

DAM HAZARD CLASS ASSESSMENT REPORT

Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern Vermont Orchard Dam

**Vermont Department of Environmental Conservation
Washington County, Vermont**

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DAM HAZARD CLASS ASSESSMENT REPORT
CARLTON RESERVOIR DAM, CURTIS POND DAM, KENNY POND DAM, AND SOUTHERN
VERMONT ORCHARD DAM
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

TABLE OF CONTENTS

1.0	INTRODUCTION AND BACKGROUND	1
1.1	Curtis Pond Dam	
1.2	Carlton Reservoir Dam	
1.3	Kenny Pond Dam	
1.4	Southern Vermont Orchard Dam	
2.0	HYDROLOGIC MODEL DEVELOPMENT	2
2.1	Hydrologic Model Development	
2.2	Curtis Pond Hydrologic Routing	
2.3	Carlton Reservoir Hydrologic Routing	
2.4	Kenny Pond Hydrologic Routing	
2.5	Southern Vermont Orchard Dam Hydrologic Routing	
3.0	DAM BREACH HYDRAULIC ANALYSIS.....	18
3.1	Curtis Pond Dam HEC-RAS 2D Breach Analysis	
3.2	Carlton Reservoir Dam HEC-RAS 2D Breach Analysis	
3.3	Kenny Pond Dam HEC-RAS 2D Breach Analysis	
3.4	Southern Vermont Orchard Dam HEC-RAS 2D Breach Analysis	
4.0	HAZARD CLASS ASSESSMENT	28
4.1	VT DEC Hazard Classification Guidance	
4.2	Curtis Pond Dam	
4.3	Carlton Reservoir Dam	
4.4	Kenny Pond Dam	
4.5	Southern Vermont Orchard Dam	
5.0	LIMITATIONS	44

LIST OF TABLES

Table 2.1:	Watershed Area
Table 2.2:	Hydrologic Model Parameters
Table 2.3:	HEC-HMS Hydrologic Model Summary
Table 2.4:	Stage-vs Storage Relationship for Curtis Pond
Table 2.5:	Reservoir Routing Results for Curtis Pond Dam
Table 2.6:	Stage-vs-Storage Relationship for Carlton Reservoir
Table 2.7:	Reservoir Routing Results for Carlton Reservoir Dam
Table 2.8:	Stage-vs-Storage Relationship for Kenny Pond
Table 2.9:	Reservoir Routing Results for Kenny Pond Dam
Table 2.10:	Stage-vs-Storage Relationship for Southern Vermont Orchard Dam
Table 3.1:	Reservoir Routing Results for Southern Vermont Orchard Dam
Table 3.2:	Curtis Downstream River Crossing
Table 3.3:	Manning's n-Value Coefficients
Table 3.4:	Curtis Pond Dam Breach Parameters
Table 3.5:	Carlton Downstream River Crossings
Table 3.6:	Carlton Reservoir Dam Breach Parameters
Table 3.7:	Kenny Downstream River Crossings
Table 3.8:	Kenny Pond Dam Breach Parameters
Table 3.9:	Southern VT Orchard Downstream River Crossings
Table 3.10:	Southern VT Orchard Dam Breach Parameters
Table 4.1:	Hazard Classification Guidelines
Table 4.2:	Impacted Structures from Sunny Day Breach – Curtis Pond
Table 4.3:	Impacted Houses – Curtis Pond 50% PMF Breach
Table 4.4:	Impacted Structures from Sunny Day Breach – Carlton Reservoir Dam
Table 4.5:	Impacted Structures – Carlton Reservoir 50% PMF Breach
Table 4.6:	Impacted Houses from Sunny Day Breach – Kenny Pond Dam
Table 4.7:	Impacted Structures – Kenny Pond 50% PMF Breach

LIST OF FIGURES

Figure 2.1:	Curtis Pond Dam Site Location
Figure 2.2:	Carlton Reservoir Dam Site Location
Figure 2.3:	Kenny Pond Dam Site Location
Figure 2.4:	Southern Vermont Orchard Dam Site Location
Figure 2.5:	Curtis Pond Dam Soils Map
Figure 2.6:	Curtis Pond Dam Land Use Map
Figure 2.7:	Carlton Reservoir Dam Soils Map
Figure 2.8:	Carlton Reservoir Dam Land Use Map
Figure 2.9:	Kenny Pond Dam Soils Map
Figure 2.10:	Kenny Pond Dam Land Use Map
Figure 2.11:	Southern Vermont Orchard Dam Soils Map
Figure 2.12:	Southern Vermont Orchard Dam Land Use Map
Figure 2.13:	Bathymetric Map for Curtis Pond Dam

Vermont Department of Environmental Conservation

Hazard Class Assessments for: Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern Vermont Orchard Dam

Figure 2.14:	View of Dam and Spillway from Downstream Side (Curtis Pond)
Figure 2.15:	View of Dam and Spillway from Right Abutment (Carlton Reservoir)
Figure 2.16:	View of Dam and Spillway from Downstream Side (Kenny Pond)
Figure 2.17:	View of Auxiliary Dike (Kenny Pond)
Figure 2.18:	View of Dam and Spillway from Left Abutment (Southern VT Orchard Dam)
Figure 3.1:	Curtis Pond Dam Inundation Map
Figure 3.2:	Carlton Reservoir Dam Inundation Map
Figure 3.3:	Kenny Pond Dam Inundation Map
Figure 3.4:	Southern Vermont Orchard Dam Inundation Map
Figure 4.1:	Depth-Velocity Flood Danger for Houses Built on Foundations and Mobile Homes (USBR ACER No. 11)
Figure 4.2:	Peak Flood Profiles for 50% PMF Scenario - Curtis Pond
Figure 4.3:	ACER 11 Plot for Houses Downstream of Curtis Pond – 50% PMF Breach
Figure 4.4:	Breach Depth vs. Non-Breach Depth for Impacted Houses – Curtis Pond 50% PMF
Figure 4.5:	Peak Flood Profiles for 50% PMF Scenario – Carlton Reservoir Dam
Figure 4.6:	ACER 11 Plot for Houses/Mobile Homes Downstream of Carlton Reservoir – 50% PMF Breach
Figure 4.7:	Breach Depth vs Non-Breach Depth for Impacted Houses – Carlton Reservoir Dam 50% PMF
Figure 4.8:	ACER 11 Plot for Sunny Day Impacted Houses/Mobile Homes – Kenny Pond Dam
Figure 4.9:	Peak Flood Profiles for 50% PMF Scenario – Kenny Pond Dam
Figure 4.10:	ACER 11 Plot 50% PMF Impacted Houses/Mobile Homes – Kenny Pond Dam
Figure 4.11:	Breach Depth vs Non-Breach Depth for Impacted Houses – Kenny Pond Dam 50% PMF

1.0 INTRODUCTION AND BACKGROUND

This report presents the results of a hydrologic and hydraulic analysis performed by **SCHNABEL ENGINEERING, LLC** (Schnabel) for four dams in Vermont for the purposes of developing opinions of the appropriate hazard classification for each facility. These dams include: Curtis Pond Dam, Carlton Reservoir Dam, Kenny Pond Dam, and Southern Vermont Orchard Dam. A detailed hazard class assessment was performed for each Dam using a 2-Dimensional (2D) dam breach hydraulic model.

A site visit was performed on April 4th and April 5th, 2019 during which Schnabel staff observed the Dams, watershed, and downstream drainageway including road and railroad crossings and adjacent residential/commercial structures. Note that Kenny Pond Dam was not observed due to inaccessible roadways. Previous studies and other information regarding the dams were received from VT DEC Dam Safety Program.

All elevations listed in this report are referenced to the North American Vertical Datum of 1988 (NAVD 88) unless noted otherwise. The abbreviation “EL” represents Elevation. The terms “right” and “left” are referenced as one looking downstream.

A brief description of each facility is provided below.

1.1 Curtis Pond Dam

Curtis Pond Dam is located by Worcester Road in Calais, Vermont. Before the dam was constructed, there were originally two separate ponds located along an un-named tributary to Pekin Brook. Curtis Pond Dam was constricted circa 1900 which raised water levels approximately 10-ft and combined the two smaller ponds together. Curtis Pond Dam is composed of laid up masonry stone with a sand and gravel embankment. Based on a 2004 Engineering Study and Evaluation the maximum height of the dam is approximately 11-ft and the length is approximately 120-ft; this is generally consistent with field measurements and topographic mapping. Based on bathymetric mapping, the dam impounds approximately 740 acre-ft at normal pool and approximately 850 acre-ft at the dam crest. Note that this includes storage at depths greater than the height of the dam and would not be released following a failure of the dam. The Hazard Classification of Curtis Pond Dam is currently Significant.

1.2 Carlton Reservoir Dam

Carlton Reservoir Dam is located by Carlton Hill Road in Woodstock, Vermont. The dam was originally constructed on an unnamed tributary to the Ottauquechee River to be used for water supply by the Woodstock Aqueduct Company, however it is no longer used as a drinking water source. The Dam is comprised of an earthen embankment with a concrete outer slab on the upstream face resting on concrete buttresses, generally an ambursen type structure. The Dam is approximately 197-ft long with a maximum height of approximately 20-ft. The service spillway consists of an 8-in PVC pipe slip-lined inside a 10-in pipe. A concrete auxiliary spillway exists on the right side of the Dam approximately 10-ft wide and has a crest elevation of approximately 2-ft below the top of dam. Based on topographic mapping and aerial imagery normal pool storage was computed to be approximately 6 acre-ft and the

maximum storage was computed to be approximately 34 acre-ft. The Hazard Classification of Carlton Reservoir Dam is currently Significant.

1.3 Kenny Pond Dam

Kenny Pond Dam is an earth embankment dam with a principal spillway and a small earth stone masonry auxiliary dike has been identified along the northeast corner of the pond. The dam does not appear to have a low-level outlet (LLO). The dam is currently classified as a significant hazard. According to file information, the dam has a total length of approximately 100 feet and a structural height of 12 feet. The upstream slope is riprap armored and inclined at approximately 2H:1V. The crest consists of an approximately 50-foot-wide section, with a grassed lawn area on the upstream side and an approximately 20-foot-wide gravel surfaced town road (Newfane Hill Road) along the downstream side. The downstream face of the dam consists of a dry-laid stone wall. The principal spillway is located near the middle of the dam and consists of a mortared stone and concrete lined channel that transitions to a stone culvert under the road. Kenny Pond at normal pool has a surface area of approximately 20 acres. The normal and maximum storage capacities of the dam are approximately 75 acre-feet and 135 acre-feet, respectively. The dam was reportedly constructed circa 1900. A repair was made to the floor slab of the principal spillway in 2013.

1.4 Southern Vermont Orchard Dam

Southern Vermont Orchard Dam is located on a small unnamed tributary to Jewitt Brook in Bennington, Vermont. The Dam consists of an earthen embankment with a principal spillway, two auxiliary spillways, and a low level outlet (LLO). The principal spillway consists of a 30-in diameter corrugated metal pipe (CMP) riser with a 24-in CMP outlet barrel. Both auxiliaries are grass-lined channels trapezoidal in shape and approximately 30-ft wide at the base. The LLO is a 3-in diameter water supply pipe, however it is not clear if it is currently operable. The Dam has a length of approximately 440-ft and a maximum height of 17-ft. Based on topographic mapping and aerial imagery the storage at normal pool was computed to be approximately 10 acre-ft and the maximum storage is approximately 25 acre-ft. The reservoir is used for irrigation and there is a pump station located in the left auxiliary channel. The Hazard Classification of Southern Vermont Orchard Dam is currently Low.

2.0 HYDROLOGIC MODEL DEVELOPMENT

2.1 Hydrologic Model Development

The U.S Army Corps of Engineers (USACE) HEC-HMS Version 4.2.1 hydrologic model was used to conduct a hydrologic analysis of the watershed. The Soil Conservation Service (SCS) Curve Number (CN) methodology was used to simulate hydrologic losses including infiltration and abstraction, and the Snyder Unit Hydrograph methodology was used to represent the rainfall/runoff response of the watershed.

2.1.1 Watershed Area and Hydrologic Parameters

2.1.1.1 Watershed Area

The watershed tributary for each Dam was delineated using the USGS StreamStats web application. See Table 2.1 for watershed sizes. Each Dam was represented as a single sub-basin in its own HEC-HMS model. The watershed for each dam overlain on USGS topographic mapping is included as Figures 2.1-2.4.

Table 2.1: Watershed Area

Dam	Watershed Area (sq. mi)
Curtis Pond	1.29
Carlton Reservoir	0.13
Kenny Pond	0.38
Southern VT Orchard	0.29

2.1.1.2 SCS CN

A weighted SCS curve number (CN) was computed for each basin using ArcMap Version 10.5 Geographic Information Systems (GIS) software coupled with available soil and land use mapping for the watershed. Soil data was obtained from the Soil Survey Geographic Database (SSURGO), and land use data is from the 2014 edition of the National Land Classification Database of 2011 (NLCD, 2011).

The Natural Resources Conservation Service (NRCS) classifies soils into four hydrologic groups: Type A, B, C, and D soils. The Type A soils have high infiltration capacity and typically consist of coarse sands, while Type D soils have very low infiltration capacity and typically consist of clays. Some soils are classified as two types such as, A/D, B/D and C/D, which reflect areas with a shallow groundwater table and infiltration capacity that is dependent on the antecedent moisture condition. As the hydrologic analysis is based on extreme rainfall events, these soil groups were conservatively treated as Soil Type D in the CN calculation. Figures 2.5 – 2.12 present the hydrologic soils groups and land cover overlain on the watershed topographic mapping.

According to the data, the Curtis Pond watershed is composed predominantly of Type D soils with some areas of Type C soils scattered throughout the watershed (Figure 2.5). The majority of the watershed consists of forested areas with some low intensity residential sections on the northern part of the basin (Figure 2.6). The weighted curve number for the Curtis Pond watershed was calculated to be 78.7.

Carlton Reservoir watershed shows that over 95% of the watershed is composed of Type D soils, with a small section of Type C soils in the northwest corner (Figure 2.7). The majority of the watershed consists of forested regions with some small sections of low intensity residential areas (Figure 2.8). The weighted curve number for the Carlton Reservoir watershed was calculated to be 77.9.

The Kenny Pond watershed is the most diverse with over half of the soils as Type B and some Type C and D soils throughout the watershed (Figure 2.9). Similarly to Curtis and Carlton, the Kenny Pond watershed consists of forested areas with some small sections of low intensity residential close to the Pond (Figure 2.10). The weighted curve number for the Kenny Pond watershed was calculated to be 66.9.

Southern Vermont Orchard watershed is primarily Type C soils with a small section of Type A soils close to the reservoir and another small section of Type D soils on the eastern edge of the watershed (Figure 2.11). The watershed is predominately deciduous forest and apple orchard zones (Figure 2.12). The weighted curve number for the Southern Vermont Orchard watershed was calculated to be 68.4.

2.1.1.3 Snyder Unit Hydrograph Methodology

The HEC-HMS model uses two parameters to define the runoff characteristics of a watershed when using the Snyder Unit Hydrograph methodology: Standard Lag (T_L), and Peaking Coefficient (C_p).

The Standard Lag Time (T_L) was computed using the Snyder watershed lag equation:

$$T_L = C_t(L \times L_{ca})^{0.3}$$

Where:

C_t = Coefficient representing variations in watershed topography

L = Length along main stream to basin divide (mi)

L_{ca} = Length along main stream to watershed centroid (mi)

Typical values of C_t range from 1.8 – 2.2. As lake levels during historic storm events were not available to calibrate hydrologic parameters, a value of 2.0 was used in the HEC-HMS hydrologic models.

The Lag Time (T_L) for each sub-basin was computed using this estimated value of C_t as well as lengths for the Longest Flow Path (L) and Centroidal Flow Path Length (L_{ca}). A Snyder Peaking Coefficient (C_p) of 0.6 was used which is in the middle of the typical range for C_p of 0.4 - 0.8. Table 2.2 summarizes the model parameters used in the hydrologic model.

Table 2.2: Hydrologic Model Parameters

Watershed	Area (sq mi)	CN	L (mi)	L_{ca} (mi)	C_t	T_L (hr)	C_p
Curtis Pond	1.29	78.7	1.77	0.8	2.0	2.2	0.6
Carlton Reservoir	0.13	77.9	0.5	0.2	2.0	1.0	0.6
Kenny Pond	0.38	66.9	0.6	0.3	2.0	1.2	0.6
Southern VT Orchard	0.29	68.4	1.1	0.42	2.0	1.6	0.6

2.1.2 Design Storm Peak Flow Analysis

Curtis Pond, Carlton Reservoir, and Kenny Pond are currently classified as Significant Hazard structures. The current regulatory prescriptive design storm for a Significant Hazard dam in Vermont is to be able to safely pass between the 100-year storm and 50% of the Probable Maximum Flood (PMF). However, upcoming Dam Safety rules are currently contemplating a prescriptive design storm of the 1,000-year storm event. NOAA's Hydrometeorological *Report No. 51* (HMR-51) was used to develop Probable Maximum Precipitation (PMP) rainfall depths and durations and the HEC-HMS was used to develop the HMR-52 distribution for the 72-hour PMP. Southern Vermont Orchard Dam is currently a Low Hazard structure and the applicable prescriptive design storm is the 100-year storm event.

Site-specific design rainfall depths for each watershed were obtained from National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 for the 10-year, 100-year, and 500-year storm with an SCS Type II distribution. The Significant Hazard Dam models were also analyzed for the 50% PMF (Table 2.3).

Note the 50% PMF peak flow is obtained by developing the runoff hydrograph for the full PMF and then multiplying the inflow hydrograph by 0.5. The rainfall depth for the 50% PMF in Table 2.3 represents the full 72-hr PMP while the other storm events are 24-hour.

Table 2.3: HEC-HMS Hydrologic Model Summary

Watershed	Storm	Rainfall Depth (in)	Peak Inflow (cfs)
Curtis Pond	10-year	3.7	221
	50-year	5.05	376
	100-year	5.7	454
	500-year	7.6	690
	1000-year	8.6	822
	50% PMF	31.0	1,744
Carlton Reservoir	10-year	4.0	47
	50-year	5.4	77
	100 year	6.0	90
	500-year	7.7	130
	1000-year	8.5	150
	50% PMF	33.2	330
Kenny Pond	10-year	4.3	71
	50-year	5.8	135
	100-year	6.5	166
	500-year	8.5	262
	1000-year	9.4	310
	50% PMF	34.6	801
Southern VT Orchard	10-year	4.2	48
	50-year	5.7	90
	100-year	6.4	111
	500-year	8.2	173
	1000-year	9.1	205

2.2 Curtis Pond Hydrologic Routing

Since the current Hazard Class for Curtis Pond is Significant, the prescriptive spillway design flood (SDF) is between the 100-year storm and the 50% PMF. However new dam safety rules are contemplating a prescriptive SDF at the 1,000 year storm. The HEC-HMS model was used to route the inflow design hydrographs through Curtis Pond based on the stage-vs-storage and spillway characteristics described in Sections 2.21 and 2.2.2, respectively.

2.2.1 Curtis Pond Stage-vs-Storage Relationship

A bathymetric map for Curtis Pond was provided by VT DEC. The bathymetry was developed in May 2018 by the Watershed Management Division Lakes and Ponds Program (Figure 2.13). The map was imported and scaled in AutoCAD Civil 3D (2018) to digitize the depth contour. Normal pool was assumed to be 1217.8 from the LiDAR based DEM. Note that the bathymetric map shows two distinct ponds with depths up to 31 ft, separated by a shallow channel with depths less than 4 ft. Also note that with a maximum dam height of approximately 11 ft, there is considerable “dead storage” that would not be

released if the dam were to fail. The digitized bathymetry was combined with the base DEM to create a combined terrain model for application in the HEC-RAS 2D model. Table 2.4 shows the stage-storage relationships derived from the bathymetry combined with LiDAR derived DEM data. The minimum dam crest elevation is approximately EL 1219.3.

Curtis Pond, Calais, VT

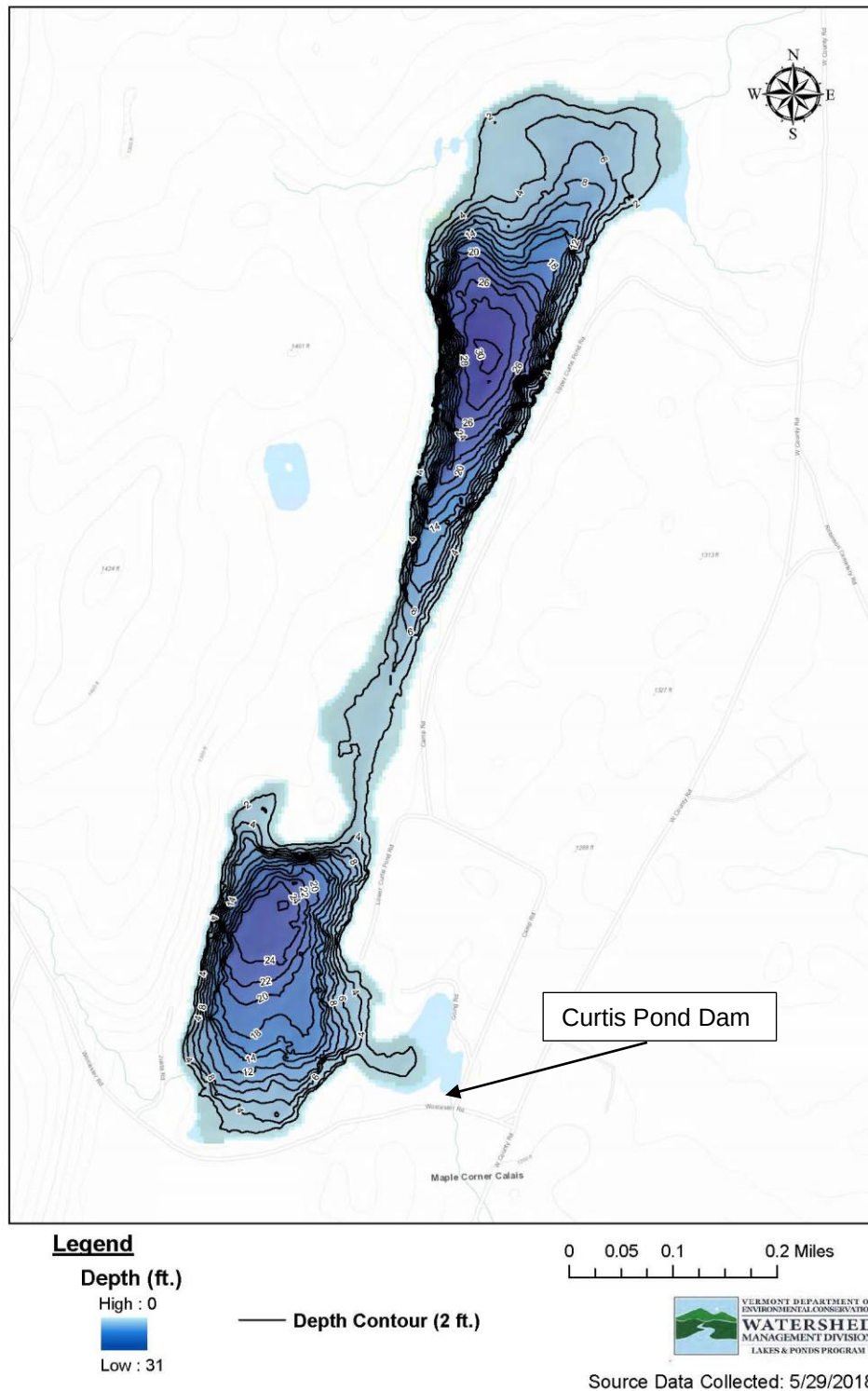


Figure 2.13 – Bathymetric Map for Curtis Pond Dam

Table 2.4: Stage-vs-Storage Relationship for Curtis Pond

Elevation	Area (acre)	ΔV (acre-ft)	Cumulative Volume (acre-ft)
1187.8	0.3	0.0	0
1191.8	4.1	7.3	7.35
1197.8	13.3	49.6	56.94
1205.8	26.7	156.9	213.89
1208	31.0	63.5	277.38
1210	35.2	66.2	343.54
1212	40.8	75.9	419.45
1214	48.7	89.4	508.83
1216	60.5	109.0	617.81
1217.8	75.8	122.4	740.20
1218	76.3	15.2	755.40
1219	78.8	77.5	832.95
1220	82.0	80.4	913.34
1221	84.9	83.4	996.78

1) Normal Pool Elevation assumed to be EL 1217.8

2) Areas below NWL estimated from bathymetric mapping by Vermont DEC

3) Minimum Dam Crest ~ EL 1219.3

2.2.2 Curtis Pond Spillway

Based on the information provided from VT DEC and the field measurements performed by Schnabel, the spillway has a crest elevation of approximately 1217.8 and is approximately 5-ft in length. Based on the DEM data, the crest of the dam has a minimum elevation of approximately EL 1219.3, providing an effective weir head of approximately 1.5-ft before the dam would overtop. The spillway was represented in the HEC-HMS hydrologic model and HEC-RAS hydraulic model with a weir coefficient of 2.65. A photograph of the dam and spillway is presented in Figure 2.14 below.



Figure 2.14 – View of Dam and Spillway from Downstream Side

2.2.3 Curtis Pond Reservoir Routing Results

A summary of the peak flows and reservoir pool elevation for each design storm event is provided in Table 2.5. Note that the 10-Year through 1,000-Year results are from HEC-HMS while the 50% PMF is from HEC-RAS to account for potential tailwater impacts on spillway flows. The peak discharge indicates that there is a lot of attenuation of flood flows likely due to the large reservoir and small watershed size. Currently the spillway is not in compliance since the dam overtops during the 50-year event, well before the SDF.

Table 2.5: Reservoir Routing Results for Curtis Pond Dam

Storm	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Reservoir Elevation (ft)	Freeboard ¹ (ft)
10-Year	221	18	1219.0	0.3
50-Year	376	80	1219.6	-0.3
100-Year	454	128	1219.7	-0.4
500-Year	690	293	1220.1	-0.8
1000-Year	822	394	1220.3	-1.0
50% PMF	1,744	533	1221.6	-2.3

¹Based on minimum dam crest EL 1219.3 per LiDAR DEM

2.3 Carlton Reservoir Hydrologic Routing

The current Hazard Class for Carlton Reservoir is Significant, therefore the current spillway design flood (SDF) is between the 100-year storm and the 50% PMF. However, new dam safety rules are

contemplating a prescriptive SDF of the 1,000-year storm. The HEC-HMS model was used to route the inflow design hydrographs through Carlton Reservoir based on the stage-vs-storage and spillway characteristics described in Sections 2.3.1 and 2.3.2, respectively.

2.3.1 Carlton Reservoir Stage-vs-Storage Relationship

A bathymetric map was not available for Carlton Reservoir so normal pool storage was computed based on a normal pool elevation of EL 1053.7 (per LiDAR DEM) and an assumed bottom elevation of EL 1044, which is lowest embankment contour at the downstream toe of the dam. This normal pool was assumed as it appears to be the current and static normal pool based in the current dam configuration. The level appears to possibly be lower than the historic normal pool level at the site. Areas at normal pool and at contours above normal pool were measured in AutoCAD Civil 3D 2018 and used to develop the stage-vs-storage relationship for Carlton Reservoir. Based on the DEM and field measurements, the crest of the concrete dam is estimated to be EL 1064.7 and the crest of the auxiliary spillway is estimated to be at EL 1062.7. Note that the estimated volume at normal pool of approximately 5.7 acre-ft is significantly lower than the value of 21 acre-ft listed in previous inspection reports. The computed maximum storage of approximately 35 acre-ft is slightly larger than the value of 27 acre-ft listed in previous inspection reports (Table 2.6).

Table 2.6: Stage-vs-Storage Relationship for Carlton Reservoir

Elevation	Area (acre)	ΔV (acre-ft)	Cumulative Volume (acre-ft)
1044	0.0	0.0	0
1053.7	1.8	5.7	5.7
1054	1.8	0.5	6.3
1056	2.2	4.0	10.3
1058	2.5	4.7	15.0
1060	2.8	5.2	20.2
1062	3.0	5.8	26.0
1062.7	3.1	2.2	28.2
1064	3.3	4.2	32.3
1066	3.4	6.7	39.0

Notes:

- 1) Normal Pool Elevation assumed to be 1053.7 per DEM
- 2) Areas at and above 1053.7 measured from LiDAR based DEM
- 3) Crest of Concrete Dam assumed to be 1064.7

2.3.2 Carlton Reservoir Spillway

The principal spillway at Carlton Reservoir is reportedly an 8-inch diameter drop inlet with a crest elevation of EL.1053.7. The auxiliary spillway was assumed to have a crest elevation of 1062.7 based on field measurement from normal pool to spillway crest and is approximately 10-ft in length. The elevation difference between the auxiliary spillway crest and the top of the dam is approximately 2 ft. A weir coefficient of 3.3 was used for the auxiliary spillway and the primary spillway was modeled as a culvert outlet. A photograph of the dam and spillways are presented in Figure 2.15 below.



Figure 2.15 – View of Dam and Spillway from Right Abutment

2.3.3 Carlton Reservoir Hydrologic Routing Results

A summary of the peak flows and reservoir pool elevation for each design storm event is provided in Table 2.7.

Table 2.7: Reservoir Routing Results for Carlton Reservoir Dam

Storm	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Reservoir Elevation (ft)	Freeboard¹ (ft)
10-Year	47	3.5	1058.1	6.6
50-Year	77	4.3	1060.7	4.0
100-Year	90	5	1061.9	2.8
500-Year	130	23	1063.3	1.4
1000-Year	150	39	1063.7	1.0
50% PMF	330	328	1065.2	-0.8

¹Based on low assumed dam crest elevation of EL 1064.7

2.4 Kenny Pond Hydrologic Routing

Kenny Pond Dam is currently regulated as a Significant Hazard facility and the current prescriptive spillway design flood (SDF) is between the 100-year storm and the 50% PMF. However, new dam safety rules are contemplating a prescriptive SDF of the 1,000-year storm. The HEC-HMS model was used to route the inflow design hydrographs through Kenny Pond based on the stage-vs-storage and spillway characteristics described in Sections 2.4.1 and 2.4.2, respectively.

2.4.1 Kenny Pond Stage-vs-Storage Relationship

A bathymetric map was not available for Kenny Pond so normal pool storage was assumed to be 75 acre-ft, which is based on previous inspection reports provided by Vermont DEC. Based on the LiDAR derived DEM data, normal pool was assumed to be at EL1249.0 and the bottom of reservoir was estimated to be at EL 1240, which is the lowest contour on the downstream side of the dam. Areas at elevations above normal pool were estimated based on the DEM to develop the stage-vs-storage relationship for Kenny Pond Dam. The crest of the dam ranges from approximately EL 1252.1 to EL 1253.2. The estimated storage at the minimum crest elevation of the dam of approximately 140 acre-ft is close to the maximum storage of 135 acre-ft listed in previous inspection reports (Table 2.8).

Table 2.8: Stage-vs-Storage Relationship for Kenny Pond

Elevation	Area (acre)	ΔV (acre-ft)	Cumulative Volume (acre-ft)
1240	0.0	0.0	0
1249	19.5	61.5	75.00
1250	20.4	20.0	94.97
1251	22.1	21.3	116.23
1252	23.5	22.8	139.00
1253	24.8	24.1	163.14
1254	26.3	25.6	188.70
1255	27.7	27.0	215.68

Notes:

- 1) Normal Pool Elevation assumed to be 1249.0 per DEM
- 2) Areas at and above 1249.0 measured from LiDAR based DEM
- 3) Crest of Dam assumed to be between 1252.1 and 1253.2

2.4.2 Kenny Pond Spillway

Due to snow cover and road closures, Schnabel was unable to perform a field visit at Kenny Dam itself but was able to observe the downstream drainageway. However, photographs of the Dam were provided by VT DEC. Based on the information provided, the principal spillway starts with a stone masonry approach channel and transitions to a 2.6-ft x 1.8-ft stone-lined culvert beneath Newfane Hill Rd, which traverses the dam crest. Based on the DEM, the upstream end of the spillway culvert was assumed to be at EL 1249.0. A photograph of the dam and spillway is presented in Figure 2.16 below.



Figure 2.16 – View of Dam and Spillway from Downstream Side

Previous inspection reports also noted a remote auxiliary spillway/dike located at the northeast end of the reservoir. The dike is reported to be a laid-stone and earthen embankment with heights up to approximately 4 ft. Vermont DEC provided photos of this auxiliary structure and collected field measurements to estimate the crest elevation of the structure. Based on this data, the low point along the dike is at approximately EL 1250.7 with the majority of the structure above EL 1252, which is close to the crest elevation of the main dam. A picture of a portion of this auxiliary dike is presented in Figure 2.17.



Figure 2.17 – View of Auxiliary Dike

2.4.3 Kenny Pond Reservoir Routing Results

A summary of the HEC-HMS predicted peak flows and reservoir pool elevation for each design storm event is provided in Table 2.9.

Table 2.9: Reservoir Routing Results for Kenny Pond Dam

Storm	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Reservoir Elevation (ft)	Freeboard ² (ft)
10-Year	71	7	1250.0	2.1
50-Year	135	16	1250.7	1.4
100-Year	166	20	1251.0	1.1
500-Year	262	38	1251.9	0.2
1000-Year	310	56	1252.3	-0.2
50% PMF	801	698 ¹	1253.5	-1.4

¹Outflow includes approximately 245 cfs over auxiliary dike

²Based on low crest EL 1252.1 per LiDAR

2.5 Southern Vermont Orchard Dam Hydrologic Routing

The Southern Vermont Orchard Dam is currently regulated as a Low Hazard facility and the current spillway design flood (SDF) is the 100-year storm. The HEC-HMS model was used to route the inflow design hydrographs through Southern Vermont Orchard Pond based on the stage-vs-storage and spillway characteristics described in Sections 2.5.1 and 2.5.2, respectively.

2.5.1 Reservoir Stage-vs-Storage Relationship

A bathymetric map was not available for Southern Vermont Orchard Pond so the normal pool storage volume of 9.7 acre-ft was estimated based upon the 1963 permit application for the dam. Normal pool elevation was assumed to be at EL1074.1 from the DEM and the bottom elevation of 1063 was based on the maximum depth of water at normal pool listed in the dam permit application. The volumes at elevations above normal pool were estimated based on the DEM data. The dam crest elevation generally varies between EL 1079.4 and 1079.9 (Table 2.10).

Table 2.10: Stage-vs-Storage Relationship for Southern Vermont Orchard Dam

Elevation	Area (acre)	ΔV (acre-ft)	Cumulative Volume (acre-ft)
1063	0.0	0.0	0
1074.1	2.4	9.7	9.7
1075	2.4	2.1	11.8
1076	2.6	2.5	14.3
1077	2.9	2.8	17.1
1078	3.2	3.0	20.1
1079	3.6	3.4	23.5
1080	4.1	3.9	27.4

Notes:

- 1) Normal Pool Elevation assumed to be 1074.1 per DEM
- 2) Areas at and above 1074.1 measured from LiDAR based DEM
- 3) Crest of Concrete Dam assumed to be 1079.3
- 4) Volume at Normal pool set to value in dam permit application

2.5.2 Reservoir Stage-vs-Discharge Relationship

Based on the information provided and the field survey performed by Schnabel, the principal spillway is a 30-in CMP riser connected to a 24-inch CMP outlet pipe. The first auxiliary spillway at the left abutment has an average crest elevation of 1075.7 and the second auxiliary spillway at the right abutment has an average crest elevation of 1075.0. Each earthen auxiliary spillway sections have a bottom width of approximately 30-ft in length with side slopes at approximately 5H:1V. The auxiliary spillways were represented in the HEC-HMS model with a weir coefficient of 2.6. A photograph of the dam and right auxiliary spillway is presented in Figure 2.18 below.



Figure 2.18 – View of Dam and Spillway from Left Abutment

2.5.3 Southern Vermont Orchard Dam Reservoir Routing Results

A summary of the peak flows and reservoir pool elevation for each design storm event is provided in Table 3.1.

Table 3.1: Reservoir Routing Results for Southern Vermont Orchard Dam

Storm	Peak Inflow (cfs)	Peak Outflow (cfs)	Peak Reservoir Elevation (ft)	Freeboard¹ (ft)
10-Year	48	44	1075.5	3.9
50-Year	90	88.4	1075.8	3.6
100-Year	111	110	1075.9	3.5
500-Year	173	172	1076.2	3.2
1000-Year	205	203	1076.3	3.1
50% PMF	546	545	1077.2	2.2

¹Based on low EL 1079.4 per LiDAR and field survey

3.0 DAM BREACH HYDRAULIC ANALYSIS

In an effort to assess the hazard classification for each Dam, Schnabel conducted a detailed dam breach analysis and inundation mapping of the downstream drainageway. The U.S. Army Corps of Engineers HEC-RAS Hydraulic Model (Version 5.0.7) was used to simulate the breach and non-breach scenarios. The inflow hydrographs derived from the HEC-HMS model were used as inflow hydrographs to the HEC-RAS model, and then routed through the Dam and the downstream drainageway utilizing a 2D mesh. The scenarios analyzed include a Sunny Day Breach, as well as breach and non-breach scenarios for the SDF depending on the Hazard class of each Dam.

3.1 Curtis Pond Dam HEC-RAS 2D Breach Analysis

As detailed bathymetry was available for Curtis Pond, the 2D mesh extended from the north end of the reservoir downstream approximately 1.7 miles to the confluence with the Pekin Brook. The entire reservoir was included in the hydraulic model to capture the influence on the shallow channel connecting the two pond areas as well as to represent any tailwater conditions that could limit breach outflows. There are 7 road crossings and two small run-of river dams that were included in the HEC-RAS model based on aerial imagery supplemented with topographic mapping and field reconnaissance by Schnabel staff. A list of the structures and the distance downstream from the dam is provided in Table 3.2.

Table 3.2: Curtis Downstream River Crossings

Road Crossing	Distance Downstream (mi)
Worcester Rd	0
Run of River Dam	0.05
West County Rd	0.1
Kent Hill Rd 1	0.5
Kent Hill Rd 2	0.7
Robinson Dam	0.8
Robinson Cemetery Rd	0.8
Kent Hill Rd 3	1
Singleton Rd	1.7

The 2D mesh was developed from a LiDAR based 0.7-meter Digital Elevation Model (DEM) with an average cell size of 25 ft by 25 ft. Break lines were used to refine the base mesh and provide finer resolution along the river and the structures crossing the river. An internal boundary condition was used along the stream centerline to simulate flow from downstream sub-basins. The 100 year peak flow was determined from the USGS StreamStats web application for the downstream sub-basin. For the downstream area of Curtis Pond, the peak flow was determined to be 111 cfs. This flow was entered as a constant value in HEC-RAS. The mesh utilized Manning's n-values based upon the 2011 National Land Classification Database (NLCD) and are summarized in Table 3.3.

Table 3.3: Manning's n-Value Coefficients

Land Use Number	Land Use Description	Manning's n
11	Open Water	0.02
21	Developed, Open Space	0.04
22	Developed Low Intensity	0.04
23	Developed Medium Intensity	0.05
24	Developed High Intensity	0.06
31	Barren land rock/sand/clay	0.05
41	Deciduous Forest	0.12
42	Evergreen Forest	0.14
43	Mixed Forest	0.11
52	Shrub/Scrub	0.07
71	Grassland, Herbaceous	0.07
81	Pasture/Hay	0.07
82	Cultivated Crops	0.06
90	Woody Wetlands	0.1
95	Emergent Herbaceous Wetlands	0.1

3.1.1 Curtis Breach Analysis and Inundation Mapping

The Dam breach analyses were conducted for a Sunny Day breach scenario as well as for rainy day scenarios during the 50% PMF. Table 3.4 provides a summary of the parameters used for each of the breach and non-breach runs as well as the peak discharge flows for each run. The breach parameters were selected based on evaluation of the Froehlich 1995 and 2008 methodologies as well as site specific constraints and general parameter ranges as recommended by FEMA, FERC, COE and the USBR.

Table 3.4: Curtis Pond Dam Breach Parameters

Parameter	Sunny Day Breach	50% PMF No Breach	50% PMF Breach
Breach Type	Piping	n/a	Overtopping
Top of Dam Elevation (ft)	1219.3	1219.3	1219.3
Bottom of Beach Elevation (ft)	1208	n/a	1208
Bottom Width (ft)	15	n/a	20
Side Sloped (H:1V)	1	n/a	1
Breach Weir Coefficient	2.6	n/a	2.6
Max. Pool Elevation (ft)	1217.8	1221.2	1221.2
Breach Formation Time (hrs)	0.25	n/a	0.25
Peak Outflow (cfs)	887	497	2,896

Note that there is a small dam located approximately 300 ft downstream of Curtis Pond Dam. Based on the LiDAR, the Dam was found to have a maximum storage capacity of approximately 1 acre-ft. Due to this limited impoundment volume, the failure of this dam would not significantly increase downstream flows; therefore a cascading failure was not simulated in the model. Note that the results for the 50% PMF no breach scenario are slightly different than presented in Section 2.2 and can be attributed to the differences in routing between the HEC-HMS hydrologic model and the 2D HEC-RAS hydraulic model.

The results of the HEC-RAS 2D dam breach analyses are depicted graphically on Figure 3.1 for the Sunny Day and 50% PMF non breach and breach scenarios. The inundation boundaries were exported from HEC-RAS Mapper and overlain in a GIS environment over recent aerial imagery.

3.2 Carlton Reservoir Dam HEC-RAS 2D Breach Analysis

The 2D model for Carlton Reservoir Dam extended from the downstream toe of the dam, downstream approximately 0.7 miles to the confluence with the Ottauquechee River. Carlton Reservoir was represented in the model as a storage area connected to the downstream 2D mesh by an SA/2D area connection representing Carlton Reservoir Dam. There are 5 road crossings along the reach that were

included in the HEC-RAS model based on aerial imagery supplemented with topographic mapping and field reconnaissance by Schnabel staff. A list of the structures and the distance downstream is provided in Table 3.5.

Table 3.5: Carlton Downstream River Crossings

Road Crossing	Distance Downstream (mi)
Grove Hill Rd	0.05
Carlton Hill Rd (1)	0.4
Carlton Hill Rd (2)	0.55
Driveway	0.6
Carlton Hill Rd (3)	0.7

The 2D mesh was developed from a LiDAR based 0.7-meter Digital Elevation Model (DEM) with an average cell size of 20 ft by 20 ft. Break lines were used to refine the base mesh and provide finer resolution along the river and the structures crossing the river. An internal boundary condition was used along the stream centerline to simulate flow from downstream sub-basins. The 100 year peak flow was determined from the USGS StreamStats web application for the downstream sub-basin. For the downstream area of Carlton Reservoir, the peak flow was determined to be 54 cfs. This flow was entered as a constant value in HEC-RAS. The mesh utilized Manning's n-values based upon the 2011 National Land Classification Database (NLCD) (See Table 3.3 in Section 3.1).

3.2.1 Carlton Breach Analysis and Inundation Mapping

The Dam breach analyses were conducted for a Sunny Day breach scenario as well as for rainy day scenarios during the 50% PMF. Table 3.6 provides a summary of the parameters used for each of the breach and non-breach runs as well as the peak discharge flows for each run.

Table 3.6: Carlton Reservoir Dam Breach Parameters

Parameter	Sunny Day Breach	50% PMF No Breach	50% PMF Breach
Breach Type	Piping	n/a	Overtopping
Top of Dam Elevation (ft)	1064.7	1064.7	1064.7
Bottom of Beach Elevation (ft)	1044	n/a	1044
Bottom Width (ft)	15	n/a	20
Side Sloped (H:1V)	0.7	n/a	1
Breach Weir Coefficient	2.6	n/a	2.6
Max. Pool Elevation (ft)	1053.7	1065.1	1065.1
Breach Formation Time (hrs)	0.2	n/a	0.25
Peak Outflow (cfs)	351	314	3,035

The results of the HEC-RAS 2D dam breach analyses are depicted graphically on Figure 3.2 for the Sunny Day and 50% PMF non breach and breach scenarios. The inundation boundaries were exported from HEC-RAS Mapper and overlain in a GIS environment over recent aerial imagery.

3.3 Kenny Pond Dam HEC-RAS 2D Breach Analysis

The 2D model for Kenny Pond Dam extended from the downstream toe of the dam, downstream approximately 4 miles to the confluence with the Rock River. Kenny Pond was represented in the model as a storage area connected to the downstream mesh with an SA/2D Area connection representing Kenny Pond Dam. Note that the model also included the auxiliary dike based upon field measurements provided by Vermont DEC. The dike was represented as a SA/2D Area connection and was connected to a supplemental 2D mesh. There are 5 road crossings along the reach that were included in the HEC-RAS model based on aerial imagery supplemented with topographic mapping and field reconnaissance by Schnabel staff. A list of the structures and the distance downstream is provided in Table 3.7.

Table 3.7: Kenny Downstream River Crossings

Road Crossing	Distance Downstream (mi)
Wooden Bridge 1	1.5
Wooden Bridge 2	1.7
Beetlestone Hill Rd	2.6
Parish Hill Rd	3.2
Dover Rd	4

The 2D mesh was developed from a LiDAR based 0.7-meter Digital Elevation Model (DEM) with an average cell size of 50 ft by 50 ft. Break lines were used to refine the base mesh and provide finer resolution along the river and the structures crossing the river. An internal boundary condition was used along the stream centerline to simulate flow from downstream sub-basins. The 100 year peak flow was determined from the USGS StreamStats web application for the downstream sub-basin. For the downstream area of Kenny Pond, the peak flow was determined to be 2,115 cfs. This flow was entered as a constant value in HEC-RAS. This approach distributes the peak flow along the entire downstream reach. The mesh utilized Manning's n-values based upon the 2011 National Land Classification Database (NLCD) (See Table 3.3 in Section 3.1).

3.3.1 Kenny Breach Analysis and Inundation Mapping

The Dam breach analyses were conducted for a Sunny Day breach scenario as well as for rainy day scenarios during the 50% PMF. Table 3.8 provides a summary of the parameters used for each of the breach and non-breach runs as well as the peak discharge flows for each run.

Table 3.8: Kenny Pond Dam Breach Parameters

Parameter	Sunny Day Breach	50% PMF No Breach	50% PMF Breach
Breach Type	Piping	n/a	Overtopping
Top of Dam Elevation (ft)	1252.1	1252.1	1252.1
Bottom of Beach Elevation (ft)	1240	n/a	1240
Bottom Width (ft)	28	n/a	30
Side Sloped (H:1V)	0.7	n/a	0.5
Breach Weir Coefficient	2.6	n/a	2.6
Max. Pool Elevation (ft)	1249	1253.4	1253.4
Breach Formation Time (hrs)	0.4	n/a	0.5
Peak Outflow (cfs)	1,252	433	3,151

The results of the HEC-RAS 2D dam breach analyses are depicted graphically on Figure 3.3 for the Sunny Day and 50% PMF non breach and breach scenarios. The inundation boundaries were exported from HEC-RAS Mapper and overlain in a GIS environment over recent aerial imagery.

3.4 Southern Vermont Orchard Dam HEC-RAS 2D Breach Analysis

The 2D model for the Southern Vermont Orchard Dam extended from the downstream toe of the dam, downstream approximately 0.75 miles to just downstream of Fuller Rd. The reservoir was represented as a storage area connected to the 2D mesh by a SA/2D Area connection representing the dam and auxiliary spillways. There are 3 road crossings along the reach that were included in the HEC-RAS model based on aerial imagery supplemented with topographic mapping and field reconnaissance by Schnabel staff. A list of the structures and the distance downstream is provided in Table 3.9.

Table 3.9: Southern VT Orchard Downstream River Crossings

Road Crossing	Distance Downstream (mi)
Carpenter Hill Rd	0.05
Route 7	0.7
Fuller Rd	0.75

The 2D mesh was developed from a LiDAR based 2-meter Digital Elevation Model (DEM) with an average cell size of 10 ft by 10 ft. Break lines were used to refine the base mesh and provide finer resolution along the river and the structures crossing the river. The Route 7 connection utilized a refinement region with a cell size of 2-ft x 2-ft to better represent flows potentially overtopping the roadway. An internal boundary condition was used along the stream centerline to simulate flow from downstream sub-basins. Since the Southern Vermont Orchard watershed is so small, a constant baseflow of 25 cfs was used. The mesh utilized Manning's n-values based upon the 2011 National Land Classification Database (NLCD) (See Table 3.3 in Section 3.1).

3.4.1 Southern Orchard Breach Analysis and Inundation Mapping

The Dam breach analyses were conducted for a Sunny Day breach scenario as well as for rainy day scenarios during the 100-Year flood. Table 3.10 provides a summary of the parameters used for each of the breach and non-breach runs as well as the peak discharge flows for each run.

Table 3.10: Southern VT Orchard Dam Breach Parameters

Parameter	Sunny Day Breach	50% PMF No Breach	50% PMF Breach
Breach Type	Piping	n/a	Piping
Top of Dam Elevation (ft)	1079.3	1079.3	1079.3
Bottom of Beach Elevation (ft)	1063	n/a	1063
Bottom Width (ft)	25	n/a	30
Side Sloped (H:1V)	0.7	n/a	0.7
Breach Weir Coefficient	2.6	n/a	2.6
Max. Pool Elevation (ft)	1074.1	1076.1	1076.1
Breach Formation Time (hrs)	0.5	n/a	0.5
Peak Outflow (cfs)	302	109	865

The results of the HEC-RAS 2D dam breach analyses are depicted graphically on Figure 3.4 for the Sunny Day and 100-Year non breach and breach scenarios. The inundation boundaries were exported from HEC-RAS Mapper and overlain in a GIS environment over recent aerial imagery.

4.0 HAZARD CLASS ASSESSMENT

VT DEC administers the dam safety program for the State of Vermont under 10 V.S.A. Chapter 43. The Dam Safety Program's current policy is to inspect and regulate dams that are capable of impounding more than 500,000 cubic feet. The frequency of inspections is based upon the hazard class of a dam. The assigned hazard class for a dam is based upon the potential of damage or loss of life if the dam were to fail and is not related to the condition of the dam. A dam's classification may change from when it was built or since the last inspection due to changes in development in the downstream drainageway.

The current Downstream Hazard Classification System Used by the Department is the same as those provided in the U.S. Army Corps of Engineers (USACE) document, *Recommended Guidelines for Safety Inspection of Dams (ER 1110-2-106, 25 Sept. 79, 24 Mar 80 Chg 1)*. Under this system, the hazard classification of a dam falls under three categories, based on the potential damage to life and property in the event of a catastrophic failure of the dam (Table 4.1).

Table 4.1: Hazard Classification Guidelines

Class	Hazard Category	Potential Loss of Life	Potential Economic Loss	Inspection Frequency
3	Low	None expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)	5-10 years
2	Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)	3-5 Years
1	High	More than few	Excessive (Extensive community, industry or agriculture)	1-2 Years

The current prescriptive regulatory Spillway Design Flood (SDF) for dams varies based upon the size and hazard classification. A Class 3 (Low Hazard) dam is required to safely pass the 100-yr flood; a Class 2 (Significant Hazard) dam is required to safely pass between the 100-year flood and 50% of the PMF; and a Class 1 (High Hazard) dam is required to safely pass 50% to the full PMF, all with 1.5-ft of freeboard.

4.1 VT DEC Hazard Classification Guidance

Based on discussions with the State Dam Safety Engineer, the Dam Safety Program understands that the current hazard classification system is generally not consistent with other state and national dam safety programs. The primary difference is for the Significant Hazard category where the current policy allows for potential loss of life of a few individuals. Most federal and state dam safety programs utilize a hazard classification system where the probable loss of a single life is sufficient for a dam to be classified as high hazard. As such, the opinions of hazard classification presented in this report will be based on the national guidance and if a dam failure is expected to result in a single loss of life, the dam will be considered high hazard.

The hazard class assessment presented herein considered both Sunny Day and Rainy Day failure scenarios. For the Rainy Day scenarios, the hazard class assessment was based on the incremental increase in flooding versus the respective non-breach model results. The primary drivers for the hazard class assessments of the four dams evaluated include potential impacts to residential structures and downstream roadways. A key tool used in assessing potential impacts to houses is application of predicted depth and velocity results with charts developed by the USBR and presented in ACER 11. Figure 4.1 is a copy of the ACER 11 Chart for Houses Built on Foundations and Mobile Homes, which categorizes the potential danger to occupants of a house into three categories based on applicable depth and velocity values. The flooding depth applied for each structure was based estimates for first floor elevation based on topographic mapping, areal imagery and field reconnaissance.

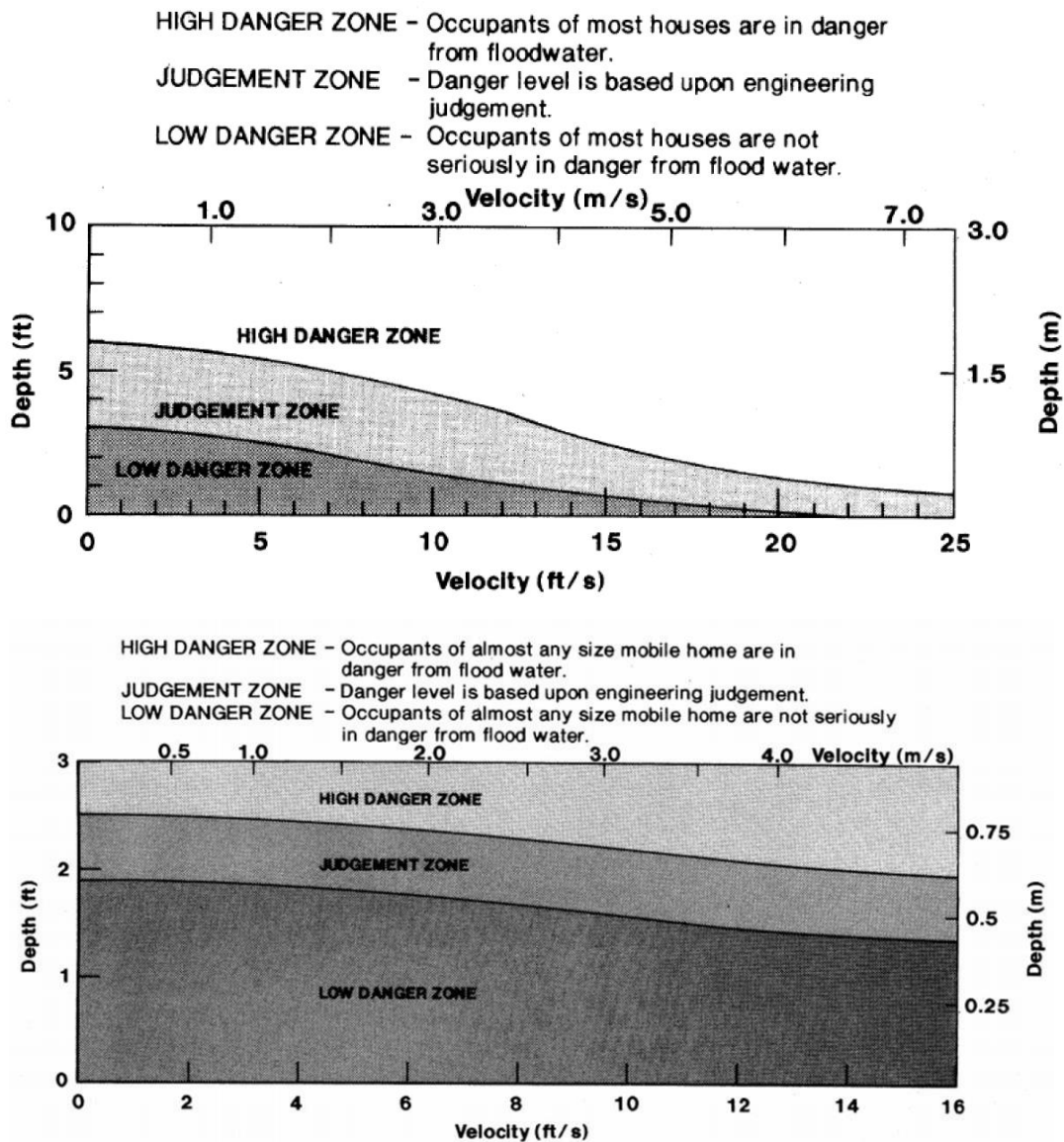


Figure 4.1: Depth-Velocity Flood Danger for Houses Built on Foundations and Mobile Homes (USBR ACER No. 11)

Potential impacts to downstream roads were based on the functional class (i.e. use type and degree of usage) of the roadway. The only facility where a downstream roadway would likely be a hazard driver is for Route 7, downstream of the Southern Vermont Orchard Dam.

4.2 Curtis Pond Dam

4.2.1 Sunny Day Breach

The Sunny Day breach analysis was conducted first to ascertain whether potential impacts are consistent with the current Significant Hazard designation. Based on the HEC-RAS 2D analysis and inundation mapping (Figure 3.1), there two houses directly downstream of W County Road that are impacted (Table 4.2). These houses plot in the Low Danger Zone on the ACER 11 graph.

Table 4.2: Impacted Structures from Sunny Day Breach – Curtis Pond

House Number	Address	House Type	Breach Depth	Breach Velocity	ACER 11 Zone
2	17 West County Rd	Residential	0.6	4.0	Low Danger
3	23 Kent Hill Rd	Residential	1.9	4.0	Low Danger

4.2.2 Rainy Day Dam Breach – 50% PMF

As Curtis Pond Dam is currently regulated as a Significant Hazard structure, the results of the 50% PMF breach and non-breach simulations were first analyzed for the Rainy Day scenarios. Figure 4.2 depicts the peak flood profiles along the channel centerline through the moderately developed reach from Worcester Road downstream to the confluence with the Pekin Brook. The peak flood profiles from the breach scenario are generally 0.1 - 0.8 ft higher than the non-breach scenario.

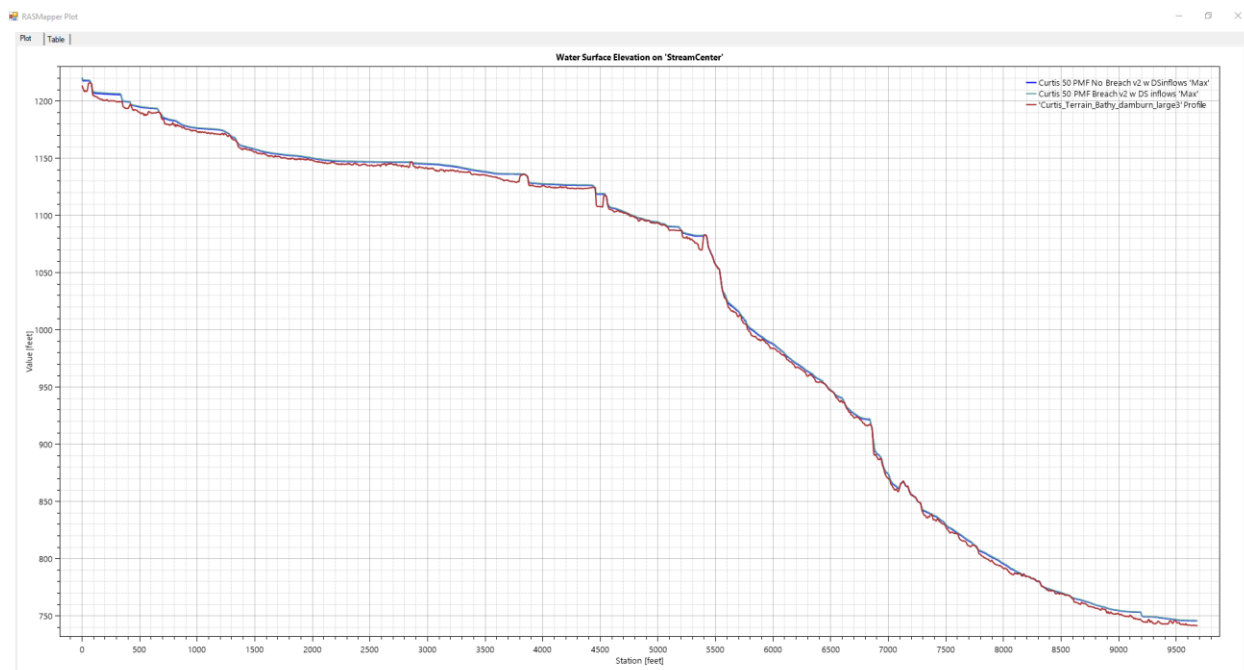


Figure 4.2 – Peak Flood Profiles for 50% PMF Scenario – Curtis Pond

In total, there are nine structures that are potentially impacted. The results on the non-breach versus breach scenarios were plotted on the ACER 11 chart (Figure 4.3).

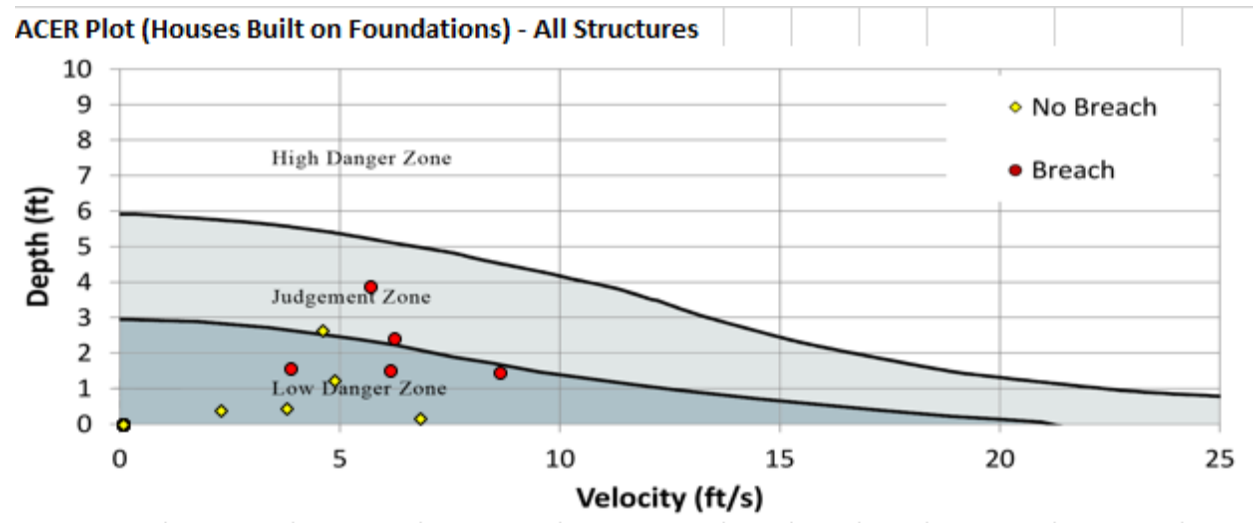


Figure 4.3: ACER 11 Plot for Houses Downstream of Curtis Pond – 50% PMF Breach

There is at least one house in the judgement zone which is consistent with the Significant Hazard Classification. During the breach scenario, House #2 moves from Low Danger to Judgement with a change in depth of 1.2-ft (Table 4.3). This indicates that there are incremental flooding impacts at the 50% PMF. The incremental flooding depths for all of the structures average approximately 1-ft (Figure 4.4).

Note that Houses 6-9 were included in the analysis because they were showing some impacts for the inundation mapping. However, based on field reconnaissance and topographic mapping we believe that the first floor elevations are not impacted for these structures.

Vermont Department of Environmental Conservation
Hazard Class Assessments for: Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern Vermont Orchard Dam

Table 4.3: Impacted Houses – Curtis Pond 50% PMF Breach

House Number	Address	House Type	No Breach Depth	No Breach Velocity	ACER 11 Zone	Breach Depth	Breach Velocity	ACER 11 Zone
1	31 W County Rd	Store	0.5	3.7	Low Danger	1.6	6.1	Low Danger
2	17 West County Rd	Residential	1.3	4.8	Low Danger	2.5	6.2	Judgement
3	23 Kent Hill Rd	Residential	2.7	4.5	Judgement	3.9	5.6	Judgement
4	97 Kent Hill Rd	Residential	0.4	2.2	Low Danger	1.6	3.8	Low Danger
5	532 Kent Hill Rd	Residential	0.2	6.8	Low Danger	1.5	8.6	Low Danger
6	605 Kent Hill Rd	Residential	0	0	No Impact	0	0	No Impact
7	748 Kent Hill Rd	Residential	0	0	No Impact	0	0	No Impact
8	757 Kent Hill Rd	Residential	0	0	No Impact	0	0	No Impact
9	760 Kent Hill Rd	Residential	0	0	No Impact	0	0	No Impact

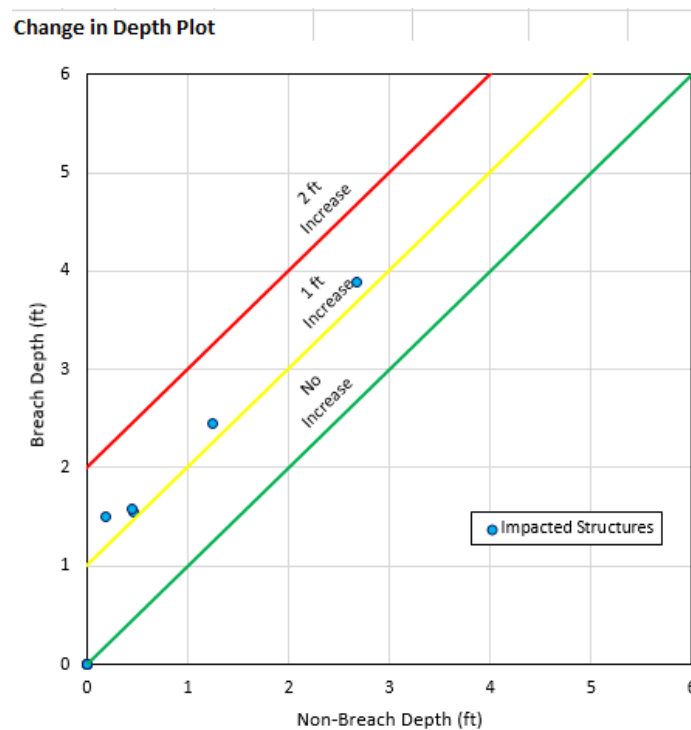


Figure 4.4: Breach Depth vs. Non-Breach Depth for Impacted Houses – Curtis Pond 50% PMF

4.2.3 Hazard Class Assessment and SDF

Based on the results from the Sunny Day and Rainy Day Breach Scenario, it is our opinion that Curtis Pond Dam is appropriately classified as a Significant Hazard structure. As there are significant incremental impacts predicted during the 50% PMF, an IFA analysis to reduce the SDF is not applicable. Therefore, the recommended SDF for Curtis Pond Dam is the 50% PMF.

4.3 Carlton Reservoir Dam

4.3.1 Sunny Day Breach

The Sunny Day breach analysis was conducted first to ascertain whether potential impacts are consistent with the current Significant Hazard designation. Based on the HEC-RAS 2D analysis and inundation mapping (Figure 3.2), there is one house downstream that is potentially impacted by the Sunny Day breach (Table 4.4). This house plots in the Low Danger Zone on the ACER 11 Mobile Homes graph.

Table 4.4: Impacted Structures from Sunny Day Breach – Carlton Reservoir Dam

House Number	Address	House Type	Depth ¹ (ft)	Velocity (ft/s)
3	497 Carlton Hill Rd	Mobile Home	0.1 (0.0)	0.2

¹Depths shown in parenthesis are estimated first floor flooding depths

Carlton Hill Road does overtop in several places. The depth of flooding ranges from approximately 0.5-ft to 3-ft for a duration of 3 hours during the Sunny Day failure. Based on the Vermont Highway Functional Class mapping, Carlton Hill Road is a local road and has not been assigned a Functional Class.

4.3.2 Rainy Day Dam Breach – 50% PMF

Since Carlton Reservoir Dam is currently regulated as a Significant Hazard structure, the results of the 50% PMF breach and non-breach simulations were first analyzed for the Rainy Day scenarios. Figure 4.5 depicts the peak flood profiles along the channel centerline from the dam downstream to the confluence with the Ottauquechee River. The peak flood profiles from the breach scenario are generally 2-3 ft higher than the non-breach scenario. Differences greater than 2-ft for peak water surface elevations is one commonly applied assessment that there are incremental impacts.

Vermont Department of Environmental Conservation
Hazard Class Assessments for: Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern
Vermont Orchard Dam

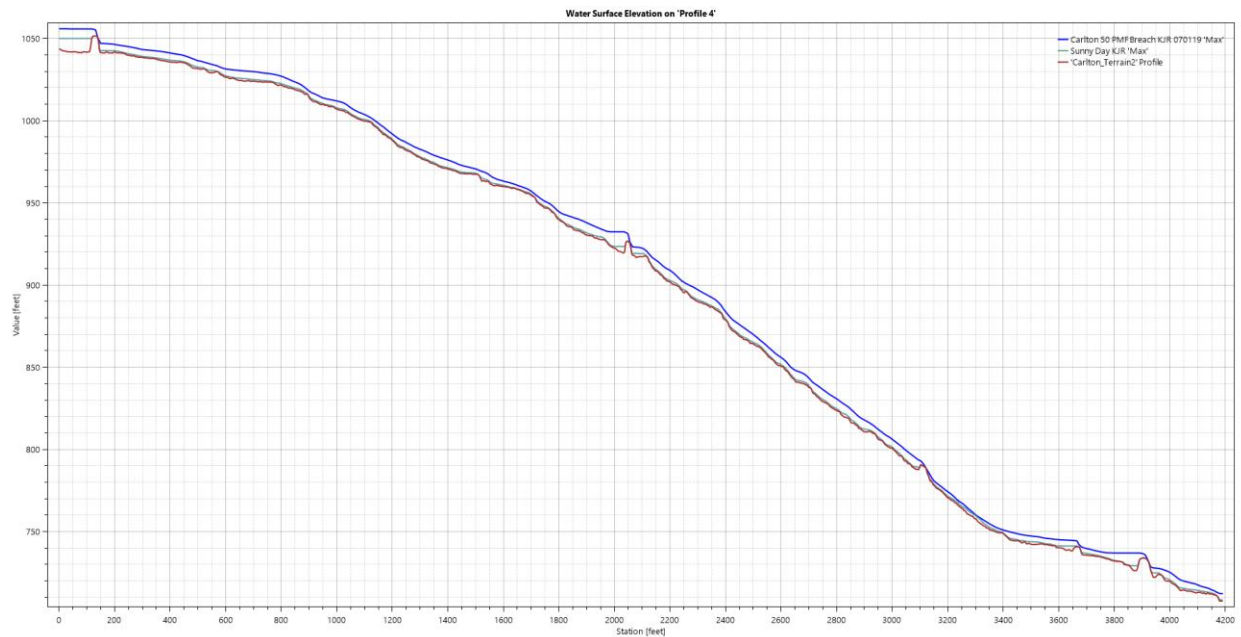
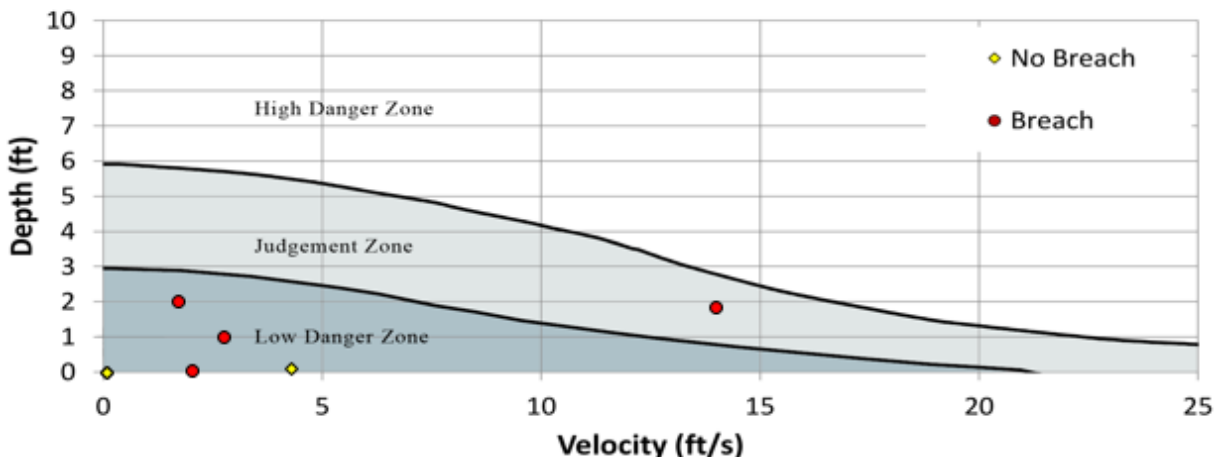


Figure 4.5 – Peak Flood Profiles for 50% PMF Scenario – Carlton Reservoir Dam

In total, there are five structures that are predicted to be impacted. The non-breach results show minimal flooding for all 5 houses. However, the breach results were much more significant with one house clearly in the Judgement Zone. The results of the non-breach versus breach scenarios were plotted on the ACER 11 chart (Figure 4.6).

ACER Plot (Houses Built on Foundations) - All Structures



HIGH DANGER ZONE - Occupants of almost any size mobile home are in danger from flood water.
JUDGEMENT ZONE - Danger level is based upon engineering judgement.
LOW DANGER ZONE - Occupants of almost any size mobile home are not seriously in danger from flood water.

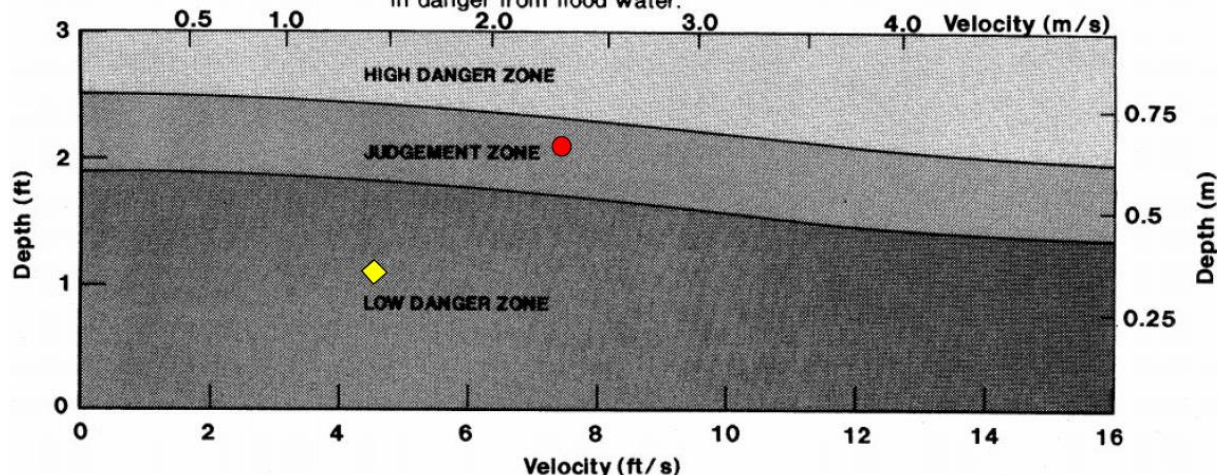


Figure 4.6: ACER 11 Plot for Houses/Mobile Homes Downstream of Carlton Reservoir – 50% PMF Breach

House 1 moves from Low Danger to Judgement between the non-breach and breach scenarios and the incremental flooding is approximately 1.8 ft. (Table 4.5). Additionally, one other structure (House 5) moves from not impacted to the Low Danger zone, and is showing incremental flooding of greater than two feet (Figure 4.7). Note that House 3 is a mobile home and we assessed flooding depths based on estimated first floor elevation as well as adjacent grades. Overall we believe that the breach analysis and potential impacts to residential structures and the mobile home support the current Significant Hazard Classification.

Vermont Department of Environmental Conservation
Hazard Class Assessments for: Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern Vermont Orchard Dam

Table 4.5: Impacted Structures – Carlton Reservoir 50% PMF Breach

House Number	Address	House Type	No Breach Depth ¹ (ft)	No Breach Velocity (ft/s)	ACER 11 Zone	Breach Depth ¹ (ft)	Breach Velocity (ft/s)	ACER 11 Zone
1	0 Carlton Hill Rd	Accessory Building	0.1	4.3	Low Danger	1.9	13.9	Judgement
2	761 Carlton Hill Rd	Residential	0.0	0.0	No Impact	0.1	1.9	Low Danger
3	497 Carlton Hill Rd	Mobile Home	1.0 (0.0)	7.3	Low Danger	2.1 (0.0)	7.5	Judgement
4	387 Carlton Hill Rd	Residential	0.0	0.0	No Impact	1.1	2.7	Low Danger
5	361 Carlton Hill Rd	Residential	0.0	0.0	No Impact	2.1	1.7	Low Danger

¹Depths shown in parenthesis are estimated first floor flooding depths

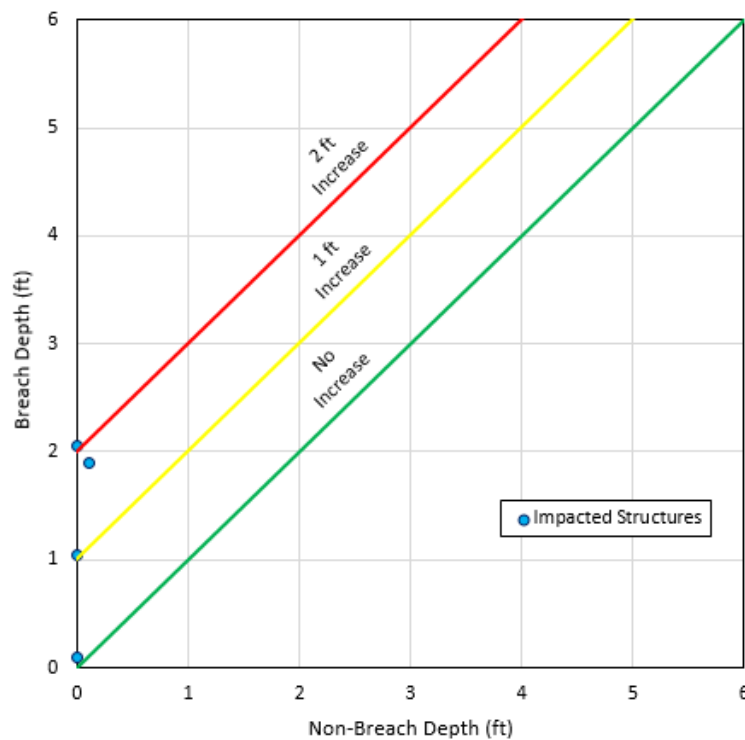


Figure 4.7: Breach Depth vs. Non-Breach Depth for Impacted Houses – Carlton Reservoir Dam
50% PMF

4.3.3 Hazard Class Assessment and SDF

Based on the results from the Sunny Day and Rainy Day Breach Scenario, it is our opinion that Carlton Reservoir Dam is appropriately classified as a Significant Hazard structure. As there are significant incremental impacts predicted during the 50% PMF, an IFA analysis to reduce the SDF is not applicable. Therefore, the recommended SDF for Carlton Reservoir Dam is the 50% PMF.

4.4 Kenny Pond Dam

4.4.1 Sunny Day Breach

The Sunny Day breach analysis was conducted first to determine whether potential impacts are consistent with the current Significant Hazard designation. Based on the HEC-RAS 2D analysis and inundation mapping (Figure 3.3), two houses and a camp are potentially impacted by a Sunny Day Breach (Table 4.6). These houses all plot in the Low Danger Zone on the ACER 11 graph (Figure 4.8).

Table 4.6: Impacted Houses from Sunny Day Breach – Kenny Pond Dam

House Number	Address	House Type	Depth (ft)	Velocity (ft/s)
1	654 Baker Brook Rd	Camp	N/A	N/A
6	417 Baker Brook Rd	Mobile Home	1.0	2.4
7	411 Baker Brook Rd	Residential	0.7	3.2

ACER Plot (Houses Built on Foundations) - All Structures

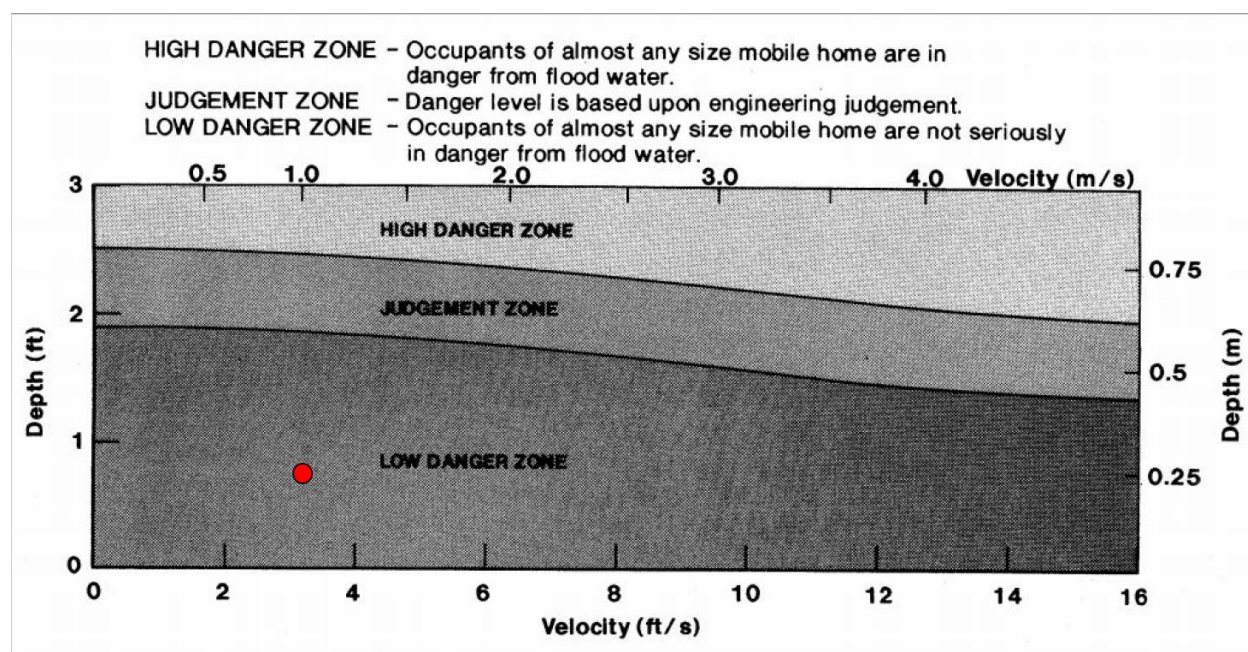
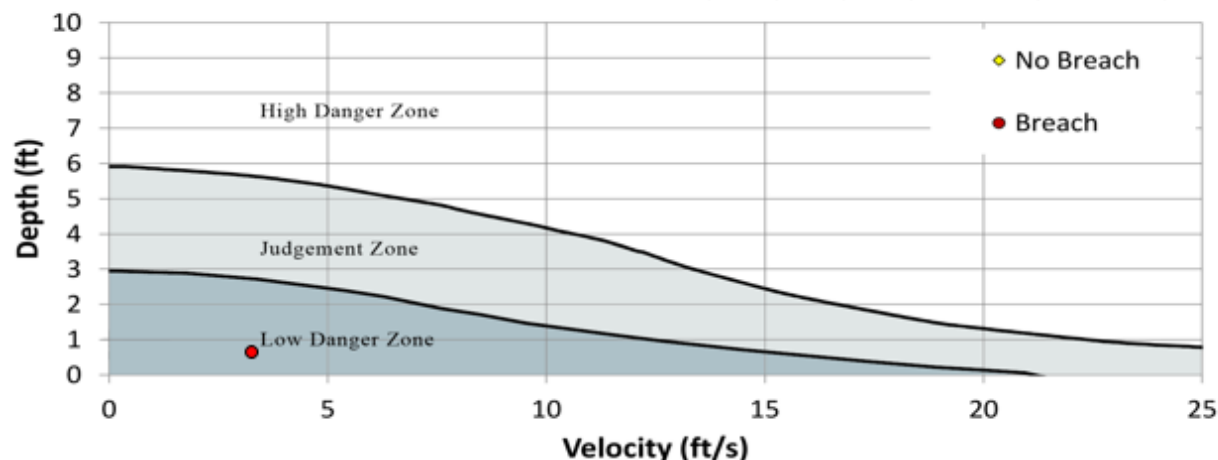


Figure 4.8: ACER 11 Plot for Sunny Day Impacted Houses/Mobile Homes – Kenny Pond Dam

Baker Brook Road is predicted to experience temporary flooding in several locations following a Sunny Day failure of Kenny Pond Dam. However, based on Vermont Functional Class mapping, Baker Brook Road is a local road that has not been assigned a Functional Class.

4.4.2 Rainy Day Dam Breach – 50% PMF

As Kenny Pond Dam is currently regulated as a Significant Hazard structure, the 50% PMF breach and non-breach simulations were first analyzed for the Rainy Day scenarios. Figure 4.9 depicts a section of the peak flood profiles along the channel centerline. The peak flood profiles from the breach scenario range from approximately 6-ft higher at the upstream end to less than 2-ft at the downstream end when compared to the non-breach scenario.

Vermont Department of Environmental Conservation
Hazard Class Assessments for: Carlton Reservoir Dam, Curtis Pond Dam, Kenny Pond Dam, and Southern
Vermont Orchard Dam

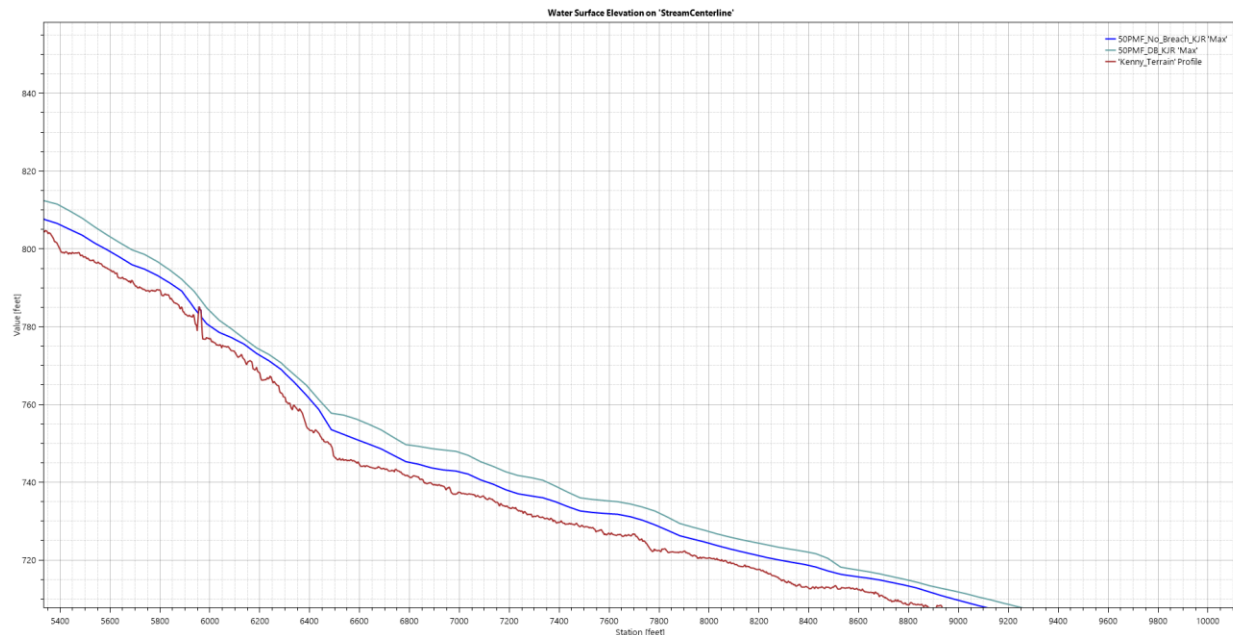


Figure 4.9: Peak Flood Profiles for 50% PMF Scenario – Kenny Pond Dam

The HEC-RAS 2D model results predict that there are 7 houses, 1 mobile home, and 2 camps that are potentially impacted as a result of a failure of Kenny Pond Dam during the 50% PMF storm event. Based on ACER 11 plotting for the 50% PMF breach and non-breach scenarios (Figure 4.10), three houses move from no impact to the Low Danger Zone, and one house and one mobile home moves from the Low Danger Zone to the Judgement Zone.

Note that the mobile home at 417 Baker Brook Rd. is plotted for the first floor elevation which estimated at approximately 2-ft above adjacent terrain based on topographic mapping and field reconnaissance. When plotted in this manner, the impacts are predicted to be within the lower end of the Judgement Zone. If the flooding depth and velocity were evaluated at the lowest adjacent terrain, the impacts would plot near the border of the Judgement and High Danger Zones. Subsequently we looked into the potential impacts further for this particular structure. When looking through the time series of flooding impacts, the model results show that this structure may experience flooding approximately several hours before the dam is assumed to breach. We believe that the occupants of the mobile home would have ample time to react to the flooding and would likely evacuate the premises before the dam breaches. However, more detailed analyses of the downstream hydrology are recommended to confirm this assumption.

ACER Plot (Houses Built on Foundations) - All Structures

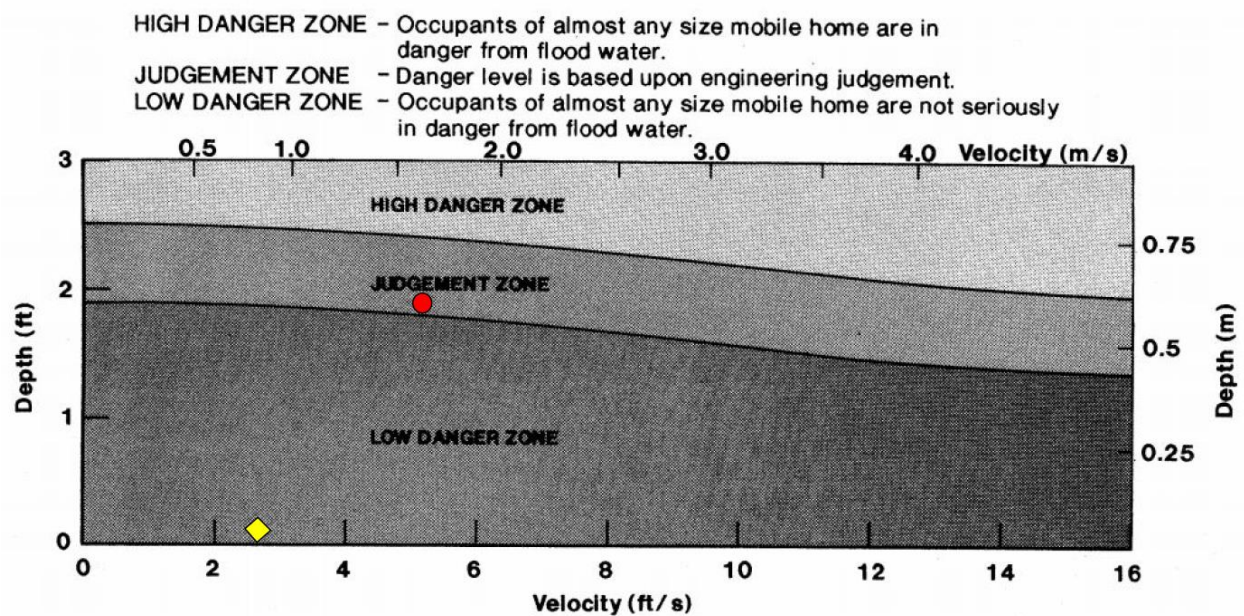
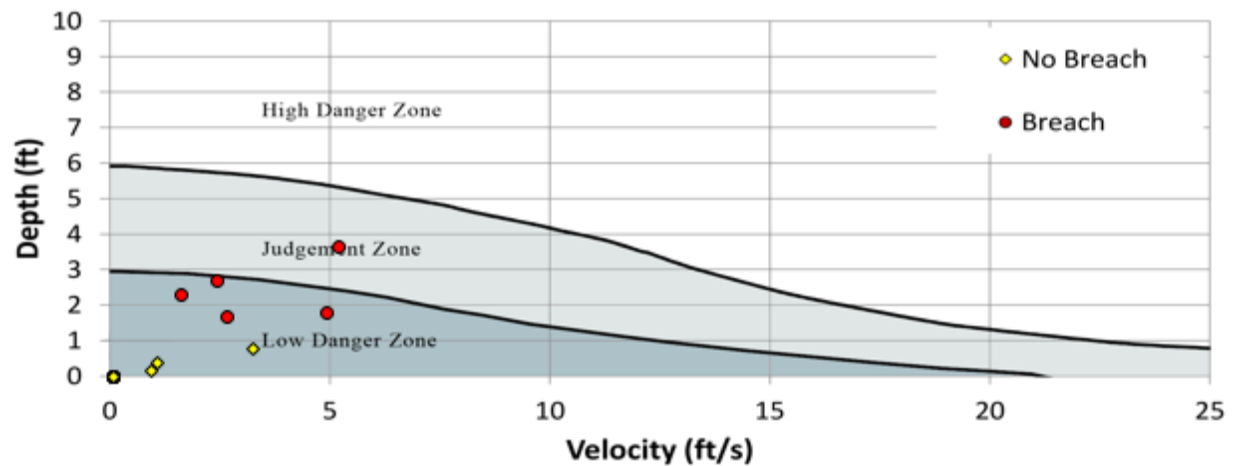


Figure 4.10: ACER 11 Plot 50% PMF Impacted Houses/Mobile Homes – Kenny Pond Dam

Based on the application of ACER 11 plots for impacted houses, four of the houses and one mobile home moves zones for the breach vs. non-breach scenario (Table 4.7) and the incremental flooding depths for four of the structures are greater than 2-ft (Figure 4.11). Note that Houses 6 and 7 are all in the Judgement zone during the 50% PMF Breach, and these are the structures that were impacted by the Sunny Day Breach.

Table 4.7: Impacted Structures – Kenny Pond 50% PMF Breach

House Number	Address	Structure Type	No Breach Depth ¹	No Breach Velocity	Acer 11 Zone	Breach Depth ¹	Breach Velocity	Acer 11 Zone
1	654 Baker Brook Rd	Camp	N/A	N/A	N/A	N/A	N/A	N/A
2	Not in ANR Database	Mobile Home	0.0	0.0	No Impact	1.7	3.7	Low Danger
3	465 Baker Brook Rd	Residential	0.0	0.0	No Impact	1.8	4.9	Low Danger
4	457 Baker Brook Rd	Camp	N/A	N/A	N/A	N/A	N/A	N/A
5	418 Baker Brook Rd	Residential	0.0	0.0	No Impact	2.7	2.4	Low Danger
6	417 Baker Brook Rd	Mobile Home	1.1 (0.0)	2.5	Low Danger	3.7 (1.7)	4.8	Judgement
7	411 Baker Brook Rd	Residential	0.8	3.2	Low Danger	3.7	5.1	Judgement
8	56 Beetlestone Hill Rd	Residential	0.4	1.0	Low Danger	2.3	1.6	Low Danger
9	111 Baker Brook Rd	Residential	0.0	0.0	No Impact	0.0	0.0	No Impact
10	65 Baker Brook Rd	Residential	0.2	0.9	Low Danger	1.7	2.6	Low Danger

¹Depths shown in parenthesis are estimated first floor flooding depths

Change in Depth Plot

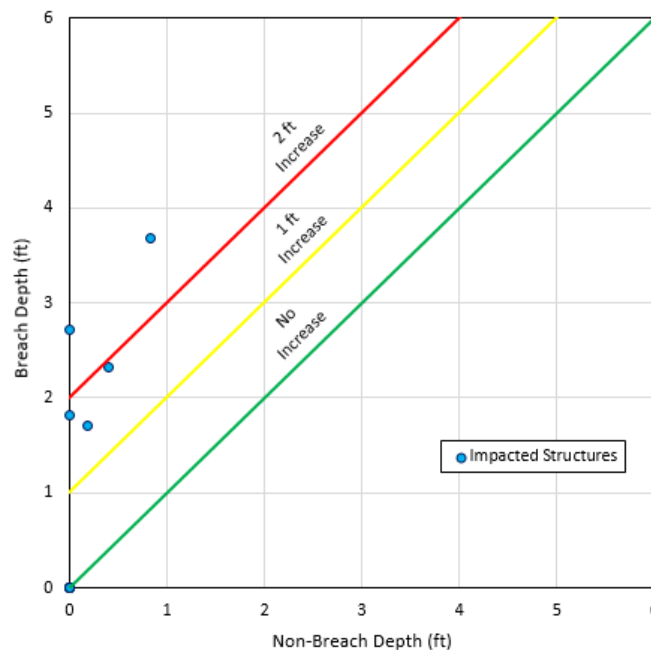


Figure 4.11: Breach Depth vs. Non-Breach Depth for Impacted Houses – Kenny Pond Dam 50% PMF

4.4.3 Hazard Class Assessment and SDF

Based on the model results from the Sunny Day and Rainy Day Breach Scenarios, it is our opinion that Kenny Pond Dam is appropriately classified as a Significant Hazard structure. As there are significant incremental impacts predicted during the 50% PMF storm event, an IFA analysis to reduce the SDF is not applicable. Therefore, the recommended SDF for Kenny Pond Dam is the 50% PMF.

4.5 Southern Vermont Orchard Dam

4.5.1 Sunny Day Breach

The Sunny Day Breach for Southern Vermont Orchard Dam was first analyzed to determine if the results were consistent with the Low Hazard Classification. While there are no houses that are impacted by the Sunny Day failure, Route 7 and Fuller Road are both predicted to overtop. At its peak, approximately 100 cfs overtops Route 7 for a duration of 30 minutes. Based on Vermont Highway Functional Class mapping, Route 7 is classified as a Principal Arterial – Other roadway.

4.5.2 Rainy Day Dam Breach – 100-Year

As the Southern Vermont Orchard Dam is currently regulated as a Low Hazard structure, the results of the 100 year non-breach and breach simulations were first analyzed for the Rainy Day scenarios. The 100 year non-breach run did not show any damage to homes and did not overtop any roads (See Figure 3.4). However, the model results from the 100-year breach scenario did predict that Route 7 and Fuller road would be overtopped. The maximum depth of overtopping for Route 7 is approximately 2 ft with peak velocities of approximately 5 ft/s and a duration of overtopping of approximately 2 hours. Note that the analysis did not include downstream inflows for Jewett Brook as the watershed is significantly larger (6.9 sq. mi) than the Southern Vermont Orchard Watershed (0.29 sq. mi) and would likely peak much later than the breach flows would arrive.

4.5.3 Hazard Class Assessment and SDF

The results of the Sunny Day and Rainy Day breach scenarios could lead to overtopping of Route 7, which is classified as a Principal Arterial roadway. The 100-year non-breach analysis predicted that Route 7 would not be overtopped. Based on these results, the recommended Hazard Classification is to re-classify Southern Vermont Orchard Dam from a Low Hazard to Significant Hazard Dam. A more detailed analysis of the overtopping depths and durations would be required to assess the potential for significant road damage that could support a move to a High Hazard classification.

An evaluation of the 50% PMF was performed at Southern Vermont Orchard Dam to assess performance with the regulatory SDF for the recommended Significant Hazard classification. The results show that the dam with the existing auxiliary spillways can safely pass the 50% PMF with approximately 2.5-ft of freeboard for the dam embankment, therefore an IFA to reduce to the recommended SDF is not applicable. However, note that the analysis presented herein did not assess the potential for erosion within the earthen auxiliary spillways.

5.0 LIMITATIONS

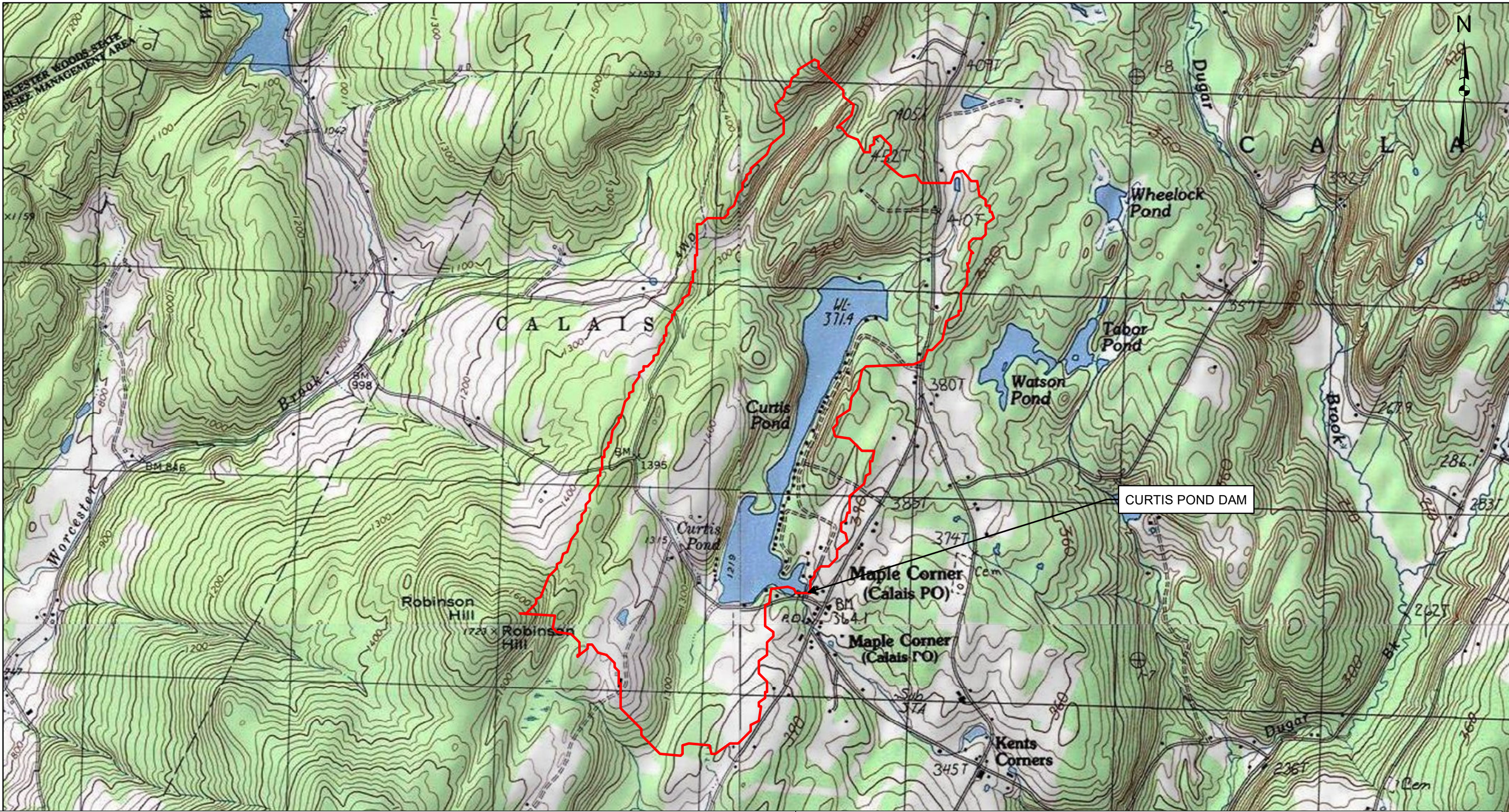
The analyses and recommendations submitted in this report are based on the information obtained by our review of the available documentation, our visual observations of the site and facilities, and our experience from other projects similar in nature. We have attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may exist at the site that influence the results of our evaluations and/or affect recommended remedial activities.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report or any other instrument of service.

FIGURES

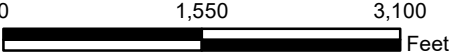
- Figure 2.1: Curtis Pond Dam Site Location
- Figure 2.2: Carlton Reservoir Dam Site Location
- Figure 2.3: Kenny Pond Dam Site Location
- Figure 2.4: Southern Vermont Orchard Dam Site Location
- Figure 2.5: Curtis Pond Dam Soils Map
- Figure 2.6: Curtis Pond Dam Land Use Map
- Figure 2.7: Carlton Reservoir Dam Soils Map
- Figure 2.8: Carlton Reservoir Dam Land Use Map
- Figure 2.9: Kenny Pond Dam Soils Map
- Figure 2.10: Kenny Pond Dam Land Use Map
- Figure 2.11: Southern Vermont Orchard Dam Soils Map
- Figure 2.12: Southern Vermont Orchard Dam Land Use Map
- Figure 3.1: Curtis Pond Dam Inundation Map
- Figure 3.2: Carlton Reservoir Dam Inundation Map
- Figure 3.3: Kenny Pond Dam Inundation Map
- Figure 3.4: Southern Vermont Orchard Dam Inundation Map

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Legend

 Curtis Pond Watershed, 1.29 sq. mi

Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Vermont FIPS 4400 Feet

Scale: 1 inch equals 1,500 feet



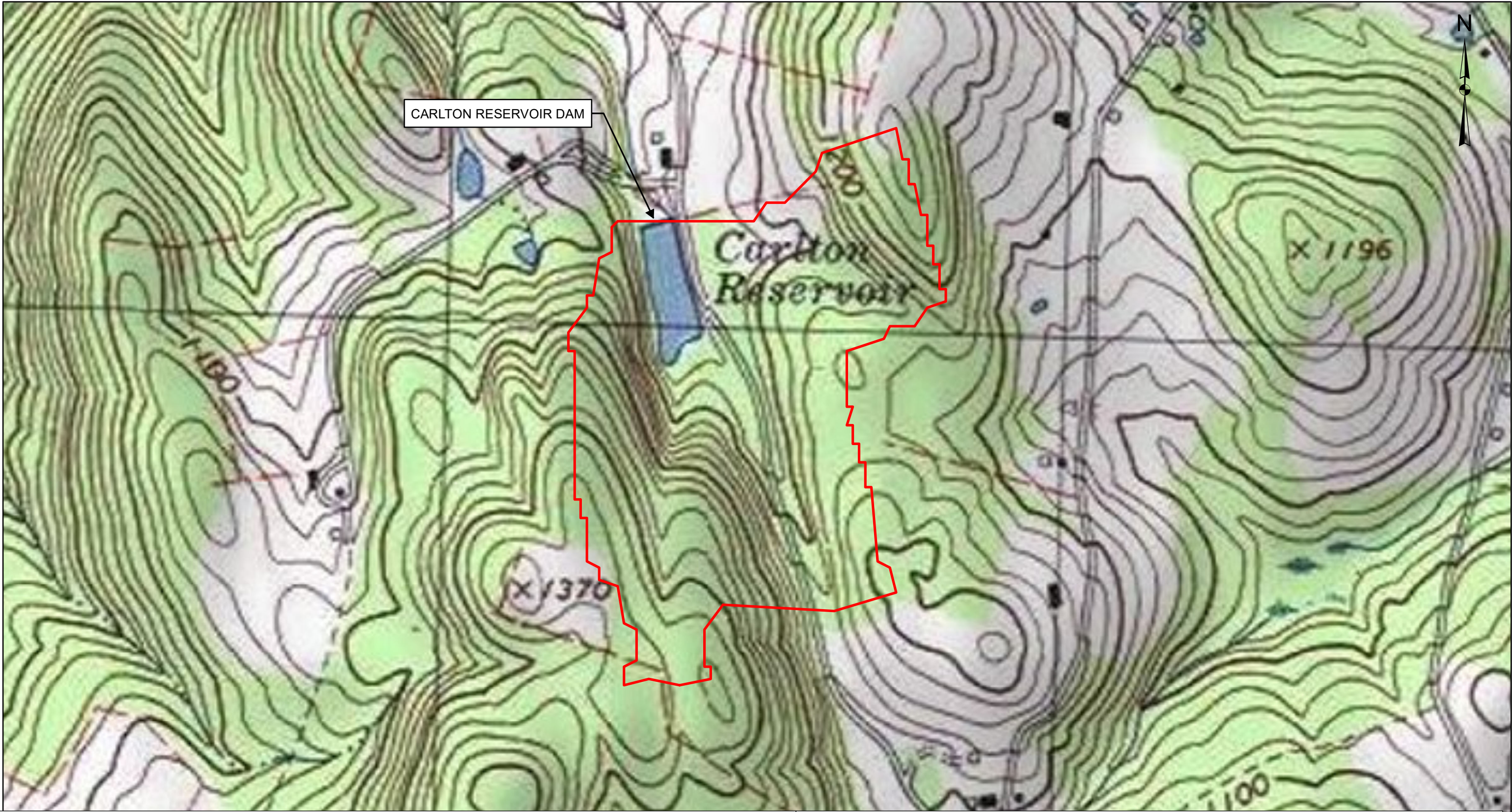
CURTIS POND DAM
CALAIS, VERMONT

PROJECT NO. 19C25003.00

WATERSHED MAP

FIGURE 2.1

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Legend

 Carlton Reservoir Watershed, 0.13 sq. mi

Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Vermont FIPS 4400 Feet

0 500 1,000
Feet
Scale: 1 inch equals 500 feet



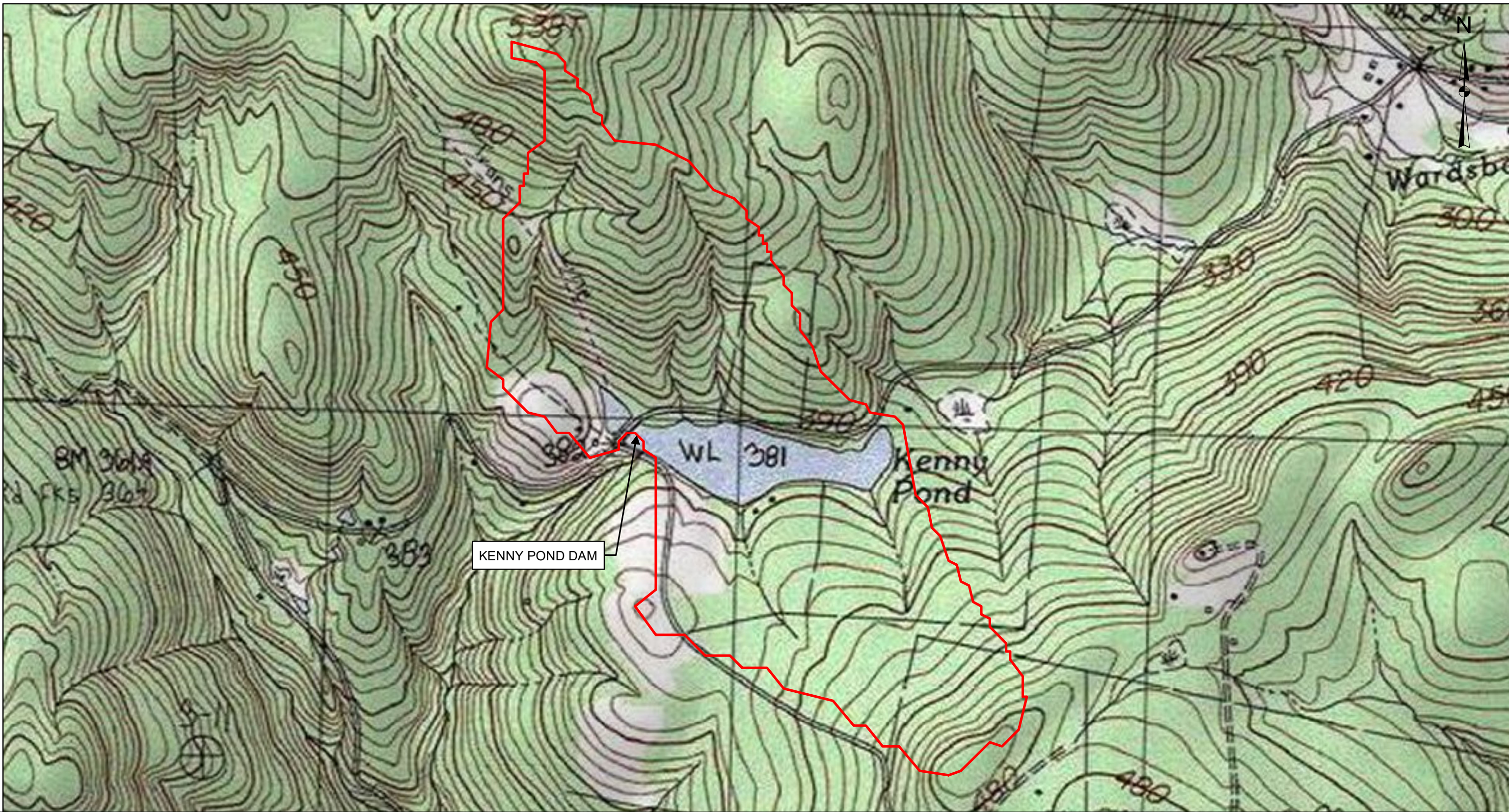
CARLTON RESERVOIR DAM
WOODSTOCK, VERMONT

PROJECT NO. 19C25003.00

WATERSHED MAP

FIGURE 2.2

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Legend

 Kenny Pond Watershed, 0.38 sq. mi

Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Vermont FIPS 4400 Feet

0 750 1,500 Feet
Scale: 1 inch equals 750 feet



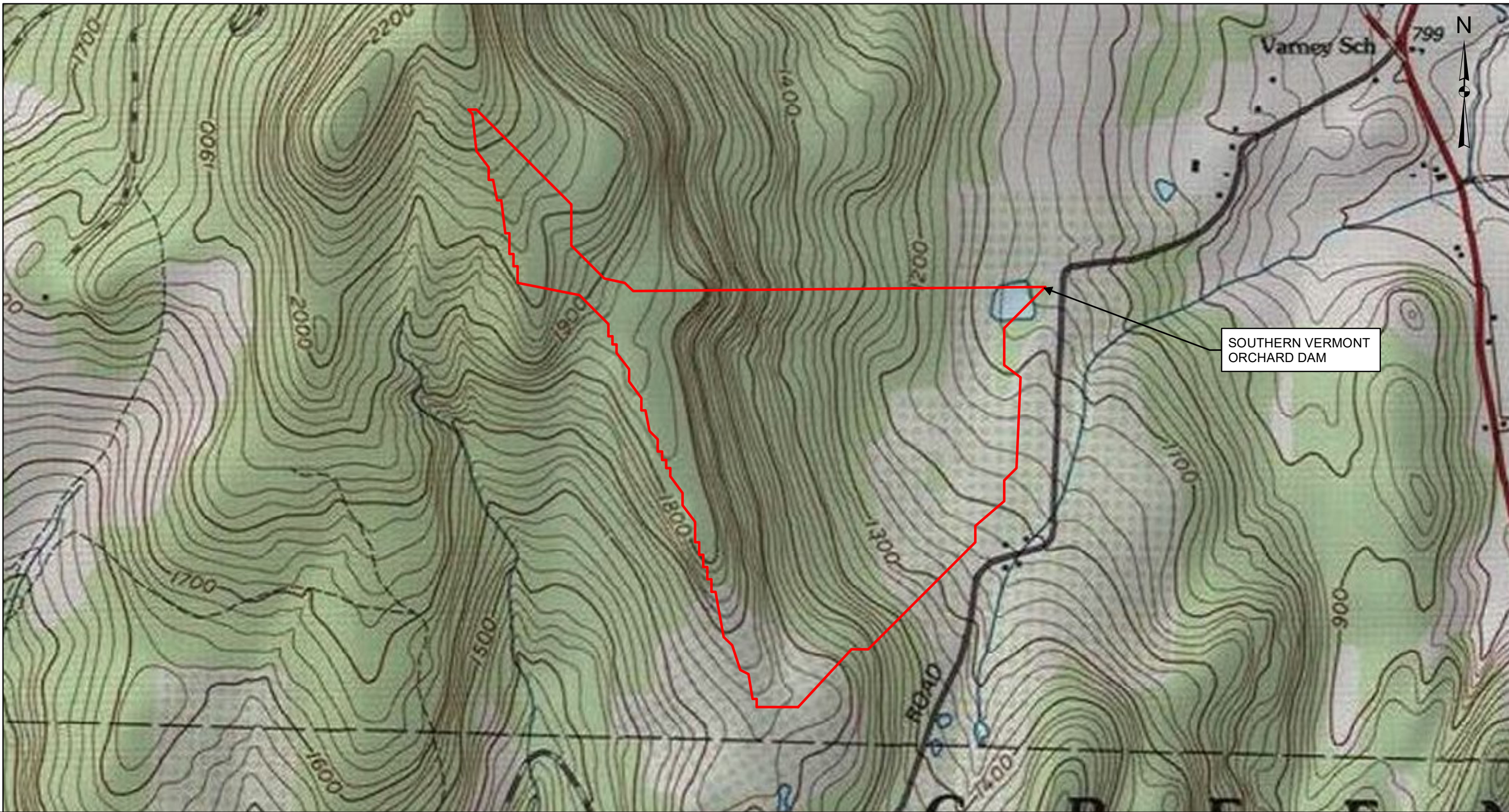
KENNY POND DAM
NEWFANE, VERMONT

PROJECT NO. 19C25003.00

WATERSHED MAP

FIGURE 2.3

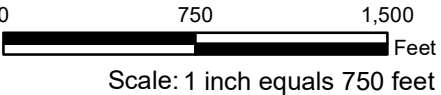
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Legend

 Southern Vermont Orchard Dam Watershed, 0.29 sq. mi

Source: Copyright:© 2013 National Geographic Society, i-cubed
Projection: NAD 1983 StatePlane Vermont FIPS 4400 Feet



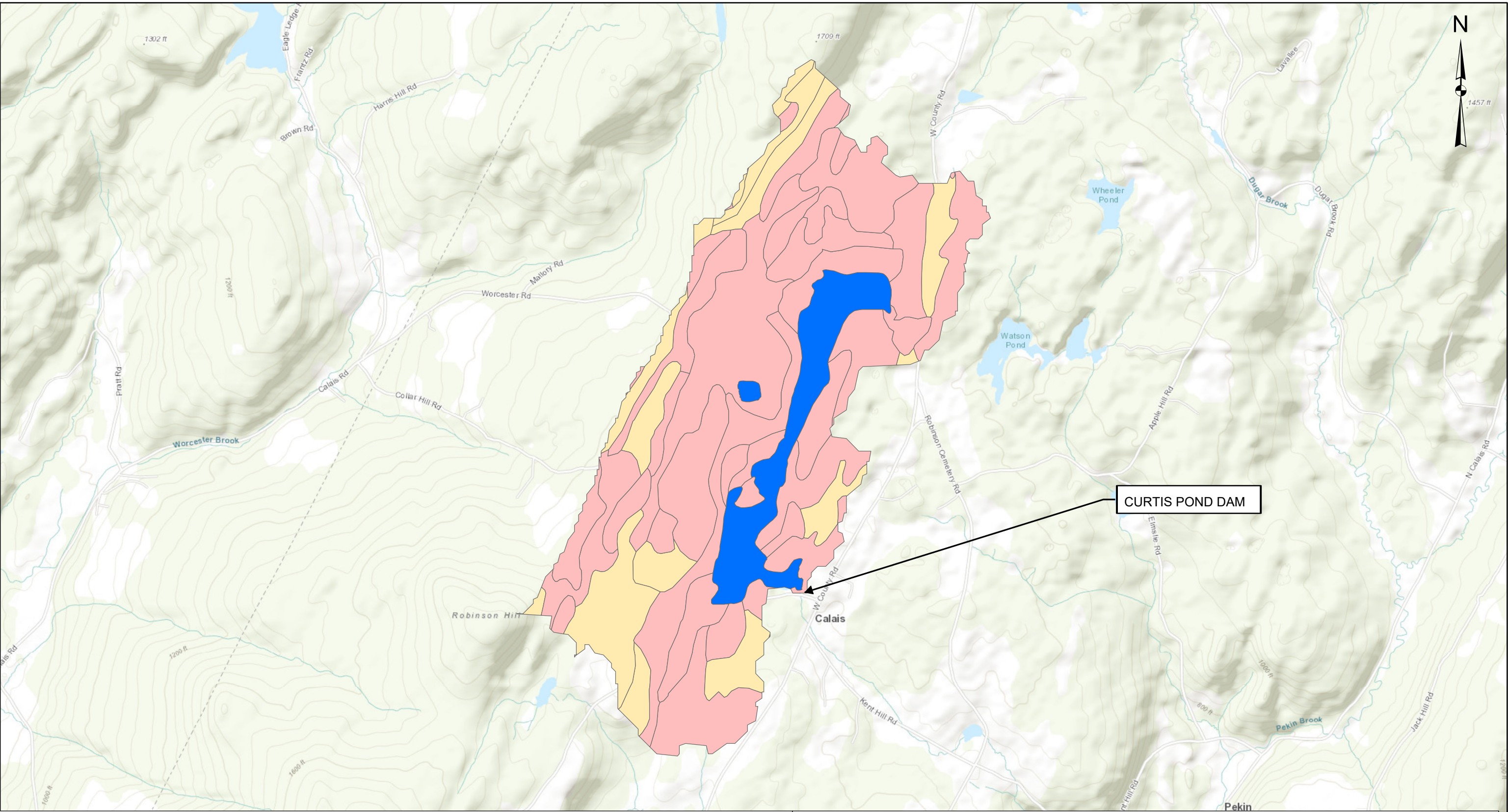
SOUTHERN VERMONT ORCHARD DAM
BENNINGTON, VERMONT

PROJECT NO. 19C25003.00

WATERSHED MAP

FIGURE 2.4

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Legend

Hydrologic Soils Group

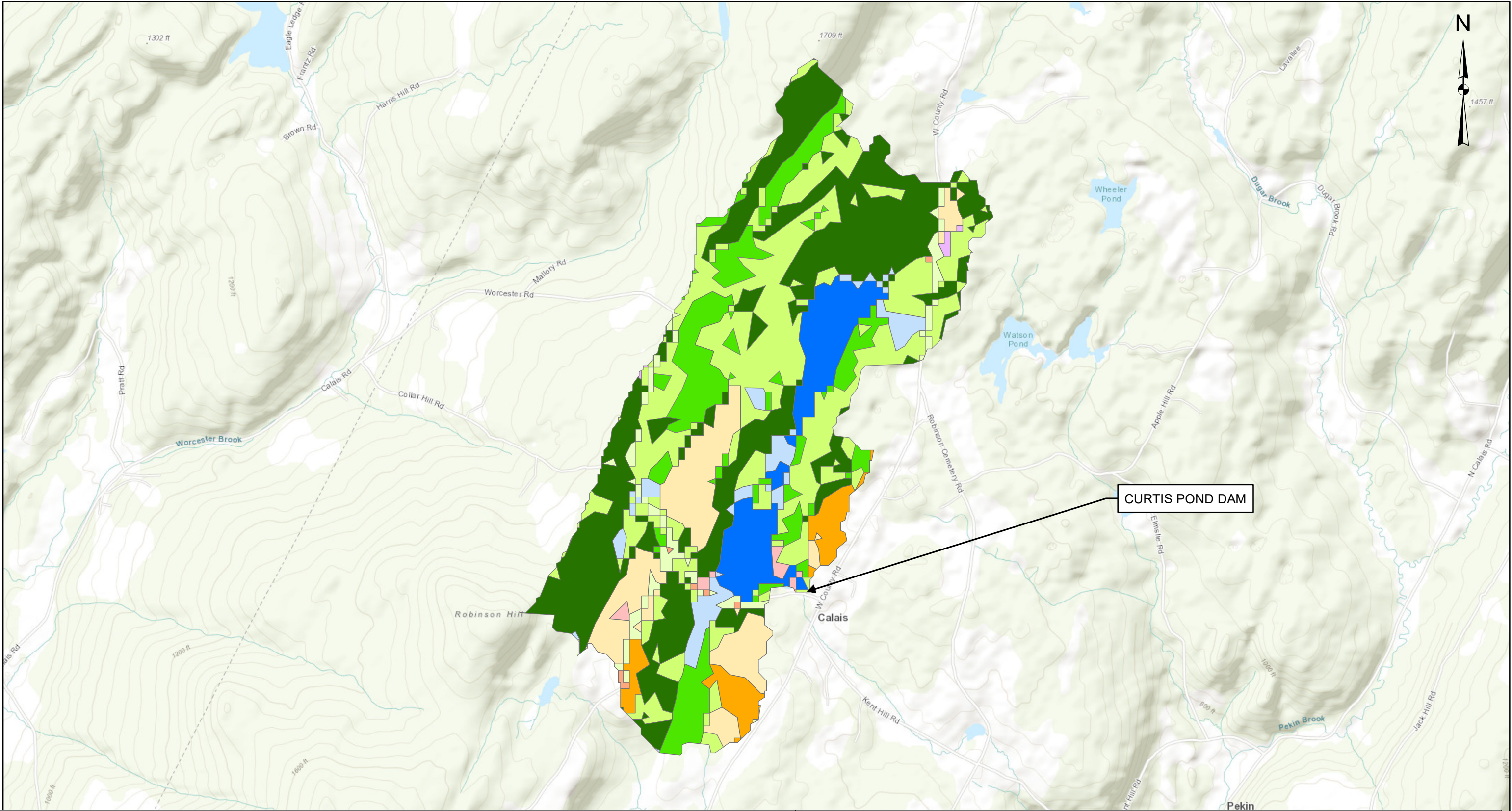
- Water
- C
- D

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

0 1,550 3,100 Feet

Scale: 1 inch equals 1,500 feet

	CURTIS POND DAM CALAIS, VERMONT PROJECT NO. 19C25003.00	SOIL MAP FIGURE 2.5
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Legend

Land Use

- | | | |
|-----------------|------------------|------------------------|
| Developed, Low | Mixed Forest | Cultivated Crops |
| Open Water | Deciduous Forest | Woody Wetlands |
| Developed, Open | Evergreen Forest | Emergent Herb Wetlands |
| | Shrub/Scrub | Hay/Pasture |

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

0 1,500 3,000 Feet

Scale: 1 inch equals 1,500 feet

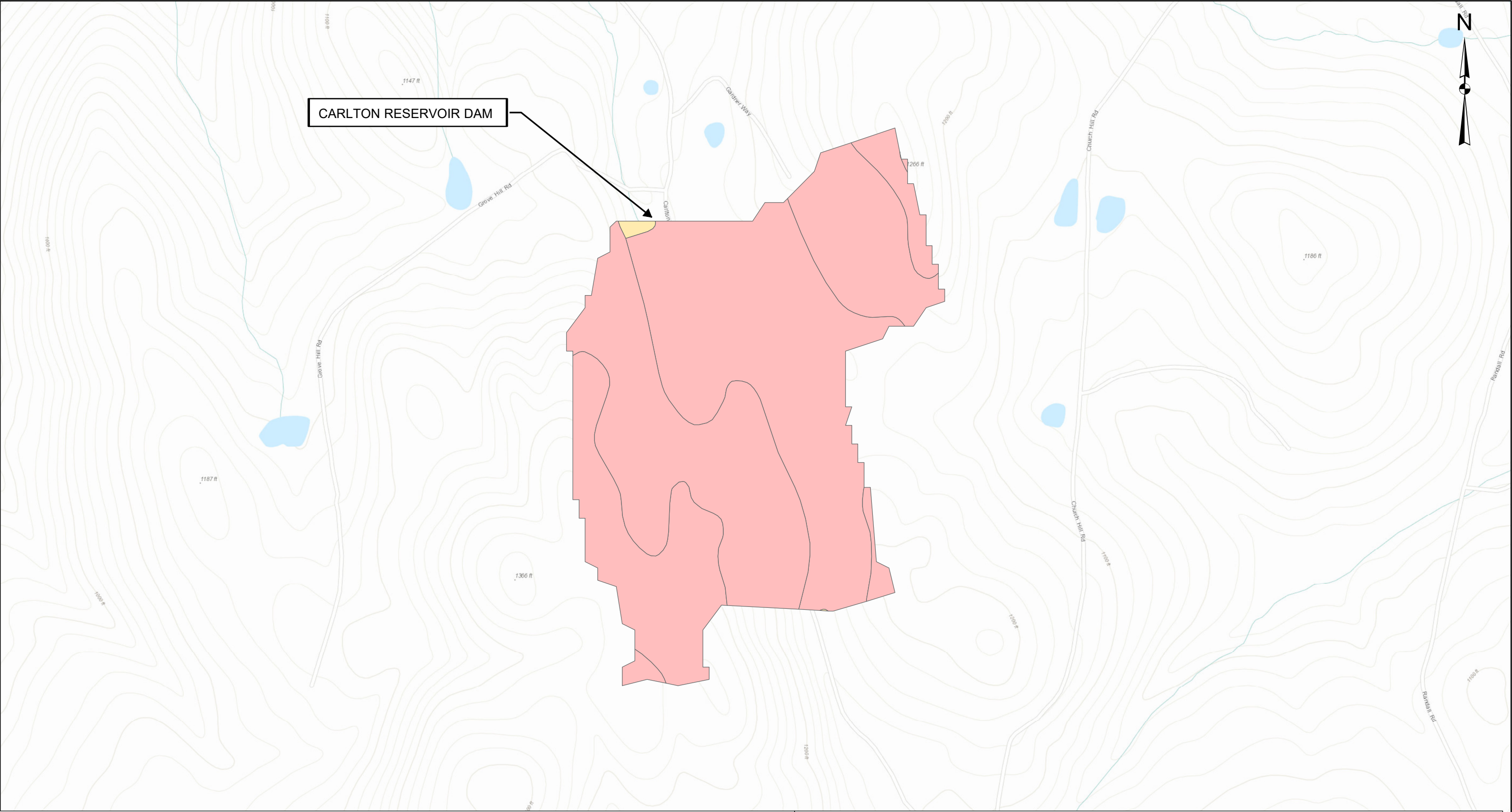


CURTIS POND DAM
CALAIS, VERMONT

PROJECT NO. 19C25003.00

LAND USE
MAP

FIGURE 2.6



Legend

Hydrologic Soils Group

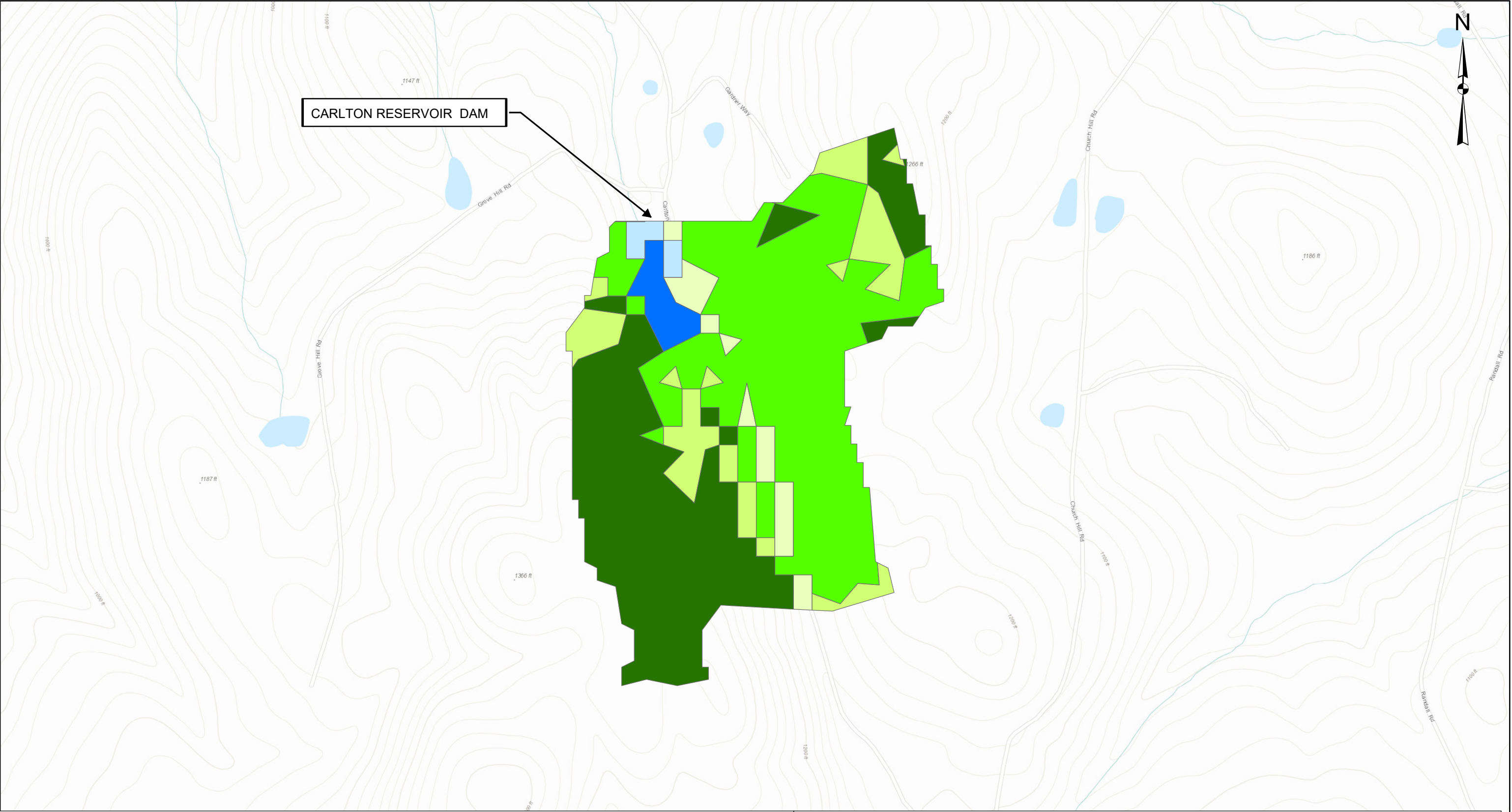
- C
- D

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

0 500 1,000 Feet

Scale: 1 inch equals 500 feet

	CARLTON RESERVOIR DAM WOODSTOCK, VERMONT	SOIL MAP
PROJECT NO. 19C25003.00	FIGURE 2.7	

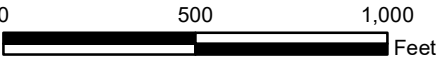


Legend

Land Use

- | | |
|---|------------------|
|  | Evergreen Forest |
|  | Mixed Forest |
|  | Developed, Open |
|  | Hay/Pasture |
|  | Deciduous Forest |
|  | Open Water |
| | Woody Wetlands |

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User



Scale: 1 inch equals 500 feet

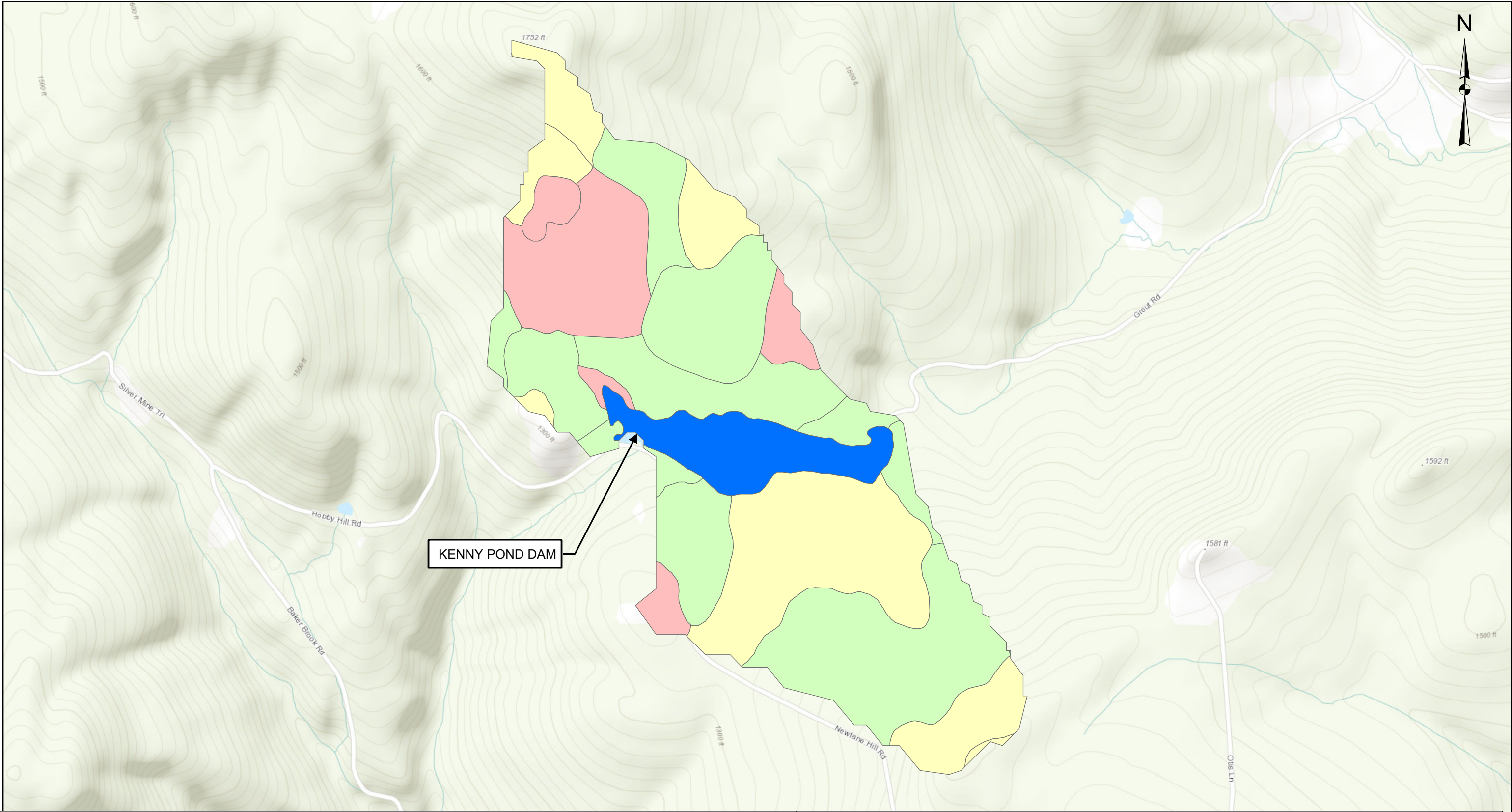


CARLTON RESERVOIR DAM
WOODSTOCK, VERMONT

PROJECT NO. 19C25003.00

LAND USE
MAP

FIGURE 2.8

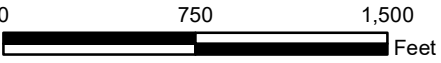


Legend

Hydrologic Soils Group

- | | | | |
|---|-------|---|---|
|  | Water |  | C |
|  | B |  | D |

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User



Scale: 1 inch equals 750 feet



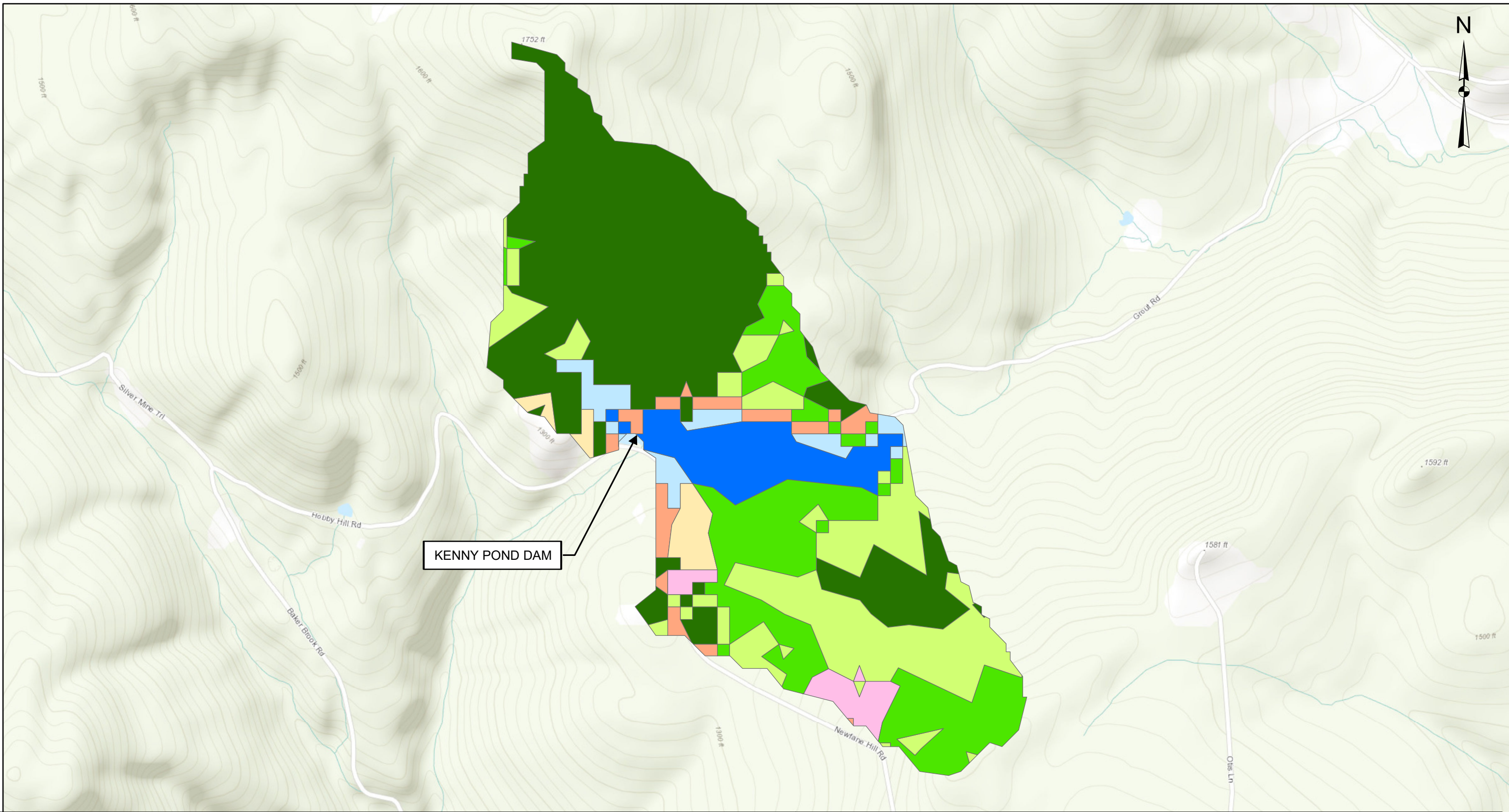
KENNY POND DAM
NEWFANE, VERMONT

PROJECT NO. 19C25003.00

SOIL MAP

FIGURE 2.9

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Legend

Land Use			
	Open Water		Developed, Low
	Deciduous Forest		Evergreen Forest
	Mixed Forest		Shrub/Scrub
	Woody Wetlands		Hay/Pasture

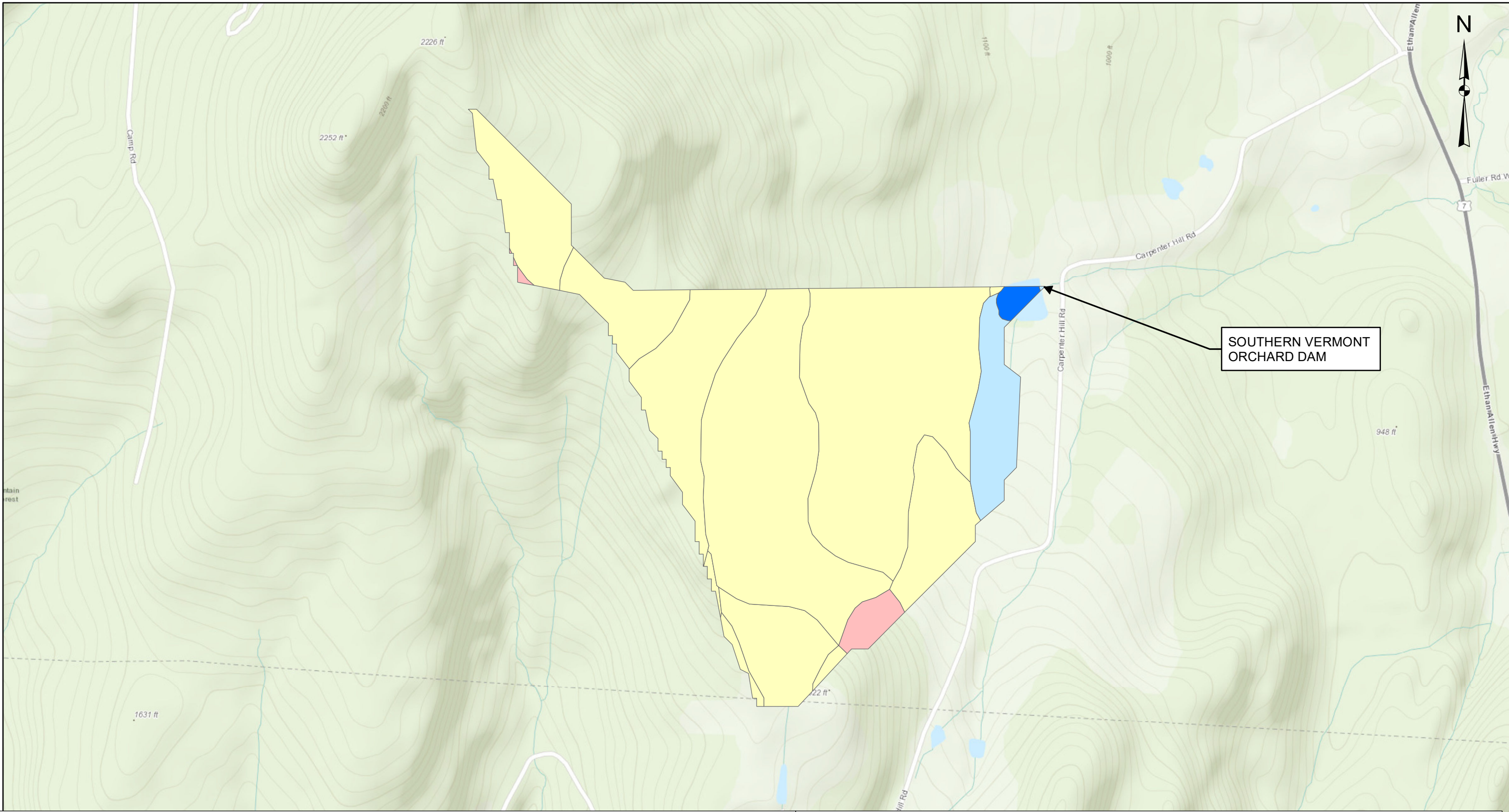
Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

0 750 1,500 Feet

Scale: 1 inch equals 750 feet

	KENNY POND DAM NEWFANE, VERMONT PROJECT NO. 19C25003.00	LAND USE MAP FIGURE 2.10
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Legend

Hydrologic Soils Group

C

D

Water

A

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

07501,500

Feet

Scale: 1 inch equals 750 feet



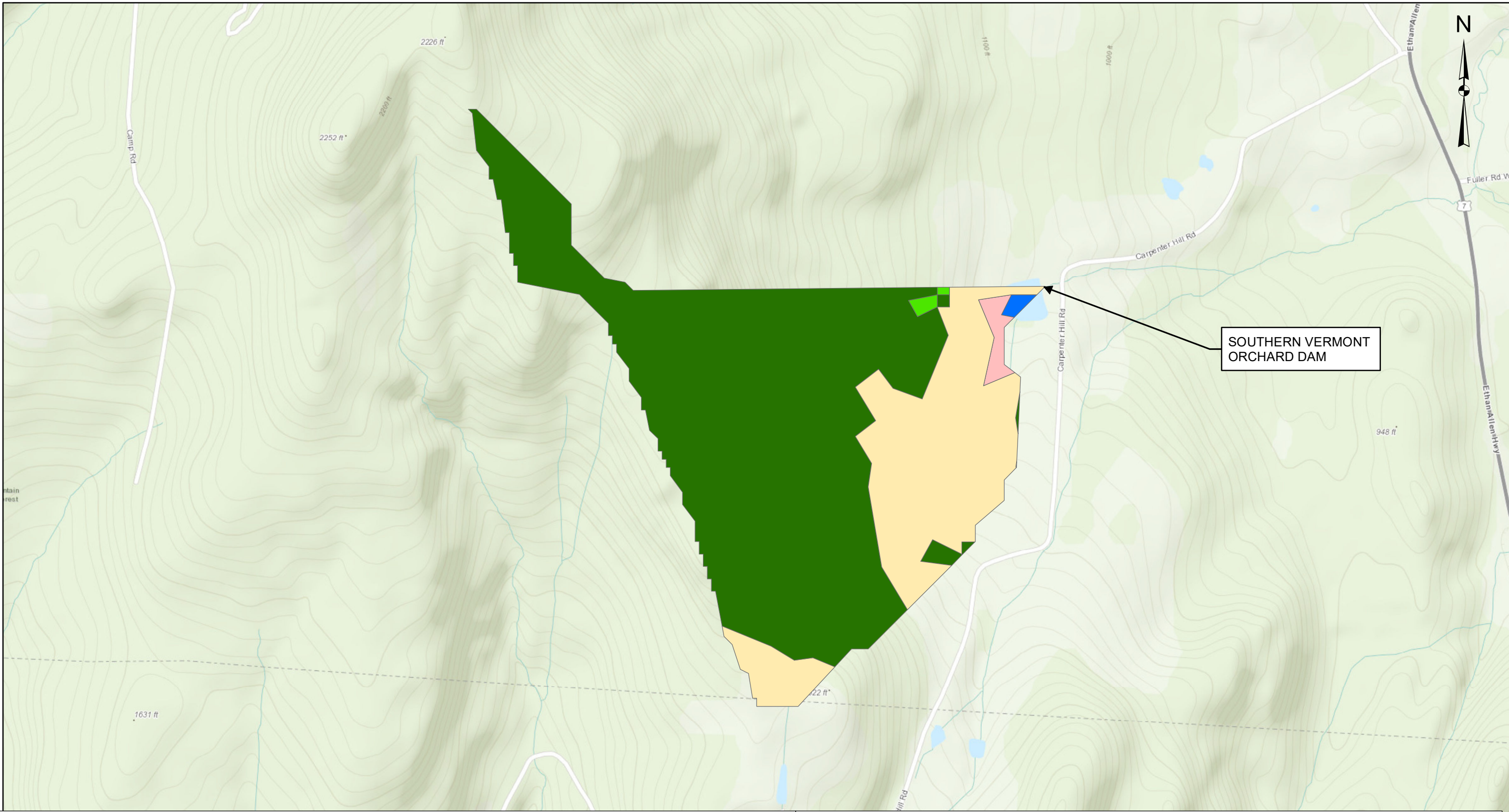
SOUTHERN VERMONT ORCHARD DAM
BENNINGTON, VERMONT

PROJECT NO. 19C25003.00

SOIL MAP

FIGURE 2.11

6/18/2019 3:01:40 PM G:\2019\Albany\19C25003_00_Vermont_2019 Hazard Class Study\03-SEProducts\07-GIS\03-Maps\Orchard_LandUse.mxd eisenstein



Legend

Land Use			Evergreen Forest
	Open Water		Hay/Pasture
	Deciduous Forest		Emergent Herb Wetlands

Source: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User

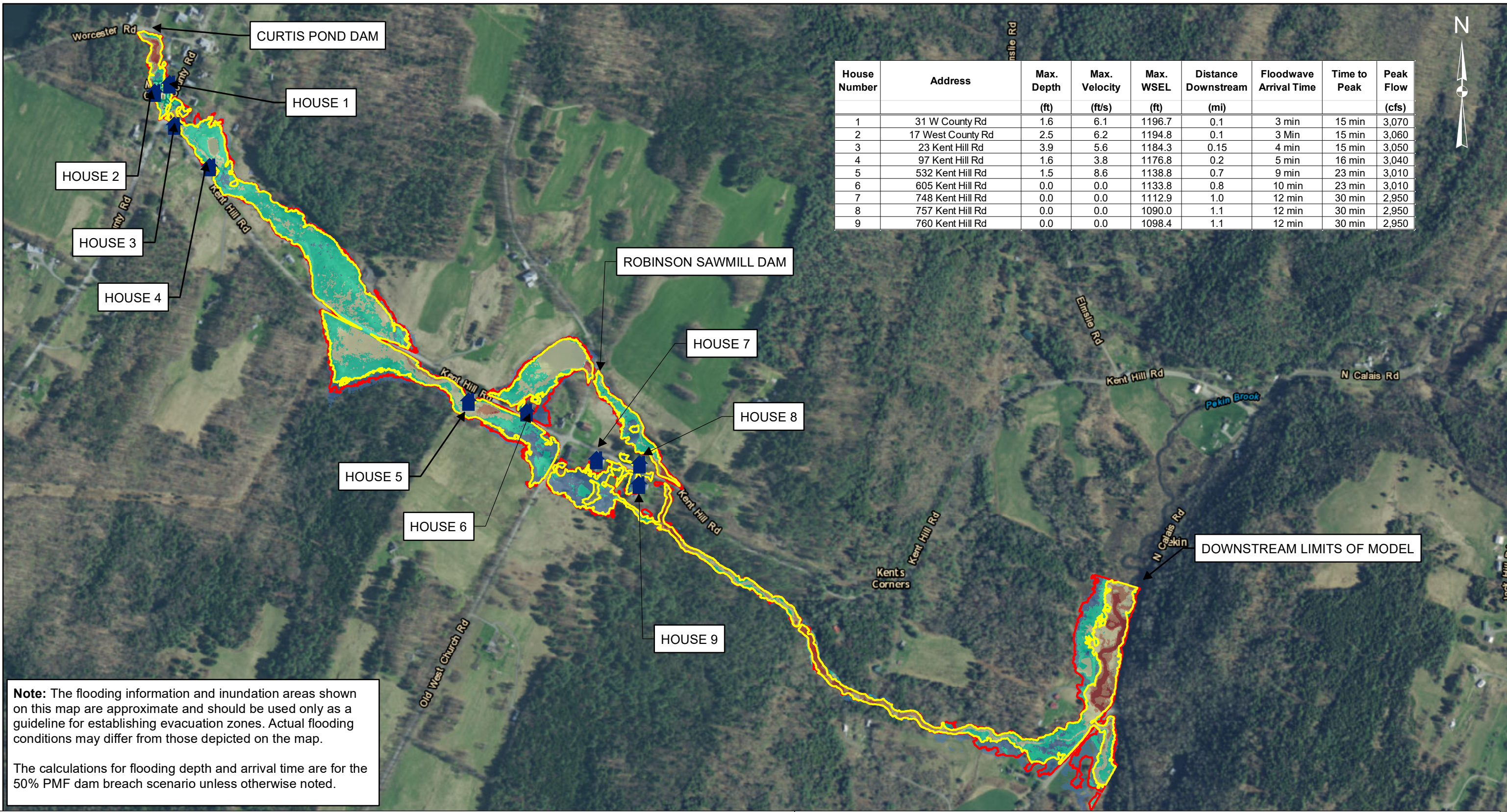
07501,500

Feet

Scale: 1 inch equals 750 feet

	SOUTHERN VERMONT ORCHARD DAM BENNINGTON, VERMONT PROJECT NO. 19C25003.00	LAND USE MAP FIGURE 2.12
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House Number	Address	Max. Depth (ft)	Max. Velocity (ft/s)	Max. WSEL (ft)	Distance Downstream (mi)	Floodwave Arrival Time	Time to Peak	Peak Flow (cfs)
1	31 W County Rd	1.6	6.1	1196.7	0.1	3 min	15 min	3,070
2	17 West County Rd	2.5	6.2	1194.8	0.1	3 Min	15 min	3,060
3	23 Kent Hill Rd	3.9	5.6	1184.3	0.15	4 min	15 min	3,050
4	97 Kent Hill Rd	1.6	3.8	1176.8	0.2	5 min	16 min	3,040
5	532 Kent Hill Rd	1.5	8.6	1138.8	0.7	9 min	23 min	3,010
6	605 Kent Hill Rd	0.0	0.0	1133.8	0.8	10 min	23 min	3,010
7	748 Kent Hill Rd	0.0	0.0	1112.9	1.0	12 min	30 min	2,950
8	757 Kent Hill Rd	0.0	0.0	1090.0	1.1	12 min	30 min	2,950
9	760 Kent Hill Rd	0.0	0.0	1098.4	1.1	12 min	30 min	2,950

Note: The flooding information and inundation areas shown on this map are approximate and should be used only as a guideline for establishing evacuation zones. Actual flooding conditions may differ from those depicted on the map.

The calculations for flooding depth and arrival time are for the 50% PMF dam breach scenario unless otherwise noted.

Legend

-  Impacted Houses

 Sunny Day

 50 PMF No Breach
- 50% PMF Breach**

Max. Flood Depth (ft)

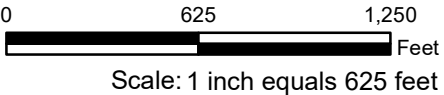
 0 - 2

 2 - 4
-  4 - 6

 6 - 8

 8+

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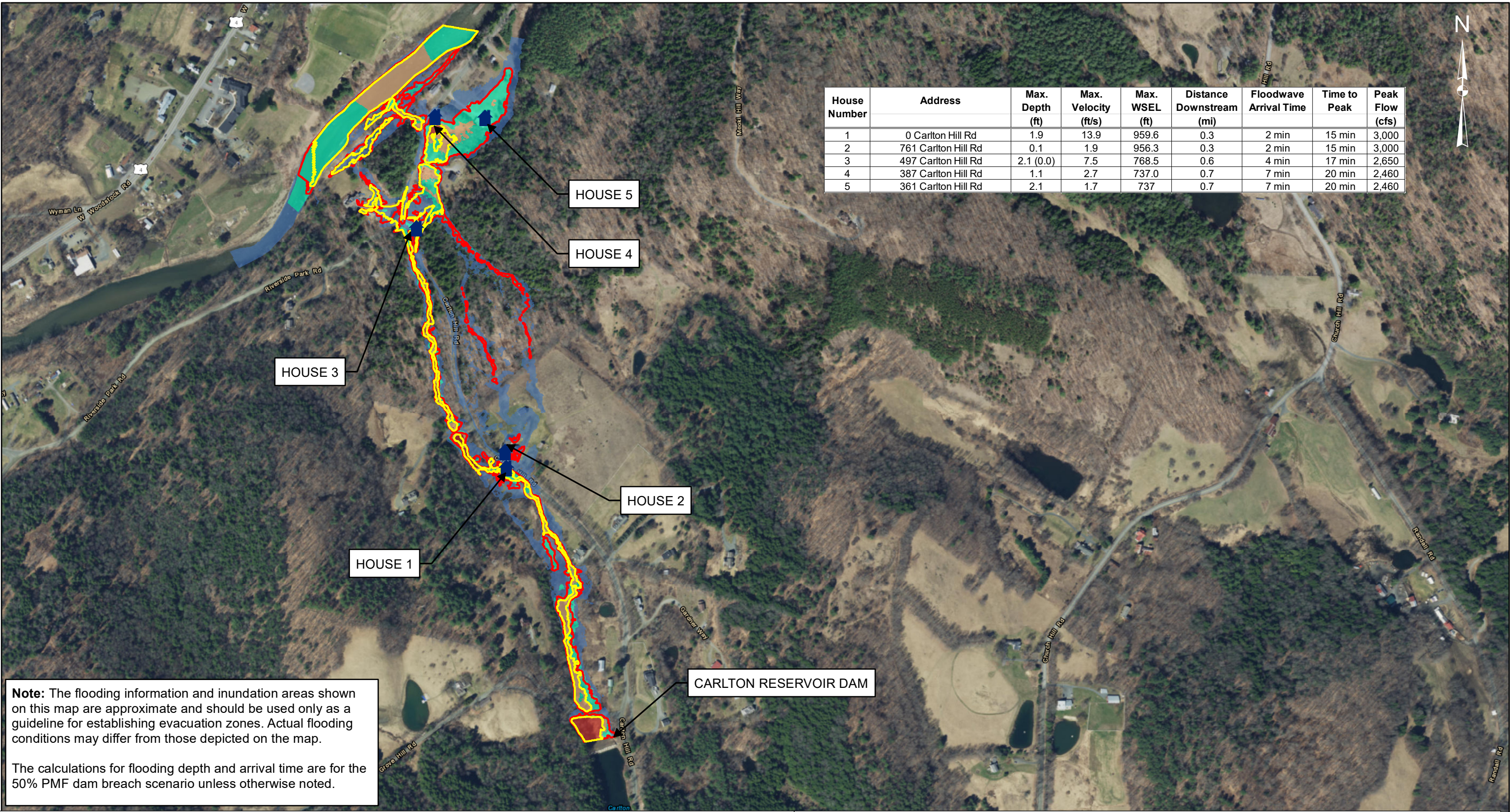
CURTIS POND DAM
CALAIS, VERMONT

PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

FIGURE 3.1

7/26/2019 10:38:16 AM G:\2019\Albany\19C25003_00_Vermont_2019 Hazard Class Study\03-SEProducts\07-GIS\03-Maps\Carlton_InundationMap.mxd eisenstein



House Number	Address	Max. Depth (ft)	Max. Velocity (ft/s)	Max. WSEL (ft)	Distance Downstream (mi)	Floodwave Arrival Time	Time to Peak	Peak Flow (cfs)
1	0 Carlton Hill Rd	1.9	13.9	959.6	0.3	2 min	15 min	3,000
2	761 Carlton Hill Rd	0.1	1.9	956.3	0.3	2 min	15 min	3,000
3	497 Carlton Hill Rd	2.1 (0.0)	7.5	768.5	0.6	4 min	17 min	2,650
4	387 Carlton Hill Rd	1.1	2.7	737.0	0.7	7 min	20 min	2,460
5	361 Carlton Hill Rd	2.1	1.7	737	0.7	7 min	20 min	2,460

Legend

- Carlton_Houses
- Sunny Day
- 50% PMF No Breach
- 50% PMF Breach
- 0 - 2
- 4 - 6
- 6+
- Max. Flood Depth (ft)

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA,

05001,000

Feet

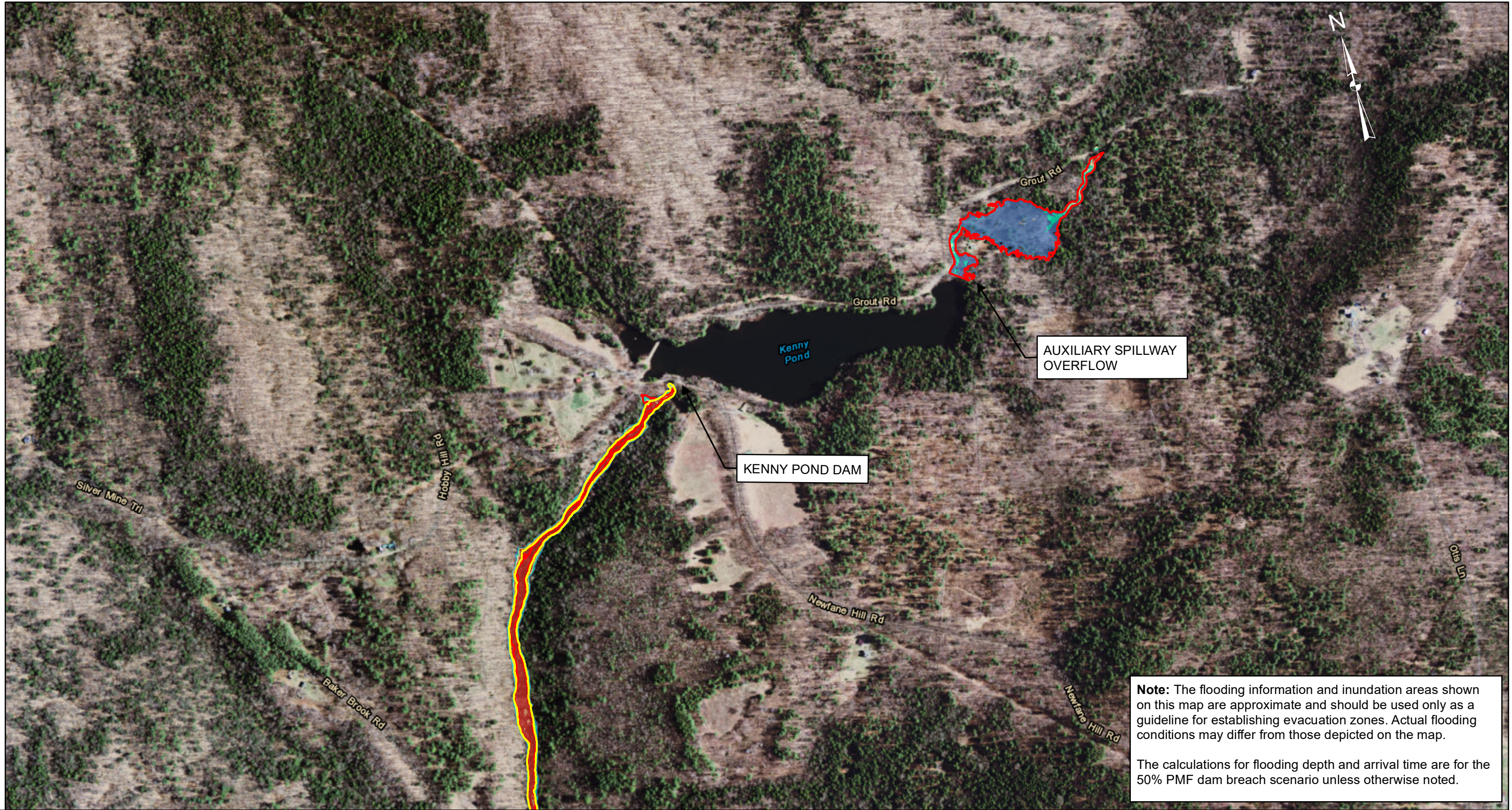
Scale: 1 inch equals 500 feet

CARLTON RESERVOIR DAM
WOODSTOCK, VERMONT
PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

FIGURE 3.2

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Note: The flooding information and inundation areas shown on this map are approximate and should be used only as a guideline for establishing evacuation zones. Actual flooding conditions may differ from those depicted on the map.

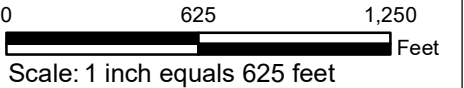
The calculations for flooding depth and arrival time are for the 50% PMF dam breach scenario unless otherwise noted.

Legend

- | | | |
|---|---|---|
|  Impacted Houses | 50% PMF Dam Breach |  4 - 6 |
|  Sunny Day Breach | Max. Flood Depth (ft) |  6 - 8 |
|  50% PMF No Breach |  0 - 2 |  8+ |
| |  2 - 4 | |



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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA,



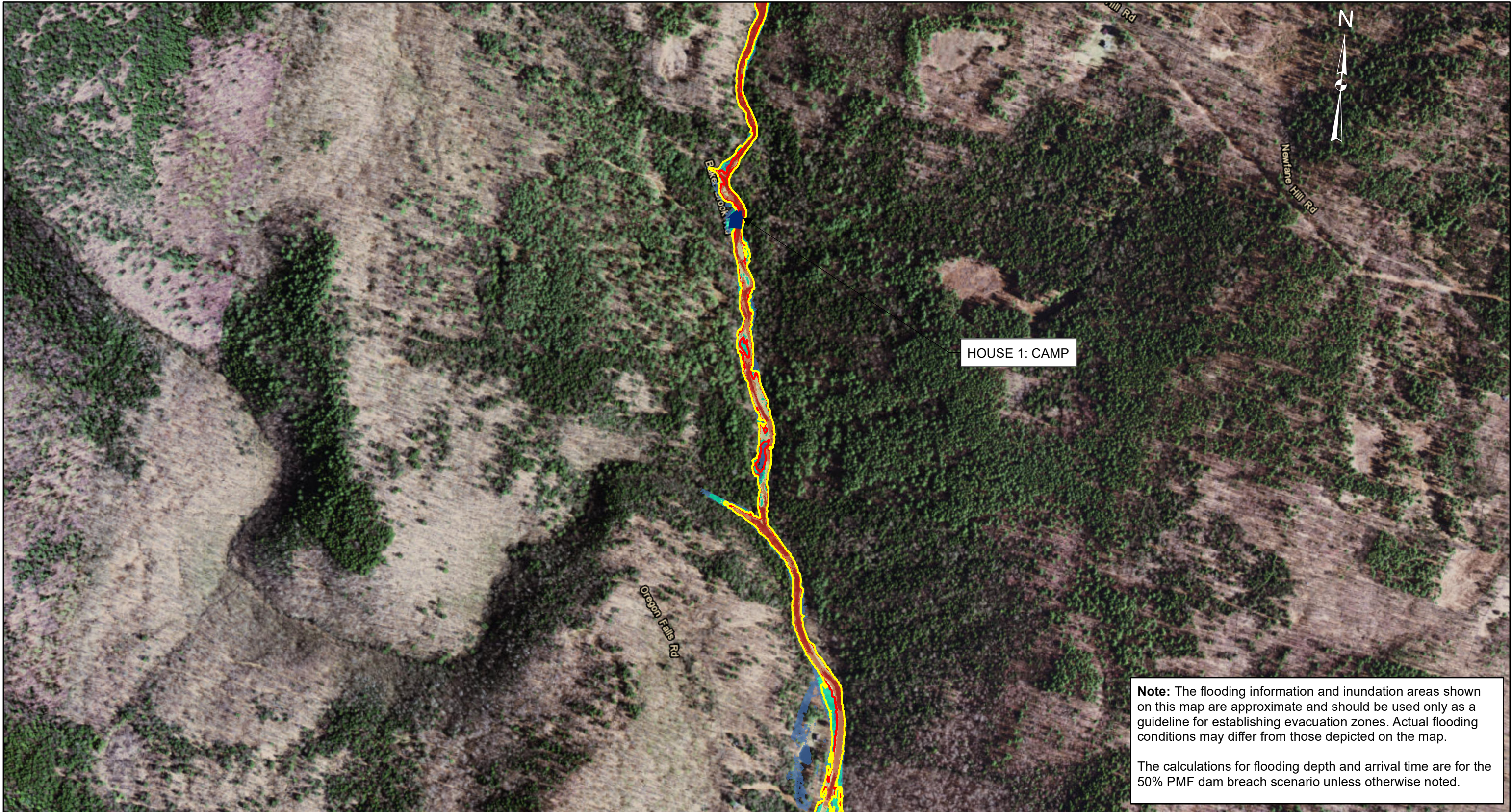
KENNY POND DAM
NEWFANE, VERMONT

PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

FIGURE 3.4
(SHEET 1 of 5)

7/26/2019 11:00:45 AM G:\2019\Albany\19C25003_00_Vermont_2019 Hazard Class Study\03-SEProducts\07-GIS\03-Maps\Kenny_InundationMap2_071019.mxd eisenstein



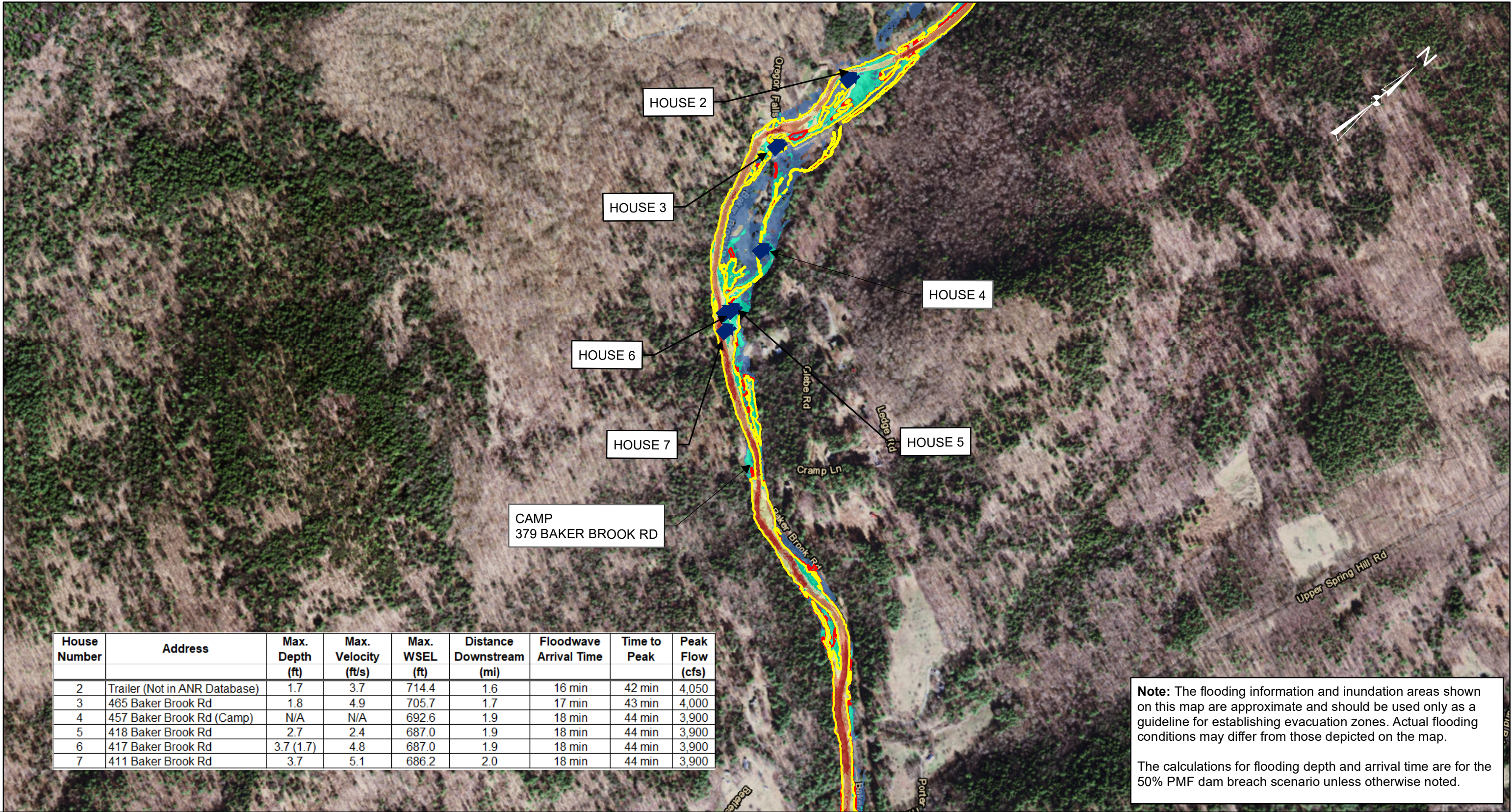
Legend

- | | | |
|---|---|---|
|  Impacted Houses | 50% PMF Dam Breach |  4 - 6 |
|  Sunny Day Breach | Max. Flood Depth (ft) |  6 - 8 |
|  50% PMF No Breach |  0 - 2 |  8+ |
| |  2 - 4 | |



Source: Esri, HERE, Garmin, (c) OpenStreetMap contributors Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA,			0 625 1,250 Feet Scale: 1 inch equals 625 feet
	KENNY POND DAM NEWFANE, VERMONT PROJECT NO. 19C25003.00	DAM BREACH INUNDATION MAP FIGURE 3.4 (SHEET 2 of 5)	

7/26/2019 11:00:45 AM G:\2019\Albany\19C25003_00_Vermont_2019 Hazard Class Study\03-SEProducts\07-GIS\03-Maps\Kenny_InundationMap2_071019.mxd eisenstein



Note: The flooding information and inundation areas shown on this map are approximate and should be used only as a guideline for establishing evacuation zones. Actual flooding conditions may differ from those depicted on the map.

The calculations for flooding depth and arrival time are for the 50% PMF dam breach scenario unless otherwise noted.

House Number	Address	Max. Depth (ft)	Max. Velocity (ft/s)	Max. WSEL (ft)	Distance Downstream (mi)	Floodwave Arrival Time	Time to Peak	Peak Flow (cfs)
2	Trailer (Not in ANR Database)	1.7	3.7	714.4	1.6	16 min	42 min	4,050
3	465 Baker Brook Rd	1.8	4.9	705.7	1.7	17 min	43 min	4,000
4	457 Baker Brook Rd (Camp)	N/A	N/A	692.6	1.9	18 min	44 min	3,900
5	418 Baker Brook Rd	2.7	2.4	687.0	1.9	18 min	44 min	3,900
6	417 Baker Brook Rd	3.7 (1.7)	4.8	687.0	1.9	18 min	44 min	3,900
7	411 Baker Brook Rd	3.7	5.1	686.2	2.0	18 min	44 min	3,900

Legend

Impacted Houses

Sunny Day Breach

50% PMF No Breach

50% PMF Dam Breach

Max. Flood Depth (ft)

0 - 2

2 - 4

4 - 6

6 - 8

8+



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KENNY POND DAM
NEWFANE, VERMONT

PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

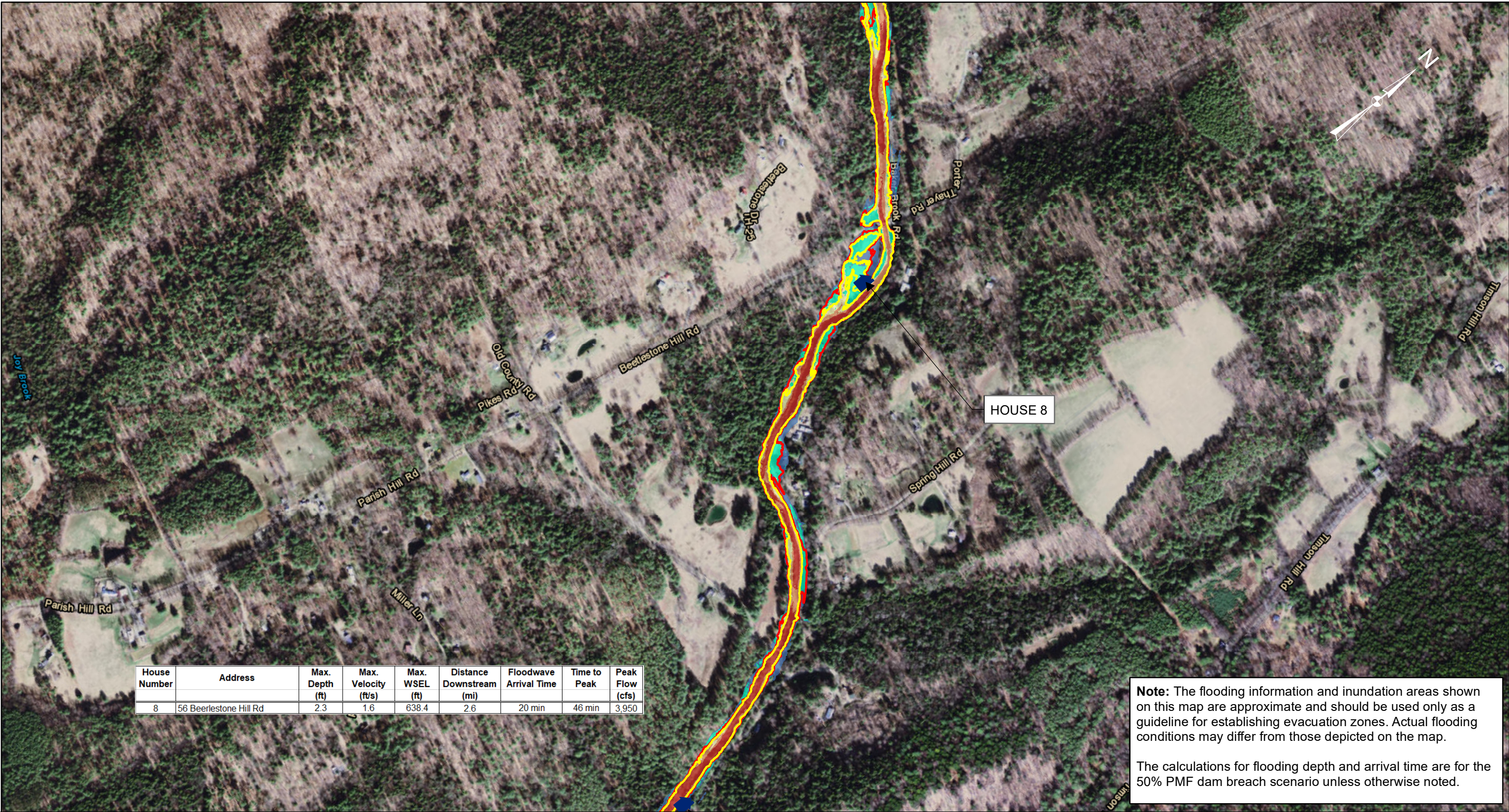
FIGURE 3.4
(SHEET 3 of 5)

06251,250

Feet

Scale: 1 inch equals 625 feet

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Legend

- Impacted Houses

Sunny Day Breach

50% PMF No Breach
- 50% PMF Dam Breach**

Max. Flood Depth (ft)

0 - 2

2 - 4

4 - 6

6 - 8

8+



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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA,

KENNY POND DAM
NEWFANE, VERMONT

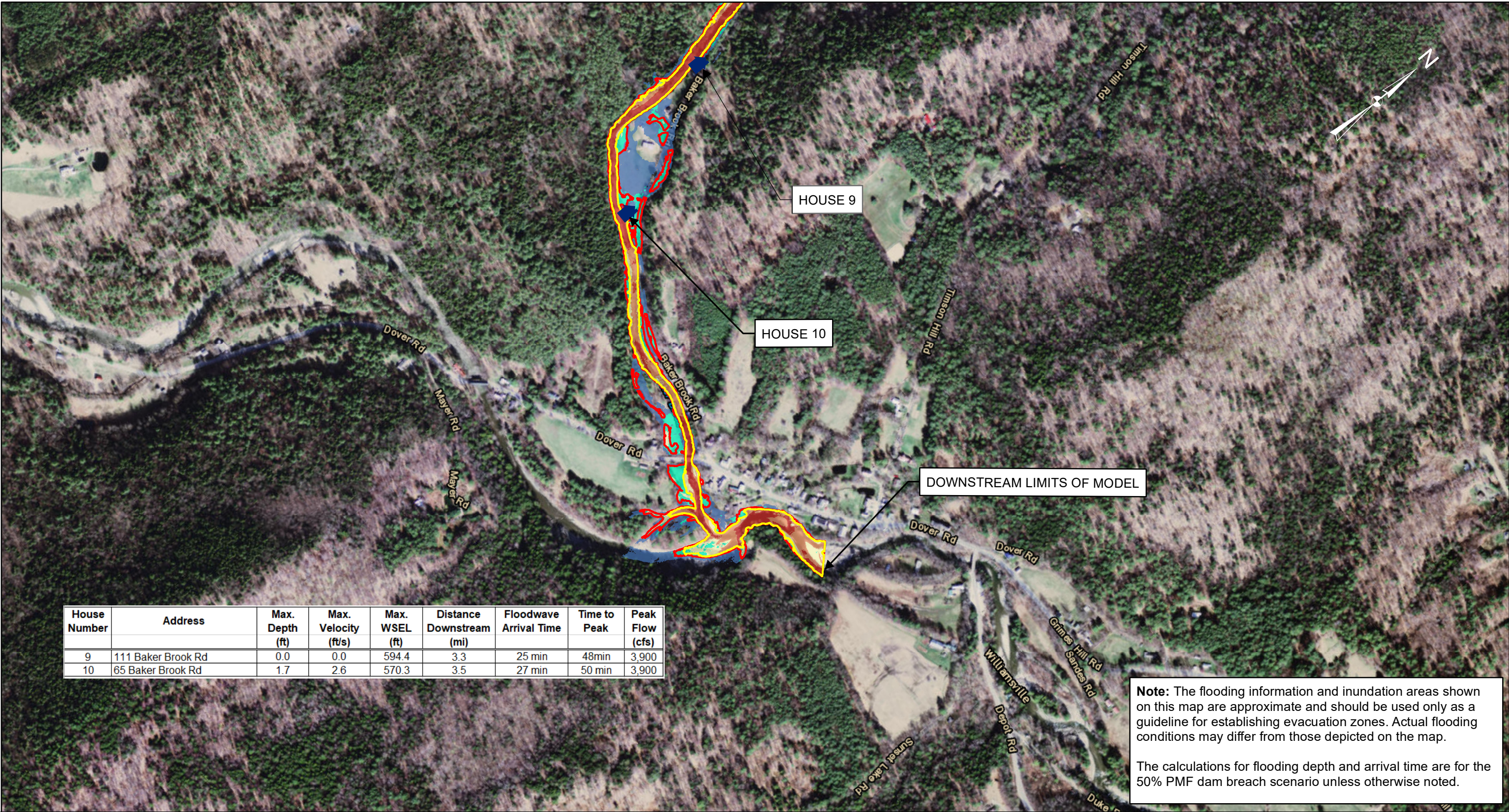
PROJECT NO. 19C25003.00

0 625 1,250
Feet
Scale: 1 inch equals 625 feet

**DAM BREACH
INUNDATION MAP**

FIGURE 3.4
(SHEET 4 of 5)

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House Number	Address	Max. Depth (ft)	Max. Velocity (ft/s)	Max. WSEL (ft)	Distance Downstream (mi)	Floodwave Arrival Time	Time to Peak	Peak Flow (cfs)
9	111 Baker Brook Rd	0.0	0.0	594.4	3.3	25 min	48min	3,900
10	65 Baker Brook Rd	1.7	2.6	570.3	3.5	27 min	50 min	3,900

Note: The flooding information and inundation areas shown on this map are approximate and should be used only as a guideline for establishing evacuation zones. Actual flooding conditions may differ from those depicted on the map.

The calculations for flooding depth and arrival time are for the 50% PMF dam breach scenario unless otherwise noted.

Legend

Impacted Houses

Sunny Day Breach

50% PMF No Breach

50% PMF Dam Breach

Max. Flood Depth (ft)

0 - 2

2 - 4

4 - 6

6 - 8

8+



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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA,

KENNY POND DAM
NEWFANE, VERMONT

PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

FIGURE 3.4

(SHEET 5 of 5)

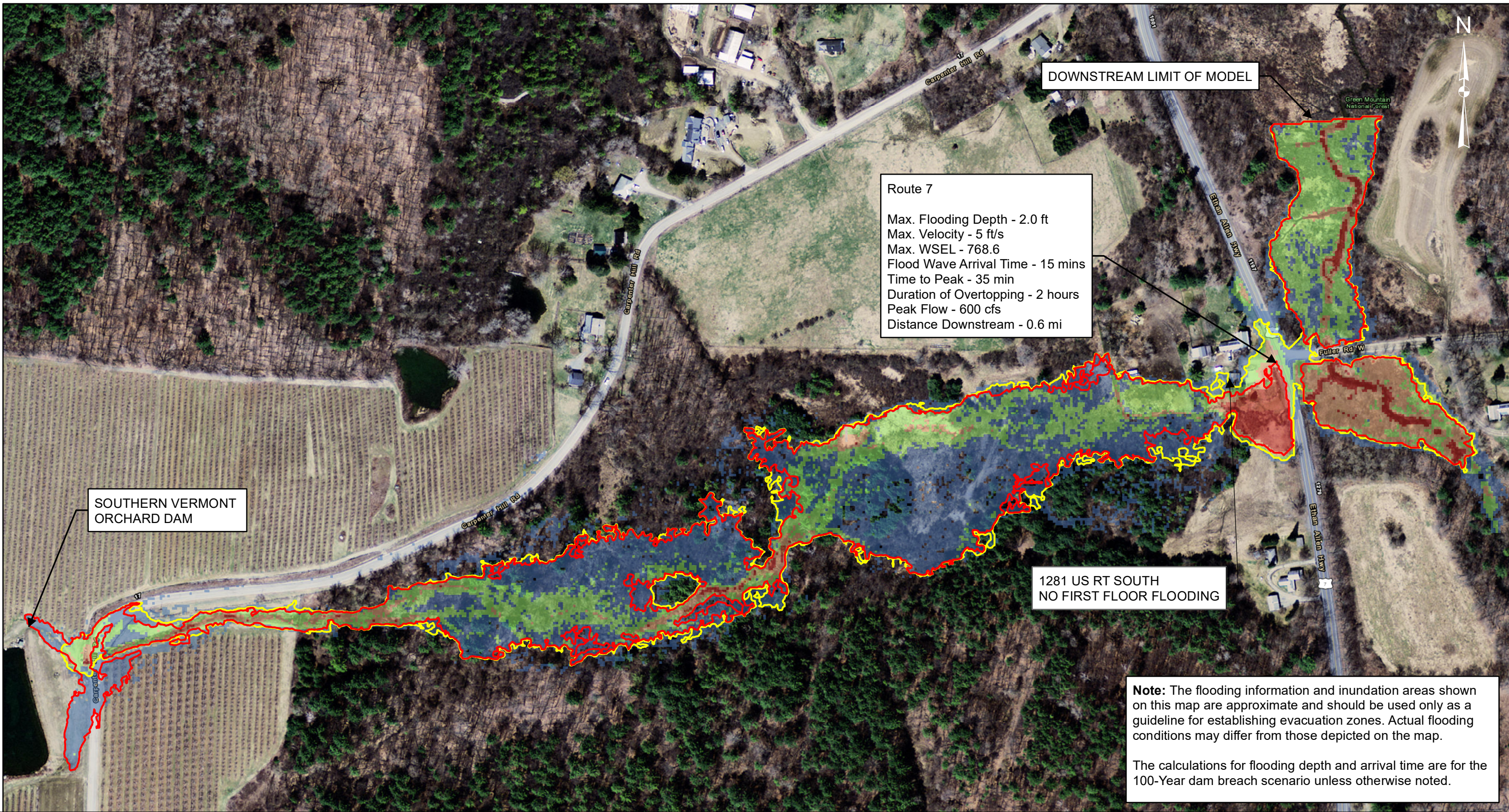
0 625 1,250

Feet

Scale: 1 inch equals 625 feet

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Legend

100 Year No Breach

Sunny Day

100 Year Breach

Max. Flood Depth (ft)

0 - 1

1 - 2

2 - 3

3+

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0

250

500

Feet

Scale: 1 inch equals 250 feet

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SOUTHERN VERMONT ORCHARD DAM
BENNINGTON, VERMONT

PROJECT NO. 19C25003.00

DAM BREACH
INUNDATION MAP

FIGURE 3.4

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