GeoHydroCycle, Inc.

Hazardous Waste
Water Supply

Assessment
Remediation
Analyses
Permitting
Modeling
Software

April 17, 2015

Mr. Steven Ventresca, P.E.
Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

re: NGI Report: Groundwater Impact Analysis
Brem Property
100 Long Ridge Road
Carlisle, MA
GHC #14015

Dear Mr. Ventresca:

GeoHydroCycle, Inc. (GHC) is in receipt of a copy of the Northeast Geosciences, Inc. (NGI) report entitled *Groundwater Impact Analysis, Brem Property*, 100 Long Ridge Road, Carlisle, MA, dated March 25, 2015. This letter presents a summary of GeoHydroCycle's review of this report along with our comments and recommendations.

General

On December 30, 2014 GHC submitted a letter to you with comments and recommendations for hydrogeologic investigations to be conducted at Long Ridge Road to meet the requirements and regulations of the Town of Carlisle. Based on our review of the NGI report, the work does not provide a complete analysis of the potential impacts of the proposed development, and it did not meet many of the recommendations noted in GHC's letter.

Other than providing the results of one water quality sampling of an existing on-site bedrock well on the property, NGI did not conduct a hydrogeologic investigation of the bedrock aquifer. Specifically, there was no testing of abutter's wells, nor the installation or testing of site wells on the property.

As a result, NGI's report was not able to meet GHC's recommendations, including:

1. Determining groundwater flow rates and directions in the bedrock aquifer.
2. Determining bedrock aquifer transmissivity or storage coefficients.
3. Conducting a pump test of the on-site wells.
4. Developing a calibrated groundwater model that includes both the surficial and bedrock aquifers.

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5. Evaluating pumping impacts of the on-site wells on abutter wells, or the impacts of the on-site wells on each other.
6. Evaluating the impacts of on-site leach fields on abutter's or on-site wells.
7. Developing a groundwater monitoring plan.
8. GHC recommends that the Long Ridge Road groundwater impact modeling be done using MODFLOW. This model was developed by the US Geological Survey in 1988 and is considered an international standard for simulating and predicting groundwater conditions. For the Long Ridge impact analysis, a single MODFLOW model has the capability to model the surficial and bedrock aquifers beneath the site and abutter's property, as well as the individual components including wastewater discharges, pumping wells, and solute transport. A calibrated MODFLOW model would be needed to assess the impacts of the proposed development.

The NGI Groundwater Impact Analysis report presents the results of a hydrogeologic investigation of the surficial aquifer at Long Ridge Road. The following comments and recommendations are based only on what was presented in the NGI report, and are presented in addition to the above comments.

Comments and Recommendations

1. Provide a schematic profile figure showing the construction of all monitoring and wetland wells. The profile should use well elevations.
2. Explain the difference in groundwater elevations in all paired wells, especially the 1.04 foot difference observed in wells MW-1-15 and MW-1A-15.
3. How was a single groundwater elevation determined at the paired well locations?
4. Seasonal high groundwater was determined by subtracting a varying adjustment value from ground surface elevations. GHC recommends the following approach:
   a.) Mottling should be compared to measured groundwater elevation contours to calculate a single adjustment value.
   b.) The adjustment value should be added to well groundwater elevations to develop seasonal high groundwater elevations.
   c.) It is not necessary to adjust surface water elevations at Long Ridge Road.
5. Saturated thickness is normally calculated based on seasonal high groundwater and a change in geologic conditions at depth. These calculations should be outlined in detail in the report. The site appears to have a low saturated thickness, which could result in higher groundwater mounds beneath the leach fields.
6. The slug test analysis data sheets show a saturated thickness of 12.83 feet for both wells MW-4-15 and MW-5-15. Is that thickness correct for both wells?
7. The use of a Kz/Kr ratio of 0.10 in the Hvorslev slug test analysis results in a higher hydraulic conductivity than would be derived using another ratio. GHC recommends a ratio of Kz/Kr = 1.0 for the slug test analysis. Rather than the

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Hvorslev method, GHC recommends the use of the Bouwer & Rice method which is more suitable to unconfined aquifers. Hydraulic conductivity has an important effect on the results of groundwater mounding calculations, a higher hydraulic conductivity results in a lower groundwater mound.

8. The Tecmound calculations did not calculate a combined mound for the three proposed leach field areas. Mounding calculations should include all four leach fields in a single simulation to account for the mutual interference of the four systems. The use of MODFLOW would allow the simulation of all four leach fields.
9. Based on GHC's conversion of report values, the mounding calculations used approximately 1,846 gallons per day for each of the three leach fields, which equates approximately with 80% of a Title 5 discharge for 20 units x 3 bedrooms per unit x 115 gallons per day. The discharge should be calculated by using Carlisle's Board of Health required 165 gallons per day per bedroom.
10. The mounding calculations used a simulation time of 30 days. GHC recommends a simulation time of 90 days as is required by MassDEP and has been used for other projects in Carlisle. The use of a low mounding time in the groundwater mounding calculations results in a lower groundwater mound.
11. In the mass balance nitrate-nitrogen loading calculations, a 50% reduction was used for the existing impervious recharge. No explanation for this reduction was presented, nor what effect the reduction would have on the resulting nitrate concentration.
12. The results of the mass balance nitrate-nitrogen loading calculations indicate a 9.6 mg/L nitrate concentration in groundwater at Long Ridge Road, which exceeds the 5 mg/L concentration Carlisle has used for other projects.
13. The solute transport modeling performed by NGI included decay and reaction terms which reduce the total nitrate-nitrogen mass and resulting nitrate-nitrogen concentrations. GHC recommends the solute transport be conducted using an advection-dispersion only transport without the use of any terms that decrease nitrate mass. This type of transport model has been used for other Carlisle projects.
14. Nitrate plumes should be plotted in plan view showing the steady-state nitrate concentrations as developed in the solute transport analysis.

If you have any questions, please call me.

Sincerely,
GeoHydroCycle, Inc.

Stephen W. Smith, P.E., P.HGW.

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GHC Com & Rec 4-17-15.lwp