Hydrogeologic Evaluations Report
Farm Road Homes
65 Farm Road, Sherborn, MA

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Prepared for:

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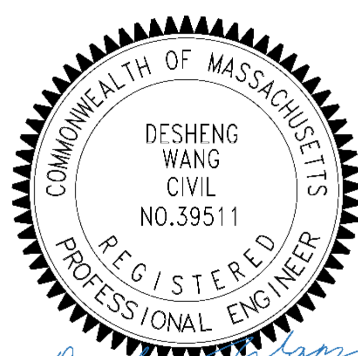

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1.0 Introduction

The applicant, Fenix Partners Farm Road Development, LLC is proposing a 32-unit (76 bedrooms) residential development consisting of clustered condominium units and associated utilities and amenities (the "Project") in Sherborn of Massachusetts pursuant to M.G.L. c. 40B. Figure 1 presents the project site locus. The development will be serviced by seven (7) on site private wells and one common on-site wastewater treatment system. The on-site wastewater treatment system is consistent with the plea of "keep water local" by MA DEP. The wastewater system consists of sewer collection, conveying, and I/A treatment then pressure dosed to soil absorption system (SAS). Upon the request of the proponent, Creative Land & Water Engineering, LLC (CLAWE) has conducted a hydrogeologic evaluation for the design of the on-site sewage disposal system according to 310CMR 15.107. This report presents the result of our evaluation.

The goals of the evaluation are as follows:

1. To demonstrate that the site condition can accommodate the project design sewage flow.
2. The SAS design considers groundwater mounding impact.
3. The design meets and exceeds applicable quantity and quality standards in 310CMR15.00

2.0 Project Description

The proposed development consists of a 32-unit (12 three bedroom units and 20 two bedroom units, a total of 76 bedrooms) residential development. The total involved watershed is about 25.57 acres, 2.8 acres drain to the front and then to southwest, 22.77 acres drain to the central west towards the onsite septic leaching fields. The land uses in the watershed are summarized in Table 1.

Table 1.1 - Project Site Condition Summary

General Site Condition	Land Condition	Land Break down	Acres	Sq.Ft	Coverage, %
		Total Area	14.00	609702	-
	Unusable land	Wetland (Unusable)	0.94	40990	6.7%
	Usable land	Upland	13.06	568711	93.3%
Existing Conditions	**Disturbed**	Total	4.42	192531	31.6%
	Impervious	**Subtotal**	0.33	14400.00	2.4%
		Building (House & Porch)	0.04	1765	0.3%
		Gravel Road & Drive	0.29	12635	2.1%
		Sidewalk & Walkway	0.00	0	0.0%
	Pervious (usable OS)	Lawn/meadow	4.09	178131	29.2%
	Undisturbed	**Total**	9.58	417171	68.4%
	Usable OS	Upland Woods	8.64	376180	61.7%
	Unusable OS	Wetlands	0.94	40990	6.7%
	Total Usable OS	Lawn/landscape/woods	12.73	554311	90.9%
Proposed Conditions	**Disturbed**	**Total**	6.57	286284	47.0%
	Impervious	**Subtotal**	2.22	96856.09	15.9%
		Building (House & Porch)	1.12	48918	8.0%
		Paved (Road & Drive)	0.92	40180	6.6%
		Sidewalk & Walkway	0.18	7758	1.3%
	Pervious (usable OS)	Lawn/landscape	4.35	189428	31.1%
	Undisturbed	**Total**	7.42	323418	53.0%
	Usable OS	Upland Woods	6.48	282427	46.3%
	Unusable OS	Wetlands	0.94	40990	6.7%
	Total Usable OS	Lawn/landscape/woods	10.83	471855	77.4%

The treatment facility is designed for an effluent flow rate calculated based on the design criteria in 310 CMR 15.203 for the proposed residential units. The total flow is 8360 gpd. The proposed I/A treatment will provide better than a secondary treatment to the wastewater influent from the development to meet the discharge standards set fourth in 310 CMR 15.202 (4) before disposal to the soil absorption system. The core treatment components include the primary septic tank, Septitech 13.5, and a pressure dosing system to the SAS. See the site plan for details. The sewage sources are limited to residential use. The facility will be designed accordingly to provide wastewater treatment functions to domestic sewage. Table 2.1 summarizes the planned usage of the development for the treatment facility. Table 2.2 summarizes the designed I/A performance exceeding a secondary standard per 310 CMR 15.202 (4).

Table2.1 - Summary of proposed buildings

Item	Total	3brm	2brm
Unit	32	12	20
Bedroom	76	36	40
Design sewage flow, gpd	8360		
Sas capacity, gpd	8415.6		

Table 2.2 – The design performance parameters for SeptiTech 13.5

Parameter		310 CMR 15.202 (4)	Influent	Effluent	Note
pH		6.0-9.0		6.0-9.0	
BOD_5	mg/L	30	250	≤30	
TSS	mg/L	30	200	≤30	
TN	mg/L	25	60	≤19	24% better

3.0 Site Conditions

The project site is a 40B residential development located at 65 Farm Road in Sherborn, MA. The existing site contains 14 acres of land, consisting of 0.94 acres of wetland and 13.06 acres of upland. The upland area, where horse stables and open space are surrounded by woods, can be accessed via a gravel driveway (see Table 1 for details). The site is bordered by conservation land to the east, north, northwest, residential houses to the southwest, and Farm Road to the south. See Figure 1 for details of the site locus.

The proposed Farm Road Homes project will see the upland area repurposed for the development of a 32unit neighborhood (16 single family homes and 8 duplexes). The units will be accessible from Farm Road via a paved road and individual driveways. A network of paved sidewalks and walkways is also proposed (see Table 1 and site plans for details).

The site has very permeable sandy soils Charlton-Hollis Rock Outcrop. In regard to surface hydrology, the site drains from north to south and southwest to Sewall Brook and then to Charles River. See Figure 1 for USGS site locus map and Figure 2 for NRCS soil map. The proposed development will create 2.22 acres (about 15.9 percent) of impervious area of road, driveway and walkway to houses. The design employs Low Impact Development (LID) using uncurbed driveway with crushed stone shoulder, grass swales, and recharge basins. The development area will be surrounded by open space wooded area.

The area is not located in a public water supply well Zone II, and not in a 500-year or a 100-year floodplain according to MSGIS and FEMA flood insurance study. See Figures 1 and 5.

The proposed onsite wastewater treatment SAS is in a broad valley with deep permeable soil and low groundwater. Eight (8) soil test pit were advanced with large excavator to evaluate the soil and groundwater conditions. Only two lower deep hole test pits (DHTP 55-10AN and DHTP 55-11AN) had some water weeping in at the depth of the downgradient wetland at about 177.5 ft. This is consistent with the onsite bedrock maps (Figure 4), which shows that there are three rock formation interfaces nearby: felsic volcanic, metamorphic rocks, and mafic rocks. It is expected that fractures will be significant in the interface area. The high yield well at 53 Farm Road agrees with the rock formation feature in this area. The percolation testing showed that the soil in the SAS area has a consistent permeability with percolation rate ranging from 3 mpi to 5 mpi. All the soil testing was witnessed by the Sherborn Board of Health agent, Mr. Mark Oram. All soil in C the horizon is coarse medium loamy sand. See Tabel 3.1 for detailed summary. See attached soil logs for details.

Table 3.1 - SAS Soil Testing Summary

Test Pit #	Test Date	GSE (ft)	Depth to pit bottom (ft)	Soil Texture	Adjusted Depth to HGW (ft)	Water adjustement, ft	EHGW, ft	Perc rate, mpi	Perc depth, in	Bottom Hole El, ft	Ledge Note: L=ledge;N=no ledge; U=unknown	Note
DHTP 55-10	4/23/2021	196.92	11.25	Co. M. L.S.	9.42		187.50			185.67	N	well installed,upslope, dry
DHTP 55-10An	4/23/2021	192.10	14.50	Co. M. L.S.	11.17		180.93			177.60	U	Well installed,lower SLP, some weeping
DHTP 55-11	4/23/2021	201.00	16.00	Co. M. L.S.	13.75	1.83	187.25	4.00	54.00	185.00	N	Well installed, upslope, dry
DHTP 55-11An	4/23/2021	193.92	18.00	Co. M. L.S.	14.42		179.50	3.00	54.00	175.92	U	Well installed, lower SLP, some weeping
DHTP-55-11B	4/23/2021	194.00	10.00	Co. M. L.S.	n/t		n/t			184.00	U	No well, confirm soil, mid slope, dry
DHTP 5-1	11/24/2021	195.04	14.50	Co. M. L.S.	10.54		184.50			180.54	N	Well installed, lower SLP, dry
DHTP 5-2	11/24/2021	200.77	17.49	Co. M. L.S.	12.86	2.38	187.91	5.00	64.00	183.28	N	well installed, upslope, dry
DHTP 5-3	11/24/2021	198.04	16.66	Co. M. L.S.	13.53		184.51	3.00	60.00	181.38	N	well insttalled, upslope, dry

Note: 1. Nearby downgradient wetland is at elevation of 177-178, which is in line with the weeping water elevation in Test pits DHTP-11An and DHTP-10An; 2. Except the two test pits, other test pits were dry and no water measured and the water table based on the depth of hole is a conservative estimate and normally will not be considered.

4.0 Historical Review

4.1 Site Plan and Locus Map.

The project engineer provided separate plans for the site with a locus map. These plans are hereby incorporated into this report as reference. Figure 1 shows the general locus of the actual common septic field on a USGS Topographic Map. Figure 6 shows the proposed location of SAS.

4.2 Chemicals.

No known chemicals were previously used, stored, or maintained at the site. There will be no chemicals to be used for the proposed I/A treatment plant. See Appendix For reference.

4.3 Method of Disposal for Chemicals.

Except for septage pumped every 2-5 years from the primary septic tank, there will be no other chemicals. The septage will be pumped and disposed of by a licensed septage hauler.

4.4 Plumbing Plans.

The plumbing plans for the I/A system will be designed by Vendor and presented as part of the septic system plan.

4.5 Utility Lines.

Final utility line design for all utilities are presented in the site plan by Creative Land & Water Engineering, LLC. Utilities will include water, sewer, phone/cable line, and electrical lines for the community.

4.6 Previous Subsurface Work.

CLAWE has carried out a series of soil evaluation and hydrogeological studies since 2021. In the SAS area, the unconsolidated soil consists of 18 ft of coarse medium loamy sand with 2-5 min/in percolation rates. In the SAS area and vicinity, eight (8) deep-hole soil evaluations were conducted in 2021 by CLAWE according to 310 CMR 15.000 (Title V) and witnessed by the Sherborn Board of Health Agent. In seven of the test pits, 4" perforated Schedule 40 PVC pipes with filter fabric sleeves were installed for groundwater monitoring per Sherborn Board of Health requirements. The well construction profiles are attached in Appendix A. All soil evaluation logs and percolation tests are presented in Appendix B.

5.0 Regional Survey

The site location complies with 310 CMR15.107 (g) as summarized in Tabel 5.1 detained in the following subsections.

Table 5.1 Sensitive Receptors located near SAS per 310 CMR 15.107 (g)

Identity	Location	Distance, ft	Note
pub surf water	N/A	>400	no know public water supplies
Pub. Well	varies	>2000	cross gradient
Priv. well	65 Farm rd, closest well	309	upgradient to SAS
Priv. well	55 Farm rd	142	upgradient to SAS
Priv. well	53 Farm rd	252	cross gradient
Priv. well	49 Farm rd	392	cross gradient
BVW	Conservation land	109	downgradient
Perennial river	N/K	>200	

5.1 Local Public Groundwater Supplies.

There is no town ground water supply or other public water supply within 25 ft of the proposed SAS area. There are some public groundwater supply contributors (IWPAs) located to the east of the site about 2000 ft from the proposed SAS. There is a large wetland system between the SAS and the public water supplies. See Figure 1 for details. No significant impact on these wells by the proposed SAS is anticipated.

5.2 Surface Water Supplies.

As mentioned in the previous section, Figure 1 shows that no public surface water supply contributor is located within 400 ft of the proposed SAS area. The SAS is believed to have no impact on surface public water supplies.

5.3 Private Wells.

The neighborhood is on private well water. There are no private wells are located within 150 ft of the proposed SAS except for the well at 55 Farm Road. This well is located about 142 ft upgradient of the proposed SAS.

5.4 Sensitive Receptors.

The proposed SAS site is located about 108 ft (101 ft for limit of disturbance) from the bordering vegetated wetland and more than 200 ft from any perennial streams to the west. See Figure 1. No significant impact is anticipated on those resource areas given that the effluent will be treated to meet DEP nitrogen requirement.

5.5 Background Geological Data.

The site locus on a USGS Topographic Map is shown in Figure 1. Surficial geological information provided by MA GIS is attached as Figure 3. The onsite soil evaluation confirmed the surficial geology condition in the proposed SAS area: loose till unconsolidated, gravelly-coarse medium loamy sand with depth up to 50 ft. The site is underlain by felsic Volcanic Rocks**:** Felsic rocks are rich in silica and light-colored minerals like quartz and feldspar. They typically have a high viscosity due to their silica content. In Massachusetts, these could include rhyolites and dacites. See Figures 4 for details. The SAS area is located in a transition area from Felsic rock to Avalon granite. The interaction between the two in the tectonic movement could create fractures in the rocks and provide better water flow. The groundwater observed on site shows that the groundwater has a mild slope and an indication of more fractures in the bedrocks in this area.

6.0 Subsurface Investigations

6.1 Groundwater Flow.

Seven (7) groundwater monitoring wells were installed in April and November 2021 by excavator to the bottom elevation of each test pit. The well is perforated 4" Sch. 40 PVC with filter fabric sleeve. The well profiles are presented in Appendix A. The groundwater table was monitored for the high groundwater season. The high-water table on the project site was determined using the monitoring data and adjusted by Frimpter method. Out of the seven wells, only two had water present. Groundwater monitoring results are presented in Appendix D.

The groundwater under the project site area generally flows east and northeast to west. The SAS is mainly located in the central west part of the site. The groundwater depth is more than 10 ft below ground surface. The NRCS soil rated the soil in this area as Hollis Rock Outcrop and Charlton Complex soil. The SAS area is in a broad valley with fairly thick coarse medium sand deposit and very permeable. The soil testing and groundwater monitoring data confirmed the condition.

6.2 High Groundwater Table.

The high groundwater table for the SAS was determined using monitoring data during high groundwater season and adjusted with USGS Frimpter method in accordance with 310 CMR 15.103 (3). As we stated in early sections, most of the test pits were observed dry during soil evaluation. We made an extra effort to use large machinery and get to water in the two lower test pits, DHTP 55-10 AN and DHTP 55-11AN, which had water at the depth of about 14.5 ft to 18 ft. The actual groundwater detected in the two soil test pits is in line with the nearby wetland during high groundwater season in about 110 ft distance. It is a good evidence that the saturated aquifer in the area is very productive to allow such a mildly sloped (almost flat) water table.

7.0 Subsurface Testing and Samples

7.1 Soil borings.

Given the highly variable terrain in the area and the consistent soil conditions we observed in the SAS area, it is our professional judgement that no soil borings are needed to design the proposed SAS system properly and adequately. Therefore, no soil borings were pursued for the study.

7.2 Percolation and Permeability Test.

Creative Land & Water Engineering, LLC (CLAWE) has been conducting a hydrogeologic study of the site in accordance with 310 CMR15 for a common large Title 5 Septic system. CLAWE conducted eight deep hole soil observations successfully, 4 percolation testing to show consistent soil conditions throughout the SAS area. See Figure 6 for locations. Soil logs are presented in Appendix B. The tests were witnessed by Mr. Mark Oram of Sherborn Board of Health Agent. CLAWE's soil evaluation and percolation tests showed that the soil in the proposed SAS area has a percolation rate between 3 min/in to 5 min/in, which confirms the very permeable soil condition in this area. Based on the percolation rate, a permeability of 24 ft/day hydraulic conductivity is recommended to be used for groundwater mounding analysis. The detailed test results are attached in Appendices B and C.

8.0 Water Quality Sampling.

No known water quality sampling was collected for the onsite Title 5 soil testing. There is a newly installed private water supply well at 53 Farm Road in the past two years. The water quality sampling was conducted as Town of Sherborn required and available at the Sherborn Board of Health.

9.0 Groundwater Mounding and SAS Sizing

In order to determine the elevation of the leaching field, Creative Land & Water Engineering, LLC conducted a groundwater analysis for the proposed treatment system according to DEP "*Guidelines for Hydrogeologic Evaluations*" and 310 CMR 15.000. The study consists of deep-hole observations, available hydrogeological information review, monitoring, and calculations of possible mounding due to the proposed septic system. This section presents the results of the groundwater mounding calculations.

9.1 Sizing Leach Field

The leaching area, or SAS, is sized using a sewage disposal rate of 0.74 gallons per square foot per day for percolation rates less than 5 min/in in loamy sand soil per 310 CMR15.242. Two leaching fields are designed for both primary and reserved uses. See Figure 6 for details of the location of the fields. The reserved leaching area will be located between the primary leaching areas in order to minimize the impact on groundwater mounding height. The large field (L1 and L2) consists of twelve (12) 78-ft laterals, the smaller field consists of six (6) Cultec Contactor 202 chamber trenches. See Figure 6 and plans for layout and details. The effluent from the treatment system will be pressure dosed by three pumps to L1, L2, and L3. L1 and L2 are lined together and was combined in groundwater mounding analysis.

9.2 Estimation of Hydraulic Conductivity

The onsite soil evaluation indicated that the soils above and around the existing groundwater table are very permeable coarse medium loamy sand. The mounding is controlled by the horizontal hydraulic conductivity. Given the soil texture and percolation rate of 3 mpi to 5 mpi, the hydraulic conductivity is estimated as 24 ft/day. The average aquifer depth is 14.09 ft for L1 and L2; and 9.5 ft for L3. These results are based on deep-hole observation in Appendix A.

9.3 Groundwater Mounding Calculations

A computer program using Hantush method is used to calculate the groundwater mounding from the proposed septic system. The parameters were determined by onsite soil testing as follows.

Sewage Discharge Rate	= 8360 GPD (see Table 1)
Hydraulic Conductivity	= 24 ft/day. (see previous section)
Specific Yield	= 0.26 (R. Brown Groundwater, Elsevier Applied Sci. Publishers LTD 1986)
Impervious Datum	= 0-50 ft. BGS, conservative value 14.5 and 9.5 ft. is used, Figure 3.
Groundwater Table	= 279.5 ft. medium value with Frimpter adjustment (soil evaluation, and monitoring)
Effective Leaching Area	= 92 ft x 82 ft (L1-# and L2-#); 82 ft x 46 ft (L3-#)
Groundwater mounding time	= 90 days –recommended by DEP guideline.

The calculated maximum groundwater mounding heights are 0.73 ft (L1 and L2), 0.61 ft (L3). These values are added to the adjusted groundwater table at each trench line conservatively to make sure the maximum mounded high ground water table would be at least 4 ft below the bottom of each trench. The calculation sheets are attached in Appendix F.
It can be seen that there will be at least 7.35 ft groundwater separation assuming the high groundwater is at the dry test pit bottom. It will be at least 8.47 ft if the water table is based on the observed water tables in the two wet wells.

Table 9.1 - Hydraulic profile design summary of SAS

Line	Bottom Elev, ft	Dist to Ref well DHTP-11An, ft	EHGW with wet well, ft	Mound EHGW, ft	GW Sep, ft	EHGW with dry well, ft	Mound GW using dry tp, ft	GW Sep, ft
L 1-1	195.33	52.34	180.66	181.39	13.94	187.25	187.98	7.35
L1-2	194.83	50.565	180.62	181.35	13.48	186.68	187.41	7.42
L1-3	194.33	49.235	180.59	181.32	13.01	186.10	186.83	7.50
L1-4	193.83	47.98	180.56	181.29	12.54	185.53	186.26	7.57
L1-5	193.33	47.38	180.55	181.28	12.05	184.95	185.68	7.65
L1-6	192.83	89.75	181.49	182.22	10.61	184.38	185.11	7.72
L2-1	192.33	0	179.50	180.23	12.10	183.80	184.53	7.80
L2-2	191.83	0	179.50	180.23	11.60	183.23	183.96	7.87
L2-3	191.33	47.6	180.56	181.29	10.04	182.66	183.39	7.94
L2-4	190.83	48.2	180.57	181.30	9.53	182.08	182.81	8.02
L2-5	190.33	48.255	180.57	181.30	9.03	181.51	182.24	8.09
L2-6	189.83	51.105	180.63	181.36	8.47	180.93	181.66	8.17
L3-1	193.33	37	180.32	180.92	12.41	184.95	185.56	7.77
L3-2	192.83	35	180.28	180.88	11.95	184.38	184.99	7.84
L3-3	192.33	0	179.50	180.10	12.23	183.80	184.41	7.92
L3-4	191.83	33	180.23	180.83	11.00	183.23	183.84	7.99
L3-5	191.33	36	180.30	180.90	10.43	182.66	183.27	8.06
L3-6	190.83	41	180.41	181.01	9.82	182.08	182.69	8.14
Average					11.35			7.82
Minimum					8.47			7.35

Note: The max mounding height in L1 and L2 is 0.73 ft
The max mounding height in L3 is 0.61 ft

Table 9.2 - Summary of groundwater mounding analysis - SAS

Parameters	Leaching Field		Note
Recharge area	SAS 1+2	SAS3	All trenches are placed more than 8 ft above the estimated highgroundwater and not be impacted by groundwater mounding.
Dimension, Length, ft	92	82	
Dimension, Width, ft	82	46	
Area, sq. ft	7544.00	3772.00	
Recharge Vol. Cu ft (per day or event)	745.10	372.55	
Duration, day	90	90	
Recharge rate, cu ft/day/sq. ft	0.10	0.10	
Dewater time, day	90	90	
GW Separation, ft	8.49	12.58	
Distance to wetland, ft	125	125	
Maximum mounding height, ft	0.73	0.61	
Estimated effective Max MH, ft	**0.73**	**0.61**	
Impact mounding height by other systems, ft	**0**	**0**	
Combined Mound height, ft	**0.73**	**0.61**	
Bottom of Trench, ft	**192.58**	**192.08**	
Top of stones, ft			
EHGW, ft	184.09	179.5	
	average		
Bottom aquifer, ft	**170**	**170**	
Flood routing elev, ft	291.670	291.670	
Top of grade, ft	292.5	275.5	
Aquafer depth, ft	14.09	9.5	
Hydraulic Conductivity, ft/day	24.00	24.00	

9.4 Groundwater Separation

Field investigations were conducted for a proposed leaching field of the on-site private wastewater disposal area. The parameters determined by field investigations and testing were used to calculate groundwater mounding due to the proposed leaching field. The proposed leaching area is divided into two separate areas with three dosing zones. The wastewater will be treated with a DEP approved I/A system to treat the effluent to the secondary standards or better. The function of vertical separation, we found that a **4 ft vertical separation** between the bottom of leaching trenches/fields and the climax of the mounding will be adequate to protect the underlying groundwater as most of the state only apply about 2 ft groundwater separation.

1. **Less than half of the average depth to bedrock (25 ft) as estimated in surficial geology map was used as the aquifer base.** This implies a conservative mounding height calculation.
2. 90 days of mounding time was used to calculate the mounding height. As we observed that the highest groundwater occurs about within about a month of the start of the growing season, then the groundwater table starts to drop, which generally overrides the extra mounding height. Given that the natural groundwater water table fluctuates 4-10 ft during high and low groundwater tables in loose till materials, the 90 days of mounding time will be very conservative. A more realistic mounding time would be 30 days to 60 days, which would yield smaller mounding heights.
3. As research revealed, viral deactivation occurs within 40 centimeters (16 inches) with unsaturated flow (Lance et al, 1976; Lance and Gerba, 1984); fecal coliforms were reduced to background levels within 61 centimeters (2 ft) of the trench bottom. Even in a sandy soil, Ziebell et al (1974) reported a 3000-fold reduction in bacteria levels 38 centimeters (15 inches) below the trench bottom and 30 centimeters (1 ft) laterally. In laboratory studies, Magdoff et al (1974) noted complete removal of fecal coliforms and fecal streptococci in a 90 centimeters (3 ft) column containing sand underlain by silt loam. Tyler et al (1977) stated that at a distance of 1 ft into the soil surrounding the trench, there was a 3 log reduction in bacterial numbers and within the second foot counts were to the acceptable range for fully treated wastewater. Lysimeter tests of the impact of septic field leachate on groundwater indicates that coliphage viruses and fecal coliform bacteria were removed by passage through approximately 100 centimeters (40 inches) of any of the soils tested (Bouma, et al. 1972). That is why many states only require 2-ft vertical groundwater separation in their regulations, e.g. Connecticut. A separation of more than 2 ft as required in 310 CMR 15.00 would give some safety guard for errors in design and high groundwater determination. For the present project, the advanced treatment (secondary) and additional adjustment added to the observation data during high groundwater season would provide good protection.
4. The leaching field bottom is set on average more than 10 ft from adjusted observed high groundwater table with mounding overlay.
5. The area of the leaching field **is not** located within any protected groundwater recharge zones. The closest wetland or open water resources are located more than 108 ft downgradient. The SAS is more than 309 ft downgradient from any onsite drinking water wells. More than 141 ft downgradient of the well at 55 Farm Road. More than 392 ft from well at 49 Farm Road at crossing gradient. More than 252 ft from well at 53 Farm Road at crossing gradient.
6. Other criteria on lateral separation, excavation, and fill slope from 310 CMR 15.255 were applied to the project design. See site plan for details.

10.0 Summary

A hydrogeologic evaluation for the project has been conducted including historic review, subsurface investigation, groundwater monitoring, percolation testing, and groundwater mounding impact by the proposed SAS discharge. The major conclusions are summarized as the following:

1. The field evaluation and testing of soils and water in conjunction with groundwater mounding calculations all show that this area of the property is suitable for the proposed onsite wastewater disposal area.
2. The soil on site consists of loose till coarse medium loamy sand in proposed SAS area with consistent percolation rate ranging from 3 mpi to 5 mpi.
3. The underlying bedrock is made of Felsic volcanics, which is formed due to explosive volcanic activities bordered by metamorphic rocks, where the interaction would have increased the structural fractures and increase permeability through rocks.
4. The surface geology map shows that the area has unconsolidated soil depth ranging 0-50 ft from rock outcrop area and deep valley deposit. This is consistent with our site soil evaluation.
5. A total of 9 monitoring wells are installed in 10 deep hole test pits for the SAS siting. Except for two wells, all other wells were observed dry.
6. The two wells observed water were advanced to the depth of nearby wetland.
7. 15 ft of water depth has been observed in the isolated wetland area, which is an excavated pond containing water year around.
8. The slowest percolation rate 5 mpi is used to estimate the hydraulic conductivity and the aquifer depth of 9.5 ft and 14.09 was used for groundwater mounding analysis.
9. The SAS consists of three dosing fields: L1, L2, and L3, each is done by a 1.5 hp dosing pump working alternately. Each dosing field consists of 6 trenches with Cultec Contactor 202 chamber. L1 and L2 are in one large field. L3 is separate in nearby area.
10. The groundwater mounding heights is calculated 0.73 ft for joint fields 1 and 2, and 0.61 ft for field 3. Based on monitored groundwater in two wet wells during high groundwater season and 1.83 ft of additional groundwater corrections, all SAS trenches have an average groundwater separation of 11.35 ft and minimum of 8.47 ft. If the dry bottom of test pits is assumed as high groundwater table with additional correction of 1.83 ft to 2.38 ft, the SAS trenches will have an average of 7.82 ft groundwater separation to the mounded peak elevation and minimum of 7.35 ft.

References.

1. Finnemor, E., John, "Estimation of Ground-water Mounding Beneath Septic Drain Fields", *Ground Water*, Vol. 31, No. 6, 1996.
2. Hall, Selden, "Vertical Separation – A review of available scientific literature and a listing from fifteen other states," Office of Environmental Health and Safety, Washington State Department of Health, P.O. Box 47825, Olympia, WA 98504-7825.
3. Wang, Desheng "**A Simple Steady-State Mathematical Model for Groundwater Mounding Calculations in Layered Heterogeneous Aquifer**" Personal communication report.

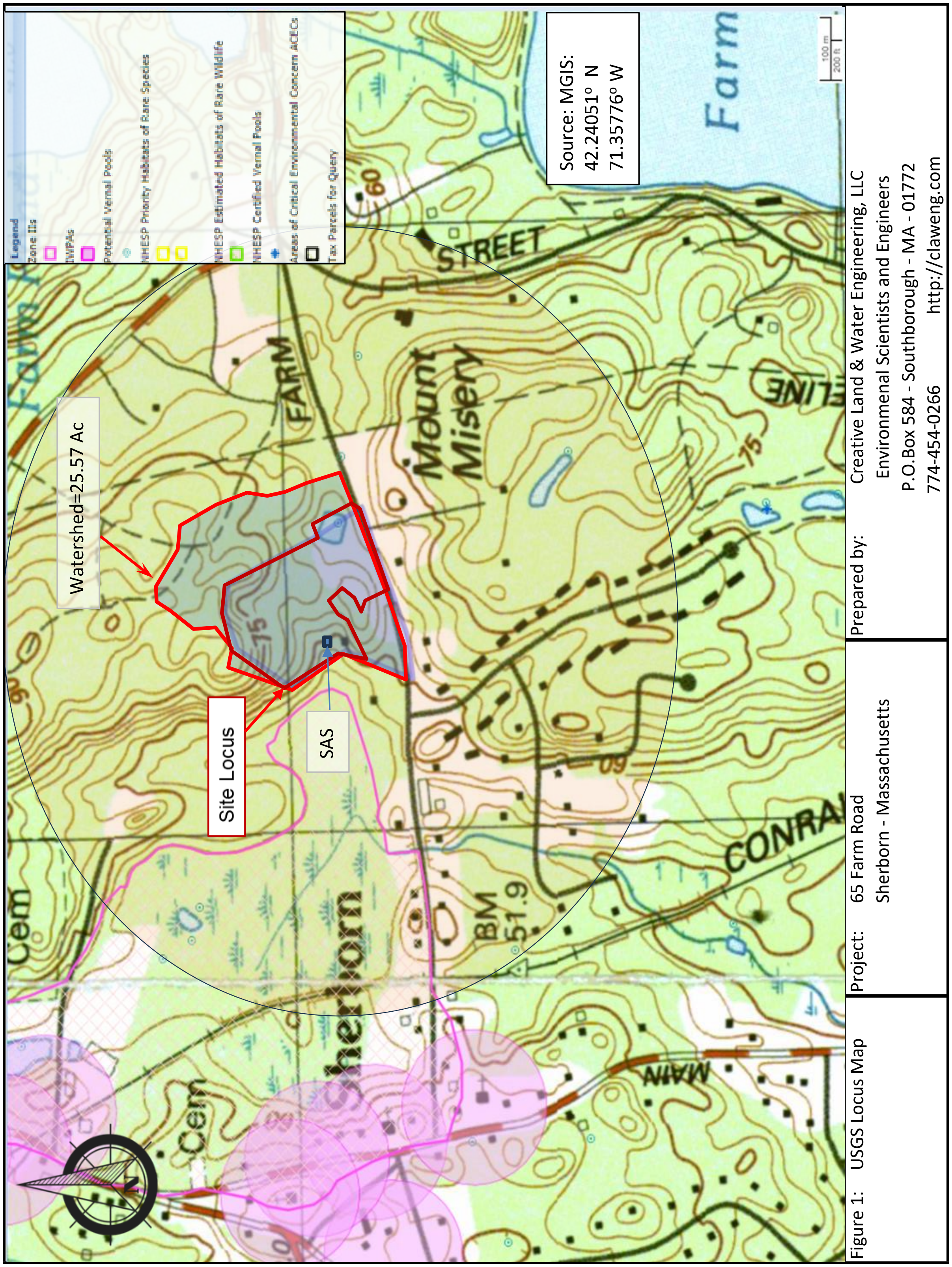
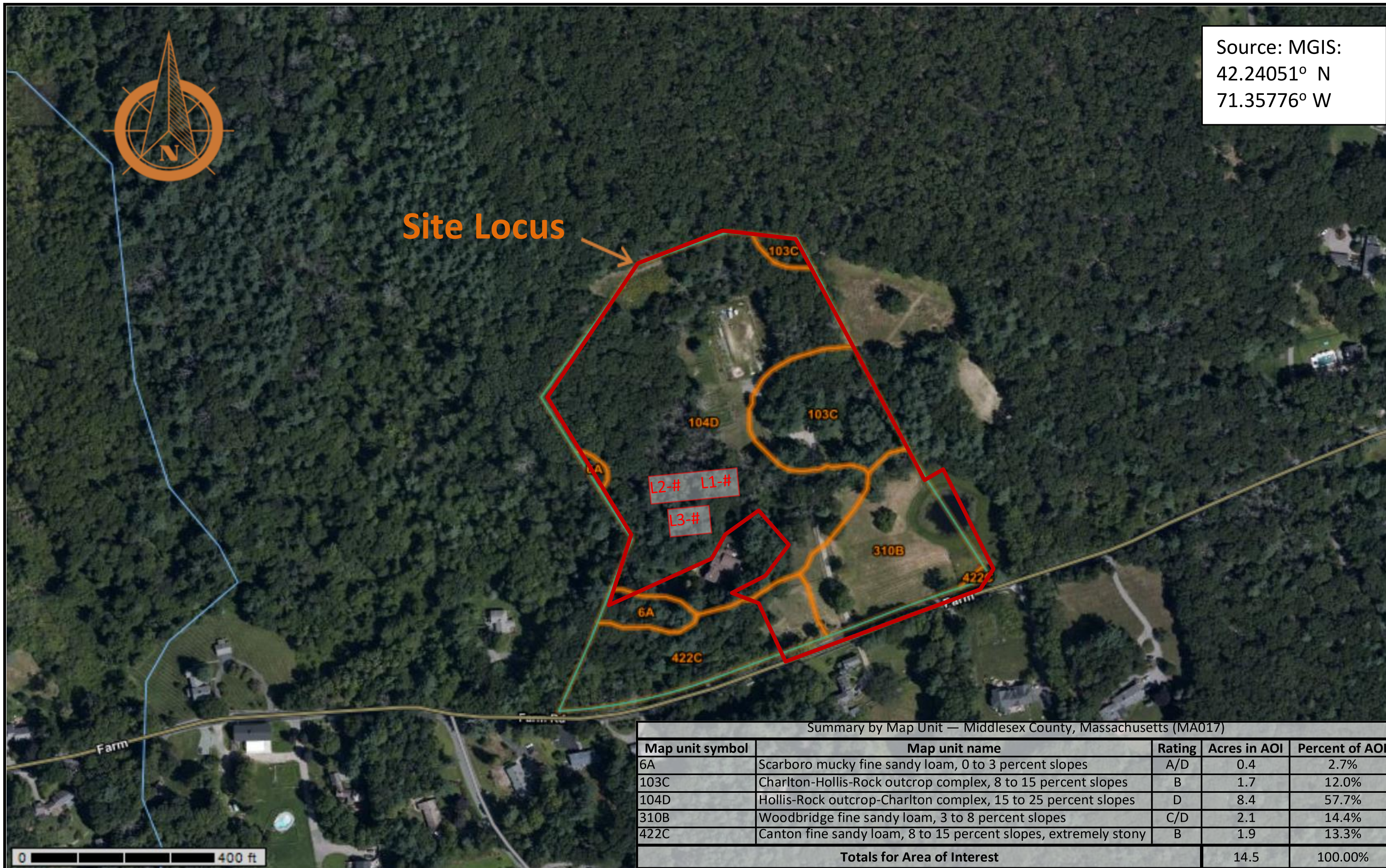


Figure 1 - Locus Map



Summary by Map Unit — Middlesex County, Massachusetts (MA017)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	0.4	2.7%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	1.7	12.0%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes	D	8.4	57.7%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	2.1	14.4%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	B	1.9	13.3%
Totals for Area of Interest			14.5	100.00%

Figure 2: NRCS Soil Map	Project: 65 Farm Road Sherborn - Massachusetts	Prepared by: Creative Land & Water Engineering, LLC Environmenal Scientists and Engineers P.O.Box 584 - Southborough - MA - 01772 774-454-0266 http://claweng.com

Figure 2 - Soil Distributions

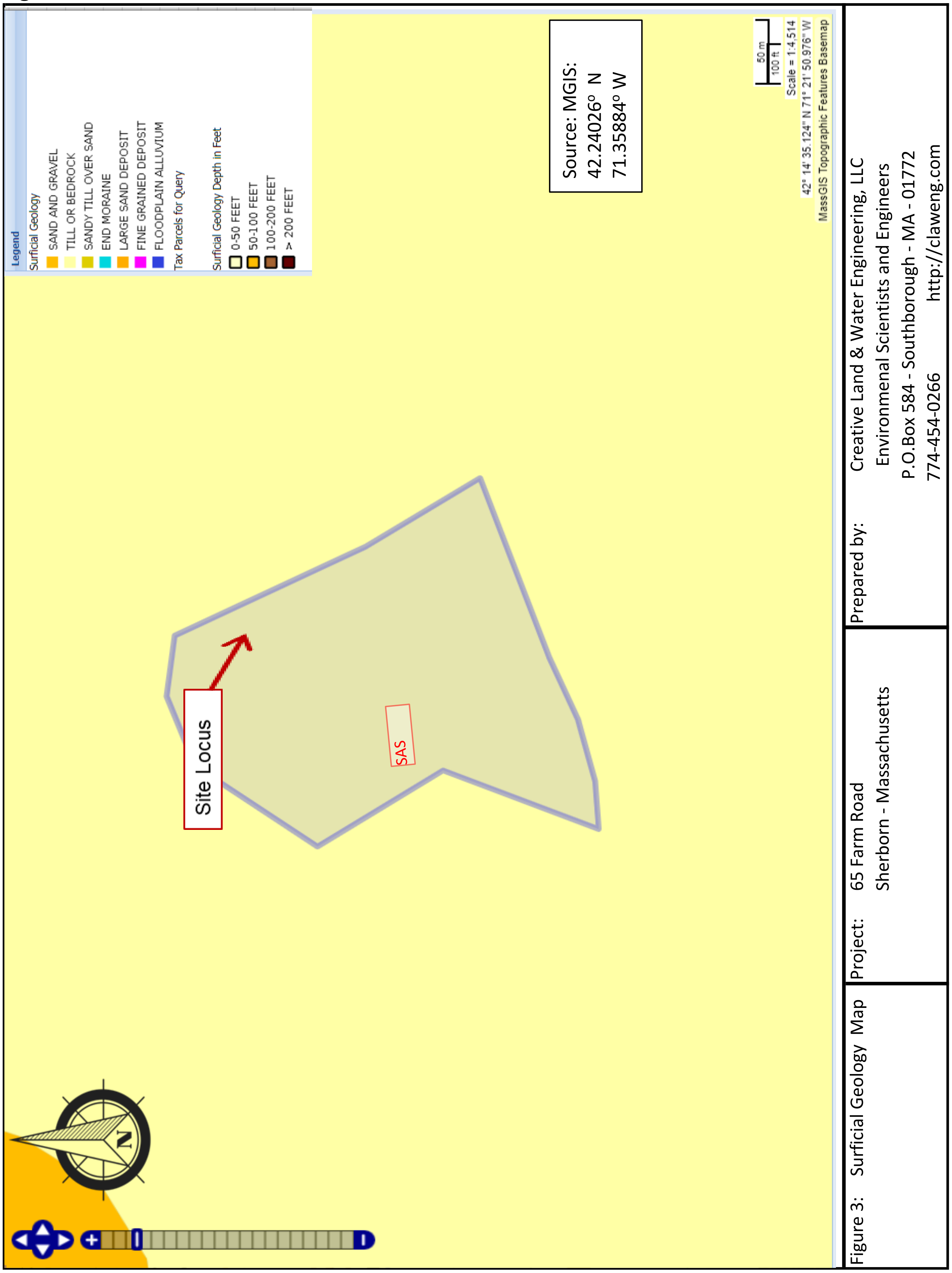


Figure 3 - Surficial Geology

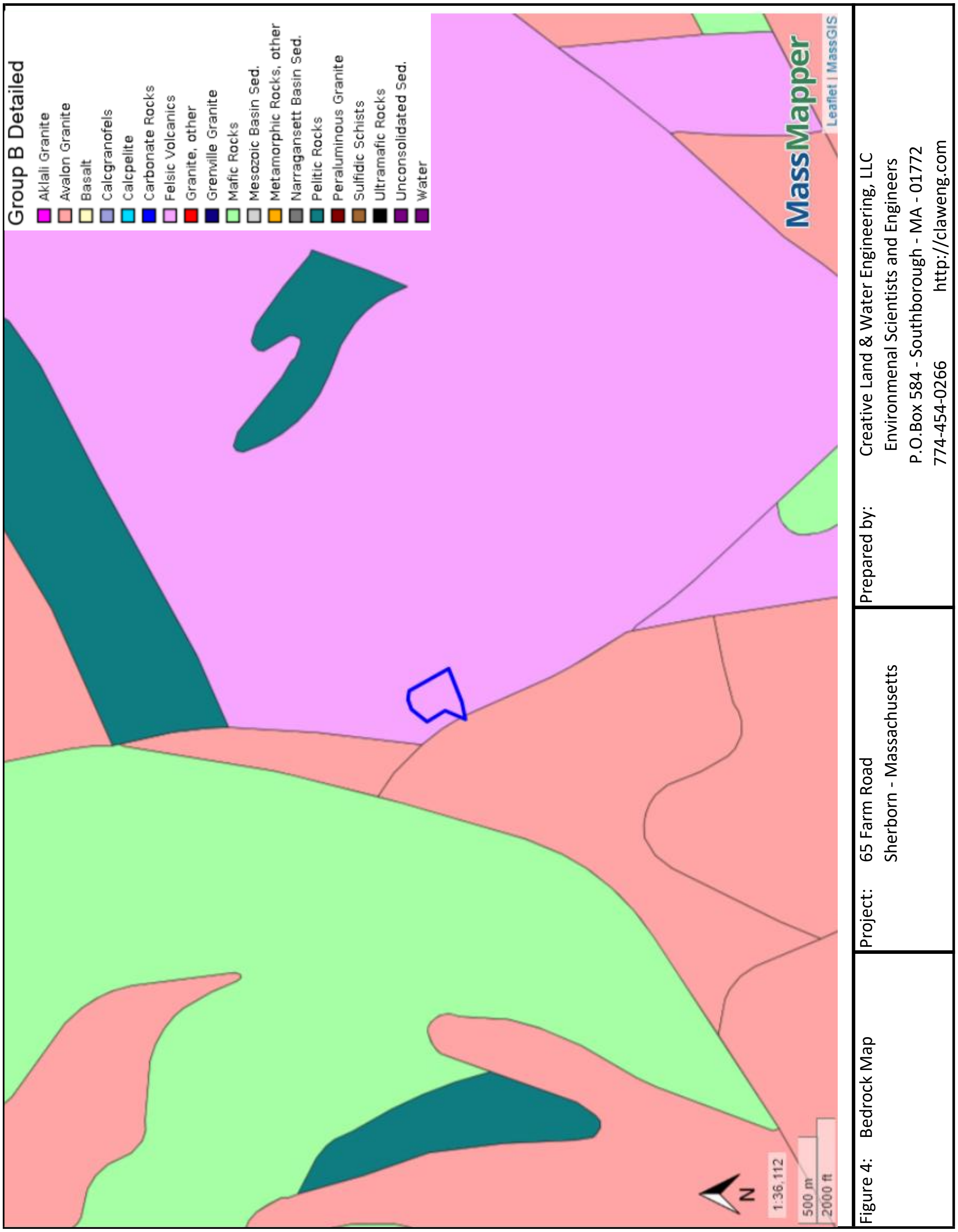


Figure 4 - Bedrock Geology – MGIS

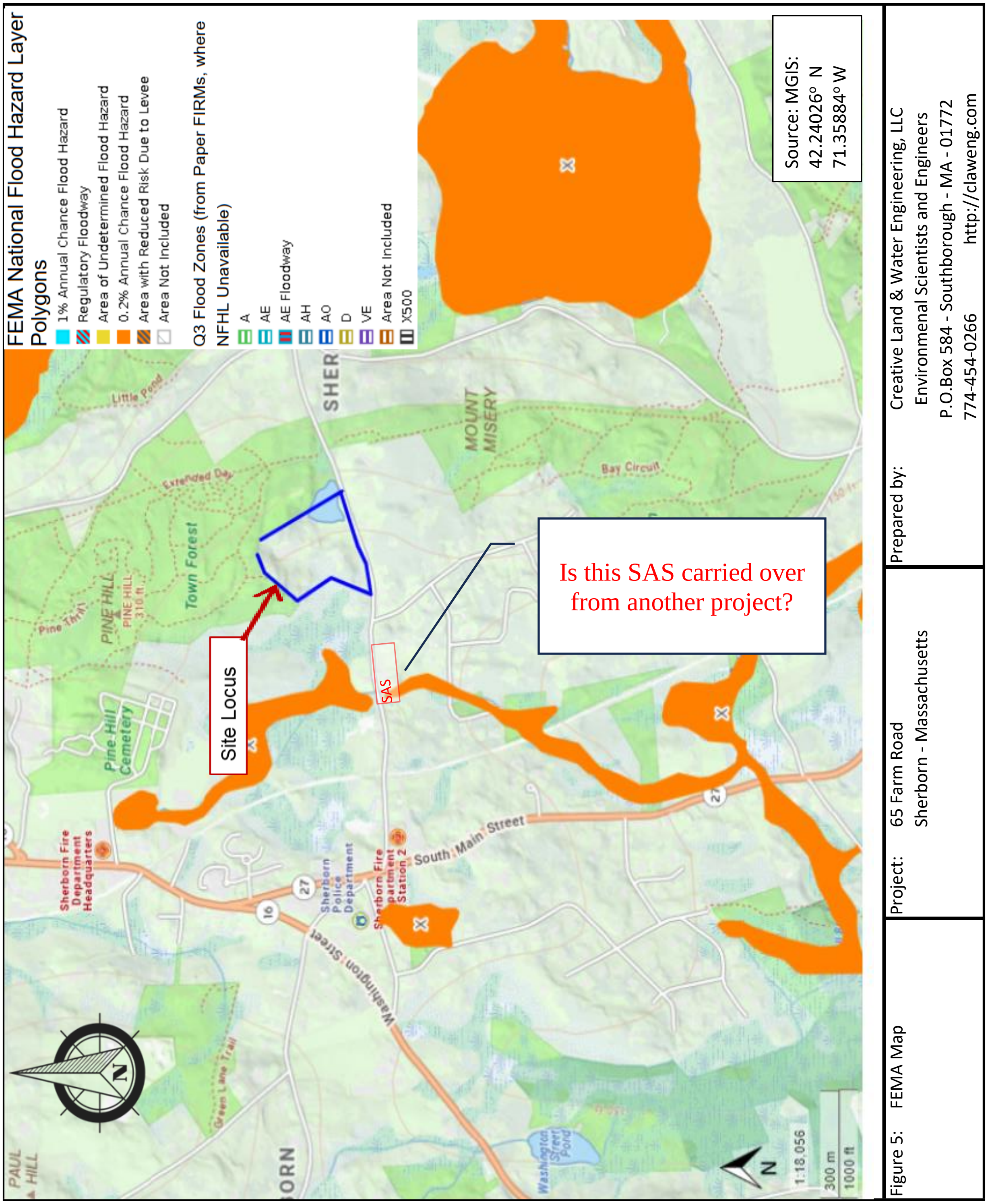


Figure 5 - FEMA Map

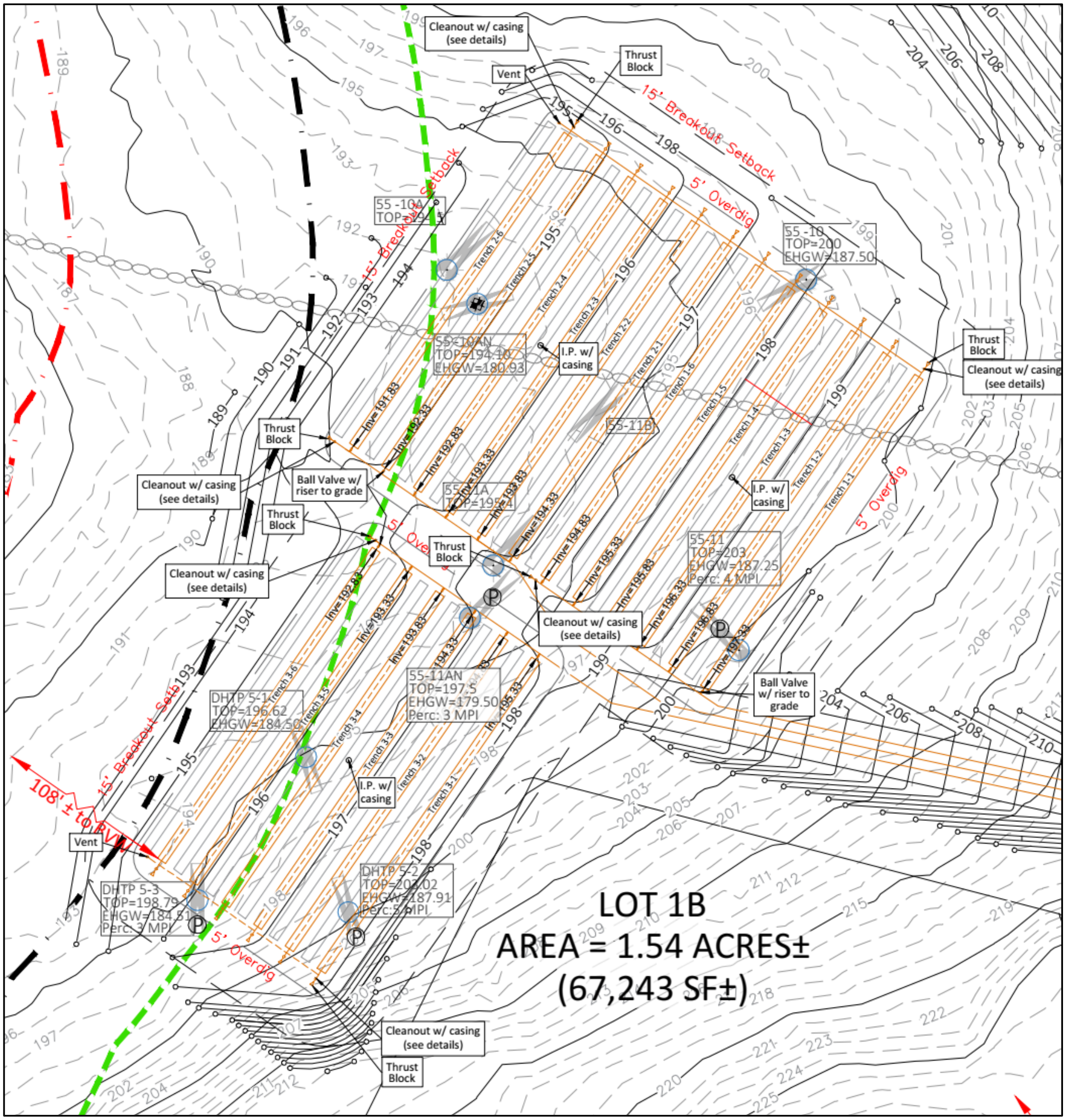


Figure 6 - Soil Testing and Monitoring Well Plan

Creative Land & Water Engineering, LLC	Subject: Estimate Hi-WT by USGS (Frimpter) Method		
Environmental Science and Engineering Service	55(2) and 65 Farm Road	By: DSW	Date: 23-Apr-21
P.O. Box 584, Southborough, MA 01772	Sherborn, MA	Chkd:	Date:
Tel: (508)281-1694 Email: desheng@yahoo.com	Location:	Job No.: J269-10	Sheet: 1

Formulation

Sc-Sh/OWc-OWmax = Sr /OWr

Sh = Sc - Sr/OWr(OWc - OWmax)

in which, Sc = measured depth to water at the site;

Sh = estimated depth to probable high water level at the site;

OWc = measured depth to water in the observation well;

OWmax = depth to recorded maximum water table at the observation well;

Sr = range of water where the site is located;

OWr = recorded upper limit of annual range of water level at the observation well.

Input Report **USGS observation well:** WINCHENDON (XNW) 13

Date/Address	MW	Soil Type	Sc	Sr	OWc	OWmax	OWr	Ground Elev.	Reference Well used
4/27/2021			ft	ft	ft	ft	ft	ft	
55 Farm Rd	55-10	Till/LS	11.25	10	3.84	1.86	10.82	196.92	WINCHENDON (XNW) 13
	55-10An	Till/LS	13.00	10	3.84	1.86	10.82	192.10	WINCHENDON (XNW) 13
	55-11	Till/LS	15.58	10	3.84	1.86	10.82	201.00	WINCHENDON (XNW) 13
	55-11An	Till/LS	16.25	10	3.84	1.86	10.82	193.92	WINCHENDON (XNW) 13
65 Farm Rd	65-10	Till/LS	9.83	10	3.84	1.86	10.82	215.87	WINCHENDON (XNW) 13
	65-10A	Till/LS	10.50	10	3.84	1.86	10.82	220.60	WINCHENDON (XNW) 13
	65-10B	Till/LS	11.08	10	3.84	1.86	10.82	215.90	WINCHENDON (XNW) 13
	66-10C	Till/LS	12.58	10	3.84	1.86	10.82	217.53	WINCHENDON (XNW) 13
	66-10D	Till/LS	14.00	10	3.84	1.86	10.82	212.90	WINCHENDON (XNW) 13
	55-4	Till/LS	17.75	10	3.84	1.86	10.82	213.77	WINCHENDON (XNW) 13
								assumed	

Output Report

Date	MW	Depth to HW, Sh, ft	Correction, ft	High Water Table Elev. (ft)	
4/27/2021	55-10	9.42	1.83	187.50	
	55-10An	11.17	1.83	**180.93**	
55 Farm Rd	55-11	13.75	1.83	187.25	
	55-11An	14.42	1.83	179.50	
	65-10	8.00	1.83	207.86	
	65-10A	8.67	1.83	211.93	
65 Farm Rd	65-10B	9.25	1.83	206.65	
	66-10C	10.75	1.83	**206.78**	dry
	66-10D	12.17	1.83	**200.73**	
	55-4	15.92	1.83	**197.85**	dry

Notes:

1. Groundwater level in XNW 13 Winchendon was measured on 4/23/2021.
2. Onsite ground water was meaured with Mr. Mark Oram on 4/23/2021 by Desheng Wang
3. Ten (10) ft of water level range for till slope (Sr) as required by Mr. Mark Oram.
4. Test pits 55-2, 55-3, 55-4, 55-10, 55-10An, 55-11, 55-11An, and 65-10D were found dry and did not reflect the true water table rather for reference.

Figure 7 - EHGW by USGS (Frimpter) Method. 04/23/21

Creative Land & Water Engineering, LLC
Environmental Science and Engineering Service
P.O. Box 584, Southborough, MA 01772
Tel: (508)281-1694 Email: desheng@yahoo.com

Subject: Estimate Hi-WT by USGS (Frimpter) Method
55(2) and 65 Farm Road
Sherborn, MA
Location:

By: DSW **Date:** 29-Nov-21
Chkd: **Date:**
Job No.: J269-10 **Sheet:** 1

Formulation

Sc-Sh/OWc-OWmax = Sr /OWr
Sh = Sc - Sr/OWr(OWc - OWmax)

in which, Sc = measured depth to water at the site;
Sh = estimated depth to probable high water level at the site;
OWc = measured depth to water in the observation well;
OWmax = depth to recorded maximum water table at the observation well;
Sr = range of water where the site is located;
OWr = recorded upper limit of annual range of water level at the observation well.

Input Report **USGS observation well:** WINCHENDON (XNW) 13

Date	MW	Soil Type	Sc	Sr	OWc	OWmax	OWr	Ground Elev.	Reference Well used
11/24/2021			ft	ft	ft	ft	ft	ft	
Lot5	DHTP 5-1	Till/LS	**12.92**	10	4.43	1.86	10.82	195.04	WINCHENDON (XNW) 13
	DHTP 5-2	Till/LS	**15.24**	10	4.43	1.86	10.82	200.77	WINCHENDON (XNW) 13
	DHTP 5-3	Till/LS	**15.91**	10	4.43	1.86	10.82	198.04	WINCHENDON (XNW) 13
									WINCHENDON (XNW) 13
Lot 4	DHTP 4-1	Till/LS	10.00	10	4.43	1.86	10.82	222.86	WINCHENDON (XNW) 13
	DHTP 4-2	Till/LS	**11.50**	10	4.43	1.86	10.82	217.92	WINCHENDON (XNW) 13
	DHTP 65-10A	Till/LS	**11.11**	10	4.43	1.86	10.82	220.60	WINCHENDON (XNW) 13
		Till/LS							WINCHENDON (XNW) 13
Lot 3 House	SL-TP4 (house)	Till/LS	10.00	10	4.43	1.86	10.82	221.41 assumed	WINCHENDON (XNW) 13

Output Report

Date	MW	Depth to HW, Sh, ft	Correction, ft	High Water Table Elev. (ft)	Note
11/24/2021	DHTP 5-1	10.54	2.38	184.50	dry use Pit DHTP 55-11N
	DHTP 5-2	12.86	2.38	**187.91**	dry
	DHTP 5-3	13.53	2.38	184.51	dry
Lot5	0				
Lot 4	DHTP 4-1	7.62	2.38	**215.24**	dry use other pit for GW
	DHTP 4-2	9.12	2.38	**208.80**	
	DHTP 65-10A	8.73	2.38	**211.87**	
	0				
Lot 3 House	SL-TP4 (house)	7.62	2.38	213.79	dry

Notes:
1. Groundwater level in XNW 13 Winchendon was measured on 11/24/2021.
2. Onsite ground water was meaured with Mr. Mark Oram on 11/24/2021 by Desheng Wang
3. Ten (10) ft of water level range for till slope (Sr) as required by Mr. Mark Oram.
4. Test pits 4-1, 5-1, 5-2, 5-3, and SL-TP4 were found dry and did not reflect the true water table rather for reference.

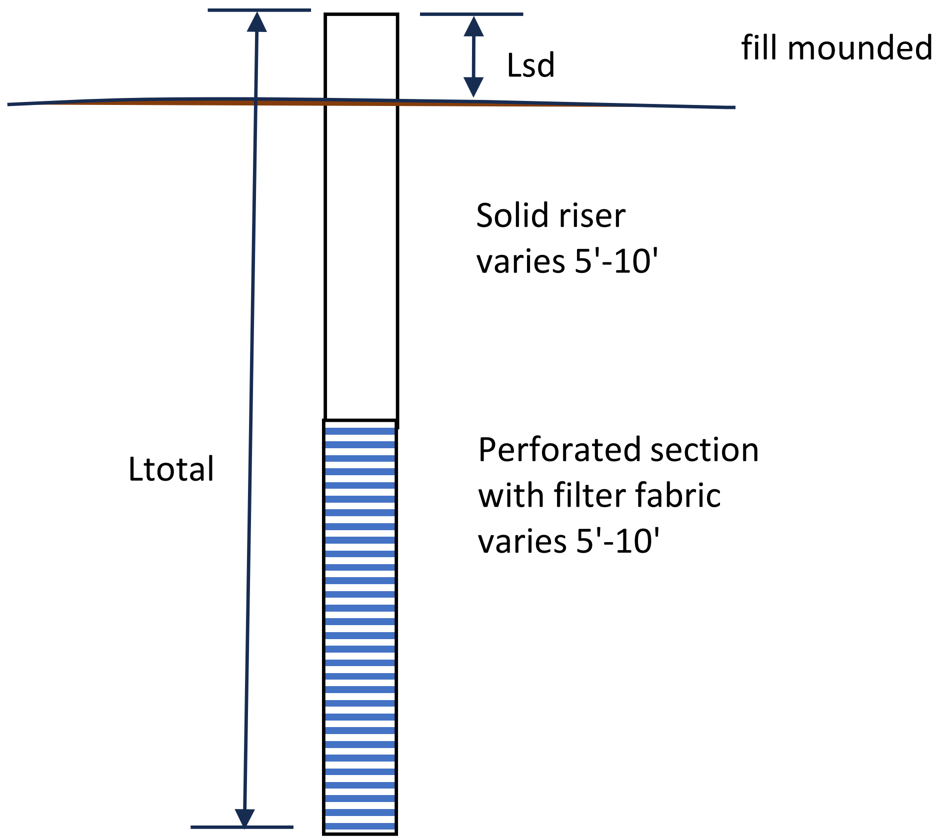
WINCHENDON (XNW) 13
Start year of record - 1939
Land-surface elevation 1209.36 ft, well depth 13.5 ft
Lithology - TILL
Topographic setting - HILLSIDE
Remarks - none
Period of record - HIGH (OWmax) 1.86, LOW 13.50, (OWr)10.82

Figure 8 - EHGW by USGS (Frimpter) Method. 11/29/21

Appendix A: Well Logs, and Well Profile

The groundwater monitoring wells are 4" perforated pipe protected with filter fabric installed in the deep hole soil evaluation holes by excavator per Sherborn Board of Health requirement. Test pits 55-10, 55-10An, 55-11, 55-11An, 5-1, 5-2, and 5-3 were found dry and did not reflect the true water table rather for reference. See soil log in Appendix B. DHTP -11B just to verify soil and no monitoring pipe installed in it.

Test Pit	Soil Texture	Total depth, inches	Perc. Rate, mpi	Approx. GS elev, ft	Top of pipe elev., ft	Water depth below GS, ft		
						Outstanding pipe, in	11/24/2021	4/27/2021
DHTP 5-1	Till/LS	174	-	195.04	196.62	19	12.92	
DHTP 5-2	Till/LS	209.88	5	200.77	203.02	27	15.24	
DHTP 5-3	Till/LS	199.92	3	198.04	198.79	9	15.91	
DHTP 55-10	Till/LS	135.00	-	**196.92**	200.00	37.00	11.25	11.25
DHTP 55-10An	Till/LS	174.00	-	**192.10**	194.10	24.00	13.00	13.00
DHTP 55-11	Till/LS	192.00	4.00	**201.00**	203.00	24.00	15.42	15.58
DHTP 55-11An	Till/LS	216.00	3.00	**193.92**	197.50	43.00	15.42	16.25
DHTP 55-11B	Till/LS	120.00		**194.00**	N/A			



Typical Monitoring Well Profile

Appendix B: Soil Logs and Percolation Testing Records

This Appendix presents the record of soil evaluation and percolation tests by creative Land & Water Engineering, LLC. on April 23, 2021 and November 24, 2021.

Test Pit #	Test Date	GSE (ft)	Depth to pit bottom (ft)	Soil Texture	Adjusted Depth to HGW (ft)	Water adjustement, ft	EHGW, ft	Perc rate, mpi	Perc depth, in	Bottom Hole El, ft	Ledge Note: L=ledge;N=no ledge; U=unknown	Note
DHTP 55-10	4/23/2021	196.92	11.25	Co. M. L.S.	9.42		187.50			185.67	N	well installed,upslope, dry
DHTP 55-10An	4/23/2021	192.10	14.50	Co. M. L.S.	11.17		180.93			177.60	U	Well installed,lower SLP, some weeping
DHTP 55-11	4/23/2021	201.00	16.00	Co. M. L.S.	13.75	1.83	187.25	4.00	54.00	185.00	N	Well installed, upslope, dry
DHTP 55-11An	4/23/2021	193.92	18.00	Co. M. L.S.	14.42		179.50	3.00	54.00	175.92	U	Well installed, lower SLP, some weeping
DHTP-55-11B	4/23/2021	194.00	10.00	Co. M. L.S.	n/t		n/t			184.00	U	No well, confirm soil, mid slope, dry
DHTP 5-1	11/24/2021	195.04	14.50	Co. M. L.S.	10.54		184.50			180.54	N	Well installed, lower SLP, dry
DHTP 5-2	11/24/2021	200.77	17.49	Co. M. L.S.	12.86	2.38	187.91	5.00	64.00	183.28	N	well installed, upslope, dry
DHTP 5-3	11/24/2021	198.04	16.66	Co. M. L.S.	13.53		184.51	3.00	60.00	181.38	N	well insttalled, upslope, dry

Note: 1. Nearby downgradient wetland is at elevation of 177-178, which is in line with the weeping water elevation in Test pits DHTP-11An and DHTP-10An; 2. Except the two test pits, other test pits were dry and no water measured and the water table based on the depth of hole is a conservative estimate and normally will not be considered.

Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Trinity Farm, LLC.
Owner Name

55 Farm Road (Lot 5)
Street Address

Assessors Map 11, Lot 60
Map/Lot #

Sherborn
City

MA
State

01770
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: Web Soil Survey (Source) 422C (Soil Map Unit)

Hollis-Rock outcrop-Charlton complex
Soil Name

Soil Limitations

Coarse-loamy over sandy melt-out till
Soil Parent material

Moraine
Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: USGS - 2018 (Year Published/Source) 3402 (Map Unit)

Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer:
Wetland Type

7. Current Water Resource Conditions (USGS): 11/24/2021 (Month/Day/ Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal

8. Other references reviewed:

Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: DHTP 5-1 (Hole #) | 11/10/2021 (Date) | 12:00 PM (Time) | 60s°F, Cloudy (Weather) | 42.24002° N (Latitude) | 71.35913° W (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | ______ Vegetation | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: Coarse-loamy over sandy melt-out till | Moraine (Landform) | SS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 125+ feet | Drainage Way -- feet | Wetlands 125+ feet
   Property Line 20+ feet | Drinking Water Well 150+ feet | Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No   If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No   If yes: none Depth Weeping from Pit   none Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0 - 9	A	S.L.	10 YR 3/2							Friable	
9 – 36	B	S.L.	2.5 Y 6/6							Friable. Bldrs	
36 – 168+	C	Co.M.L.S.	2.5 Y 5/4							Dense. 20% Stones	

Additional Notes: SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: DHTP 5-2 (Hole #) 11/09/2021 (Date) 3:25 pm (Time) 60s°F, M. Sunny (Weather) 42.24002° N (Latitude) 71.35913° W (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: Coarse-loamy over sandy melt-out till; Moraine (Landform); SS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 125+ feet; Drainage Way -- feet; Wetlands 125+ feet; Property Line 20+ feet; Drinking Water Well 150+ feet; Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: none Depth Weeping from Pit none Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0 – 4	A	S.L.	10 YR 3/2							Friable	
4 – 30	B	S.L.	2.5 Y 6/6							Friable	
30 -180+	C	Co.L.S.	2.5 Y 5/4							Fri-Loose	

Additional Notes: SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: DHTP 5-3 (Hole #) | 11/10/2021 (Date) | 11:04 pm (Time) | 60s°F, Cloudy (Weather) | 42.24002° N (Latitude) | 71.35913° W (Longitude:)

1. Land Use: Woods (e.g., woodland, agricultural field, vacant lot, etc.) | ______ Vegetation | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: Coarse-loamy over sandy melt-out till | Moraine (Landform) | SS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 125+ feet | Drainage Way -- feet | Wetland
   Property Line 20+ feet | Drinking Water Well 150+ feet | Other

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: none Depth Weeping from Pit none Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0 – 4	A	S.L.	10 YR 3/2							Friable	
4 – 30	B	S.L.	2.5 Y 6/6							Fri. L. Boulders	
30 – 54	C1	M.S.	2.5 Y 6/4							Loose	
54-180+	C2	Co.M.L.S.	2.5 Y 5/4							Dense. 20% Stones	

Additional Notes: SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

D. Determination of High Groundwater Elevation

1. Method Used:

	Obs. Hole # DHTP 5-1	Obs. Hole # DHTP 5-2	Obs. Hole # DHTP 5-3
☒ Depth observed standing water in observation hole	none inches	144 inches	144 inches
☒ Depth weeping from side of observation hole	none inches	144 inches	144 inches
☒ Depth to soil redoximorphic features (mottles)	none inches	none inches	none inches
☒ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	10.54 ft	12.86 ft	13.53 ft

Index Well Number 11/24/21

Reading Date

$S_h = S_c – [S_r \times (OW_c – OW_{max})/OW_r]$ See separate calculation sheet see analysis sheet for details

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater: _____ inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)?

DHTP 55-1	Upper boundary:	36 Inches	Lower boundary:	168 Inches
DHTP 55-2	Upper boundary:	30 Inches	Lower boundary:	180 Inches
DHTP 55-3	Upper boundary:	30 Inches	Lower boundary:	180 Inches

c. If no, at what depth was impervious material observed? Upper boundary: Inches Lower boundary: Inches

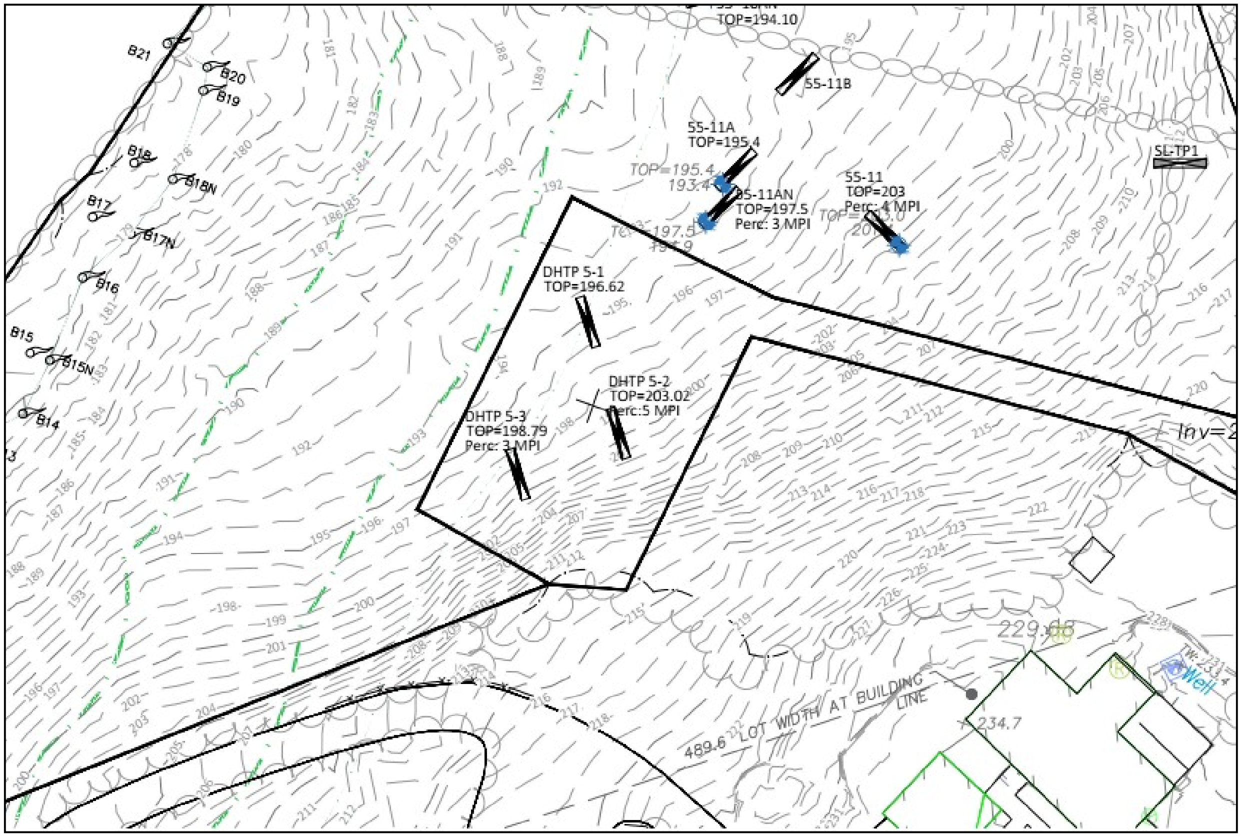
F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

Signature of Soil Evaluator	12/21/2021 Date
Desheng Wang/ SE2545 Typed or Printed Name of Soil Evaluator / License #	6/30/2022 Expiration Date of License
Mark Oram Name of Approving Authority Witness	Sherborn Board of Health Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams: See Soil testing plan for details



Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Fenix Partners Farm Road, LLC.
Owner Name

55 Farm Road (Area #2)
Street Address

Assessors Map 11, Lot 60
Map/Lot #

Sherborn
City

MA
State

01770
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: Web Soil Survey (Source) 104D (Charlton part) (Soil Map Unit)

   Hollis-Rock outcrop-Charlton complex
   Soil Name

   Soil Limitations

   Friable, shallow loamy basal till
   Soil Parent material

   Hills
   Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: USGS - 2018 (Year Published/Source) 3402 (Map Unit)

   Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: Wetland Type

7. Current Water Resource Conditions (USGS): 4/23/2021 (Month/Day/ Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal

8. Other references reviewed:

Commonwealth of Massachusetts
City/Town of Sherborn

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: DHTP-55-10AN (Hole #) 04/21/2021 (Date) 3:00 PM (Time) 54°F, Mostly Sunny (Weather) 42.24028° N (Latitude) 71.35899° W (Longitude:)

1. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) Pine forest (Vegetation) Boulders on surface (Surface Stones (e.g., cobbles, stones, boulders, etc.)) 3-10% (Slope (%))

   Description of Location:________________________

2. Soil Parent Material: Friable, shallow loamy basal till Moraine valley slope (Landform) TS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 200+ feet Drainage Way --- feet Wetlands 125+ feet
   Property Line 125+ feet Drinking Water Well 200+ feet Other --- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 168" Depth Weeping from Pit 168" Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-6	A	S.L.	10 YR 3/2	N/A						Friable	
6-30	B	S.L.	2.5 Y 6/6	N/A						Friable	
30-174	C	L.S.	2.5 Y 6/4	N/A						Fri-Dense	

Additional Notes: SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: DHTP-55-10 (Hole #) 04/21/21 (Date) 2:05 PM (Time) 54°F, M. Sunny (Weather) 42.24028° N (Latitude) 71.35899° W (Longitude:)

1. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) 10 Slope (%)

   Description of Location: See plan

2. Soil Parent Material: Friable, shallow loamy basal till Moraine valley (Landform) BS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 200+ feet Drainage Way -- feet Wetlands 200+ feet
   Property Line 125+ feet Drinking Water Well 125+ feet Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: 0 Depth Weeping from Pit 0 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-6	A	S.L.	10 YR 3/2	N/A						Friable	
6-30	B	S.L.	2.5 Y 6/6	N/A						Friable	
30-135	C	L.S.	2.5 Y 5/4	N/A						Dense-Fri	

Additional Notes:
SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area*)

Deep Observation Hole Number: DHTP-55-11 (Hole #) | 04/21/21 (Date) | 1:05 PM (Time) | 54°F, M. Sunny (Weather) | 42.24028° N (Latitude) | 71.35899° W (Longitude:)

1. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) | ____ Vegetation | ____ Surface Stones (e.g., cobbles, stones, boulders, etc.) | ____ Slope (%)

   Description of Location: See plan

2. Soil Parent Material: Friable, shallow loamy basal till | Moraine valley (Landform) | SS (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 200+ feet | Drainage Way -- feet | Wetlands 200+ feet

   Property Line 125+ feet | Drinking Water Well 125+ feet | Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: 0 Depth Weeping from Pit 0 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A	S.L.	10 YR 3/2							Friable	
4-30	B	S.L.	10 YR 6/6							Friable	
30-192	C	L.S.	2.5 Y 5/4							Dense-Fri	

Additional Notes:

SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: DHTP-55-11AN (Hole #) 04/21/21 (Date) 1:49 PM (Time) 54°F, M. Sunny (Weather) 42.24028° N (Latitude) 71.35899° W (Longitude:)

1. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location:

2. Soil Parent Material: Friable, shallow loamy basil till Moraine (Landform) ss (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 200+ feet Drainage Way -- feet Wetlands 140+ feet

   Property Line 175+ feet Drinking Water Well 175+ feet Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 204 Depth Weeping from Pit 204 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-4	A	S.L.	10 YR 3/2							Friable	
4-32	B	S.L.	2.5 Y 6/6							Friable	
32-216	C	L.S.	2.5 Y 5/4							Friable	

Additional Notes:
SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: DHTP-55-11B Hole # | 04/21/21 Date | 2:35 PM Time | 54°F, M. Sunny Weather | 42.24028° N Latitude | 71.35899° W Longitude:

1. Land Use: Woodland (e.g., woodland, agricultural field, vacant lot, etc.) | Pine, oak Vegetation | Surface Stones (e.g., cobbles, stones, boulders, etc.) | 5 Slope (%)

   Description of Location: See plan, check soil consistence in the area

2. Soil Parent Material: Friable, shallow loamy basal till | Moraine valley Landform | BS Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body 200+ feet | Drainage Way -- feet | Wetlands 200+ feet

   Property Line 125+ feet | Drinking Water Well 125+ feet | Other -- feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: 0 Depth Weeping from Pit 0 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-6	A	S.L.	10 YR 3/2	N/A						Friable	
6-30	B	S.L.	2.5 Y 6/6	N/A						Friable	
30-120+	C	L.S.	2.5 Y 6/4	N/A						Dense	Bony

Additional Notes:
SU = summit; SH=Slope of hill; BS=base slope; FS=foot slope; TS=toe slope; HS = head slope; NS = nose slope; SS = side slope

D. Determination of High Groundwater Elevation

1. Method Used:

	Obs. Hole # DHTP-55-10	Obs. Hole # DHTP-55-10AN	Obs. Hole # DHTP-55-11	Obs. Hole # DHTP-55-11AN
☒ Depth observed standing water in observation hole	135 inches	168 inches	dry inches	204 inches
☒ Depth weeping from side of observation hole	135 inches dry	168 inches	dry inches	204 inches
☒ Depth to soil redoximorphic features (mottles)	N/A inches	N/A inches	N/A inches	N/A inches
☒ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	9.76 ft	11.51 ft	13.93 ft dry	13.93 ft

Index Well Number ______ 4/23/2021 Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$ See separate calculation sheet See USGS Frimpter method analysis sheet for details

Obs. Hole/Well# ______ S_c ______ S_r ______ OW_c ______ OW_{max} ______ OW_r ______ S_h ______

2. Estimated Depth to High Groundwater: ______ inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)?

	Upper boundary	Lower boundary
DHTP-55-10AN	30 inches	174 inches
DHTP-55-11	30 inches	192 inches
DHTP-55-11AN	32 inches	216 inches

c. If no, at what depth was impervious material observed? Upper boundary: - inches Lower boundary: - inches

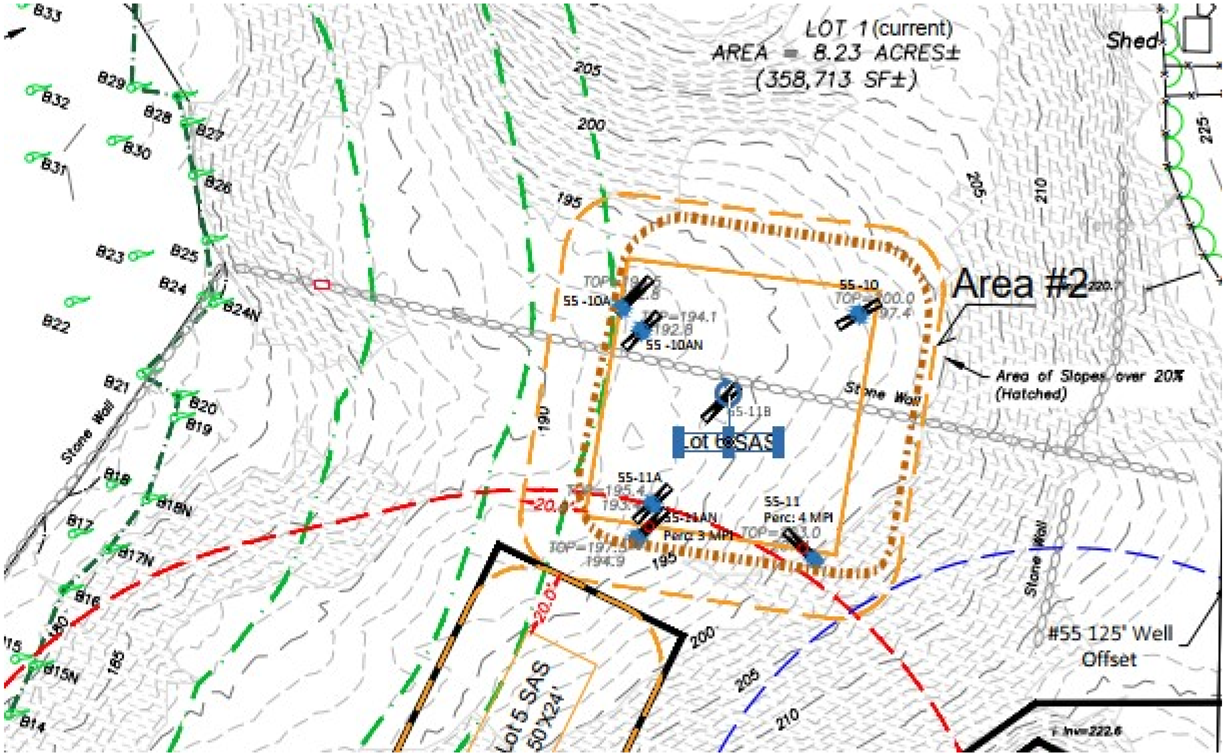
F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

[signature]	7/28/2021
Signature of Soil Evaluator	Date
Desheng Wang/ SE2545	6/30/2022
Typed or Printed Name of Soil Evaluator / License #	Expiration Date of License
Mark Oram	Sherborn Board of Health
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams: See Soil testing plan for details



Commonwealth of Massachusetts
City/Town of Sherborn
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A. Site Information

Fenix Partners Farm Road, LLC.
Owner Name

55 Farm Road (Lot 5)
Street Address or Lot #

City/Town	State	Zip Code
Sherborn	MA	01770

Contact Person (if different from Owner)	Telephone Number
Desheng Wang	(774) 454-0266

B. Test Results

	Date	Time	Date	Time
	11/09/2021	3:25 PM	11/10/2021	11:04 PM

Observation Hole #	DHTP 5-2	DHTP 5-3
Depth of Perc	64"	60"
Start Pre-Soak	3:25 PM	11:04 AM
End Pre-Soak	3:40 PM	11:04 AM
Time at 12"	3:40 PM @ 10"	11:20 AM
Time at 9"	3:44 PM	11:28 AM
Time at 6"	3:59 PM	11:35 AM
Time (9"-6")	15 Min.	7 Min.
Rate (Min./Inch)	5	3
	Test Passed: ☒	Test Passed: ☒
	Test Failed: ☐	Test Failed: ☐

Desheng Wang
Test Performed By:

Mark Oram
Board of Health Witness

Comments:

Commonwealth of Massachusetts
City/Town of Sherborn
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A. Site Information

Fenix Partners Farm Road, LLC.
Owner Name

55 Farm Road (Area #2)
Street Address or Lot #

City/Town	State	Zip Code
Sherborn	MA	01770

Contact Person (if different from Owner)	Telephone Number
Desheng Wang	(774) 454-0266

B. Test Results

	Test 1		Test 2	
	Date: 04/21/2021	Time: 1:05 PM	Date: 04/21/2021	Time: 1:49 PM
Observation Hole #	DHTP-55-11		DHTP-55-11AN	
Depth of Perc	54"		54"	
Start Pre-Soak	1:05 PM		1:49 PM	
End Pre-Soak	1:20 PM		2:04 PM	
Time at 12”	1:20 PM		2:04 PM	
Time at 9”	1:30 PM		2:12 PM	
Time at 6”	1:42 PM		2:21 PM	
Time (9”-6”)	12 Min.		9 Min.	
Rate (Min./Inch)	4		3	
	Test Passed: ☒		Test Passed: ☒	
	Test Failed: ☐		Test Failed: ☐	

Desheng Wang
Test Performed By:

Mark Oram
Board of Health Witness

Comments:

Appendix C: In-Situ Hydraulic Conductivity Test and Calculation[1]

Soil hydraulic conductivity (or permeability) can be determined in-situ. There are many ways to conduct field tests [2]. In this study two methods are used based on the same theorem. One is the constant head test, and the other is the falling head test. These two methods are compared, and field tests show good consistency.

Test Procedure

1. Begin with a known length of open-ended pipe. A test hole is dug or augured into the test soil. The bottom of the hole should be excavated to a clean natural surface with no large rocks. No soils should be disturbed below the bottom of the hole.
2. Work pipe into undisturbed soil using light pressure and rotating motion. The pipe should be buried no less than 10 times of its radius. There also should be at least 10 times the radius of soil beneath the bottom of the hole to the impervious bedrock. Use a bentonite seal on outside of the lower end of the pipe. Be sure no bentonite pellets or dust gets into the open end of pipe. Replace soils outside of the test pipe and pack tightly. Pre-wet the outside of the test pipe so a bentonite seal is assured before the start of a test.
3. Check for water level in pipe (if any) and record the value. If the pipe penetrates the water table, wait until the water level in pipe is stabilized before the start of testing.
4. Several inches of clean stone should be placed at the bottom of the pipe to prevent soils from being stirred.
5. Mark a visible level on the inner side wall of the pipe for monitoring water level, or use a water level meter at a known depth.
6. Have several containers of de-aired water available. At least one container should hold a known volume of water. Record the temperature of the water at the time of the test. Fill the pipe with de-aired water, soak soil for about 5 minutes.
7. Fill the pipe above the reference mark. If using a water level meter, fill to higher than the reference point. Once water has dropped to the reference point, start stopwatch and start adding the known volume of water and count the time for infiltration of certain volume of water. Keep the water level fluctuation within one tenth of an inch of the marked level.
8. For falling head test, fill the water to the marked level, then, let the water level fall. Keep records of time when water in the pipe falls 1', 2', . . . and so on.
9. The tests are to be repeated several times until a test result is nearly constant. If results keep changing, results are to be analyzed on probability paper. The value corresponding 95% of probability should be used.
10. A soil log should be included for the test hole. Where feasible, the high water table should be also observed by digging the test hole deeper and using the soil observation.

Calculation Theorem

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[1] Groundwater Analysis Version 1.0, (c) 2012, by Desheng Wang, Ph.D., P.E., Creative Land & Water Engineering, LLC.

Constant Head Test

On-site constant head test [1] [2] uses the following formula to calculate soil permeability:

$$k = \frac{Q}{2.75DH}$$

where, k = permeability; Q = constant rate of flow into the test hole; D = internal diameter of casing; and H = differential head of water.

Falling Head Test

On-site falling head test uses the time integration of the constant head test equation and solve it for permeability:

$$k = \frac{\int_0^t Qdt}{2.75D\int_0^t Hdt}$$

The detailed records and calculations of the hydraulic conductivities are attached.

Temperature Correction

The following equation can be used to calculate the permeability at reference water

$$\frac{k_s}{k_f} = \frac{\mu_f}{\mu_s}$$

temperature from the field test result:
where, k_s = permeability at reference temperature, 68 ^oF (20 ^oC); k_f = field measured value of permeability; μ_f and μ_s= dynamic viscosities for water temperature at the test and reference temperatures, respectively. Standard permeability is the value at temperature 20 ^oC (68 ^oF). Using the measured permeability, soil type can be confirmed with published permeability ranges [3].

Estimation of Hydraulic Conductivity

Saturated hydraulic conductivity can be estimated by grain-size of granular porous media. Hazen (1911) established an empirical relation between hydraulic conductivity and the effective grain size, D_{10} , which is the size for which 10% by weight of the material is finer. The formula is presented as follows (Kashef 1986):

$$K = C_h D_{10}^{\;2}$$

in which, C_h = a factor with a dimension $s^{-1}cm^{-1}$ ranging 81 to 117, average value of 100. Moreover, Hazen's equation is restricted to value of D_{10} between 0.1 and 3 mm and uniformity coefficient $C_u=D_{60}/D_{10}$ less than or equal to 5. C_h is a function of grain shape, size distribution, and water temperature:

$$C_h = C_s \frac{\gamma_w}{\mu} \frac{e^3}{1+e}$$

where, C_s= shape factor that depends on the pattern of the capillary tube system in the soil and on the tortuosity of the flow path; γ_w = specific weight of water; μ = dynamic viscosity; e = void ratio. The larger the Uniformity coefficient, the smaller the C_h is.

Estimate Permeability from Percolation Rate (Wang, 1999)

Based on field filed investigation of both percolation and permeability test, Wang (1999) developed a method to transfer percolation rate to permeability by the following equation [5]:

$$K = \frac{\pi D}{11.78(H1+H2)P_r}$$

where, *K = permeability, ft/s; P_r =* $t/(H1-H2)$, percolation rate*, s/ft; H1 =* starting water depth from the bottom*, ft; H2 =* ending water depth from the bottom*, ft; D =2r,* diameter of the test hole*; t =* time of percolation. Rearranging above the equation, another form of the equation can be obtained to calculate percolation rate for a given permeability:

$$P_r = \frac{\pi D}{11.78(H1+H2)K}$$

Reference:

[1] Domey Handout, Town of Norfolk, Nov. 30, 1988 file No. T-11102.1.
[2] U.S. D. I. (1974) *Earth Manual - A Water Resources Technical Publication,* Washington, D.C.
[3] Freeze, R. A. and Cherry, J. A. (1979). *Groundwater*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632.
[4] Kashef, A-A I. (1986). *Groundwater Engineering,* McGraw-Hill Book Company, NY.
[5] Wang, D. S. (1999). "A Simple Mathematical Model for Infiltration BMP Design," *J. of Hydrological Science and Technology*, November 1999.

Creative Land & Water Engineering, LLC
Environmental Science and Engineering
P.O. Box 584, Southborough, MA 01772
Tel: (508)281-1694 Fax: (508)281-1694

Subject: Permeability Estimate

Perc. by: dsw & CW **Date:**
Calc.: DSW **Date:** 1-Dec-23
Job No.: 269-12 **Sheet:** 1

Project: 40B SAS Depth to test See soil log ft
Site: 65 Farm Roac Total depth: See soil log ft
Sherborn, MA H.G.W: See soil log ft

For falling head percolation:

Standard Temperature for Permeability Calculation (oC): 20 (68 oF)

Area	Test Pit No.	Soil Texture	Pit diameter in	Starting Water depth (in)	Ending Water Depth (in)	Perc. Rate (min/in)	Water Tem. oC	Permeability (ft/s) Allen	Bouma	Michigan	**Wang**	Average
			12	9	6	0.05	20	1.39E-02	3.99E-02	1.59E-02	**5.93E-03**	1.89E-02
			12	9	6	0.18	20	2.99E-03	5.25E-03	4.33E-03	**1.62E-03**	3.55E-03
			12	9	6	0.2333333	20	2.25E-03	3.60E-03	3.40E-03	**1.27E-03**	2.63E-03
			12	9	6	0.4	20	1.19E-03	1.55E-03	1.98E-03	**7.41E-04**	1.37E-03
			12	9	6	0.5	20	9.11E-04	1.10E-03	1.59E-03	**5.93E-04**	1.05E-03
			12	9	6	0.7	20	6.11E-04	6.50E-04	1.13E-03	**4.23E-04**	7.04E-04
			12	9	6	1	20	4.00E-04	3.72E-04	7.94E-04	**2.96E-04**	4.66E-04
			12	9	6	1.50	20	2.48E-04	1.98E-04	5.29E-04	**1.98E-04**	2.93E-04
			12	9	6	2.000	20	1.76E-04	1.26E-04	3.97E-04	**1.48E-04**	2.12E-04
SAS	5-3,11An	Co m LS	12	9	6	3	10	1.09E-04	6.71E-05	2.65E-04	**9.88E-05**	1.35E-04
SAS	11	Co m LS	12	9	6	4	10	7.75E-05	4.28E-05	1.98E-04	**7.41E-05**	9.82E-05
SAS	5-2	Co m LS	12	9	6	5	10	5.95E-05	3.02E-05	1.59E-04	**5.93E-05**	7.69E-05
			12	9	6	6	20	4.79E-05	2.28E-05	1.32E-04	**4.94E-05**	6.31E-05
			12	9	6	7	20	3.99E-05	1.79E-05	1.13E-04	**4.23E-05**	5.34E-05
			12	9	6	8	20	3.41E-05	1.45E-05	9.92E-05	**3.70E-05**	4.62E-05
			12	9	6	9	20	2.96E-05	1.21E-05	8.82E-05	**3.29E-05**	4.07E-05
			12	9	6	10	20	2.62E-05	1.03E-05	7.94E-05	**2.96E-05**	3.64E-05
			12	9	6	11	20	2.34E-05	8.84E-06	7.22E-05	**2.69E-05**	3.28E-05
			12	9	6	12	20	2.11E-05	7.72E-06	6.61E-05	**2.47E-05**	2.99E-05
			12	9	6	15	20	1.62E-05	5.45E-06	5.29E-05	**1.98E-05**	2.36E-05
			12	9	6	20	20	1.15E-05	3.48E-06	3.97E-05	**1.48E-05**	1.74E-05
			12	9	6	25	20	8.83E-06	2.46E-06	3.17E-05	**1.19E-05**	1.37E-05
			12	9	6	30	20	7.11E-06	1.85E-06	2.65E-05	**9.88E-06**	1.13E-05
			12	9	6	35	20	5.93E-06	1.45E-06	2.27E-05	**8.47E-06**	9.63E-06
			12	9	6	40	20	5.06E-06	1.18E-06	1.98E-05	**7.41E-06**	8.37E-06
			12	9	6	45	20	4.40E-06	9.82E-07	1.76E-05	**6.58E-06**	7.40E-06
			12	9	6	50	20	3.88E-06	8.33E-07	1.59E-05	**5.93E-06**	6.63E-06
			12	9	6	55	20	3.47E-06	7.18E-07	1.44E-05	**5.39E-06**	6.00E-06
			12	9	6	60	20	3.13E-06	6.27E-07	1.32E-05	**4.94E-06**	5.48E-06

Percolation Test
Pit Dia. = 12 inches

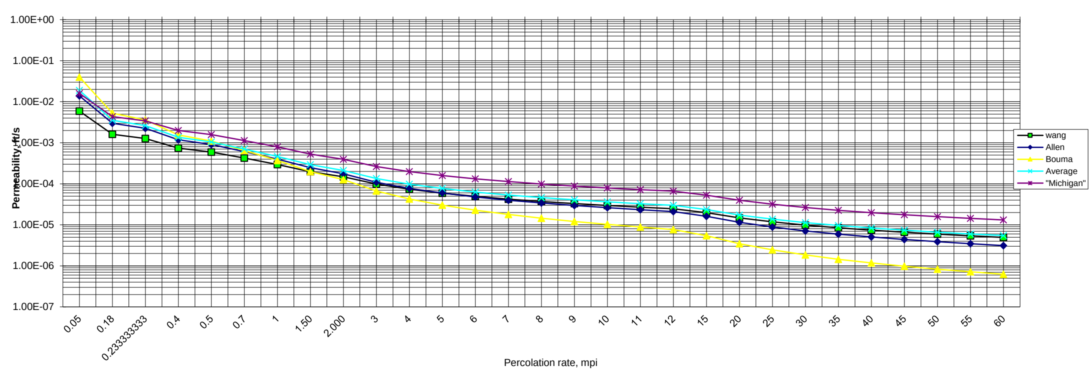


Fig. Percolation to Permeability Comparison

References:
Allen, Dan H. 1979. "Hydraulic Mounding of Groundwater under Axisymmetric Recharge," Research Report No. 24, Water Resource Research Center, University of New Hampshire, Durham, NH;
Bouma, J., et al. 1972. "Soil Absorption of Septic Tank Effluents," University of Wisconsin-Extension, Information Circular No. 20, 235pp.
Wang, Desheng 1999. "A simple mathematical model for infiltration BMP design," Hydrological Science and Technology, American Institute of Hydrology, Vol. 15, No. 1-4.
LID Manual for Michigan: Appendix E

Appendix D: Groundwater Table Records

This Appendix presents the records of on-site groundwater table monitoring.

Table D.1. Sumary of Soil Evaluation and GW Monitoring data

Test Pit	Soil Texture	Total depth, inches	Perc. Rate, mpi	Approx. GS elev, ft	Top of pipe elev., ft	Water depth below GS, ft			Corrected Water depth below GS, ft		Corrected water table for design, ft
						Outstanding pipe, in	11/24/2021	4/27/2021	11/24/2021	4/27/2021	
DHTP 5-1	Till/LS	174	-	195.04	196.62	19	12.92		**10.54**		184.50
DHTP 5-2	Till/LS	209.88	5	200.77	203.02	27	15.24		**12.86**		187.91
DHTP 5-3	Till/LS	199.92	3	198.04	198.79	9	15.91		**13.53**		184.51
DHTP 55-10	Till/LS	135.00	-	**196.92**	200.00	37.00	11.25	11.25	9.76	**9.42**	187.50
DHTP 55-10An	Till/LS	174.00	-	**192.10**	194.10	24.00	13.00	13.00	11.51	**11.17**	180.93
DHTP 55-11	Till/LS	192.00	4.00	**201.00**	203.00	24.00	15.42	15.58	13.93	**13.75**	187.25
DHTP 55-11An	Till/LS	216.00	3.00	**193.92**	197.50	43.00	15.42	16.25	13.93	**14.42**	179.50

Notes: 1 See USGS Frimpter method for high groundwater correction analsysis sheet for details.

2. Test pits 55-10, 55-10An, 55-11, 55-11An, 5-1, 5-2, and 5-3 were found dry and did not reflect the true water table rather for reference.

Appendix E: Groundwater Mounding Analysis

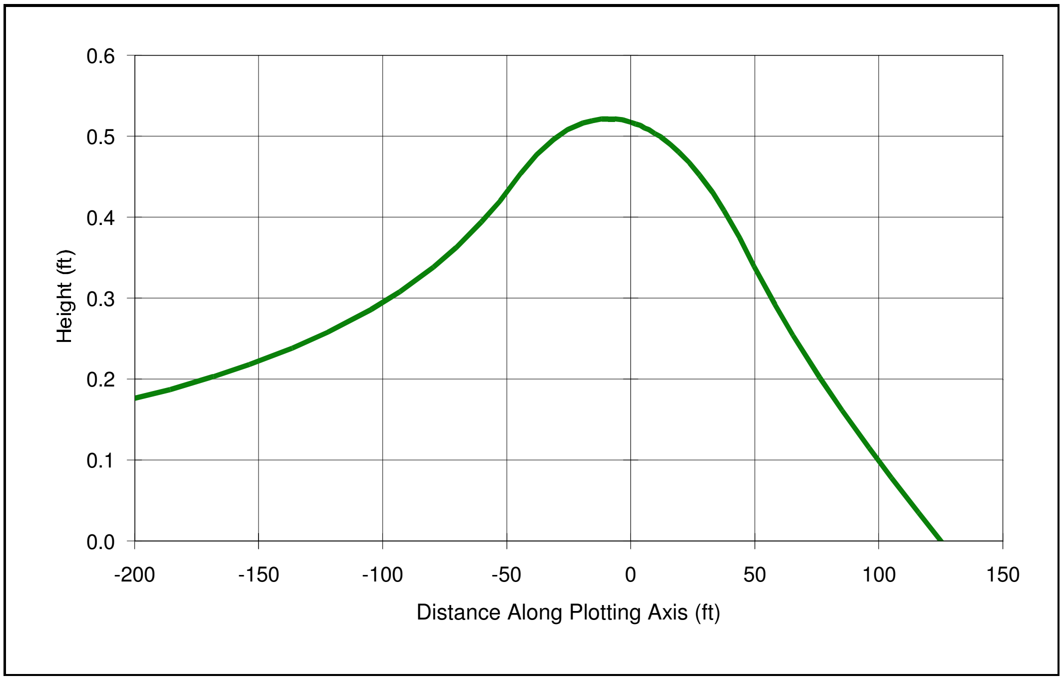
This Appendix presents the calculation sheets of groundwater mounding analysis using Hantush Method.

Parameters	Leaching Field		Note
Recharge area	SAS 1+2	SAS3	All trenches are placed more than 8 ft above the estimated high groundwater and not be impacted by groundwater mounding.
Dimension, Length, ft	92	82	
Dimension, Width, ft	82	46	
Area, sq. ft	7544.00	3772.00	
Recharge Vol. Cu ft (per day or event)	745.10	372.55	
Duration, day	90	90	
Recharge rate, cu ft/day/sq. ft	0.10	0.10	
Dewater time, day	90	90	
GW Separation, ft	8.49	12.58	
Distance to wetland, ft	125	125	
Maximum mounding height, ft	0.73	0.61	
Estimated effective Max MH, ft	**0.73**	**0.61**	
Impact mounding height by other systems, ft	**0**	**0**	
Combined Mound height, ft	**0.73**	**0.61**	
Bottom of Trench, ft	**192.58**	**192.08**	
Top of stones, ft			
EHGW, ft	184.09	179.5	
	average		
Bottom aquifer, ft	**170**	**170**	
Flood routing elev, ft	291.670	291.670	
Top of grade, ft	292.5	275.5	
Aquafer depth, ft	14.09	9.5	
Hydraulic Conductivity, ft/day	24.00	24.00	

References:

Hantush, M. S. 1967. Growth and decay of Groundwater-mounds in response to uniform percolation, Water Resources Research, v. 3, no. 1, pp. 227-234.

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: CLAWE

PROJECT: Farm Road Homes - SAS 1 and 2

ANALYST: Desheng Wang

DATE: 11/2/2023 TIME: 10:43:30 PM

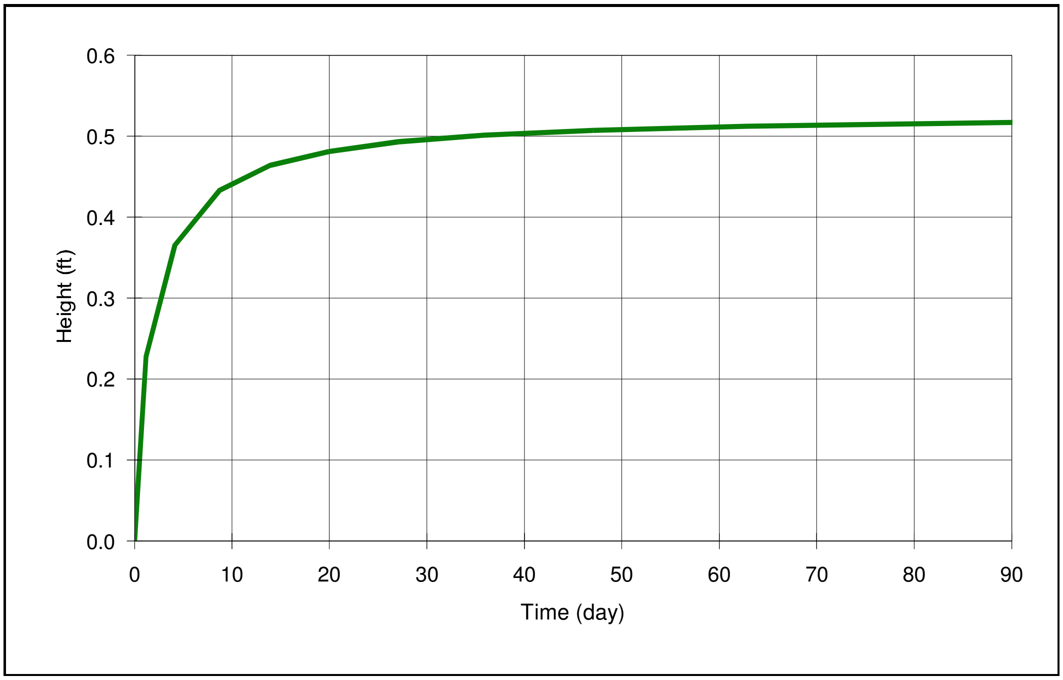
INPUT PARAMETERS

Application rate: 0.1 c.ft/day/sq. ft
Duration of application: 90 days
Fillable porosity: 0.26
Hydraulic conductivity: 24 ft/day
Initial saturated thickness: 20 ft
Length of application area: 92 ft
Width of application area: 82 ft
Constant head boundary used at: 125 ft
Plotting axis from Y-Axis: 0 degrees
Edge of recharge area:
positive X: 0 ft
positive Y: 46 ft
Total volume applied: 67896 c.ft

MODEL RESULTS

X (ft)	Y (ft)	Plot Axis (ft)	Mound Height (ft)
0	-200	-200	0.18
0	-168.2	-168	0.2
0	-136.4	-136	0.24
0	-104.6	-105	0.29
0	-79.6	-80	0.34
0	-60.2	-60	0.39
0	-44.4	-44	0.45
0	-31	-31	0.5
0	-19.4	-19	0.52
0	-11.6	-12	0.52
0	-6.3	-6	0.52
0	0	0	0.52
0	3.9	4	0.51
0	7.2	7	0.51
0	12.1	12	0.5
0	19.4	19	0.48
0	27.7	28	0.45
0	37.6	38	0.41
0	49.7	50	0.34
0	65.4	65	0.25
0	85.2	85	0.16
0	105.1	105	0.08
0	125	125	0

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: CLAWE

PROJECT: Farm Road Homes - SAS 1 and 2

ANALYST: Desheng Wang

DATE: 11/2/2023 TIME: 10:43:53 PM

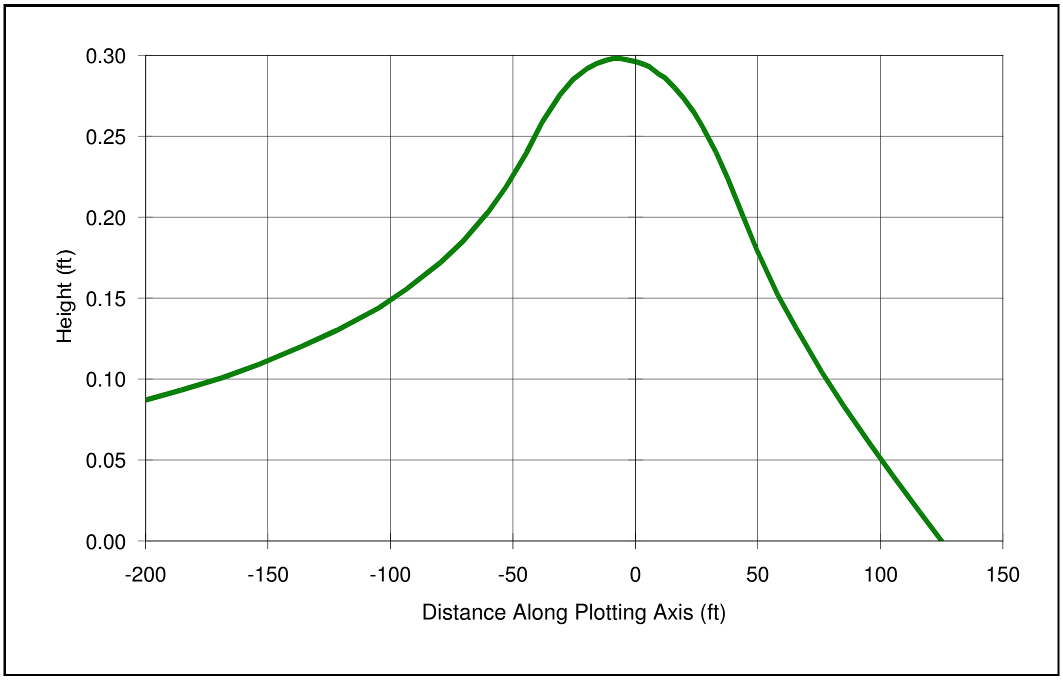
INPUT PARAMETERS

Application rate: 0.1 c.ft/day/sq. ft
Duration of application: 90 day
Total simulation time: 90 day
Fillable porosity: 0.26
Hydraulic conductivity: 24 ft/day
Initial saturated thickness: 20 ft
Length of application area: 92 ft
Width of application area: 82 ft
Constant head boundary used at: 125 ft
Groundwater mounding @
X coordinate: 0 ft
Y coordinate: 0 ft
Total volume applied: 67896 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
1	0.23
4	0.36
9	0.43
14	0.46
20	0.48
27	0.49
36	0.5
47	0.51
63	0.51
90	0.52

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: CLAWE

PROJECT: Farm Road Homes - SAS 3

ANALYST: Desheng Wang

DATE: 11/2/2023 TIME: 10:46:47 PM

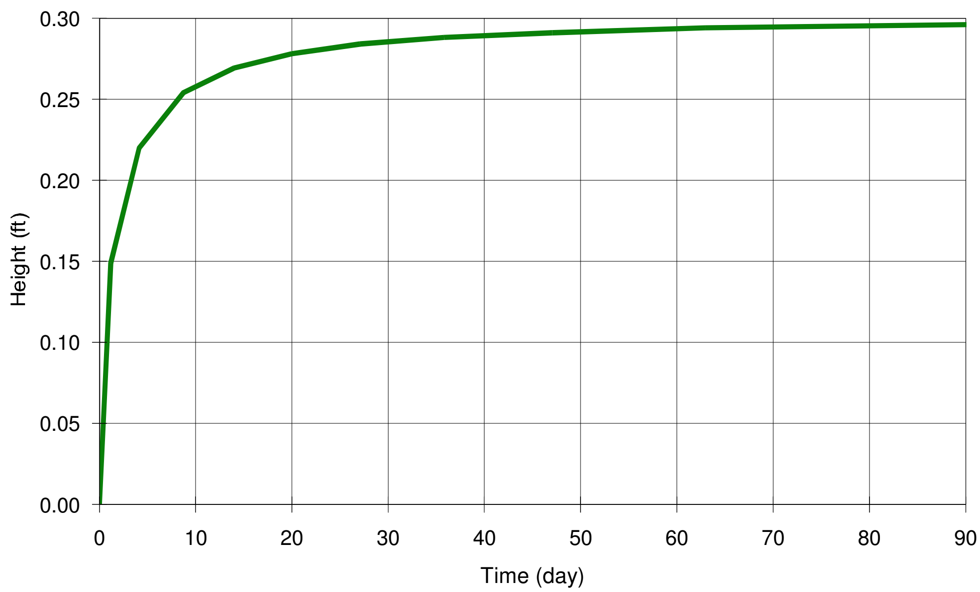
INPUT PARAMETERS

Application rate: 0.1 c.ft/day/sq. ft
Duration of application: 90 days
Fillable porosity: 0.26
Hydraulic conductivity: 24 ft/day
Initial saturated thickness: 20 ft
Length of application area: 82 ft
Width of application area: 46 ft
Constant head boundary used at: 125 ft
Plotting axis from Y-Axis: 0 degrees
Edge of recharge area:
positive X: 0 ft
positive Y: 41 ft
Total volume applied: 33948 c.ft

MODEL RESULTS

X (ft)	Y (ft)	Plot Axis (ft)	Mound Height (ft)
0	-200	-200	0.09
0	-168.2	-168	0.1
0	-136.4	-136	0.12
0	-104.6	-105	0.14
0	-79.6	-80	0.17
0	-60.2	-60	0.2
0	-44.4	-44	0.24
0	-31	-31	0.28
0	-19.4	-19	0.29
0	-11.6	-12	0.3
0	-6.3	-6	0.3
0	0	0	0.3
0	3.9	4	0.29
0	7.2	7	0.29
0	12.1	12	0.29
0	19.4	19	0.27
0	27.7	28	0.26
0	37.6	38	0.22
0	49.7	50	0.18
0	65.4	65	0.13
0	85.2	85	0.08
0	105.1	105	0.04
0	125	125	0

Groundwater Mounding Analysis (Hantush's Method using Glover's Solution)



COMPANY: CLAWE

PROJECT: Farm Road Homes - SAS 3

ANALYST: Desheng Wang

DATE: 11/2/2023 TIME: 10:46:58 PM

INPUT PARAMETERS

Application rate: 0.1 c.ft/day/sq. ft
Duration of application: 90 day
Total simulation time: 90 day
Fillable porosity: 0.26
Hydraulic conductivity: 24 ft/day
Initial saturated thickness: 20 ft
Length of application area: 82 ft
Width of application area: 46 ft
Constant head boundary used at: 125 ft
Groundwater mounding @
X coordinate: 0 ft
Y coordinate: 0 ft
Total volume applied: 33948 cft

MODEL RESULTS

Time (day)	Mound Height (ft)
0	0
1	0.15
4	0.22
9	0.25
14	0.27
20	0.28
27	0.28
36	0.29
47	0.29
63	0.29
90	0.3

Appendix F: Operation and Maintenance Plan

This plan is designed according to 310 CMR 15.202 (4):

1. By January 31st of each year, unless otherwise determined by the Department, the system must be inspected at least annually by a Massachusetts certified operator of an appropriate grade to operate the system, unless the Department has approved in writing a reduction in frequency of inspection or the facility is subject to a Department approved comprehensive local plan of on-site system inspection, the system owner shall submit a certification by the system operator to the local Approving Authority and the Department for the previous calendar year stating that the system and its components are functioning as designed and were inspected in accordance with the Department's approval.

2. SeptiTech systems are essentially operationally maintenance-free. Designed to be operationally simple, the system is manufactured of non-corrodible materials such as stainless steel fittings and hardware, PVC piping, high-density polyethylene or pre-cast concrete tanks, and industrial hardened electronics (PLC). All pumps have been carefully selected to be of the highest quality and longest service life possible. There are no chemicals to add, filters to clean, or media to replace. The pump-back mitigates the need to ever pump the SeptiTech processor. (Note: periodic pumping of the primary septic tank is still required). As such, quarterly maintenance entails a diagnostic review of the PLC, visual inspection of the processor vessel and internal parts, a check of the effluent clarity to assure the system is operating at maximum efficiency, and a visual check of the disposal area.
   Equipment will be inspected at least 4 times per year per 310 CMR15.351, with the first inspections beginning (clear water testing date) ____. These inspections will include:

   3. Testing of the sludge depth in the septic tank.
   4. Inspection and power testing of the system processing components.
   5. Inspection of the alarm system.
   6. Inspect overall condition of SeptiTech STAAR® System.
   7. Notification to **OWNER** of any problems encountered.

3. Water quality testing: Influent & Effluent sample taken quarterly and delivered to a qualified testing lab for evaluation. Results sent to State and local Agencies as well as the **OWNER**. **OWNER** is responsible for providing acceptable access to effluent to enable a grab sample to be taken for laboratory testing performed. The testing parameters include pH, BOD, TSS, Nitrate, Nitrite, TKN, Ammonia, Alkalinity.

4. Septic tanks shall be accessible for inspection and maintenance. No structures shall be located directly upon or above the septic tank access locations which interfere with performance, access, inspection, pumping, or repair.

5. Septic tanks shall be inspected and maintained in accordance with 310 CMR 15.300 and applicable local requirements.

6. The septic tank shall be pumped whenever necessary to ensure proper functioning of the system. Pumping is required whenever the top of the sludge or solids layer is within 12 inches or less of the bottom of the outlet tee, or the top of the scum layer is within two inches of the top of the outlet tee, or the bottom of the scum layer is within two inches of the bottom of the outlet tee. Pumping frequency is a function of use, although pumping is typically necessary at least once every three years. No domestic garbage grinders are permitted in the subdivision and will be deed restricted.

7. Pumps, alarms and other equipment requiring periodic or routine inspection and maintenance shall be operated, inspected and maintained in accordance with the manufacturer's and the designer's specifications. In no instance shall inspection be performed less frequently than once every three months for any system serving a facility with a design flow of 2,000 gallons per day or greater, and annually for any system serving a facility with a design flow of less than 2,000 gallons per day. The system owner shall submit the results of such inspections to the Approving Authority annually by January 31st of each year for the previous calendar year.