MEMORANDUM

TO: Gary Abraham

FR: K. Scott King, King Groundwater Science, Inc.

DATE: 26 July 2006

SUBJECT: COMMENTS ON GEOLOGY AND HYDROGEOLOGY
RMU-2 SCOPING DOCUMENT, CWM MODEL CITY FACILITY

Per your request, I have prepared the following comments with regard to geologic and hydrogeologic issues associated with the DEIS Public Scoping Document prepared by CWM Chemical Services, LLC, dated November 30 2005, and revised March 2006.

1. Although the description of geology and soils (Section 3.3) is a summary, it conveys a simplicity of site conditions which does not exist. The reality is that the overburden deposits above the bedrock are the product of at least three glacial advances and erosional episodes. Site investigations for earlier landfill expansions such as Wehran Engineering Corporation (1977) and the most recent hydrogeologic characterization (Golder Associates Inc. 1993) recognize subsurface complexity of the overburden. This complexity is particularly significant with regard to understanding the movement of groundwater and the optimal placement of monitoring wells. The presence of bedrock valleys, till ridges, and the distribution of coarser and finer grained geologic materials require that the subsurface unconsolidated materials should be considered to be complex.

2. The Glaciolacustrine Clay layer in the RMU-2 area is noted by CWM to be between 1 and 25 feet thick. This suggests significant variability and perhaps discontinuous "windows" in the clay. In CWM's TSCA Disposal Approval Request, the presence of this Glaciolacustrine Clay layer is highlighted as protecting the uppermost aquifer, or as a third containment system.[1] This "protection" is unlikely to be the case everywhere under RMU-2, if the clay layer thins. Additional site characterization may be required to determine this.

   Assessment of the natural protection that a clayey aquitard can provide to contaminant transport requires specific approaches. The topic of "aquitard integrity" in glacial overburden environments such as Model City has been the subject of much scientific research over the past 20 years. The integrity of the Glaciolacustrine Clay is not well-documented under the footprint of RMU-2. Aquitard integrity depends on three factors: i) hydraulic head distribution, ii) characteristics of the contaminant(s) and iii) hydrogeologic characteristics such as hydraulic conductivity, porosity and thickness. Specific methods and techniques are now available to hydrogeologists which can be applied to confirm that aquitards do actually have the degree of integrity required for groundwater protection.

   The site conceptual hydrogeologic model at Model City assumes very low migration rates of groundwater horizontally and vertically through the Glaciolacustrine Clay and Upper Till units based on a large number of field and laboratory hydraulic conductivity tests. However remnant discontinuities in the Upper tills caused the bulk vertical hydraulic conductivity to be one order of magnitude greater than assumed from testing (Golder Associates Inc. 1993). Since it is

[1] Toxic Substances Control Act (TSCA) Disposal Approval Request, Residual Management Unit 2, April 2003, p.6-1.

known that downward vertical hydraulic gradients exist over most of the site most of the time, the Glaciolacustrine Clay layer may be thin in places, vertical factures exist in the upper tills, vertical hydraulic conductivity may be greater than expected from testing individual samples and the potential contaminants from a hazardous waste landfill are of concern and will be present for a very long time, then aquitard integrity beneath the RMU-2 area could be less than expected.

The hydrogeologic investigation in support of RMU-2 should include specific testing of aquitards such as continuous coring instead of split-spoon samples to log geologic features, depth-discrete multilevel head monitoring within and across the aquitard, and careful sampling for specific chemistry markers, noble gases and/or isotopes that can provide essential information regarding relative age or past contact with the atmosphere. If groundwater flow velocities are as low as calculated, then it should be reasonably possible to prove this or provide bounding calculations. I am not aware that any of these techniques have been attempted at Model City.

3. Most of the Upper Clay Till layer under RMU-2 would be excavated and removed during construction, and would not provide any additional natural groundwater protection.

4. There is no discussion concerning the presence of sandy lenses in the Upper Till. This issue has been recognized and investigated by the U.S. Army Corps of Engineers at the nearby Niagara Falls Storage Site. This issue may impact the path that shallow groundwater (potentially contaminated by leachate) might follow under or from the landfill, and should be included in the characterization process.

5. The water table will likely occur at an elevation that is above the base of the proposed RMU-2 (elevation 305 according to Permit Drawings). Previous groundwater level measurements and inferred contours indicate the potentiometric surface in the Upper Till unit of el. 314 to 316 (Golder Associates Inc. 1993) and el. 312 to 316 (Golder Associates Inc. 1995). The proposed top of Operations Layer Grades are in the range of approximately el. 312 at the edges, to el. 324 according to the Permit Drawings. Inward hydraulic gradients will occur only if levels of leachate within the landfill can be kept less than those outside the liner, and in this case, very low. I could not easily find the design height for leachate on the liner in the permit application, but it would need to be minimal in order to maintain an inward gradient.

   The potentiometric surface in the Upper Tills is very irregular due to the existing landfills and ponds on the CWM property, causing groundwater to flow in many directions, even southward which is considered to be generally “upgradient” (Golder Associates Inc. 2006, Fig 4). This complicates the location of shallow monitoring wells and identification of surface water bodies where groundwater may discharge. There appear to be a lack of monitoring wells to the southeast and southwest that could provide additional lateral contouring support.

6. The proposed RMU-2 would occupy designated wetland areas which would require mitigation as appropriate.

7. Since the CWM property contains contaminated groundwater (known and perhaps unknown), any buried waterlines or other infrastructure should be constructed in such a manner as to minimize groundwater or vapor migration along the pipe or backfill.

8. Procedures for the proper abandonment of existing monitoring wells under the RMU-2 should be specified. In view of the large number of wells, boreholes and test pits from many previous investigations, it would seem reasonable to expect that not all were, or will be, sealed perfectly to

prevent downward migration of leachate. Therefore, an assessment of the consequences of multiple vertical preferential pathways to the lower aquifer should be included in the DEIS.

9. The site preparation list does not include the installation of new monitoring wells for RMU-2.

10. The low permeability soil at site does inhibit migration, but also makes remediation and monitoring difficult. The surficial till deposits contain vertical fractures which could make precise prediction of leachate migration and monitoring difficult. Although all areas impacted by RMU-2 were certified as "in compliance" by Department of Energy (DOE), there is some doubt that the DOE surface surveys were thorough enough to find all radioactive contamination, if present or buried, to meet current-day standards. An acceptable plan for excavating, handling and assessing soil in this area should be prepared by CWM to deal with potential radiation or other contamination if encountered. All excavated soil should be subjected to radiologic and chemical testing, and approved prior to use in the liner system. The source of materials to be used in construction should be defined, tested and approved to ensure that contaminated materials are not used in the landfill construction. This should apply to offsite sources as well.

11. The effect of the proposed cutoff wall on groundwater flow, and hence groundwater monitoring locations should be addressed. Since the wall is intended to be keyed into the Glaciolacustrine Clay, shallow groundwater flow in the Upper Tills will likely be diverted in some manner which should be determined to aid in proper monitor well placement.

12. Contrary to what is stated in the last sentence of Sec 6.5, the Model City area does not have a "low water table". It is actually near or at the surface during part of the year, and a depth range of 2 to 5 feet below grade is mentioned on P. 13 of the document.

13. Reference is made to the chemical resistance of the liner materials to chemical attack. I assume this refers to the HDPE geomembrane, which has been long accepted. But, there is no reference to leachate compatibility studies that have been performed with site leachate on the actual clayey materials that will be used at this site, or the bentonite slurry wall to surround the landfill.

14. Mean hydraulic conductivity values have been used to calculate low representative groundwater velocities. A probabilistic approach would be a much better way to include uncertainty and variability in the data, and recognize the role of thin highly permeable zones in groundwater movement. It should also be noted that the hydraulic conductivity (K) value often used as representative of the Glaciolacustrine Silt/Sand zone (an important monitoring target) does not include the highest values of K, which were estimated to be one to two orders of magnitude larger than the "representative" value (Golder Associates Inc. 1993, Tables 6 and 7). Some shallow "background" wells on the south side of SLF-6 and RMU-1 are actually downgradient of the waste due to the effect of the landfills on shallow groundwater.

15. The well spacing previously determined and justified in 1985 indicated that a 140 foot separation between monitor wells was suitable around RMU-1. A re-evaluation of this issue should be performed for the particular site circumstances of RMU-2 within the overall context of existing landfills. Any groundwater contaminant modeling should use more realistic values of dispersivity (i.e. lower), as plume dispersion in general is now known to be less than typically assumed twenty years ago.

16. The lengths of the well screens for monitoring wells were not specified in the Preliminary Groundwater Monitoring Plan Prepared in 2003. The maximum length should be restricted to 5 feet or less, and not be allowed to cover the entire thickness of the Glaciolacustrine Sand and Silt aquifer as currently proposed. Multi-level piezometers to measure potentiometric head within

and across the Glaciolacustrine Clay aquitard should be considered in order to confirm its integrity.

17. The issue of climate change has not been discussed and since the waste at this site will be in place "in perpetuity", an effort should be made to consider potential effects on the landfill using some assessment of variability. In particular, climate records were previously used to estimate a site water balance and resulting infiltration rates. Potential error, or sensitivity, of these calculations to future change should be addressed.

As a general comment, there has been considerable effort expended over the years at the CWM Facility to understand hydrogeologic conditions. Nevertheless, it is my opinion that a fresh perspective on site conditions is warranted and that the points made above should be considered in the assessment of the hydrogeologic suitability of the proposed RMU-2 landfill.

REFERENCES

Golder Associates Inc. (1993). 1993 Hydrogeologic Characterization Update, Model City TSDR Facility, Model City, New York, volume I to III.

Golder Associates Inc. (1995). 1994 Ground Water Level Interpretation, Model City TSDR Facility, Model City, New York.

Golder Associates Inc. (2006). 2005 Groundwater Interpretation, Model City, New York.

Wehran Engineering Corporation (1977). Hydrogeologic Investigation, Chem-Trol Pollution Services, Inc., Township of Porter and Lewiston, Niagara County, New York, Prepared for Chem-Trol Pollution Sevices, Inc.