair activities. The leachate collection system will include clean-out risers that can be accessed from the ground surface.

Calculations provided in Appendix L demonstrate that the leachate collection system is appropriately sized to convey the maximum estimated leachate flow volumes expected for the landfill. The proposed design also exceeds the IEPA performance requirements by maintaining less than the maximum allowable one foot of leachate head across the liner floor.
Origin of Leachate

Leachate is any liquid that has contacted waste. Leachate can come from several sources, including the biological breakdown of waste or the movement of infiltrated moisture, such as rainwater, through the waste. Leachate generation will vary depending on the composition and moisture content of the incoming waste (i.e., dry waste will absorb more water than wet waste). The rate of leachate generation and the composition of the leachate are influenced principally by the following factors.

1. The availability and potential for infiltration or seepage of water into the landfill.
2. The physical and chemical characteristics of the waste (i.e., the moisture content, absorptive capacity, and solubility of the waste).
3. The environment in which the biological decomposition process takes place (i.e., pH, availability of oxygen and temperature).

Municipal solid waste landfill leachate typically contains the following chemicals in order of decreasing concentrations: 1) dissolved and suspended solids including salts (i.e., sodium chloride), sulfates, and sodium bicarbonate; 2) metals (principally iron and zinc); and, 3) organic compounds. The waste decomposition process will also yield methane, carbon dioxide, and traces of other gases. Some heat will be generated as the waste decomposes.

Inert materials (i.e., particles of sand, grit, metal, plastics, and construction/demolition debris) which do not readily degrade will essentially remain unchanged by the decomposition process.

The rate of decomposition in a landfill depends on the type of waste and the landfill environment in which the waste is present, with moisture content being the primary factor. Food wastes typically decompose first, followed by paper, wood, textiles, and discarded un-stabilized plastics. Microbes that are initially present in the waste or introduced with the materials used as daily cover will initiate the aerobic portion of the decomposition process.

Most of the leachate in a conventional landfill stems from precipitation that falls on the active area of the landfill, or from precipitation that percolates through daily/intermediate cover. The low permeability final cover employed at Landfill No. 3 will essentially eliminate long-term leachate generation on sections of the landfill that have been capped.

Leachate Collection System

The leachate collection system consists of a highly permeable leachate drainage layer overlaying the entire base of the landfill and a system of leachate collection pipes, collection sumps, collection risers and cleanout risers. The location and details of the components of the leachate collection system are shown on Drawing Nos. D8, D15, and D16. Material and installation specifications for the various components are provided in Specifications Section 02200 (Earthwork), Section 02640 (Geotextiles), Section 20045 (Geonet) Section 02646 (Geocomposite Drainage Layer), and Section 15105 (HDPE Pipe and Fittings).

The leachate collection system of Landfill No. 3 has been designed to efficiently collect leachate throughout the operating life, post-closure care period, and beyond. The system is designed to handle leachate quantities determined based on computer modeling and rates at similar facilities. The granular drainage materials to be used in the drainage layers have survived for thousands of years. The CQA Program requires testing (ASTM D2488 and ASTM D3042) to verify that the granular materials will be compatible with the expected leachate at
the landfill.

Long-term laboratory testing of the HDPE indicates that the service life of the geomembranes is several hundred years (see Appendix K). Design calculations, with supporting assumptions and information, are provided in Appendix K. The calculations were performed using conservative assumptions, resulting in a collection system that is more than capable of handling projected leachate quantities. The leachate collection system is also evaluated for its geotechnical stability in Appendix J, and has been determined to be stable (i.e. function) under both short-term and long-term stability. Thus, the leachate collection system has been demonstrated to function for the entire design period, pursuant to 811.307(a).

The leachate collection system for the landfill expansion will have the following benefits:

1. The highly permeable granular drainage layer will have a minimum hydraulic conductivity of $2.0 \times 10^{-2}$ cm/sec and 12-inches in thickness across the floor of the landfill. This drainage layer will minimize the leachate head above the HDPE composite liner system by promoting flow to the collection pipes.

2. The collection pipes are capable of handling volumes far exceeding the maximum estimated leachate flow volumes.

3. The leachate collection cleanout risers will allow access to all points along the collection lines for cleaning out the pipes and back-flushing, if necessary.

4. The granular pipe envelope will serve as a conduit to other collection points in the unlikely event that a temporary leak or localized pipe failure occurs.

5. All of the components of the leachate collection system will be constructed of materials that are chemically resistant to the anticipated composition of leachate.

The drainage material will have a minimum hydraulic conductivity of $2.0 \times 10^{-2}$ cm/sec, which will facilitate the flow of leachate across the base of the landfill and into the trenches containing the collection pipes. Along the 3H:1V sideslopes a high flow geonet or geocomposite drainage layer will be used in place of the 1 foot drainage layer.

A non-woven geotextile will be placed above the entire drainage layer to minimize clogging and biologic growth within the drainage layer. The geotextile seams will be overlapped and field sewn as required by the CQA Plan. The drainage material will also act as protection for the geomembrane against sharp objects which may be contained within the waste material. The drainage layer has been designed to maintain laminar flow and will be constructed of materials that are chemically resistant to leachate.

The bottom liner for Landfill No. 3 is designed to slope at a minimum of 2.0 percent toward the leachate pipe. The maximum horizontal spacing between leachate collection pipes is approximately 450 feet, resulting in a maximum horizontal distance from the leachate drainage divide to the collection point of approximately 225 feet. The leachate collection pipes will be sloped at a minimum of 0.5 percent to promote drainage within the pipes to the leachate header pipes and leachate collection sumps.

The pipe component of the leachate collection system will consist of a 6-inch diameter HDPE pipe with a wall thickness of SDR-11 or thicker. All HDPE collection pipe has been shown to have the necessary flexibility to conform to localized variations in the bottom slope. The pipe
also has the necessary strength to withstand the weight of the overlaying operating equipment, and daily and final soil covers. The collection pipes will slope toward leachate collection sumps as shown on Drawing No. D8. Calculations demonstrating the structural capacity of the perforated pipe are presented in Appendix K.

Leachate will be extracted from the landfill using riser pipes. The riser pipes will extend from the collection sumps to the edge of the waste footprint, where the point of extraction is accessible. Pumps will be placed within the risers to remove leachate from the landfill, and will be equipped with a leachate level detection system for monitoring leachate levels.

The leachate management system has been designed to safely handle leachate during routine maintenance and repair activities. To facilitate cleanout, each collection pipe will be connected to a cleanout riser at one or both ends. The proposed cleanout riser locations are shown on Drawing No. D8. The leachate collection pipes will most likely be cleaned by hydraulic jetting or flushing, which requires access from only one end of the pipe.

Hydraulic flushing or jetting typically uses a 1" hose connected to a 3" diameter nozzle assembly to deliver high-pressure water to remove obstructions. The hose and nozzle will fit through the 6" diameter leachate collection pipe. The 3" diameter nozzle can produce approximately 3,000 psi of hydraulic pressure, allowing it to easily breakup any obstructions. Pictures showing typical equipment used in the hydraulic jetting is provided in Appendix K of this application.

Any liquid or debris from the cleaning of the leachate collection line will be properly handled and disposed. It is anticipated that all liquid will be treated as leachate and any solid debris will be returned to the active face of the landfill or hauled by a properly licensed truck to another permitted disposal facility.

All of the components of the leachate collection system will be constructed of materials that are chemically resistant to the anticipated composition of leachate. The leachate collection pipes will be cleaned and maintained as necessary utilizing an approved cleaning method. The cleanout system has been designed so that all work can be performed at the ground surface. The leachate collection and management system will be routinely inspected for evidence of clogging or general system repair. Areas specifically targeted for maintenance inspections and monitoring include: collection pipes (leachate levels), extraction points, leachate storage tanks, and leachate containment structures. Any observed damage or deficiencies will be quickly repaired following detection. The leachate management system has been designed to safely handle leachate during routine maintenance and repair activities.

Leachate Collection System Efficiency (Ability to Remove Leachate from the Landfill)

The leachate collection system was determined to be highly efficient even under conservative assumptions that overestimate the amount of leachate likely to be generated and component clogging. The maximum leachate head in the granular drainage blanket was calculated based on the estimated leachate generation rates, the hydraulic conductivity of the drainage layer and the leachate collection system design. The analysis indicates that the maximum leachate head in the granular drainage blanket will not exceed 12 inches during operation of the landfill. The calculations used to determine the leachate head are presented in Appendix K.

The efficiency of the leachate collection pipes to collect and transport the maximum estimated leachate volume was assessed using Manning’s equation for open channel flow. The analysis indicates that the proposed 6-Inch diameter pipes are more than capable of collecting and
transporting the peak percolation rate calculated by the HELP model. The pipes will not restrict leachate flow from the granular drainage blanket, and have more than enough capacity to collect and transport the predicted leachate volume. The 6-inch diameter pipe size will also accommodate conventional sewer cleaning equipment for pipe cleaning and inspection purposes. Calculations which demonstrate the capacity of the leachate collection system are contained in Appendix K.

**Leachate Collection and Disposal**

All leachate will be pumped from the sumps to the leachate recirculation system, "liquid" waste solidification area, and/or storage tank(s). Leachate not recirculated will be solidified and disposed onsite, or hauled to a licensed pre-treatment or treatment facility. Buried leachate piping located outside the waste boundary will be double-walled.

The type of pumps used will depend on the actual quantity and quality of leachate generated for each cell and is anticipated to vary over the life of the landfill. Pumps will be installed with an automated leachate-level activated switch to pump leachate from the collection system when the leachate level within each sump rises to the level of the lowest leachate collection pipe entering the sump. The leachate drainage and collection system will not be used for the purpose of storing leachate.

**Leachate Storage Tank and Secondary Containment System**

Leachate and landfill gas condensate (collectively referred to herein as leachate) that is extracted from Landfill No. 3 will be stored in one or more storage tank(s). It is anticipated that one 2,000 gallon (minimum) capacity above-ground storage tank located near the landfill gas facilities (see Drawing No. D9) will be used to store landfill gas condensate once the landfill gas collection and control system is installed, whereas one or more above-ground or underground storage tank(s) located south of Landfill No. 3 will be used to store leachate. All leachate and condensate storage tanks will incorporate secondary containment equivalent to the protection provided by a 2 feet thick clay liner having a permeability no greater than 1 x 10^-7 centimeters per second. The primary tank shells will be coated steel.

Regulations at 35 Ill. Adm. Code 811.309d) require that sufficient storage capacity is provided to contain the volume of leachate that is generated over a 5 day period, assuming the maximum daily leachate generation rate calculated in accordance with 35 Ill. Adm. Code 811.307. The required volume of storage can be reduced if multiple leachate treatment, storage and disposal options are approved.

Calculations of the maximum daily leachate generation rate for different stages of landfill development are provided in Appendix K. A leachate storage tank with a capacity of at least 30,000 gallons will be installed during the first phase of development. Additional leachate storage capacity will be installed in subsequent stages as required to meet the criteria provided at 35 Ill. Adm. Code 811.309d).

Leachate storage tanks will be located within a secondary containment system. All on-site storage structures and secondary containment facilities will comply with the conditions and specifications required by 35 Ill. Admin. Code Section 811.309.

**Leachate Pre-Treatment**

It is anticipated that leachate generated from this expansion will be transported to the Peoria Disposal Company (PDC) Wastewater Treatment Facility near Peoria for pre-treatment. The
PDC Wastewater Treatment Facility meets the requirements of 35 Ill. Admin. Code Section 811.309(e) and is permitted to pre-treat leachate from multiple landfills. The PDC Wastewater Treatment Facility discharges its treated effluent into the Greater Peoria Sanitary District sanitary sewer system. All required permits and approvals will be secured and maintained in accordance with local, state, and federal regulations.

**Leachate Recirculation**

Leachate recirculation, the process of removing the leachate from the leachate collection system and re-entering the leachate back into the landfill is a technology that has been used at the Peoria City/County Landfill No. 2 for more than 10 years and is proposed to be used at Landfill No. 3. Leachate is recirculated back into the landfill to create an environment favorable to the rapid microbial decomposition of the biodegradable solid waste. The landfill becomes a treatment system rather than a simply a storage facility. Leachate recirculation is anticipated to take place at Landfill No. 3 up to thirty years after closure.

Some of the advantages to leachate recirculation are listed below:

- Increased rate of waste settlement, which reduces the long-term settlement and maintenance of the final cover system;
- Increased rate of landfill gas production, which facilitates beneficial use of the landfill gas; and
- Increased rate of biological stabilization of the organic faction of the solid waste.

PCCLI will recirculate leachate and landfill gas condensate (collectively referred to as leachate herein) into the waste mass using either or all of the following methods:

1. **Temporary Leachate Recirculation Sumps**: Temporary leachate recirculation sump details are shown on Drawing No. D24. Each temporary leachate recirculation sump is intended to be used for a relatively limited period of time (e.g. a few months) in areas which are rapidly being filled, and will only be placed in areas in which the landfill surface slopes away from the landfill perimeter.

   Leachate will be injected into the temporary leachate recirculation sumps using above-ground fittings that will minimize contact with air. Leachate will be transported to the temporary sumps either by piping from the leachate extraction sumps or by tank truck. The temporary leachate recirculation sumps will only receive leachate during the landfill operating hours. Additionally, they will not be used during, and immediately after, precipitation events. Because the temporary leachate recirculation sumps directly recirculate leachate into the waste mass, a companion leachate level observation well will be installed within 10 feet to monitor the potential build-up of leachate within the landfill adjacent to the sump.

2. **Leachate Recirculation Wells**: Leachate recirculation well details are shown on Drawing No. D24. Leachate recirculation wells are engineered to be utilized for extended periods of time and include an extensive permeable zone in which leachate will be recirculated and distributed throughout the waste mass. The leachate recirculation wells will consist of PVC- or HDPE-cased wells extending at least 15 feet beneath the landfill surface. The wells will be completed within
permeable material consisting of a well-drained material. Optional radial recirculation laterals may be installed as shown on Drawing No. D24 to further improve the distribution of leachate. Additionally, a small sheet of geomembrane will be placed beneath a portion of the permeable material directly beneath the well casing in order to help spread the recirculated leachate.

Leachate will be injected into each leachate recirculation well via underground piping that directly connects a leachate extraction sump to the recirculation well, and/or via an above-ground fitting as illustrated on Drawing No. D24. Leachate recirculated through the above-ground fitting will be transported to the recirculation well either by piping from the leachate extraction sumps or by tank truck. The entire system is designed to minimize air contact with leachate in order to prevent odors. Leachate will only be recirculated via the above-ground fitting in areas where the landfill surface drains away from the landfill perimeter. Additionally, leachate will only be recirculated via the above-ground fitting during the landfill operating hours, and only during periods with no measurable precipitation.

It is intended that the leachate recirculation well risers will be extended upwards as additional waste is placed. In order to evenly distribute leachate throughout the landfill waste mass, leachate will be recirculated in the upper portions of the landfill and, therefore, recirculation wells will be decommissioned and replaced with recirculation wells installed at higher elevations as landfilling continues. Leachate recirculation wells no longer used to recirculate leachate may remain for use to extract landfill gas.

3. Lateral Leachate Recirculation Lines (Recirculation Laterals): Lateral leachate recirculation line conceptual details are shown on Drawing No. D24. Recirculation laterals are engineered to be utilized for extended periods of time and include an extensive permeable zone in which leachate will be recirculated and distributed throughout the waste mass. Recirculation laterals consist of nearly horizontal recirculation lines consisting of perforated pipe enveloped within well drained material or multiple layers of geonet. The recirculation laterals will be installed, and extended, in stages as waste is placed.

Leachate will be injected into each recirculation lateral via underground piping that directly connects a leachate extraction sump to the recirculation lateral, and/or via an above-ground fitting (similar to the above-ground fitting for the leachate recirculation wells). Leachate recirculated through the above-ground fitting will be transported to the recirculation lateral either by piping from the leachate extraction sumps or by tank truck. The entire system is designed to minimize air contact with leachate in order to prevent odors. Leachate will only be recirculated via the above-ground fitting in areas where the landfill surface drains away from the landfill perimeter. Additionally, leachate will only be recirculated via the above-ground fitting during the landfill operating hours, and only during periods with no measurable precipitation.

It is intended that multiple layers of recirculation laterals will be installed at different elevations as waste is placed. In order to evenly distribute leachate throughout the landfill waste mass, leachate will be recirculated in the upper portions of the landfill and, therefore, recirculation laterals that were previously installed at lower elevations will be decommissioned and replaced with
recirculation laterals installed at higher elevations as landfilling continues. Recirculation laterals no longer used to recirculate leachate may remain for use to extract landfill gas.

Leachate will only be recirculated following the installation of an active landfill gas management system. Additional operation details are provided in the facility Operations Plan.

Leachate Monitoring

Leachate will be sampled in accordance with 35 Illinois Admin. Code 811.309(g). Sampling will be conducted as long as the leachate collection system is in operation. Test results will be submitted to the IEPA. The schedule for leachate monitoring program is discussed in further detail in Section 2.8 of this Application.

Construction Phasing

The Landfill will be developed in phases. The size of each development phase will vary. Preliminary Phasing Plans are shown on Drawings Nos. D28-D35. Each phase includes liner construction and waste filling sequences. All adjacent stormwater management systems and environmental monitoring points will be constructed concurrently with phase development.

The phasing of landfill development will have a number of important benefits that enhance the environmental safety of the facility:

1. Construction will occur in a planned, orderly manner.
2. Adequate disposal areas will be constructed to handle incoming waste flows.
3. The size of "active" disposal areas will be minimized, reducing the quantities of leachate generated and the potential for nuisance impacts (e.g., dust, odors) to develop.
4. Completed sections of the landfill may be capped with final cover as they reach final grades, reducing the quantities of leachate generated.

Cell Development

Landfill No. 3 has been designed for the phasing of operations within 7 cells. Depending on the volume of incoming waste, each cell may be constructed in stages. Landfill development is phased such that as one area nears completion, a new lined area is being constructed.

The general sequence of cell development is shown on Drawings Nos. D28-D35. Considering all of the various influences on construction schedules, including weather and fill volumes, the estimated sequence of construction represents the phasing envisioned at the time of design. Adjustments and modifications are anticipated considering the size, complexity and life of this project, and the design of Landfill No. 3 provides the flexibility to make adjustments as necessary.

Initial construction is anticipated to consist of constructing the Southeast Detention Basin and Cell 1. The development of the perimeter ditches and detention basins will be phased to correspond with cell development, groundwater monitoring wells, and perimeter gas monitoring probes. No landfill areas will be developed without adequate stormwater
management and environmental monitoring controls. It is noted that because the stormwater controls have been designed to accommodate the fully developed landfill, they are also sufficiently sized to handle interim conditions. However, additional temporary measures will be incorporated to divert stormwater away from active landfilling and liner construction areas. Prior to the start of liner construction, diversion berms and drainage ditches will be developed to prevent runoff from impacting construction areas. These perimeter features will intercept the runoff from undisturbed areas before it reaches construction areas.

Construction of subsequent areas will be phased to ensure that adequate landfill capacity is continuously available. Once construction of a new area is complete and the operating authorization from the IEPA has been received, waste disposal will be diverted from the area currently receiving waste to the newly-developed area to establish a protective layer of waste.

**Estimated Construction Schedule**

The estimated construction dates for the cells, stormwater controls, final cover, etc. are provided in Appendix R. Note that filling simultaneously occurs in multiple cells as cells cannot be filled to final grade until adjacent cells approach final grade. The anticipated phasing is dependent upon variable conditions such as incoming waste volumes and weather conditions.

**Initial Filling Sequence**

After receipt of the operating authorization, waste filling will initiate, and select waste will be placed over the leachate collection drainage layer. The initial waste lift will be placed approximately 5 to 10 feet thick to cover the entire floor. Select fill will be placed against the sidewalls as equipment access allows. The initial waste and select fill layers will serve as a protective and insulating layer over the leachate collection system and synthetic liner. Daily (or intermediate) cover will be placed over the initial lift of waste to serve as a working surface. Subsequent lifts of waste will be covered at the end of each day with daily cover. Daily and intermediate cover will be partially removed prior to placement of new waste to facilitate leachate drainage.

**Seasonal Construction and Filling Considerations**

The anticipated sequence of landfill construction and filling is dependent upon variable conditions such as incoming waste volumes and weather conditions. Therefore, typical seasonal conditions and the corresponding construction activities most suited to the temperature and precipitation associated with these seasons have been assumed.

The construction of the liner system and leachate collection system will generally take place in the drier late spring and summer, and possibly during early months of fall. However, if weather permits, construction may occur outside these seasons.

Daily cover placement, haul road construction, fill placement and other necessary activities will take place throughout the year as needed. Construction materials such as pipe, geotextile, and processed gravel for the leachate collection system may be stockpiled on-site to be ready for placement at all times. The proposed sequence of construction will allow for orderly construction and minimize the periods in which there is either a lack or an excess of manpower and equipment.

**Groundwater Seepage**

The CQA Personnel shall observe excavations and fill subgrades for evidence of excessive groundwater seepage. The CQA Personnel shall notify the Contractor and the Design
Engineer in the event that excessive seepage is noted. Work in areas with excessive groundwater seepage shall be suspended until a solution that is acceptable to the Design Engineer and CQA Officer is developed. Example solutions may include allowing the excess seepage water to naturally drain (acceptable for pockets with limited water), installing and temporarily operating a de-watering system until sufficient overburden is placed to resist hydrostatic uplift, and/or installing a drain tile. Perforated drain tiles that are to remain operational after waste is placed in the nearby landfill cell shall be maintained at an elevation at least 1 foot above the nearest landfill floor elevation to the extent possible in order to prevent a potential preferential leachate pathway. Where this is not possible, the Operating Permit application shall include a request to include the drain tile discharge in the facility water monitoring plan. After de-watering activities have been stopped the drain tile will be grouted. Typical de-watering system details are shown on Drawing No. D17.

Placement of Final Cover

Construction of the final cover is recognized to have a direct influence on the amount of leachate generated. Therefore, the final cover will be constructed in phases. The objective will be to establish the stabilized final surface as quickly as possible after the filling has been completed in a particular area.

Material Balance

The estimated soil excavation quantities are sufficient to meet the needs for construction of the bottom liner, daily cover, intermediate cover, final cover and other engineered features as documented in Appendix N. It is anticipated that aggregates for the leachate drainage and collection systems will be obtained from off-site sources.

Based on estimated soil quantities calculations provided in Appendix N, the net soil balance is approximately 3.2 million cubic yards surplus soil (excess cut). PCCLI intends to use approximately 1 million cubic yards of soil to upgrade the existing Landfill No. 1 final cover, effectively reducing the soil surplus to 2.2 million cubic yards. To the extent possible, soils will be distributed to miscellaneous development projects in and around Peoria County. However, sufficient space is available to stockpile surplus soil on and adjacent to the facility, as shown on Drawing No. D26. All construction and stormwater permitting, as well as any necessary clearances, will be secured prior to stockpiling activities.

Borrow Areas

It is anticipated that soil for landfill development will primarily be derived from site excavations that satisfy the CQA requirements. However, it is expected that onsite material for the leachate collection blanket and some parts of the liner/cover systems may come from off-site sources. Any material from offsite sources will comply with all the applicable CQA requirements.

During excavation, material types will be identified and segregated. Excavated materials needed for liner construction will be directly hauled to the fill or stockpiled near the areas intended for utilization. In order to reduce the amount of stockpiling, daily and intermediate cover will be taken as needed from excavation areas, to the extent practical.
Final Cover System

Landfill No. 3 will be covered with an engineered final cover system which will meet or exceed all federal, state, and local requirements. The final cover will be used to: 1) minimize the infiltration of precipitation, 2) prevent the release of landfill gas to the atmosphere, 3) support vegetation, and, 4) eliminate accessibility to the waste by vectors. The proposed final cover system is a multi-layer system consisting of:

1. A 12-inch thick intermediate cover layer (foundation soils)
2. A 12-inch thick low permeability compacted cohesive soil cover (maximum constructed hydraulic conductivity of $1 \times 10^{-7}$ cm/sec).
3. A 40-mil HDPE geomembrane liner (double-sided textured on slopes steeper than 10H:1V).
4. A geocomposite drainage layer.
5. A minimum three-foot thick protective layer overlaying the low permeability layer, with the uppermost six inches consisting of soil suitable for vegetation.
6. A vegetation layer.

The final cover system shall cover the entire landfill unit and connect with the bottom liner system. A typical cross section of the proposed final cover is shown in Drawing No. D18, and the contours of the final landform are shown on Drawing No. D9. As shown on Drawing No. D15, the low permeability layer of the final cover will connect with the bottom liner system. The slope of the final cover will be a minimum of 10 percent, with typical sideslopes of 4H:1V. The following text provides a more detailed description of each layer within the final cover system.

Low Permeability Layer

The low permeability soil layer will have a constructed hydraulic conductivity of $1 \times 10^{-7}$ cm/sec or less. The low permeability soil layer will be placed and compacted in lifts. Each soil layer will be uniformly placed with roots, cobbles, debris, organic, and other deleterious material removed prior to compaction. Additionally, the final surface will be inspected prior to geomembrane installation to ensure that no rocks, roots, or other objectionable items are exposed on the cover surface. All construction will be conducted and documented in accordance with the procedures outlined in the Construction Quality Assurance Program located in Appendix O of this application.

Geomembrane Layer

A 40-mil high-density polyethylene (HDPE) geomembrane will be included in the composite final cover system for the facility. The material specifications for the 40-mil geomembrane liner material are included in Appendix O of this application. The geomembrane layer will serve as an impermeable barrier against infiltration of moisture through the final cover into the landfill as well as a barrier preventing landfill gas from migrating out of the landfill. Double-sided textured HDPE will be used on all slopes 10H:1V or steeper.
Geocomposite Drainage Layer

Overlaying the geomembrane layer is a geocomposite drainage layer. The geocomposite drainage layer consists of a geonet (drainage net) sandwiched by two non-woven needle-punched geotextiles. The geocomposite drainage layer will discharge at the toe of the final cover. The geocomposite will remain free-draining, as demonstrated in Appendix J of this application. The end of the geocomposite drainage layer will be protected, as shown on Drawing No. D15. The material specifications for the geocomposite material are included in Appendix O of this application. The geocomposite drainage layer will serve two purposes. The first is to lower the hydraulic head acting on the final cover and therefore enhance the slope stability of the final cover and minimize the ability of water to seep through the geomembrane. The second purpose is to provide a cushion layer between the geomembrane and the protective layer. The geocomposite will be installed and tested in accordance with the requirements of the Construction Quality Assurance Program detailed in Appendix O of this application.

Protective Layer

A protective layer consisting of a minimum of 36-inches of soil will be placed over the geocomposite to protect the underlying layers from frost, desiccation, erosion, and penetration by roots or vectors. On-site material will be supplied for use in constructing the protective layer. The uppermost six inches of the material will consist of soil capable of supporting vegetation. The protective layer will be tested and placed in accordance with the requirements detailed in the Construction Quality Assurance Program, Appendix O of this application.

Vegetative Cover

The vegetative cover planned for the Landfill No. 3 is intended to protect the final cover from wind and water erosion, as well as to minimize run-off and maximize evapo-transpiration. The vegetative cover will be placed after completion of the protective layer at the appropriate time for successful germination and growth.

The vegetative cover will consist of a variety of grasses that will: 1) protect the soil surface against erosion; 2) not interfere with the integrity of the low permeable layer; 3) increase evapo-transpiration thereby minimizing infiltration into the landfill; 4) provide for sufficient stormwater management; 5) establish a diverse grassland habitat; and 6) improve the appearance of the final land surface. The vegetative cover will be established in accordance with Specification Section 02900 (Turf Establishment).

Time of planting is a critical factor in successful establishment of plants from seeds. Seed will be planted at the appropriate time for successful germination and growth based on soil temperature and precipitation, to be determined each year at the time of planting. Generally, seed will be planted in the spring or late summer/early autumn. Mulch and/or erosion control blankets will be applied as needed to control erosion and enhance vegetation establishment.

Final Cover Construction and Maintenance

The final cover will be constructed in accordance with the construction quality control guidelines outlined in the comprehensive Construction Quality Assurance Program (Appendix O of this application). The low permeability layer of the final cover system will be constructed no later than 60 days after placement of the final lift of solid waste. The final protective layer will be placed as soon as possible after placement of the low permeability layer to prevent desiccation, cracking, freezing or other damage to the low permeability layer. The final protective layer will
be 36-inches thick. The maximum depth of frost penetration at the site is approximately 36 inches\textsuperscript{2}. However, experience with liner and cap construction in Illinois indicates the frost depth is substantially less. The final protective layer is therefore sufficiently thick to prevent frost penetration into the underlying low permeability layer. Cover maintenance will be performed as necessary to maintain the final cover to meet the design objectives.

**Cover Percolation**

After placement of final cover, virtually all of the precipitation which falls on the landfill will be diverted into the stormwater management system. Controlled runoff, evaporation, evaportranspiration, and barrier layers will minimize percolation through the final cover system.

**Final Landform**

Suitable grasses will be used for the vegetative cover, which will provide erosion protection. The grass seed mixture that is selected will be amenable to the soil quality/thickness, slopes and moisture/climatological conditions that exist and will not require significant maintenance. The seed mixture will be selected to protect the low permeability liner system from root penetration. Generally a protective layer that is 450 mm (17.7 in) to 600 mm (23.6 in.) is adequate to protect against root penetration\textsuperscript{2}. Since the protective layer will be 36-inches thick and the grass seed mixture will be carefully selected, the protective layer is deemed more than adequate to prevent root penetration from occurring in the low permeability layer. Long-term management of grassed areas will require regular mowing. Fertilizer, lime, and mulch will be used at rates necessary to establish proper growth of the seed.

The maximum elevation of Landfill No. 3 will be approximately 804 feet above MSL. The gentle slopes of the landfill top are proposed to be constructed no flatter than 10 percent to promote drainage from the top of the landform, allowing for differential settlement. Landfill No. 3 will have maximum slopes of 4H:1V on the sideslopes.

Terrace ditches and lined terrace downslope ditches and/or letdown culverts will be incorporated into the final slopes to further minimize erosion, as described in the Stormwater Management Plan in Section 2.4 of this application.

**Landfill Gas Management**

Landfill gas is a natural byproduct of the decomposition of waste in a landfill. Landfill gas contains methane and other trace constituents. When captured for reuse, landfill gas is an important source of renewable energy. Landfill No. 3 includes systems to monitor and manage landfill gas.

Both below grade and above grade air monitoring will be provided at the facility. The landfill gas monitoring probes and detection devices will be constructed/installed in accordance with all applicable federal and state requirements. A detail of a typical monitoring probe is included on Drawing No. D18 and the proposed conceptual landfill gas management system is shown.


on Drawing No. D11.

The low permeability composite bottom liner and final cover systems minimize the potential for landfill gas to migrate from the waste boundary. Landfill gas will typically migrate through the most permeable zones within the landfill waste, and will be less likely to migrate through the low permeable liner and cover systems. The landfill gas will typically migrate through pathways in the waste, flowing toward a landfill gas extraction well.

An active gas collection system will be installed to collect and control landfill gas no later than five years after the landfill first accepts waste. At a minimum, the proposed landfill gas system will collect gas and destroy methane and other constituents, reducing the potential for odors and greenhouse gas emissions. The landfill gas is planned to be recovered for reuse as energy when a sufficient volume of landfill gas is available and a suitable end user is identified. A detail of a typical landfill gas extraction well is shown on Drawing No. D21. Landfill gas extraction wells will be fitted with a pump to remove leachate as necessary to ensure adequate landfill gas extraction.

Landfill Gas Composition

Landfill gas quality is an important determinant of the end use for collected landfill gas. Landfill gas results from the decomposition of the waste, and therefore the quality of the landfill gas produced depends almost exclusively on the decomposition process. Landfill gas quality is different at each landfill, and will also vary at different stages during the design life of a given landfill. In order to more fully appreciate how landfill gas quality will vary, it is important to understand the waste decomposition process.

The biological and chemical decomposition of solid waste results in the formation of heat, leachate, and landfill gas. Decomposition will begin soon after the waste material is placed in the landfill. The rate of decomposition will be affected by the availability of moisture, the physical and chemical characteristics of the waste, and the availability of oxygen. Waste decomposition passes through three phases, beginning with aerobic decomposition and proceeding to a two-phase anaerobic decomposition.

Initially, aerobic decomposition will take place with the principal by-product being carbon dioxide. Aerobic decomposition requires oxygen to continue. Modern landfills are designed to keep oxygen out as a method of fire control. Therefore, as the finite amount of oxygen within the waste is depleted, anaerobic decomposition will begin to take place. During the first phase of anaerobic decomposition, carbon dioxide is again the principal gas generated. Once the first phase of anaerobic decomposition is completed, the second phase of anaerobic decomposition begins. This decomposition results in the generation of methane (CH₄) and carbon dioxide (CO₂), as well as trace amounts of nitrogen, hydrogen sulfide, and other non-methanogenic organic compounds (NMOCs). The typical composition of landfill gas generated at a conventional sanitary landfill during this second phase is summarized in Table 2.3-2.
**TABLE 2.3-2**  
TYPICAL COMPOSITION OF LANDFILL GAS

<table>
<thead>
<tr>
<th>Landfill Gas</th>
<th>Component Percentage* (Dry Volume Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane (CH₄)</td>
<td>45% to 65%</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>35% to 55%</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>1%</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>1% to 4%</td>
</tr>
<tr>
<td>Other Constituents</td>
<td>1%</td>
</tr>
</tbody>
</table>

* Reference the Solid Waste Handbook, 1986

**Quantity of Landfill Gas**

The rate of landfill gas generation is dependent upon the waste decomposition process, which is controlled by many factors including moisture availability, waste composition and availability of oxygen. Diversion of paper, aluminum, plastics, and landscape waste may also have an effect on the generation of methane. The total quantity of landfill gas that will be generated can be estimated based on measurements of gas quantities at existing conventional landfills. Actual monitoring of the landfill gas at Landfill No. 3 will verify the quantity and quality of the landfill gas.

The quantity of landfill gas that is generated also depends on the quantity of waste being decomposed. The rate of waste decomposition and landfill gas production is primarily controlled by the moisture content of the waste. The most significant landfill gas generation rates occur when moisture in the form of leachate flows through the waste, transporting the bacteria and nutrients necessary for decomposition. This movement of leachate through the waste occurs only when the moisture content of the waste is above field capacity or when infiltrated moisture passes through preferential pathways that may exist in the waste. The final cover of the landfill has been designed to minimize the infiltration of moisture into the waste after closure.

Typically, generation of significant quantities of landfill gas occurs for a period of thirty to forty years after placement. An active landfill gas collection system will be constructed to manage (and potentially reuse) landfill gas once sufficient quantities of landfill gas are detected.

**Landfill Gas Collection**

Landfill gas generated by Landfill No. 3 will be controlled in accordance with all applicable current and future regulations, including the Clean Air Act New Source Performance Standards (NSPS) and 35 Ill. Admin. Code requirements. The gas collection system and all associated equipment will be part of the facility. Under no circumstance shall the gas collection system comprise the integrity of the liner, leachate collection system, or final cover system.

The gas collection system shall be designed and constructed to function for the entire design period and be able to accommodate changing gas flow rates or compositions. Drawing No. D11 illustrates conceptual extraction well locations for Landfill No. 3, and Drawing No. D21...
shows a typical extraction well for such a system. The gas collection system shall be operated until the waste has stabilized enough to no longer produce methane quantities that exceed allowable concentrations in Section 811.311(a)(1-3). The IEPA will be notified if methane gas levels have been exceeded.

A vertical gas extraction well spacing with a radius of influence of 100 feet is currently anticipated. The actual well locations will be determined based on field monitoring once the landfill is operational. The landfill gas collection and control system will be installed in stages as landfilling progresses. Depending on landfill gas quality and quantity, the system will be installed in order to control gas from areas in which waste has been in-place five years or longer. The landfill gas collection and control system will be operated until such time as the landfill gas generation rate exceeds thresholds established by the IEPA and USEPA.

An interconnected piping system will transport the extracted landfill gas to a central location for processing at a landfill gas flare, gas-to-energy facility or other approved method of processing depending on the landfill gas quality and the prevailing technology. A minimum 6” solid HDPE pipe will be used. However, all header pipes will be properly sized to accommodate the landfill gas quantity. The gas header pipes will be sloped to drain condensate to either condensate driplegs within the landfill waste, or to condensate traps located outside the waste boundaries. Condensate traps located outside the waste boundary will be double-walled with leak detection. Condensate that is collected in the traps will be pumped into either the leachate tank(s) or separate condensate storage tank(s). All underground condensate transmission pipe will be double-walled. All condensate storage tanks will incorporate secondary containment. The exact number and locations of condensate traps and driplegs will be established to ensure that condensate is well managed. Condensate that is collected will be stored and managed as leachate.

PCCLI plans to beneficially use landfill gas from Landfill No. 3 once sufficient quantities of gas are generated. A detailed landfill gas-to-energy system design meeting the requirements of 35 Admin. Code Section 811.311 and 811.312 will be submitted to the IEPA for approval prior to development.