Four Corners Area
Clarksburg MA
Interim Existing Conditions
Hydrologic and Hydraulic Analysis

Prepared for:
Town of Clarksburg MA

Prepared by:
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Civil Engineers-Planning, Design and Permitting Services

March 12, 2026

BACKGROUND AND OBJECTIVE

Through the Municipal Vulnerability Preparedness (MVP) grant program, the Client is preparing the Hudson Brook watershed for climate change by planning priority projects such as parcel conservation, culvert replacements, stream restoration, and other projects to increase resiliency in the watershed. T Reynolds Engineering (TRE) has been contracted to characterize the fluvial geomorphology, hydrology, and hydraulics of the present Hudson Brook watershed, and to also consider potential future climate change impacts.

The objective of the hydrologic analysis was to develop peak flow rates for the Hudson Brook watershed to be used in hydraulic modeling. The analysis included the 1-year, 2-year, 10-year, 25-year, 50-year, 100-year, and 500-year peak flow rates for the present day, as well as consideration of the late-century (2070) potential climate change scenarios. The objective of the existing conditions hydraulic analysis was to evaluate flood water surface elevations, velocities, and inundation extents under present and projected future conditions considering climate change. Results from the existing conditions model were used to evaluate conditions in the Hudson Brook watershed to inform the development of proposed restoration options.

PROJECT DESCRIPTION

In recent years there has been an increasing concern regarding increased flooding in the area and resulting impacts on local residences. The study focuses on evaluating the hydrology of the associated drainage basin contributing stormwater flows and existing flood potential at the Four Corners area of Clarksburg, MA.

The Hudson Brook watershed extends from Bennington County, Vermont down into Berkshire County, Massachusetts and primarily is in the towns of Stamford Vermont and Clarksburg Massachusetts. The 7.28 mi^2 watershed is approximately 84% forested, 4.7% developed with the remaining drainage area split between water/wetlands, agriculture, grasslands, and bare land according to 2016 Massachusetts land cover/land use data accessed from MassGIS. The watershed's topography is characterized by mostly steep and hilly terrain.

Hudson Brook is a single thread mountain stream that levels out in the Four Corners area of Clarksburg before flowing down to North Adams where it converges with the Hoosic River. The floodplain of Hudson Brook in the Four Corners transitions from being very restricted to moderately restricted from upstream to downstream with the floodplain widest at the Four Corners area in Clarksburg. The Hudson Brook floodplain is predominantly agricultural with patches of residential development, limited woodlands and significant wetlands. East of the Hudson Brook is a large wetland out of which Tamarac Brook flows and converges with Hudon Brook approximately 580 feet south of Cross Road. The other wetland is located to the west in the flood plain adjacent to the town fields and flows into Hudson Brook via an unknown stream. There are three bridges crossing over the main channel in the Four Corners area.

HYDROLOGICAL ANALYSIS

DATUM

Elevations reflected in this report are based on the North American Vertical Datum of 1988 (NAVD88). Locations in this report reference horizontal datum NAD83 Massachusetts Mainland State Plane Projection. Vertical and horizontal units are in feet, unless otherwise specified.

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HYDROLOGIC METHODOLOGY AND INPUTS

StreamStats Analysis

TRE used the StreamStats 4.31.1 online web application tool to estimate peak flow in Hudson Brook at the private bridge at 260 Middle Road. StreamStats uses watershed characteristic information developed using GIS to estimate flow statistics based on regional and state regression equations for flow developed by the USGS. Present-day peak flows estimated using StreamStats 4.31.1 ranged from 422 cfs for the 2-year flood to 3,260 cfs for the 500-year flood. StreamStats does not provide an estimate for mid- and late-century peak flow estimates. The peak flows estimated using StreamStats 4.31.1 are presented below in the *Hydrologic Results* section (**Table 2**).

FEMA Analysis

TRE reviewed the online FEMA Flood Map Service Center to locate the most recent FIS available for Hudson Brook, which was published in November of 1982[1]. FEMA's hydrologic study of Hudson Brook consisted of estimating the 10-, 50-, 100-, and 500-year peak flood flows using regional flow regression equations. The then-present-day (1982) peak flows estimated by FEMA ranged from 1,736 cfs for the 10-year flood to 5,019 cfs for the 500-year flood. FEMA does not provide an estimate for mid- and late century peak flow estimates. The peak flows estimated by FEMA are presented in **Table 2**.

HEC-HMS Watershed Modeling

TRE used GeoHECHMS that utilized USACE's HEC-HMS version 4.10 the U.S. Army Corps of Engineers Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) 4.10 computer program watershed rainfall-runoff model computer software program to estimate the 1-, 2-, 10-, 25-, 50-100-, and 500-year flow hydrographs for the present and late century. TRE delineated the total drainage area in GeoHECHMS using 1-meter by 1-meter 2015 Massachusetts LiDAR data from MassGIS. As shown in **Figures 1-3 in Appendix**, TRE modeled the drainage area as 46 sub-basins based on the location of tributary confluences. The HEC-HMS model utilized the NRCS Curve Number method to model losses, outlined in the USDA-NRCS Technical Release 55. Hydrologic soil group data, shown in **Figure 4 of Appendix**, was obtained from digital county soil maps provided by the National Resource Conservation Service (NRCS). TRE obtained land cover data from the MassGIS 2016 Land Use/Land Cover dataset, shown in **Figure 5 of Appendix**. The soil and land use data were then used to compute composite runoff curve numbers.

Times of concentration (Tc) and lag times were developed for each subbasin using the DEM, land cover, and the velocity method based on estimated water velocities for overland and channel flows from USDA-NRCS National Engineering Handbook Section 630 Chapter 15.

TRE used depth-duration-frequency precipitation data developed by NOAA, available from Atlas 14, Volume 10, for the Northeastern United States Online Tool (**Figure 6** in **Appendix**). The projected 2070 precipitation depth-duration-frequency precipitation data was taken from the Resilient Mass Climate Change Projection Dashboard (**Figure 7 of Appendix**). The present and future design storm rainfall depths are shown in **Table 1.** TRE used the SCS Type III rainfall distribution for each precipitation recurrence interval, as recommended in the Tier 2 RMAT Climate Resilience Design Standards and Guidelines.

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[1] Federal Emergency Management Agency "Flood Insurance Study – Town of Clarksburg, Massachusetts", December 1982

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Table 1: HEC-HMS Input Data

Time Period	RAINFALL DATA (precipitation in inches)						
	1-yr	2-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Present	2.52	3.00	4.46	5.37	6.06	6.78	8.81
Late Century	3.5	4.2	6.2	7.5	8.5	9.5	12.4
WATERSHED DATA							
Watershed Area	See GeoHECHMS Watershed Summary Appendix						
SCS Curve Number							
Lag Time (0.6 x Time of Concentration)							

HYDROLOGICAL MODELING RESULTS

As described above, TRE used three methodologies to estimate peak flows for storms/floods of various recurrence intervals in the Hudson Brook watershed. **Table 2** below presents the estimated present-day peak flow results for these floods using each of the methods along with future peak flow results using GeoHECHMS.

Table 2: Estimated Present-Day and Future Peak Flows for Various Methodologies

Recurrence Interval (RI)	Estimated Peak Flow of Hudson Brook at 261 Middle Road Bridge (cfs)			
	StreamStats 4.6.2	*FEMA Flood Insurance Study*	*HEC-HMS (Present)*	*HEC-HMS (2070)*
1-year		-	462	1,116
2-year	422 90% PI*: 194-919 ASEp: 42.3	-	759	1,691
10-year	1,000 90% PI*: 438-2,290 ASEp: 44.7	1736	1,918	3,597
25-year	1,410 90% PI*: 591-3,370 ASEp: 47.1	-	2,743	4,980
50-year	1,770 90% PI: 712-4,400 ASEp: 49.4	3067	3,451	6,076
100-year	2,160 90% PI: 836-5,580 ASEp: 51.8	3700	4,220	7,185
500-ear	3,260 90% PI: 1,150-9,270 ASEp: 57.6	5019	6,421	10,431

* 90% PI = 90% prediction interval, which is the interval that a future observation will fall with 90% certainty

ASEp = Average Standard Error of Prediction, a measure of the accuracy of predictions calculated as the square root of the average squared deviation

Table 2 indicates peak flow estimates at the Hudon Brook bridge at 260 Middle Road vary depending on the methodology used to estimate the flows. The selection of hydrologic procedures is associated with the size and characteristics of the watershed, availability of data, the requirements of the hydraulic analysis, and the regulatory context of the project.

The two regression methods provided lower estimates of peak flows than the NRCS Method as implemented in the HEC-HMS model. Significant uncertainty can be associated with the various methods of estimating peak flow depending on the level of effort and detail provided in developing input parameters for use in the analysis. In particular, the FEMA regression analysis was performed over 40 years ago using regression equations that have since been superseded. As noted above, the StreamStats regression estimates are subject to a standard error for each recurrence interval flood, as shown by the ASEp values in **Table 2**. TRE notes that the HEC-HMS analysis approaches the upper prediction interval of the StreamStats predictions.

Based on the comparison of peak flow values from the analysis methods, TRE's supplemental analyses, engineering judgment, and to be consistent with requirements of the RMAT, TRE recommends using the peak flows obtained from the HEC-HMS analysis for hydraulic evaluations. It is our opinion that while the HEC-HMS results may be conservative (e.g., higher than expected), it is reasonable to use

these flood flow rates to incorporate additional resiliency into future infrastructure improvements and other planning activities. Output hydrographs from HEC-HMS are shown in **Figure 8** of **Appendix**. TRE could not calibrate and validate the model to known values because no observed stage or discharge data exists for Hudson Brook to TRE's knowledge.

HYDRAULIC MODEL

The hydraulic analysis was performed using the two-dimensional, unsteady, mixed flow regimes within GeoHECRAS. GeoHECRAS utilized USACE's HEC-RAS version 6.4.1 the U.S. Army Corps of Engineers Hydrologic Engineering Center – River Analysis System (HEC-RAS) 6.4.1 computer program. TRE created one hydraulic model for the Four Corners area. The model at the Four Corners area extends from approximately 925 feet upstream of the Hudson Brook bridge on Middle Road and downstream approximately 860 feet from the private bridge at 260 Middle Road. The model also extends approximately 3,000 feet east and 3,500 feet west of the Hudson Brook to capture the overall flood plain for the Four Corners area.

The HEC-RAS models were developed following these steps:

1. TRE defined the model extents, defined by the model's study area and referred to within HEC-RAS as the "2D Flow Area."

2. TRE imported digital terrain data and land cover data from MassGIS and other sources, as described below, for the model's study area.

3. TRE utilized field data and observations, described below, to edit the terrain data to create an "existing conditions" terrain.

4. TRE assigned an adaptive grid size resolution, and HEC-RAS generated a grid within the model extents.

5. TRE applied breaklines to the model terrain surface, which are used to align grid cells with significant topographic features, such as high points (i.e., ridges) and refinement regions, which are used to create higher grid resolutions to better represent microtopography.

6. TRE added culverts and bridges within the model extents.

7. TRE added boundary conditions. Boundary conditions can be locations of incoming or outgoing flow. Incoming flow was added at upstream locations of the model and within the 2-D flow area to simulate flows from multiple locations. Outgoing flow was modeled using Manning's equation at the downstream edge of the model extent.

HEC-RAS uses the terrain data, land cover data, and grid to generate cross sections at each grid face and storage-elevation curves for each grid cell. Once the boundary conditions and grid were complete, TRE was able to route flow through the model extents.

Inundation mapping was then developed from the results of the HEC-RAS simulations. The inundation area is calculated by HEC-RAS and can be exported to ArcMap (GIS). Water surface elevations are linearly interpolated between grid faces. In those areas where the water surface elevation is greater than the ground elevation, the area is considered inundated.

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The timing and extent of flooding at various locations can be extracted from HEC-RAS. Information such as peak flows, maximum water surface elevations (i.e., stage), and flow paths are useful outputs extracted from the model.

2D FLOW AREAS

The perimeter of the 2D Flow Area for the first model at Hudson Brook is shown in **Figures 9 of Appendix**. TRE used an adaptive cell size for this area, along with refinement regions which have a cell size of 100-400 sq. ft.

Each 2D Flow Area was linked with a terrain. The terrain was created from LiDAR data captured in 2024 with .5-meter spacing and elevations in meters, which TRE converted to feet. TRE downloaded the LiDAR data from NOAA Data Access Viewer, 2024 USGS Lidar:Western MA[2] which mosaiced, reprojected, and clipped the data. TRE added bathymetry to the LiDAR using the HEC-RAS Mapper functionality and the following sources:

Field investigations were performed using centimeter grade gps by TRE in October and November of 2025 to obtain cross sectional information within the channel of Hudson Brook and Tamarac Brook. Additional field investigations were performed to obtain bridge and culvert detail along with high point information along the levees and roadways.

Breaklines were used to align grid cell edges with high ground, such as roadways and ridges. Breaklines were added to capture the Hudson Brooks's berms, located on the east and west banks downstream of Middle Road. Additional breaklines were added to capture detail along Tamarac Brook.

The 2D Flow Areas for the model was also linked with spatial MassGIS and imported to GeoHECRAS (see Figures 6). TRE assigned a Manning's n value to each land use type[34]. The land use data is a statewide data set based on imagery captured in 2021 (**see Figure 5**). The Manning's n values ranged from 0.025 to 0.160 and are summarized in the table below.

Table 3: Manning's n Values for Different Land Uses

Land Use	Manning's n	Land Use	Manning's n
Bare Land	0.025	Palustrine Scrub/Shrub Wetland	0.070
Deciduous Forest	0.160	Palustrine Forested Wetland	0.120
Evergreen Forest	0.160	Palustrine Emergent Wetland	0.070
Developed Open Space	0.040	Palustrine Aquatic Bed	0.035
Cultivated	0.035	Pasture/Hay	0.030
Grassland	0.035	Scrub/Shrub	0.100
Impervious	0.100	Water	0.035

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[2] 2024 USGS Lidar DEM: Western Massachusetts, acquired January 2026.

[3] 2016 Land Cover/Land Use data layer, published by MassGIS and NOAA OCM, acquired January 2021.

[4] Manning's n Values for Various Land Covers to Use for Dam Breach Analyses, NRCS Kansas, July 12, 2017.

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BRIDGES/CULVERTS

TRE's model in Hudson Brook includes six culvert/bridge crossings. TRE modeled the culverts as hydraulic structures within the 2D grid. Dimensions of the bridge structures were based on site investigations performed by TRE. The flow through the culverts was calculated using culvert flow equations. A summary of structures modeled is provided in Table 4.

Table 4: Hudson and Tamarac Brooks Bridge and Culverts Inputs

Bridge/Culvert	Shape	Length (ft)	Span/Diam (ft)	Rise/Diameter (ft)	Inlet Elevation (ft)	Outlet Elevation (ft)	Top of Road Elevation (ft)
Middle Road Bridge Crossing	Box	38	25	14.0	1056.5	1055.9	1069.8
Cross Road Bridge Crossing	Box	28	26	7.5	1042.3	1042.0	1051.3
260 Middle Road Bridge Crossing	Box	18	25	8.0	1028.1	1028.0	1039.4
370 Cross Road Culvert	Circular	60	4.0	4.0	1037.8	1037.6	1042.4
401/431 Cross Road Culvert	Circular	44	1.5	1.5	1040.2	1040.0	1043.8
261 Middle Rd Culvert	Circular	65	3.0	3.0	1032.4	1031.9	1036.6

DOWNSTREAM BOUNDARY CONDITIONS

The model of Huson Brook terminates approximately 860 feet from the private bridge for 260 Middle Road. The streambed slope at the downstream limit is approximately 0.32%, based on LiDAR data. TRE assigned a normal depth boundary condition (i.e., Manning's equation) with the measured slope.

INFLOW HYDROGRAPHS

The upstream boundary conditions for the 2D Flow Areas are the inflow hydrographs computed using HEC-HMS as summarized in Table 4.

FLOW STRUCTURES

TRE modeled known bridge structures along the Hudson Brook main channel and culvert structures contributing flows from the wetlands and residential areas. The geometry for modeled bridge and culvert crossings was based on field measurements taken late 2025. TRE modeled the crossings as hydraulic structures within the 2D grid. The flow through the structures was calculated using the 2D culvert and bridge equations internal to HEC-RAS. Structures such as berms and abutments were captured by LiDAR terrain and enforced within the 2D grid by adding breaklines to associated high ground.

EXISITING CONDITIONS HYDRAULIC MODELING RESULTS

Existing conditions modeling results are assessed through the following: flood parameters at cross-sections, the area of total modeled inundation, and areas of depth × velocity (DV) hazard/severity classifications.

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CROSS-SECTION RESULTS

A summary of the HEC-RAS flood analysis results at user-defined cross-sections are shown in Table 6 below. Cross-sections were defined where structures crossed the main channel of Hudson Brook. Water surface elevations (WSEs), velocities, and unit discharges (i.e. depth × velocity or DV) are provided at each chosen cross-section. Since the 2D model does not give a single maximum WSE, velocity, and DV for each cross-section, the maximum values shown in Table 9 are the average maximum WSEs, velocities, and DVs in the structure cross-section.

INUNDATION AREAS

Table 5 lists the inundation areas for the 10-, 50-, 100-, and 500-year floods in the present and late century. TRE notes that the inundation area of the late century 10-, and 100-year floods are approximately equal to the present century 50-, and 500-year floods, respectively. This means that, in terms of inundation area, the 100-year flood of the late century is equivalent to the 500-year flood of the present. Table 5 also shows that the inundation area moderately increases as the recurrence interval (i.e. peak flood discharge) increases due to the moderately confined nature of the Hudson Brook floodplain. This is further visible in **Figures 10 of Appendix**, which shows the lateral extent of flooding for the present and late century 10-, 50- , 100-, and 500-year floods, respectively. The inundation of present day 100-yr flood is odd with increased area of inundation toward the town field and a reduction in the residential area east of Hudson Brook compared to the 50-yr event.

The modeled inundation extent for the present-day 100-year flood event exhibits an atypical pattern when compared to the 50-year flood event. Specifically, the results indicate an increase in inundation toward the town field, while showing a reduction in the extent of flooding within the residential area located east of Hudson Brook. Under typical hydraulic conditions, the 100-year flood event would be expected to produce an inundation extent equal to or greater than that associated with the 50-year event throughout the study area. This result suggests that localized topographic controls or flow redistribution within the modeled floodplain may be influencing the simulated flood extents.

Table 5: Maximum Inundation Area of 10-, 50-, 100-, and 500-year floods

Flow Event	Inundation Area (acres)	
	Present	Late Century (2070)
10-yr Flood	105.5	125.7
50-yr Flood	130.7	140.2
100-yr Flood	129.7	144.2
500-yr Flood	148.0	155.1

Inundation mapping was prepared that includes color coded hazard classifications for various storm events. This mapping is useful as high hazard areas can be identified occurring outside of the stream channels within the flood zone **Figure 11 of Appendix**.

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Table 6: WSE, Velocity, and DV Results at Structures Crossing Clesson Brook

Cross-Section Name	Min. Top of Road/Low Cord Elevation (ft)	Average of Maximum Value in Cross-Section	Flood Return Period							
			Present				Future 2070			
			10yr	50yr	100yr	500yr	10yr	50yr	100yr	500yr
Middle Road Bridge	1069.8/1066.3	WSE (ft)	1066.8	1069.7	1070.5	1071.5	1070.0	1071.6	1072.4	1073.6
		Velocity (ft/s)	8.25	11.0	13.75	12.5	11.25	20.0	20.0	10.0
		DV (ft2/s)	88.4	148.8	197.9	192.5	156.3	309.4	325.6	175.4
Cross Road Bridge	1051.4/1048.6	WSE (ft)	1050.1	1050.4	1050.7	1050.8	1050.6	1051.0	1051.1	1051.4
		Velocity (ft/s)	6.75	6.75	7.5	6.75	7.5	7.5	8.25	6.75
		DV (ft2/s)	53.4	55.5	63.8	58.1	63.1	65.8	73.1	61.9
260 Middle Road Bridge	1039.5/1037.8	WSE (ft)	1039.0	1041.0	1041.7	1045.2	1041.3	1043.2	1043.8	1045.2
		Velocity (ft/s)	7.5	7.5	8.25	8.0	8.3	8.5	8.8	8.0
		DV (ft2/s)	79.6	95.9	112.0	121.2	108.4	129.0	138.6	137.3

Table 6 indicates that WSEs at each structure increase between the present and future flood scenarios. Between the present and late century, the 10-, 50-, 100-, and 500-year WSEs increase on average by 2.3, 0.5, and 1.6 feet, respectively. Velocity and DV both significantly increase at the Middle Road and 260 Middle Road crossings between the present and future flood scenarios.

As a result of increasing WSEs between the present and future flood scenarios, the recurrence interval flood at which overtopping occurs will change in the future. Road and flood elevations in Table 6 can be compared to identify when overtopping occurs, as summarized in Table 7. The model predicts that Middle Road Bridge and 26 Middle Road Bridge will overtop in each modeled flow scenario for both the present and the late century scenarios. All three bridges are expected to have WSE exceeding low cord elevations during the 100 and 500 present day events with Cross Road and 260 Middle Road exceeding low cord elevations during all events. Low cord elevations will be exceeded during all future events. This condition should be considered with any future bridge replacement.

Table 7: Summary of Anticipated Structure Overtopping on the Hudson Brook Main Channel

Name in HEC-RAS	Anticipated Overtopping							
	Present				Late Century (2070)			
	10-yr	50-yr	100-yr	500-yr	10-yr	50-yr	100-yr	500-yr
Middle Road Bridge	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Cross Road Bridge	No	No	No	No	No	No	No	No
260 Middle Rd. Bridge	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

FLOOD HAZARD & SEVERITY

TRE conducted an analysis of the depth–velocity (DV) results generated by HEC-RAS to evaluate flood hazard severity using criteria adapted from applicable technical guidance[56]. Based on the analysis, TRE determined that the hazard classification for flows at all three bridge crossings is **"Unsafe for vehicles and people. All building types considered vulnerable to failure"** during extreme storm events. DV hazard categories, summarized in Table 6, range from conditions generally considered safe to conditions classified as unsafe for vehicles and pedestrians, with buildings vulnerable to structural failure.

DV hazard categories and the percent change in the area associated with each hazard class between present-day and late-century conditions for the 100-year flood event are summarized in Table 8. Results indicate that projected climate change conditions substantially increase the spatial extent of **"Very High"** and **"Extreme"** hazard zones, where flooding has the potential to damage infrastructure in addition to posing risks to vehicles and human life. Expansion of the **"Very High"** and **"Extreme"** hazard zones generally occurs adjacent to the channel where flow velocities are highest.

The hazard classifications presented in Table 8 also indicate that the structures identified in Table 6 may be susceptible to flood damage during a range of recurrence interval events. Hazard maps presented in

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[5] FEMA, 2020, Guidance for Flood Risk Analysis and Mapping: Flood Depth and Analysis Rasters.
[6] Australian Institute for Disaster Resilience, 2017, Australian Disaster Resilience Handbook Collection: Flood Hazard Guideline 7-3.

Figure 11 (Appendix) illustrate areas where floodwaters overtop the banks of Hudson Brook. Overtopping is particularly evident upstream near the Middle Road Bridge and at locations where flow passes through the levee along the eastern bank of Hudson Brook.

High-velocity flow is expected to bypass the Middle Road Bridge along the western side of the channel and extend across adjacent fields. During larger storm events, additional high-velocity flow paths are projected to occur through the levee along the eastern bank of Hudson Brook, with floodwaters potentially moving between and through the adjacent residential neighborhood. As storm magnitudes increase, additional hazard areas ranging from **Medium** to **Very High** are also expected where floodwaters overtop Middle Road and Cross Road.

Table 8: Hazard Categories

Category	DV (ft^s/s)	Qualitative Description
Low	0 - 2.2	Generally safe for vehicles, people and buildings.
Medium	2.2 - 5.4	Unsafe for small vehicles, children, and the elderly.
High	5.4 – 16.1	Unsafe for vehicles and people
Very High	16.1 - 26.9	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
Extreme	> 26.9	Unsafe for vehicles and people. All building types considered vulnerable to failure.

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Appendix

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Figure 1. Locus and GeoHECHMS Model Drainage Basin Area with Areal Imagery

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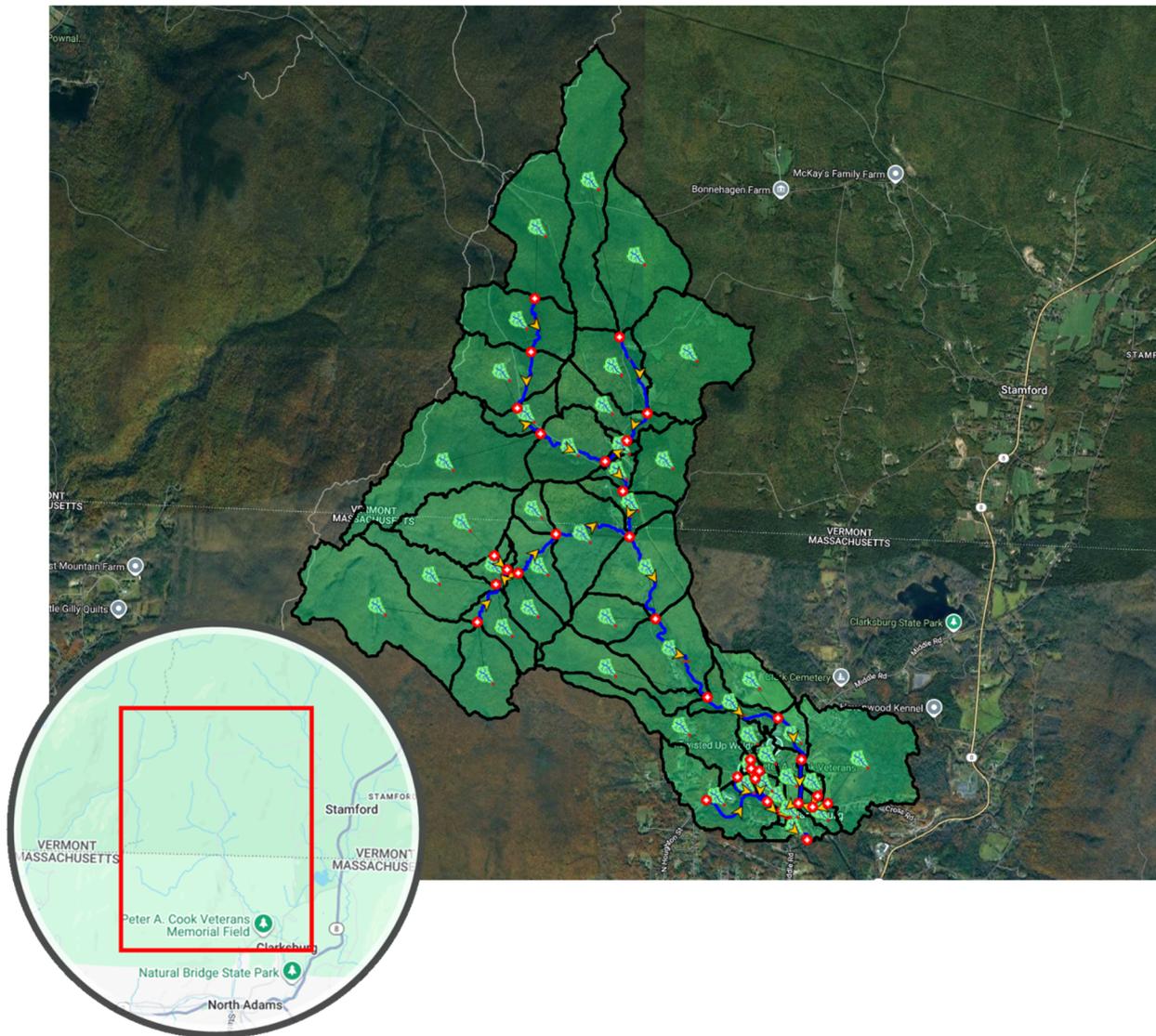
Figure 2. Watershed Routing Diagram

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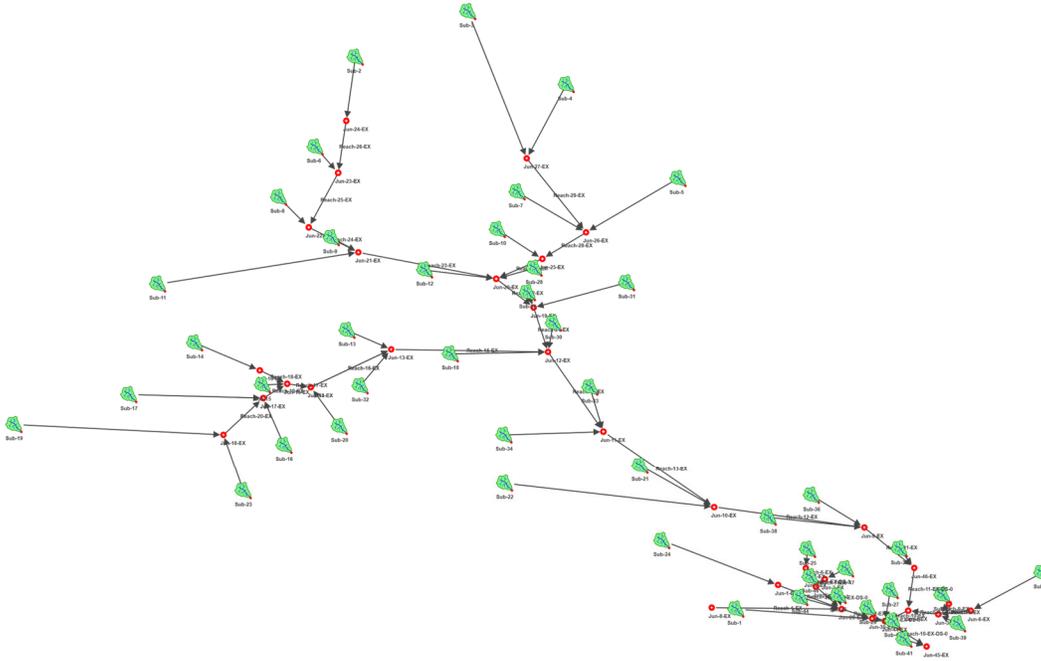Hydrologic & Hydraulic Analysis
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Figure 3. Watershed Summary

Subbasin ID	Drainage Area (acres)	Initial Abstraction (in)	Curve Number	Impervious Surface (%)	Lag Time (minutes)	Peak Discharge (cfs)
Sub-1	142.597	N/A	69.3	20.00	25.75	65.17
Sub-2	220.161	N/A	71.6	20.00	82.21	60.36
Sub-3	308.693	N/A	70.42	20.00	27.72	142.39
Sub-4	213.111	N/A	70.71	20.00	103.09	49.05
Sub-5	264.746	N/A	70.67	20.00	70.55	76.28
Sub-6	151.809	N/A	70.77	20.00	66.8	45.67
Sub-7	116.158	N/A	70.77	20.00	15.94	61.9
Sub-8	146.877	N/A	69.54	20.00	61.4	44.09
Sub-9	52.937	N/A	72.22	20.00	45.23	20.85
Sub-10	82.114	N/A	73.31	20.00	51.96	31.84
Sub-11	316.826	N/A	71.47	20.00	167.68	54.97
Sub-12	120.518	N/A	67.83	20.00	24.64	52.67
Sub-13	34.447	N/A	66.84	20.00	25.33	14.21
Sub-14	167.839	N/A	72.86	20.00	69.29	53.76
Sub-15	27.278	N/A	77.15	20.00	28.6	16.46
Sub-16	64.874	N/A	76.2	20.00	34.45	34.87
Sub-17	135.293	N/A	73.22	20.00	78.25	41.02
Sub-18	160.108	N/A	69.2	20.00	42.34	57.3
Sub-19	320.320	N/A	73.41	20.00	210.02	51.64
Sub-20	65.225	N/A	75.76	20.00	40.73	31.77
Sub-21	151.421	N/A	65.96	20.00	32.62	53.6
Sub-22	114.501	N/A	72.55	20.00	50.39	43.77
Sub-23	114.828	N/A	75.73	20.00	40.06	56.45
Sub-24	145.982	N/A	69.54	20.00	73.46	39.34
Sub-25	17.336	N/A	76.59	20.00	8.62	14.68
Sub-26	9.001	N/A	78.93	20.00	10.43	7.99
Sub-27	31.427	N/A	67.79	20.00	16.85	14.8
Sub-28	13.857	N/A	71.87	20.00	17.38	7.75
Sub-29	24.072	N/A	63.95	20.00	6.09	12.18
Sub-30	56.060	N/A	61.79	20.00	20.44	19.87
Sub-31	98.146	N/A	74.37	20.00	95.87	27.39
Sub-32	84.975	N/A	75.53	20.00	34.1	44.6
Sub-33	157.714	N/A	69.56	20.00	26.17	72.31
Sub-34	71.751	N/A	75.91	20.00	21.64	46.21
Sub-36	78.606	N/A	74.89	20.00	41.83	36.29
Sub-37	35.957	N/A	63.29	20.00	19.36	13.74
Sub-38	48.189	N/A	62.59	20.00	30.5	14.9
Sub-39	24.694	N/A	75.56	20.00	77.75	8.27

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Sub-40	1.328	N/A	78.68	20.00	10.64	1.16
Sub-41	29.829	N/A	75.04	20.00	16.93	18.91
Sub-42	12.498	N/A	54.81	20.00	16.24	3.61
Sub-43	259.410	N/A	71.89	20.00	61.03	86.17
Sub-44	8.400	N/A	78.99	20.00	10.78	7.41
Sub-45	11.719	N/A	81.3	20.00	11.89	10.94
Sub-46	7.838	N/A	78.22	20.00	14.12	6.11
Sub-47	16.806	N/A	71.36	20.00	40.97	6.77

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Figure 4. Watershed NRCS Soil Mapping

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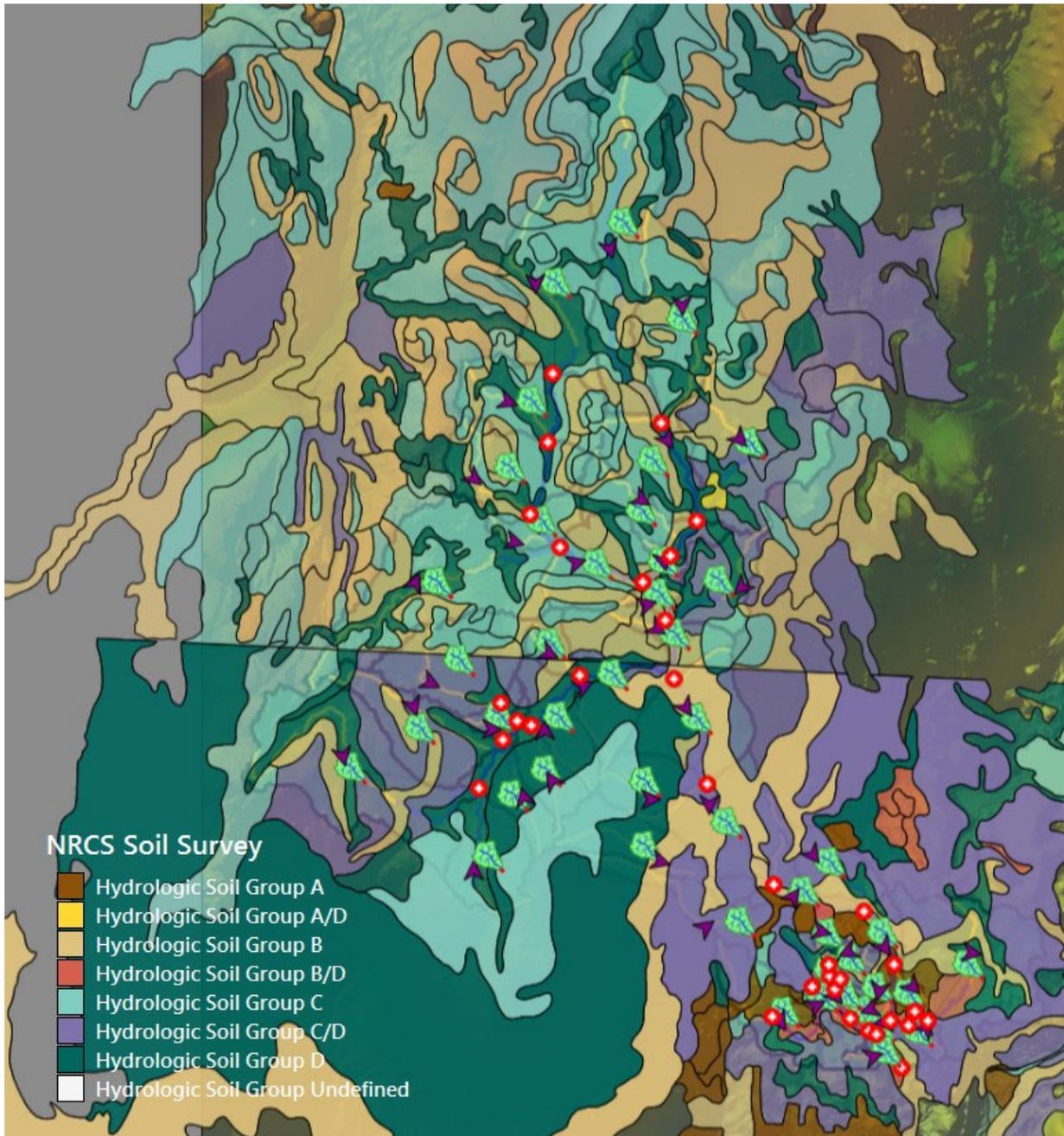
Figure 5. Land Use Mapping, USGS, NLCD 2021

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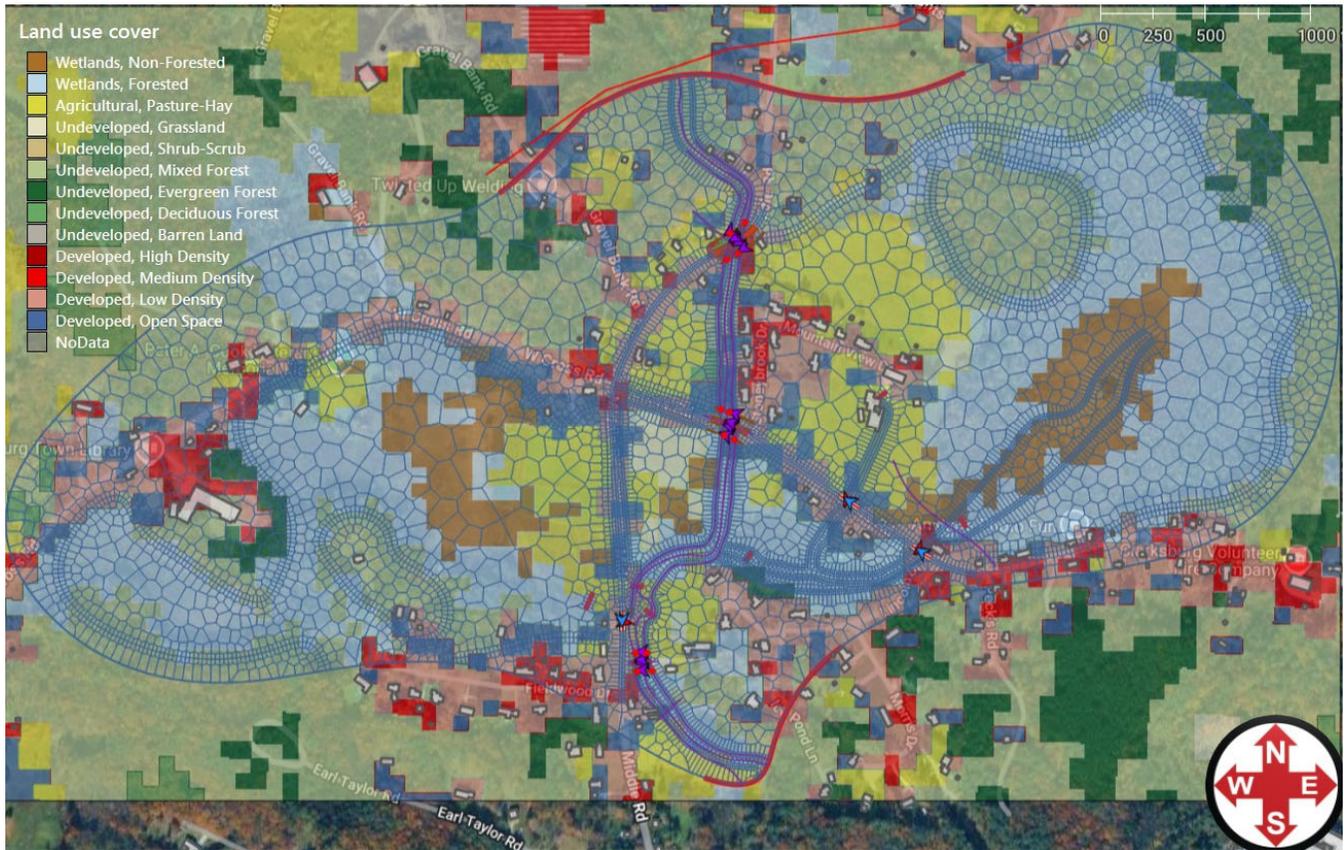
Figure 6. NOAA Atlas 14 Precipitation Frequency Estimates

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Precipitation Frequency Data Server

NOAA Atlas 14, Volume 10, Version 3
Location name: Stamford, Vermont, USA*
Latitude: 42.7496°, Longitude: -73.1204°
Elevation: 1826 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

Duration	Average recurrence interval (years)								
	1	2	5	10	25	50	100	200	500	1000

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	1	2	5	10	25	50	100	200	500	1000
5-min	0.326 (0.251-0.420)	0.384 (0.295-0.495)	0.478 (0.366-0.619)	0.556 (0.424-0.722)	0.664 (0.491-0.895)	0.746 (0.541-1.02)	0.831 (0.585-1.18)	0.923 (0.620-1.34)	1.05 (0.680-1.57)	1.15 (0.729-1.75)
10-min	0.462 (0.355-0.595)	0.544 (0.418-0.701)	0.678 (0.520-0.877)	0.788 (0.601-1.03)	0.941 (0.696-1.27)	1.06 (0.766-1.45)	1.18 (0.828-1.66)	1.31 (0.877-1.89)	1.49 (0.963-2.22)	1.63 (1.03-2.48)
15-min	0.543 (0.418-0.700)	0.640 (0.492-0.825)	0.798 (0.611-1.03)	0.928 (0.707-1.21)	1.11 (0.818-1.49)	1.24 (0.900-1.70)	1.38 (0.974-1.96)	1.54 (1.03-2.22)	1.75 (1.13-2.61)	1.92 (1.22-2.92)
30-min	0.741 (0.570-0.955)	0.871 (0.670-1.12)	1.08 (0.831-1.40)	1.26 (0.961-1.64)	1.50 (1.11-2.02)	1.69 (1.22-2.31)	1.88 (1.32-2.65)	2.08 (1.40-3.01)	2.37 (1.53-3.53)	2.60 (1.64-3.94)
60-min	0.939 (0.723-1.21)	1.10 (0.848-1.42)	1.37 (1.05-1.77)	1.59 (1.21-2.07)	1.90 (1.40-2.56)	2.13 (1.54-2.92)	2.37 (1.67-3.35)	2.63 (1.76-3.80)	2.99 (1.93-4.46)	3.27 (2.07-4.97)
2-hr	1.17 (0.908-1.50)	1.38 (1.07-1.77)	1.73 (1.33-2.22)	2.02 (1.54-2.60)	2.41 (1.79-3.23)	2.71 (1.97-3.69)	3.02 (2.14-4.24)	3.36 (2.26-4.82)	3.83 (2.49-5.68)	4.22 (2.68-6.37)
3-hr	1.34 (1.04-1.70)	1.58 (1.22-2.02)	1.98 (1.53-2.53)	2.31 (1.78-2.97)	2.76 (2.06-3.69)	3.11 (2.27-4.23)	3.46 (2.46-4.86)	3.86 (2.61-5.53)	4.42 (2.88-6.53)	4.88 (3.10-7.33)
6-hr	1.67 (1.31-2.12)	1.98 (1.55-2.52)	2.49 (1.94-3.17)	2.91 (2.25-3.72)	3.49 (2.61-4.63)	3.92 (2.88-5.30)	4.38 (3.12-6.11)	4.88 (3.31-6.95)	5.61 (3.66-8.23)	6.20 (3.96-9.26)
12-hr	2.09 (1.64-2.64)	2.48 (1.95-3.13)	3.12 (2.44-3.94)	3.64 (2.84-4.64)	4.37 (3.30-5.77)	4.92 (3.64-6.62)	5.49 (3.94-7.63)	6.14 (4.18-8.68)	7.06 (4.63-10.3)	7.82 (5.00-11.6)
24-hr	2.52 (1.99-3.15)	3.00 (2.37-3.77)	3.80 (2.99-4.78)	4.46 (3.49-5.64)	5.37 (4.08-7.06)	6.06 (4.50-8.10)	6.78 (4.90-9.38)	7.60 (5.19-10.7)	8.81 (5.79-12.8)	9.81 (6.30-14.4)
2-day	2.92 (2.32-3.63)	3.52 (2.79-4.38)	4.50 (3.56-5.62)	5.31 (4.18-6.67)	6.43 (4.91-8.42)	7.27 (5.44-9.70)	8.16 (5.95-11.3)	9.22 (6.32-12.9)	10.8 (7.12-15.5)	12.1 (7.82-17.8)
3-day	3.20 (2.55-3.96)	3.86 (3.08-4.79)	4.94 (3.93-6.15)	5.84 (4.62-7.31)	7.08 (5.43-9.24)	8.00 (6.02-10.6)	9.00 (6.58-12.4)	10.2 (6.99-14.2)	12.0 (7.91-17.2)	13.5 (8.71-19.7)
4-day	3.44 (2.76-4.26)	4.15 (3.31-5.13)	5.30 (4.22-6.57)	6.25 (4.95-7.80)	7.56 (5.81-9.84)	8.54 (6.43-11.3)	9.59 (7.04-13.2)	10.9 (7.46-15.1)	12.8 (8.44-18.2)	14.4 (9.30-20.9)
7-day	4.13 (3.32-5.08)	4.89 (3.93-6.02)	6.14 (4.92-7.59)	7.18 (5.72-8.91)	8.61 (6.64-11.1)	9.68 (7.31-12.7)	10.8 (7.95-14.8)	12.2 (8.40-16.8)	14.2 (9.42-20.2)	15.9 (10.3-23.0)
10-day	4.83 (3.89-5.92)	5.63 (4.53-6.91)	6.94 (5.57-8.53)	8.02 (6.40-9.92)	9.51 (7.35-12.2)	10.6 (8.04-13.9)	11.8 (8.67-16.0)	13.2 (9.12-18.1)	15.2 (10.1-21.5)	16.9 (10.9-24.3)
20-day	7.05 (5.72-8.59)	7.92 (6.42-9.65)	9.33 (7.54-11.4)	10.5 (8.44-12.9)	12.1 (9.39-15.4)	13.4 (10.1-17.2)	14.6 (10.7-19.4)	15.9 (11.1-21.7)	17.7 (11.8-24.9)	19.1 (12.4-27.3)
30-day	8.88 (7.23-10.8)	9.80 (7.97-11.9)	11.3 (9.16-13.8)	12.5 (10.1-15.4)	14.3 (11.1-18.0)	15.6 (11.8-19.9)	16.9 (12.3-22.2)	18.2 (12.7-24.6)	19.8 (13.3-27.7)	21.0 (13.7-29.9)
45-day	11.1 (9.06-13.4)	12.1 (9.85-14.6)	13.7 (11.1-16.6)	15.0 (12.1-18.3)	16.9 (13.1-21.1)	18.3 (13.9-23.3)	19.7 (14.3-25.6)	21.0 (14.7-28.3)	22.5 (15.1-31.2)	23.5 (15.3-33.3)
60-day	12.9 (10.5-15.5)	13.9 (11.4-16.8)	15.6 (12.8-18.9)	17.1 (13.8-20.7)	19.0 (14.8-23.7)	20.6 (15.6-26.0)	22.0 (16.1-28.5)	23.3 (16.4-31.3)	24.8 (16.7-34.4)	25.8 (16.8-36.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.
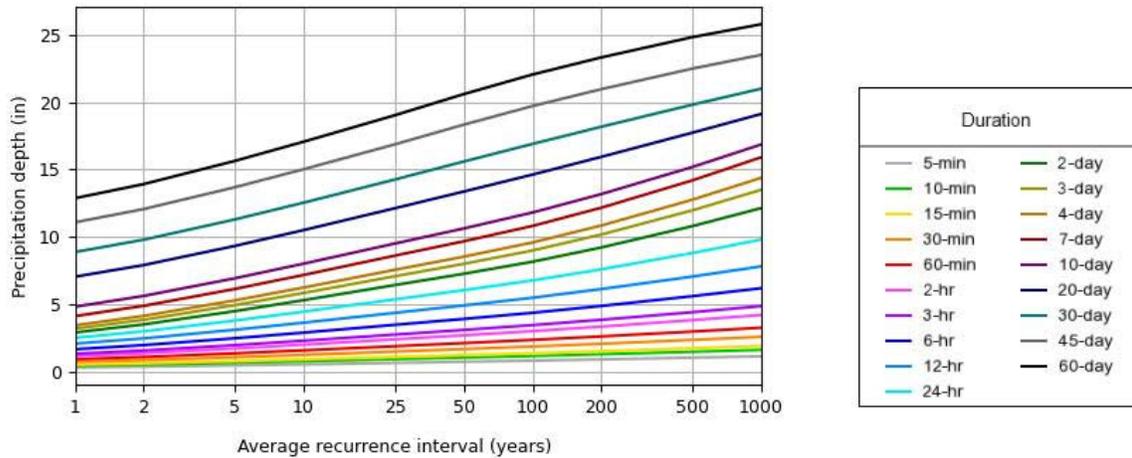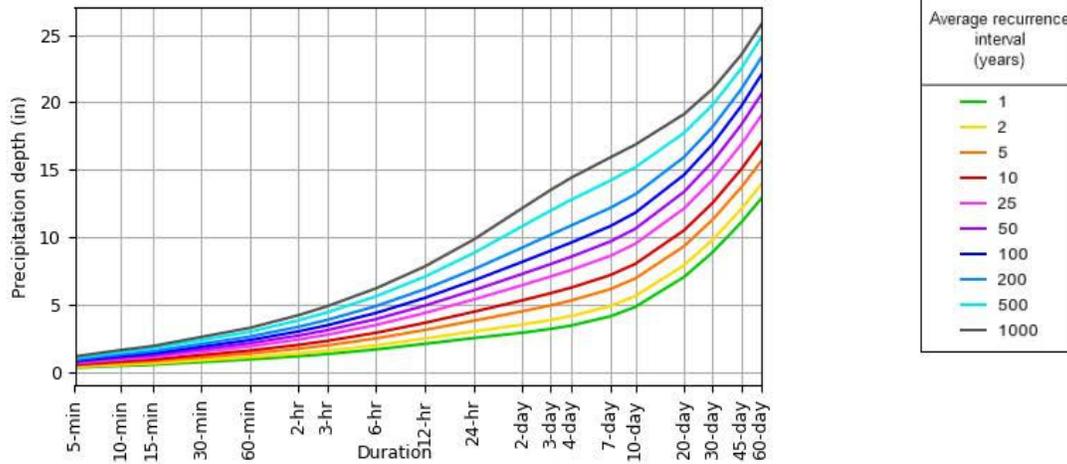
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PF graphical

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PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.7496°, Longitude: -73.1204°

NOAA Atlas 14, Volume 10, Version 3

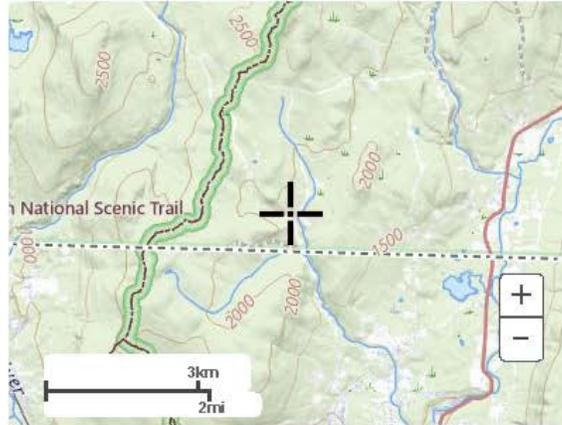Created (GMT): Mon Mar 9 20:51:45 2026

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Maps & aerials

Small scale terrain

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Large scale terrain

Large scale map

Large scale aerial
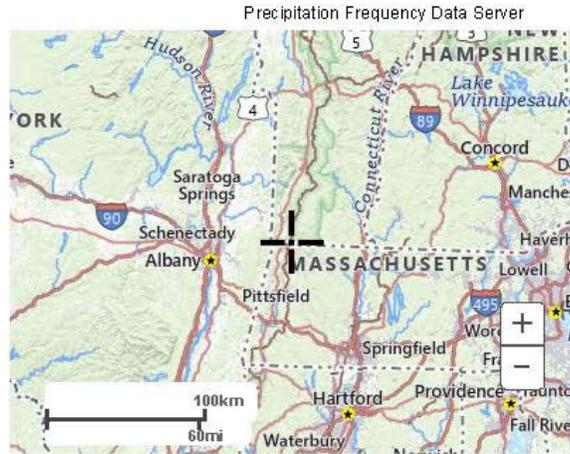
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Figure 7. RMAT Climate Change Projections - 2070 Projected 24-hr Precipitation Depths

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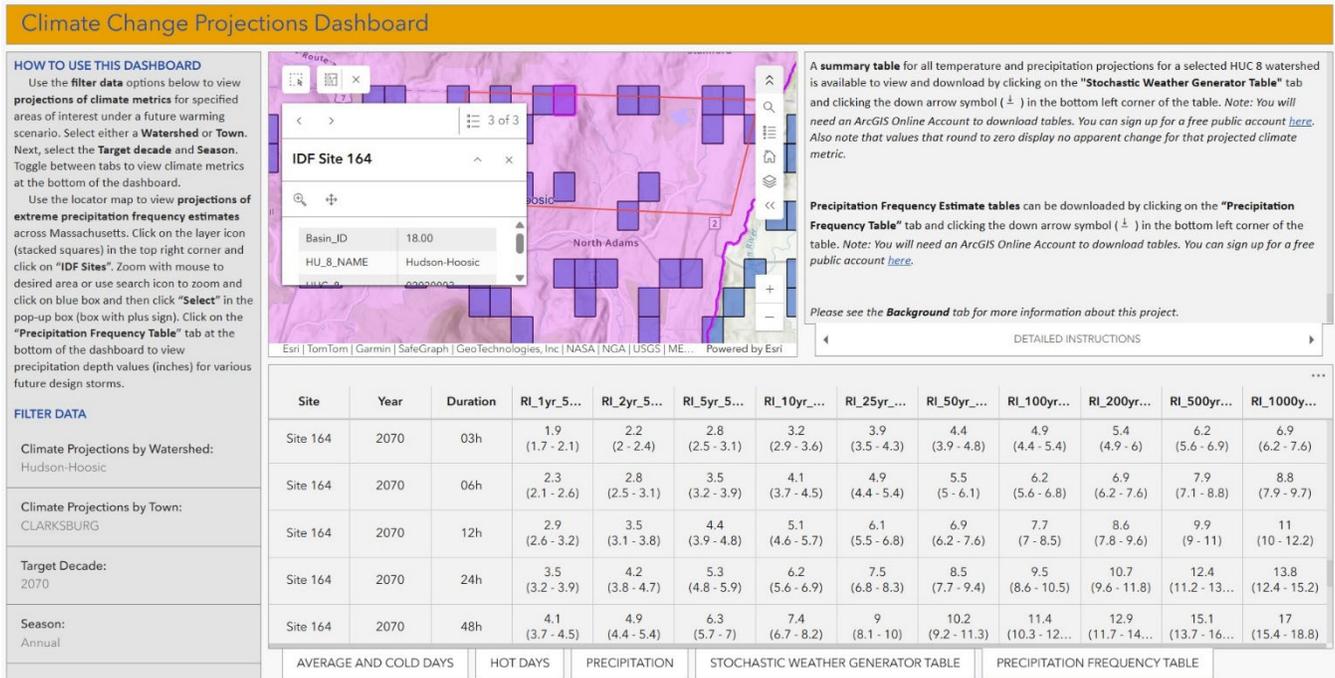
Figure 8. Present and Future 2070 GeoHECHMS Output Hydrographs
Present

Future 2070

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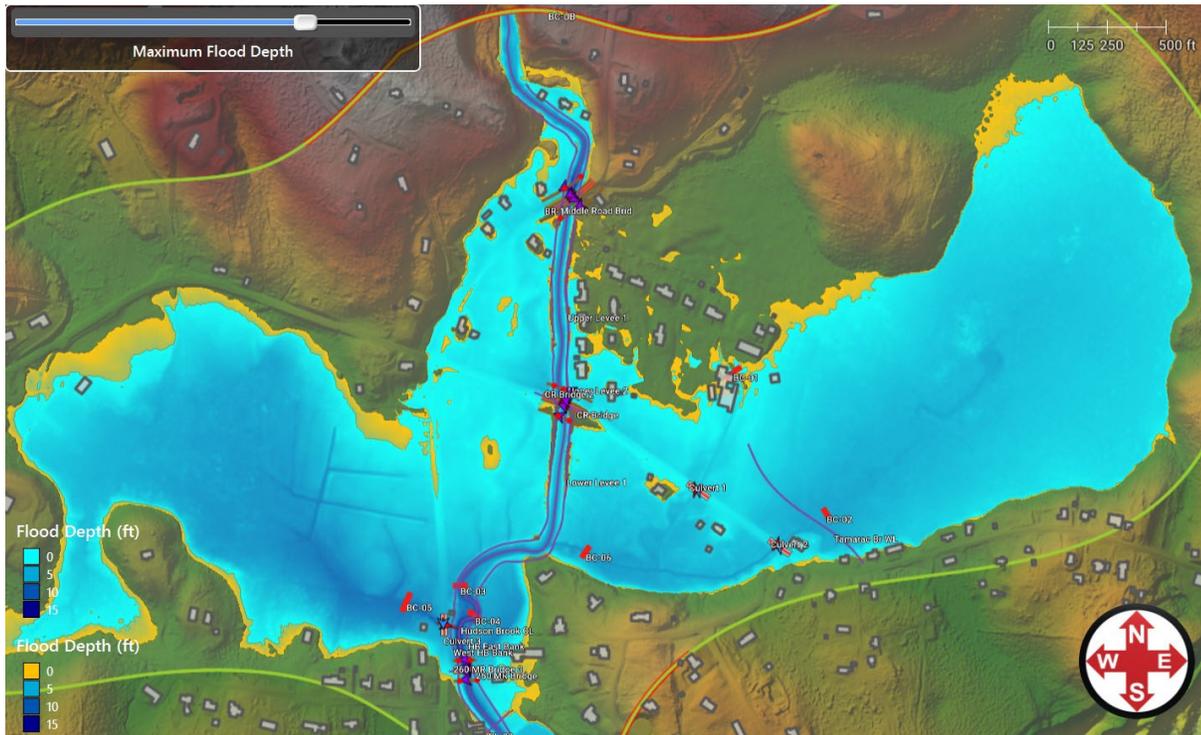Town of Clarksburg, MA
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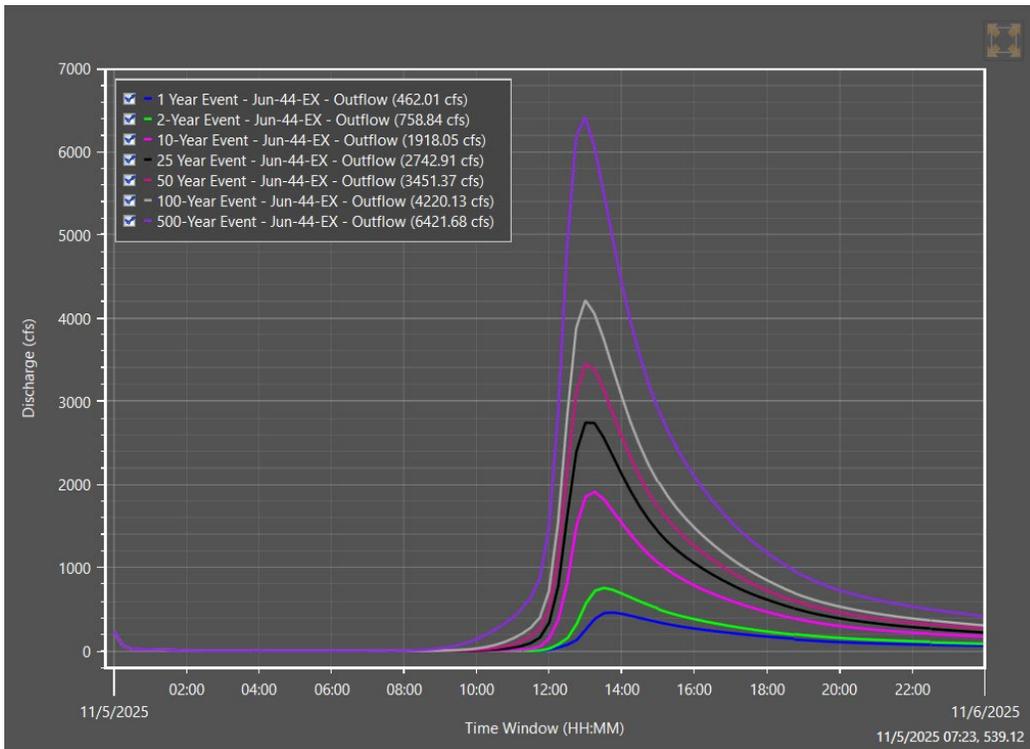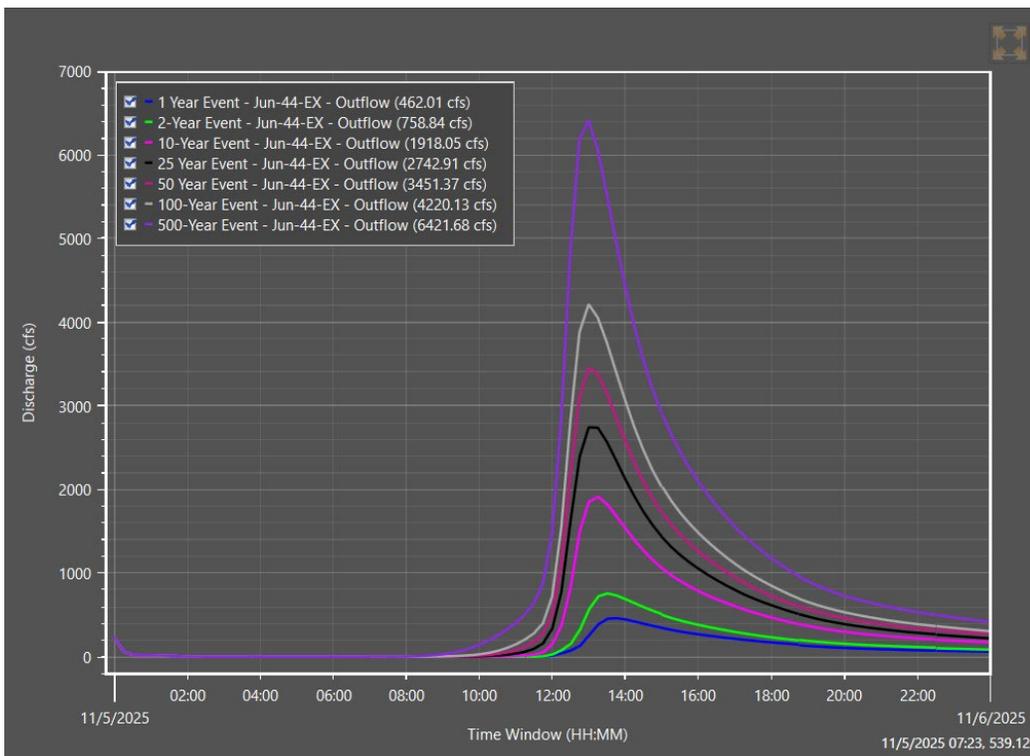
Figure 8. GeoHECRAS 2D-Flow Area Model

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Figure 9. Comparative Present and Future Flood Inundation Mapping

10-Year Present

50-Year

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100-Year Present

500-Year

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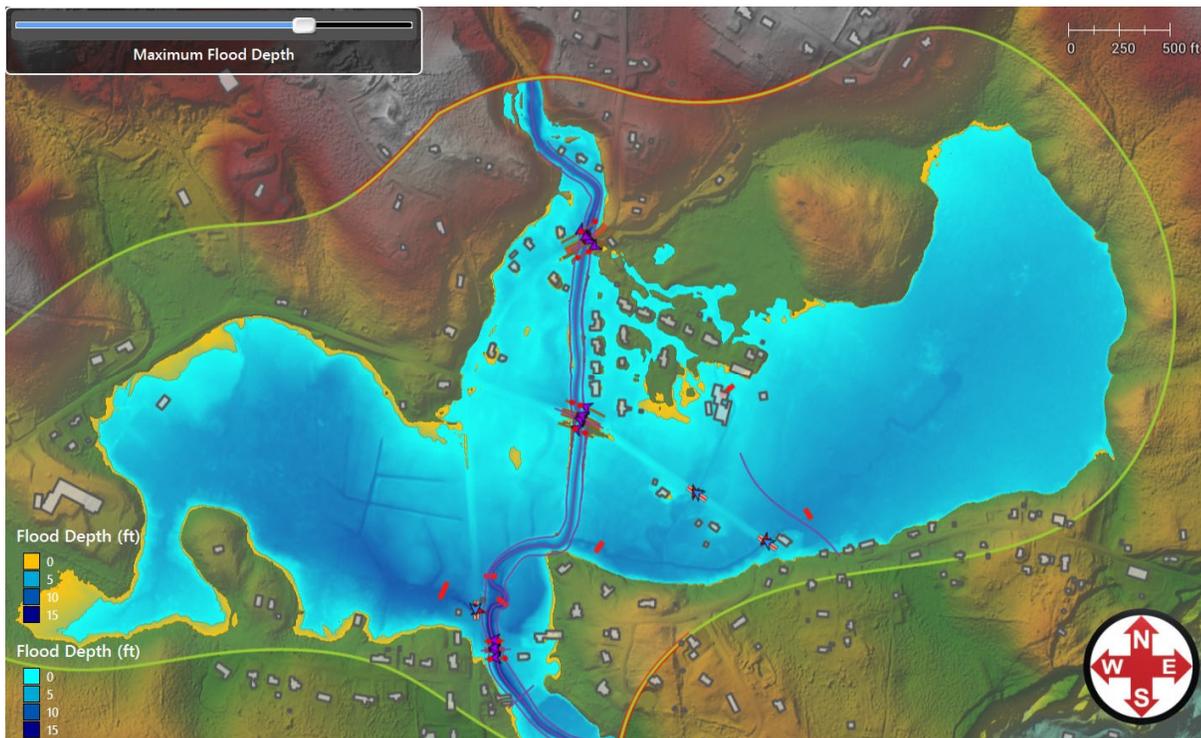3/12/2026

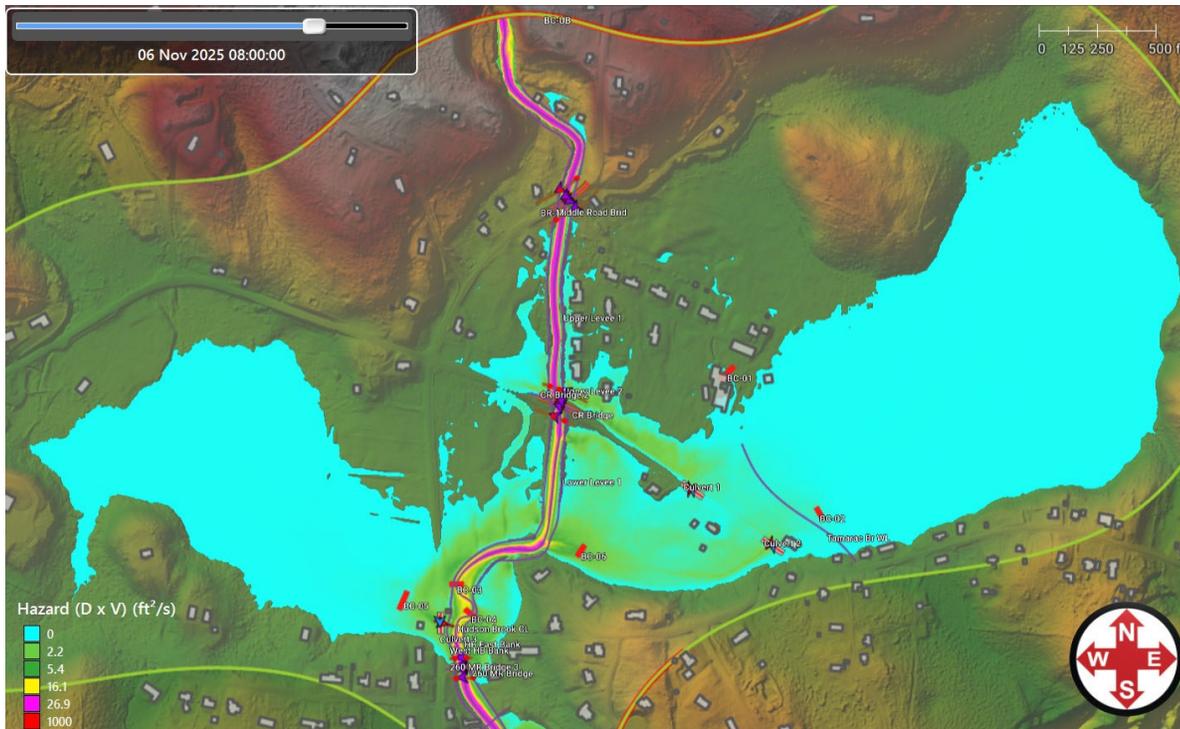Town of Clarksburg, MA
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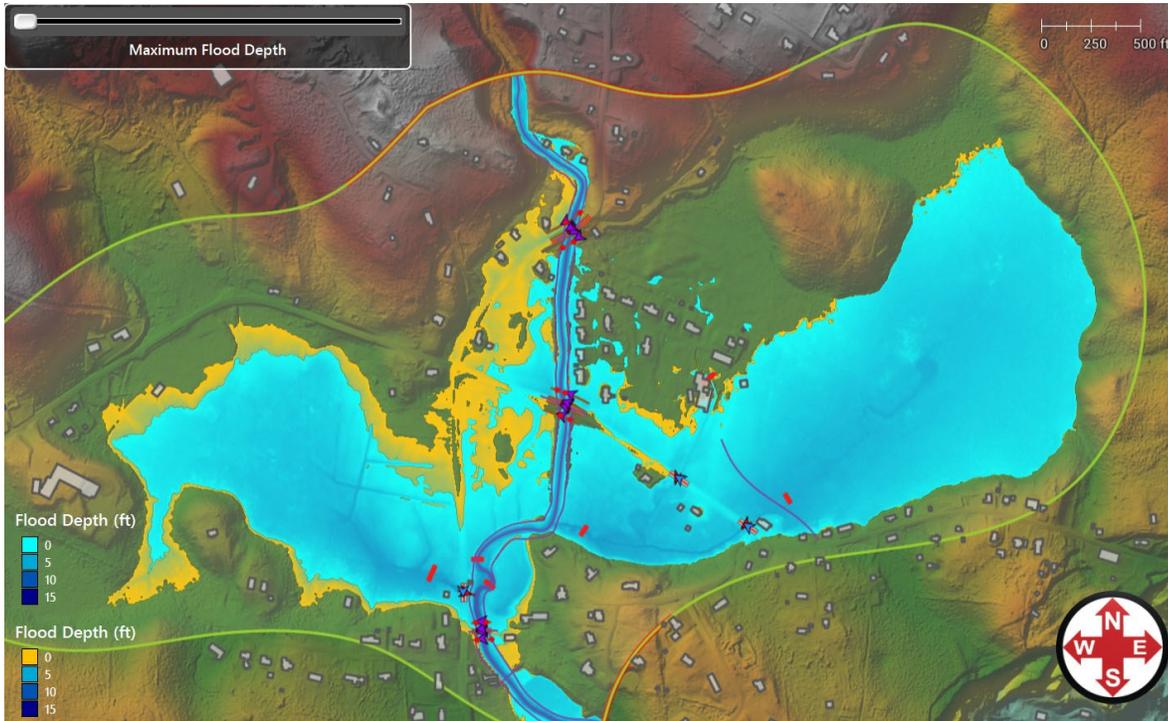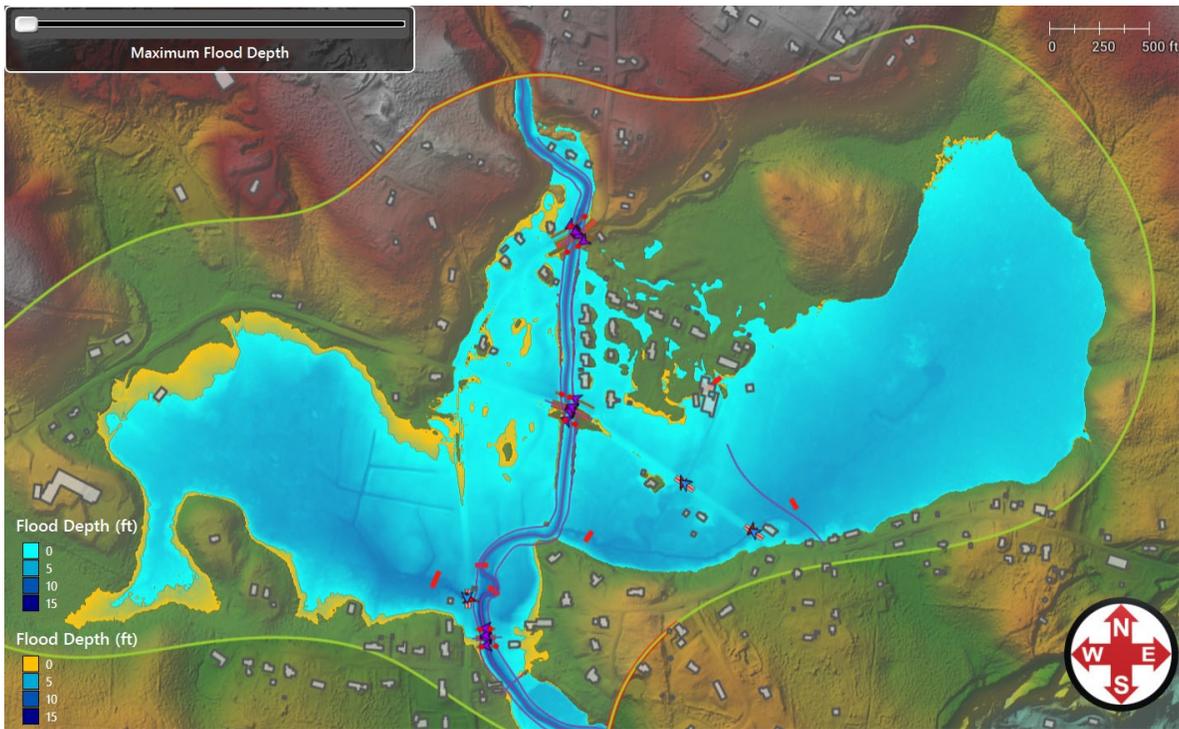
Figure 10. DV Flood Hazard Mapping

10-Year Present

10-Year Future 2070

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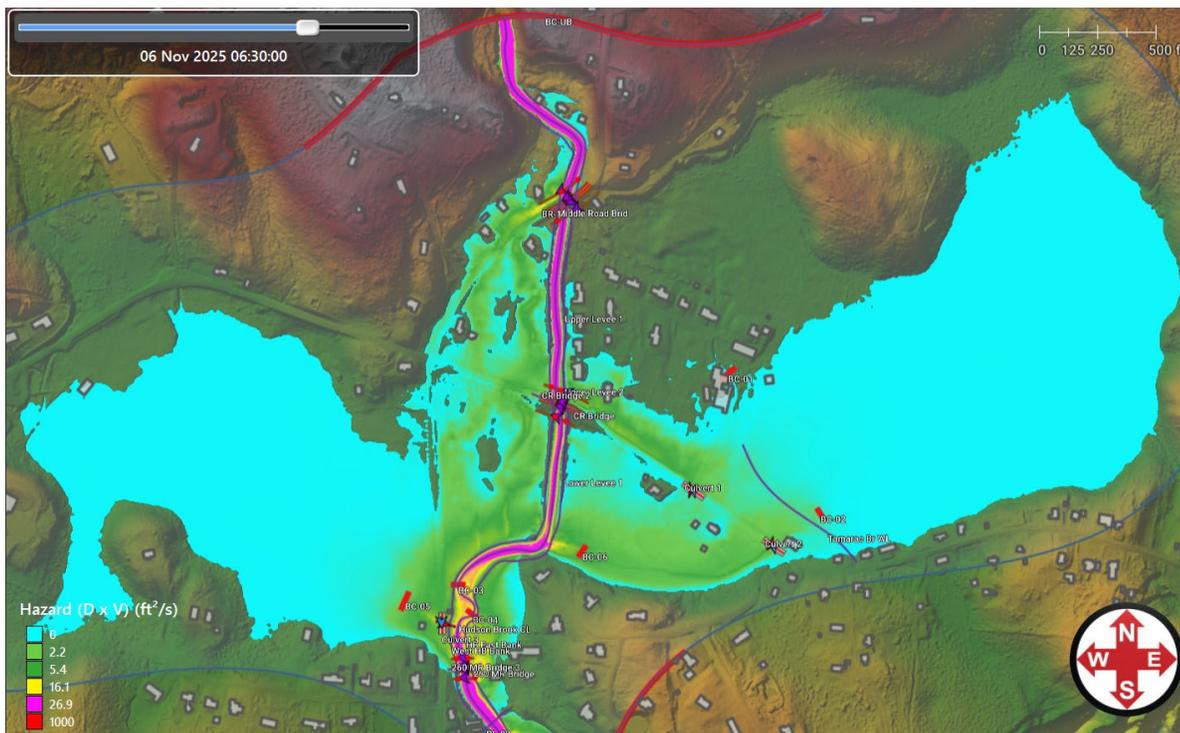
50-Year

50-Year Future 2070

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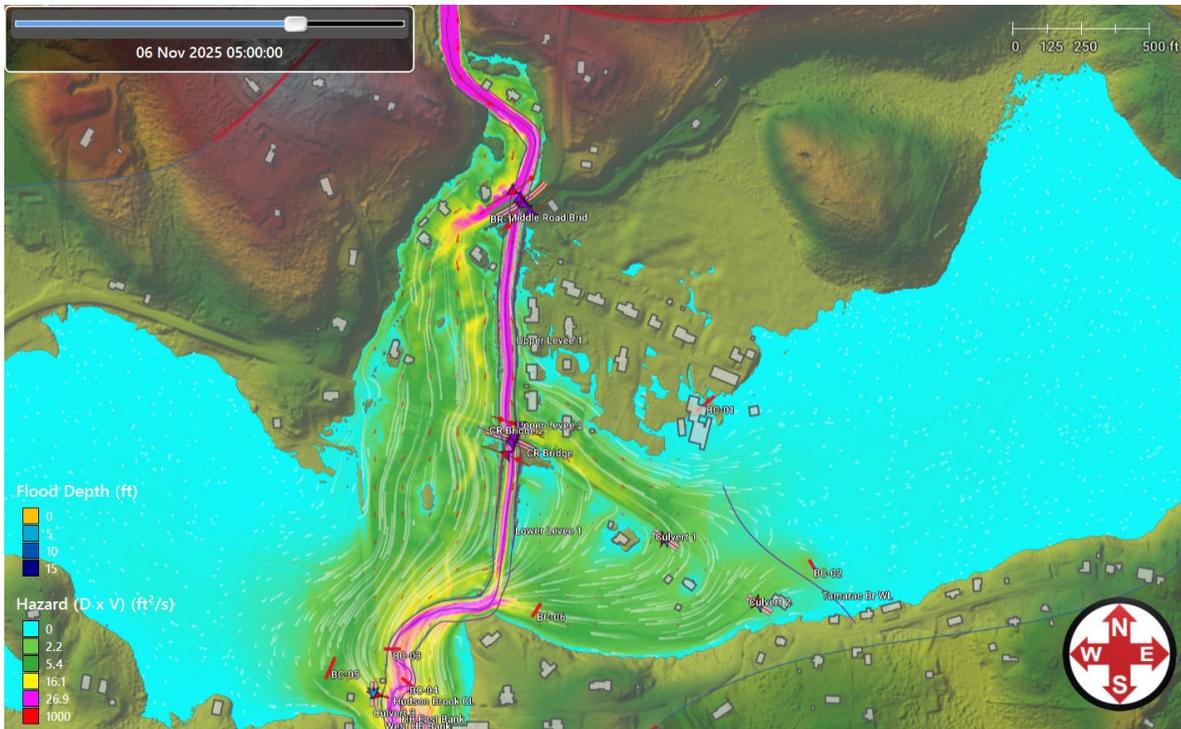
100-Year Present

100-Year Future 2070

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500-Year Present

500-Year Present

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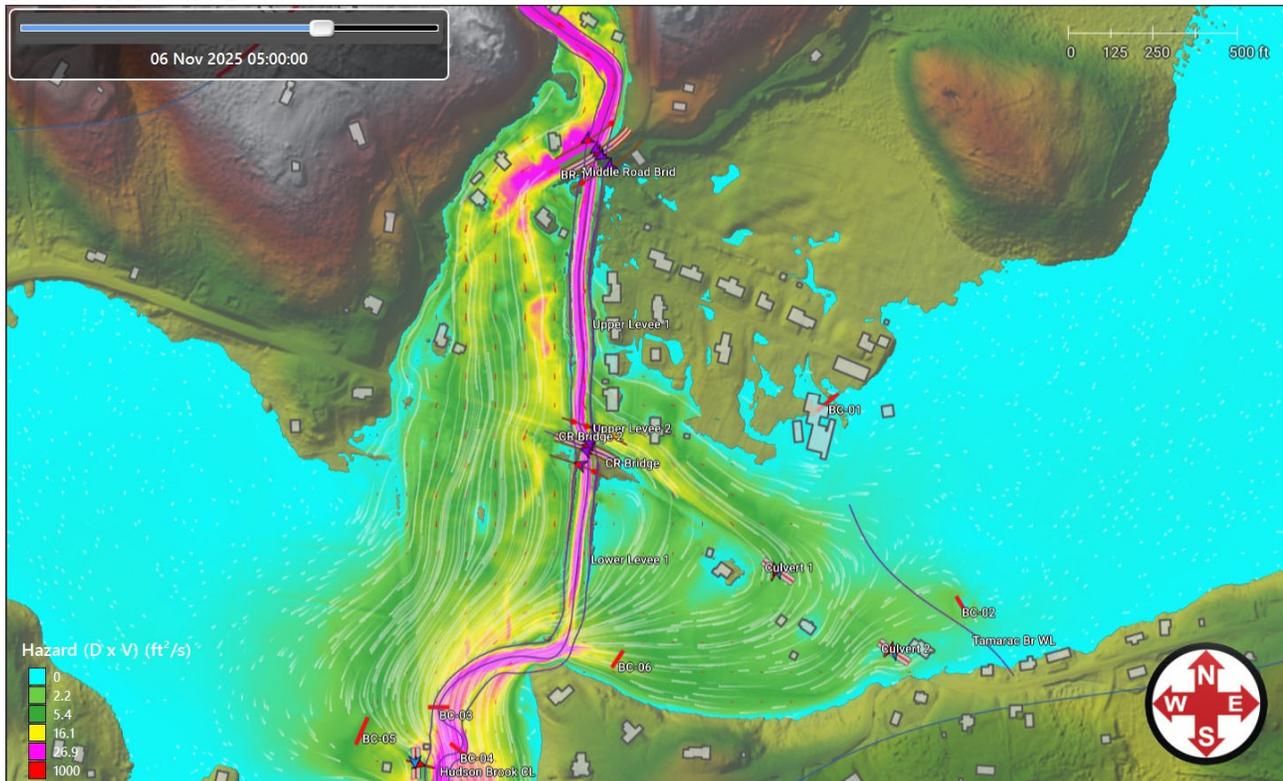
LIMITATIONS

USE OF REPORT

1. T Reynolds Engineering (TRE) prepared this Report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this Report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at the party's sole risk, and without any liability to TRE.

STANDARD OF CARE

TRE's findings and conclusions are based on work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

TRE's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or similar property. No warranty, express or implied, is made. Specifically, TRE does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by TRE during its study. Additionally, TRE makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state, or federal agency.

In conducting our work, TRE relied upon certain information made available by public agencies, Client and/or others. TRE did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

INTERPRETATION OF DATA

Our opinions are based on available information and data as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support he opinions provided in the Report.

ADDITIONAL INFORMATION

In the event that the Client or others authorized to use this report obtain additional information on environmental or hazardous waste issues at the Site not contained in this Report, such information shall be brought to TRE's attention forthwith. TRE will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this Report.

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ADDITIONAL SERVICES

8. TRE recommends that we be retained to provide services during future investigations, design, implementation, activities, construction, and/or property development/redevelopment of the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.