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ENVIRONMENTAL CONSULTATION & REMEDIATION

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VIA FedEx Overnight

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Re: Clinton Landfill #3
TSCA Permit Application

KPRG Project No: 10110

Dear Mssrs. Gonzalez and Johnson

KPRG and Associates, Inc. has reviewed the permit application submitted by Clinton Landfill, Inc. of Peoria, Illinois. KPRG was retained by the Mahomet Valley Water Authority ("MVWA") a public water authority created by Illinois Law. We are concerned that the proposed hazardous waste landfill may pose a threat to the Mahomet Aquifer – the main source of drinkable water for the Mahomet Valley. Our hope and intention is to assist you in your evaluation of this permit application.

Executive Summary

The application for Clinton Landfill Number 3 gained IEPA approval based on simulations created by a program that is very limited in its capabilities. The simulations, and data and analysis provided to the USEPA, largely ignored these limitations except to the extent the limitations were exploited for the benefit of the applicant. Most notable of these failures is the lack of calibration, absence of fundamental hydrogeologic data, and lack of evaluation of lateral migration.

Additionally, site specific, reasonable and meaningful hydrogeologic data is lacking. The perceived hydrogeology is just that – perceived. The evaluation assumes much but is based on little more than inapplicable speculation. What is necessary is a more detailed review in light of known geologic and hydrogeologic systems at the site. This accurate understanding must then be applied to a three-dimensional groundwater model. The evaluation of the model must be expanded both in terms of time and distance. Failure to perform this most basic evaluation will result in a failure to identify potential threats to human health and the environment.

Introduction

KPRG's project team performed a technical review of the geologic and hydrogeologic portions of applications filed for the Clinton Landfill No. 3 expansion in DeWitt County, Illinois. This review focused on the application for a chemical waste disposal facility within the footprint and airspace of the proposed expansion of the Landfill No. 3 facility. Our review has identified several issues that should be of concern to, and be considered by, the United States Environmental Protection Agency (USEPA) in reviewing the pending application. The following sections describe the proposed site and landfill characteristics, and detail concerns identified in our review.

Site Geology
The important geologic units beneath Clinton Landfill No. 3 are the layers of glacial (ice age) sediments that lie between the land surface and the bedrock beneath those sediments. These sediments were deposited by multiple advances of glaciers. These sediments are of different ages, different origins, different soil types, different thicknesses, different properties, and different levels of modification and weathering.

The glacial sediments are important to the pending permit application for multiple reasons. First they are the foundation upon which the landfill is built. They form the sediments against which the buried portions of the side-walls of the landfill presently lie. The glacial sediments also provide the pathways for migration of landfill contaminants away from the landfill in gaseous and/or liquid form. They contain the water resources that are used by individual households and by public water supplies to meet personal, agricultural and industrial needs (Shaw 2005, Appendix E.3 and Shaw 2009, Attachment 1). They provide the storage capacity and migration pathways that allow precipitation to renew water resources. The glacial sediments provide a limited capacity to mitigate and absorb damage induced by human activities at or near the surface.

At this site, the glacial sediments at the ground surface are young sediments associated with the Wisconsinan glacial that ended about 12,000 years ago. The landfill location is near the southern terminus of this glacial advance and the sediments are relatively thin, a few tens of feet. Sediments of the Illinoian glacial advances underlie the Wisconsinan-aged sediments. The last of the Illinoian advances occurred around 125,000 years ago. These glaciers advanced substantially further south than the Wisconsinan glaciers and their preserved sediments are thicker than the younger units. Illinoian sediments were weathered, altered and eroded during the many millennia between the Illinoian and Wisconsinan glacial epochs. Weathering, cracking and the presence of significant sands within the Wisconsinan and Illinoian sediments facilitate significant movement of groundwater. This is verified in the vicinity of the site by the presence of many domestic water supply wells that produce water from these units (Shaw 2005, Appendix E.3).

Directly beneath the Illinoian glacial sediments is the Mahomet Aquifer, the oldest of the major unconsolidated sediments beneath this site. The gravel and sand of the Mahomet Aquifer is deposited in valleys carved in the underlying Pennsylvanian-aged bedrock, which consists primarily of shale and sandstone with some thin but significant beds of limestone and coal (Shaw 2005, Section 812.314.1). It is the lower part of the Banner Formation that was deposited about 500,000 years ago. The Mahomet Aquifer has been repeatedly penetrated by domestic water supply wells and in the Clinton well field at a depth of around 240 feet and it is typically 100 feet thick. The presence of domestic and municipal water supply wells that produce water from both the glacial sediments and Mahomet Aquifer establish that human are potential receptors of contaminants released from the Clinton Landfill.

Site Hydrogeology

Domestic water wells in the area are often completed in gravels and sands of the Wisconsinan and Illinoian glacial sediments. These local aquifers are sometimes fed directly by precipitation but are also usually recharged with precipitation that infiltrates from the surface through fractures and weathered zones within the fine-grained glacial sediments and through interbedded organic and peat layers. Occasionally private wells will penetrate to gravel and sand units within the glacial sediments below the Illinoian-aged sediments and into the Mahomet Aquifer.

The natural water table surface in the glacial sediments is unconfined and expected to form a subdued replica of the land surface. It will lie below the land surface in topographically high areas and decrease away from those areas to the elevation of Salt Creek. The water table provides the driving force, or potential, for groundwater flow. Under that potential, groundwater flow within the glacial sediments will come from areas of higher topography to areas of lower topography, primarily through pathways of higher conductivity. Groundwater typically recharges in areas of higher topography and discharges to streams or surface water bodies in areas of lower topography. At this site, the shallow flow direction is generally north to south, consistent with the surface topography toward Salt Creek to the south.

The Mahomet Aquifer serves as the major municipal and public water supply source across central Illinois between the Indiana border and the Illinois River (www.isws.illinois.edu/gws/mahomet.asp). Flow in the aquifer is generally from east to west, consistent with greater regional topography. Recharge to the Mahomet Aquifer originates from infiltration through the overlying glacial sediments, recharge from rivers locally where connections exist, subsurface flow from portions of the aquifer east of the Illinois River and some upward flow from bedrock near its regional discharge. The aquifer discharges into the Illinois River as base flow where the river is sufficiently incised. Head levels in the aquifer near Clinton are around 600 to 605 feet above mean sea level (ft-msl). Since the head levels in the Mahomet Aquifer are lower than the elevation of Salt Creek (approximately 635 ft-msl) and the heads measured in the glacial sediments under the facilities, some portion of the groundwater under the facilities migrates to, and recharges, the Mahomet Aquifer.

The base of Clinton Landfill No. 3 will be excavated into the glacial sediments to elevations as low as 665 ft-msl. The base of the excavation approximately coincides with the bottom of the Wisconsinan sediments and the top of the Illinoian sediments. The excavation at this level puts the basal liner(s) and the lower portions of the sidewalls of the landfills below the uppermost encountered water during the drilling of boring EX-14 which was recorded at approximately 672 ft-msl.and also below the heads recorded after well completion at location EX-14 (approximately 678 ft-msl) which screens the major water bearing strata at and near the base of the excavation over most of the footprint of the landfill.

If the landfill is constructed and operated in accordance with the pending application, the landfill would maintain an inward gradient (i.e. groundwater will flow from the outside of the landfill toward the artificially maintained low fluid level inside the landfill) as long as the leachate extraction system is properly operated and appropriately maintained. This configuration is a transient condition resulting from the operation of the leachate collection system. During the operating and post-closure periods, moisture brought in with the refuse, precipitation, and groundwater that penetrates the liner will sink to the bottom of the landfill and subsequently be removed via the leachate collection system.

Diffusion of contaminants through the liner will inevitably occur. The permit application contains no evaluation of the magnitude of contaminant diffusion through the liner system during the operating and post-closure period. The groundwater impact assessment considers diffusion only post-closure (i.e., the time at which the leachate collection system is turned off), assuming a "clean" system at the start of post-closure.

It is not until after the post-closure, leachate extraction and monitoring periods that the full potential for release of contaminants from the landfill into groundwater will develop. The Operating Plan takes great care to show that leachate head on the Chemical Waste Unit will be maintained at less than 12-inches during the operating life of the landfill. Leachate collected in the sumps will be removed for offsite disposal. Although the Closure and Post-Closure Care Plan suggests the landfill will be cared for "perpetually", there is no requirement for continued collection and removal of contaminated leachate after closure. Groundwater inflow through the liner and infiltration through the cap will begin to saturate the waste once the leachate collection system ceases to be operated. Leachate formed from the contact and interaction of this water and waste will saturate the waste to an equilibrium level, the level at which the amount of water flowing into the landfill equals the amount of leachate leaking from the landfill. The application includes no evaluation of the timing, magnitude or impact of these equilibrium releases. Consideration of the final equilibrium condition was not part of the permitting process and was not considered by the Illinois Environmental Protection Agency (IEPA). Therefore, evaluation of equilibrium releases will only be done if required by USEPA.

Evaluation

Adequacy of the Site Characterization

In theory, site characterization provides data from which an understanding of the site can be developed. From that understanding, the facility can be designed, constructed, operated, and monitored reliably.

The facility's performance can also be reasonably projected using computer simulations to assess likely impacts of the facility on proximal and local groundwater conditions into the near-term future.

This sequence is critical because the ultimate criterion for evaluation of a landfill application is the acceptance by IEPA of the facility's computer simulation assessments of the groundwater impacts (GIA). This is the computer projection of landfill impacts 100 feet laterally from the waste boundary 100 years after closure. It is the summary demonstration by the applicant that the landfill will not damage its surroundings beyond a level that is acceptable under the statutes and regulations. Construction of a calibrated, three-dimensional, numeric groundwater model is required in order to adequately investigate and interpret performance of the facility over the long term.

Without a proper sequence of characterization, the subsequent steps of site interpretation, facility design construction, operations and monitoring are not based upon site conditions. Similarly, the computer projections of the GIA are not defensibly based on either site conditions or an appropriately designed, constructed, operated, and monitored facility (i.e., unreliable or indefensible data input results in unreliable and indefensible data output).

The pending application lacks a proper characterization. The sequence for this application began with a presumed understanding of the site upon which the facilities were designed, are being or will be constructed, operated and monitored. Unfortunately it appears that data was forced into a pre-conceived site understanding or ignored when the data did not match this pre-conceived view. The facilities will be monitored by systems that are potentially inadequate to measure impacts. Additionally the applicant used "assumed" input data that varies from being unreliable to being known to represent improbable conditions. Specific examples of insufficiencies, inadequacies, or errors in the application are provided below:

Interpretive Errors and Inadequacies

- **Inattention to Wisconsinan Sediments** – The application ignores the significance of Wisconsonian Age glacial sediments with respect to the facility to be constructed. These sediments include obviously weathered till and sand and peat layers as much as 10 feet in thickness, not insignificant amounts. Although these sediments will be removed within the footprint of the excavation, they are also the sediments that will lie adjacent to the sidewalls of the landfill(s). They contain the water table that will rise and fall seasonally and provide the migration paths for contaminants that diffuse or flow from the landfill(s) laterally into undisturbed strata. These may provide unmonitored preferential pathways for contaminants to migrate.
- **Failure to Characterize Water Table** – Review of the boring logs included with the permit application shows that water-bearing sediments are present well above the screened intervals in the Lower Radnor Sand that is depicted as the uppermost water-bearing unit at the site. Likewise

no water table elevation data or water table maps are provided with the application. We have confirmed that your office, the USEPA, was never provided the water table data or water table maps. The groundwater flow direction and velocity at the water table have not been characterized. This is a significant deficiency of the permit application. The water table provides the fundamental driving force for groundwater flow and ultimately determines the potential impacts from this facility.

- **Improper Interpretation of Fine-sediment Properties** – The Landfill's pending application assumes that the laboratory data collected from boring samples of the fine-grained sediments represents the functional hydraulic conductivity of those layers within the glacial sediments under actual field conditions. This assumption is appropriate only to the degree that it a) is realistically likely and b) is supported by all data at the site. Based on knowledge of regional geologic/hydrogeologic conditions and application data review, neither condition is met. Hydraulically significant fracturing of glacial tills is the rule, not the exception in the midwest, and water moves faster and at higher volumes than laboratory data would suggests; contrary to the Landfill's assumption hydrogeologic data at the site (gradients, heads and head changes, saturations, field permeability testing, etc.) collectively establish that the fine-grained glacial sediments do not act as impermeable layers significantly inhibiting downward or lateral flow beneath or adjacent to the facility. The large increase in head level recorded in some wells (discussed below) which were not addressed or discussed in the application illustrates the applicant's lack of understanding of fine-grained sediments.

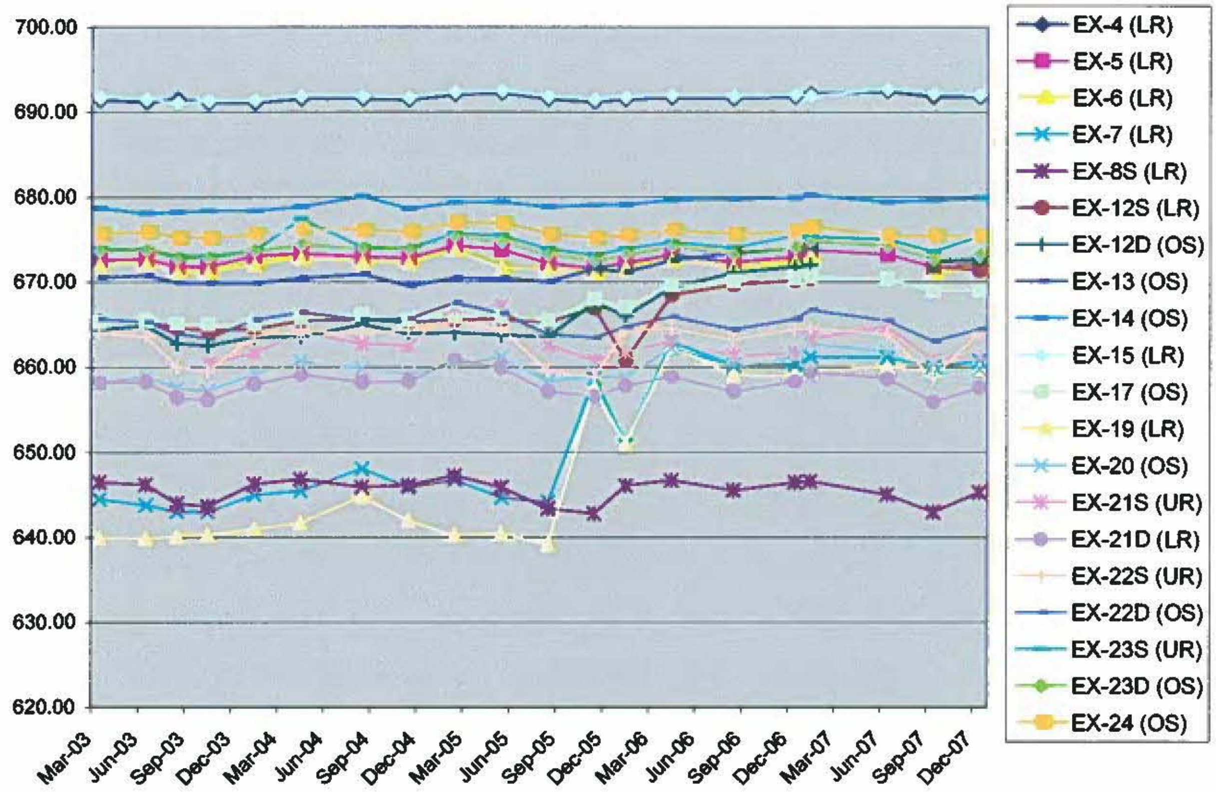
- **Poor Use of Constraints due to Data Depth** – A review of the mapped extent of the sands deemed important by the application shows an improper or inaccurate integration of the boring data. In particular, there are instances (e.g., wells EX-10, EX-26, EX-27, and EX-29) where wells that may have been too shallow to penetrate the Lower Radnor sand are interpreted as the sand having zero thickness at that location. An absence of data at a location is not evidence of an absence of the sand. This failure is yet another example of the Landfill's failure to submit an accurate representation of the proposed facility.

- **Inconsistent Interpretations of Flow Systems** – The flow of groundwater in the application is represented as isolated flow within separate, discrete aquifer layers. Contrary, the flow is interpreted as two-dimensional (i.e., strictly within the isolated layers). This ignores the significance of the vertical gradients documented in the data (both upward and downward), seasonal variations, systematic head changes related to site operations, thickness variations, areas where aquifers are absent, and correspondence between head levels in deeper aquifers and the shallowest saturation (first water) at a boring location. One extreme example of the Landfill's interpretation that is inconsistent with the site data is the mapping of potentiometric surfaces within aquifers as moving water directly across boundaries where the aquifers pinch out. If flow is restricted to occurring within the aquifer, there can be no flow across the zero line (Shaw 2005, Figures 812.314-19 and 812.314-27). Either the flow direction is wrong, or the map of the limits of the aquifer is wrong. Either way, the Landfill's failure to properly identify groundwater conditions will result in multiple subsequent errors in the application including but not limited to the not being able to properly detect or secure contaminants from migrating from the landfill.

- **Inappropriate Interpretations of Permeability Testing** – The interpretation of the slug test data acquired at the site is in consistent with the recovery character observed for the tests. Spot-checking the solution shown on the graphs does not reproduce the value reported. The recovery curves for the slug tests are characteristic of curves from a multi-porosity, multi-permeability system, like a combined system of permeable sand and fractured fine-grained tills. The curves are not consistent with a sand aquifer contained within non-permeable bounding beds. Therefore, any results from the evaluation of slug test data must be disregarded or at the very least discounted.

- **Insufficient Evaluation of Head Data** - Review of the groundwater head data supplied with permit application (see graph of heads below) shows that all monitoring wells located along the west and northwest boundaries of the Clinton Landfill (e.g., wells EX-7, EX-12S, EX12-D, EX-13, EX-17, and EX-19) for which head data was reported experienced rapidly rising heads commencing in late 2005 and 2006 while the remaining monitoring wells remained nearly static. This is an unusual occurrence that is completely unaddressed in the permit application.

  To identify the cause of the increase in heads, readily available aerial photographs of the site were reviewed. It was observed that what appear to be storm water retention ponds, associated with construction on adjacent portions of the Clinton Landfill, had been constructed near the west and north perimeters of the permit area. If these ponds are the source of water causing the localized rise in heads, the glacial sediments when the proposed Chemical Waste Unit are capable of readily transmitting groundwater in a flow system that is significantly different than that described in the permit application. This casts doubt on the entire site characterization and resulting GIA in the Landfill application.



<u>*Monitoring Inadequacies*</u>

- **Directions and Rates of Flow** – The hydrogeologic data provided with the application includes a 4-year snapshot of monitoring wells. It is noteworthy that several of the wells showed noticeable -- and in some cases dramatic -- changes in groundwater head which are reflected in changes in the direction and velocity of groundwater flow. Without detailed evaluation and explanation of this, the applicant cannot reasonably infer the range of hydrologic conditions associated with existing or future conditions at the site. From this lack of examination and understanding the USEPA cannot, reasonably assess varying levels of risk to the public health, safety and welfare.

  The groundwater monitoring system proposed for the facility is laid out under the premise that flow rates and directions inferred from the original groundwater head levels are representative of the flow rates and directions that will exist after the Chemical Waste Unit is constructed. That assumption is flawed and does not even apply to the existing heads and resulting contemporary flow system. The flow system will change further as a result of the construction of the landfill – it inherently must and has shown that it will change – and the groundwater monitoring system(s) must be laid out in a manner that is consistent with the anticipated new flow regime to successfully document landfill performance.

Quantifying the extent, location and magnitude of flow regime changes that will result from the expansion to the degree necessary to design a groundwater monitoring network capable of demonstrating protection of the public health safety and welfare, requires a full 3-D numerical groundwater flow model calibrated to existing conditions and verified to transient seasonal variation or, if available, earlier historic data. The application suggests two material changes to the existing flow system (from construction) that would be expected at this site. The first is change to the lateral flow patterns in response to the insertion of the landfill mass into the horizontal flow system in the unconsolidated sediments. The second are the changes to the vertical component of the flow system that will occur as a result of depriving additional (landfill and Chemical Waste Unit footprints) acres of their existing recharge. These were not considered in the application and are discussed below.

In comparison to the existing unconsolidated sediments, the volume of the landfill mass encased in the basal liner would function as a barrier to horizontal groundwater flow. A low-permeability barrier inserted into a horizontal groundwater flow system has an impact directly analogous to dropping a boulder into a flowing stream. Water that previously could flow through the aquifer volume now occupied by the landfill either cannot flow or must find a new path around the obstacle. Like the boulder, the landfill will create a bow wave with divergent flow upgradient (upstream) and there will be convergent shadow downgradient (downstream) of the landfill.

Vertical flow at this site is demonstrably important to understanding conditions and monitoring post-construction conditions. With the exception of the well cluster located nearest Salt Creek, the hydrogeologic data with the application provide evidence of predominantly downward vertical gradients across most of the existing facility and the expansion areas. The hydrogeologic characterization in the application completely fails to assess the significance of this downward driving force, the magnitude of the downward flow in response to it, its significance to the overall flow of groundwater under the proposed landfill, and its implications upon monitoring the post-construction hydrogeologic system that will control contaminant migration.

The full, properly designed and calibrated, three-dimensional numerical groundwater model suggested above, including a GIA evaluating the final equilibrium condition after post-closure, would appropriately evaluate this potential deficiency and the ability of the proposed monitoring system to adequately detect releases into the groundwater flow system that has been modified by construction of such an extensive barrier to existing groundwater flow. Insisting upon such modeling and evaluation would allow USEPA to make an informed determination that is based upon demonstrated performance and sound scientific principles – rather than simple acceptance of hopeful projections and assumptions by the applicant.

- **Verification of HELP Simulations** – The Site Location Application presents considerable detail about expected leachate generation rates derived from use of the Hydrologic Evaluation of Landfill Performance ("HELP") model. The HELP results are presented by the permit applicant without any calibration and without a monitoring program that provides verification of the assumptions and simulated results. Careful monitoring and reporting of the volume and chemistry of leachate produced in the Chemical Waste Unit, would provide near real-time verification whether the landfill is or is not performing to the planned specifications. Departure from the HELP performance projections would allow design modification and/or remedial actions to be taken proactively, before a more significant contamination problem develops.

  In order to take advantage of the opportunity to monitor actual landfill performance, model simulations of monthly leachate generation in the Chemical Waste Unit should be submitted for both the operating and closed conditions. The USEPA should also require monthly reporting of the volume of leachate pumped. Comparison of HELP-predicted rates to the actual leachate generation rates would indicate whether individual cell liner and cover systems are functioning as assumed in the HELP simulations.

- **Leachate Production and Internal Head Monitoring-** The Environmental Monitoring Plan calls for leachate samples from the Chemical Waste Unit to be collected and analyzed on a monthly basis during site operation. This monitoring should be expanded to include the post-closure period as well. Tracking the chemistry of leachate, in parallel with fluid production described above would allow regulators to identify unexpected changes that signal breeches or construction flaws in the landfill liner or cover systems and allow for timely implementation of remedial measures.

  The Landfill applicant should also install piezometers within the Chemical Waste Unit in order to assure accurate measurement of leachate elevation. Piezometers would also allow ready detection of leachate buildup in the landfill if the geotextile fabric and/or filter material in the leachate collection systems became bio-fouled or plugged with sediment during or after the leachate extraction system is operational.

- **Perimeter Monitoring-** Effective perimeter monitoring can only occur if the monitoring occurs at locations and times where contamination will occur. As discussed above, the monitoring locations currently planned at depths below the landfill invert are located not based on the flow system that will exist after the facility is in place. Perimeter monitoring must also be installed laterally along the sides of the landfill to verify no unacceptable leakage from the sidewalls. This monitoring must include groundwater pathways in saturated sediments and soil gas pathways in unsaturated sediments.

- **Sub-Landfill Monitoring-** The post-construction site will virtually eliminate recharge over the footprint of the landfill(s). However, recharge will continue as it does currently outside that footprint. That change in the distribution and quantity of recharge, coupled with the downward vertical gradients across most of the site, will result in lateral convergence of flow from the flanks toward the facility and downward under it. Perimeter monitoring will simply observe the water moving toward the landfill, not water flowing away from the landfill. As proposed the only contamination that might be observed would be diffusive transport outward that exceeds flow transport toward the landfill. For meaningful monitoring in the significant paths of flow, the operator must also monitor under the landfill, not just around its flanks.

- **Duration of Monitoring-** Throughout the period of landfill operation and during the nominal 30-year post-closure care period, the landfill owner is required to maintain and operate the leachate collection system and monitor groundwater to detect releases. Barring catastrophic liner or cover failure or improper construction, continuing operation of the leachate collection system will maintain the inward groundwater gradient discussed in the application.

  When the post-closure care period expires, infiltration of groundwater through the liner and precipitation through the cap will continue but leachate will no longer be removed. Leachate will then, 30-years after site closure, begin to accumulate in the closed cells, initially at the sumps and then flooding progressively higher in the waste and progressively further up the slope of the individual cells away from the sumps. Leachate will saturate the waste to an equilibrium level at which the amount of water flowing into the landfill equals the amount of leachate leaking from the landfill. The process of saturating the waste to the equilibrium point may take additional years depending upon the failure rates of the liner and cover, but saturation of the waste is inevitable. At that equilibrium point in the future, when the potential for significant releases from the landfill is highest, regular sampling of the monitoring wells is no longer required by IEPA. Without additional USEPA-imposed monitoring requirements, the first notice that leachate levels have risen, that outward flow has begun, or that groundwater is being contaminated, will be contamination of an area water supply well or surface water body. Thus, the USEPA should require:

  1) A review of the groundwater flow and monitoring systems at the landfill be conducted upon closure of the landfill and at 5-year intervals thereafter until equilibrium conditions, both inside and outside of the landfill, are established to verify the monitoring system continues to be capable of detecting a release; and

  2) Monitoring of the functioning groundwater monitoring system continues for a minimum of 30-years after equilibrium conditions are verified. Extension of the post-closure care monitoring period in this manner will provide the public a level of assurance that its health, safety and welfare are being protected.

Evaluation of Impacts to Groundwater

Impacts to groundwater were assessed by the permit applicant using the MIGRATE program. The validity of the results of the MIGRATE simulations are not defensible for each of the problems in hydrogeologic characterization that are described above. However, beyond the problems with inputs to the program (identified above), there are other weaknesses to this GIA related to the choice of the program, the design of the simulations, and the conditions being simulated. Even if the above noted characterization problems were eliminated, the simulations run by the permit application would not produce meaningful results due to the following deficiencies:

Limitations of MIGRATE

- **Model Cannot Be Calibrated** – The model is deterministic. The projections of future concentrations assume the input flow systems are correct; there are no provisions within the model to either verify that or to use the model results to improve the input. The model does not compute flow paths, head values, head gradients, discharge rates, or changes of any of these against which to check observational data. The inability to calibrate MIGRATE robs the user from the opportunity to perform a critical check of validity of model inputs. Without calibration, there can be no check of modeled conditions against actual field conditions. If there are unidentified erroneous inputs, the model will generate a meaningless calculation that does not reflect known conditions and does not predict future impacts.

- **Simulation Does Not Use Fundamental Hydrogeologic Data** – The input to the model does not include head data, permeability data, or spatial variations in such data. The user provides a single specific flux value for vertical flow and a single specific flux value for horizontal flow. Developing these flux values for input must be done outside the model from the appropriate data. Proper reduction of the fundamental hydrologic data is imperative for MIGRATE to render a model that reflects the hydrogeological conditions at this site and to project future impacts. As developed the model used to support this application is not capable of simulating or even remotely resembling actual site conditions.

- **Mass Balance is not a Constraint** – The model does not confirm the flux values that are input for consistency or mass balance. For example, twice as much water can be designated as entering a layer as is leaving the layer and there is no resulting impact, such as head increases, because heads are not part of model input or model computation. Similarly, twice as much water can be defined as leaving a layer as entering the layer, and the layer does not go dry. Further, the model does not consider changes within a layer as water is added or removed along a flow path. These failures result in erroneous model values.

- **Model Simulates only 2-D Slice** – The equations that are solved assume infinite homogeneous and isotropic conditions exist at right angles to the slice that is simulated.

- **Model Layers are Infinite and Invariable** – There can be no changes to the parameterization of a layer in the model. If a vertical flux of 6 inches per year enters Layer 2 at one point, it enters at that rate everywhere in the model. If the water flowing out of the layer horizontally is 12 inches per year, the horizontal flow is 12 inches per year everywhere along it, regardless of water that is specified to be flowing into or out of it vertically. One implication of this is that the specified conditions of liner properties and liner fluxes appropriate for flow through the liners are also assigned outside the landfill where conditions are known to be dramatically different. Again, this is an inaccurate characterization, results in an incorrect representation of conditions renders the erroneous model predictions, and fails properly to assess potential impacts.
- **Baseline/Background Concentrations Cannot Be Set** – The model assumes that there is zero concentration of a contaminant outside the landfill at the start of the simulation and that only the landfill is a source of the contaminant. While this assumption is perhaps appropriate for strictly anthropogenic compounds, it is not a valid constraint for any compound that is also naturally occurring or that exists in background due to a pre-existing source, such as is common in agricultural communities.
- **Only Vertical Migration from Landfill is Simulated** – The model can only simulate contamination migrating downward from the base of a landfill. Lateral migration from the flanks cannot be simulated, nor can such lateral contamination be simulated as migrating downward with groundwater flow - as is observed and documented at this site.

Design of the GIA Simulations

- **Simulations Only Evaluate Landfill Half-Space** – The simulation is structured to look only at the results of contamination from the center of the landfill to the downgradient edge of the landfill. With respect to early migration and migration through the clay liners, contamination migration is dominated by diffusion which knows no upgradient and downgradient limitations. Further, this spatial perspective does not allow simulation of the Municipal solid waste landfill that will be upgradient of the chemical waste facility. Contamination from the chemical waste facility will add to that from the municipal facility. This failure again results in inaccurate results from the model.
- **Simulations Only Evaluate Zone of Attenuation** – The simulation is structured only to look at the first 100 feet from the waste boundary. The model should be structured to allow simulation of the system at greater distances. Simulations that look at the solution at greater distances often reveal problems in the inputs to the numeric parameters at distances greater than 100 feet. That check is not possible as the model is structured for this GIA.
- **Simulations only Evaluate 100 years Post-Closure** – The simulations for this GIA are limited to 100 years post-closure. If the landfill is built successfully to its design, that period of time will largely be a period of refilling to bring the system back to equilibrium. To establish risks from the facility, simulations need to be run to determine the approximate time when the landfill reaches

equilibrium conditions. Additional simulations would then be necessary to consider the eventual and permanent condition of outward flow for at least 100 years after equilibrium conditions are reached.

- **Simulations Ignore Vertical Flow in Soils** – The Landfill Applicants' simulations do not include the observed vertical flow in the glacial sediments at the site.
- **Simulations Preclude Vertical Flow below Uppermost Aquifer** – The Landfill's simulations do not allow any penetration of contamination below the upper-most sand.
- **Simulations Ignore Overlying and Adjacent Municipal Landfill** – The simulations assume the chemical waste facility is a facility with nothing around it. The concentrations used as source terms do not recognize the potential of municipal leachate impacting the leachate in the chemical waste unit. The simulations do not consider the impacts of contaminant migration from the municipal landfill to groundwater that is upgradient of the chemical waste landfill, contamination to which the latter facility would add.
- **Sensitivity Simulations Test Single Parameters** – The sensitivity runs that were made are not meaningful from the standpoint of hydrogeology. Accepting for the sake of argument that inputs to the base case did represent parameters appropriate to a well-characterized and calibrated understanding of the site hydrogeology, the purpose of the sensitivity runs is to determine whether the results vary significantly if there are errors in that original interpretation. That cannot be done by taking a single parameter and changing its value. Doubling the hydraulic conductivity for example is unrealistic and unreliable unless a corresponding change is made to other parameter(s), such as recharge, such that the input set still describes a calibrated system. Sensitivity runs of single parameters require a demonstration that the variation maintains a modeled domain with parameterization that is at least possible. Without such demonstration, as was done with this implementation of MIGRATE, runs potentially simulate systems that cannot exist. Such modeling does not provide indications of meaningful uncertainties in fate and transport.

Hydrogeologic Conditions for the Simulations

- **Flow Directions Simulated Are Not Possible** – The orientation of the model slice needs to be parallel to the direction of horizontal flow. As discussed in earlier comments, flow directions are mapped in a manner inconsistent and physically impossible with respect to the mapped distribution of the sands.
- **Vertical Fluxes Simulated Are Unsupported by Data** – The vertical fluxes that are used in the simulations are not representative of the vertical fluxes observed in site data. First, the vertical fluxes used by the applicant ignore vertical flow through the glacial sediments and are simply assigned at all layers as the hypothetical flow leaking through the landfill liner - a rate far less than the flow through the glacial sediments. Second, the model assigns a no-flow, no-diffusion

boundary at the base of the sand being simulated. This precludes evaluation of further downward migration in a system dominated by vertical from the surface to the Mahomet Aquifer.

- **Pre-Construction Flow Is Simulated** - As discussed above, the evaluation of the flow directions and hydraulic gradients is based upon pre-construction head readings at the various wells. Even at this point, significant differences have developed as a result of construction activities. Further changes will occur from additional construction as more area is put under the footprint of liners and as surface water is re-routed. Meaningful fate and transport modeling can only be done using the best understanding of the post-construction hydrogeology that will control post-construction migration. No attempt has been made to develop an understanding of that controlling system.

Additional Review Notes

As part of the general/overall review of the provided, KPRG has identified several additional deficiencies, errors, and points of concern. These issues are summarized below:

- The copy of the CQA Report and Certification by SKS Engineers, Inc. dated March 2007 provided was incomplete and out of order.

- In Attachment 5, Section 6 - the calculated field permeability average was incorrect. SKS incorrectly calculated an average Boutwell field permeability result of 3.28×10^{-9} cm/sec versus the actual value of 9.82×10^{-9} cm/sec. This error results in a false conclusion that the horizontal field permeability could be calculated by multiplying the laboratory permeability by a multiplier of 2 when the actual multiplier was 0.334. Due to this error, SKS' calculation underestimates the horizontal field permeability.

- The January 2009 Slope Stability Analysis by the Shaw Group using the SLIDE modeling program analyzed only one mode of failure: foundation stability. However, given the proximity of the proposed Clinton Landfill No. 3 to the existing municipal solid waste landfill (plans ultimately call for one to "toe out" above the other), a complex failure mode should also be simulated. Such a complex failure could occur if one failure mode induces another. For example, a rotational or translational slide could induce a flow of or a fall failure of the foundation. Such two-part failure scenarios were not contemplated and the potential affects of the existing manmade landfill structure were not considered.

- Due to the stable chemical nature of PCBs, their potential to threaten groundwater resources extends past the stated monitoring period (34 years of active landfill use and 30 years of post closure). According to the US Department of Health and Human Services Agency for Toxic Substances and Disease Registry, there are up to 209 individual chlorinated compounds that are known as PCBs. Despite a wealth of research concerning these chemicals, their exact half lives remain unknown. However, studies by the USEPA and others of sediments in New York's Hudson River indicate PCBs have the potential to persist in soils and sediments for more than 60 years. Therefore, the proposed monitoring period is inadequate to protect area potable water supplies.

- A possible conflict of interest was noted in that Peoria Disposal Company (PDC), the proposed landfill's owner, appears to be planning to use its subsidiary, PDC Laboratories, Inc., to analyze quarterly, semi-annual, and annual groundwater samples. In KPRG's opinion, the analysis should be conducted by an independent laboratory with no affiliation or shared interests with PDC.

- The Appendix D drawing from the January 2009 Additional Information on the LFG Management System was missing from the attachment produced by USEPA.

Summary and Conclusion

The applications for Clinton Landfill No. 3, including the chemical waste cells, gained IEPA approval based upon computer simulations that estimated acceptable levels of contamination at the lateral compliance boundary 100 years after landfill closure. Those simulations were performed using a program that is extremely limited in its capabilities. The simulations performed largely ignored limitations of the software. The limitations of the software were seemingly exploited instead to generate acceptable results that do not reflect probable reality.

The partially biased implementation of the modeling software limitations is not the greatest problem with the GIA. The greatest problem is the failure of the applicant to produce a reasonable, meaningful, and representative interpretation of the site hydrogeology based upon the extensive degree of exploration and applicable data. Based upon the expressed understanding of the site, it is apparent that the expressed "understanding" is not unbiased interpretation – but rather is a statement of a preconceived notion or anticipation of the geology and hydrogeology. The results are simulations of possible fate and transport of contaminants from the chemical waste units, but without support from site data.

To meaningfully simulate the potential of the site to impact the surrounding areas, the characterization data must be reviewed in detail and interpreted into a geologic and hydrogeologic system that honors known geologic and hydrogeologic principles and actual site data. That new understanding of the site must then be conveyed into a three-dimensional numerical groundwater model capable of assessing impacts to groundwater in the vicinity of the landfill both laterally and vertically. That assessment needs be done at the 100-ft and 100-yr thresholds. But the assessment also must be performed at times and places that represent the maximum and/or most damaging to human health and the environment (i.e. after equilibrium conditions are established which will occur at some yet undefined time after leachate collection system shut-down). That new assessment should include an integrated assessment of the time(s) and place(s) of impact to the Mahomet Aquifer regardless of arbitrary regulatory timeframes.

On behalf of our project team, we invite you to contact us at any time should you have questions about this evaluation.

Very truly yours,

KPRG and Associates, Inc.

David G. Pyles, P.G.
Principal

cc: Mahomet Valley Water Authority