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NEON Site Level Plot Summary
Harvard Forest (HARV)

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Site Background

Harvard Forest (HARV) Domain 01 is in east central Massachusetts in the towns of Petersham and Phillipston, approximately 65 miles west of Boston, MA and 50 miles northeast of Springfield, MA (Figure 1). Elevation in the Harvard Forest (HARV) Domain 01 project area ranges from a high of 1,044 feet (318 m) at Camels Hump Hill and a low of 522 feet (159 m) at the surface elevation for the Quabbin Reservoir, which is also the drinking water supply for Boston. The terrain ranges from nearly level to very steep and has been extensively modified by the late Wisconsin glacial period (10 – 12 Thousand years B.P.). HARV is found in two Major Land Resource Areas (MLRA), MLRA 144A - New England and Eastern New York Upland, Southern Part and, MLRA 144B - New England and Eastern New York Upland, Northern Part. MLRA 144A is dominated by mesic soils vegetation, diversified agriculture/land uses and extensive anthropogenic influences. MLRA 144B is dominated by frigid soils, northern hardwood and coniferous forests along with some agriculture and limited anthropogenic disturbance. The majority of the project area is found in MLRA 144A.

The project area consists of approximately 12,114 Acres of non-federal land, and the dominant land cover is forest. The area is under a variety of management and ownership, with a portion owned/managed by Harvard University and the majority being owned/managed by the Massachusetts Department of Conservation and Recreation.

Site Information

Harvard Forest (HARV) is dominated by metamorphic schist and gneiss bedrock, which has been smoothed and reworked by the late Wisconsin glaciation 10 to 12 thousand years before present. The undulating metamorphic bedrock is covered primary with till and limited amounts of glacial fluvial materials at lower elevations. The higher and steeper portions of the landscape tend to have numerous bedrock outcroppings and shallow to moderately deep soils. Bedrock ranges in depth from the surface in outcrop areas to tens of meters in areas of very deep till and glacial fluvial deposits. Till is by far the most common parent material found at the site, and both dense lodgment and friable melt-out tills are common. The till soils have a coarse loamy solum and a sandy and gravelly substratum. Till soils are common on hills and bedrock controlled ridges. The glacial fluvial soils are typically dominated by sand and gravel and may have a loamy eolian cap. These soils are found on terraces and kames at lower elevations along

valleys. Very poorly drained wetland organic soils occupy many of the depressions with in the project area.

Figure 1. Overview map of the NEON Harvard site.

Mixed hard wood and conifer forest occur throughout the project area; however, this was not always the case. In the 1800's early settlers cleared the trees, stumps and surface stones where they could, leaving a patchwork of small fields devoid of surface stones in selected areas. Field-stone walls are common in many areas within the site, a testament to past agricultural land use and the glacial till character. Areas with steeper slopes were cleared, grazed or used for charcoal production for the early iron industry.

A second wave of agriculture land abandonment occurred during the early-mid 1900's due to the construction of the 36.6 square-mile Quabbin Reservoir built between 1930 – 1939. The Quabbin Reservoir serves as a water supply for the Boston metropolitan area 65 miles to the east.

Typical forest trees of the area include Northern Red Oak, Black Oak, Sweet Birch, Sugar Maple, Red Maple, American Beech, Eastern White Pine and Eastern Hemlock. Forests in the project area are managed for a variety of uses including: timber production, wildlife, recreation, scientific study, and watershed protection. The forests exhibit a range of age classes and species composition. Common wildlife in the area are white-tailed deer, black bear, moose, coyotes, porcupines, beavers, and numerous forestland bird species.

Analysis of Plots for Sampling

Soil Map Unit, Parent Material, landform and land cover were all part of the selection criteria for the project. A total of 18 sample locations were selected to represent the soil area from total of 34 possible plots. The selected plots include soils formed from till, glacial fluvial, and organic

soil parent materials. Land cover classes represented by the plots include: mixed forest, deciduous forest, coniferous forest and wetland shrub.

HARV is part of three soil survey areas: MA614 - Worcester County, MA, Northwestern Part (88%), MA011 – Franklin County, MA (9%) and MA017 – Middlesex County, MA (3%). Table 1 documents the distribution and extent of soil map units within the sample area.

Map unit Symbol	Soil Map Unit Name	Number of plots sampled in map unit	Map Unit Area %
927C	Montauk-Scituate-Canton association, 3 to 15 percent slopes, extremely stony	8	3.9
915E	Montauk-Canton association, 15 to 35 percent slopes, extremely stony	3	10.4
253E	Hinckley loamy sand, 25 to 35 percent slopes	1	2
245B,253B	Hinckley loamy sand, 3 to 8 percent slopes	1	7
245C,253C	Hinckley loamy sand, 8 to 15 percent slopes	1	2.3
901E	Berkshire-Marlow association, 15 to 45 percent slopes, extremely stony	1	2
59A	Bucksport and Wonsqueak mucks, 0 to 2 percent slopes	1	8.9
926C	Charlton-Chatfield association, 3 to 15 percent slopes, extremely stony	1	7.5
918B	Ridgebury-Whitman association, 0 to 8 percent slopes, extremely stony	1	6.7
900E	Becket-Monadnock association, 15 to 45 percent slopes, extremely stony		0.9
908C	Becket-Skerry association, 0 to 15 percent slopes, extremely stony		0.8
421B	Canton fine sandy loam, 0 to 8 percent slopes, very stony		0.9
421D	Canton fine sandy loam, 15 to 25 percent slopes, very stony		0.3
421F	Canton fine sandy loam, 25 to 45 percent slopes, very stony		0.1
420B	Canton fine sandy loam, 3 to 8 percent slopes		0.5
420C	Canton fine sandy loam, 8 to 15 percent slopes		0.1
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony		1.1

112D	Canton-Chatfield-Hollis complex, 15 to 35 percent slopes, rocky		0.3
112B	Canton-Chatfield-Hollis complex, 3 to 8 percent slopes, rocky		0.8
112C	Canton-Chatfield-Hollis complex, 8 to 15 percent slopes, rocky		0.5
925E	Charlton-Chatfield-Hollis association, 15 to 45 percent slopes, very rocky		11
103D	Charlton-Hollis-Rock outcrop complex, 15 to 25 percent slopes		0.2
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes		0.1
902E	Charlton-Paxton association, 15 to 45 percent slopes, extremely stony		3.9
109D	Chatfield-Hollis complex, 15 to 25 percent slopes, rocky		0.5
109F	Chatfield-Hollis complex, 25 to 60 percent slopes, rocky		0.3
245A,253A	Hinckley loamy sand, 0 to 3 percent slopes		1.5
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes		0.7
913E	Lyman-Tunbridge-Berkshire association, 15 to 45 percent slopes, very rocky		1
355B	Marlow fine sandy loam, 3 to 8 percent slopes		1
355C	Marlow fine sandy loam, 8 to 15 percent slopes		0.5
254B	Merrimac fine sandy loam, 3 to 8 percent slopes		1.1
301B	Montauk fine sandy loam, 0 to 8 percent slopes, very stony		0.1
305B	Paxton fine sandy loam, 3 to 8 percent slopes		0.5
905C	Peru-Marlow association, 3 to 15 percent slopes, extremely stony		2.4
917B	Pillsbury-Peacham association, 0 to 8 percent slopes, extremely stony		1.5
70B	Ridgebury fine sandy loam, 3 to 8 percent slopes		0.2
105E	Rock outcrop-Hollis complex, 3 to 35 percent slopes		0.7
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes		0.2

6A	Scarboro mucky sandy loam, 0 to 2 percent slopes		0.4
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony		0.7
316B	Scituate fine sandy loam, 3 to 8 percent slopes, very stony		0.3
260A	Sudbury fine sandy loam, 0 to 3 percent slopes		2
260B	Sudbury fine sandy loam, 3 to 8 percent slopes		0.7
260A	Sudbury sandy loam, 0 to 3 percent slopes		0.5
924C	Tunbridge-Lyman-Berkshire association, 3 to 15 percent slopes, extremely stony		1
31A	Walpole sandy loam, 0 to 3 percent slopes		1.7
771A	Walpole fine sandy loam, 0 to 3 percent slopes, very stony		0.2
1	Water		4.1
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony		1.2
255A	Windsor loamy sand, 0 to 3 percent slopes		0.1
255B	Windsor loamy sand, 3 to 8 percent slopes		0.2
910C	Woodbridge-Paxton association, 3 to 15 percent slopes, extremely stony		2.4
623C	Woodbridge-Urban land complex, 3 to 15 percent slopes		0.1
	Total Areal Percentage		100

Table 1. Soil Survey Map Unit Distribution at the Harvard Forest (HARV) site, Domain 01. Map Unit Area percent represents the percent areal coverage of the soil map unit in the HARV site boundary; actual boundary in which NEON ground-based sampling can occur may encompass a smaller area.

Plots were selected for sampling to capture maximum variability within the site area. Soil parent materials according to the soil survey consist of approximately 67% glacial till, 20% glacial fluvial, 9% organic soil materials, and 4% water. Fourteen sample points (78% of selected plots) are in glacial till-dominated map units, three sample points (15%) are in glacial fluvial dominated map units, and one sample point (6%) is in organic soil materials. The number of replicates in the till map units is justifiable given the variability of soils with respect to land form position, drainage class and mode of glacial deposition. Many of the till-derived soil map units were multiple member associations with a diversity of soil components within them and a variety of past land uses. The glacial fluvial soils were chosen to capture variability in slope classes, landforms and parent material. The lone organic soil selected was essential, as organic parent materials represent 9% of the project area. The selected plots represent a balance between

statistical integrity and efficiency in accomplishing the work, and the plots represent a good cross section of the NEON site area.

Plot Findings

A total of 18 plots were selected, sampled and described by the 12-TOL Soil Survey Office Staff and associated supplemental staff from the Region 12 Office and other NRCS offices. Sampling was conducted between 10/2016 and 08/2017. Sample plots included all identified parent materials including till, glacial fluvial and organic soil materials. All sites were in forest cover except the plot in the organic wetland shrub swamp. Table 2 summarizes the soil map units identified within the sampled plots. A map of the plot locations within the site is shown in Figure 2.

Map Unit Symbol	Map Unit Name	NEON Plots in Map Unit	Notes
901E	Berkshire-Marlow association, 15 to 45 percent slopes, extremely stony	HARV_015	Frigid, till uplands
59A	Bucksport and Wonsqueak mucks, 0 to 2 percent slopes	HARV_021	Organic wetlands
926C	Charlton-Chatfield association, 3 to 15 percent slopes, extremely stony	HARV_013	Bedrock-controlled till uplands
253E	Hinckley loamy sand, 25 to 35 percent slopes	HARV_030	Glacial fluvial
253B	Hinckley loamy sand, 3 to 8 percent slopes	HARV_031	Glacial fluvial
253C	Hinckley loamy sand, 8 to 15 percent slopes	HARV_022	Glacial fluvial
915E	Montauk-Canton association, 15 to 35 percent slopes, extremely stony	HARV_001, HARV_006, HARV_058	Well-drained till
927C	Montauk-Scituate-Canton association, 3 to 15 percent slopes, extremely stony	HARV_005, HARV_008, HARV_011, HARV_017, HARV_018, HARV_027, HARV_029, HARV_024	Moderately well-drained to well-drained till
918B	Ridgebury-Whitman association, 0 to 8 percent slopes, extremely stony	HARV_059	Wetland till

Table 2. Plots sampled at the NEON HARV site.

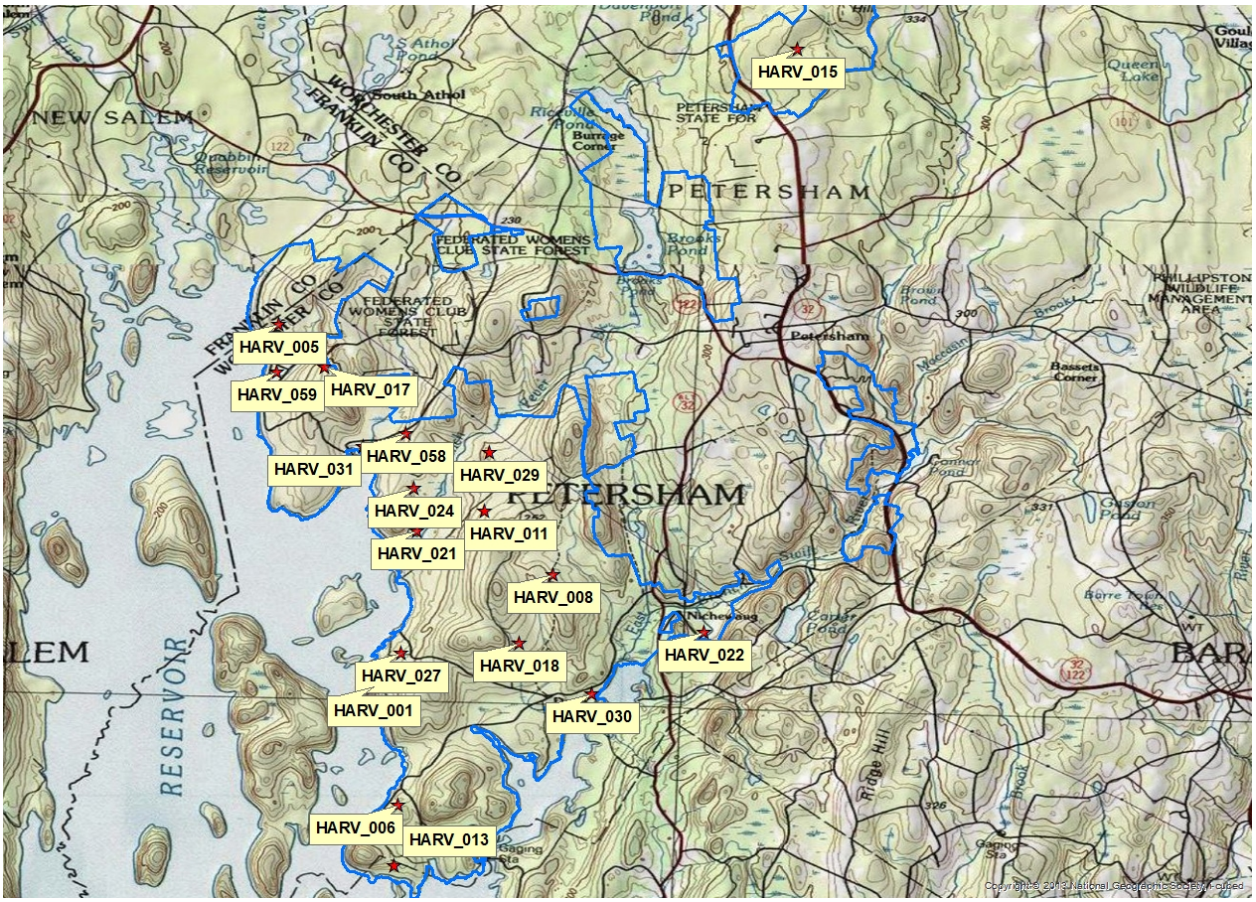

Figure 2. Neon plots sampled within the Harvard Site. Blue line represents NEON site boundary.

Summary of Soils

The sampled soil pedons exhibited a wide range of soil classifications, with 13 different soil series including correlated taxajuncts (Table 3). The soil orders observed included Inceptisols (14 plots), Entisols (3 plots) and Histisols (1 plot). In general, the soils sampled are low in clay, with coarse-loamy, loamy-skeletal, sandy, or sandy-skeletal particle size control sections. Drainage class ranged from very poorly drained to excessively drained. Soil pH measured in the field ranged from extremely acid to moderately acid and tended to be lowest at or near the soil surface. All pedons sampled had at least one O horizon at the soil surface. Four soil sample locations are in glacial fluvial parent materials, nine are in sandy friable melt out till, four are in dense lodgment till, and oneis in very poorly drained organic soil materials. Sandy and gravelly soil materials are the dominant textures for the site area in the substratum. On average, sand content increased with depth. Many of the pedons contain more than 35% rock fragments in the particle size control section, yielding loamy skeletal or sandy skeletal particle size classes. Coarse loamy till, glacial fluvial and eolian mantels were all common in the upper part of the soil profiles sampled.

Sample Point	Soil Series	Current Taxonomic Class
HARV_031	Agawam	Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Typic Dystrudepts
HARV_001	Canton	Loamy-skeletal over sandy or sandy-skeletal, mixed, superactive, mesic Typic Dystrudepts
HARV_006	Canton	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Dystrudepts
HARV_029	Canton	Sandy-skeletal, mixed, mesic Typic Dystrudepts
HARV_013	Chatfield	Loamy-skeletal, mixed, superactive, mesic Typic Dystrudepts
HARV_015	Chichester	Loamy-skeletal, mixed, superactive, frigid Typic Dystrudepts
HARV_024	Freetown	Dysic, mesic Typic Haplosaprists
HARV_030	Hinckley	Sandy-skeletal, mixed, mesic Typic Udorthents
HARV_027	Leicester	Loamy-skeletal, mixed, superactive, nonacid, mesic Typic Humaquepts
HARV_005	Montauk	Loamy-skeletal, mixed, active, mesic Oxyaquic Dystrudepts
HARV_017	Montauk	Coarse-loamy, mixed, active, mesic Oxyaquic Dystrudepts
HARV_058	Montauk	Coarse-loamy, mixed, active, mesic Oxyaquic Dystrudepts
HARV_011	Newfields	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Aquic Dystrudepts
HARV_059	Newfields	Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Oxyaquic Dystrudepts
HARV_018	Scituate	Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
HARV_021	Sudbury	Sandy-skeletal, mixed, mesic Oxyaquic Udorthents
HARV_008	Sutton	Coarse-loamy, mixed, superactive, mesic Aquic Dystrudepts
HARV_022	Windsor	Mixed, mesic Typic Udipsamments

Table 3. Soils Series and Taxonomic Classification at sampled plots.

HARV_031 – This sample point is on an outwash terrace above the Quabbin Reservoir, and it classifies as the Agawam soil series, a well-drained glacial fluvial soil with coarse- loamy eolian deposition overlying stratified sand and gravel derived from gneiss, schist and granite. The pedon contains contrasting particle size control section, sandy loam in the upper 50 cm over extremely gravelly coarse sand below. The vegetation is dominated by Eastern White Pine.

HARV_001 – This sample point is a taxajunct to the well-drained Canton series, a soil formed in friable melt-out till derived for gneiss, schist and granite. The pedon is a taxajunct to the series because it contains more than 35% rock fragments in the solum. This soil also contains some eolian deposits above the sandy melt out till. It is found on the convex back slope of a hill. The vegetation is dominated by Eastern White Pine.

HARV_006 – This sample point is also a well-drained Canton soil. It is on a convex back slope of an upland hill. This soil formed in fine sandy loam eolian deposits over sandy melt out till, and the fine sandy loam solum is 80 cm thick. This soil fits the central concept of the series very well. Charcoal fragments in the soil are an indication of past forest fire history. Vegetation is inter-mixed conifers and hardwoods.

HARV_029 – This sample point is a taxajunct to the well-drained Canton series, a soil formed in friable melt-out till derived for gneiss, schist and granite. The pedon is a taxajunct to the series because it contains more than 35% rock fragments in the solum. This soil also contains some eolian deposits above the sandy melt out till. It is found on the convex back slope of a hill. Vegetation is inter-mixed conifers and hardwoods.

HARV_013 – This sample point is on a bedrock controlled upland ridge and is an example of the Chatfield Soil Series, a well-drained melt out till soil overlying bedrock. The bedrock is at a depth of 97 cm. This soil is a taxajunct to the Chatfield soil because it contains more than 35% rock fragments in the control section. Vegetation is inter-mixed conifers and hardwoods.

HARV_015 – This sample point is the only point within the frigid temperature regime, MLRA 144B in the northeast portion of the project area at elevation 370 meters. The soil pit is located on the backslope of an upland hill. Soil is sampled as a taxajunct to the Chichester Series, and is a very deep, well-drained till soil with a sandy substratum. The pedon is a taxajunct to the series because it lacks the split family particle size and contains more than 35% rock fragments in the solum, the soil has a gradual increase of sand with depth, and the soil contains many angular cobbles and gravel throughout the soil profile. The soil is friable throughout, which is an indication of melt-out till parent material. Vegetation onsite is mixed conifers and hardwoods.

HARV_024 – This sample point falls within a very poorly drained wetland, and the soil is a Freetown series. The landform is a depression. This is a Histisol formed from organic material greater than 130 cm thick, formed from mixed herbaceous and woody vegetation. The organic material is predominantly muck, highly decomposed sapric material. Water is at or very near the surface most of the year at this site. The soil is classified as dysic and has a low pH. The plot is colonized by hydrophytic vegetation, mostly shrubs and herbs.

HARV_030 – This sample point is a good example of the excessively drained Hinckley soil, formed from sandy and gravely glacial fluvial parent materials. The pedon is located on the riser back slope of a glacial kame terrace. The soil contains more 35% rock fragments and has sandy textures below a depth of 31 cm. The rock fragments are mixtures of sub-rounded gravel, cobble and stone of gneiss and schist origins. The dominant tree species at the site are Red Pine and Eastern White Pine.

HARV_027 – This sample point is in a wetland and is located near an intermittent drainage way in a sloping concave swale landscape position. The soil classifies as a taxajunct to the poorly drained Leicester Series. The Leicester Series is a hydric soil formed in friable melt out till. The soil is a taxajunct to the series because it contains more than 35% rock fragments in the control section and it has an Umbric epipedon. Sub-angular stones are the dominant size rock fragments in the soil. The water table during the time of observation on 8/25/2017 was 36 cm. The site is colonized by mixed conifers and hardwoods.

HARV_005 - This sample plot is a representation of the well-drained Montauk soil series, a soil formed in sandy dense till derived from schist, gneiss and granite. The dense till is compacted by the weight of glacial ice and is considered root-limiting and will at time perch a water table. The densic contact for this pedon is 63 cm. The solum of the pedon is coarse loamy and friable while the substratum is sandy. The soil is a taxajunct to the series because it contains more than 35% rock fragments in the solum and has a loamy skeletal particle size control section. The vegetation on this site is mixed conifers and hardwoods.

HARV_017 – This sample point is a great representation of the well-drained Montauk soil series formed in true lodgment till (Figure 3). The site is found on a convex back slope of a hill and the densic contact is at 83 cm. Redoximorphic concentrations are preset above the densic contact, an indication of a perched water table during wet periods of the year. The vegetation on this site is mixed conifers and hardwoods.

Figure 3. Photo from the HARV_017 soil pit demonstrating a Montauk Soil Series, well drained sandy lodgment till soil.

HARV_058 – This sample point is also a Montauk soil located on a convex linear backslope of a hill. The hill is oriented north-south and appears to be smoothed and streamlined by glacial ice, this hill resembles a drumlin-like landform. The depth to dense compact lodgment till is 89 cm in this pedon and water was observed weeping into the pit in the sandy substratum below 1 meter. Redoximorphic feature are present in the soil at a depth of 66 cm, an indication that the seasonal high-water table is present in the solum during wetter periods of the year. The vegetation on this site is mixed conifers and hardwoods.

HARV_011 – This sample point is a Newfields soil series, very deep, moderately well drained soils formed in a loamy mantle underlain by sandy till on upland hills. This pedon is located on a concave lower back slope landscape position. Redoximorphic features start at 36 cm in this soil, an indication of the seasonal high-water table. Both iron concentrations and depletions are present in the soil. Depth to the contrasting friable sandy till is 76 cm. The vegetation on this site is mixed conifers and hardwoods.

HARV_059 – This sample point is a Newfields soil series, very deep, moderately well drained soils formed in a loamy mantle underlain by sandy till on upland hills. This pedon is a taxajunct to the series because it lacks iron depletions within 60 cm of the mineral soil surface, which is required for the aquic subgroup in soil taxonomy. This pedon is located on a linear, nearly level lower back slope landscape position adjacent to a wetland. Redoximorphic features start at 80 cm in this soil, an indication of the seasonal high-water table. Depth to the contrasting sandy till is 58 cm. The pedon has an Ap horizon, a plow zone below the surface organic horizon, an

indication of past agricultural use as well as the nearly level site being devoid of surface stones. The vegetation on this site is mixed conifers and hardwoods.

HARV_018 – This sample point is a Scituate series and consists of moderately well drained soils formed in a loamy eolian influenced mantle of till underlain by sandy lodgment till. The soils are very deep to bedrock and moderately deep to a densic contact. The sandy till densic contact is at 68 cm in this pedon. They are nearly level through moderately steep soils on glaciated uplands. The pedon has an Ap horizon, a plow zone below the surface organic horizon, an indication of past agricultural use as well as the gently sloping site being devoid of surface stones. The vegetation on this site is mixed conifers and hardwoods.

HARV_021 - This sample point falls in a taxajunct to the Sudbury soil series and 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. The pedon is a taxajunct to the series because it has more than 35% rock fragments in the solum and it lacks a cambic horizon. The rock fragment content is as high as 85% in the substratum and is dominated by rounded gravel and cobbles. The vegetation on this site is mixed conifers and hardwoods.

HARV_008 - This sample point falls in a Sutton series and consists of very deep, moderately well drained loamy soils formed in friable melt-out till. They are nearly level to strongly sloping soils on hills, low ridges, and ground moraines, typically on foot slopes, lower backslopes and in slight depressions. This is one of the few pedons in the site area that did not have a sandy substratum within 1 meter. Redoximorphic features are found at a depth of 36 cm in the pedon. The vegetation on this site is mixed conifers and hardwoods.

HARV_022 – This sample point is in a Windsor series and consists of very deep, excessively drained soils formed in sandy outwash or eolian deposits. They are nearly level through very steep soils on glaciofluvial landforms. The sample point is on a nearly level kame terrace landform adjacent to a wetland. The pedon has an Ap horizon, a plow zone below the organic horizon surface, and indication of past agricultural use. The vegetation on this site is mixed conifers.