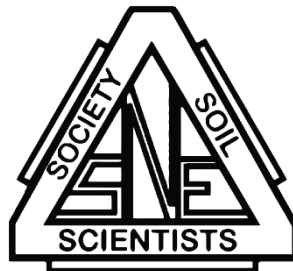


2026 Soils and OWTS Workshop



University of Rhode Island

Peckham Research Farm and East Farm, South Kingstown, Rhode Island



THE
UNIVERSITY
OF RHODE ISLAND
COOPERATIVE
EXTENSION

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Background

This guide supports a two-stop field tour built around a single question that every soil and onsite wastewater treatment system (OWTS) professional in southern New England has to answer at the test hole: where on this landscape can effluent be treated by the soil before it reaches groundwater, and where can it not? The two stops were chosen to highlight specific issues here in southern New England.

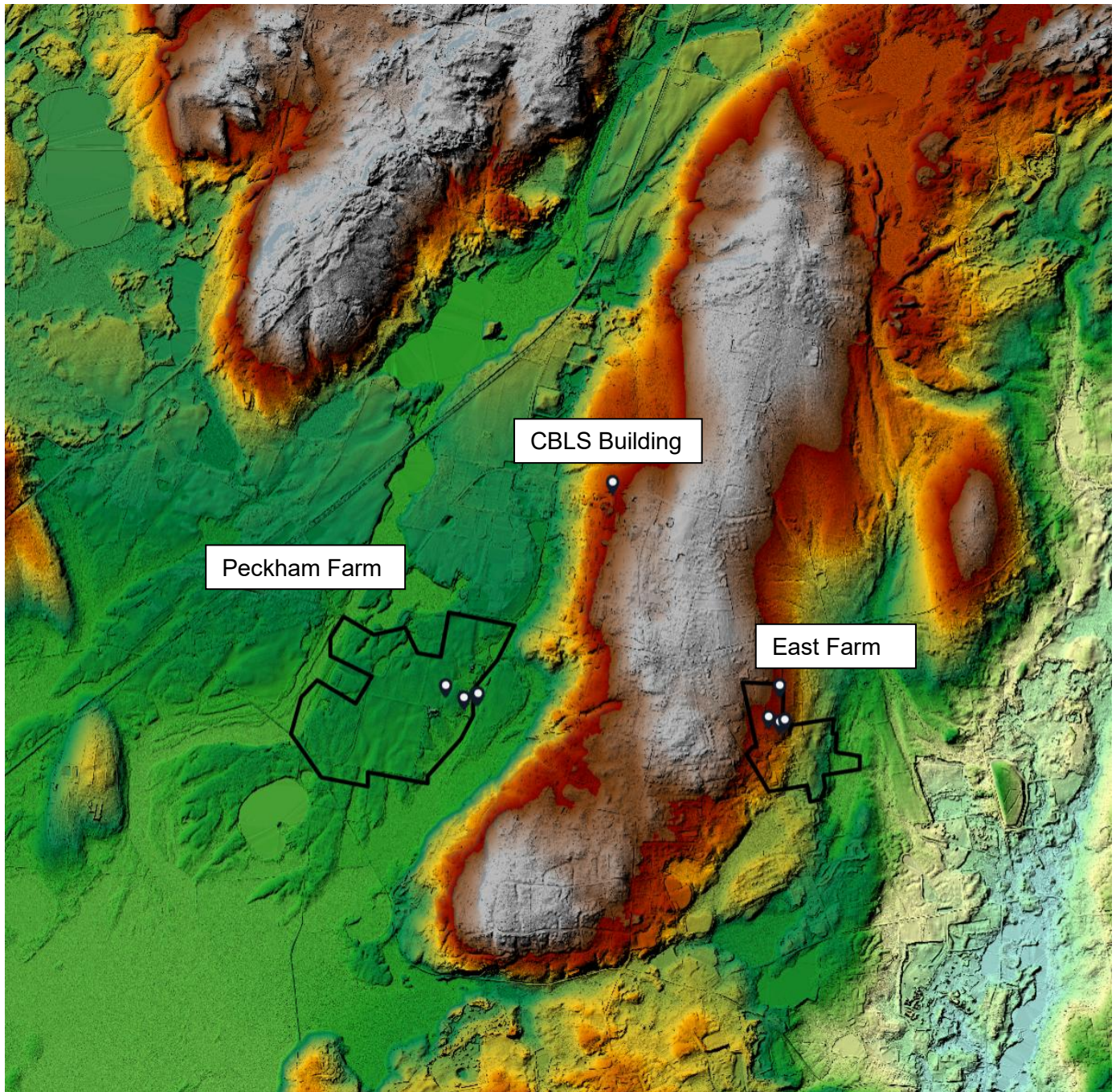
- **Stop 1, Peckham Research Farm**, sits on a glacial outwash plain. The parent material is deep, stratified sand and gravel, which is close to ideal for dispersal, but worse for treatment due to the low surface area of sands and gravel. The complications here are a silty eolian cap that can perch water while also allowing for better treatment as long as it is not saturated. Here, a sequence of natural drainage classes within a few hundred feet, and pit with human transported materials over the natural soil profile show how landscape position, parent materials, and human alteration influence OWTS siting. We will also use this stop to review some hydric soil indicators at our poorly drained soil pit .
- **Stop 2, East Farm**, sits on a drumlin-like till feature. The four pits, all mapped as the Rainbow series, have a dense, compact basal till at shallow depth. That densic layer perches a seasonal high water table near the surface and sharply limits where a conventional system can go. Sites with soils like these often rely on advanced treatment with pressurized (and sometimes elevated) drainfields to provide adequate wastewater treatment.

Learning objectives

After completing this tour, participants should be able to:

1. Read a soil profile for the three limiting conditions that govern OWTS design choices: the seasonal high water table, a restrictive (densic or otherwise slowly permeable) layer, and bedrock.
2. Use redoximorphic features, matrix depletions, and gleyed colors to estimate the seasonal high water table when the site is dry, and explain why that estimate, not the water observed on the day, informs the OWTS design.
3. Translate a profile description into both a series of Rhode Island soil categories that determine design criteria, and a Massachusetts percolation-class and long-term acceptance rate, and identify where the two states diverge.
4. Recognize anthropogenic fill and explain why filled and compacted soils are unsuitable for OWTS siting in southern New England.
5. Decide, for a given pit, whether a conventional gravity drainfield is feasible, whether an elevated or advanced technology or pressurized shallow system is required, or whether the location should be considered unsuitable for an OWTS altogether.
6. Consider how to communicate holistic interpretations of soil conditions and additional (unregulated) risks present on a site, and what role soil evaluators play in influencing long-term OWTS performance and resilience

LIDAR Map of Landscape



General overview of workshop location

Part 1. Regional and Regulatory Context

1.1 Glacial setting and parent materials

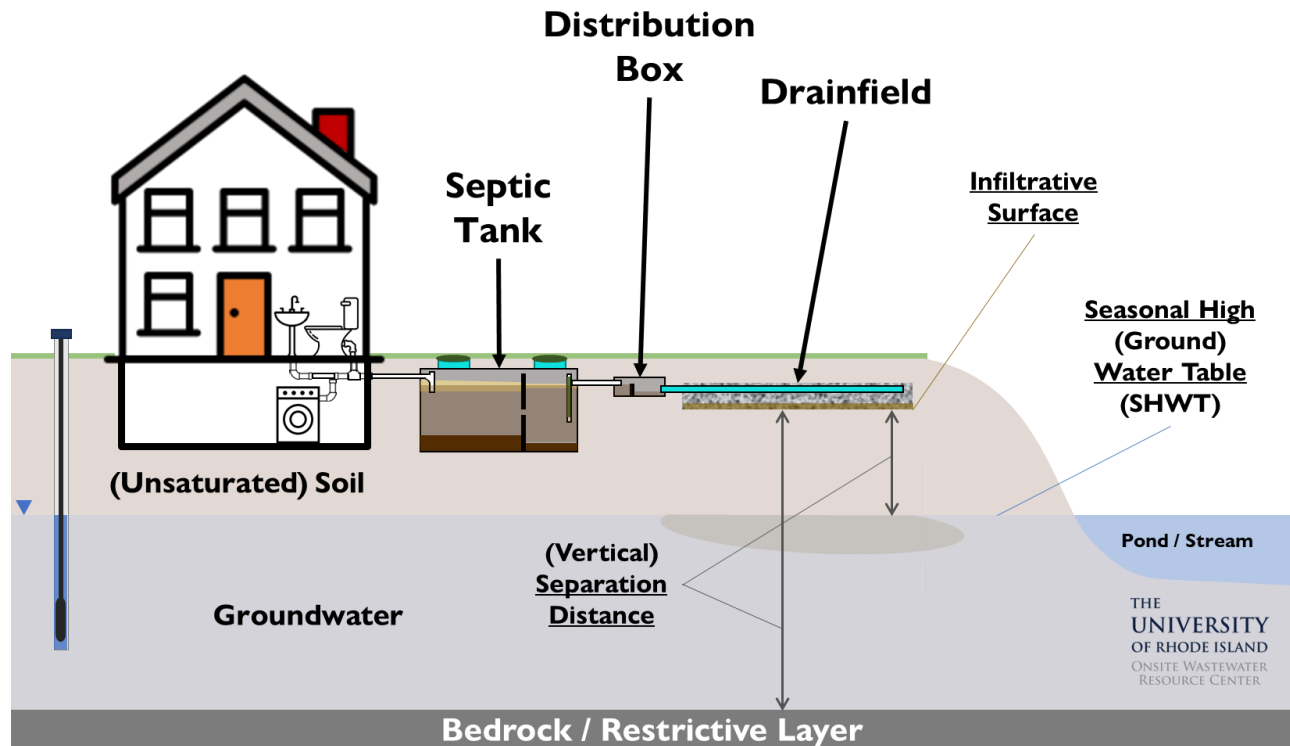
Both field tour stops lie within Major Land Resource Area 144A, the New England and Eastern New York Upland, Southern Part. The land surface is entirely a product of the late Wisconsinan glaciation and the periglacial centuries that followed. Almost nothing here is residual soil weathered in place; the materials that matter for OWTS work were delivered by ice or meltwater and then reworked by wind, frost, and centuries of plowing and manipulation.

The three primary parent materials on this tour are:

- **Outwash.** Stratified sand and gravel laid down by braided meltwater streams south of the ice. It is well sorted, loose, and rapidly permeable, and it commonly fines upward. This is the parent material under Peckham Farm and the reason that plain is prime farmland and, in principle, good ground for dispersal.
- **Dense (basal or lodgment) till.** Material ground beneath the ice and compacted under its weight. It transmits water slowly. Dense till forms drumlins and other till features and underlies the densic contact at East Farm. It perches water and is the single most common reason a New England upland site fails for a conventional system.
- **Loess (eolian silt cap).** A blanket of wind-blown silt deposited from exposed glacial outwash and deltas during the periglacial period. The cap thins and grows finer to the north and west. It holds water far better than parent material beneath it, and where it sits over rapidly permeable outwash it can create a hanging water table.

1.2 Why soils govern OWTS placement

An onsite system disperses settled or treated effluent into the unsaturated soil beneath the drainfield. Treatment—which means the removal of pathogens, biochemical oxygen demand, and some nutrients—happens in the aerated soil column between the bottom of the drainfield components and the top of the water table. If that column is too thin, effluent reaches groundwater before the soil can treat it. If the soil's drainage is too slow, effluent backs up and surfaces. Both states therefore build their entire siting framework on the same idea: find the shallowest limiting condition (either a restrictive layer like bedrock or other impermeable material, or the seasonal high water table), then require a fixed thickness of suitable unsaturated soil above it (referred to as the “vertical separation distance”).



Three limiting conditions are read directly from the profile:

- **Seasonal high water table (SHWT).** The highest level groundwater reaches in a normal year, almost always in late winter and spring. On the day of a summer evaluation the water is usually far below its highest elevation, so the SHWT is inferred from soil morphology: redoximorphic depletions and concentrations, low-chroma matrices, and gleyed colors mark the zone of seasonal saturation and reduction. However, redoximorphic features only form when the water table has reached that elevation for sufficient time to produce these features. The soil must also be warm enough (typically > 5 degrees C) for soil microbes to reduce and oxidize Iron and Manganese. – it is likely that the SHWT is higher than indicated by the redox for some time of the year. Certain soils, especially those consisting mostly of sands or yellow/greyish matrix colors can make it challenging to identify redox characteristics accurately. In other soils, such as the red tills in the CT River valley, may not display obvious redox features due to the parent material's colors. Redox features may also be covered or otherwise obscured by organic materials in dark-colored horizons or may not be obvious in dark till derived from carboniferous rocks (such as in the Narragansett Basin, e.g. Aquidneck Island). Additionally, redox can only indicate past SHWT conditions at a particular site – they cannot account for future conditions under a changing climate (e.g. more frequent and intense precipitation events, changing groundwater tables, rising sea level).
- **Restrictive layer.** A densic contact (dense till), a cemented horizon, bedrock, or any horizon with low enough permeability to perch water. A restrictive layer matters twice: it limits the depth of usable soil from a hydraulic loading perspective, and it commonly creates the perched SHWT above it.

1.3 Differences among southern New England states' regulatory approach

Rhode Island and Massachusetts both use soil evaluations to inform drainfield sizing by determining loading rates for different soil textures, though each state has additional nuances that inform OWTS design (e.g. structure and consistence in RI, percolation rate in MA). The soil evaluation's description of the presence of redoximorphic features is also used to estimate the elevation of the seasonal high water table (SHWT) in both states, which affects the elevation of the drainfield. Connecticut site investigation for OWTS design involves similar identification of SHWT via use of redox features, but drainfield sizing is based exclusively on soil percolation rates, which we do not cover in the workshop. Therefore, CT OWTS design considerations will be absent from our discussions today. The professional who works across the state line, as many in this region do, has to understand multiple regulatory approaches at once. The essentials of MA and RI OWTS design implications are summarized below and applied at every pit.

Rhode Island: RIDEM OWTS Rules (250-RICR-150-10, Part 6)

In Rhode Island, soil evaluators are licensed state-wide by the RIDEM. Licensing requires university-level soils coursework, and passing an RIDEM-administered written exam that includes both regulations-focused and field practical components. A licensed Class IV Soil Evaluator performs the soil evaluation under Section 6.16 of the OWTS rules (augmented by the 2008 Soil Evaluation Guidance document). The soil evaluator describes each horizon, assigns a soil category (1-10) used to set the drainfield loading rate, and records the design seasonal high water table from soil morphology or observed site characteristics. Where dry-season soil morphology is inconclusive, the rules provide for a wet-season SHWT determination.

Two criteria from soil evaluations inform OWTS design decisions in Rhode Island at each site:

- **Vertical separation.** The drainfield's infiltrative surface (e.g. bottom of the stone beneath the drainfield, or the surface on which the biomat develops), must sit at least three (inland) or four (critical resource area) feet above the seasonal high groundwater table.
- **Loading rate by soil category.** In RI, soil texture, structure and consistence mainly determine the soil category (numbered 1-10), which determines the drainfield loading rate in gallons per square foot per day. Percolation rate is not used in determining drainfield loading rate in RI. Coarser, more permeable soils and medium-textured soils with good structure are awarded higher loading rates and therefore the drainfield need less area. The soil categories run from clean, rapidly permeable outwash at the favorable end to extremely firm lodgment till at the slow end (the soil-category determination table is in Section 6.16.L of the rules, and the numbered soil categories correspond to the loading rates in the drainfield sections of the rules). The RIDEM Soil Evaluation Guidance Document provides great guidance and detail on how to determine soil categories for each horizon you describe. The dense till under East Farm falls in the slowest, highest-numbered categories, which are allowed only the lowest loading rates, making advanced treatment with pressurized dispersal drainfields more practical for many of these sites.

Inside the Salt Pond and Narrow River Critical Resource Areas and the drinking water supply watersheds, siting is stricter still: a system may not be placed where the SHWT is within five feet of the original ground surface or where a restrictive layer or bedrock is within seven feet, except under specific allowances. The separation of the bottom of the drainfield to the SHWT must be 4 feet in the CRA, not 3 feet. Neither our site is inside those areas.

Massachusetts: Title 5 (310 CMR 15.000)

In Massachusetts, soil evaluators are approved by MassDEP and require additional registration with the local Approving Authority (typically a board of health). Licensing requires enrolling in a Soil Evaluator certification class and passing a written exam with regulatory and field components (administered by NEIWPC) or pre-approval based on relevant education or field experience. Site evaluation for OWTS design under Title 5 section 15.101 rests on five elements: deep observation hole testing, soil profile determination, percolation testing, landscape position, and hydrogeologic properties. Massachusetts Title 5 rules center the percolation rate and soil textural class, which is tied to both the required separation between drainfield and seasonal high water table, and the drainfield (called a soil absorption system in MA) loading rate.

- **Vertical separation distance (15.212).** Four feet between the bottom of the soil absorption system and the high groundwater elevation in soils with a percolation rate slower than two minutes per inch; five feet in soils with a rate of two minutes per inch or faster. The faster the soil, the more separation Massachusetts requires.
- **Long-term acceptance rate (15.242).** The stable loading rate, in gallons per square foot per day, is set from soil textural class (15.243) and the percolation rate. It ranges from about 0.74 for a Class I sand or loamy sand at a fast rate down to 0.15 for a Class III silt loam at 60 minutes per inch. Pervious soil percolates at 60 minutes per inch or faster; slower than 60 is impervious and unsuitable for a standard system.
- **System types and constrained sites.** Conventional soil absorption systems are trenches (15.251), beds or fields (15.252), and pits, galleries, or chambers (15.253). Where the native profile cannot meet separation, Title 5 provides for construction in fill, a raised system (15.255), and/or pressure distribution (15.254), and may include requirements for advanced treatment via innovative or alternative (I/A) technologies (15.280 through 15.289), which is the path for nitrogen reduction and for some reduced-criteria sites.

Note that the Bottomless Sand Filter (BSF; an advanced pressurized drainfield that can only be used after an advanced treatment (I/A) technology) design guidelines approved in MA are identical to those in RI; therefore MA professionals who perform soil evaluations on sites that might include a BSF drainfield option need to be familiar with and apply the RI soil category assignment process for each horizon, in addition to following the normal Title 5 Soil Evaluation procedure.

Side by side comparison

Element	Rhode Island (RIDEM)	Massachusetts (Title 5)
Who evaluates the soil	Class IV Soil Evaluator	DEP-approved Soil Evaluator with local Approving Authority approval
Core field method	Horizon-by-horizon morphology translated into soil category; parent-material class; SHWT determined from redox	Deep observation holes; soil profile description and textural class determination; percolation test; landscape position; hydrogeology
SHWT determination	Soil morphology; wet-season check if inconclusive	Redoximorphic features and observed groundwater; water-year context
Vertical separation to SHWT / Restrictive Layer	3 ft (SHWT) / 5 ft (Restrictive) in most of RI; 4 ft (SHWT) / 5 ft (Restrictive) in Salt Pond, Narrow River, and drinking-water CRAs	4 ft if perc rate slower than 2 min/in; 5 ft if perc rate 2 min/in or faster
Loading / sizing basis	Soil category loading rate of most restrictive horizon within 5' of proposed bottom of conventional drainfield	Long-term acceptance rate from texture and perc rate (15.242) below drainfield

Element	Rhode Island (RIDEM)	Massachusetts (Title 5)
Unsuitable soil for OWTS siting	Restrictive dense till (category 10) are considered unsuitable	Perc slower than 60 min/in is considered impervious and are considered unsuitable

1.4 Assumptions behind the system-type recommendations

Each pit's description below closes with a suitable OWTS recommendation. The recommendation follows the soil's limiting conditions: in some cases there is enough vertical separation distance to the SHWT to fit a conventional system. In instances where there is not adequate vertical separation distance, the options we'll evaluate are to go with a fill (MA only), raised, or pressurized drainfield, and/or advanced treatment systems, or if landscape and site conditions argue for determining that the site is unsuitable for an OWTS. Additionally, we will explore how we can influence the design of more resilient OWTS systems, by considering effects of climate change on drainfields.

Three variables that the soil profile alone does not settle can change the final design, and sometimes the type. They are assumed below and flagged on each pit page where they bite.

Stated assumptions and open variables

Design flow and technology selection. Recommendations assume a three-bedroom single-family home: a design flow of 345 gpd in Rhode Island (115 gpd per bedroom) and 330 gpd in Massachusetts (110 gpd per bedroom). Minimum required drainfield area is calculated by taking daily design flow divided by the soil loading rate. Different drainfield technologies have varying calculations for how component and layouts meet the minimum required areas.

Special-area status. Each recommendation is given in two forms: a standard case (not nitrogen-sensitive) and a nitrogen-sensitive or Critical Resource Area case. In a RIDEM Critical Resource Area, nitrogen-reducing technology is required (Rules 6.42 and 6.43) and siting is stricter; Massachusetts applies nitrogen-loading limits and innovative/alternative technologies, though this varies from town to town.

New construction versus repair. Recommendations are given for both new construction (which must meet current regulations) and repair or replacement/upgrade (which are usually designed with a best-fit approach, maximizing compliance with today's rules to the extent feasible on a site), side by side. RIDEM repairs generally do not require a new soil evaluation, though RIDEM field inspectors do evaluate soils during bottom inspections; Title 5 provides separate upgrade criteria and local upgrade approvals (15.405).

Exact loading and category. RI soil categories and loading rates come from the Section 6.16.L table; the exact category and associated loading rate per horizon should be confirmed. In RI, drainfields are designed on the most restrictive loading rate/soil category within 5' of the bottom of the proposed drainfield base. Additionally, different technologies (conventional vs advanced drainfields) have different loading rates. Note that BSF design in MA requires the assignment of a RI soil category for each horizon in order to size the BSF correctly.

Other risks posed by site characteristics, landscape location and proximity to waterways not addressed in today's regulations. Note that neither state has additional requirements in flood-prone areas, nor is climate change, projected changes in floodplains or storm intensity required to be addressed by OWTS design in either state. However, given that many of the easy-to-develop parcels with well-draining, deep soils have already been developed, the OWTS and soils professional community must consider long-term system performance and resilience to floods and other climate hazards (such as rising ground water due to rising sea levels), particularly on challenging sites. Systems that are not designed to mitigate these risks put public and environmental health at risk when they fail (often prematurely).

Part 2. Stop 1: Peckham Research Farm: the Outwash Plain

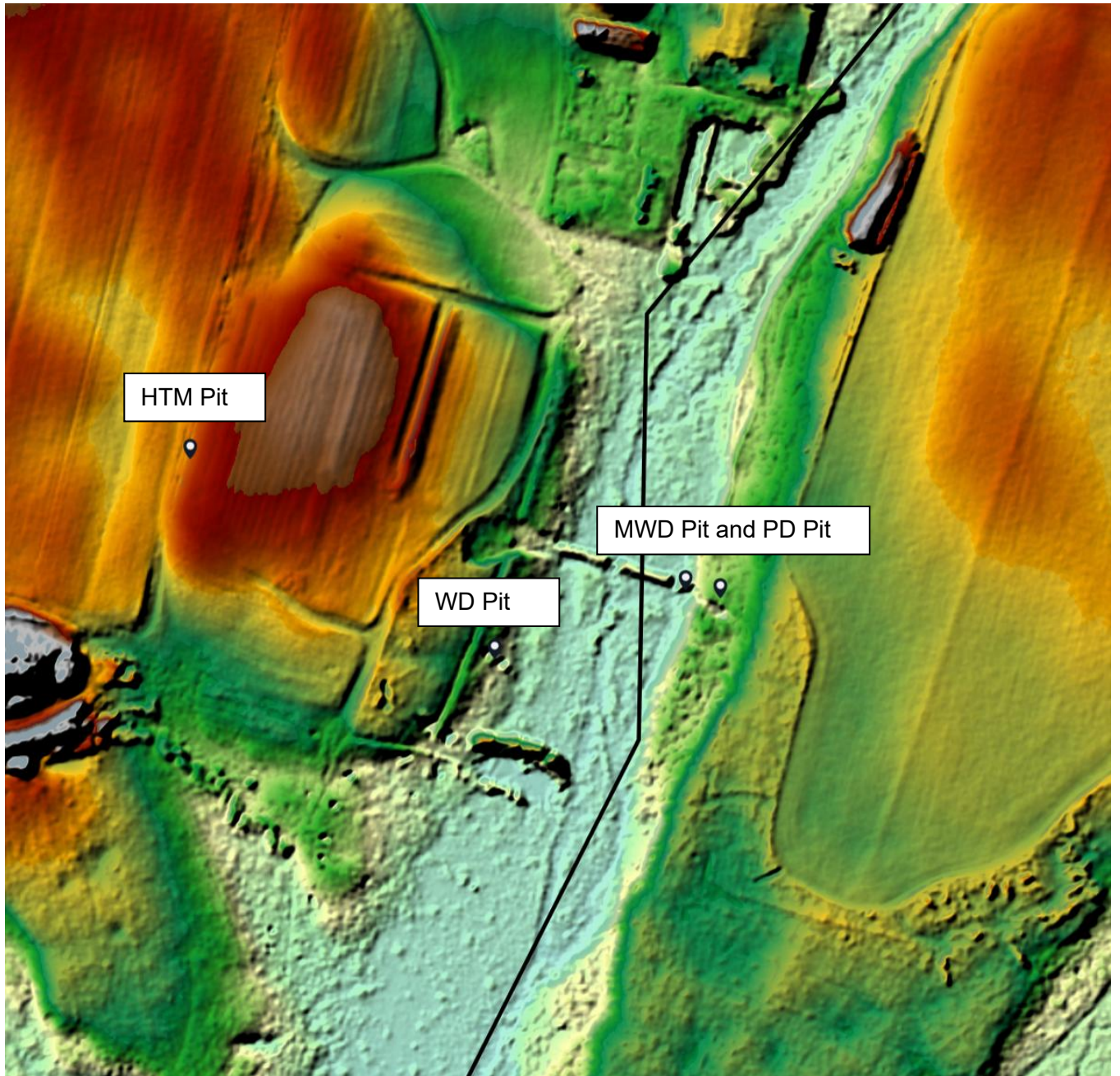
Peckham Research Farm covers roughly 160 acres acquired by the university in 1936 and 1944 and used historically for hay and pasture. In recent decades parts of the farm have been leased for sod, which has removed much of the eolian silt cap from the leased fields; one harvest strips one to two centimeters of soil, and on actively operated South County sod farms, the long-term loss has been measured at 74 to 114 metric tons per hectare per year, roughly a third of an inch annually.

The tour pits sit on a wooded part of the farm. Traditionally these pits have served the URI introductory soils courses as a drainage catena, a sequence of soils that differ mainly in how high and how low the water table sits. We also have another pit in the field which has human transported material (fill)

2.1 The drainage catena as an OWTS teaching tool

On a single outwash plain at nearly constant elevation, the depth to the seasonal high water table is what separates one soil from the next. As that depth shrinks, the natural drainage class steps down from well drained to very poorly drained, and the available separation distance for a drainfield shrinks with it. The table below frames the sequence in OWTS terms before the individual pits.

Position on catena	Natural drainage	Approx. depth to SHWT	OWTS notes
Merrimac	Well drained	Deep (no redox in profile)	Favorable for dispersion; rapid transport must be accounted for with increased drainfield size to maximize treatment
Deerfield	Moderately well to somewhat poorly	31"	Marginal; separation distance tight, BSF/Advanced drainfield likely a better choice. Close to wetland.
Scarboro Taxadjunct	Poorly drained	At or near surface	Generally unsuitable for OWTS, though an above-ground BSF may be allowed in some instances. Within wetland boundaries
Histic epipedon / Histosol	Very poorly drained	Surface; ponded much of the year	Wetland; no OWTS permitted.



Peckham farm locations

2.2 Somewhat excessively drained/Well drained: Merrimac

Mapped and correlated as the Merrimac series. The profile is sandy loam outwash over gravelly outwash sand, with no redoximorphic features and no water table within the described depth. Aerial imagery suggests the spot has not been cultivated in about ninety years, although there is evidence of old plowing.

Classification (2022 KST)	Sandy, mixed, mesic Typic Dystrudepts
Natural drainage	Well drained or Somewhat excessively drained (outwash)
Parent material	Proglacial outwash
Limiting condition	Apparent water table well below profile; no redox observed to 200 cm via auger

Rhode Island (RIDEM OWTS Rules)	Massachusetts (Title 5, 310 CMR 15.000)
<p>Deep, well-drained outwash with no redox: separation to SHWT is not the constraint. Depending on test hole depth, assume SHWT to be 2' above bottom of hole.</p> <p>Coarse substratum represents a favorable soil category, which sets a high loading rate and a.</p>	<p>Likely a fast percolation rate, so plan on the five-foot separation, not four.</p> <p>High long-term acceptance rate; small absorption area.</p> <p>Confirm perc rate in the most restrictive layer below the proposed SAS.</p>

Suitable OWTS: system type and rationale

New construction, RI: Conventional gravity drainfield with dispersal trenches (6.34). The deep, well-drained outwash meets the three-foot separation easily and the coarse Class C parent material's soil categories enable a high loading rate (0.61 – 0.7 gallons per square foot per day), so the field is compact (345 gpd needs a minimum of 495 to 565 square feet, depending on the loading rate).

New construction, MA: Conventional trench soil absorption system in a Class I soil; the fast-perc five-foot separation applies, and at an LTAR near 0.74 the 330 gpd design flow needs roughly 450 square feet of absorption area.

Repair or upgrade: Straightforward like-for-like conventional field. RI repairs do not generally require a new soil evaluation, and depending on site constraints and setback distances, may allow deep concrete chambers (if no other drainfield option will fit); a MA upgrade could use dewatered perc if the season demands. Soil is not the constraint.

If nitrogen-sensitive or in a CRA: Use a denitrifying advanced treatment technology, followed by a pressurized or advanced drainfield. For maximum treatment performance via even dispersal, a drainfield following and advanced treatment technology should be pressurized, since advanced-treated/denitrified effluent does not form a biomat. While the regulations do allow a gravity drainfield to follow advanced treatment, a gravity-fed drainfield will not see even dispersal of advanced-treated wastewater, resulting in small localized areas of saturated flow amid dry portions of the drainfield. RIDEM requires nitrogen-reducing technology in a Critical Resource Area (6.42, 6.43) and stricter design in a water-supply watershed (6.44); Massachusetts as a state does not currently apply nitrogen-loading limits and or require I/A technologies (though many towns do). Clean outwash leaches nitrogen readily, thus drainfield needs to be sized appropriately with considerations taken for coastal areas which need additional denitrification.



STATE OF RHODE ISLAND
 Department of Environmental Management
 Office of Water Resources
 Email: dem.OWTS@dem.ri.gov
 Site Evaluation Form



Part A - Soil Profile Description Application Number _____

Property Owner: VRI Peckham (UP - Dry)
 Property Location: _____ Plat: _____ Lot: _____
 Date of Test Hole: _____ Weather: _____ Shaded: Yes No Time: _____
 Soil Evaluator: _____ License Number: _____
 Soil Evaluator email address: _____

TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab. S. Contr.				
Oe	0-2	clear	waxy	5YR 2.5/1	—	—	—	—	—	—
Ap	2-9	clear	waxy	7.5YR 3/2	—	—	SL	weak med SBK	VF	3
Bw	9-16	clear	waxy	10YR 4/6	—	—	CoSL	CSBK	F	1
BC	16-21	clear	waxy	2.5Y 5/4	—	—	LCOS	SG	loose	1
C	21-49	/	/	2.5Y 6/4	—	—	F5 (silt) EXGCOs	SG	loose	1

TH P UP Soil Class C Total Depth 49 Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)
 TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

Comments: _____

2.3 Moderately well drained: Sudbury

A few feet of relief and ~150 feet toward the wetland. This pit classifies as an Oxyaquic Dystrudept, indicating periodic wetness deep in the profile rather than a shallow seasonal table. This pit borders the wetland boundary and would likely not be a suitable place for an OWTS, unless it is a replacement of a failing system for an existing home (e.g. repair application). Note that resilience to climate events would be an important consideration for an OWTS that were installed on this site – short-term flooding could cause problems for buoyant components, and treatment performance would be minimal to non-existent during periods of unusually elevated groundwater tables.

Classification (2022 KST)	Coarse-loamy, mixed, active, mesic, Oxyaquic Dystrudept
Natural drainage	Moderately well drained
Parent material	Outwash
Limiting condition	Deep periodic wetness (oxyaquic); wetland boundary immediately east

Rhode Island (RIDEM OWTS Rules)	Massachusetts (Title 5, 310 CMR 15.000)
Since the SWHT is less than 4 feet from the original ground surface, a conventional system would not be permitted here for new construction. The three-foot separation distance between drainfield and SHWT requirement is tough to meet without elevating the system, and an elevated advanced drainfield would likely be the only solution. Note that proximity to the wetland narrows the usable footprint and the system would likely be better-located uphill.	Confirm the high groundwater elevation in a deep observation hole; do not rely on the dry-season water level. Setbacks to the adjacent wetland will likely govern the layout as much as the vertical separation.

Suitable OWTS: system type and rationale

New construction, RI: Advanced drainfield raised above original grade to reach 3 or 4 feet separation (6.33). No conventional system permitted because water table is less than 4 feet from the original ground surface.

New construction, MA: Conventional trench system, with construction in fill (raised system, 15.255) only if the deep-hole high groundwater proves too shallow. Class I or II soil, moderate area.

Repair or upgrade: Feasible as a conventional with modestly raised field. On a repair the wetland horizontal setback, not the soil, usually drives the layout.

If nitrogen-sensitive or in a CRA: Add nitrogen-reducing treatment (RI 6.42, 6.43; MA I/A) and elevated pressurized drainfield. RI CRA siting bars new systems where the SHWT is within five feet of the original ground surface, which could disqualify the wetter side of this pit.



STATE OF RHODE ISLAND
 Department of Environmental Management
 Office of Water Resources
 Email: dem.OWTS@dem.ri.gov
 Site Evaluation Form
 Part A - Soil Profile Description



Application Number Peckham MW

Property Owner: _____
 Property Location: _____ Plat: _____ Lot: _____
 Date of Test Hole: _____ Weather: _____ Shaded: Yes No Time: _____
 Soil Evaluator: Lindbo & Allen License Number: _____
 Soil Evaluator email address: _____

TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab.	S. Contr.				
<u>Oi</u>	<u>2-0</u>										
<u>A</u>	<u>0-6</u>	<u>Clear</u>	<u>Wavy</u>	<u>10YR2/1</u>	<u>none</u>			<u>SL</u>	<u>Wk med SBK</u>	<u>Fr</u>	<u>3</u>
<u>Bw1</u>	<u>6-15</u>	<u>Diffuse</u>	<u>wavy</u>	<u>10YR4/6</u>	<u>none</u>			<u>SL</u>			<u>3</u>
<u>Bw2</u>	<u>15-23</u>	<u>Diffuse</u>	<u>Wavy</u>	<u>10YR4/6</u>	<u>none</u>			<u>LS</u>			<u>3</u>
<u>Bw3</u>	<u>23-31</u>	<u>Diffuse</u>	<u>Wavy</u>	<u>10YR4/6</u>	<u>2.5Y5/4</u>	<u>few</u>					<u>3</u>
<u>Bw4</u>	<u>31-36</u>	<u>Clear</u>	<u>Wavy</u>	<u>10YR4/6</u>	<u>2.5Y5/3</u>	<u>common</u>					<u>3</u>
					<u>7.5YR4/6</u>	<u>common</u>					
TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab.	S. Contr.				
<u>Cg</u>	<u>36+</u>			<u>2.5Y4/2</u>	<u>none</u>			<u>Sand</u>	<u>Structureless SG1</u>	<u>Lo</u>	<u>1</u>

TH _____ Soil Class C Total Depth 36 Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth 38 SHWT 31 (og)
 TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

Comments: Outwash
Bw1 has filled root channels w/ 10YR3/3 filling

2.4 Poorly drained: Scarboro Taxadjunct

Morphology is variable across the pit face, which is itself characteristic of these marginal soils on the lines of Rhode Island wetlands. The seasonal high water table is at or near the surface for part of the year.

Classification (2022 KST)	Coarse-loamy over sandy or sandy-skeletal mixed, mesic Aeric Humaquepts
Natural drainage	Poorly drained
Parent material	Outwash
Limiting condition	Seasonal high water table at or near surface; mucky modified A
Hydric Soil Indicator	S1: Sandy Mucky Mineral

Rhode Island (RIDEM OWTS Rules)	Massachusetts (Title 5, 310 CMR 15.000)
<p>A poorly drained soil with a near-surface SHWT cannot meet the minimum-required four-foot separation from the original ground surface.</p> <p>This is a wetland; freshwater wetland jurisdiction and setbacks are in play.</p>	<p>Treat as unsuitable for a conventional system; any approval would be an upgrade-only or heavily engineered exception.</p>

Suitable OWTS: system type and rationale

New construction, RI and MA: No conventional system. A poorly drained soil with a near-surface water table at a wetland margin is not a new-construction location under either code.

Repair or upgrade: If a failed system on an existing lot had to be replaced, the realistic path is substantial fill well above grade plus advanced denitrifying treatment and a variance, decided case by case. Both states treat this as an engineered exception, not a standard design.

If nitrogen-sensitive or in a CRA: More restrictive still: nitrogen-reducing technology required and CRA siting bars placement outright.

Hydric Soil Notes:

Bw under mucky modified A is unusual. This is why it is an Aeric subgroup.

Very variable morphology across the pit face. Previous sampling has found areas of spodic materials and small pockets of eluviated materials. The description from the summer 2025 describing/sampling was done to the right of the pit.

Few fine faint concentrations in the A horizon in some areas of the pit face. Not originally described.

Previous sampling for a pedology tour in summer 2025 sampled the pit when it was about 8-12 inches closer to the upland. That description is below. At the time a spodic-like profile was found and described. This is not in the current pit face.



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 Department of Environmental Management
 Office of Water Resources
 Email: dem.OWTS@dem.ri.gov
 Site Evaluation Form
 Part A - Soil Profile Description



Application Number _____

Property Owner: _____
 Property Location: Peckham PD Plat: _____ Lot: _____
 Date of Test Hole: _____ Weather: _____ Shaded: Yes No Time: _____
 Soil Evaluator: JM, BEF License Number: _____
 Soil Evaluator email address: _____

TH Horizon	Depth cm	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab.	S. Contr.				
De	0-4	A	S	7.5YR 2.5/2	-	-	-	MK PT	-	-	-
A	4-20	A	W	10YR 2/1	-	-	-	MK-LS	F SBK	FR	3
Bw	20-45	C	S	10YR 4/3	Common distinct masses		-	LS	M SBK	FR	3
Cg1	45-62	C	S	10YR 4/2	-	-	-	LCOS	O SGR	LO	1
Cg2	62+	-	-	2.5Y 5/2	-	-	-	S	O SGR	LO	1

TH _____ Soil Class C Total Depth 65 Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth 6 SHWT 6 (og)
 TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

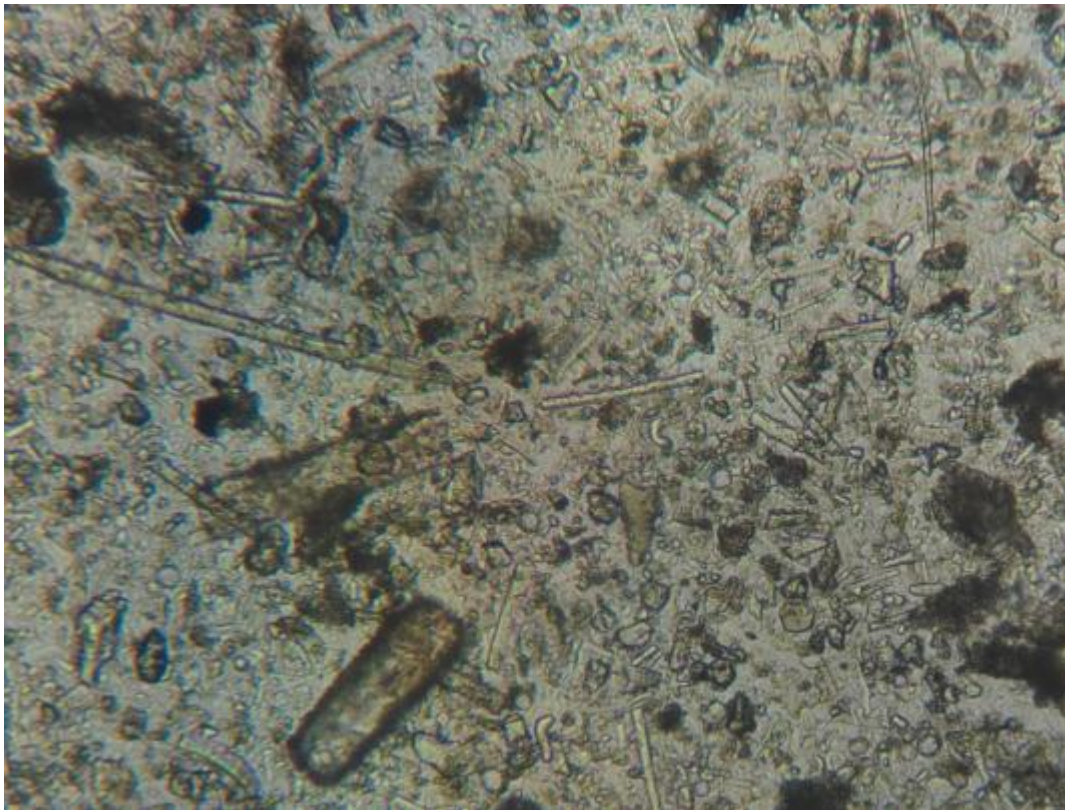
Comments: Pockets of E horizon at bottom of A

Field Morphology																											
Horizon	Upper Depth	Lower Depth	Bou ndar y	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes	Lab Data															
												Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550°C LOI %	Estimated C %	Bulk density	
Oe	0	7	AS	10YR 2/1	MPT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.92	49.7776	-	
A	7	20	AS	7.5YR 2.5/1	SL	5-F SR GR	1 F SBK	CFR	F F Pore Linings	Outwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
A/E	20	25	CS	7.5YR 2.5/1 & 10YR 5/3	SL	5-F SR GR	1 M SPK	FR	N	Outwash	Intermittent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bhs	25	53	CS	7.5YR 4/4	SL	10-F/M SR GR	1 F SPK	FR	N	Outwash	Intermittent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bw	53	70	CS	7.5YR 5/4 OR 10YR 4/4	GR LS	20-F/M SR GR	1 M SPK	FR	C D Masses	Outwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cg	70	70+	-	10YR 4/2	GR S	20-F/M SR GR	0 SG	LO	C D Masses	Outwash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Oe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.92	49.7776	-	
A	78.36	11.8	9.84	3.34	0.36	2.37	8.54	12.69	33.31	21.46	7.41	4.39	-	-	-	-	-	-	-	-	-	-	-	-	-	0.79	
A/E	68.44	24.84	6.72	4.9	0.13	2.37	8.54	12.69	33.31	21.46	22.29	2.55	3.24	1.7172	1.27	-	-	-	-	-	-	-	-	-	-	-	1.27
Bhs	68.11	23.39	8.5	4.23	0.29	4.65	13.15	28.48	17.11	5.05	21.49	1.9	7.15	3.7895	1.29	-	-	-	-	-	-	-	-	-	-	-	1.29
Bw	85.79	12.12	2.09	3.54	0.15	4.49	14.73	27.03	17.11	4.75	-	-	2.01	1.0653	1.34	-	-	-	-	-	-	-	-	-	-	-	1.34
Cg	92.26	4.53	3.21	3.65	-	2.04	12.3	38.29	27.11	6.05	3.32	1.21	1.62	0.8586	1.47	-	-	-	-	-	-	-	-	-	-	-	1.47

2.5 Very poorly drained: Histic epipedon / Histosol

In the basin against White Horn Brook the soil is organic. Muck overlies a thin lacustrine limnic horizon with diatomaceous earth (evidence of former beaver impoundment) over gleyed, stratified mineral material; free water stood at about 10 centimeters below the surface when described in July of 2025. Two profiles occur within a short distance, a Terric Haplosaprist and a Histic Humaquept. This is the wet end of the catena, and it is included to define the “wet” end of the catena. This soil will be available as a tray/trays next to the poorly drained pit. Below is a description from summer 2025 tour, as well as some images of diatoms found in the Oa/Ldi horizon.

Classification	Terric Haplosaprist and Histic Humaquept (two nearby profiles)
Natural drainage	Very poorly drained
Parent material	Organic over lacustrine over outwash.
Hydric soil indicators	A1/A2 (depending on location). A3.



Above: Diatom skeletons found in Oa/Ldi horizon @ 33 cm. Indication that this area was ponded, potentially due to beaver damming downstream. Diatomaceous earth (Ldi horizon) is not mapped in RI but may be common in areas like this. Upon drying, the diatomaceous earth appears stark white and will not re-darken to the original dark color.

Peckham VPD															
Classification:															
Field Morphology															
Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes				
Oa	0	30	A	N 2.5/	MUCK	0	-	-	N	Woody herbaceous materials	Free water @ 10 cm				
Oa/Ldi	30	35	C	90% N 2.5/ 10% 2.5Y 5/3	MUCK	-	-	-	N	Lacustrine deposit	10% apparent diatomaceous earth. Meets color requirements. Diatoms observed under microscope				
Cg1	35	45	A	2.5Y 5/2	L	10 - F SR GR	0 MA	FR	N	Lacustrine deposit	Marked alluvium because of texture difference. Diatoms found at contact of Oa/Ldi and mineral soil surface				
2Cg2	45	45+	-	2.5Y 5/1	GR SL	25 - F/M SR GR	0 SG	LO	N	Outwash	Stratified. Some stratifications are VGR.				
Lab Data															
Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCSS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550°C LOI %	Estimated C %	Bulk Density
Oa	-	-	-	-	-	-	-	-	-	-	-	-	64.37	34.11	-
Oa/Ldi	-	-	-	-	-	-	-	-	-	-	-	-	65.12	34.51	-
Cg1	41.74	45.39	12.87	3.89	-	10.72	11.45	12.81	5.13	1.62	43.3	2.09	9.61	5.1	-
2Cg2	61.05	34.99	3.96	3.53	-	7.61	13.67	20.85	11.99	6.92	32.28	2.71	1.55	0.82	-

2.6 Artesol (anthropogenic fill)

This pit looks, from the surface, like ordinary ground. Auguring revealed thick human-transported material over the original soil. The likely story is that sod operators filled a wet drainageway, a remnant outwash channel, to make it farmable. The fill compacted into anthropogenic horizons that now perch water, and includes relic redox features within the fill itself, above a buried soil that resembles the moderately well drained pit (see section 2.3). Roots were found within and below the dense layers, so it is not a true densic contact, but it behaves like a restrictive layer for water.

The Ksat for the receiving layer was measured at 5.2 min/in via use of a Saturo courtesy of the Tolland NRCS.

Classification (2022 KST)	Coarse-loamy, mixed, active, mesic Anthroptic Udorthent
Proposed (Under Artesol proposal)	Coarse-loamy, mixed, spolic, mesic, udic Typic Haploorthart
Parent material	Local human-transported material over loess over outwash
Limiting condition	SHWT below fill

Rhode Island (RIDEM OWTS Rules)	Massachusetts (Title 5, 310 CMR 15.000)
<p>Fill and compacted (anthropogenic) layers are not suitable for dispersal – base of treatment area must be below this layer.</p> <p>Loading and separation distance values cannot be taken from the fill; the buried soil and any imported material must be characterized.</p> <p>Filled wet drainageways are a recurring problem in old farm fields.</p>	<p>A profile of unknown, placed fill does not satisfy naturally occurring pervious material requirements.</p> <p>Perched water on compacted fill defeats the separation the surface elevation seems to offer.</p> <p>Disturbed sites typically need re-excavation and verified material before any design.</p>

Suitable OWTS: system type and rationale

New construction or repair: Fill must be excavated away (“Full + Perimeter Strip Out”) and SHWT assumed from original soil surface. Would likely need BSF or other elevated design (using approved materials (e.g. Title 5 sand in MA, BSF sand or septic gravel in RI)) for dispersal system to meet separation requirements.

Part 3. Stop 2: East Farm: Dense till on Kingston Hill

East Farm is an 85-acre URI Agricultural Experiment Station property, a colonial pasture bought in 1928 for orchard and poultry trials and now used mainly by the URI Master Gardeners and the Entomology program. The tour visits four pits, all mapped as the Rainbow series, set on the slopes of a till feature.

There are active honey-bee hives between the western and eastern pits, which is how the Rainbow Bees pit earned its name; please keep a distance of at least 10 feet from these active hives.

Whereas Peckham demonstrates a drainage catena in permeable soils, East Farm demonstrates a restrictive layer at shallow depth. The Rainbow soils formed in a silty eolian and flow-till mantle over compact basal (lodgment) till. That dense till is a densic contact: it transmits water slowly, perches a seasonal high water table above itself, and limits the depth of usable soil. This is the dominant OWTS siting problem of the New England uplands, and the four pits show it affecting the SHWT drastically.

All soils here, with the exception of rainbow North, have somewhat similar SHWT and thus we have put a blanket OWTS regs/sizing information below. NOTE: We have only dug deep enough to uncover category 8 soils here but the till likely gets denser with depth and so OWTS designs may be functionally limited if there is a category 10 soil among the restrictive layers.

Rhode Island (RIDEM OWTS Rules)	Massachusetts (Title 5, 310 CMR 15.000)
<p>Inland, a conventional in-ground drainfield needs its infiltrative surface 3 feet (36 in) above the SHWT and 5 feet (60 in) above the densic. No Rainbow pit meets either, so a conventional system is not permitted for new construction. Advanced systems such as a BSF paired with a pressurized drainfield may be used in some areas with the drainfield located in the Cat 5 loess at least 3 feet above the dense till, but certainly not at Rainbow North where water comes to the soil surface.</p>	<p>Similar reasoning to RI rules (see left), these soils would not qualify for a conventional system and so a soil absorption system would have to be constructed above-grade in order to have an OWTS here (raised system, 15.255).</p>

Suitable OWTS: system type and rationale:

New construction, RI and MA: Advanced system (such as BSF) and shallow pressurized drainfield due to high water table and dense till contact.

Repair or upgrade: Repairs in RI don't typically require a new soil evaluation, though to design an advanced drainfield, RIDEM may require it. MA

If nitrogen-sensitive or in a CRA: A denitrifying advanced treatment technology ahead of the elevated pressurized drainfield. In a RIDEM CRA, nitrogen-reducing technology is required. Similar in most coastal MA towns.

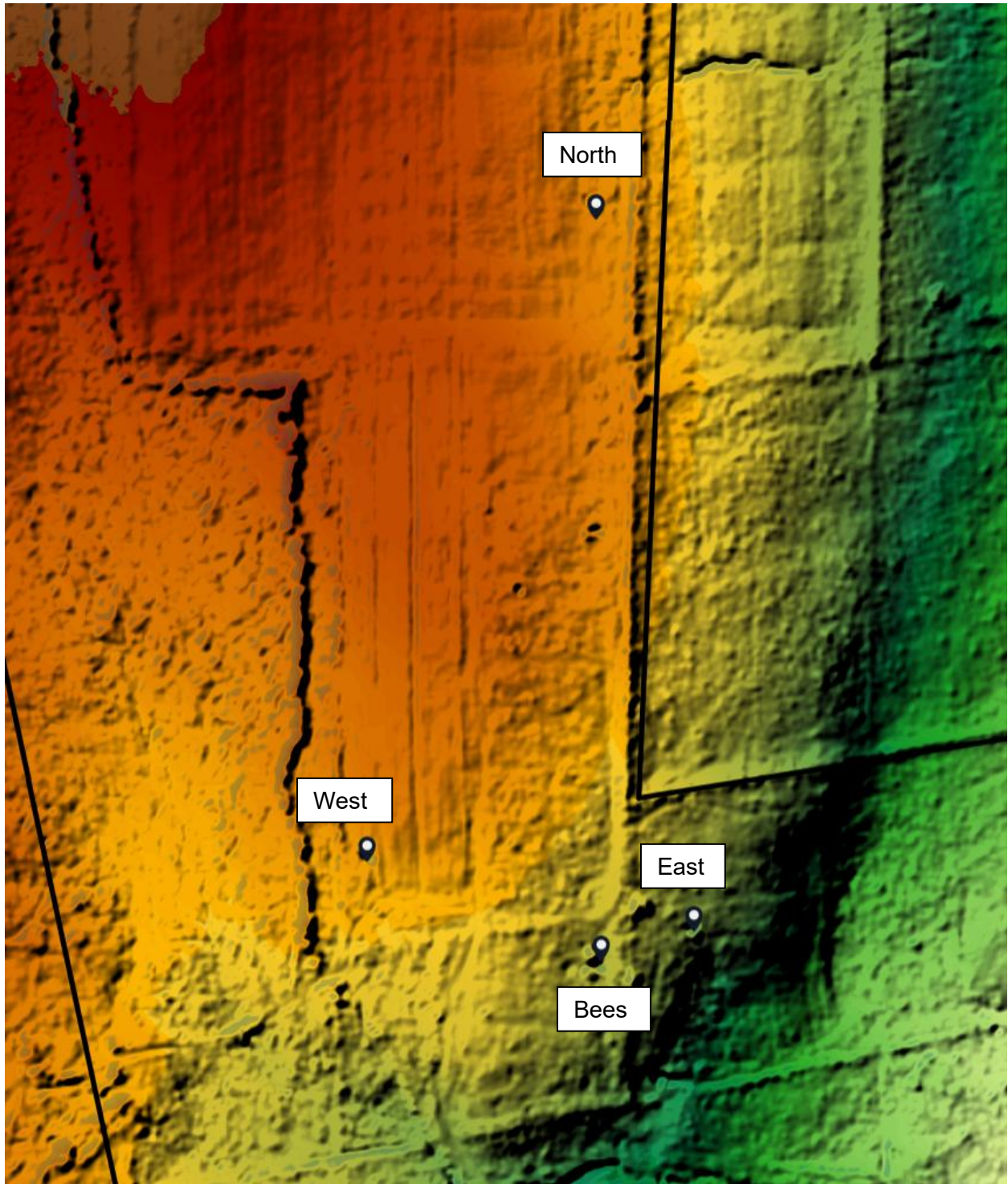
3.1 The Rainbow series

Rainbow is a moderately well drained soil formed in silty material over compact basal till, very deep to bedrock but moderately deep to a densic contact, classified as a coarse-loamy, mixed, active, mesic Aquic Dystrudept. Its seasonal high water table is perched at 1.5 to 3 feet from the ground surface in November through May, and its hydrologic group is C. The four profiles East, Bees, and West were described as Humic Densiuudepts, reflecting the dense C horizons and a thick dark surface. North was described as an Aquic Densiuudept due to distinct redox in the Ap horizons.

Rainbow sits in the middle of a classic dense-till drainage catena. On convex upper slopes it gives way to well drained Paxton, Montauk, and Broadbrook; in the lows and drainageways it grades to poorly drained Ridgebury and Norwell and very poorly drained Whitman, all sharing the same dense substratum.

Rainbow North borders an area mapped as Ridgebury (in the woods). Rainbow West is perhaps better correlated as Broadbrook. The North pit consistently the wettest of all, then “East”. “Bees” and “West” almost never have any water in them.

Pit	Depth to densic materials	SHWT	Observed water table
Rainbow East	38"/97 cm	Bw2 21 inches	Yes, until June or later
Rainbow Bees	50"/127 cm	Bw2 18 inches	Often muddy early in the season
Rainbow West	34"/86 cm	Bw2 26 inches	No
Rainbow North	39"/99 cm	Shallow, at or near surface	Often to the surface in April, and at the bottom of the pit sometimes through summer



East farm locations

3.2 Rainbow East

This pit is notably wetter than Rainbow Bees and Rainbow West due to its slightly lower position on the landscape. Here we see a good example of less dense till over dense till. This less dense till wither formed from a small smear of ablation till on top of the dense till or was otherwise broken up due to freeze/thaw process. The pit face shows evidence of tree throw with the uneven Ap horizon depth.

Mapped series	Rainbow (moderately well drained)
Classification	Coarse-loamy, mixed, active, mesic Humic Densiudept (OSD: Aquic Dystrudept)
Parent material	Silty loess mantle over sandy lodgment till
Limiting conditions	Perched SHWT (redox at 21 inches); densic contact at 38 inches

3.3 Rainbow Bees (middle)

One of the prettier pits we have on campus. Very nice examples of redox, gleyed matrices, and clean loess. The lower Bw3 horizon is either clean silt or a VFSL. Note we have split the Bw horizons into 3 horizons, this is due to differences in the quantity of redox features in each horizon.

Mapped series	Rainbow (moderately well drained)
Classification	Coarse-loamy, mixed, active, mesic Humic Densiudept (OSD: Aquic Dystrudept)
Parent material	Silty loess over sandy lodegment till
Limiting conditions	Redox masses + depletions at 18 inches; densic Cd at 57 inches
Notes	Often muddy in the bottom early in the season but rarely standing water

3.4 Rainbow West

This pit may be better correlated as Broadbrook taxadjunct with its deeper water table which makes this pit oxyaquic rather than aquic like a true Rainbow series, though the Dense contact would push this soil into being a “Densiudepts” rather than a Dystrudept as it is currently classified in the OSD. This pit is rarely if ever wet, but there are enough redox features to call the water table. It is likely the water sits right above the dense till but drains away quickly enough that we rarely observe it.

The Ksat for the receiving layer was measured at 52 min/in via use of a Saturo courtesy of the Tolland NRCS. This is just below the maximum of 60 min/in which is set as the max by MASS DEP.

Mapped series	Rainbow (moderately well drained) – More likely Broadbrook
Classification	Coarse-loamy, mixed, active, mesic Humic Densiudept (OSD: Aquic Dystrudept). Oxyaquic Densiudept does not exist.
Parent material	Silty loess over silty flow till over sandy lodegment till
Limiting conditions	Redox/depletions from ~46 cm; densic 2Cd at ~70 cm
Notes	Rarely if ever wet. Well data confirms redox depth as SHWT



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 Site Evaluation Form



Part A - Soil Profile Description Application Number Rainbow East

Property Owner: IRE
 Property Location: Rainbow East Plat: _____ Lot: _____
 Date of Test Hole: _____ Weather: _____ Shaded: Yes No Time: _____
 Soil Evaluator: _____ License Number: _____
 Soil Evaluator email address: Lindbo & Allen

TH Horizon	Depth (in)	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrx	Re-Dox Features	Ab. S. Contr.				
A1	0-4	gradual	smooth	10YR2/1	none		silt/loam	weak, sub-angular blocky	friable	5
Ap	4-11	abrupt	smooth	10YR2/2	none					5
Bw1	11-21	gradual	smooth	10YR4/3	5YR2/4	few				5
Bw2	21-25	clear	smooth	10YR4/4	10YR4/2 7.5YR4/4	common				5
Bw3	25-30	gradual	smooth	10YR5/6	2.5Y5/2 7.5YR4/4	common				5
Bw4	30-38	clear	wavy	2.5Y5/4	2.5Y5/1 7.5YR4/6	faint common	↓	↓	↓	5
TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrx	Re-Dox Features	Ab. S. Contr.				
Cd	38+	—	—	2.5Y5/3	7.5YR4/6	common	sandy loam	massive	firm	8

TH R-E Soil Clas G/A Total Depth 38+ Impervious/Limiting Layer Depth 38" (og) GW Seepage Depth 48" SHWT 21" (og)
 TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth 38" (og) GW Seepage Depth 48" SHWT 21" (og)

Comments: Aeolian is borderline silt loam or very fine sandy loam
common root channels to 25"
Rooting to 38"



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 Site Evaluation Form



Part A - Soil Profile Description Application Number _____

Property Owner: URI
 Property Location: Rainbow Acres Plat: _____ Lot: _____
 Date of Test Hole: 5/22/26 Weather: Sunny Shaded: Yes No Time: 9:00 am
 Soil Evaluator: JMT + BS License Number: _____
 Soil Evaluator email address: _____

THRBAs Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab.	S. Contr.				
Ap	11" / 28cm	C	S	7.5YR 2.5/3	—	—	—	SIL	1 SBK	FR	5
Bw1	18" / 45cm	C	S	10YR 4/6	7.5YR5/6 2.5Y5/1	F M D F M D	—	SIL	1 SBK	FR	5
Bw2	32" / 82cm	C	S	10YR 4/6	7.5YR5/6 2.5Y5/1	C M-EC D C M-EC D	—	SIL	1 SBK	FR	5
Bw3	43" / 110cm	A	S	10YR 5/6	7.5YR5/6 2.5Y5/1	M EC P M EC P	—	SI	1 SBK	FR	5
2C	50" / 127cm	A	W	2.5Y 4/3	7.5YR5/8 2.5Y5/2	M M D C M D	—	SL	OMA	FR	6
2Cdy	57" / 145cm	—	—	2.5Y 5/2	10YR 4/3 2.5Y5/1	C M D M M O	—	LS	OMA	FI	8
TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab.	S. Contr.				

TH R Soil Class G/B/A Total Depth 57" Impervious/Limiting Layer Depth 57" (og) GW Seepage Depth — SHWT 18" (og)

TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

Comments: _____



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(Broadbrook?) organic.

Part A - Soil Profile Description Application Number _____

Property Owner: URI
 Property Location: EAST FARM - RAINBOW WEST Plat: _____ Lot: _____
 Date of Test Hole: 5/22/26 Weather: SUN 60°F Shaded: Yes No Time: 9:15 AM
 Soil Evaluator: DONALD PARIZEK BRADEN FLEMING License Number: _____
 Soil Evaluator email address: _____

TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox		Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrx	Re-Dox Features	Ab.	S. Contr.				
Ap	0-14	A	S	10YR 3/2	-	-	-	SiL	2 M-FGt	FR	5
Bw1	14-26	G	W	10YR 4/4	-	-	-	SiL	1 Co SBK	FR	5
Bw2	26-34	C	W	10YR 5/4	7.5YR 4/6	2% F P	-	SiL	1 Co SBK	FR	5
2Cd	34-42	-	-	50% 2.5Y 5/3 2.5Y 5/2	7.5YR 4/6	5% F P	-	SL	0 MA	FI	8

TH R-W Soil Cls: G/A Total Depth 42 + Impervious/Limiting Layer Depth 34 in (og) GW Seepage Depth None SHWT 26 (og)

TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

Comments: Pockets of LS in Cd horizon. 10% Cratering in Bw1 and 10% in Bw2. 10YR 3/2 color
10% Gravel and cobble in Cd horizon. 2% gr in Ap and 5% gr in Bw1 and Bw2

3.6 Rainbow North (wettest overall)

The north pit is consistently wetter than the three to the south. This pit's SHWT and field behavior place it at the wet end of the catena despite being at the top of the hill. This soil borders an area mapped as Ridgebury and the limiting conditions are near the surface lack of separation to the water table.

Mapped series	Rainbow (wettest position)
Parent material	Silty mantle over dense lodgment till
Limiting conditions	Shallow perched SHWT and densic contact (no full description on file)
Seasonal wetness	Consistently wettest of the four pits
Hydric Soil Indicator	None

Notes:

This soil does not meet any hydric soil indicator, though it is saturated to the soil surface for much of the fall, winter, and spring.

A few meters into the woods is mapped as Ridgebury, a hydric soil

Distinct root pore linings are found to the soil surface indicating seasonal high water to the soil surface. This is confirmed via site visits in April.

No hydrophytic vegetation present.

Dense till perches water table for majority of year but little if any water enters Cd (note brighter color)

Should this be a hydric soil? What do you think?



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 Site Evaluation Form



Part A - Soil Profile Description Application Number _____

Property Owner: URI
 Property Location: Rainbow North Plot: _____ Lot: _____
 Date of Test Hole: 5/17/16 Weather: cloudy Shaded: Yes No Time: 10:00am
 Soil Evaluator: RE, JM, DP, DL, BS, AA License Number: _____
 Soil Evaluator email address: _____

TH Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab. S. Contr.				
Ap1	4" / 6cm	C	S	10YR3/2	7.5YR 4/4	C F	SIL	1 M GR	F-R	5
Ap2	13" / 5.3cm	VA	S	10YR3/2	7.5YR 4M	C F	SIL	1 M SBK	FR	5
Bw1	20" / 5.1cm	C	W	10YR4M	7.5YR 4/6 2.5Y 5/0	C F C M	SIL	1 Co SBK	FR	5
Bw2	23" / 7.1cm	C	W	10YR4M	7.5YR 4/6 2.5Y 5/2	C F M M	SIL	1 Co SBK	FR	5
Bc	37" / 9.4cm	G	W	10YR3M	7.5YR 4/6 2.5Y 5/2	C M M M	FSL	1 Co SBK	FI	8
Bcdg	42" / 10.7cm	-	-	2.5Y 4/2	7.5YR 5/6	C F	SL	0 MA	FI	8
TH Horizon	Depth	Dist	Topo	Matrix	Re-Dox Features	Ab. S. Contr.	Texture	Structure	Consistence	Soil Category

TH R-N Soil Cla: G/B/A Total Depth 42 in Impervious/Limiting Layer Depth 39 in (og) GW Seepage Depth 40 in SHWT 0 in (og)
 TH _____ Soil Class _____ Total Depth _____ Impervious/Limiting Layer Depth _____ (og) GW Seepage Depth _____ SHWT _____ (og)

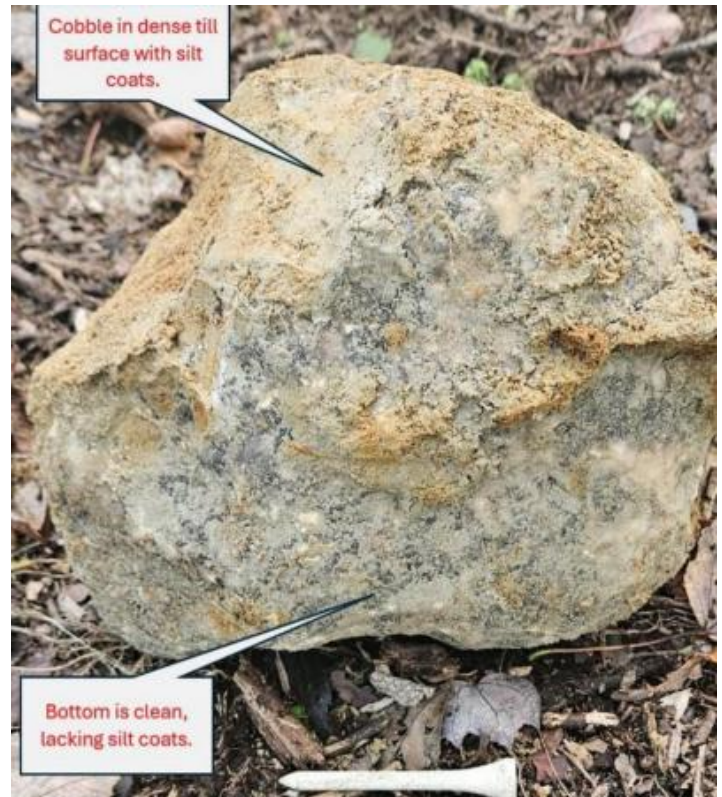
Comments: _____

3.6 Sidebar: silt caps on stones

In till, you can often find coarse fragments which have an apparent “silt cap”. These coatings are interpreted as having formed either during subglacial transport, where pressure and friction may cause matrix fines to smear or adhere to stone surfaces, or during post-depositional processes such as chemical weathering or soil formation. These thin layers are particularly common in dense tills and may act as a record of the depositional environment. Some of these coatings are enriched in Fe and Al oxides, especially around clasts and along voids. Fluctuating redox conditions mobilize and reprecipitate these elements at clast boundaries. The resulting coatings resemble illuvial silt or Fe-oxide skins. See image and interpretation by Dr. Stone below.

<https://www.youtube.com/shorts/DZIkRs4zdOU>

Another interpretation (favored by us geologically inept pedologists) is that these stones were thrust up through the soil/sediment by frost heave and compacted fine material above the stone, which subsequently stuck to the top of the stone as we see today. This interpretation is supported when we find rocks like these on top of each other with silt caps, but no silt coatings on the side of either rock. Multiple examples will be available at Rainbow East and West.



Appendix. Estimating the Seasonal High Water Table from Soil Morphology

In a summer or early fall soil evaluation the water table is usually below the pit, so the SHWT is inferred from the features that form where the soil is periodically saturated and chemically reduced.

- **Redox depletions.** Low-chroma (gray) zones where iron has been stripped during saturation.
- **Redox concentrations.** Masses and pore linings of oxidized iron and manganese where reduced iron re-oxidized; they mark a fluctuating, periodically saturated zone.
- **Gleyed and depleted matrices.** A dominantly gray matrix (Chroma 2 or less) due to wetness.
- **Perched indicators.** Redox immediately above a densic or cemented layer (East Farm), points to perched rather than regional water table, though it is still be considered for OWTS siting purposes.
- **Hanging water table.** Hanging water tables occur when there is a distinct change in textures: A particularly fine horizon above a coarser horizon will hold water longer (better adhesion and capillary action to retain water) before it drips into the coarser material below. This is not considered a SHWT for OWTS purposes as the soil is not truly saturated even though it reaches reducing conditions.

The determination sets the elevation against which separation is measured. In RI, if a 10 foot test hole shows no sign of a water table, the design point for the assumed water table at that site is 2 feet above the bottom of the test hole (so often this means systems are designed on a water table that is 8 feet below the ground surface). When morphology is ambiguous, or there is disagreement on the water table interpretation, both states allow or expect a wet-season observation, and in RI it takes precedence over a soil evaluation.

Some difficulties in SHWT determination may be due to parent material color where low chroma high value colors occur in dry areas which have not had either enough wetness or carbon to drive the reduction and oxidation of iron minerals. Additionally, soils may have low chroma colors due to organic matter or carbonates, though carbonates are rare to non-existent in RI and southeast MA due to acidic parent materials and bedrock. Some horizons may be leached or stripped of Fe/Mn coatings due to chelated organic matter: this is common in E horizons. Although this stripping is not due to water, large E horizons are often associated with spodic horizons beneath which are associated with wetness.

Soils from dark parent materials, such as those soils formed in the dense till on Pennsylvanian-age shale in the Narragansett basin, redox features may be difficult to impossible to see and care should be taken to ensure SHWT is called carefully with close inspection of broken peds.

Sometimes, nodules and concretions may be relicts of past wet conditions, or they may be transported to a site via water. When nodules and or concentrations are the only redox feature found in a soil they should not be considered for the water table; however, if water transported these items into a soil it is likely there are indicators of wetness other than these nodules/concretions.

Finally: redox features may be relict in HTM due to the original soil having redox features. These are not an indication of a true water table and can be identified due to odd/non consistent shape/distribution and “sharp” boundaries compared to natural or “active” redox features.

OSDs

Various soil series were mentioned in this document. Find OSDs for each mentioned soil series below for reference.

DEERFIELD SERIES

The Deerfield series consists of very deep, moderately well drained soils formed in glaciofluvial deposits. They are nearly level to strongly sloping soils on terraces, deltas, and outwash plains. Slope ranges from 0 to 15 percent. Saturated hydraulic conductivity is high or very high. Mean annual temperature is about 9 degrees C. and mean annual precipitation is about 1194 mm.

TAXONOMIC CLASS: Mixed, mesic Aquic Udipsamments

TYPICAL PEDON: Deerfield loamy fine sand in a hayfield at an elevation of about 19 meters. (Colors are for moist soil.)

Ap --0 to 23 cm; very dark brown (10YR 2/2) loamy fine sand; weak fine and medium granular structure; very friable; common fine roots; moderately acid; abrupt smooth boundary. (15 to 30 cm thick)

Bw1 --23 to 43 cm; strong brown (7.5YR 5/6) loamy fine sand; weak fine and medium granular structure; very friable; common fine roots; moderately acid; clear smooth boundary.

Bw2 --43 to 64 cm; yellowish brown (10YR 5/6) loamy fine sand; weak fine granular structure; very friable; few fine faint brownish yellow (10YR 6/6), moist, masses of oxidized iron accumulation; strongly acid; clear wavy boundary. (Combined thickness of the Bw horizons is 13 to 69 cm.)

BC --64 to 84 cm; yellowish brown (10YR 5/6) fine sand; single grain structure; loose; common fine and medium distinct strong brown (7.5YR 5/8) masses of oxidized iron accumulation and common fine and medium distinct light brownish gray (10YR 6/2) iron depletions; strongly acid; clear broken boundary. (0 to 51 cm thick)

C1 --84 to 102 cm; light brownish gray (10YR 6/2) stratified sand and fine sand; single grain structure; loose; common fine prominent strong brown (7.5YR 5/8) masses of oxidized iron accumulation; strongly acid; clear wavy boundary.

C2 --102 to 152 cm; light brownish gray (10YR 6/2) stratified sand and gravelly sand; single grain structure; loose; common fine and medium prominent strong brown (7.5YR 5/8) masses of oxidized iron accumulation; 10 percent rounded fine granite and quartzite gravel; very strongly acid; individual strata contain up to 20 percent gravel.

TYPE LOCATION: Essex County, Massachusetts; Town of Andover, 2,525 feet north-northwest (345 deg) of the intersection of Laurel Lane and Old River Road, in a hayfield. USGS Lawrence, Massachusetts topographic quadrangle; Lat. 42 degrees 41 minutes 49.57 seconds N. and long. 71 degrees 12 minutes 52.52 seconds W., WGS 84.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 38 to 100 cm. Gravel, generally fine gravel, ranges from 0 to less than 15 percent in the solum and 0 to 20 percent in the substratum. Reaction ranges from extremely acid through slightly acid unless limed. Iron depletions with chroma of two or less are between depths of 38 and 100 cm from the mineral soil surface.

MERRIMAC SERIES

The Merrimac series consists of very deep, somewhat excessively drained soils formed in outwash. They are nearly level through very steep soils on outwash terraces and plains and other glaciofluvial landforms. Slope ranges from 0 through 35 percent. Saturated hydraulic conductivity is high or very high. Mean annual temperature is about 48 degrees F. (9 degrees C.) and mean annual precipitation is about 42 inches (1067 millimeters).

TAXONOMIC CLASS: Sandy, mixed, mesic Typic Dystrudepts

TYPICAL PEDON: Merrimac fine sandy loam cultivated, at an elevation of about 122 meters. (Colors are for moist soil.)

Ap -- 0 to 10 inches (0 to 25 centimeters); very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine and medium granular structure; very friable; many fine roots; 10 percent fine gravel; strongly acid; abrupt smooth boundary. (1 to 14 inches (3 to 36 centimeters) thick.)

Bw1 -- 10 to 15 inches (25 to 38 centimeters); brown (7.5YR 4/4) fine sandy loam; weak fine and medium granular structure; very friable; common fine roots; 10 percent fine gravel; strongly acid; clear wavy boundary.

Bw2 -- 15 to 22 inches (38 to 56 centimeters); dark yellowish brown (10YR 4/4) gravelly sandy loam; weak fine and medium granular structure; very friable; few fine roots; 15 percent gravel; strongly acid; clear wavy boundary.

Bw3 -- 22 to 26 inches (56 to 66 centimeters); dark yellowish brown (10YR 4/4) gravelly loamy sand; very weak fine granular structure; very friable; few fine roots; 25 percent gravel; moderately acid; clear wavy boundary. (Combined thickness of the Bw horizons is 6 to 34 inches (15 to 86 centimeters).)

2C -- 26 to 65 inches (66 to 165 centimeters); 80 percent yellowish brown (10YR 5/4) and 20 percent dark grayish brown (10YR 4/2) very gravelly sand; single grain; loose; stratified; few fine roots in upper 4 inches; 40 percent gravel, 10 percent cobbles; moderately acid.

TYPE LOCATION: Franklin County, Massachusetts; Town of Leverett, 2.75 miles south-southeast of Montague Village, 0.13 miles southeast of Cranberry Pond, just west of Route 63. USGS Williamsburg, MA topographic quadrangle, Latitude 42 degrees, 29 minutes, 51 seconds N. and Longitude 72 degrees, 31 minutes, 12 seconds W., NAD 1983.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 18 through 36 inches (46 through 91 centimeters). Rock fragments are commonly granite or gneiss or schist but up to 25 percent are flat, fine-grained slate, shale, or phyllite fragments. The upper part of the solum commonly has 2 through 20 percent gravel, but includes cobbles in some pedons, and the lower part 5 through 30 percent. The substratum contains 2 through 55 percent gravel and 5 through 15 percent cobbles. Total volume of rock fragments in the particle-size control section is less than 35 percent. Clay content is less than 18 percent. Reaction ranges from extremely acid through moderately acid, unless limed.

SCARBORO SERIES

The Scarboro series consists of very deep, very poorly drained soils in sandy glaciofluvial deposits on outwash plains, deltas, and terraces. They are nearly level soils in depressions. Slope ranges from 0 through 3 percent. Saturated hydraulic conductivity is high or very high. Mean annual temperature is about 49 degrees F. (9 degrees C.) and the mean annual precipitation is about 44 inches (1118 millimeters).

TAXONOMIC CLASS: Sandy, mixed, mesic Histic Humaquepts

TYPICAL PEDON: Scarboro mucky fine sandy loam woodland; in an area of Scarboro mucky fine sandy loam at an elevation of about 212 meters. (Colors are for moist soil.)

Oi-- 0 to 1 inch (0 to 3 centimeters); slightly decomposed maple leaves and other plant material

Oa-- 1 to 8 inches (3 to 20 centimeters); dark brown (10YR3/3) mucky peat; thin platy structure; friable; common fine roots; very strongly acid; abrupt wavy boundary. (Combined thickness of Oi, Oe, and Oa horizons is 8 to 13 inches (20 to 33 centimeters).)

A-- 8 to 14 inches (20 to 36 centimeters); black (N 2/0) mucky fine sandy loam; weak medium granular structure; friable; common fine roots; very strongly acid; abrupt smooth boundary. (0 to 14 inches (0 to 36 centimeters) thick.)

Cg1-- 14 to 19 inches (36 to 48 centimeters); grayish brown (2.5Y 5/2) loamy sand; massive; friable; many fine roots; very strongly acid; abrupt irregular boundary.

Cg2-- 19 to 22 inches (48 to 56 centimeters); grayish brown (2.5Y 5/2) sand; massive; friable; few fine roots; 10 percent rock fragments; common medium prominent dark brown (7.5YR 3/2) areas of iron depletion and common medium prominent yellowish red (5YR 4/6) masses of iron; very strongly acid; clear wavy boundary.

Cg3-- 22 to 65 inches (56 to 165 centimeters); grayish brown (2.5Y 5/2) gravelly sand; single grain; loose; 15 percent rock fragments; strongly acid.

TYPE LOCATION: 60 feet north of Electric Avenue near the south edge of Forest Hill Cemetery in the City of Fitchburg, Massachusetts. USGS Fitchburg, MA topographic quadrangle, Latitude 42 degrees, 34 minutes, 0.3 seconds N., and Longitude 71 degrees, 48 minutes, 33.3 seconds W., NAD 1983.

RANGE IN CHARACTERISTICS: Stones range from 0 through 5 percent by volume in the A horizon and upper part of the C horizon and are absent in the lower part of the C horizon. Cobbles range from 0 through 10 percent in the A horizon, 0 through 5 percent in the upper part of the C horizon, and are absent in the lower part of the C horizon. Gravel ranges from 0 through 10 percent by volume in the A horizon, 0 through 20 percent in the upper part of the C horizon to a depth of 30 inches (76 centimeters), and 0 through 50 percent in the C horizon below a depth of 30 inches (76 centimeters). Reaction ranges from very strongly acid through moderately acid in the A horizon and upper part of the C horizon, and from very strongly acid through neutral in the lower part of the C horizon.

SUDBURY SERIES

The Sudbury series consists of very deep, moderately well and somewhat poorly drained soils on outwash plains. They are nearly level through strongly sloping soils in slight depressions and on terraces and foot slopes in areas of outwash or glaciofluvial deposits. Slope ranges from 0 through 15 percent. Saturated hydraulic conductivity is moderately high or high in the upper solum and high or very high in the lower solum and substratum. Mean annual temperature is about 48 degrees F. (9 degrees C.) and the mean annual precipitation is about 43 inches (1092 millimeters).

TAXONOMIC CLASS: Sandy, mixed, mesic Aquic Dystrudepts

TYPICAL PEDON: Sudbury fine sandy loam in a cultivated field at an elevation of about 92 feet (28 meters). (Colors are for moist soils unless otherwise stated.)

Ap -- 0 to 13 inches (0 to 33 centimeters); very dark grayish brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) dry; moderate fine granular structure; very friable; many fine roots; 5 percent gravel; moderately acid; abrupt smooth boundary. (6 to 14 inches, 15 to 36 centimeters thick.)

Bw -- 13 to 19 inches (33 to 48 centimeters); yellowish brown (10YR 5/6) sandy loam; weak medium granular structure; very friable; common grass roots; 10 percent fine gravel; few fine and medium prominent dark reddish gray (5YR 4/2) areas of iron depletion in the lower 3 inches (8 centimeters); moderately acid; abrupt wavy boundary. (2 to 20 inches, 5 to 51 centimeters thick.)

2CB -- 19 to 26 inches (48 to 66 centimeters); yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; few fine roots; yellowish red (5YR 4/8) coatings on some sand grains; 20 percent gravel; many fine prominent dark reddish brown (2.5YR 3/4) and common coarse prominent reddish yellow (5YR 6/8) masses of iron accumulations; moderately acid; abrupt wavy boundary. (0 to 10 inches, 0 to 25 centimeters thick.)

2C -- 26 to 65 inches (66 to 165 centimeters); light olive brown (2.5Y 5/4) very gravelly coarse sand; single grain; loose; many sand grains coated with strong brown (7.5YR 5/6) and some sand grains slightly cemented, and many pebbles and cobbles coated with black (5YR 2/1); few fine roots; strata of sand and gravel consisting of about 50 percent gravel and some cobbles; common medium prominent strong brown (7.5YR 5/6) masses of iron accumulation; moderately acid.

TYPE LOCATION: Essex County, Massachusetts; town of Beverly, 0.2 miles south of the junction of Essex Street and Cole Street and 150 feet south of railroad track. USGS Salem, MA quadrangle; Latitude 42 degrees, 33 minutes, 52 seconds N., Longitude 70 degrees, 51 minutes, 38 seconds W., NAD 1983.

RANGE IN CHARACTERISTICS: Thickness of the solum and depth to stratified sand and gravel range from 18 through 36 inches (46 through 91 centimeters). Depth to redoximorphic features ranges from 12 through 24 inches (30 through 60 centimeters) and must include redoximorphic depletions with chroma of 2 or less. Rock fragment content of individual horizons of the solum ranges from 0 through 30 percent by volume. The fragments are primarily fine gravel but include some medium gravel, coarse gravel and cobbles. Rock fragment content of the C horizon ranges from 0 through 75 percent, and consists of 0 through 65 percent gravel and 0 through 25 percent cobbles and stones. The fragments are mainly granite or gneiss with less than 25 percent dark, fine-grained shale, slate, or phyllite. Reaction ranges from extremely acid through slightly acid in the solum, unless limed, and from very strongly acid through slightly acid in the substratum.

RAINBOW SERIES

The Rainbow series consists of moderately well drained loamy soils formed in silty mantled lodgement till. The soils are very deep to bedrock and moderately deep to a densic contact. They are nearly level to strongly sloping soils on till plains, hills and drumlins. Slope ranges from 0 to 15 percent. Saturated hydraulic conductivity is moderately high or high in the surface layer and subsoil, and low to moderately high in the dense substratum. Mean annual temperature is about 49 degrees F., and mean annual precipitation is about 48 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, active, mesic Aquic Dystrudepts

TYPICAL PEDON: Rainbow silt loam in a grassy field at an elevation of about 195 feet. (Colors are for moist soil unless otherwise noted.)

Ap--0 to 6 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; many fine roots; few pebbles; strongly acid; clear wavy boundary. (6 to 10 inches thick)

Bw1--6 to 18 inches; yellowish brown (10YR 5/6) silt loam; weak medium subangular blocky structure; very friable; few fine roots; few pebbles; strongly acid; clear wavy boundary.

Bw2--18 to 26 inches; light yellowish brown (10YR 6/4) silt loam; weak fine and medium subangular blocky structure; very friable; few fine roots; few pebbles; common medium prominent light gray (5Y 7/1) iron depletions and distinct strong brown (7.5YR 5/6) masses of iron concentrations; strongly acid; clear wavy boundary. (Combined thickness of the Bw horizons is 12 to 37 inches.)

2Cd--26 to 65 inches; pale brown (10YR 6/3) gravelly fine sandy loam; very firm, brittle; common silt films on rock fragments; 15 percent gravel; common medium faint light olive brown (2.5Y 5/4) and common distinct brownish yellow (10YR 6/6) masses of iron concentrations; strongly acid.

TYPE LOCATION: New London County, Connecticut; town of Montville, 1,600 feet west along Haley Road from the intersection with Jerome Road, 100 feet south of Haley Road, and 100 feet north of the Montville-Waterford town line. USGS Uncasville topographic quadrangle, latitude 41 degrees 25 minutes 33 seconds N., longitude 72 degrees 7 minutes 8 seconds W., NAD 27.

RANGE IN CHARACTERISTICS: Thickness of the solum ranges from 18 to 40 inches. Depth to the densic contact commonly ranges from 20 to 40 inches but the range currently includes 18 to 40 inches. Depth to bedrock is commonly more than 6 feet. Rock fragments range from 0 to 20 percent by volume in the solum and from 5 to 35 percent in the substratum. Except where the surface is stony, the fragments are mostly subrounded gravel and typically make up 60 percent or more of the total rock fragments. Unless limed, reaction ranges from very strongly acid to moderately acid.