TECHNICAL MEMORANDUM

To: Steve Hinton, Carlisle ZBA; Chris Heep, Miyares-Harrington

From: Jim Vernon, Nobis Engineering, Inc.

Subject: Overburden/Bedrock Groundwater Connectivity Assessment, 100 Long Ridge Road

Date: December 8, 2016

Background

In Nobis Engineering's "Phase 4 Report, Independent Hydrogeologic Study, 100 Long Ridge Road, Carlisle, MA", dated September 30, 2016, we concluded, *"The degree of hydraulic connection between overburden groundwater and bedrock groundwater at the Site has not been characterized. If dense, low permeability glacial till deposits are present on top of the bedrock in some locations, these deposits may inhibit flow between the overburden and the bedrock. If a low-permeability layer is absent, impacted overburden groundwater is more likely to reach a well drilled in bedrock. Proposed wastewater discharge will be to the overburden; all new and proposed wells obtain their water from the bedrock."* Nobis also recommended that on-site borings be installed through the overburden, to bedrock (Recommendation 3 on page 22 of Nobis' Phase 4 report) and that transducers be installed in existing shallow monitoring wells to measure water levels over a period of time (Recommendation 4 in Nobis' Phase 4 report). The Town authorized these investigations and related analyses in Amendment 6, dated October 24, 2016, to Nobis' existing contract.

This Technical Memorandum presents the results of these investigations. This Memo also discusses the degree of hydraulic connection between overburden and bedrock groundwater and the implications of these results regarding the potential for existing and new bedrock water supply wells to be impacted by the proposed septic system for the 40B development. See Nobis Phase 4 report for background information on the site (100 Long Ridge Road property) and the proposed development by Lifetime Green Homes (Applicant).

11/23/16 Boring Results

Nobis subcontracted a drilling and boring company, Technical Drilling Services, of Sterling, MA (TecDrill), who worked with Nobis on November 23, 2016 to drill borings at pre-agreed locations, selected during a site visit on November 18. TecDrill arranged for Dig Safe Clearance for 100 Long Ridge Road (site) and for neighbors who had also given permission to drill on their properties (132 Long Ridge Road, 200 Long Ridge Road, and 68 Garnet Rock Lane). In addition, Nobis retained a private utility locating company, TMD, who checked the prospective drilling locations on site and on the neighbors' properties. The drilling proceeded with permission of the landowner(s); Jeff Brem (owner and project Applicant) and Joel Frisch (Northeast Geoscience) were present for the borings on the project site.

The objective of the borings was to characterize the overburden deposits that overlie the bedrock beneath the site. Drilling for monitoring well installation in 2015 (Northeast Geoscience report dated March 25, 2015) did not extend to bedrock in the vicinity of the proposed Septic Disposal Areas (SDAs) and generally encountered sandy glacial till. If low permeability deposits such as clay or dense, compact glacial till overlie bedrock, these deposits may restrict groundwater flow between overburden and bedrock, as described above in the Background section. If sandy deposits extend to bedrock, this might allow flow of groundwater between overburden and bedrock and the possible transport of nitrates and other wastewater constituents into bedrock.

The borings were drilled using a Geoprobe drilling rig, by driving 5-foot sections of 2.25-inch diameter steel pipe. Plastic liners (1.25 inches in diameter) were placed inside the steel pipes and used to collect the soils penetrated in each 5-foot section. Nobis described the soils collected in the plastic liners (see boring logs in Attachment 1). At some locations multiple attempts were required in order to reach the desired depth (presumed top of bedrock). Borings were drilled at three locations on site; the locations were selected to be near each of the three proposed SDAs (Figure 1). A fourth boring was drilled south of the site, on the northern edge of the 68 Garnet Rock Lane property.

Boring B3-16 was located about 10 feet west of existing monitoring wells MW-3 and 3A, near proposed SDA3. The boring was advanced to a depth of 30 feet below ground surface (ft bgs) without reaching "refusal". (Refusal is a drilling term for the inability to advance the boring further; refusal can be caused by bedrock, a boulder, or very dense glacial till or hardpan.) Boring B3 encountered a clay layer from about 17 ft bgs to about 20 ft bgs (see boring log in Attachment 1). This clay layer can be expected to inhibit downward movement of groundwater and mixing or transport of dissolved wastewater components in this location. The areal extent of the clay layer is unknown. Also of interest is the fact that bedrock had not been encountered by the depth of 30 ft bgs. Based on drilling records in the vicinity, the deepest previous known depth to bedrock in the area was 24 ft bgs, so this result was unexpected.

Boring B2-16 was located in a grassy area west of the Brem garage and near the proposed SDA2; there is no monitoring well in this area. The boring was advanced to 20 ft bgs after several attempts, required due to dense, resistant deposits. Penetration by the drilling pipes was difficult below 10 ft, and the plastic sample sleeve fused to the metal pipe due to frictional heat. The final depth of 20 ft bgs may not have been complete "refusal", but TecDrill feared that if they drilled further, they would not be able to recover the drilling pipes. The boring encountered wet sandy clay from 10 – 15 ft bgs and dense glacial till from 15 – 20 ft bgs. (See boring log in Attachment 1.) These deposits likely restrict and slow the downward movement or mixing of groundwater and dissolved wastewater components at this location.

Boring B1-16 was located near some trees, about 15 feet northeast of MW-1 and MW-1A and near proposed SDA1. Initial drilling attempts appeared to reach refusal at 11 ft bgs; a final attempt reached refusal at 12.5 ft bgs. This refusal may indicate that bedrock was reached, because if refusal had been caused by a boulder, moving the drilling rig would likely have resulted in a significantly greater drilling depth for some of the locations. The deposits encountered were sandy, down to refusal, with no evidence of a layer that would restrict downward mixing of groundwater or transport of wastewater components at this location (see boring log in Attachment 1).

Boring B4-16 was located about 10 feet south of the edge of pavement on Long Ridge Road and on the 68 Garnet Rock Lane property, as shown on Figure 1. Boring B4 encountered refusal at 12.5 ft bgs and similar sandy deposits to those in boring B1 (see log in Attachment 1). Because of the similarities between this boring and B1, it is likely that refusal also represents bedrock at this location, but this is not certain. There is no evidence of a layer that would restrict downward mixing of groundwater or transport of wastewater components at this location.

There was not enough time to drill borings at other locations. Nobis is grateful to the property owners at 132 Long Ridge Road and 200 Long Ridge Road for making their properties accessible. Nobis also thanks Jeffrey Brem, Applicant and owner of 100 Long Ridge Road, and we also thank the owner of 68 Garnet Rock Lane.

Water Level Gauging Results

Nobis rented pressure transducers (In Situ Level Troll 700, vented, 5 psig) designed to collect and store water level measurements when submersed in a well. Because the transducers were vented and attached to vented cables, data corrections due to barometric pressure changes were not necessary. Nobis pre-programmed the transducers to collect a water level reading once per minute. The water levels were calibrated using manual measurements of water levels in each well, collected when the transducers were placed within each well and again when the transducers were removed.

The objective for gauging the water levels in the on-site monitoring wells is to see if there is evidence (or not) of a hydraulic connection between bedrock groundwater and overburden groundwater. Because all of the water supply wells in the area obtain water from bedrock and all the on-site monitoring wells are screened in the overburden, changes in water levels in the monitoring wells, that might be attributed to pumping, would indicate that a hydraulic connection is present. While bedrock well water level changes due to pumping are typically abrupt, damped responses that appear as rounded fluctuations on a water level graph for an overburden monitoring well might be expected if there is some hydraulic connection between bedrock and overburden groundwater.

Nobis placed the transducers in the wells on Friday, November 18, 2016 and removed the transducers on Wednesday, November 23, 2016. The transducers were placed in existing wells MW-1, MW-2 (or 2A), MW-3 (or 3A), MW-4, and MW-5 (Figure 1). (Subsequent to the well installations in January 2015, well couplets MW2/2A and MW3/3A had been cut below ground surface; upon relocating the wells with a shovel, Nobis was unsure which members of the couplets we accessed for gauging the water levels.) For each well, Nobis measured the distance from the ground surface, upward (“stickup”) or downward to a measuring point on the top edge of casing. Nobis used these measurements, along with hand measurements of water levels, to calibrate and adjust the transducer water levels to feet below ground surface (ft bgs).

The resulting water levels, graphed versus time, are shown in the graph in the lower right corner of Figure 2. Water levels in MW-1, MW-2, MW-3, and MW-4 show net increases of less than one foot during the monitoring period. MW-5 declined more than two feet during the monitoring period; the reason why water levels in this well declined while water rose in the other wells is unclear, but not critical to meeting the objective described above. Detailed plots of water levels for each well

are also shown in Figure 2. No fluctuations that might be due to pumping of nearby wells are evident in MW-2, MW-3, or MW-4.

Water level fluctuations are evident in MW-1, the most southerly well monitored, and in MW-5, located near the brook. The depth to bedrock at MW-1 may be 15 feet, the depth of refusal noted in NGI's log in their March 2015 report. Nobis' boring B1 reached refusal at 12.5 ft bgs and did not encounter an impermeable layer. A hydraulic connection between bedrock and overburden groundwater is possible at this location, and the small fluctuations in water level possibly reflect the pumping of a well or wells in the area. The depth to bedrock at MW-5 is 16 feet, and an extensive bedrock outcrop is present east of the brook. It is possible that a hydraulic connection between bedrock and overburden groundwater occurs at this location and that the observed water level fluctuations are damped pumping effects from bedrock wells in the area. However, the fluctuations in Well 1 and Well 5 water levels are very small (a few hundredths of a foot to a tenth of a foot) and cannot be conclusively proven to reflect pumping in neighboring wells.

Nitrate Levels in Existing Wells

Background levels for nitrate in groundwater in New England typically range from less than 0.5 milligrams per liter (mg/L) to 1.0 or 1.5 mg/L. Levels higher than this range usually indicate the influence of either septic systems or fertilizer application. The maximum contaminant level (MCL) for nitrate in Public Water Systems is 10.0 mg/L.

Water quality results for a number of wells in the Long Ridge Road area are available from the Carlisle Board of Health. All wells for which nitrate results are available and that were reviewed by Nobis showed nitrate levels within the background range. This includes samples collected from the wells at 100 Long Ridge Road and 90 Long Ridge Road, collected by Northeast Geoscience in 2015 and the Carlisle ZBA in 2016, respectively (Attachment 2). These latter two results are significant because they were collected after the wells and the septic systems that serve the two homes had been active for a period of time. However, the low nitrate result in the 90 Long Ridge Road well may not be significant, because this well was a free-flowing artesian well when drilled. This means that there is an upward gradient from bedrock to overburden at this location and nitrate-impacted groundwater would not be expected to flow downward from overburden into bedrock, even if present at this location. Most of the other well tests are from samples collected when the wells were new. Presumably the septic systems for these homes were not yet in use. Thus, a low nitrate result for a new well does not necessarily mean that groundwater impacted by a septic system could not reach the well.

The nitrate results from wells in the area are encouraging and may suggest that the soils and groundwater in the Long Ridge Road area may be capable of accepting nitrates discharging to overburden groundwater without impacting active bedrock wells, with the current development density. However, because most of the data are from new wells, there may not be enough information to draw that conclusion.

It has also been suggested that the low nitrate levels in the wells at 90 and 100 Long Ridge Road occur despite the presence, for several years, of a significant manure pile at the site (100 Long Ridge), which is currently used as a horse farm. Northeast Geoscience (March 2015 report) has suggested that the manure pile has likely contributed as much (or more) nitrate to the site as the

proposed SDAs would contribute. Nobis questions whether this analogy is conclusive for the following reasons:

- Nitrates in the manure pile start at the ground surface or several feet above the surface, while nitrates in wastewater from the proposed SDAs will be discharged several feet below the ground surface and much closer to the water table.
- Nitrates in the manure pile may be dry and immobile much of the time, only infiltrating down and into the ground after heavy rains or snow melt, but nitrates are already dissolved in wastewater when the wastewater is discharged to the SDA.
- The manure pile may be removed before all of its nitrate reaches the ground or the groundwater. Septic systems, by design, discharge nitrates and other constituents to groundwater.

Discussion

Results of the above investigations suggest that in some parts of the 100 Long Ridge Road site, groundwater flow and contaminant transport may be slowed, restricted, or precluded, between overburden (where the proposed SDAs will discharge) and bedrock (from which all area water supply wells obtain their water). Such areas include boring B3/proposed SDA3 and boring B2/proposed SDA2. Wastewater discharged from SDA3 may remain perched above a clay layer at 17-20 ft bgs, but the areal extent of this clay layer is unknown. Wastewater discharged from SDA2 may be prevented from mixing with deeper bedrock groundwater by dense glacial till that underlies the location of boring B2.

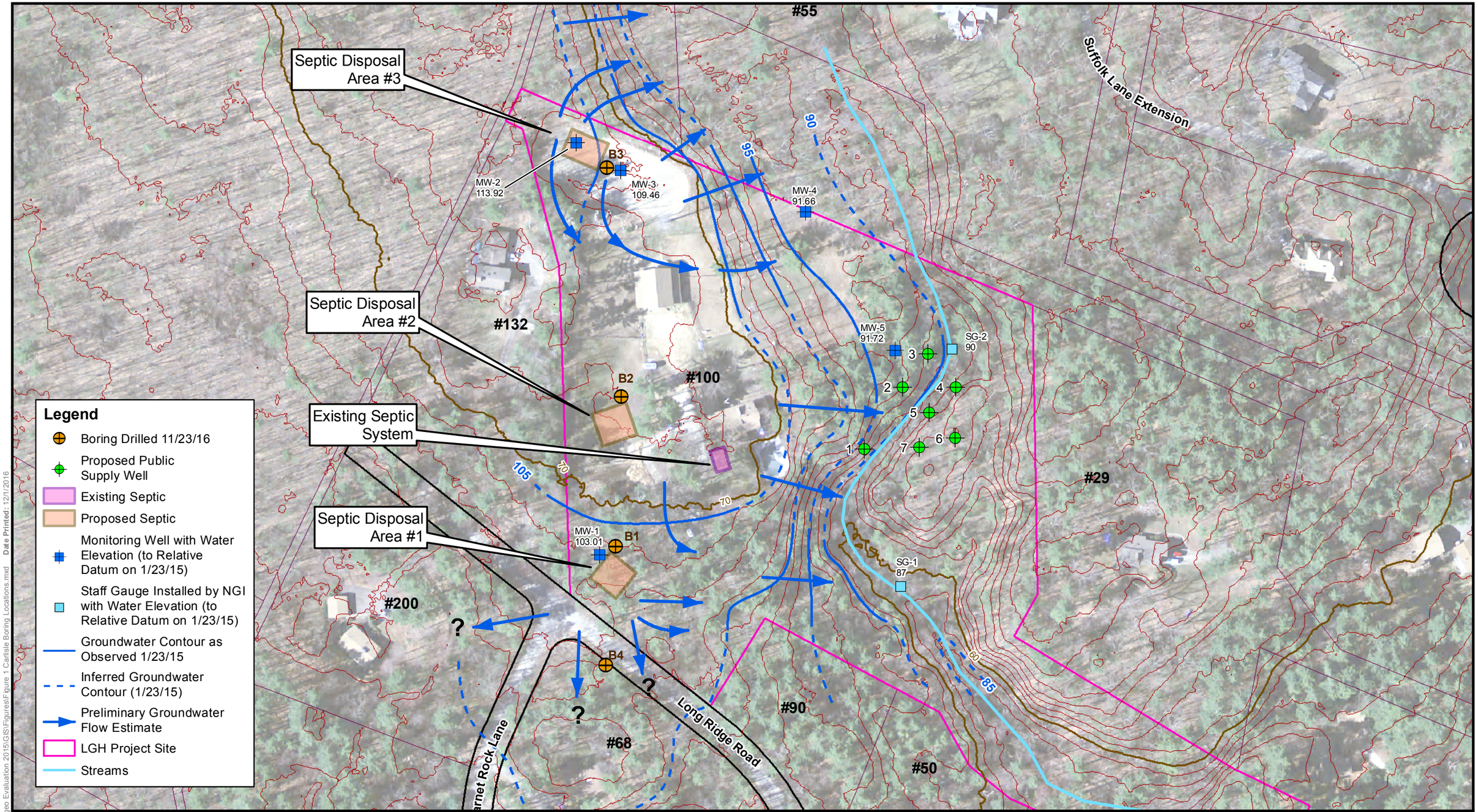
Although the areal extent of the clay layer at B-3 is unknown, drilling logs for MW-4 and MW-5 (NGI March 2015 report) show that competent rock was reached without encountering either clay or dense glacial till. Rather, bedrock in these locations is overlain by several feet of relatively soft weathered bedrock (saprolite). This information indicates that low permeability deposits (clay and/or dense glacial till), present at B-3 (near proposed SDA3) pinches out and disappears somewhere between the SDA3 location and MW-4 and MW-5. This raises the concern that in these down-gradient locations, impacted groundwater might infiltrate into bedrock fractures. This may pose a concern for the proposed Public Water System wells, to be located east of MW-5. This same general concern could be raised for waste water discharged at SDA2, because the areal extent of dense, low permeability deposits (probably compact glacial till) in B-2 is unknown. Groundwater flow directions from SDA2 may be eastward, southward, or both. In the eastward direction, the dense till probably pinches out before the brook/wetland area is reached, based on the drilling log for MW-5, as described above. If impacted groundwater flows south from SDA2, the dense till also probably pinches out, because it was not observed in boring B-1. Thus, infiltration of impacted groundwater into bedrock fractures cannot be ruled out either east or south of proposed SDA2.

Water level gauging in MW-3 and MW-2, located near proposed SDA3, showed no evidence of local well pumping, consistent with the boring evidence that overburden and bedrock groundwater may not be connected in this area. The lack of evidence of local well pumping seen in water level results in MW-4 may indicate that similar conditions exist along the northern property line, east of proposed SDA3. However, the lack of response in MW-4 may also be due to its distance from pumping wells.

In other parts of the site, however, there is no convincing evidence that overburden and bedrock groundwater are disconnected. The shallower depth to refusal in borings B1 and B4 and the existence of sandy deposits down to refusal (presumably bedrock) indicate that flow of groundwater between overburden and bedrock is more likely in the southern part of the site and just to the south of the site, along Long Ridge Road. The presence of small-amplitude water level fluctuations in MW-1 water levels possibly indicate hydraulic connection with pumping wells, but this evidence is not conclusive. Further, local topography suggests that there may be a southerly component of groundwater flow, from proposed SDA1, toward 68 Garnet Rock Lane. A new round of water level measurements that include monitoring wells drilled east and south of proposed SDA1, would be needed to determine if groundwater flows east, south, or both from this area. Present information does not rule out the possibility that impacted groundwater from proposed SDA1 could reach the southern property line at the site.

Available data on nitrate levels in existing wells are encouraging, but the current septic systems in the area and the manure pile at 100 Long Ridge Road probably do not represent an analogous “test” of impacts that might or might not occur if the proposed SDAs become operational.

FIGURES



Path: J:\89220.00 - Carlisle Hydrogeo Evaluation 2015\GIS\Figures\Figure 1 Carlisle Boring Locations.mxd Date Printed: 12/1/2016

Notes:

1. Proposed well and septic locations from a plan titled 'Plan P - Public Water Supply' by Meisner Brem Corp., February 2, 2016.

2. Assessor's parcels are from the Town of Carlisle. Aerial photography provided by ESRI. Lot line for #90 Long Ridge Road is Approximate.

3. All elevations are based on a relative datum, not sea level.

4. Locations of site features, including borings depicted hereon are approximate and given for illustrative purposes only.

0 75 150 300

Feet

N

Nobis

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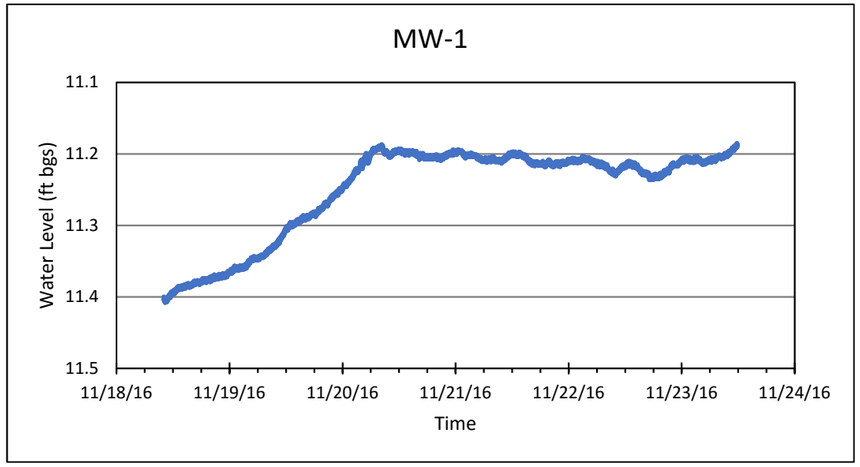
Client-Focused, Employee-Owned

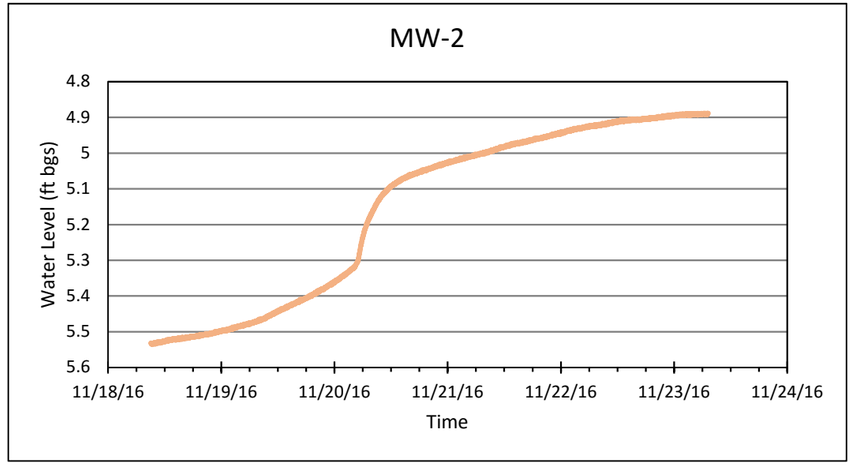
FIGURE 1

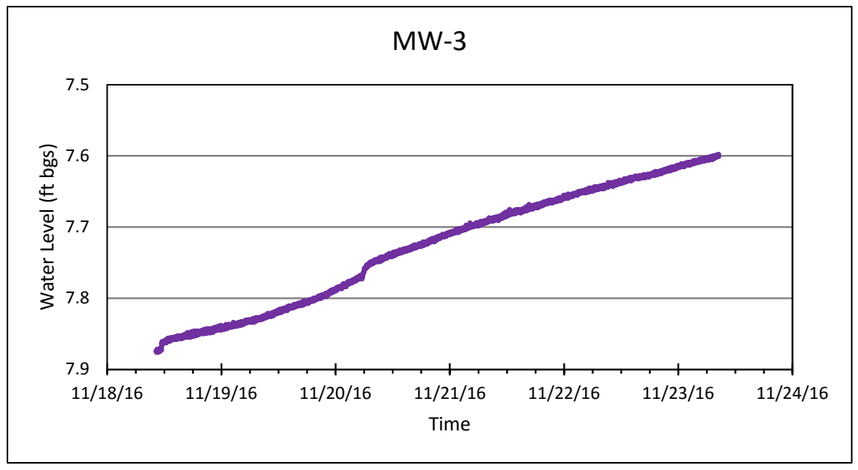
2016 BORING LOCATIONS
100 LONG RIDGE ROAD
CARLISLE, MASSACHUSETTS

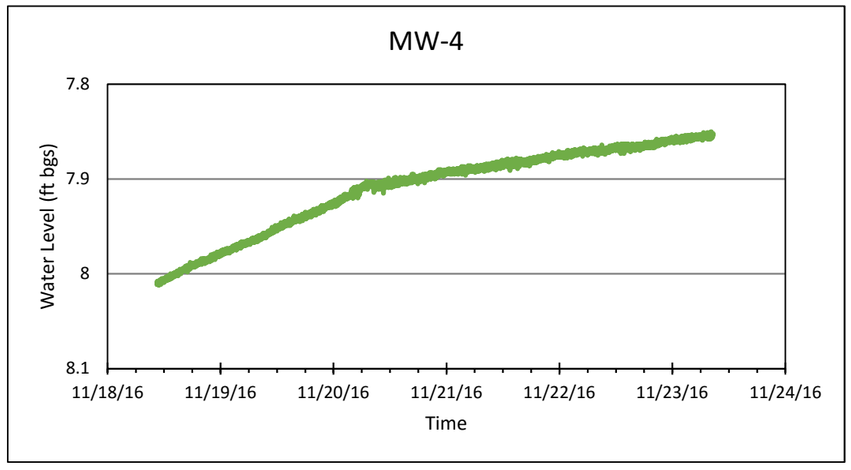
PREPARED BY: JH	CHECKED BY: JV
PROJECT NO. 89220.00	DATE: NOVEMBER 2016

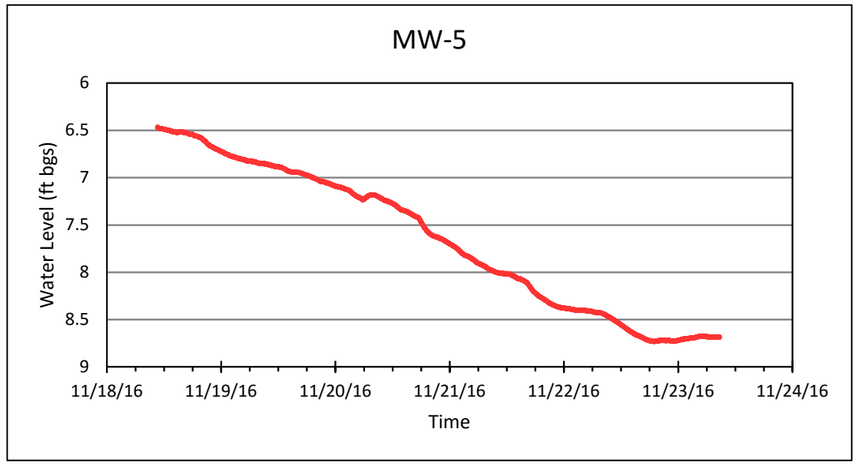
FIGURE 2
Monitoring Well Water Levels, November 2016
100 Long Ridge Road
Carlisle, Massachusetts

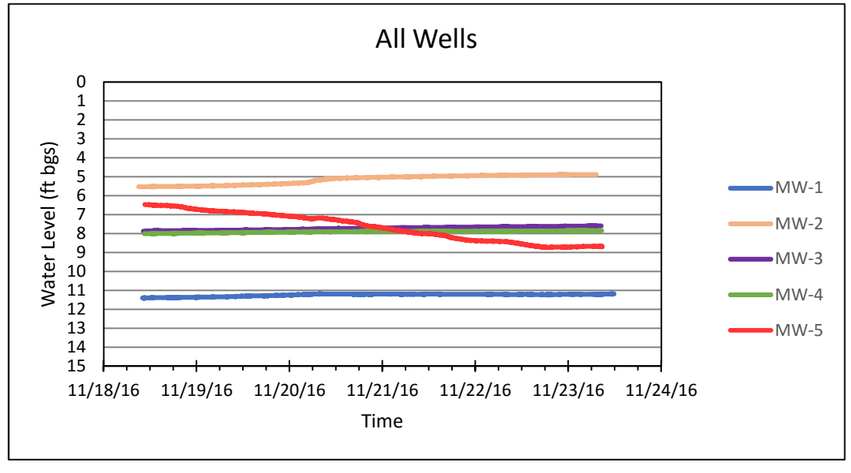












ATTACHMENTS

Attachment 1

Boring Logs

Nobis	**PROJECT** Independent Hydrogeologic Study, 100 Long Ridge Road, Carlisle, MA	BORING NO. B1-16 SHEET 1 of 1 FILE NO. 89220 CHKD. BY

Boring Co.	Tec Drill	Boring Location	approx. 15 ft east of MW-1; near proposed SDA1
Driller	Al	Ground Surface El.	TBM Geoprobe
Geologist	Jim Vernon	Date Start 11/23/2016	Date End 11/23/2016

Sampler: 1.25-inch plaxtic sleeve, 5 ft long

Casing: 2.25-inch steel pipe

Casing Size: Other: Geoprobe drilling

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	SAMPLE No.	PEN/ REC.	DEPTH (ft)	BLOWS/6"	SPT N-Value	SAMPLE DESCRIPTION	STRATUM DESC.	REMKS
5						0-5 ft: 4 ft recovery Brown soil underlain by gray-brown silt & fine sand; underlain by orange-brown silt w/ trace clay and granitic cobble; underlain by fine-med sand w/ pebbles and iron oxide	0-12.5 ft: Soil and sandy glacial till	
10						5-10 ft: 5 ft recovery Tan-brown silt, organic material, fine sand & pebbles; underlain by silt, fine sand & trace clay; wet		
15						10-12.5 ft: 2.5 ft recovery Gray-brown fine sand w/ silt & pebbles; trace clay		
						12.5 ft: End of boring at refusal	12.5 ft: Presumed Bedrock	
20						\		
25								
30								
35								

GRANULAR SOILS (N-Values)	COHESIVE SOILS (N-Values)	DEFINITIONS
0 to 4 - Very Loose	0 to 2 - Very Soft	Standard Penetration Test (SPT) = 140 lb hammer falling 30 in.
5 to 10 - Loose	3 to 4 - Soft	Blows required to drive a 2 ft long x 2" O.D. split spoon sampler
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	from 6 to 18 inches are recorded as the Standard Penetration
31 to 50 - Dense	9 to 15 - Stiff	Resistance (N-Value).
Over 50 - Very Dense	16 to 30 - Very Stiff	
	Over 30 - Hard	

NOTES:

1) Stratification lines represent approximate boundaries between soil types; Actual transitions may be gradual and varied.
2) For the first three attempts, refusal at 11 ft; fourth attempt reached refusal at 12.5 ft; presumed bedrock.

PROJECT

Independent Hydrogeologic Study, 100 Long Ridge Road,
Carlisle, MA

BORING NO. B2-16
SHEET 1 of 1
FILE NO. 89220
CHKD. BY

Boring Co.	Tec Drill	Boring Location	approx. 75 ft west of Brem garage; near proposed SDA2		
Driller	Al	Ground Surface El.		TBM	Geoprobe
Geologist	Jim Vernon	Date Start	11/23/2016	Date End	11/23/2016

Sampler: 1.25-inch plaxtic sleeve, 5 ft long
Casing: 2.25-inch steel pipe
Casing Size: Other: Geoprobe drilling

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	SAMPLE No.	PEN/ REC.	DEPTH (ft)	BLOWS/6"	SPT N-Value	SAMPLE DESCRIPTION	STRATUM DESC.	REMKS
5						0-5 ft: 2.5 ft recovery Brown fine-medium sand underlain by brown silt with fine sand and pebbles	0-10 ft: Fill and gray-brown sandy glacial till	
10						5-10 ft: 5 ft recovery Gray-brown fine-medium sand, moist		
15						10-15 ft: 3.5 ft recovery Gray-brown wet clay with sand	10-15 ft: Gray-brown wet sandy clay	
20						15-20 ft: 5 ft recovery 15-17 ft: Gray, dense silt, sand & pebbles 17-18 ft: Granitic pebbles & cobbles 18-20 ft: Gray, dense silt with pebbles	15-20 ft: Dense gray glacial till	
25						20 ft -- End of boring; probable refusal		
30								
35								

GRANULAR SOILS (N-Values)
0 to 4 - Very Loose
5 to 10 - Loose
11 to 30 - Medium Dense
31 to 50 - Dense
Over 50 - Very Dense

COHESIVE SOILS (N-Values)
0 to 2 - Very Soft
3 to 4 - Soft
5 to 8 - Medium Stiff
9 to 15 - Stiff
16 to 30 - Very Stiff
Over 30 - Hard

DEFINITIONS
Standard Penetration Test (SPT) = 140 lb hammer falling 30 in. Blows required to drive a 2 ft long x 2" O.D. split spoon sampler from 6 to 18 inches are recorded as the Standard Penetration Resistance (N-Value).

NOTES:
1) Stratification lines represent approximate boundaries between soil types; Actual transitions may be gradual and varied.
2) Three attempts were required to recover samples below 10 ft; the 10-15 interval was particularly difficult, with friction fusing plastic sample tube to casing.
3) Boring terminated at 20 ft due to fears that pipe could not be reovered if the boring went deeper; not total refusal at this depth.

Nobis	**PROJECT** Independent Hydrogeologic Study, 100 Long Ridge Road, Carlisle, MA	BORING NO. B3-16 SHEET 1 of 1 FILE NO. 89220 CHKD. BY

Boring Co.	Tec Drill	Boring Location	10 ft west of MW-3-15; near proposed SDA3
Driller	Al	Ground Surface El.	TBM Geoprobe
Geologist	Jim Vernon	Date Start 11/23/2016	Date End 11/23/2016

Sampler: 1.25-inch plaxtic sleeve, 5 ft long

Casing: 2.25-inch steel pipe

Casing Size: Other: Geoprobe drilling

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	SAMPLE No.	PEN/ REC.	DEPTH (ft)	BLOWS/6"	SPT N-Value	SAMPLE DESCRIPTION	STRATUM DESC.	REMKS
5						0-5 ft: 3 ft recovery Brown fine sand and silt Small rock at 3.5 ft	0-17 ft: Fill and gray-brown glacial till	
10						5-10 ft: 5 ft recovery Brown sitt and fine sand; pebbles; trace clay Gray granitic rock at 7.5 ft		
15						10-15 ft: 5 ft recovery Gray-brown silt with minor sand and pebbles Reddish-brown silt and fine sand @ 11-12 ft		
20						15-20 ft: 5 ft recovery 15-17 ft: silt and fine sand with black organic material 17-18 ft: Tan clay, wet 18-20 ft: Olive-tan clay and silt	17-20 ft: Wet tan clay	
25						20-25 ft: 3 ft recovery Gray-black clay, silt, & fine sand; dry and pebbly at bottom	20-30-? ft: Gray-black glacial till with organic matter	
30						25-30 ft: 3 ft recovery Gray-black organic silt at top; gray silt & fine sand at bottom		
35						30 ft -- End of boring; no refusal		

GRANULAR SOILS (N-Values)
- 0 to 4 - Very Loose
- 5 to 10 - Loose
- 11 to 30 - Medium Dense
- 31 to 50 - Dense
- Over 50 - Very Dense

COHESIVE SOILS (N-Values)
- 0 to 2 - Very Soft
- 3 to 4 - Soft
- 5 to 8 - Medium Stiff
- 9 to 15 - Stiff
- 16 to 30 - Very Stiff
- Over 30 - Hard

DEFINITIONS
Standard Penetration Test (SPT) = 140 lb hammer falling 30 in. Blows required to drive a 2 ft long x 2" O.D. split spoon sampler from 6 to 18 inches are recorded as the Standard Penetration Resistance (N-Value).

NOTES:
1) Stratification lines represent approximate boundaries between soil types; Actual transitions may be gradual and varied.
2) At end of boring, there was no water in the borehole, though the clay layer was wet.

Nobis	**PROJECT** Independent Hydrogeologic Study, 100 Long Ridge Road, Carlisle, MA	BORING NO. B4-16 SHEET 1 of 1 FILE NO. 89220 CHKD. BY

Boring Co.	Tec Drill	Boring Location	S shoulder of Long Ridge Rd, on 68 Garnet Rock Rd property		
Driller	Al	Ground Surface El.		TBM	Geoprobe
Geologist	Jim Vernon	Date Start	11/23/2016	Date End	11/23/2016

Sampler: 1.25-inch plaxtic sleeve, 5 ft long

Casing: 2.25-inch steel pipe

Casing Size: Other: Geoprobe drilling

Groundwater Readings (from ground surface)

Date	Time	Depth	Elev.	Stabilization Time

DEPTH	SAMPLE No.	PEN/ REC.	DEPTH (ft)	BLOWS/6"	SPT N-Value	SAMPLE DESCRIPTION	STRATUM DESC.	REMKS
5						0-5 ft: 3 ft recovery 0-1 ft: Brown topsoil 1-5 ft: Gray-brown fine-med sand w/ rocks, trace silt, few pebbles	0-12.5 ft: Soil and sandy glacial till	
10						5-10 ft: 5 ft recovery Light tan fine-med sand w/ trace silt, few pebbles		
15						10-12.5 ft: 2.5 ft recovery Fine sand, pebbles, silt		
						12.5 ft: End of boring at refusal	12.5 ft: Presumed Bedrock	
20						\		
25								
30								
35								

GRANULAR SOILS (N-Values)
- 0 to 4 - Very Loose
- 5 to 10 - Loose
- 11 to 30 - Medium Dense
- 31 to 50 - Dense
- Over 50 - Very Dense

COHESIVE SOILS (N-Values)
- 0 to 2 - Very Soft
- 3 to 4 - Soft
- 5 to 8 - Medium Stiff
- 9 to 15 - Stiff
- 16 to 30 - Very Stiff
- Over 30 - Hard

DEFINITIONS

Standard Penetration Test (SPT) = 140 lb hammer falling 30 in. Blows required to drive a 2 ft long x 2" O.D. split spoon sampler from 6 to 18 inches are recorded as the Standard Penetration Resistance (N-Value).

NOTES:

1) Stratification lines represent approximate boundaries between soil types; Actual transitions may be gradual and varied.

Attachment 2

Water Test Results, 90 Long Ridge Road and 100 Long Ridge Road

Project Name: BREM
Project Number: Not Specified

Lab Number: L1501318
Report Date: 01/27/15

SAMPLE RESULTS

Lab ID: L1501318-01
Client ID: BREM #100
Sample Location: CARLISLE, MA
Matrix: Dw

Date Collected: 01/19/15 17:00
Date Received: 01/21/15
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Nitrogen, Nitrate	ND		mg/l	0.50	--	5	-	01/22/15 01:12	44,353.2	A1

Nashoba Analytical, LLC Tel: 978-391-4428 Fax: 978-391-4643 LabNumber: **171422**

31A Willow Road, Ayer MA 01432 Website: http://www.NashobaAnalytical.com Use this number with all correspondence

Client:

Steve Hinton ReportDate: 10/13/2016

684 East Street

Carlisle, MA 01741

Certificate of Analysis

90 Long Ridge Road, Carlisle MA

Parameter	Method		Result	MCL	MRL	Date of Analysis	Analyst
- Kitchen Sink							
Sampled: 10/9/2016 7:00:00 PM by Client							
Iron, MG/L	EPA 200.7		0.027	0.3	0.003	10/12/2016	M-MA1118
Manganese, MG/L	EPA 200.7		ND	0.05	0.002	10/12/2016	M-MA1118
Sodium, MG/L	EPA 200.7		45.9	See Note	0.2	10/12/2016	M-MA1118
Chloride, MG/L	EPA 300.0		33	250	1	10/11/2016	M-MA1118
Hardness, Total, MG/L	SM 2340B		ND	Not Spec	1	10/12/2016	M-MA1118
Nitrate as N, MG/L	EPA 300.0		ND	10	0.05	10/11/2016	M-MA1118
Nitrite as N, MG/L	EPA 300.0		ND	1	0.02	10/11/2016	M-MA1118
pH, PH AT 25C	SM 4500-H-B	#	6	6.5 - 8.5	NA	10/11/2016	M-MA1118

MCL=Maximum Contaminant Level (EPA Limit), MRL = Minimum Reporting Level

Sodium Guidelines- Mass 20, EPA 250, # = Result Exceeds Limit or Guideline

ND = None Detected (<MRL), * = Background Bacteria Noted

Analysis performed according to 310CMR42.00

Massachusetts Certified
Laboratory #M-MA1118

David L. Knowlton
Laboratory Director