Stormwater Analysis and Calculations

23 Johnson Place

Newton, Massachusetts

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PROJECT OVERVIEW

The existing site consists of a 16,767 square foot lot with an existing multi family residential dwelling, driveway, walkway, patios and dilapidated pool. The site has a high point behind the existing dwelling and slopes towards the front & rear property lines. The dwelling, driveway and the majority of the impervious surfaces slope towards the front out towards Johnson Place. The concrete pool deck and rear hillside slope towards the rear property line. The existing vegetation on the front portion of the lot consists of landscape and grass lawn areas in fair condition. The existing vegetation on the rear portion of the lot consists a steep wooded hillside and heavily overgrown lawn & landscape areas in poor condition.

The proposed project will result in the demolition of the existing building and the construction of two buildings that will each contain two residential dwelling units. The existing driveway will be removed and the entire site located to the left side of the proposed buildings will be significantly excavated in order to access garages that are proposed to be located within the basement level of each building. The proposed driveway access to the garages will slope down to the basement level. The front and right side lawn and landscape areas shall be leveled and improved. The total impervious area will increase by approximately 3,646 square feet with the construction of the proposed buildings, access driveway, paved walkway and patio areas.

In order to mitigate any increase in runoff from the property, two separate subsurface drainage system has been designed to intercept and infiltrate stormwater from the new building rooftop areas and driveway.

Infiltration System #1 will be constructed within the front yard area and will accept stormwater flows from the majority of both proposed building rooftop areas. Runoff from the building rooftop areas will enter a system of gutters & downspouts and will be directed into 4" subsurface piping that will flow into the infiltration system.

Infiltration System #2 will accept runoff from the western portion of both building's rooftop areas and runoff from the entire driveway and will be located under the driveway adjacent to the side of the rear building. Runoff from the building rooftop areas will enter a system of gutters & downspouts and will be directed into 4" subsurface piping that will flow into the infiltration system. Surface water flows from the driveway will enter a catch basin located towards the rear of the proposed driveway and will be directed into this infiltration system. A site wall will be constructed at the rear of the driveway and the finished grade of the proposed sloping rear lawn area will be constructed higher in elevation than the proposed driveway to ensure that no stormwater runoff from the new building or driveway is capable of flowing towards the rear of the property and potentially impacting downhill properties. Infiltration System #2 has been designed to mitigate the entire volume of all storm events through the 100 year storm as the surface of the driveway will be entirely below grade.

These systems have been designed to intercept and mitigate the peak rate of runoff generated through the 2, 10, 25 & 100-year storm events. The attached drainage calculations demonstrate that both subsurface infiltration systems have been designed to mitigate peak rate and volume of runoff in the post-development conditions.

During construction, erosion control will be installed around the limit of work and maintained until the entire site is stabilized with vegetation. The erosion control barrier will consist of a line of staked-in hay bales and silt fencing along the rear, down hill property line. Filter fabric will be installed permanently around the top and sides of all infiltration systems to prevent fine sediment from entering the leaching systems and preventing exfiltration.

OBJECTIVE OF CALCULATIONS

The objective of these calculations is:

- To determine the pre and post- development peak rate and volume of runoff during the 2, 10, 25 and 100-year 24-hour storm events.
- Size a Stormwater Management System to remediate additional flow generated during the design storm events.

CALCULATION METHODS

One or a combination of the following methods will be used to calculate the runoff:

- The Rational Method (Q=CIA), a standard engineering formula used for determining peak rate of runoff for smaller drainage basins (under 100 acres).
- Technical Release 55 (TR55), a simplified procedure developed by the Soil Conservation Service (SCS) for estimating runoff and peak discharges in small watersheds.
- HydroCAD ver. 10.50, a Computer Aided Design program for modeling the hydrology and hydraulics of stormwater runoff, it is based on techniques developed by the Soil Conservation Service (SCS) and standard hydraulic calculations.

SELECTION OF STORM EVENTS

The storm event Intensities for the 2, 10, 25, & 100-year storm events were determined from the "Extreme Precipitation in New York & New England" a joint collaboration between the Northeast Regional Climate Center (NRCC) and the National Resources Concervation Service (NRCS). Intensity values used in these calculations exceed the City of Newton's required 100 year storm event.

The rainfall frequency data has been provided as follows:

Frequency (Years)	Rainfall (24-hr event inches)
2	**3.16**
10	**4.77**
25	**6.03**
100	**8.62**

EXISTING DRAINAGE CONDITIONS

The existing lot is 17,767 SF in area and consists of two subcatchment areas (SA). Subcatchment 1S consists of the building, driveway, walkway and all lawn and landscape areas on the front portion of the lot which slope towards the front of the property and discharge out to Johnson Place. The existing building rooftop area discharges to grade around the dwelling. Subcatchment 2S consists of the existing concrete pool deck, lawn & landscape areas on the rear portion of the lot and the wooded hillside which slopes down towards the rear of the property.

Existing Drainage Basin

Sub-catchment Area	Discharge Location	Area (sf)	Curve Number	Tc min.
1S	Johnson Place	10,773	74	6
2S	rear of lot	5,994	63	6

PROPOSED DRAINAGE CONDITIONS

The proposed site will consist of four (4) subcatchments areas. Subcatchment area 4S consists of the majority of the proposed newly created rooftop areas from the front and rear buildings. Runoff from these areas will be directed from the building gutters & downspouts into a system of subsurface piping and directed into subsurface infiltration systems located in the front yard area of the property. Subcatchment area 5S consists of the western portion of both building's rooftop areas and runoff from the entire driveway. Runoff from this area will be directed into a catch basin and into the subsurface infiltration systems located beneath the driveway. Subcatchment area 6S consists of the rear half of the proposed concrete walkway along the right side property line, center & rear concrete patios, lawn and landscape areas and the rear portion of the rear building's rooftop areas. Runoff from these areas will flow towards the rear of the property. Subcatchment area 7S consists of the front half of the proposed concrete walkway along the right side property line, the front concrete patio and the newly created lawn & landscape areas. Runoff from these areas will flow towards the front of the property as it now does in the preconstruction conditions.

Proposed Drainage Basin

Sub-catchment Area	Discharge Location	Area (sf)	Curve Number	Tc min.
4S	Infiltration System	1624	98	6
5S	Infiltration System	4765	98	6
6S	rear of lot	5705	62	6
7S	Johnson Place	4774	59	6

PROPOSED STORMWATER MANAGEMENT SYSTEM

This project will consist of constructing two separate stormwater infiltration systems;

Subsurface Infiltration System #1 located within the front yard area that will collect stormwater runoff from a portion of both of the new building rooftop areas. Downspouts will be routed into a system of underground piping and directed to a single 8" diameter perforated ADS pipe located within a 22' long, 6' wide and 2' deep stone trench. This infiltration systems will have overflows at the closest downspouts located along the front of the building should the system become overwhelmed during larger storm events.

Subsurface Infiltration System #2 located beneath the rear portion of the proposed driveway that will collect stormwater runoff from the western portion of both building's rooftop areas and runoff from the entire driveway. Rooftop areas will flow into gutters & downspouts that will be routed into 4" subsurface piping and directed to the infiltration system. All stormwater flows from the driveway will sheet flow towards a catch basin located at the rear of the driveway and into the subsurface infiltration systems consisting of 40' an 8" diameter perforated ADS piping located within a 44' long, 11' wide and 2' deep stone trench. This infiltration systems has been sized to mitigate all stormwater flows through the 100 year Storm Event. There is no overflow on this infiltration system as the driveway is below grade of all surrounding property.

Stormwater flows that sheet flow out towards Johnson Place will be significantly reduced in the post construction conditions as the majority of the newly created impervious surfaces are being directed into subsurface infiltration systems.

Much consideration has been given in this design to ensure that stormwater runoff that are proposed to flow from this property towards the rear was not increased in the postconstruction conditions as not to negatively impact adjacent downhill properties. An evaluation of the preconstruction conditions (Subcatchment Area 2S) verses postconstruction conditions (Subcatchment Area 6S) demonstrate that runoff that sheet flow towards the rear of the property from all newly created hardscape and lawn & landscape area will be reduced in both peak rate and volume through all Storm Events up to and including the 100-year storm in the postconstruction conditions.

RESULTS & CONCLUSIONS

The stormwater management selected for this site will consist of two separate subsurface infiltration systems to accept flows from all newly created building rooftop and driveway impervious areas. These systems have been sized to accommodate the increase in peak rate and volume of stormwater runoff though the 100-year storm event from all newly created impervious areas.

The following tables summarize the results of the stormwater

Project Summary runoff analysis.

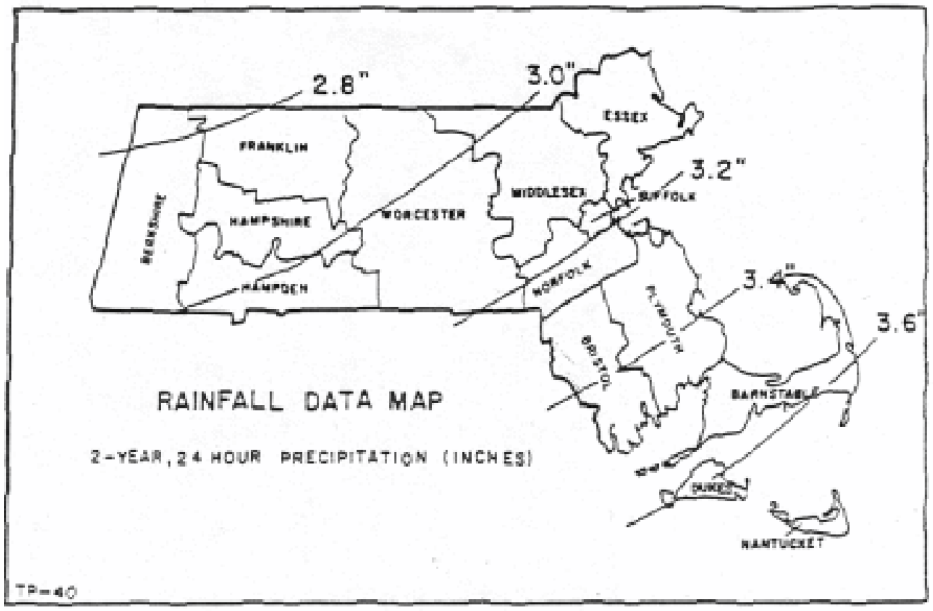
Storm Event YR	Pre-Development Q (CFS)	Post-Development Q (CFS)
2	0.33	0.07
10	0.80	0.30
25	1.22	0.52
100	2.13	1.26

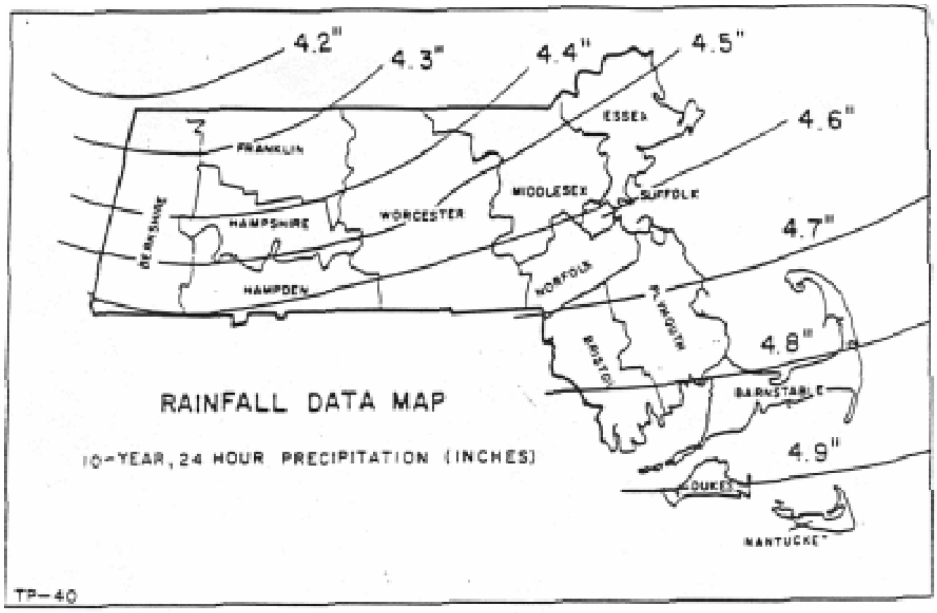
Storm Event YR	Pre-Development Volume (acre-ft / cf)	Post-Development Volume (acre-ft / cubic feet)
2	0.027 af / 1,176 cf	0.004 af / 348 cf
10	0.061 af / 2,657 cf	0.022 af / 1,046 cf
25	0.091 af / 3,964 cf	0.072 ft / 1,742 cf
100	0.161 af / 7,013 cf	0.102 af / 3,485 cf

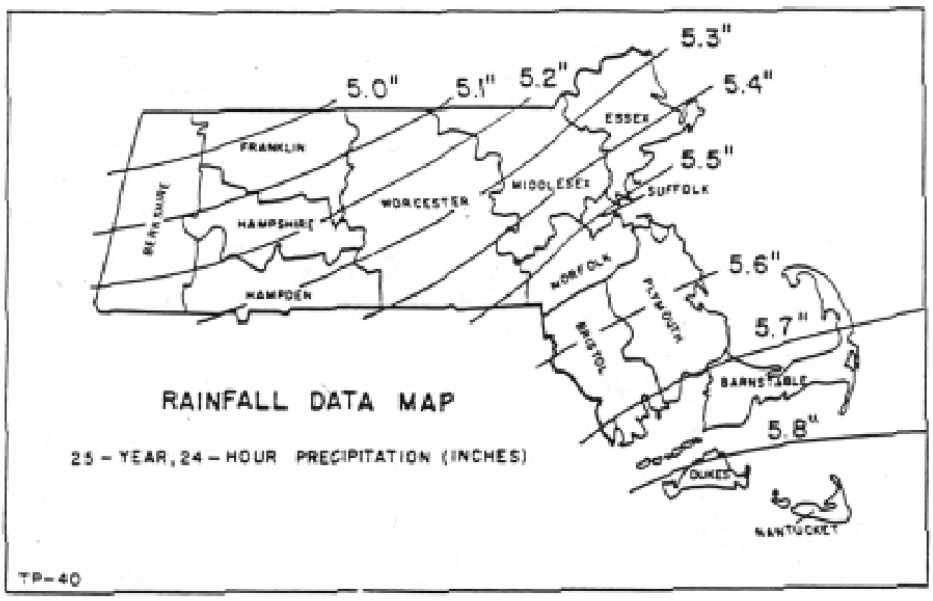
As can be seen in the above tables, any increase in the peak runoff rate and volume for this site will be significantly decreased in the post-development condition through the 100-year storm event.

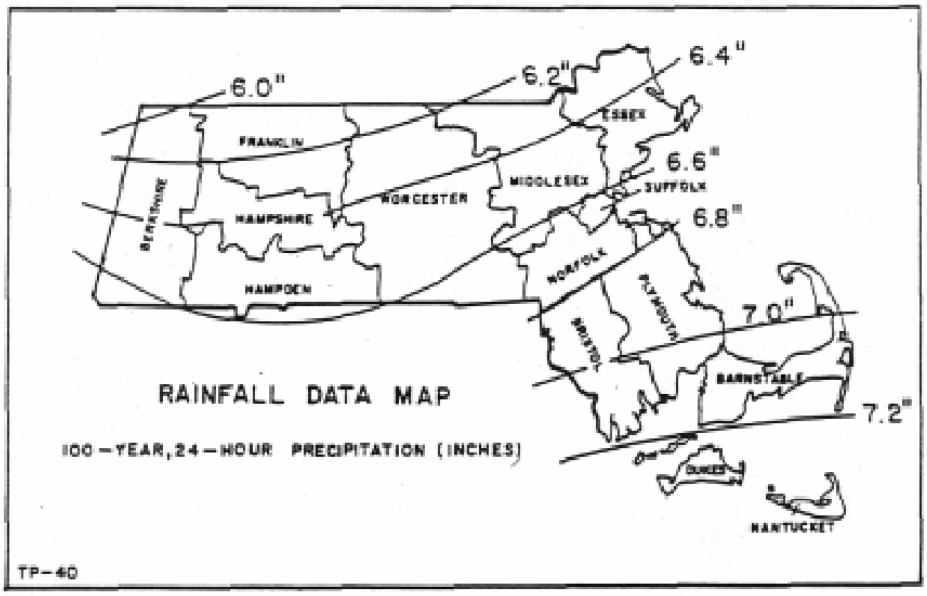
APPENDIX

Rainfall Frequency Atlas of the United States (TP-40)






5.0"
5.1"
5.2"
5.3"
5.4"
5.5"
5.6"
5.7"
5.8"
FRANKLIN
ESSEX
MIDDLESEX
SUFFOLK
WORCESTER
HAMPSHIRE
BERKSHIRE
HAMPDEN
NORFOLK
PLYMOUTH
BRISTOL
BARNSTABLE
DUKES
NANTUCKET
RAINFALL DATA MAP
25 - YEAR, 24 - HOUR PRECIPITATION (INCHES)
TP-40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FRANKLIN
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MIDDLESEX
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WORCESTER
HAMPSHIRE
BERKSHIRE
HAMPDEN
NORFOLK
PLYMOUTH
BRISTOL
BARNSTABLE
DUKES
NANTUCKET
RAINFALL DATA MAP
100 - YEAR, 24 - HOUR PRECIPITATION (INCHES)
TP-40

Table of Runoff Curve Numbers (SCS, 1986)

Description of Land Use	**Hydrologic Soil Group**			
	A	**B**	**C**	**D**
Paved parking lots, roofs, driveways	98	98	98	98
Streets and Roads:				
Paved with curbs and storm sewers	98	98	98	98
Gravel	76	85	89	91
Dirt	72	82	87	89
Pasture or Range Land:				
Poor (<50% ground cover or heavily grazed)	68	79	86	89
Good (50-75% ground cover; not heavily grazed)	39	61	74	80
Meadow (grass, no grazing, mowed for hay)	30	58	71	78
Brush (good, >75% ground cover)	30	48	65	73
Woods and Forests:				
Poor (small trees/brush destroyed by over-grazing or burning)	45	66	77	83
Fair (grazing but not burned; some brush)	36	60	73	79
Good (no grazing; brush covers ground)	30	55	70	77
Open Spaces (lawns, parks, golf courses, cemeteries, etc.):				
Fair (grass covers 50-75% of area)	49	69	79	84
Good (grass covers >75% of area)	39	61	74	80
Commercial and Business Districts (85% impervious)	89	92	94	95
Industrial Districts (72% impervious)	81	88	91	93
Residential Areas:				
1/8 Acre lots, about 65% impervious	77	85	90	92
1/4 Acre lots, about 38% impervious	61	75	83	87
1/2 Acre lots, about 25% impervious	54	70	80	85
1 Acre lots, about 20% impervious	51	68	79	84

Extreme Precipitation Tables

Northeast Regional Climate Center

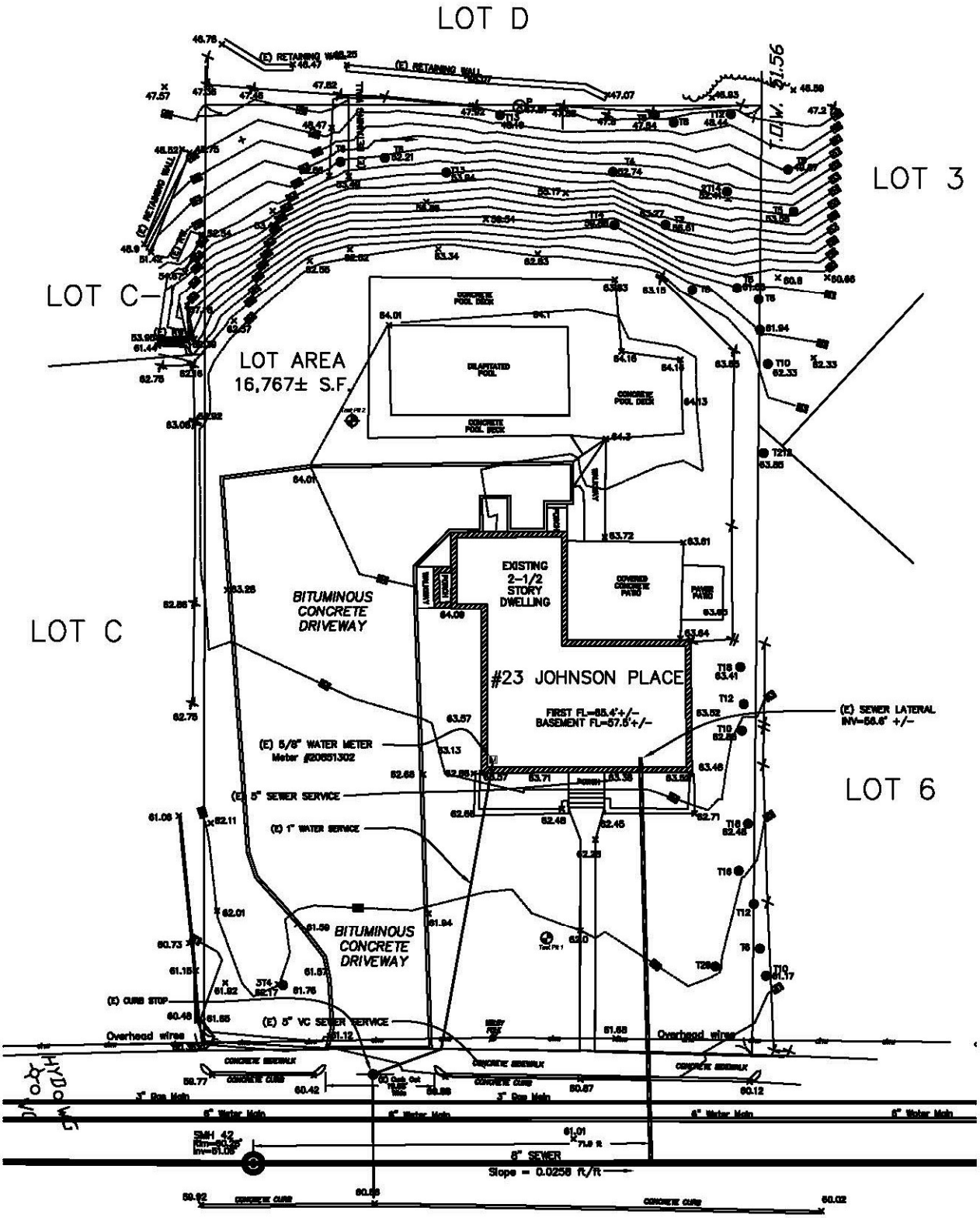
Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	71.254 degrees West
Latitude	42.344 degrees North
Elevation	0 feet
Date/Time	Fri, 17 Jul 2020 12:22:24 -0400

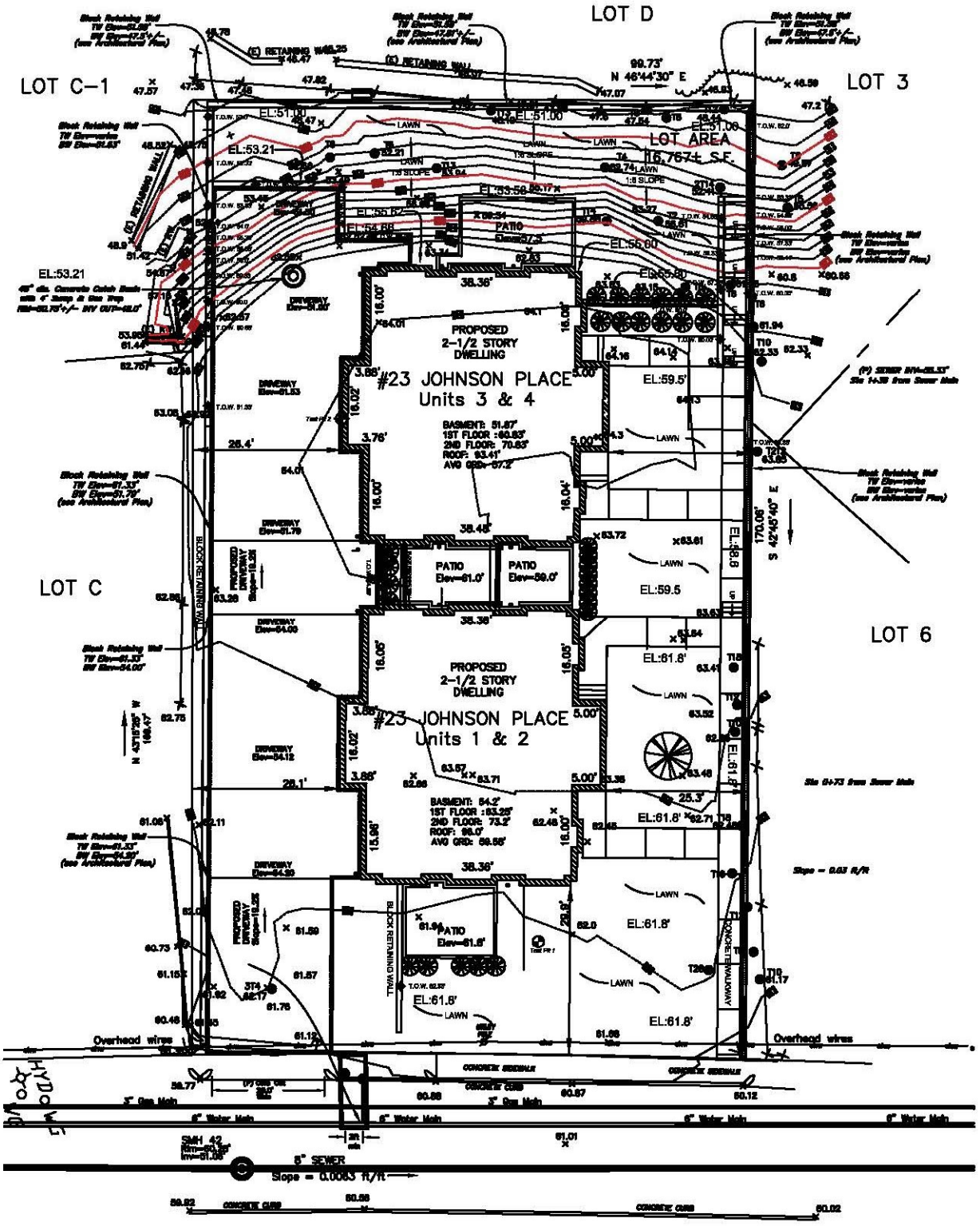
Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.54	0.70	0.88	1.11	**1yr**	0.76	1.05	1.29	1.63	2.08	2.65	2.87	**1yr**	2.35	2.76	3.25	3.92	4.59	**1yr**
2yr	0.35	0.54	0.67	0.89	1.11	1.40	**2yr**	0.96	1.29	1.62	2.03	2.54	3.18	3.52	**2yr**	2.81	3.38	3.88	4.62	5.26	**2yr**
5yr	0.42	0.65	0.82	1.10	1.40	1.78	**5yr**	1.21	1.62	2.07	2.59	3.23	4.01	4.48	**5yr**	3.55	4.31	4.93	5.87	6.57	**5yr**
10yr	0.47	0.75	0.94	1.28	1.67	2.13	**10yr**	1.44	1.92	2.48	3.11	3.87	4.79	5.38	**10yr**	4.24	5.18	5.92	7.04	7.77	**10yr**
25yr	0.57	0.90	1.15	1.58	2.10	2.71	**25yr**	1.81	2.40	3.16	3.96	4.92	6.06	6.86	**25yr**	5.36	6.60	7.54	8.95	9.72	**25yr**
50yr	0.64	1.03	1.33	1.86	2.50	3.26	**50yr**	2.16	2.85	3.81	4.78	5.92	7.25	8.26	**50yr**	6.41	7.94	9.05	10.74	11.51	**50yr**
100yr	0.74	1.20	1.54	2.19	2.99	3.92	**100yr**	2.58	3.39	4.59	5.76	7.10	8.66	9.93	**100yr**	7.67	9.55	10.88	12.89	13.64	**100yr**
200yr	0.86	1.40	1.81	2.59	3.57	4.70	**200yr**	3.08	4.03	5.51	6.91	8.52	10.37	11.96	**200yr**	9.17	11.50	13.08	15.47	16.16	**200yr**
500yr	1.03	1.70	2.22	3.23	4.52	5.99	**500yr**	3.90	5.06	7.05	8.83	10.86	13.15	15.29	**500yr**	11.64	14.70	16.69	19.72	20.25	**500yr**

Existing Drainage Conditions



Proposed Drainage Conditions



On Site Soil Evaluations

Soil Log Address - 23 Johnson Place, Newton, MA

Date: 5/13/2020 **Weather:** Clear, 70's **Witnessed By:** Laurance Hayes - SE 2957

Soil Classification per NRCS 626B - Merrimac-Urban Land Complex, 0 to 8 percent slopes

Test Pit # 1

Depth	Soil	Soil Matrix:	Redoximorphic Features			Soil	Coarse Fragments % by			
(in)	Horizon /	Color- Moist	Depth (in)	Color	Percent	Texture	Gravel	Cobbles & Stones	Soil Structure	Soil Consistence
0-8	Ab	10 YR 2/2				FSL	0%	0%	granular	friable
8-40	Bw1	10 YR 4/6				Sand	0%	0%	granular	friable
40-120	Cd	10 YR 6/4				Sand	30%	0%	granular	friable

Notes: No redoximorphic features observed in test pit
No weeping or standing groundwater was observed in test pit

Perc Test

Depth	Time
presoak	11:13
12	11:28
11	11:30
10	11:33
9	11:35
8	11:38
7	11:40
6	11:43

Average Percolation Rate = 2.50 mpi

Use a Conservative Rate of 20 in/hr per NRCS soil classification

Soil Log Address - 23 Johnson Place, Newton, MA

Date: 5/13/2020 **Weather:** Clear, 70's **Witnessed By:** Laurance Hayes - SE 2957

Soil Classification per NRCS 626B - Merrimac-Urban Land Complex, 0 to 8 percent slopes

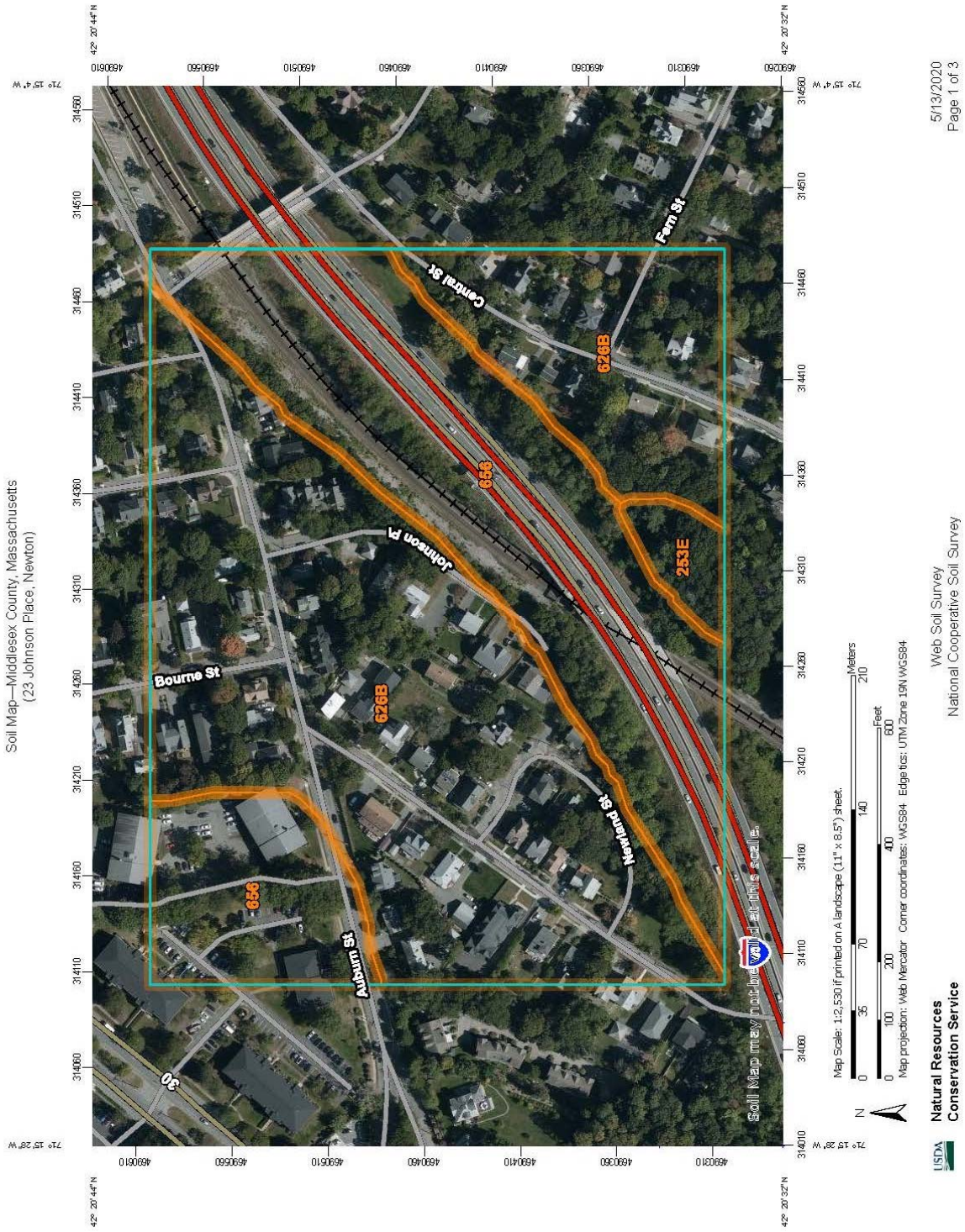
Test Pit # 2

Depth (in)	Soil Horizon /	Soil Matrix: Color- Moist	Redoximorphic Features			Soil Texture	Coarse Fragments % by		Soil Structure	Soil Consistence
			Depth (in)	Color	Percent		Gravel	Cobbles & Stones		
0-8	Ab	10 YR 2/2				FSL	0%	0%	granular	friable
8-38	Bw1	10 YR 4/6				Sand	0%	0%	granular	friable
38-120	Cd	10 YR 6/4				Sand	30%	0%	granular	friable

Notes: No redoximorphic features observed in test pit
No weeping or standing groundwater was observed in test pit

Test Pit #2 was performed at Elevation 63', which is 12' higher than the Proposed Finish Grade
Once the site is excavated, another Test Pit must be performed to confirm soil conditions at the actual depth of the proposed infiltration system at this location

NRCS Soil Map & Information



Soil Map—Middlesex County, Massachusetts
(23 Johnson Place, Newton)

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 19, Sep 12, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 11, 2019—Oct 5, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
253E	Hinckley loamy sand, 25 to 35 percent slopes	0.6	2.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	17.1	60.0%
656	Udorthents-Urban land complex	10.8	37.9%
Totals for Area of Interest		**28.5**	**100.0%**

Middlesex County, Massachusetts

626B—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Moraines, outwash plains, kames, eskers, outwash terraces
Landform position (two-dimensional): Backslope, footslope, summit, shoulder
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)

Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Urban Land

Typical profile
M - 0 to 10 inches: cemented material

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water storage in profile: Very low (about 0.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Windsor
Percent of map unit: 5 percent
Landform: Deltas, outwash plains, dunes, outwash terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Sudbury
Percent of map unit: 5 percent
Landform: Terraces, deltas, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Hinckley
Percent of map unit: 5 percent
Landform: Deltas, outwash plains, kames, eskers
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, crest, head slope, side slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear

Hydric soil rating: No

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 19, Sep 12, 2019

HydroCAD Results