

To: The Effingham Planning Board

January 23, 2022

With Regard to: Meena application for a new gas station

My name is Bob Newton. I am a professor emeritus of geosciences at Smith College in Northampton Massachusetts where I taught courses in groundwater hydrology and geomorphology (among others). I have unique knowledge of the Ossipee Aquifer at the site of the proposed gas station as I mapped the surficial geology of the Ossipee Lake 15minute quadrangle for the State of New Hampshire, published in 1974 (Newton, 1974). Since that time, I have been involved in a number of other groundwater studies of the Ossipee Aquifer done in cooperation with the Green Mountain Conservation Group. I have also served over 20 years on the Barnes Aquifer Protection Advisory Committee (BAPAC) in western Massachusetts. This committee advised Planning Boards in the cities of Holyoke, Westfield, Easthampton, and the town of Southampton on projects impacting the Barnes Aquifer. I have literally reviewed hundreds of plans for projects built on this highly productive aquifer. These qualifications give me unique insight for evaluating the Meena application. I write today to help the Planning Board understand some of the issues surrounding the installation of a gas station at this particular site.

The Ossipee Aquifer is a highly productive groundwater resource (Moore and Medalie, 1995), hosted by stratified drift deposits that were deposited by meltwater streams associated with the melting of the Laurentide Ice Sheet, approximately 15,000 years ago. Some of the most permeable sand and gravel deposits are exposed at the surface in the area of the proposed gas station (Figure 1), making that portion, part of the primary recharge area for the aquifer (Figures 2 and 3). The geologic cross section in Figure 3 shows that the gas station is located within a highly permeable kame delta complex where precipitation can directly enter the aquifer. Areas on either side of it are lower and less permeable. The infiltration basin on the southeast side of the site was created when the new Route 25 was constructed on a ridge of artificial fill. All water entering this feature is directly recharged to the aquifer.

The fact that the proposed gas station will be located in an old gravel pit (Figure 4) makes this site exceptionally sensitive to groundwater contamination. The thick unsaturated zone has been greatly reduced by mining. The unsaturated zone slows the downward movement of contaminants and allows for more attenuation. Removing these semi protective layers increases the likelihood that even small spills will contaminate the groundwater.

Most of the facilities making up the site are composed of impermeable surfaces (parking areas, roofs, etc.). Precipitation falling on these impervious surfaces produces stormwater runoff (over 800,000 gallons per year at this site based on total annual precipitation of 45in) that will directly infiltrate into the aquifer as soon as it leaves the pavement. As this stormwater moves across the pavement it may become contaminated from drips and spills associated with fueling operations and thus the stormwater flushes contaminants directly into the aquifer where they can be rapidly transported to nearby wells.

Contamination at gas stations can come from two different sources; operational drips and splashes or from higher volume accidental spills. Research is showing that even operational drips and splashes can, under the right conditions, lead to aquifer contamination as gasoline constituents accumulate and eventually “break through” the concrete pad to the underlying materials (Hilpert and Breysse, 2014).

Accidental spills are not infrequent events at gas stations and can be catastrophic. A recent (December, 2021) spill at a gas station in California released 1,300 gallons of gasoline when an SUV backed into a gas pump. The safety systems failed and 1,300 gallons of gas spilled into the stormwater system. If this were to happen at the Meena site, all the gasoline would run off the pavement, into the infiltration basin where it would immediately, catastrophically, contaminate the aquifer eventually moving through the groundwater system to Phillips Brook and Leavitt Bay. Smaller spills are more likely and Table 1 shows the types of spill incidents reported reported to NHDES from Carroll County gas stations. It is NOT a complete list of all spills, but shows the range of types of spill incidents that have occurred at local stations. Given that runoff from the Meena site would rapidly run directly into the aquifer, the volumes associated with any of these spills would likely result in significant contamination of the groundwater.

Table 1. Types of spills reported at local gas stations

Town	Gallons	Cause
Moultonborough	20	Drive-off with hose attached
North Conway	20	Car gas tank leaked
Bartlett	45	Snow plow hit pump
Wakefield	25	Fill shutoff failed
Ossipee	30	UST overflow during refill
Wolfeboro	20	Gas pump leak

Nearby wells would be rapidly contaminated. While it would take longer to contaminate wells located further down gradient from the site, the large number of these wells (Figure 5) is concerning, especially as they include a nearby public water supply well. Most of these wells lie within the town of Ossipee and many are driven points which are particularly sensitive to contamination from gasoline as they obtain their water from near the top of the saturated zone. Most concerning is the lack of a water quality testing program. None of these wells are tested for Volatile Organic Compounds (VOC's). An unreported spill could unknowingly expose nearby residents to carcinogenic compounds in their drinking water.

Evaluating this project proposal in light of the site-specific geomorphology involves a number of geologic and hydrologic factors. It is difficult to address these issues in a letter, so I would ask that you allocate me time at one of the Planning Board Public Hearings to present the issues introduced in this letter.

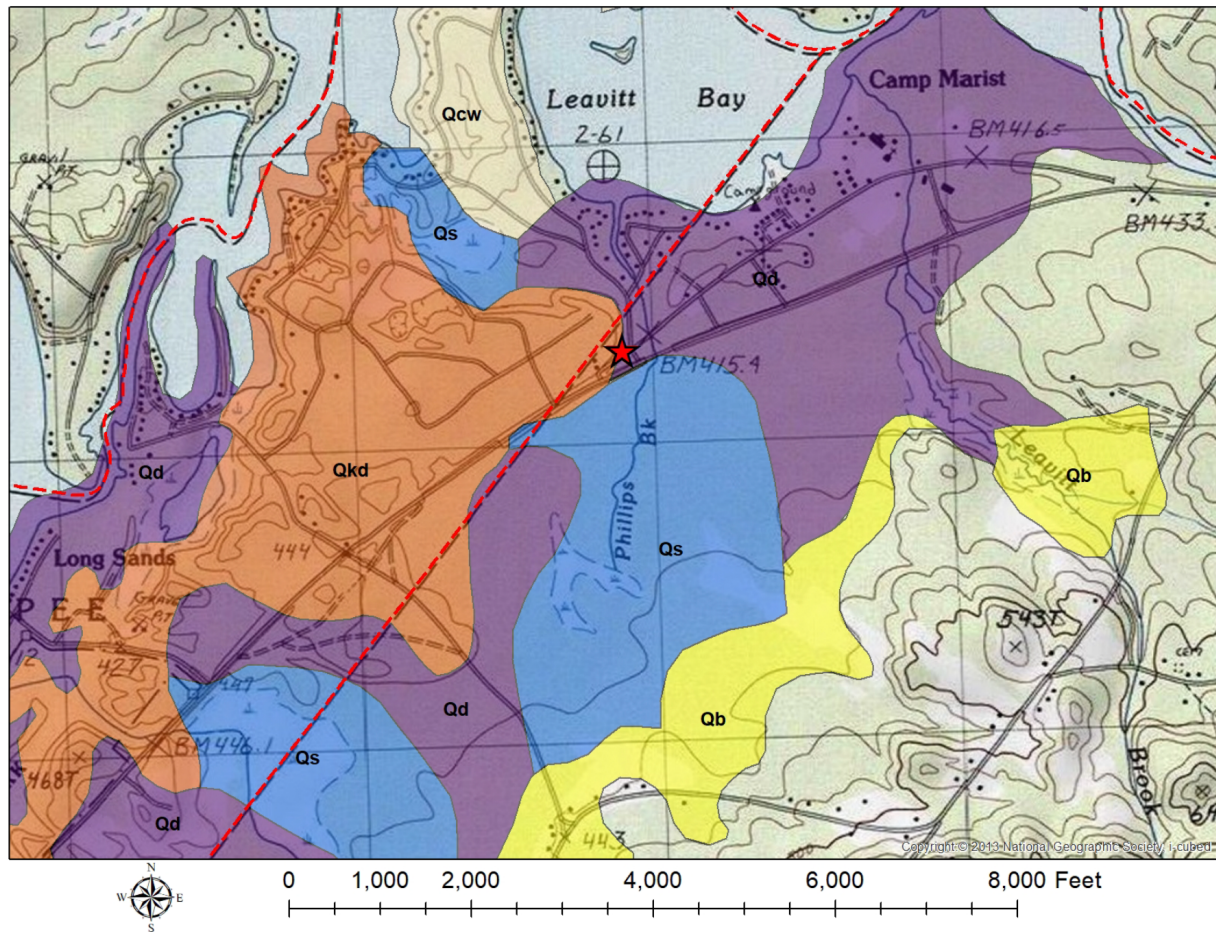


Figure 1. This map shows surficial geologic map units from Newton (1974) in the area of the gas station (red star). The Qkd unit is a kame delta complex that was deposited at the ice margin where meltwater rivers entered into a glacial lake. It is composed of very well sorted sands and gravels that make up this portion of the Ossipee Aquifer. Since these deposits are exposed at the surface and are at a high elevation (450ft) relative to the surrounding area, they form the principal recharge area for the aquifer in this region.

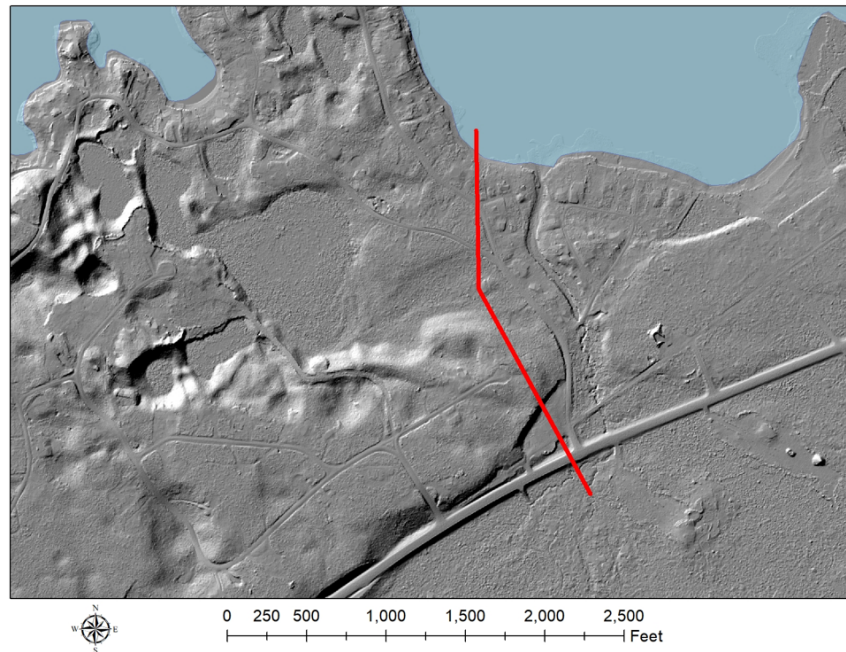


Figure 2. This is a topographic hillshade made from a LiDAR based Digital Elevation Model (DEM) with the sun located 45° above the horizon on a 315° azimuth. The DEM has a cell size of 2.5ft x 2.5ft with a vertical resolution of less than 0.5ft. The red line is the line of profile for Figure 3.

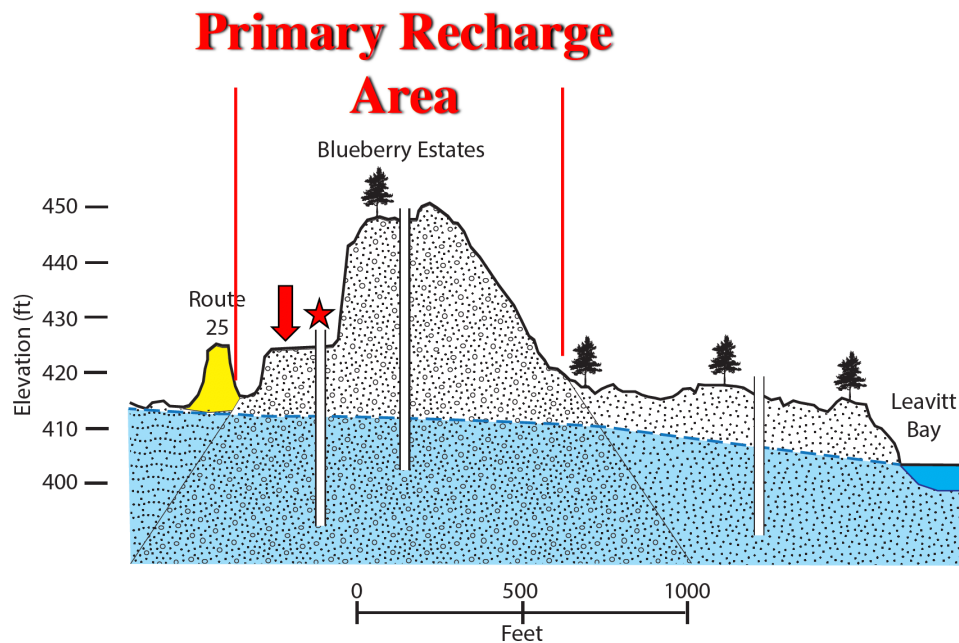


Figure 3. This topographic profile was constructed from the DEM along the line of section shown in Figure 2. The primary recharge area occurs within coarse Qkd sediments shown in Figure 1. Sediments on the left side of the figure are finer grained materials deposited in the glacial lake while sediments on the Leavitt Bay side are finer grained deposits formed after the ice margin had retreated further north. Route 25 is built on artificial fill that forms an enclosed infiltration basin next to the Meena site. The arrow shows the location of the gas station and the starred well represents the Public Water Supply well. The water table shows groundwater movement towards Leavitt Bay.



Figure 4. This is a topographic hillshade made from a LiDAR based Digital Elevation Model (DEM) with the sun located 45° above the horizon on a 315° azimuth. It clearly shows the extent of the gravel pit, where the proposed gas station is located. This makes this site extremely sensitive to contaminating the underlying groundwater.



Figure 5. This is an orthophoto taken in 2006 with parcel data showing the property boundaries. The star is located at the Meena site and the black line shows the Ossiipee – Effingham town line. Groundwater flow from the Meena site is generally northward and all properties north of the site are serviced by private wells. All these properties could be impacted from a spill at the Meena site.

Sincerely,

Robert M. Newton PhD
Professor emeritus, Smith College

References Cited

Hilpert, M., and Breyse, P.N., 2014, Infiltration and evaporation of small hydrocarbon spills at gas stations, *Journal of Contaminant Hydrology*, v. 170, p. 39-52.

- Moore, R.B., and Medalie, L., 1995, *Geohydrology and water quality of stratified-drift aquifers in the Saco and Ossipee River Basins, east-central New Hampshire*: US Geological Survey, Water Resources Investigations Report 94-4182, 234 p.
- Newton, R.M., 1974, *Surficial geology of the Ossipee Lake Quadrangle, New Hampshire*: New Hampshire Department of Resources and Economic Development, Concord, New Hampshire, 52 p.