NORTHEAST GEOSCIENCE INC

*Water Supply and Environmental Consulting*

September 15, 2014

Jeffrey Brem, PE
Meisner Brem Corporation
142 Littleton Road, Suite 16
Westford, MA 01886

Re: Groundwater Impact Analysis
Brem Property
100 Long Ridge Road
Carlisle, MA

Dear Mr. Brem:

Northeast Geoscience, Inc. (NGI) has developed the following scope of work to assess potential groundwater impacts from drinking water withdrawals and waste water discharges from a proposed 40B residential development the above referenced property. It is our understanding that the property currently consists of approximately 10 acres land with an existing single family home and barn. The proposed development would add 19 new single family homes and associated roads and utilities. The development would be served by a total of nine private wells serving up to 3 units each and a shared wastewater disposal system. It is our understanding that concerns have been raised regarding: 1) decreased yields or water quality changes of abutting private water supply wells from proposed on-site pumping; 2) increased nutrient and pathogen loading from onsite wastewater disposal; and 3) groundwater mounding effects from groundwater discharges. The scope of work described below has been developed to address these concerns.

**PRIVATE WATER SUPPLY WELLS DISCUSSION**

According to the Massachusetts Private Well Guidelines over 500,000 people in the Commonwealth rely on private water systems for domestic water. Most of these systems tap groundwater from shallow unconsolidated sediments (dug or driven "gravel" wells) or fractured rock ("bedrock" wells) and many have been in continuous operation for generations. Bedrock wells, though often of lower yield than the typical gravel wells, generally have hundreds of gallons of water stored in the well casing (a.k.a. "casing storage") available for immediate use. The extensive use and long history of bedrock wells for domestic water in the Region, including their wide use throughout the Town of Carlisle, support the fact that these types of water sources are both practical and reliable. In fact, during a search of the DEP well database we identified over 1,200 domestic wells currently serving homes and businesses throughout Carlisle with few known issues involving significantly diminished yields from wells pumping on adjacent properties or impaired water quality on-site wastewater disposal.

It is not possible to guarantee that all of the wells drilled at a site will have sufficient yield, and some wells drilled in town have limited yields and some have required yield enhancement by hydrofracturing. Therefore, in order to understand the likelihood of success NGI conducted a review of existing private wells in the vicinity of the proposed development. Well logs available from the MassDEP *SearchWell* database were reviewed for average well depths, water levels and well yields within ¼ mile of the existing well serving 100 Long Ridge Road. A total of 20 well logs were obtained (see attached table). Well yields for the wells investigated ranged from 6 gpm to 100 gpm with a median well yield of 15 gpm. Well depths ranged from 110 feet to 645 feet with an average of 228 feet. These data suggest is it likely that private wells will be adequate to meet the domestic water needs of the proposed development.

**PRIVATE WELL IMPACTS FROM GROUNDWATER WITHDRAWALS**

In order to assess the potential impacts to private water supply wells NGI will conduct pre-development well yield and water quality tests on all private drinking water wells within 500 feet of the proposed water supply wells (with the well owners approval). Testing procedures will be conducted as follows:

1) Disinfect sample tap with sodium hypochlorite solution, flush for 10-15 minutes and collect sample for total coliform bacteria.
2) Remove well cap and gauge depth to static water level with an electronic water level probe accurate to +/- 0.01 feet.
3) Open sample tap and pump to waste for approximately 20-40 minutes while recording water level drawdown and flow rate, collect baseline water quality samples (total coliform bacteria, pH, arsenic, chloride, sodium, iron, manganese, lead, sulfate, conductivity, and nitrate).
4) Close sample tap and record water level recovery.
5) Disinfect well by adding approximately one tablespoon of sodium hypochlorite and replace cap.

The above private well testing procedures will be conducted on each of the private water supply wells within 500 feet of the proposed wells prior to the start of construction (to determine baseline yield and water quality). In addition, neighboring wells (with the owners' permission) will be monitored during the yield testing of proposed wells (in accordance with Carlisle Board of Health testing requirements) to determine if the wells are interconnected and if any reductions in yield are likely.

**NUTRIENT LOADING AND PATHOGENS**

NGI will develop and mass-balance nitrogen loading model to estimate the post-development nitrogen concentration in groundwater. According to the DEP Nutrient Loading Approach to Wastewater Permitting and Disposal (dated August 20, 1999), nitrogen is used as the basis for typical nutrient loading analyses because it is the most conservative contaminant in sanitary wastewater and may have severe public health impacts. The approach we propose is a simple dilution model that sums all nitrogen inputs from a particular facility and site, and dilutes that nitrogen load by the volume of rainwater that percolates down to the water table annually. The analysis conducted will included a variety of scenarios in order to understand not only theoretical impacts from the groundwater discharge under maximum system capacity but also under the typical flows, as well as with and without fertilizer application.

Septic systems are a common source of pathogens in groundwater and the primary pathogens of concern include bacteria and viruses. Adequate setbacks of potable sources of water from wastewater discharges are important to ensure pathogen inactivation (die-off) during groundwater transport. Inactivation of viruses in groundwater is most effective at higher temperatures, in the absence of rainfall, in finer grained soils, in areas where the depth to groundwater is high, and at increasing horizontal distance from the source. In general, the longer the travel time between source and receptor the more likely the pathogen inactivation, the lower the risk of impact. Therefore, travel time is an important factor in determining the potential for virus inactivation in groundwater.

In order to determine time of travel for pathogens from the proposed groundwater discharges to downgradient sensitive receptors a groundwater contour map will be developed for the site based on test pit data and observed surface water elevations on and in the vicinity of the site. The groundwater contour map will be used to determine approximate groundwater flow directions and hydraulic gradients across the site. Time of travel estimates will be calculated based on soil permeability and

porosity estimates, observed hydraulic gradients and the measured distances to down gradient sensitive receptors. Estimates of travel time will be used to determine the potential impacts from pathogens such as viruses in the wastewater discharges.

**GROUNDWATER MOUNDING**

A groundwater mounding analysis will be conducted using test pit data and percolation tests collected from the site, estimates of soil permeability, porosity, and specific yield from literature values, and Title 5 flow estimates for the proposed development. The data will be used to develop an analytical groundwater flow model to estimate the expected water level rise due to wastewater discharges from the development.

Please do not hesitate to call if you have any questions regarding this matter.

Sincerely;
**NORTHEAST GEOSCIENCE, INC.**

Joel Frisch, P.G.
Hydrogeologist

***TABLE 1***

**DOMESTIC WELLS WITHIN 1/4 MILE OF WELL SERVING 100 LONG RIDGE ROAD**

**CARLISLE, MASSACHUSETTS**

| STREET NUMBER | STREET NAME | LATITUDE | LONGITUDE | DATE COMPLETED | WELL TYPE | TOTAL DEPTH | DEPTH TO BEDROCK | WATER LEVEL | WELL YIELD |
|---|---|---|---|---|---|---|---|---|---|
| 41 | Garnet Rock Lane | 42.50989 | -71.334638 | 11/7/1977 | Domestic | 200 | 8 | | 6 |
| 60 | Garnet Rock Lane | 42.51054 | -71.334706 | 7/28/1975 | Domestic | 185 | 12 | | 6 |
| 194 | Nowell Farme Road | 42.508922 | -71.330322 | 1/27/1975 | Domestic | 175 | 4 | | 12 |
| 26 | Garnet Rock Lane | 42.509212 | -71.333241 | 10/27/1976 | Domestic | 275 | 10 | | 12 |
| 40 | Long Ridge Road | 42.50987 | -71.331042 | 10/21/1975 | Domestic | 250 | 8 | | 12 |
| 132 | Long Ridge Road | 42.51217 | -71.334056 | 4/28/1988 | Domestic | 405 | 25 | | 12 |
| 316 | Nowell Farme Road | 42.509102 | -71.334506 | 10/17/1975 | Domestic | 150 | 10 | 10 | 15 |
| 39 | Long Ridge Road | 42.509158 | -71.332196 | 4/12/1974 | Domestic | 175 | 0 | | 15 |
| 162 | Nowell Farme Road | 42.50946 | -71.329935 | 2/20/1974 | Domestic | 250 | 5 | | 15 |
| 126 | Nowell Farme Road | 42.509811 | -71.329333 | 5/31/1977 | Domestic | 200 | 10 | | 15 |
| 50 | Long Ridge Road | 42.510311 | -71.33152 | 3/15/1973 | Domestic | 110 | 10 | 10 | 15 |
| 29 | Suffolk Lane | 42.511609 | -71.330058 | 3/1/1980 | Domestic | 155 | 12 | | 15 |
| 59 | Suffolk Street Extension | 42.513754 | -71.331211 | 9/8/1989 | Domestic | 645 | 10 | 20 | 15 |
| 74 | Suffolk Lane | 42.513811 | -71.329922 | 7/16/1986 | Domestic | 225 | 10 | 5 | 15 |
| 100 | Long Ridge Road | 42.511899 | -71.332882 | 4/13/1974 | Domestic | 150 | 8 | | 20 |
| 213 | Prospect Street | 42.509156 | -71.335537 | 8/9/2000 | Domestic | 125 | 10 | 12 | 25 |
| 68 | Garnet Rock Lane | 42.510579 | -71.333168 | 4/6/1973 | Domestic | 185 | 5 | | 25 |
| 64 | Suffolk Lane | 42.513149 | -71.329848 | 5/21/1986 | Domestic | 300 | 5 | 20 | 25 |
| 148 | Stoney Gate | 42.514947 | -71.330956 | 9/1/1980 | Domestic | 180 | 18 | | 100 |

**NOTES:** - Data obtained from MADEP *SearchWell* database on 09/08/2014