

APPENDIX C:
Public Meeting Materials



Listening Meeting General Outline

1. Meeting Kickoff	Town	6:00
2. Overview of the General Scope of the Study	Pare	6:10
3. Present Supporting Figures & Site Photographs	Pare	6:15
4. Open Discussion	All Attendees	6:30 – 7:30

General Scope: Planning Study for the Mumford River / Dark Brook watershed and river corridor with particular focus on flooding issues within the Manchaug Village area.

The Listening Session

a) Hydrologic and Hydraulic (H&H) Analyses of Existing Conditions (EC)

- i. Data Collection – Completed September
- ii. Develop HydroCAD Model of Entire Watershed and Adjoining Watersheds
- iii. Develop HEC-RAS Hydraulic Model of Flooding Area of Interest
- iv. Run all storms (1-year through 1,000-year) through the Hydraulic Model
- v. Review and Refine the Model and Model Inputs as needed

b) Decipher EC Model Results & Identify Strengths & Vulnerabilities

- i. Structures Vulnerable to Flood Damage
- ii. Hydraulic Structure Performance
 - Dams

a) Upper Tucker Pond Dams	d) Mill Site #2 Dam
b) Manchaug Pond Dam	e) Potter Road Dam
c) Stevens Pond Dam	f) Sutton Falls Dam
 - Roadway Crossings

1. Putnam Hill Road (2 each)	4. Whitins Road (2 each)
2. Tucker Lane	5. Torrey Road
3. Manchaug Road (4 each)	6. Potter Road
- iii. Other
 - Beaver Dams along Dark Brook (2 for sure; possibly as many as 6 total)
 - Former Dams Partially Removed/Breached (Mill Site #1, Upstream of Putnam Hill Road)
 - River and Floodplain Performance
 - Watershed Characteristics (Land Cover and Soils)

The Problem Meeting

c) Develop & Evaluate Potential Alternatives

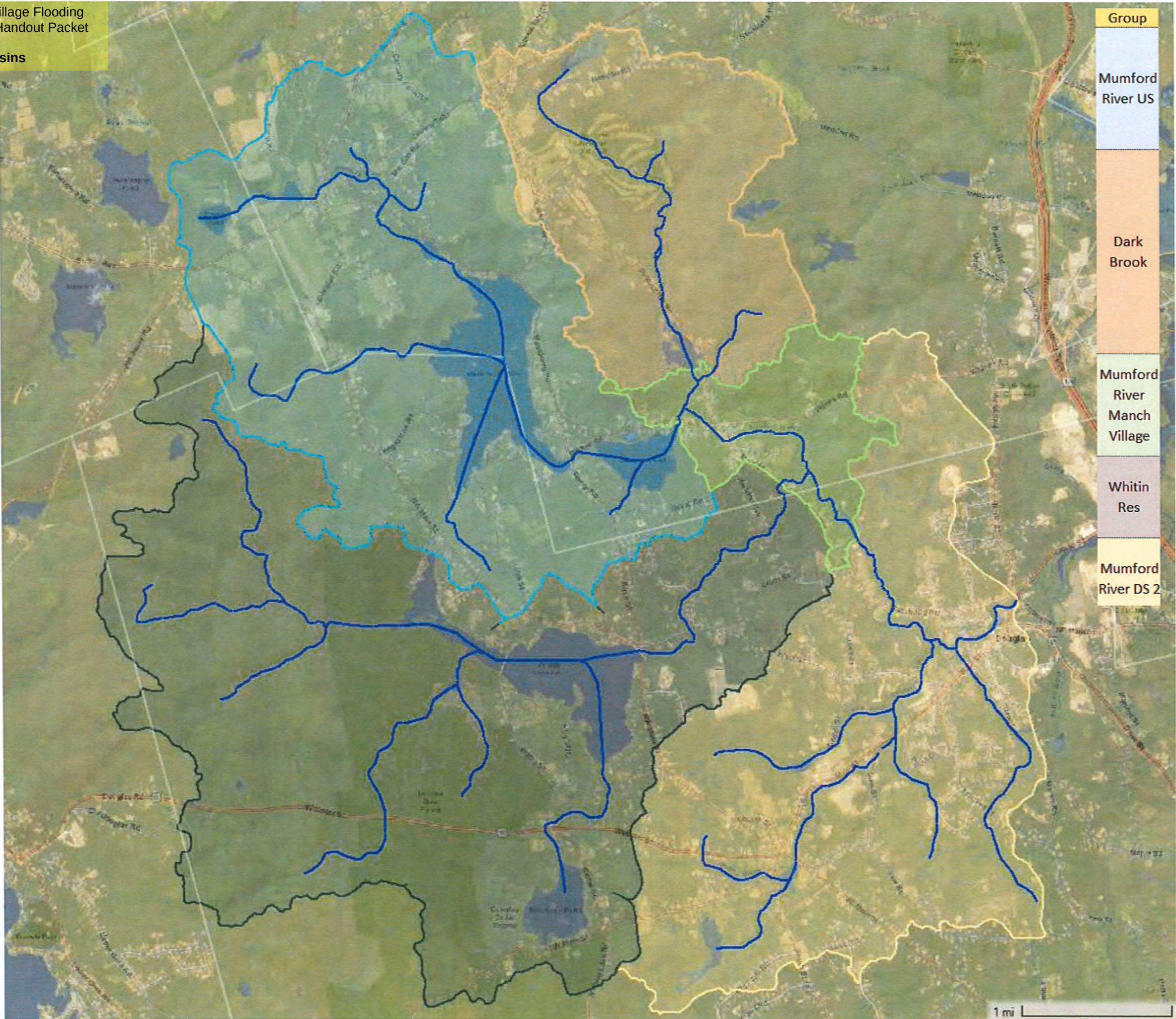
- | | |
|-----------------------------------|--------------------------------|
| i. Structure Floodproofing | vi. Beaver Maintenance |
| ii. Dam Modifications | vii. Land Cover Preservation |
| iii. Dam Removals | viii. Infiltration Improvement |
| iv. Roadway Crossing Replacements | ix. Attenuation Improvement |
| v. River & Floodplain Restoration | |

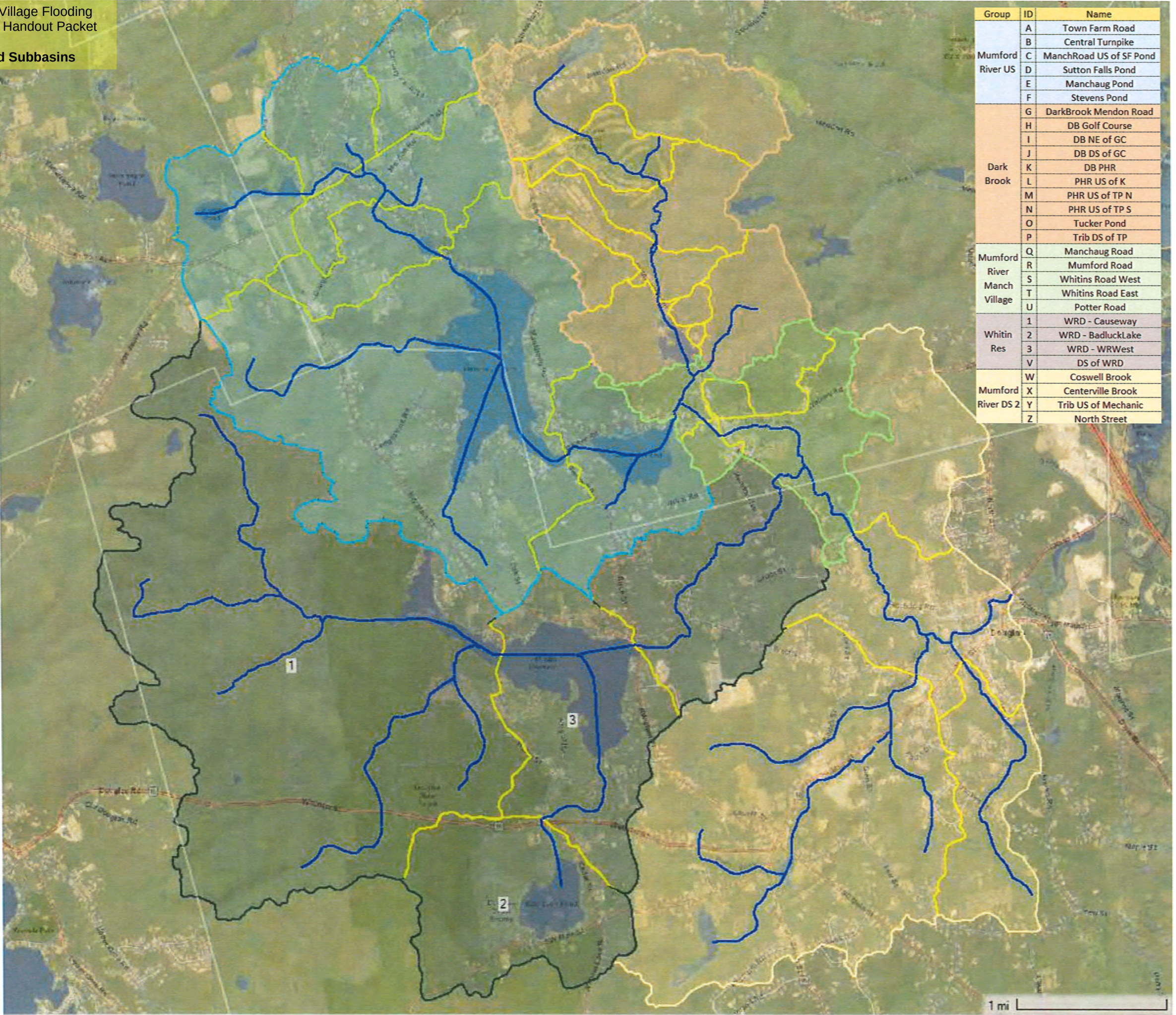
The Solutions Meeting

d) Summary Report

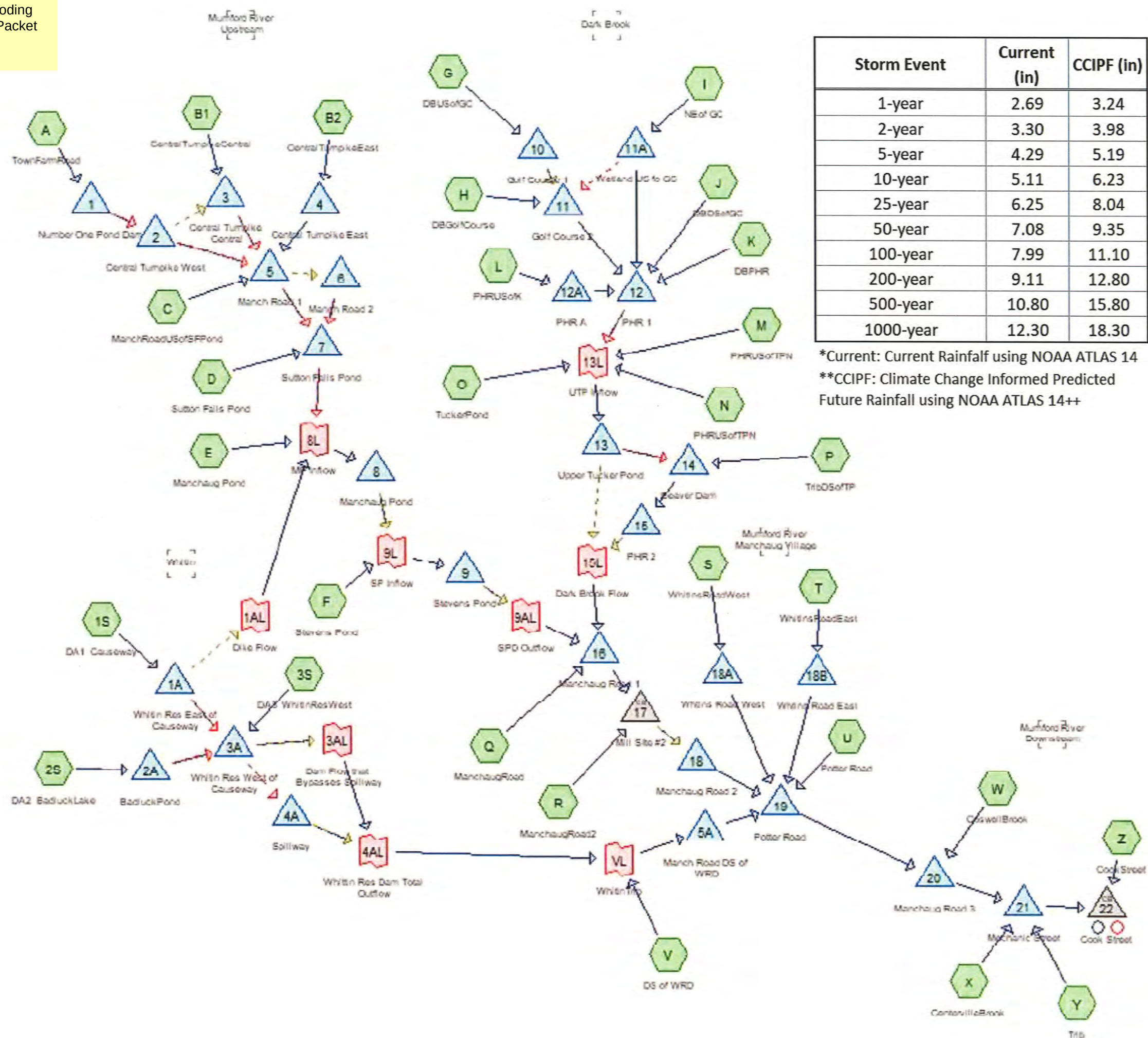
The Closing Meeting

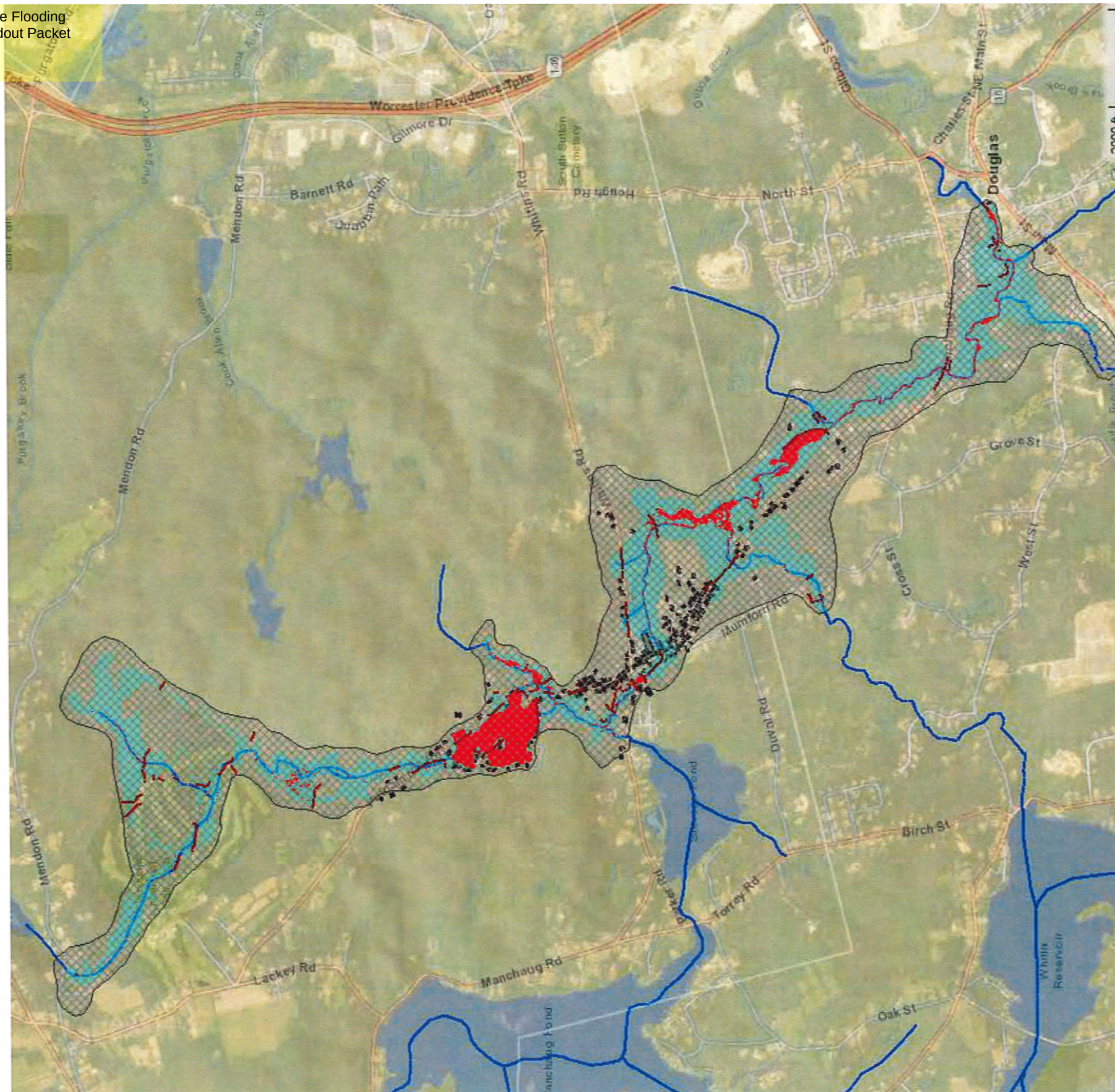


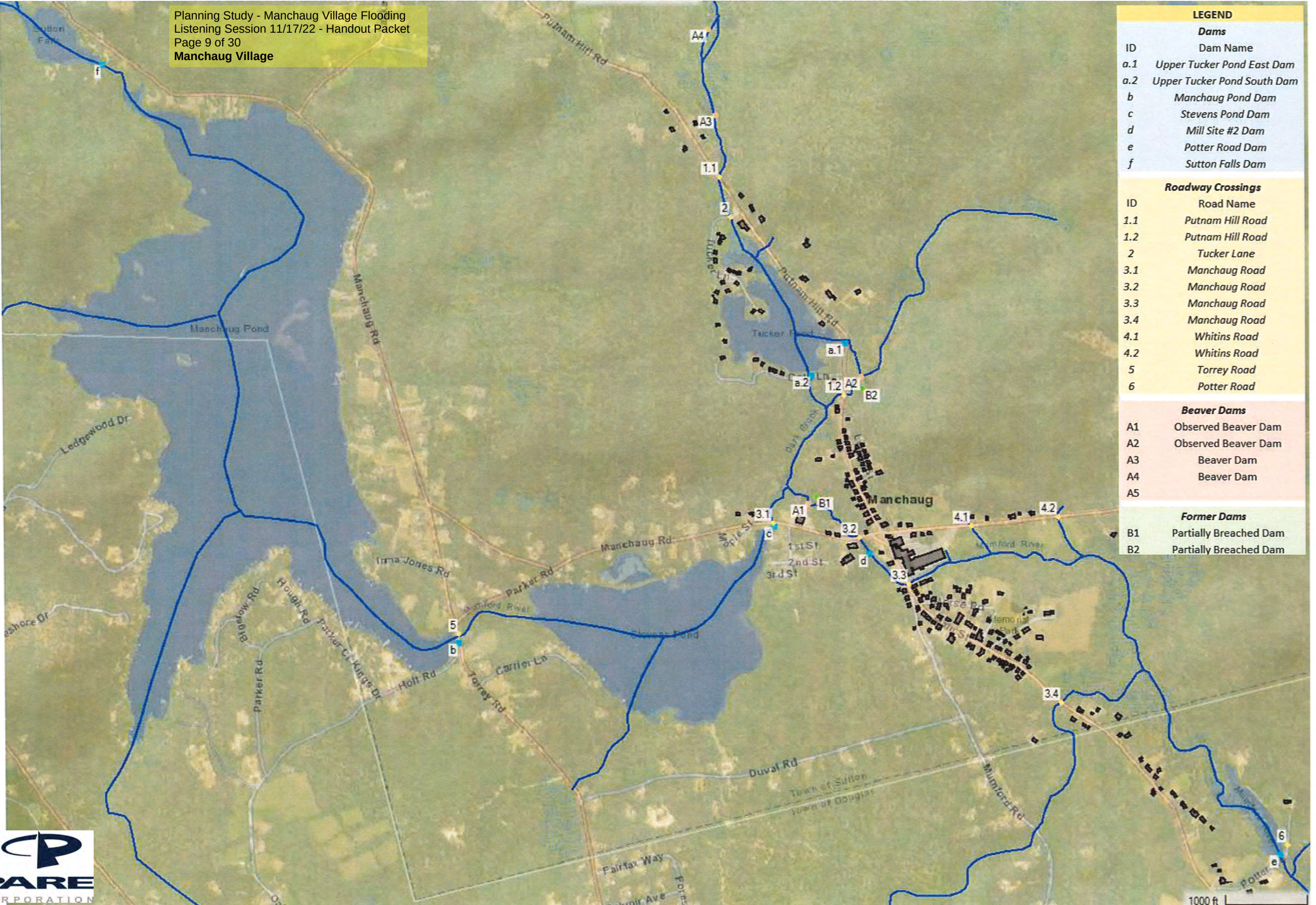




Drainage Area Parameters																			
			Size		Tc		Curve Number					Hydrologic Soil Group				Land Cover Group			
Group	ID	Name	s.m.	acres	Baseflow	Tc	LFP	CN	% Imp	Imp acres	CN*	A	B	C	D	1	2	3	4
Mumford River US	A	Town Farm Road	0.74	473	1.5	461	2700	78	9.0%	43	76	0%	0%	80%	20%	52%	32%	7%	9%
	B	Central Turnpike	0.91	582	1.8	443	4300	70	5.3%	31	68	4%	44%	29%	23%	59%	25%	11%	5%
	C	ManchRoad US of SF Pond	0.67	427	1.3	388	4500	73	4.6%	20	72	3%	27%	40%	30%	58%	24%	13%	5%
	D	Sutton Falls Pond	0.49	314	1.0	396	7700	69	8.2%	26	66	4%	52%	18%	26%	57%	26%	9%	8%
	E	Manchaug Pond	3.94	2519	7.9	750	11600	72	17.6%	443	66	2%	37%	23%	38%	68%	9%	5%	18%
	F	Stevens Pond	0.93	593	1.9	415	7300	73	18.0%	107	68	3%	19%	52%	26%	72%	6%	4%	18%
Dark Brook	G	DarkBrook Mendon Road	0.60	382	1.2	267	4000	77	10.4%	40	75	0%	8%	59%	33%	60%	21%	9%	10%
	H	DB Golf Course	0.30	193	0.6	127	2000	69	1.9%	4	68	0%	65%	7%	28%	47%	44%	7%	2%
	I	DB NE of GC	0.59	375	1.2	280	3300	70	2.0%	8	69	0%	41%	25%	34%	75%	5%	18%	2%
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	M	PHR US of TP N	0.06	35	0.1	77	1800	60	1.8%	1	59	0%	82%	0%	18%	95%	1%	2%	2%
	N	PHR US of TP S	0.01	9	0.0	61	850	56	3.7%	0	55	11%	89%	0%	0%	81%	15%	0%	4%
	O	Tucker Pond	0.36	231	0.7	187	5600	69	14.3%	33	64	0%	45%	37%	18%	81%	2%	3%	14%
	P	Trib DS of TP	0.46	295	0.9	208	6200	64	0.7%	2	64	2%	57%	14%	27%	92%	0%	7%	1%
Mumford River Manch Village	Q	Manchaug Road	0.19	121	0.4	141	3200	63	7.9%	10	60	18%	58%	4%	20%	73%	9%	10%	8%
	R	Mumford Road	0.10	62	0.2	60	1500	65	11.9%	7	61	26%	29%	36%	9%	77%	12%	0%	12%
	S	Whitins Road West	0.07	45	0.1	45	1100	60	5.0%	2	58	37%	26%	9%	28%	80%	6%	9%	5%
	T	Whitins Road East	0.22	138	0.4	120	3800	59	1.3%	2	58	0%	88%	3%	9%	92%	1%	6%	1%
	U	Potter Road	0.63	405	1.3	406	6600	65	6.0%	24	63	21%	45%	21%	13%	62%	9%	23%	6%
Whitin Res	1	WRD - Causeway	6.04	3867	12.1	1235	20000	62	2.9%	112	61	2%	71%	13%	14%	86%	1%	10%	3%
	2	WRD - BadluckLake	1.35	867	2.7	294	8200	73	13.7%	119	69	2%	26%	59%	13%	66%	2%	18%	14%
	3	WRD - WRWest	1.55	992	3.1	258	10000	74	31.6%	313	63	5%	23%	30%	42%	56%	9%	4%	32%
	V	DS of WRD	1.44	920	2.9	461	6600	66	3.7%	34	65	6%	41%	47%	6%	81%	8%	8%	4%
Mumford River DS 2	W	Coswell Brook	0.89	571	1.8	660	12500	67	2.0%	11	66	4%	56%	23%	17%	74%	5%	19%	2%
	X	Centerville Brook	3.96	2537	7.9	1000	12000	61	7.1%	180	58	27%	45%	21%	7%	67%	14%	12%	7%
	Y	Trib US of Mechanic	0.79	504	1.6	500	10800	58	5.7%	29	56	39%	24%	31%	6%	74%	11%	10%	6%
	Z	North Street	1.09	696	2.2	600	9800	59	12.2%	85	54	41%	49%	10%	0%	59%	18%	11%	12%
Totals			29.39	18809	58.8				9.0%	1697		11%	40%	27%	22%	69%	13%	9%	9%
Hydrologic Soil Group										Land Cover Group									
A	High Absorption		Clean Sands & Gravels (<10% fines)							1	High Absorption		Forests, Shrubs, Grass						
B	Moderate Absorption		Silty Sands & Gravels (10-20% fines)							2	Moderate Absorption		Bare, Cultivated/Pasture						
C	Low Absorption		Sandy Silts & Silts (20-40% fines)							3	Low Absorption		Wetlands, Aquatic Beds						
D	Very Low / No Absorption		Silts & Clays (>40% fines), Bedrock, Water							4	Very Low / No Absorption		Impervious						







LEGEND	
Dams	
ID	Dam Name
a.1	Upper Tucker Pond East Dam
a.2	Upper Tucker Pond South Dam
b	Manchaug Pond Dam
c	Stevens Pond Dam
d	Mill Site #2 Dam
e	Potter Road Dam
f	Sutton Falls Dam
Roadway Crossings	
ID	Road Name
1.1	Putnam Hill Road
1.2	Putnam Hill Road
2	Tucker Lane
3.1	Manchaug Road
3.2	Manchaug Road
3.3	Manchaug Road
3.4	Manchaug Road
4.1	Whitins Road
4.2	Whitins Road
5	Torrey Road
6	Potter Road
Beaver Dams	
A1	Observed Beaver Dam
A2	Observed Beaver Dam
A3	Beaver Dam
A4	Beaver Dam
A5	
Former Dams	
B1	Partially Breached Dam
B2	Partially Breached Dam



Photo No. 1.: Upper Tucker Pond East Dam spillway controls (a.1)



Photo No. 2.: Upper Tucker Pond East Dam discharge end of spillway culvert (a.1)



Photo No. 3.: Upper Tucker Pond South Dam low area at right end of dam that serves as informal auxiliary spillway (a.2)



Photo No. 4.: Upper Tucker Pond South Dam from low area looking left (a.2)



Photo No. 5.: Manchaug Pond Dam upstream face (b)



Photo No. 6.: Manchaug Pond Dam spillway controls (b)



Photo No. 7.: Stevens Pond Dam spillway controls (c)



Photo No. 8.: Stevens Pond Dam crest overview (c)



Photo No. 9.: Mill Site #2 Dam upstream face. (d)



Photo No. 10.: Mill Site #2 Dam downstream face (d)



Photo No. 11.: Potter Road Dam downstream face left (e)



Photo No. 12.: Potter Road Dam downstream face right (e)



Photo No. 13.: Sutton Falls Dam upstream face (f)



Photo No. 14.: Sutton Falls Dam downstream face (f)



Photo No. 15.: Putnam Hill Road (1.1)



Photo No. 16.: Putnam Hill Road bridge crossing looking upstream (1.1)



Photo No. 17.: Putnam Hill Road (1.2)



Photo No. 18.: Putnam Hill Road culvert crossing upstream end (1.2)



Photo No. 19.: Tucker Lane (2)



Photo No. 20.: Tucker Lane bridge overview from downstream looking upstream (2)



Photo No. 21.: Manchaug Road (3.1)



Photo No. 22.: Manchaug Road bridge (3.1)



Photo No. 23.: Manchaug Road (3.2)



Photo No. 24.: Manchaug Road bridge (3.2)



Photo No. 25.: Manchaug Road 3.3



Photo No. 26.: Manchaug Road bridge looking upstream (3.3)



Photo No. 27.: Manchaug Road culvert upstream end (3.4)



Photo No. 28.: Manchaug Road culvert discharge area / downstream channel (3.4)



Photo No. 29.: Whitins Road culvert from downstream end (4.2)



Photo No. 30.: Potter Road bridge (6)



Photo No. 31.: 3-foot high beaver dam (A1) that has formed within breached section of the former dam embankment at Mill Site #1 (B1).



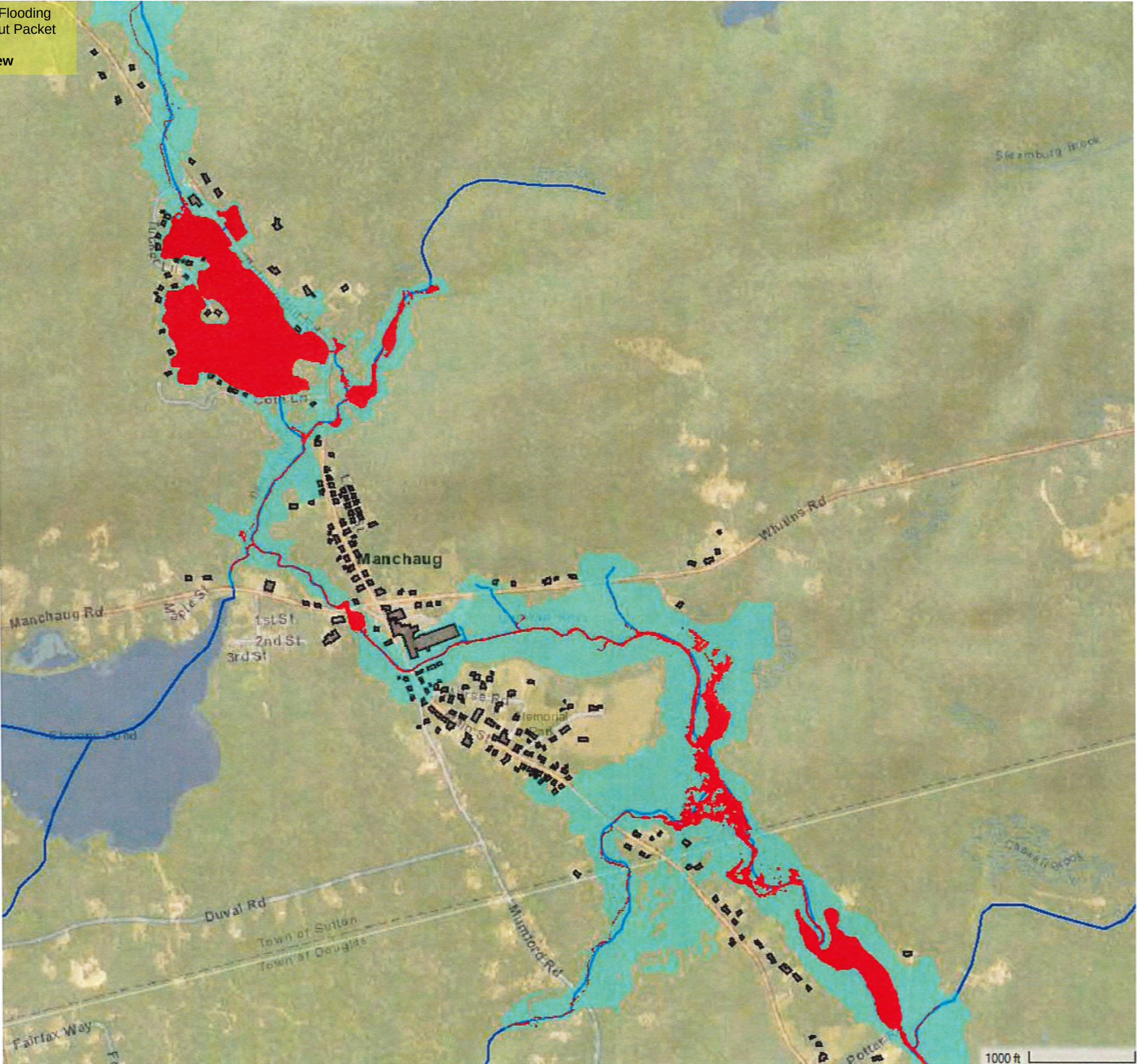
Photo No. 32.: Another view of the 3-foot high beaver dam (A1) that has formed within breached section of the former dam embankment at Mill Site #1 (B1).

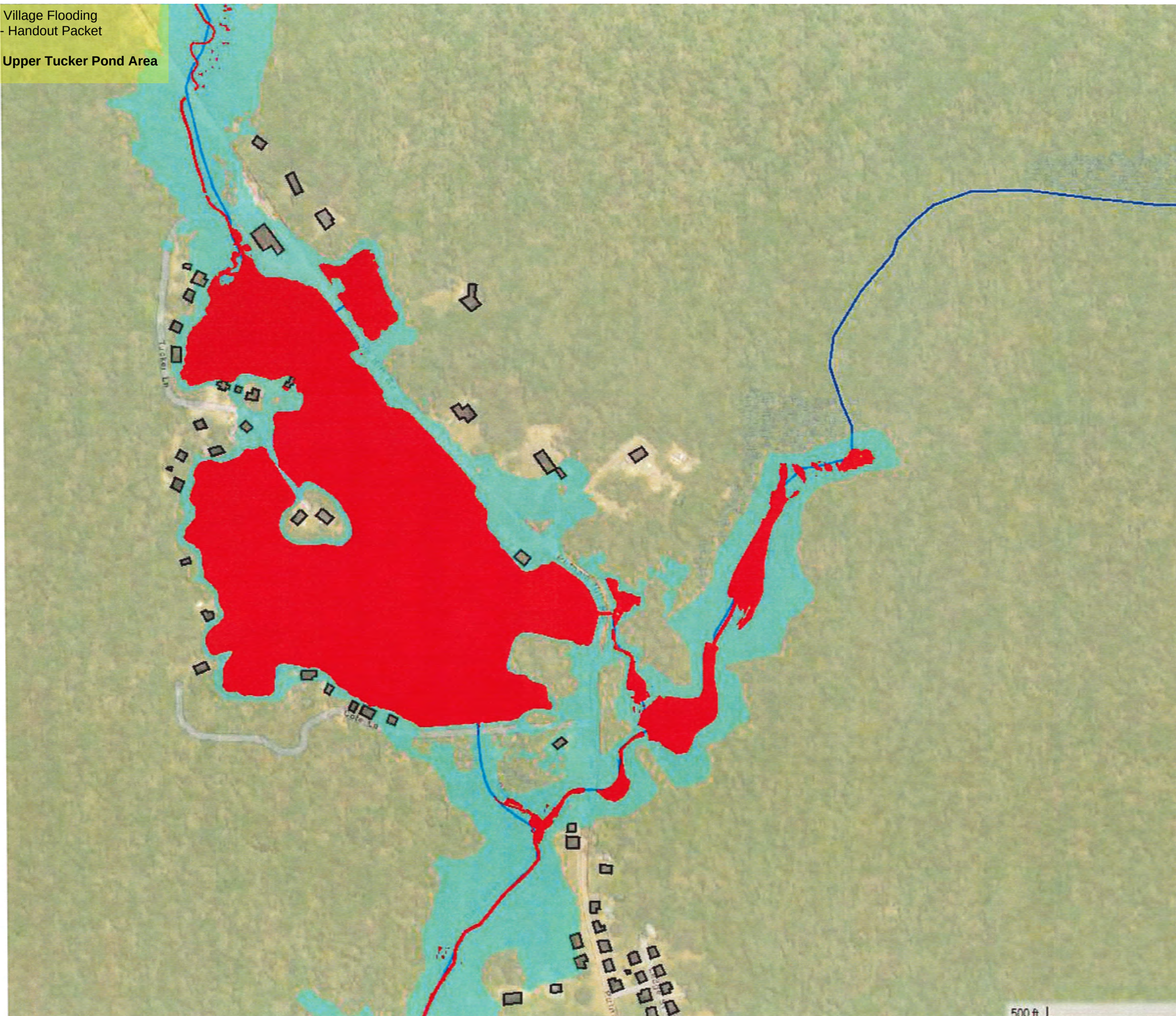


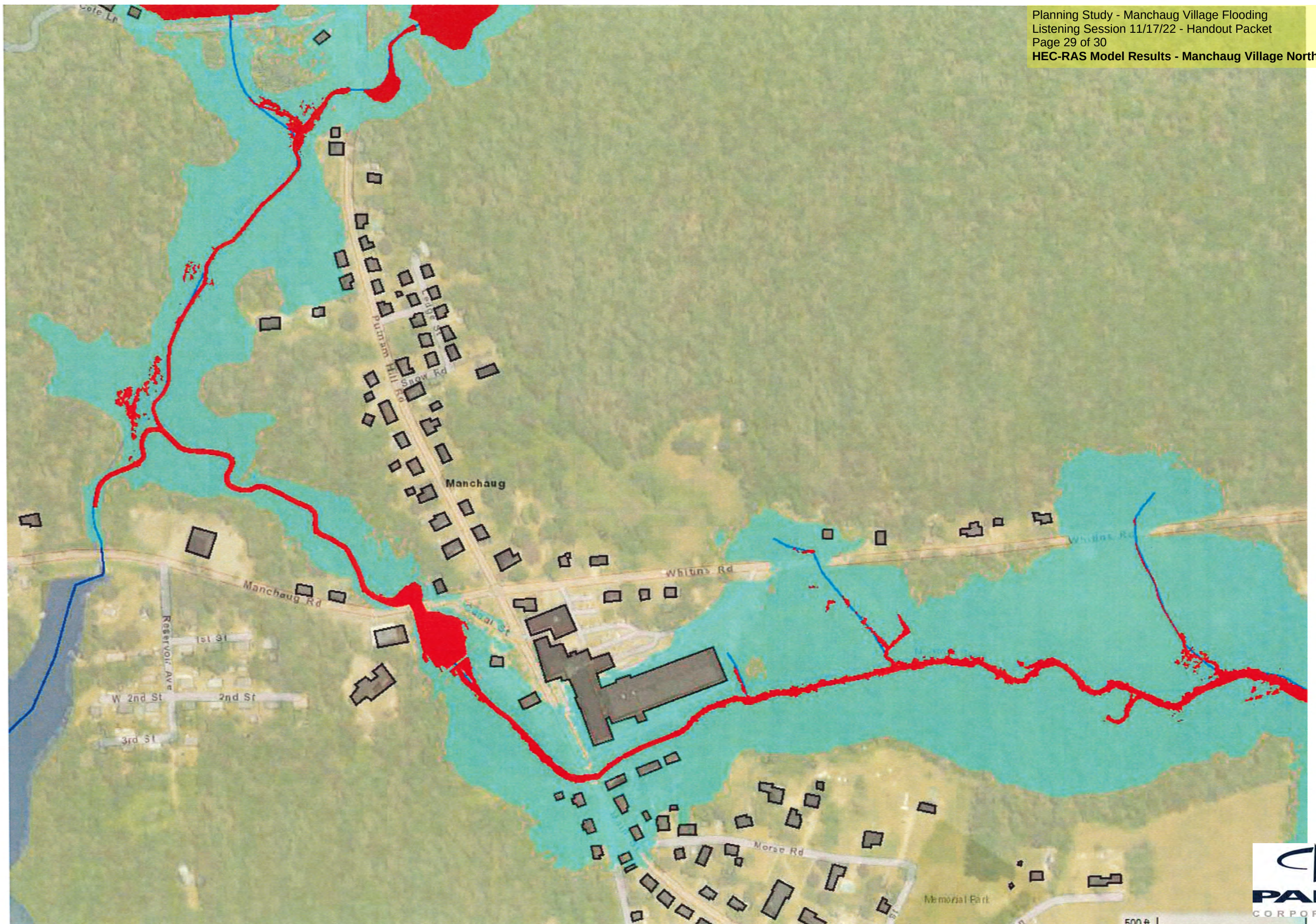
Photo No. 33.: View of the 6-foot high beaver dam (A2) that has formed within the breached section of a former dam embankment (B2).

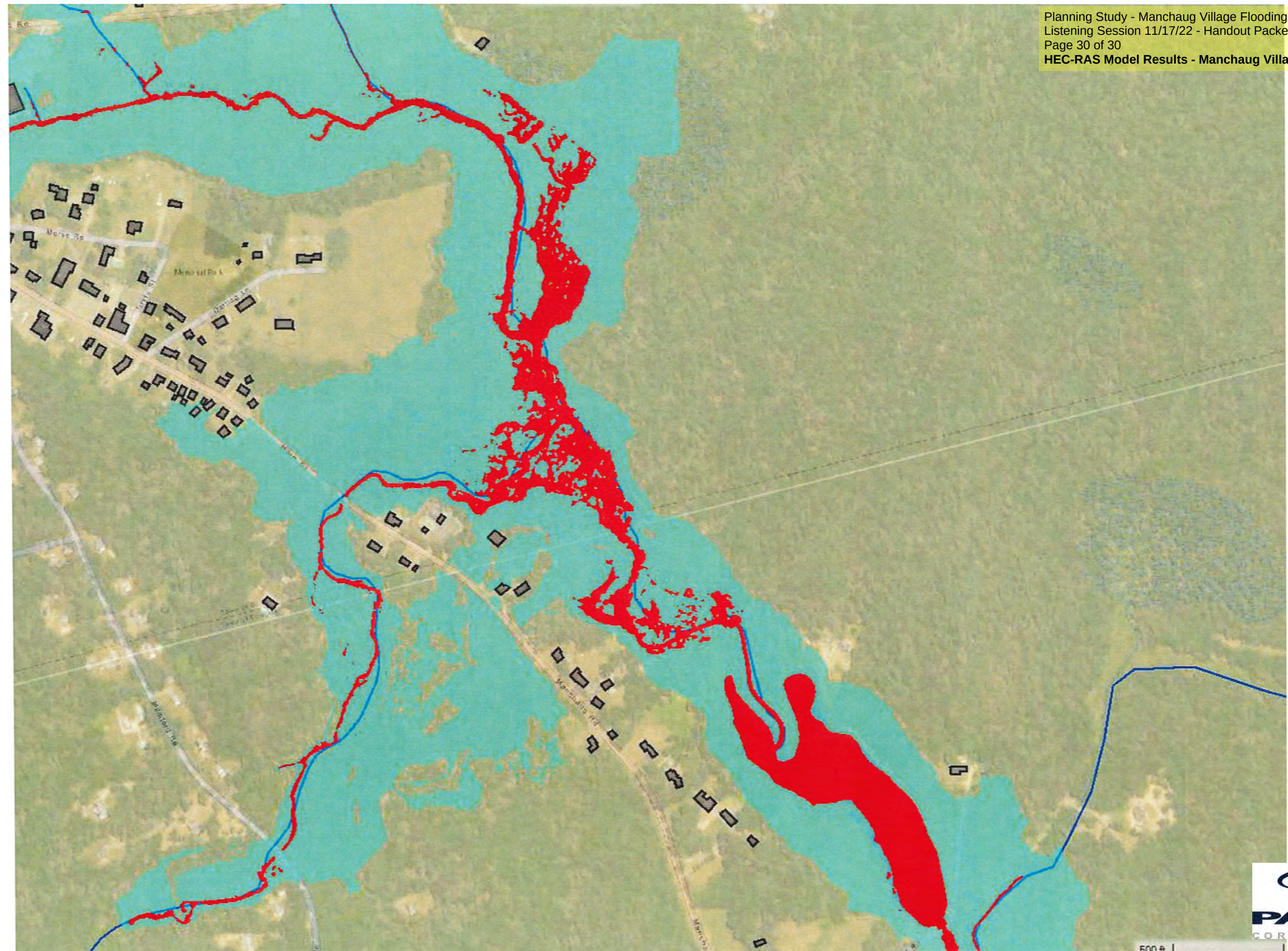


Photo No. 34.: View of the impoundment created by this beaver dam; note the beaver inlet cage photo right (A2 / B2)









MANCHAUG VILLAGE FLOODING PLANNING STUDY



MVP

Municipal Vulnerability
Preparedness



Second Public Meeting
"The Problem"
MARCH 16, 2023



Planning Study Overview

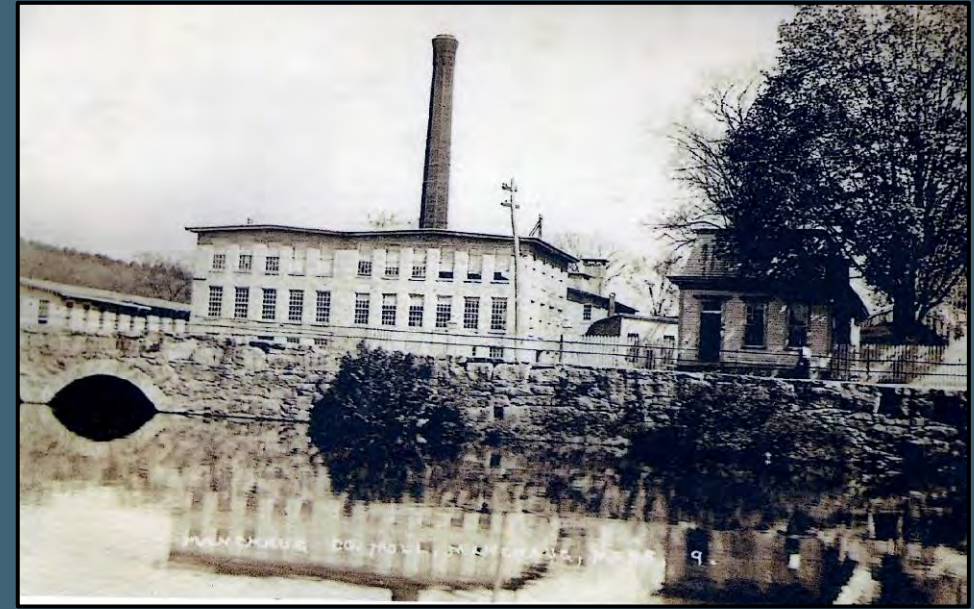
- ▶ General Scope: Planning Study for the Mumford River / Dark Brook watershed and river corridor with a specific focus on the issue of flooding within Manchaug Village

- ▶ Scope & Schedule



The Problem Meeting - Agenda

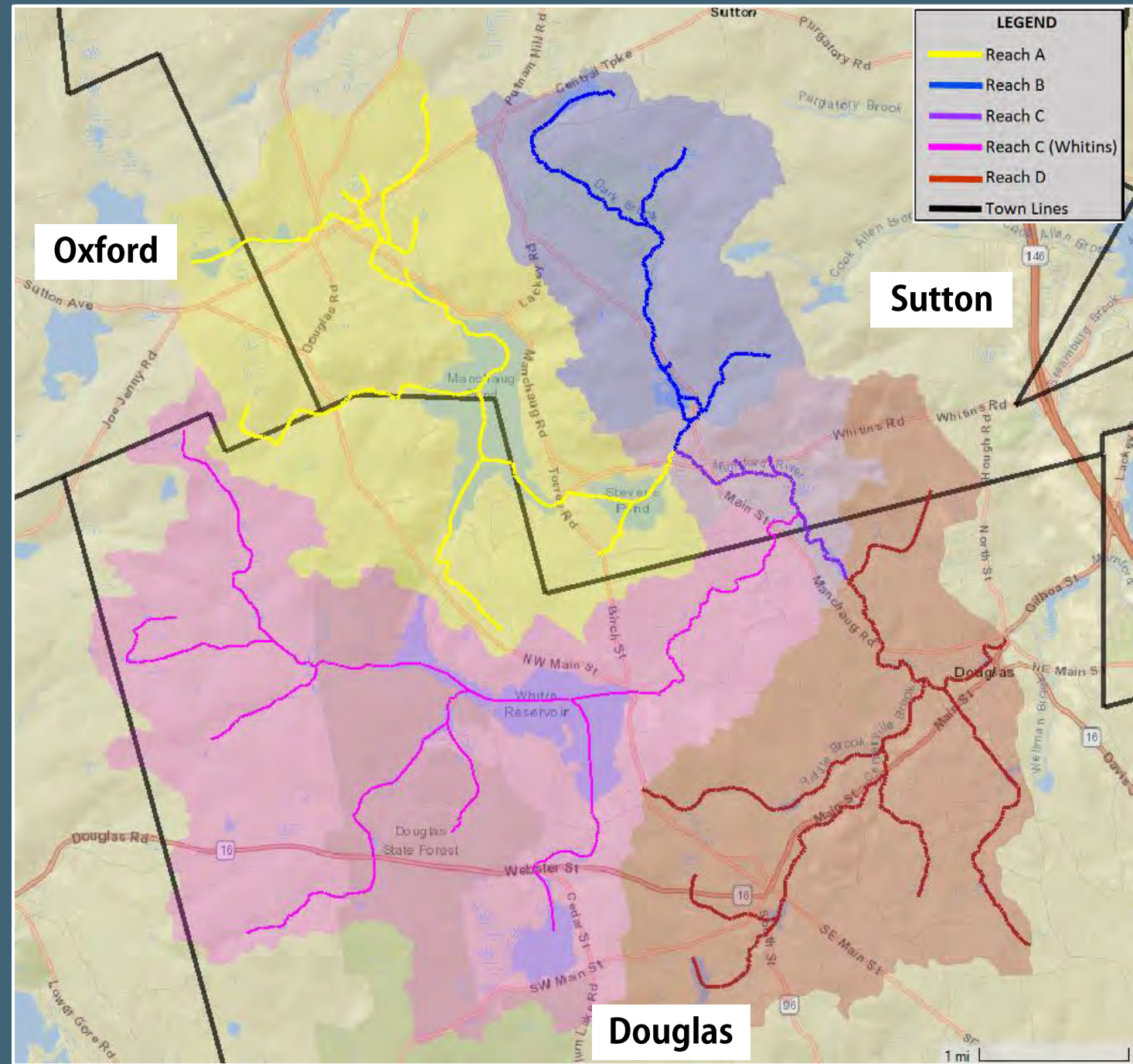
- ▶ Project Area Overview
- ▶ Evaluations
- ▶ Evaluation Findings
- ▶ Next Steps
- ▶ Discussion



Project Area Overview

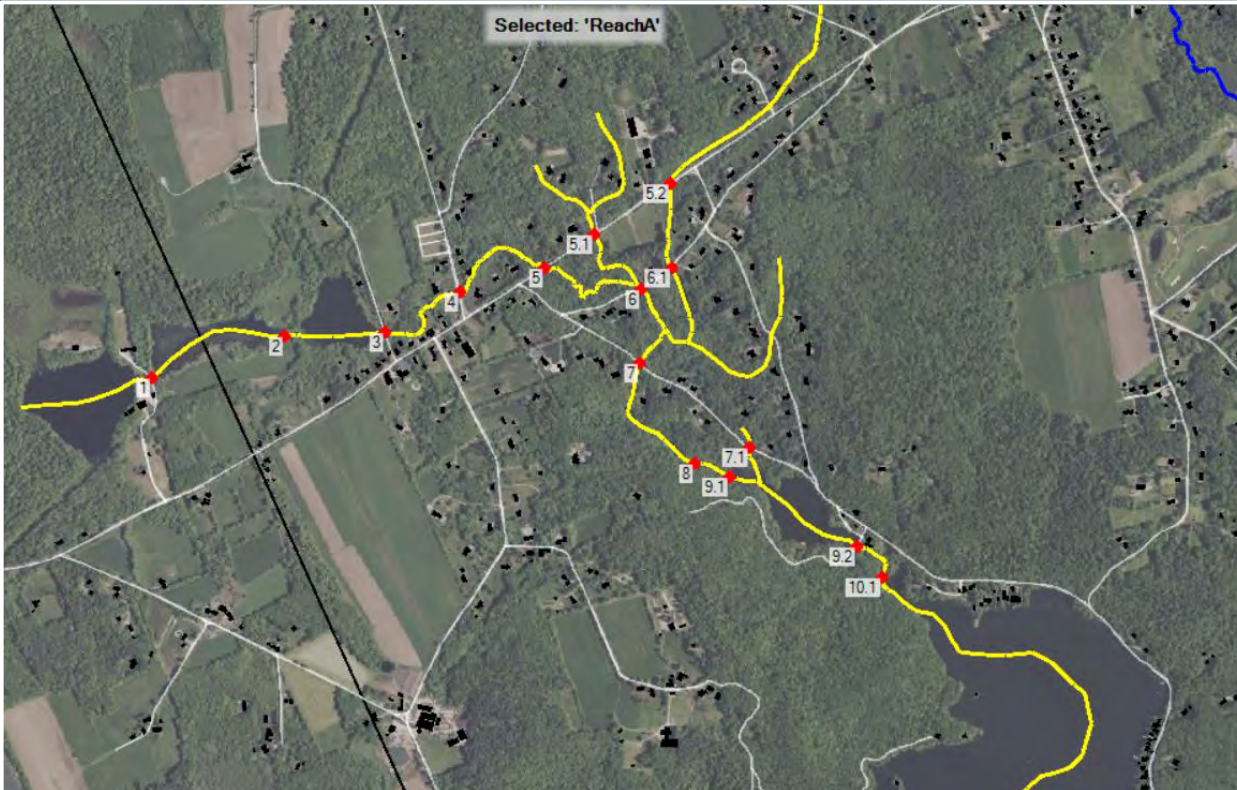
Four Reaches **A**, **B**, **C**, & **D**

- ▶ **Reach A:** Mumford River - Upstream
- ▶ **Reach B:** Dark Brook
- ▶ **Reach C:** Mumford River - Manchaug Village
 - ▶ Whitins Reservoir Tributary
- ▶ **Reach D:** Mumford River - Douglas



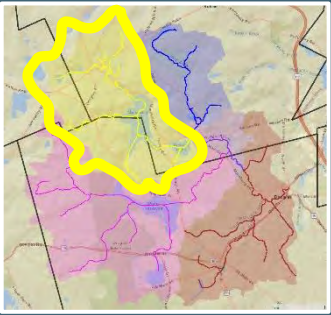
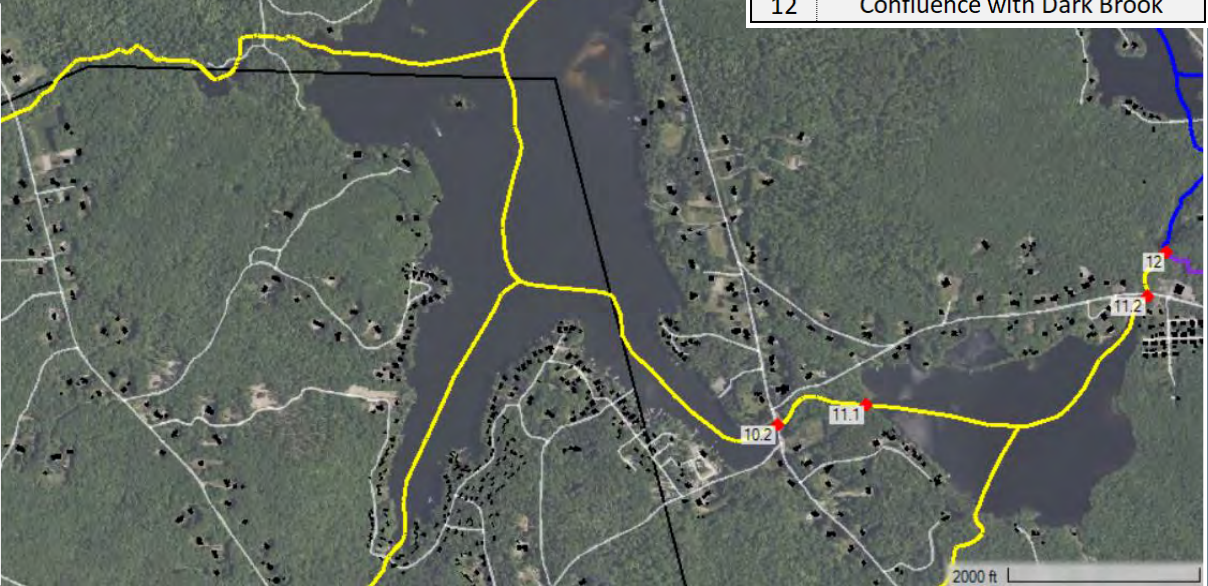
Reach A Overview

- ▶ 5.4 river miles
- ▶ 7.8 mi² watershed
- ▶ 14 crossings
 - ▶ 6 dams
 - ▶ 1 former dam
 - ▶ 7 road crossings
- ▶ 15 identified locations



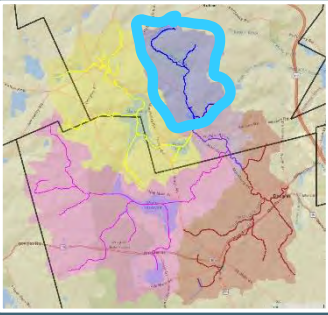
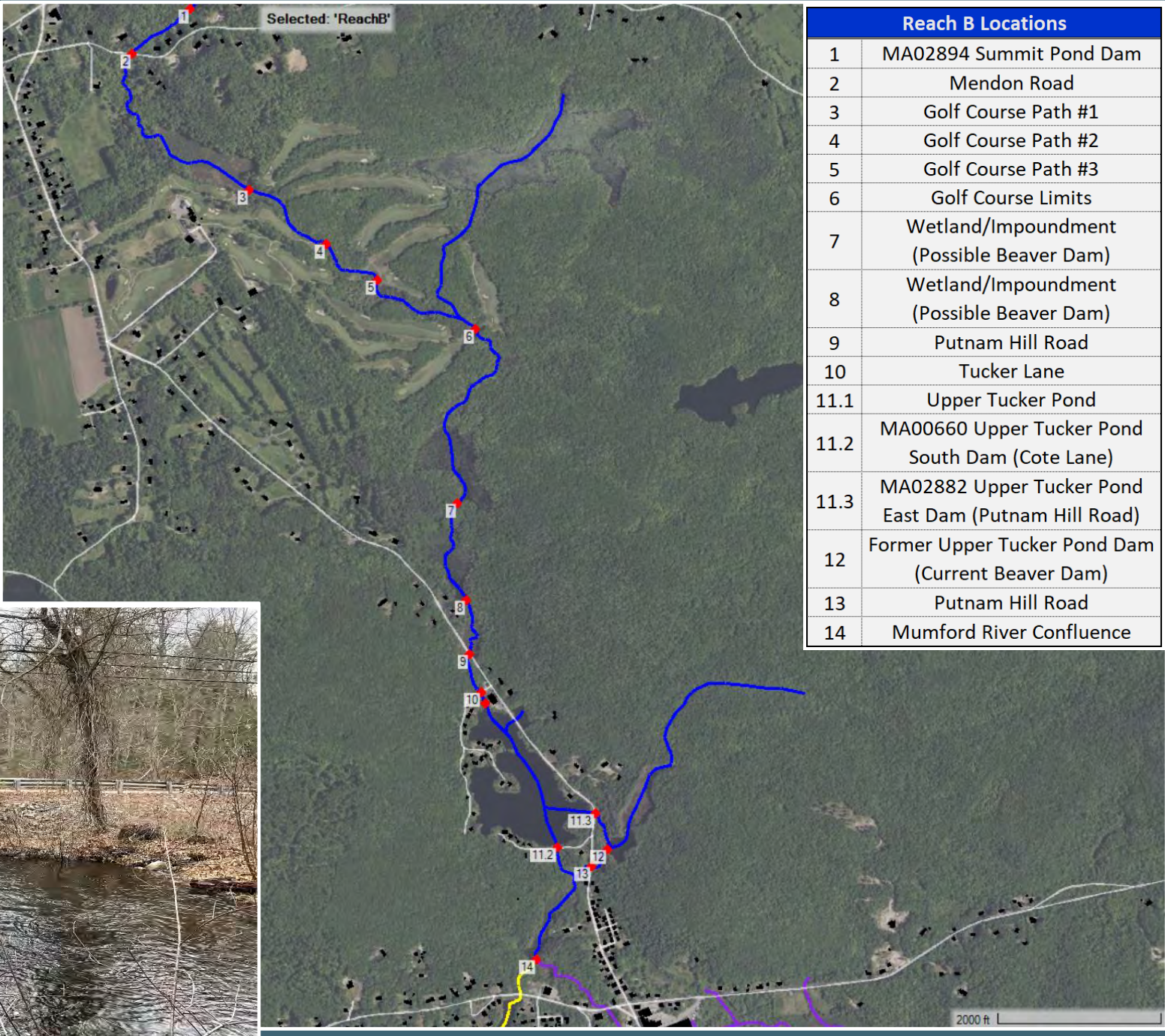
Reach A Locations	
1	MA00671 Stump Pond Dam
2	MA03383 Number Two Pond Dam
3	MA03382 Number One Pond Dam / Town Farm Road
4	West Sutton Road
5	Central Turnpike Main
5.1	Central Turnpike East
5.2	Central Turnpike East #2
6	Mendon Road Main
6.1	Mendon Road East
7	Manchaug Road Main
7.1	Manchaug Road East
8	MA02889 Homes Pond Dam
9.1	Sutton Falls Pond
9.2	MA00956 Sutton Falls Pond Dam
10.1	Manchaug Pond
10.2	MA00955 Manchaug Pond Dam / Torrey Road
11.1	Stevens Pond
11.2	MA00957 Stevens Pond Dam / Manchaug Road
12	Confluence with Dark Brook

#11.2



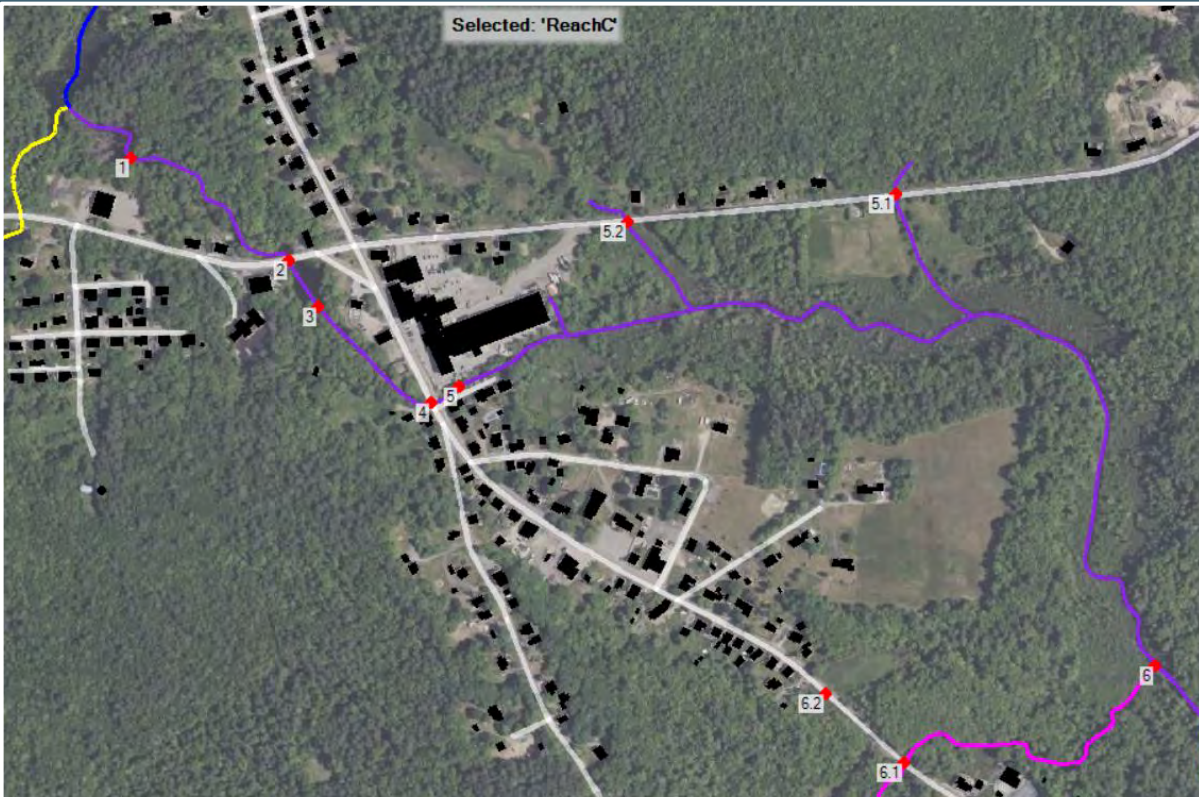
Reach B Overview

- ▶ 3.7 river miles
- ▶ 3.5 mi² watershed
- ▶ 10 crossings
 - ▶ 3 dams
 - ▶ 1 former dam
 - ▶ 3 cart paths
 - ▶ 3 road crossings
- ▶ 16 identified locations

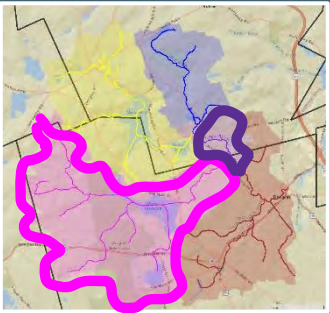


Reach C Overview

- ▶ 1.9 river miles
- ▶ 18.3 mi² watershed
 - ▶ 7.8 mi² from Reach A
 - ▶ 3.5 mi² from Reach B
 - ▶ 11.4 mi² direct
 - ▶ 10.4 mi² from Whitins
- ▶ 6 crossings
 - ▶ 2 dams
 - ▶ 1 former dam
 - ▶ 3 road crossings
- ▶ 9 identified locations

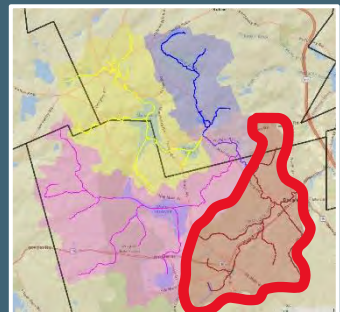
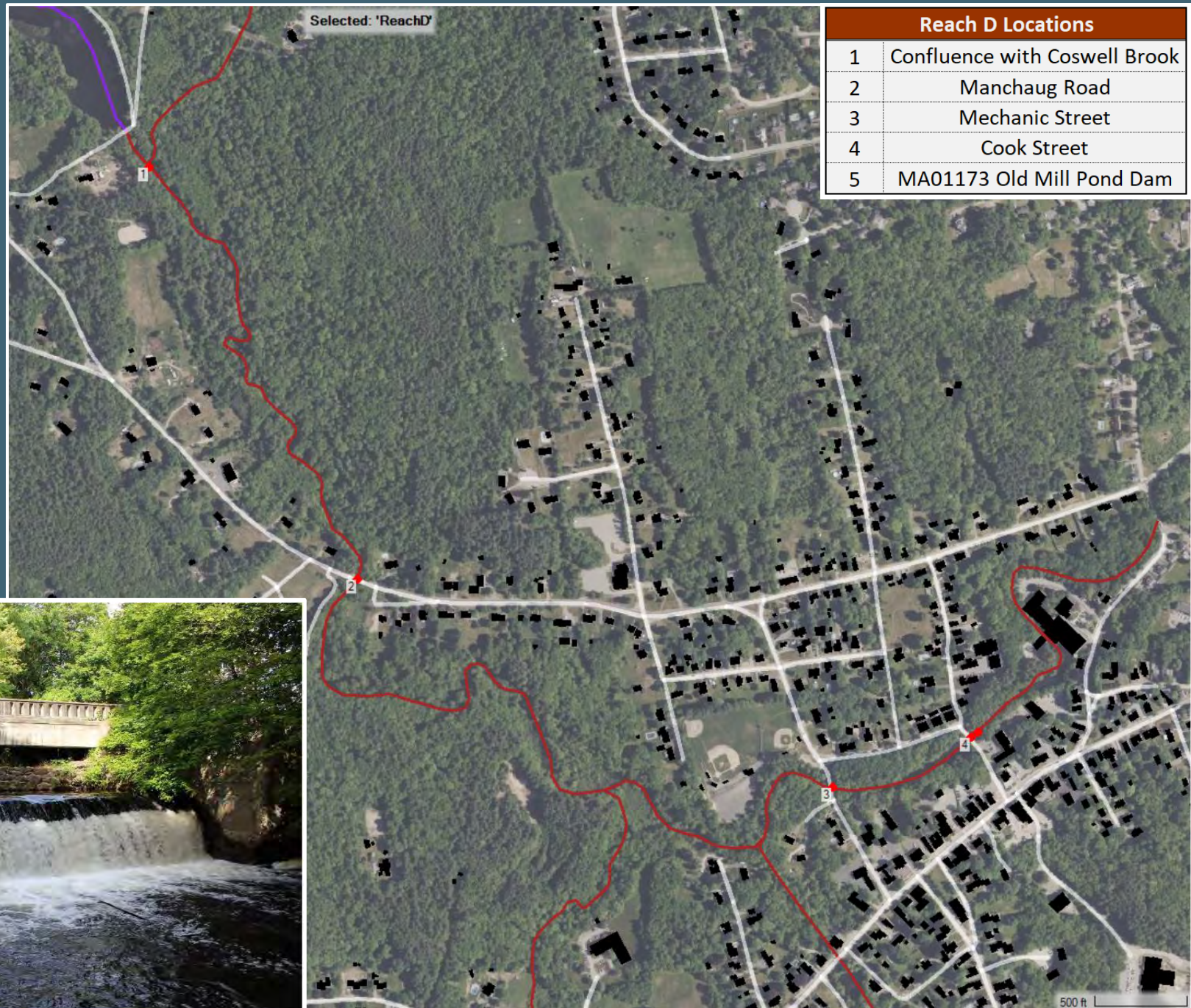


Reach C Locations	
1	Former Lower Tucker Pond Dam (Current Beaver Dam)
2	Manchaug Road
3	MA02881 Mill Pond #1 Dam
4	Main Street
5	Stone Weir
5.1	Whitins Road East
5.2	Whitins Road West
6	Confluence from Whitin Reservoir Dam
6.1	Main Street Main
6.2	Main Street West
6.3	Main Street East (Manchaug Road)
6.4	Mumford Road
7	Potter Road Impoundment
8	MA01172 Potter Road Dam
9	Potter Road



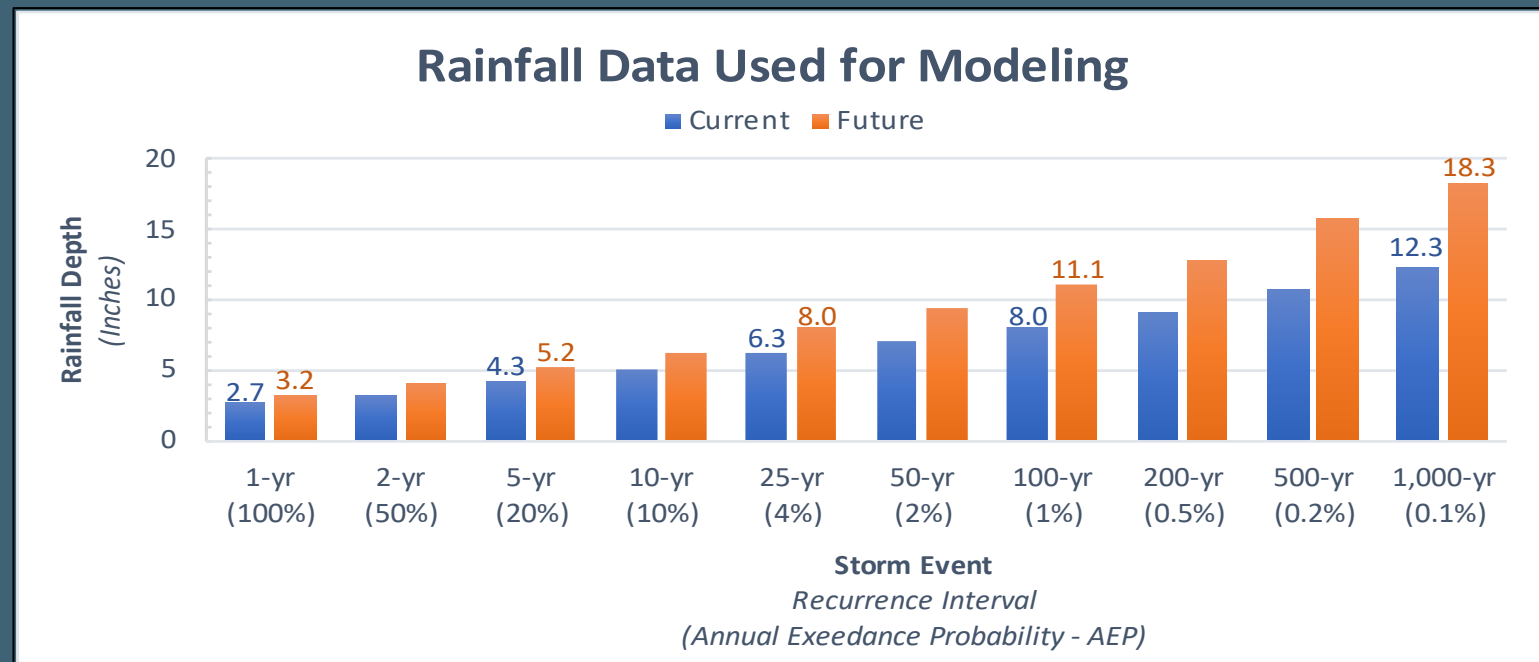
Reach D Overview

- ▶ 1.6 river miles
- ▶ 29.4 mi² watershed
 - ▶ 7.8 mi² from Reach A
 - ▶ 3.5 mi² from Reach B
 - ▶ 11.4 mi² from Reach C
 - ▶ 6.7 mi² direct
- ▶ 4 crossings (1 dam, 3 road)
- ▶ 5 identified locations



Evaluations

- ▶ Hydrologic¹ & Hydraulic² (H&H) Modeling
 - ▶ Current and Future³ Rainfall Scenarios
- ▶ Decipher Model Results
- ▶ Identify Strengths & Vulnerabilities of Assets
 - ▶ Dams
 - ▶ Roadways
 - ▶ Structures (EAD⁴)
- ▶ Watershed-Wide Assessment

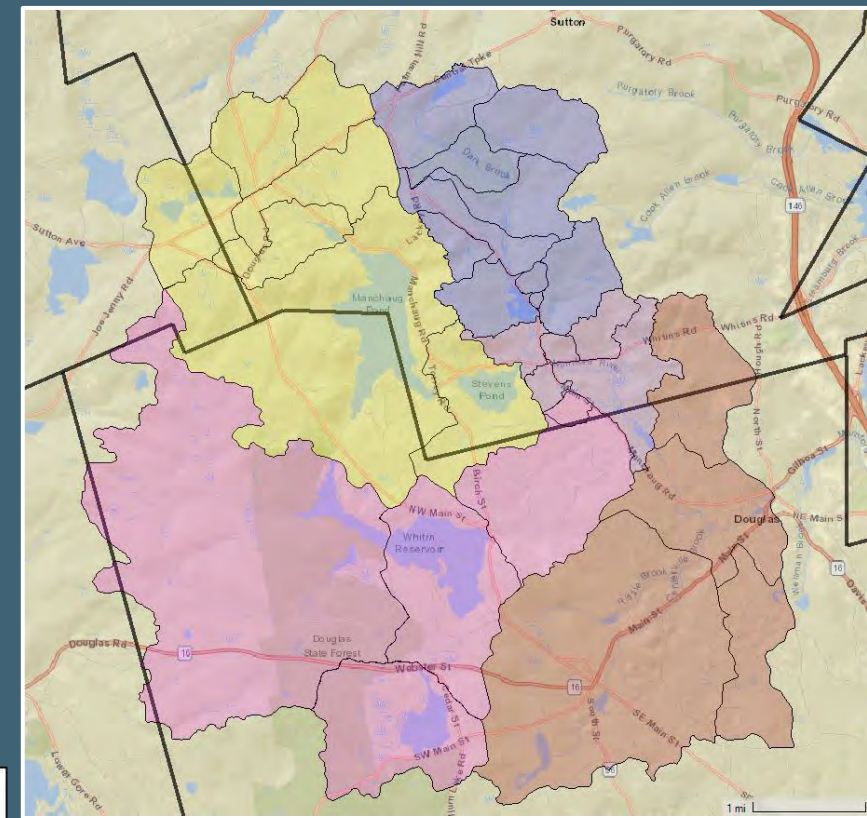


Definitions:

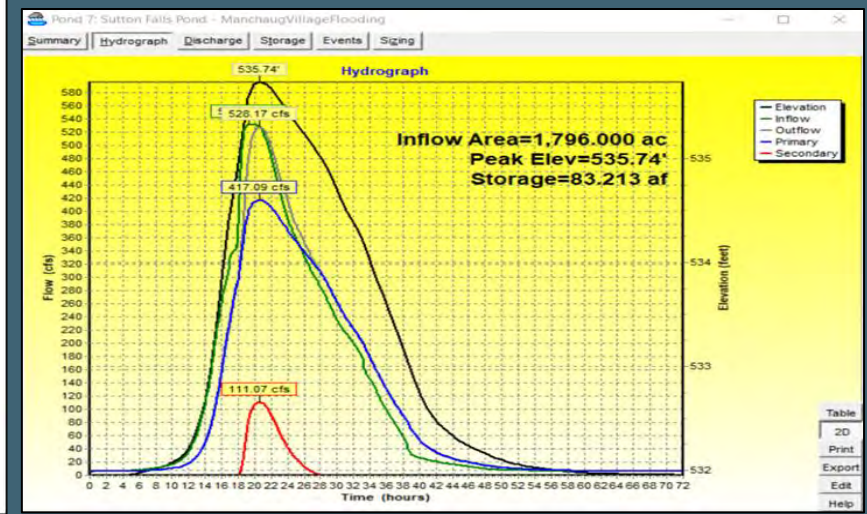
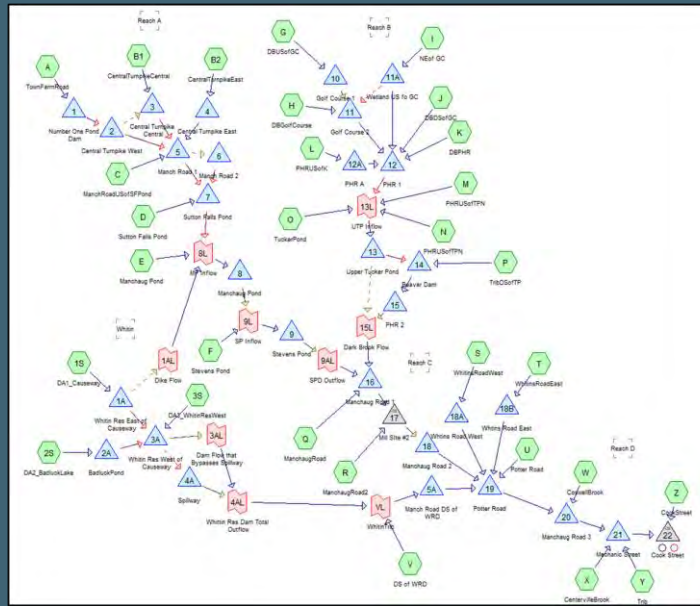
- Hydrologic Modeling:** Used to determine how rainfall interacts with the ground surface.
 - ▶ How much of the rain is absorbed by the ground surface?
 - ▶ How much of the rain runs off to rivers and streams? And how much does it runoff?
- Hydraulic Modeling:** Used to determine what the runoff does to the river, its floodplain, and nearby infrastructure.
 - ▶ How high and wide does the water level reach? And how fast is it flowing?
 - ▶ What is expected to be impacted by those water levels?
- Climate Change Informed Predicted Future Rainfall Data**
- EAD: Equivalent Annual Damage**

Hydrologic Modeling

- ▶ Subbasin Development (31 each)
- ▶ Hydrological Parameters (mi², CN, Tc)
- ▶ Rainfall (Current & Future)
- ▶ HydroCAD Model
- ▶ Model Results Used Directly for Reach A
- ▶ Produced Runoff Hydrographs for Reaches B-D

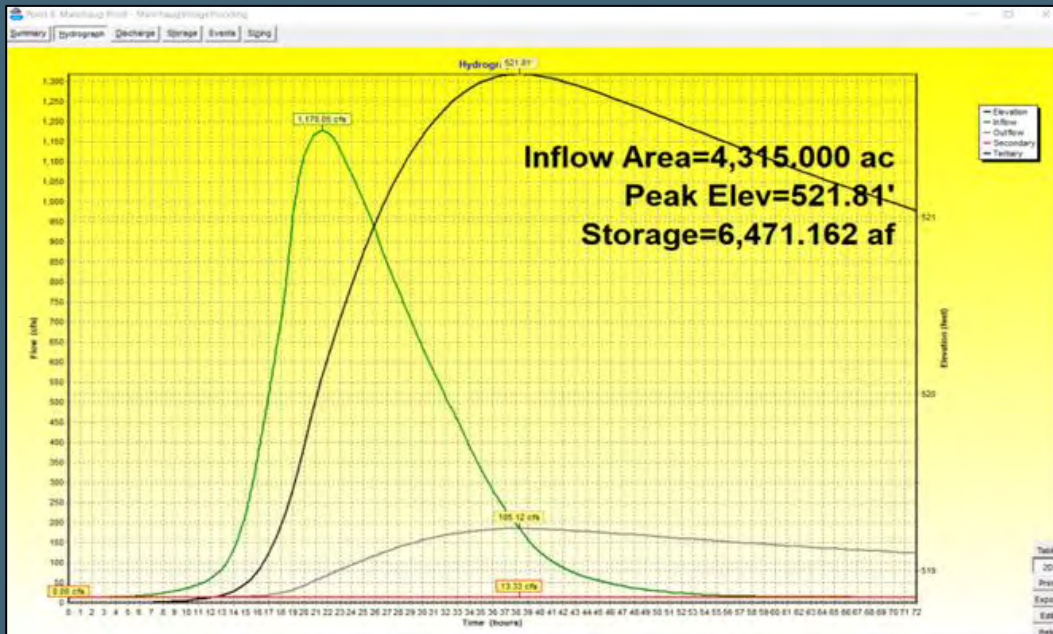
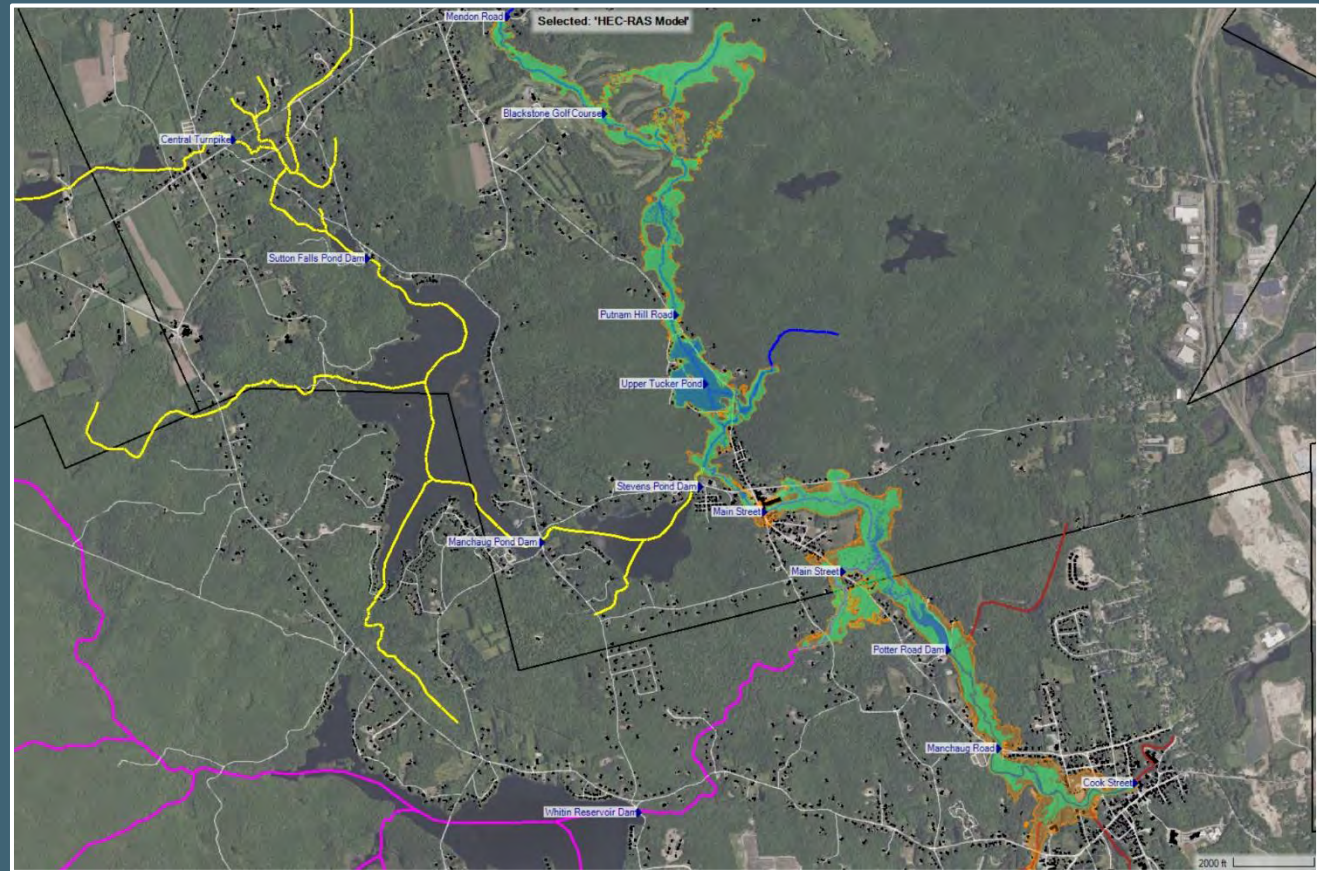
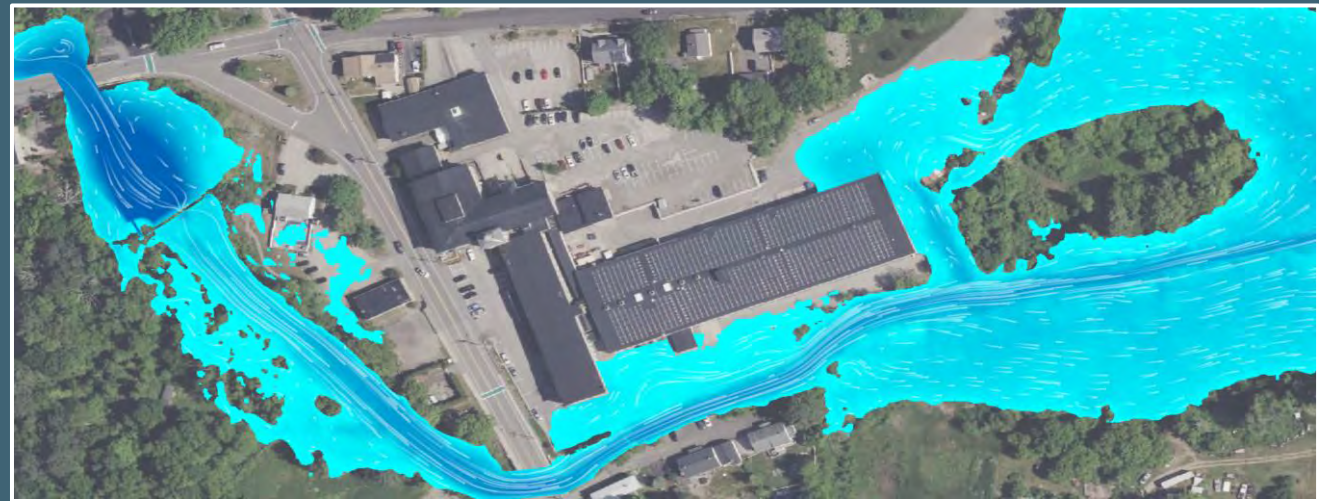


Drainage Area Parameters																						
Group	Reach	ID	Name	Size	Baseflow	Tc	Curve Number	HSG	LCG													
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Dark Brook	B	G	Dark Brook Mendon Road	0.60	382	1.2	267	4000	77	10.4%	40	75	0%	8%	59%	33%	60%	21%	9%	10%		
		H	DB Golf Course	0.30	193	0.6	127	2000	69	1.9%	4	68	0%	65%	7%	28%	47%	44%	7%	2%		
		I	DB NE of GC	0.59	375	1.2	280	3300	70	2.0%	8	69	0%	41%	25%	34%	75%	5%	18%	2%		
		J	DB DS of GC	0.48	306	1.0	280	4000	63	0.6%	2	63	0%	72%	1%	27%	89%	3%	7%	1%		
		K	DB PHR	0.37	237	0.7	217	3800	73	3.5%	8	72	0%	30%	15%	55%	68%	23%	5%	4%		
		L	PHR US of K	0.18	112	0.4	142	2400	67	1.4%	2	67	0%	43%	37%	20%	88%	5%	6%	1%		
		M	PHR US of TP N	0.06	35	0.1	77	1800	60	1.8%	1	59	0%	82%	0%	18%	95%	1%	2%	2%		
		N	PHR US of TP S	0.01	9	0.0	61	850	56	3.7%	0	55	11%	89%	0%	0%	81%	15%	0%	4%		
		O	Tucker Pond	0.36	231	0.7	187	5600	69	14.3%	33	64	0%	45%	37%	18%	81%	2%	3%	14%		
		P	Trib DS of TP	0.46	295	0.9	208	6200	64	0.7%	2	64	2%	57%	14%	27%	92%	0%	7%	1%		
Mumford River Manch Village	C	Q	Manchaug Road	0.19	121	0.4	141	3200	63	7.9%	10	60	18%	58%	4%	20%	73%	9%	10%	8%		
		R	Mumford Road	0.10	62	0.2	60	1500	65	11.9%	7	61	26%	29%	36%	9%	77%	12%	0%	12%		
		S	Whitins Road West	0.07	45	0.1	45	1100	60	5.0%	2	58	37%	26%	9%	28%	80%	6%	9%	5%		
		T	Whitins Road East	0.22	138	0.4	120	3800	59	1.3%	2	58	0%	88%	3%	9%	92%	1%	6%	1%		
		U	Potter Road	0.63	405	1.3	406	6600	65	6.0%	24	63	21%	45%	21%	13%	62%	9%	23%	6%		
Whitins Res	C	1	WRD - Causeway	6.04	3867	12.1	1235	20000	62	2.9%	112	61	2%	71%	13%	14%	86%	1%	10%	3%		
		2	WRD - BadluckLake	1.35	867	2.7	294	8200	73	13.7%	119	69	2%	26%	59%	13%	66%	2%	18%	14%		
		3	WRD - WRRest	1.55	992	3.1	258	10000	74	31.6%	313	63	5%	23%	30%	42%	56%	9%	4%	32%		
		V	DS of WRD	1.44	920	2.9	461	6600	66	3.7%	34	65	6%	41%	47%	6%	81%	8%	8%	4%		
Mumford River DS 2	D	W	Cowell Brook	0.89	571	1.8	660	12500	67	2.0%	11	66	4%	56%	23%	17%	74%	5%	19%	2%		
		X	Centerville Brook	3.96	2537	7.9	1000	12000	61	7.1%	180	58	27%	45%	21%	7%	67%	14%	12%	7%		
		Y	Trib US of Mechanic	0.79	504	1.6	500	10800	58	5.7%	29	56	39%	24%	31%	6%	74%	11%	10%	6%		
		Z	North Street	1.09	656	2.2	600	9800	59	12.2%	85	54	41%	49%	10%	0%	59%	18%	11%	12%		
Totals				29.39	18809	58.8			9.0%	1697	111%	40%	27%	22%	69%	13%	9%	9%				
HSG Hydrologic Soil Group																						
A High Absorption				Clean Sands & Gravels (<10% fines)							1		High Absorption				Forests, Shrubs, Grass					
B Moderate Absorption				Silty Sands & Gravels (10-20% fines)							2		Moderate Absorption				Bare, Cultivated/Pasture					
C Low Absorption				Sandy Silts/Silts (20-40% fines)							3		Low Absorption				Wetlands, Aquatic Beds					
D Very Low / No Absorption				Silts & Clays (>40% fines), Bedrock, Water							4		Very Low / No Absorption				Impervious					



Hydraulic Modeling

- ▶ HydroCAD Model for Reach A
- ▶ HEC-RAS 2D Model For Reaches B-D
 - ▶ Topography, Land Cover, Crossing Information
 - ▶ Flow Data from HydroCAD
- ▶ 10 storm events x 2 rainfall scenarios



Reach A Model Results

Dams

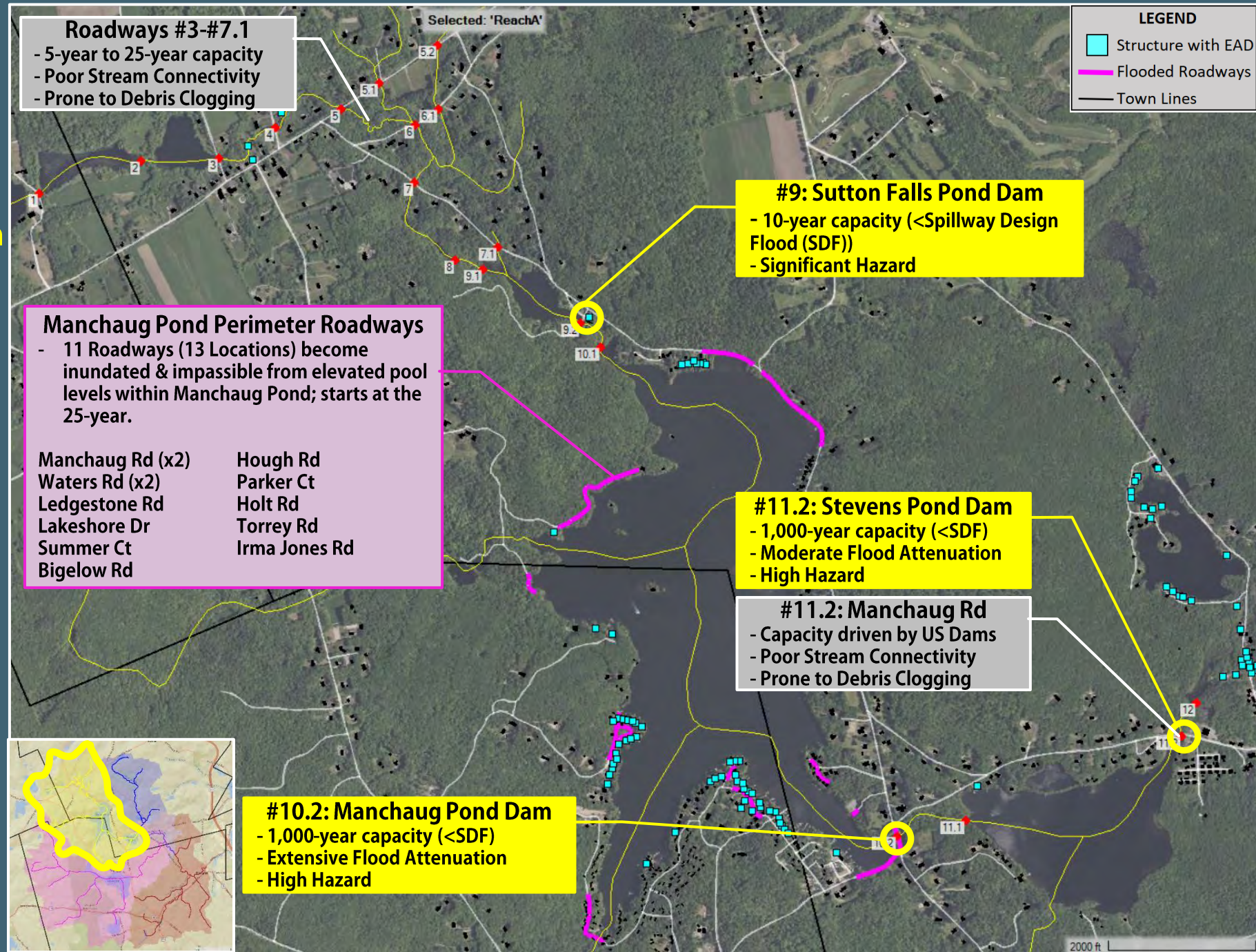
- ▶ #9 Sutton Falls Pond Dam
- ▶ #10 Manchaug Pond Dam
- ▶ #11 Stevens Pond Dam (SPD)

Roads

- ▶ All upstream (US) of Sutton Falls Pond Dam
- ▶ Manchaug Pond Perimeter
- ▶ Manchaug Road downstream (DS) of SPD

Structures

- ▶ 58 with potential for EAD
- ▶ 4 US of Manchaug Pond
- ▶ 53 along Manchaug Pond



Reach B Model Results

► Dams

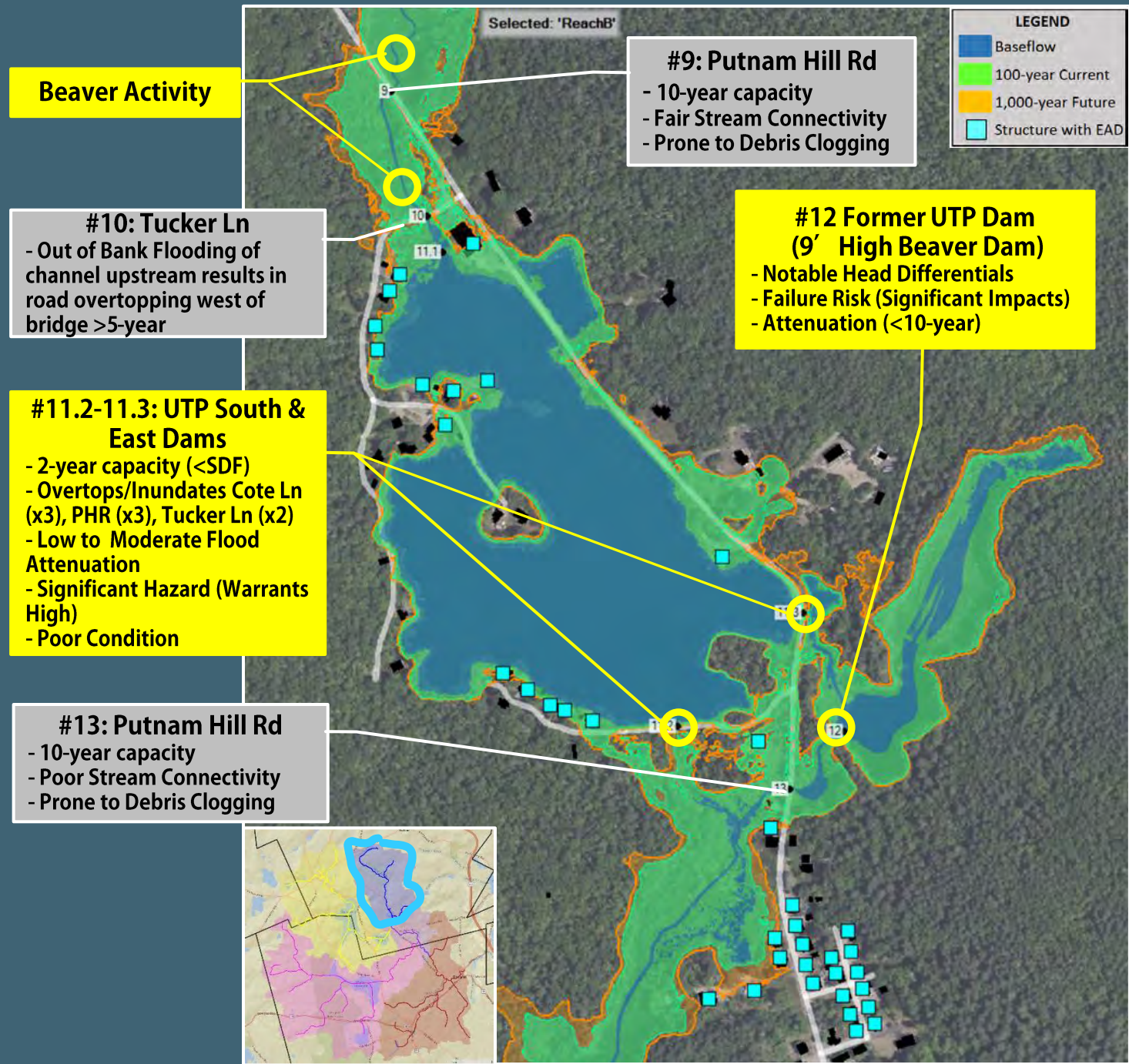
- #11.2-11.3 Upper Tucker Pond (UTP) Dams
- #12 Former UTP Dam (Current Beaver Dam)
- Other Beaver Activity

► Roads

- Putnam Hill Road (5 locations)
- Tucker Lane (3 locations)
- Cote Lane (3 locations)

► Structures

- 37 with potential for EAD
- 15 along Upper Tucker Pond
- 11 downstream of UTP



Reach C Model Results

► Dams

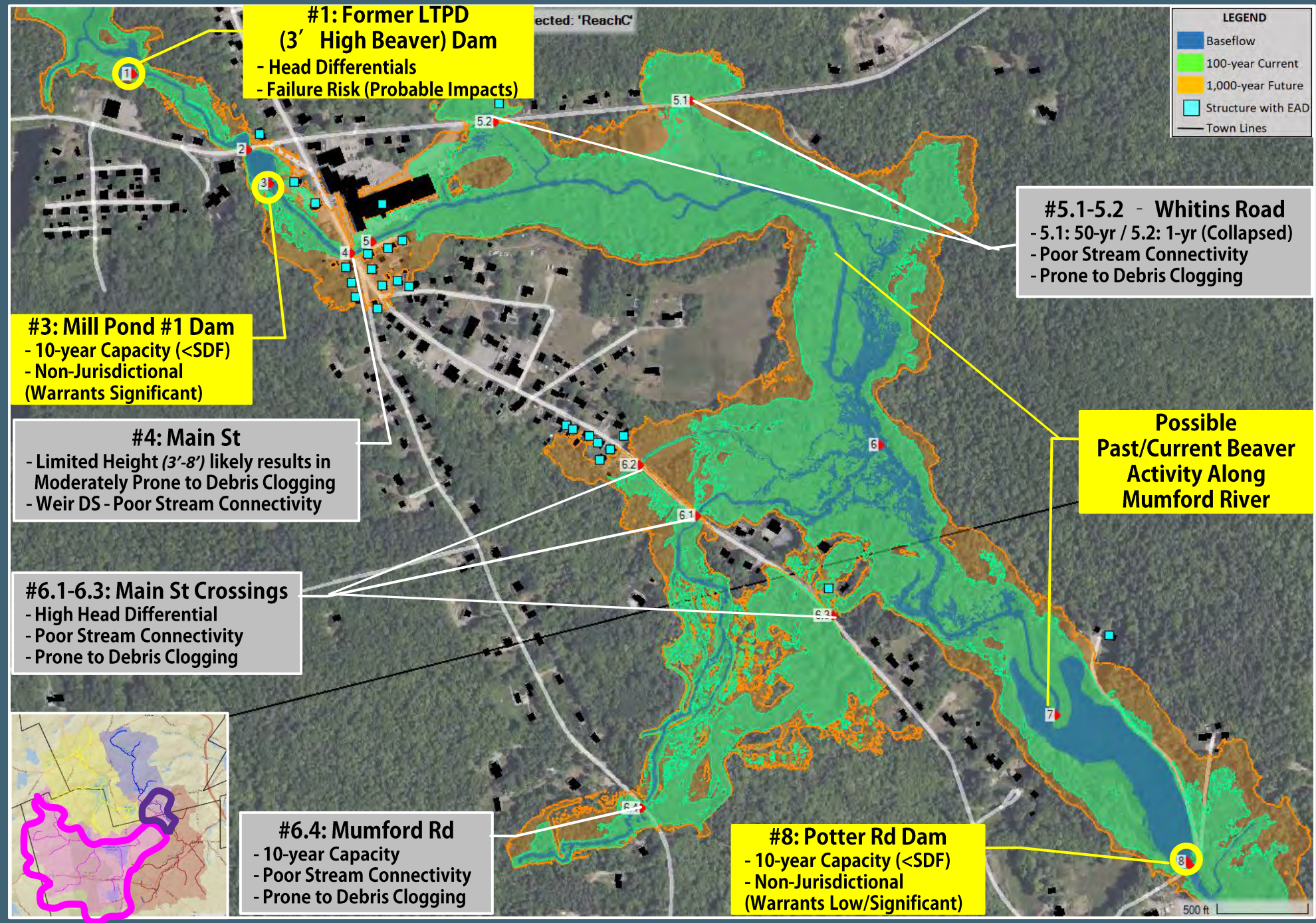
- #1 Former Lower Tucker Pond (LTP) Dam
- #3 Mill Pond Dam
- #8 Potter Road Dam
- Other Beaver Activity

► Roads

- #4 Main Street
- #9 Potter Road
- All 6 Tribs (3 Main Street, 2 Whitins Road, 1 Mumford Road)

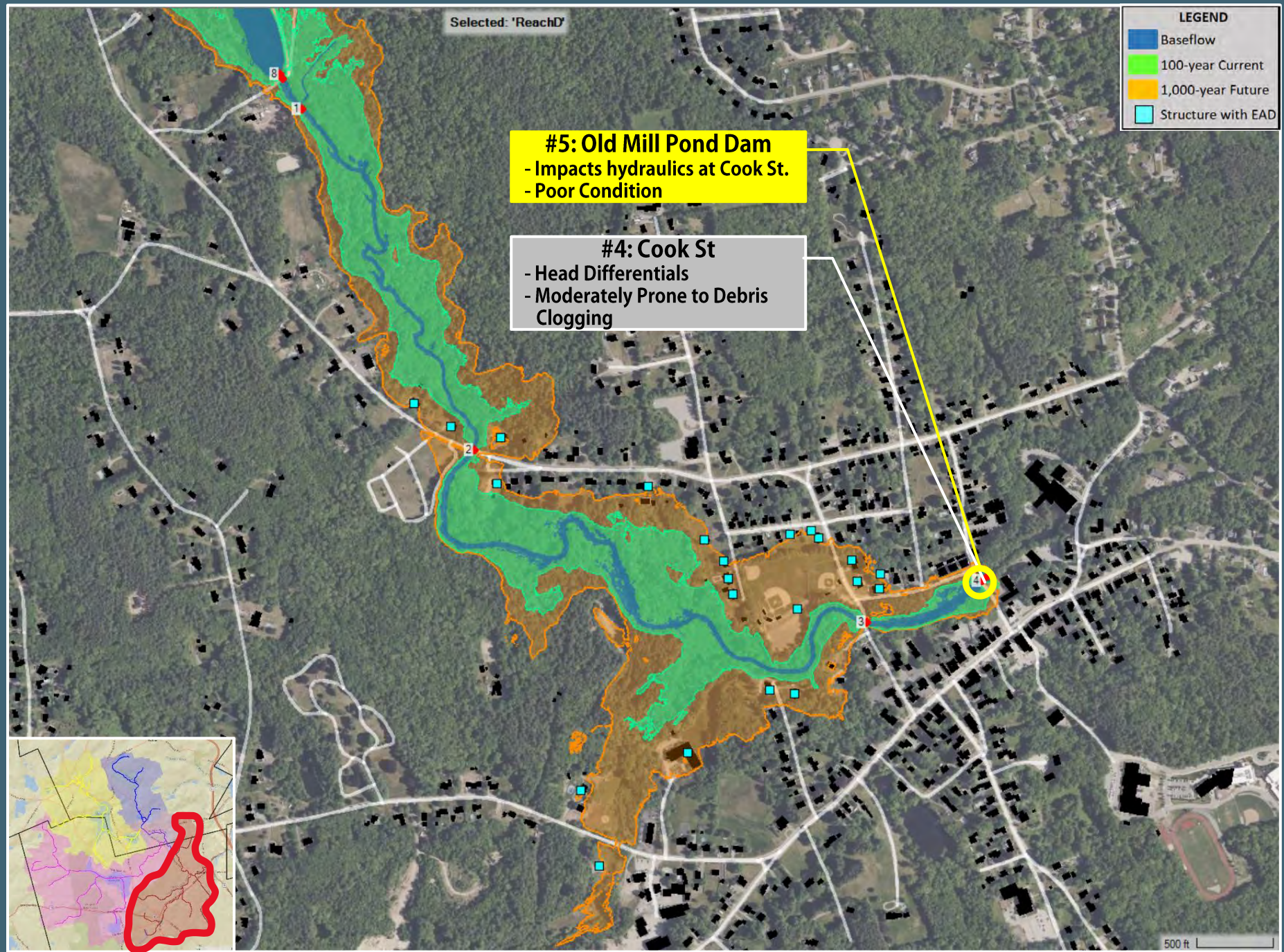
► Structures

- 25 with potential for EAD
- Mill Site #1



Reach D Model Results

- ▶ Dams
 - ▶ #5 Old Mill Pond Dam
- ▶ Roads
 - ▶ #4 Cook Street
- ▶ Structures
 - ▶ 22 with potential for EAD



Model Findings – Within Report

Crossings along Reach A (Mumford River Upstream of Dark Brook Confluence)								
ID	Location	+Tribes	Drng. Area	Crossing Information			Capacity	
#	River Mi.	No.	s.m.	Name	Description	Owner	Current	CCIPF
1*	0.2	-	0.3	MA00671 Stump Pond Dam	8' high dam embankment	Private	-	-
2*	0.6	-	0.6	MA03383 Number Two Pond Dam	5' high dam embankment	Private	-	-
3*	0.8	-	0.7	MA03382 Number One Pond Dam (Town Farm Road)	11' high dam/roadway embankment with three 3' CMP spillway conduits	Private	25-yr	10-yr
4*	1.0	-	0.8	West Sutton Road	11' high roadway embankment with uninventoried low head dam upstream	Town	-	-
5	1.2	-	1.0	Central Turnpike	7' high roadway embankment with 4'wx6'h box culvert	Town	10-yr	2-yr
6*	1.4	+1	1.7	Mendon Road	4' high roadway embankment	Town	-	-
7	1.6	+1	2.3	Manchaug Road	9' high roadway embankment with 6' CMP conduit	Town	5-yr	2-yr
8*	1.9	-	2.4	MA02899 Homes Pond Dam	7' high partially breached dam embankment	Private	-	-
9.1	2.0	-	2.8	Sutton Falls Pond	Impoundment	Private	10-yr	5-yr
9.2	2.3	-	2.8	MA00956 Sutton Falls Pond Dam (Aldrich Lane)	12' high dam embankment with 19' long spillway	Private	10-yr	5-yr
10.1	2.4	+2	6.7	Manchaug Pond	Impoundment	Town & Private	-	-
10.2	4.4	-	6.7	MA00955 Manchaug Pond Dam (Torrey Road)	29' high dam/roadway embankment with 10' wide stop log controlled spillway culvert and 2' square gated LLO conduit	Town	>1,000-yr	200-yr
11.1	4.6	+1	7.7	Stevens Pond	Impoundment	Town	-	-
11.2	5.3	-	7.7	MA00957 Stevens Pond Dam (Manchaug Road)	30' high dam/roadway embankment with 16' wide spillway and 3' square LLO routed to 16'wx5'h arch culvert under road	Town	>1,000-yr	200-yr
12	5.4	-	7.8	Confluence with Dark Brook	Open Channel	Private	-	-

*Not included in data collection task; information provided from available documentation, LIDAR terrain data, and aerial imagery

Reach A: Mumford River Upstream of Confluence with Dark Brook

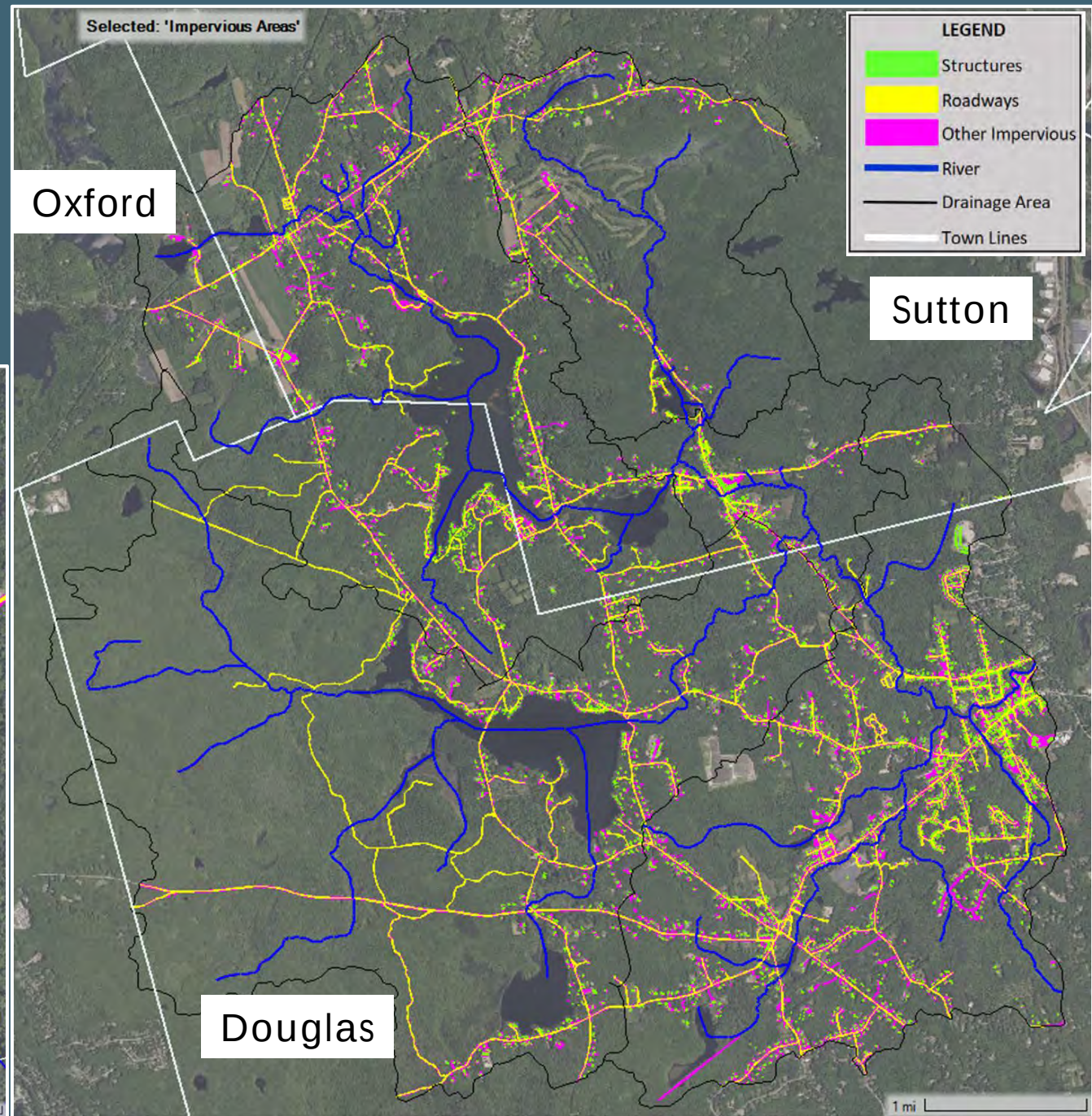
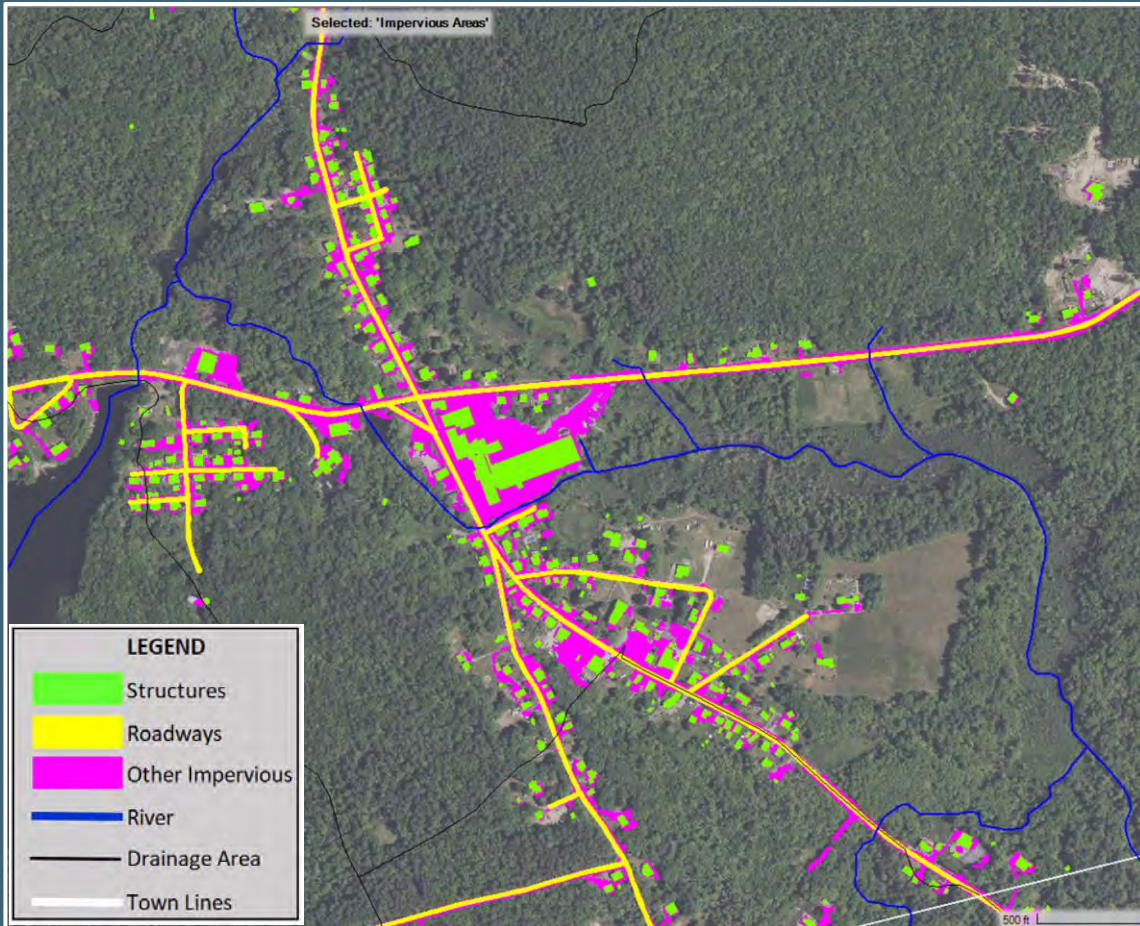
- a. **Dams**
- i. Sutton Falls Pond Dam – *limited capacity and SDF compliance*
 - ii. Manchaug Pond Dam – *attenuation, hazard, and SDF compliance*
 - iii. Stevens Pond Dam – *attenuation, hazard, and SDF compliance*
- b. **Roadways**
- i. All roadways upstream of Sutton Falls Pond Dam – *limited capacity, poor stream connectivity, proneness to debris clogging*
 - ii. Roadways along perimeter of Manchaug Pond – *flooding from Manchaug Pond storm pool elevations*
 - iii. Manchaug Road DS of Stevens Pond – *poor stream connectivity, proneness to debris clogging, capacity dependent on dam attenuation provided upstream*
- c. **Structures:**
- i. 58 structures identified as having potential to sustain flood damage.

Structures Impacted by Flooding Along Reach A									
ID	FID	Map-Par ID	Address	CITY	Description	TFP*	Start of Damage	CCIPF	EAD
							Current	Current	CCIPF
1	1174	35-82	650 Central Turnpike	SUTTON	House in Close Proximity with River		ND	ND	ND
2	798	35-143		SUTTON	Structure in Close Proximity with River		ND	ND	ND
3	375	35-47	381 West Sutton Road	SUTTON	House in Close Proximity with River		ND	ND	ND
4	1211	0	90 Manchaug Road	SUTTON	Sutton Falls Camping Area Intake Building - May See Flooding during events that OT Sutton Falls Pond Dam		25-yr	10-yr	ND
5	157	111-35	34 HOUGH RD	DOUGLAS	House likely to experience flooding during high pool levels in Manchaug Pond	525	100-yr	25-yr	\$285 \$2,109
6	86	110-14	115 LEDGESTONE RD	DOUGLAS	Same Description as #5	528.8	10-yr	5-yr	\$4,825 \$10,410
7	159	111-38	38 HOUGH RD	DOUGLAS	Same Description as #5	528.5	10-yr	5-yr	\$4,142 \$9,244
8	183	111-15	84 BIGELOW RD	DOUGLAS	Same Description as #5	524.5	10-yr	25-yr	\$546 \$2,701
9	90	110-20	101 LEDGESTONE RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$3,700 \$8,257
10	158	111-37	37 HOUGH RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$5,464 \$12,294
11	136	111-18	55 BIGELOW RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$4,254 \$9,498
12	95	110-22	89 LEDGESTONE RD	DOUGLAS	Same Description as #5	523.2	10-yr	5-yr	\$1,185 \$2,572
13	137	111-19	53 BIGELOW RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$1,227 \$2,739
14	96	110-23	87 LEDGESTONE RD	DOUGLAS	Same Description as #5	523.2	10-yr	5-yr	\$1,103 \$2,501
15	163	111-41	17 HOUGH RD	DOUGLAS	Same Description as #5	522.7	10-yr	2-yr	\$1,881 \$8,044
16	85	110-13	117 LEDGESTONE RD	DOUGLAS	Same Description as #5	524	25-yr	10-yr	\$874 \$7,564
17	699	42-11	12 MANCHAUG RD	SUTTON	Same Description as #5	523.5	10-yr	5-yr	\$2,373 \$5,296
18	166	111-44	3 HOUGH RD	DOUGLAS	Same Description as #5	524	10-yr	5-yr	\$653 \$1,917
19	162	111-40	25 HOUGH RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$5,478 \$12,224
20	132	111-34	82 BIGELOW RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$1,334 \$2,976
21	570	42-12	126.5 MANCHAUG RD	SUTTON	Same Description as #5	523.5	10-yr	5-yr	\$640 \$1,419
22	165	111-43	7 HOUGH RD	DOUGLAS	Same Description as #5	523.5	10-yr	5-yr	\$1,566 \$3,406
23	94	110-21	95 LEDGESTONE RD	DOUGLAS	Same Description as #5	523.7	25-yr	10-yr	\$533 \$1,605
24	790	48-35	3 PARKER CT	SUTTON	House likely to experience flooding during high pool levels in Stevens Pond	474	25-yr	10-yr	\$1,282 \$8,426
25	80	110-18	105 LEDGESTONE RD	DOUGLAS	Same Description as #5	524.3	50-yr	25-yr	\$625 \$3,114
26	123	110-7	107 LEDGESTONE RD	DOUGLAS	Same Description as #5	525	100-yr	25-yr	\$263 \$1,946
27	169	111-47	12 PARKER CT	DOUGLAS	Same Description as #5	524.2	50-yr	25-yr	\$404 \$2,081
28	87	110-15	113 LEDGESTONE RD	DOUGLAS	Same Description as #5	524.5	100-yr	25-yr	\$288 \$1,401
29	617	42-7	122 MANCHAUG RD	SUTTON	Same Description as #5	524	50-yr	25-yr	\$265 \$777
30	185	111-17	65 BIGELOW RD	DOUGLAS	Same Description as #5	524.5	50-yr	25-yr	\$91 \$402
31	156	111-36	30 HOUGH RD	DOUGLAS	Same Description as #5	523.5	500-yr	50-yr	\$138 \$630
32	35	110-19	103 LEDGESTONE RD	DOUGLAS	Same Description as #5	525.4	200-yr	50-yr	\$127 \$729
33	80	110-17	109 LEDGESTONE RD	DOUGLAS	Same Description as #5	525.6	500-yr	50-yr	\$328 \$615
34	1386	0	24 HOLY RD	SUTTON	Same Description as #5	\$25-\$46	200-yr	50-yr	\$8 \$85
35	128	111-10	48 BIGELOW RD	DOUGLAS	Same Description as #5	525	200-yr	50-yr	\$95 \$703
36	131	111-13	76 BIGELOW RD	DOUGLAS	Same Description as #5	526.5	1000-yr	100-yr	\$44 \$457
37	167	111-45	4 PARKER CT	DOUGLAS	Same Description as #5	526.2	500-yr	100-yr	\$27 \$999
38	968	42-10	124.5 MANCHAUG RD	SUTTON	Same Description as #5	528	500-yr	100-yr	\$21 \$189
39	154	111-32	18 HOUGH RD	DOUGLAS	Same Description as #5	526.5	1000-yr	100-yr	\$12 \$121
40	168	111-46	8 PARKER CT	DOUGLAS	Same Description as #5	526.7	1000-yr	200-yr	\$7 \$157
41	170	111-48	18 PARKER CT	DOUGLAS	Same Description as #5	\$26.9	1000-yr	200-yr	\$6 \$124
42	171	111-49	24 PARKER CT	DOUGLAS	Same Description as #5	\$26.6	1000-yr	200-yr	\$8 \$58
43	100	110-27	77 LEDGESTONE RD	DOUGLAS	Same Description as #5	527	1000-yr	200-yr	\$3 \$85
44	634	42-9	124 MANCHAUG RD	SUTTON	Same Description as #5	527	1000-yr	200-yr	\$1 \$50
45	99	110-26	79 LEDGESTONE RD	DOUGLAS	Same Description as #5	528	-	500-yr	\$0 \$201
46	130	111-12	64 BIGELOW RD	DOUGLAS	Same Description as #5	528	-	500-yr	\$0 \$197
47	145	111-26	42 HOUGH RD	DOUGLAS	Same Description as #5	\$27.5	-	200-yr	\$0 \$165
48	98	110-35	81 LEDGESTONE RD	DOUGLAS	Same Description as #5	527.5	-	200-yr	\$0 \$153
49	181	110-36	111 LEDGESTONE RD	DOUGLAS	Same Description as #5	527.7	-	500-yr	\$0 \$118
50	97	110-24	85 LEDGESTONE RD	DOUGLAS	Same Description as #5	528.5	-	500-yr	\$0 \$109
51	8	102-7	58 LEDGEWOOD DR	DOUGLAS	Same Description as #5	528.5	-	500-yr	\$0 \$99
52	129	111-11	56 BIGELOW RD	DOUGLAS	Same Description as #5	528	-	500-yr	\$0 \$45
53	7	102-6	34 LEDGEWOOD DR	DOUGLAS	Same Description as #5	528	-	500-yr	\$0 \$44
54	624	42-8	122.5 MANCHAUG RD	SUTTON	Same Description as #5	530	-	1000-yr	\$0 \$26
55	118	110-43	8 SUMMIT CT	DOUGLAS	Same Description as #5	528.5	-	1000-yr	\$0 \$18
56	1221	0	120 MANCHAUG RD	SUTTON	Same Description as #5	529	-	500-yr	\$0 \$18
57	280	121-1	76 OAK ST	DOUGLAS	Same Description as #5	528	-	500-yr	\$0 \$16
58	1214	0	628 WATERS RD	SUTTON	Same Description as #5	530	-	1000-yr	\$0 \$20
59	125	110-8	0 LEDGESTONE RD	DOUGLAS	Same Description as #5	526.5	500-yr	100-yr	\$20 \$238

*Approximated first floor elevation based upon available LIDAR

Watershed-Wide Assessment

Impervious Area Type	Count	Area (acres)	Percent of Drainage Area
Structures	4,520	13	0.1%
Roadways	670	24	0.1%
Other Impervious	3,610	22	0.1%
Total Paved	8,800	59	0.3%
Surface Water	20	1,638	8.7%



Next Steps:

- ▶ Develop Improvement Strategies (Solutions)
- ▶ The “Solutions” Meeting
 - ▶ April 27th, 6:00pm, Location: TBD
- ▶ Planning Study Report - Draft
 - ▶ Available to Public - May 12th Target date
 - ▶ Public Comment Period Until - May 22nd
- ▶ Select Board Meeting - Present Draft of Study
 - ▶ June 6th, 6:00pm, Sutton Town Hall
- ▶ Planning Study Report - Final
 - ▶ June 30th

Contact Information:

- ▶ Jen Hager:
j.hager@town.sutton.ma.us
(508)-865-8729

Discussion



MANCHAUG WATER RESOURCES RESILIENCY ACTION PLAN



MVP

Municipal Vulnerability
Preparedness

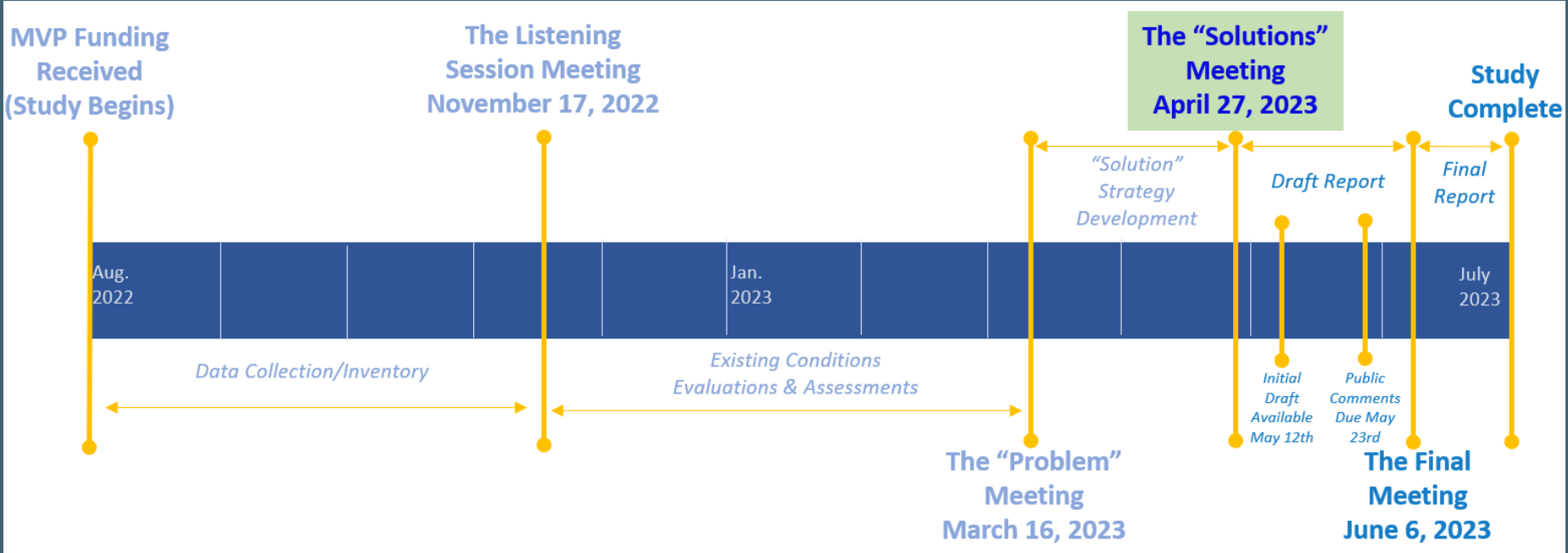


Third Public Meeting
"The Solutions"
April 27, 2023



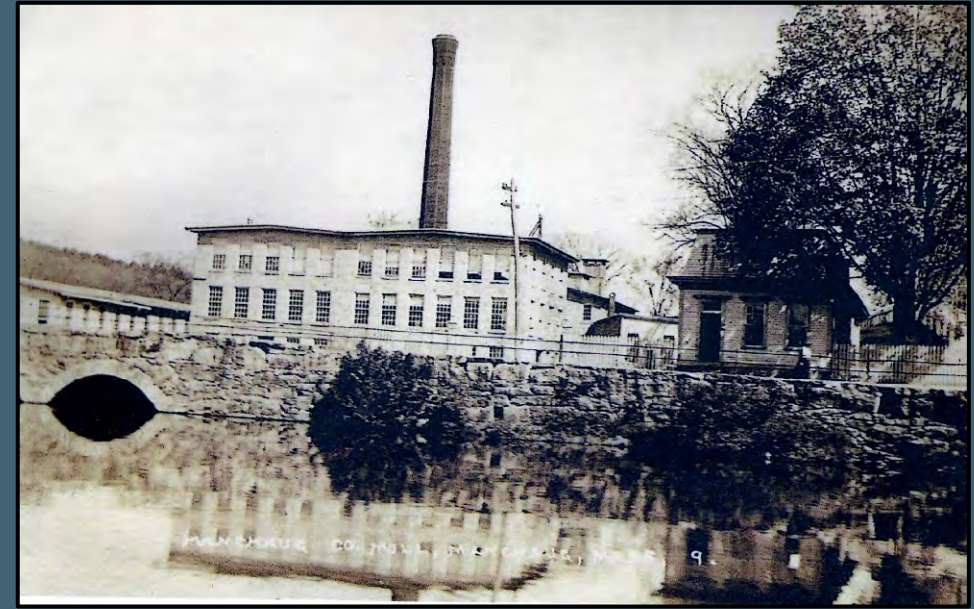
Resiliency Action Plan Overview

- General Scope: Resiliency Action Plan for the Mumford River/Dark Brook watershed & river corridor with a specific focus on the issue of flooding within Manchaug Village
- Scope & Schedule



The Solutions Meeting - Agenda

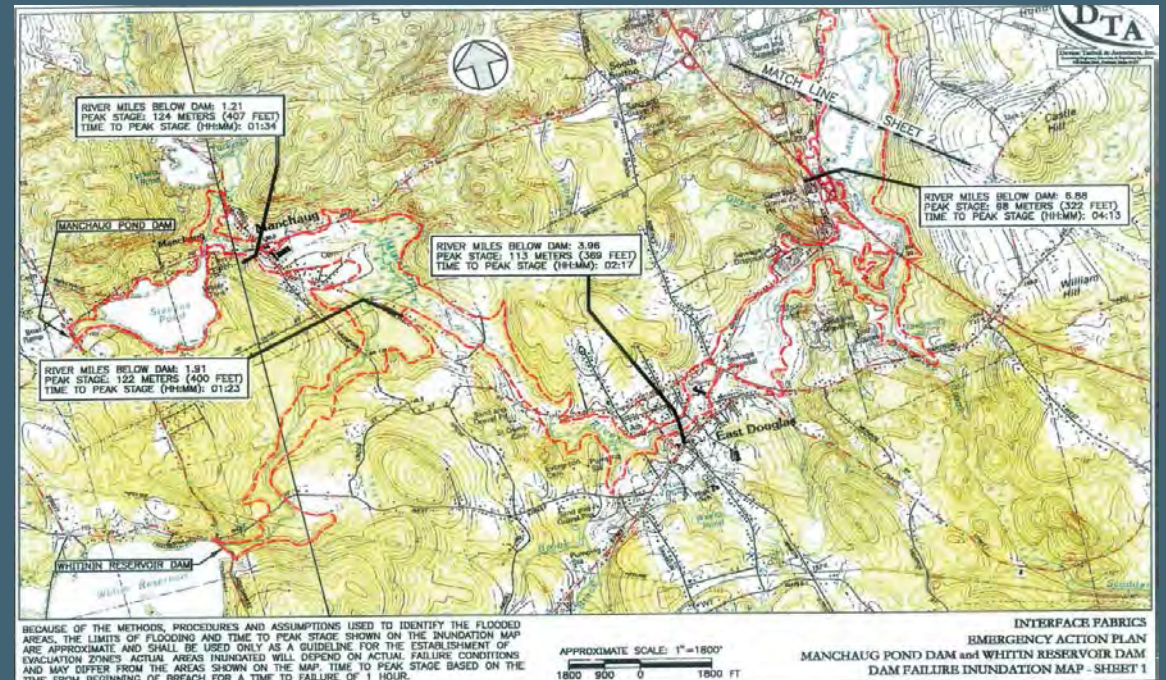
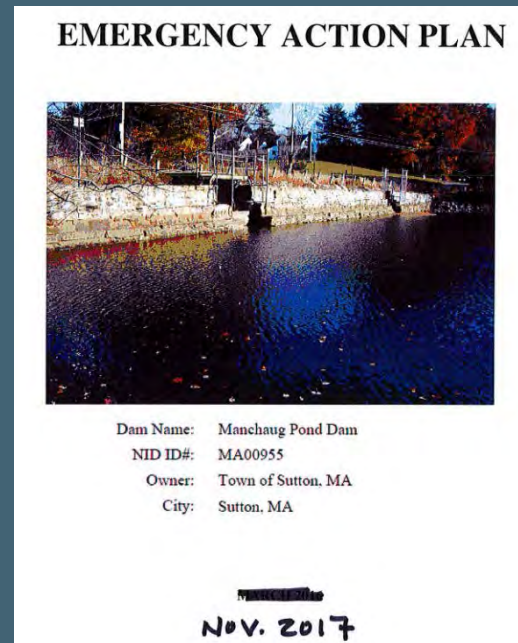
- Watershed-Wide “Solutions”
- Reach Specific “Solutions”
- Merge and Recap of “Solutions”
- Next Steps
- Discussion



-
- The map displays the Mumford River watershed, divided into four reaches. Reach A (Upper Mumford) is highlighted in yellow, Reach B (Dark Brook) in blue, Reach C (Manchaug Village and Whitins Tributary) in purple, and Reach D (Middle Mumford) in orange. Black lines represent town boundaries for Oxford, Sutton, and Douglas. Key geographical features include Douglas State Forest, the Whitins Reservoir, and several roads such as Douglas Rd, Main St, and Whitins Rd. A legend in the top right corner provides a key for the reaches and town lines. A scale bar in the bottom right corner indicates a distance of 1 mile.

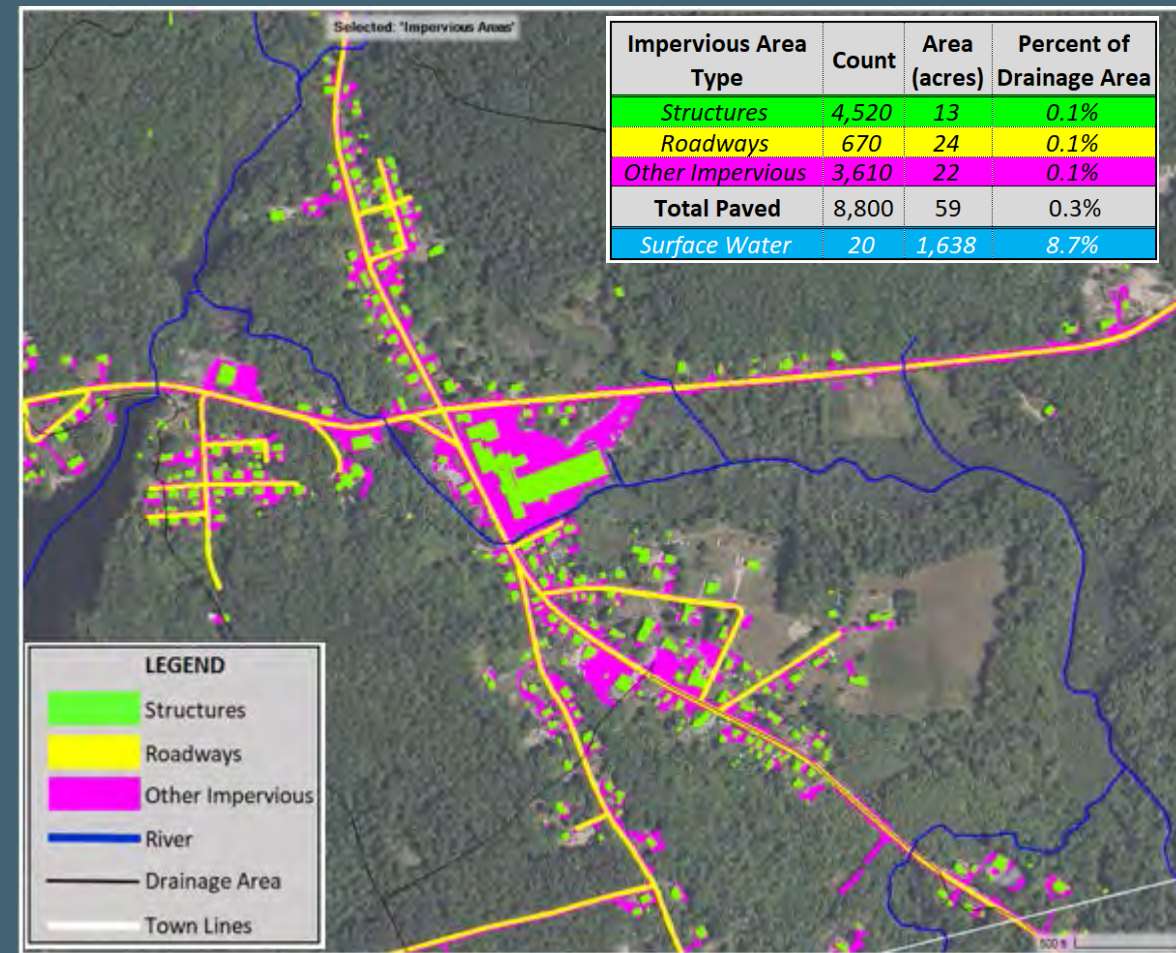
Emergency Action Plan (EAP)

- Current study has identified:
 - Extent of riverine flooding (2"- 18" rain events)
 - Vulnerable assets
 - Triggering rain events
 - Failure potential & impacts of failure (Start)
- Technical basis for watershed specific EAP for riverine flooding; an EAP that could improve:
 - Knowledge of Risks
 - Preparedness & Warning
 - Preventive Action (Pre-Storm)
 - Emergency Response
 - Post Storm Recovery



Land Cover Interventions

- **Land Cover Preservation:** Preserving & enhancing vegetated areas (>90% of watershed currently)
- **Land Cover Conversion:** Converting impervious areas to pervious areas (<1% of watershed currently)
- **Green Stormwater Infrastructure (GSI):** Installing GSI adjacent to impervious areas to collect & infiltrate its runoff. Potential GSI alternatives include:
 - Downspout Disconnection
 - Rainwater Harvesting
 - Rain Gardens
 - Bioswales
 - Planter Boxes
 - Permeable Pavement
 - Green Roofs



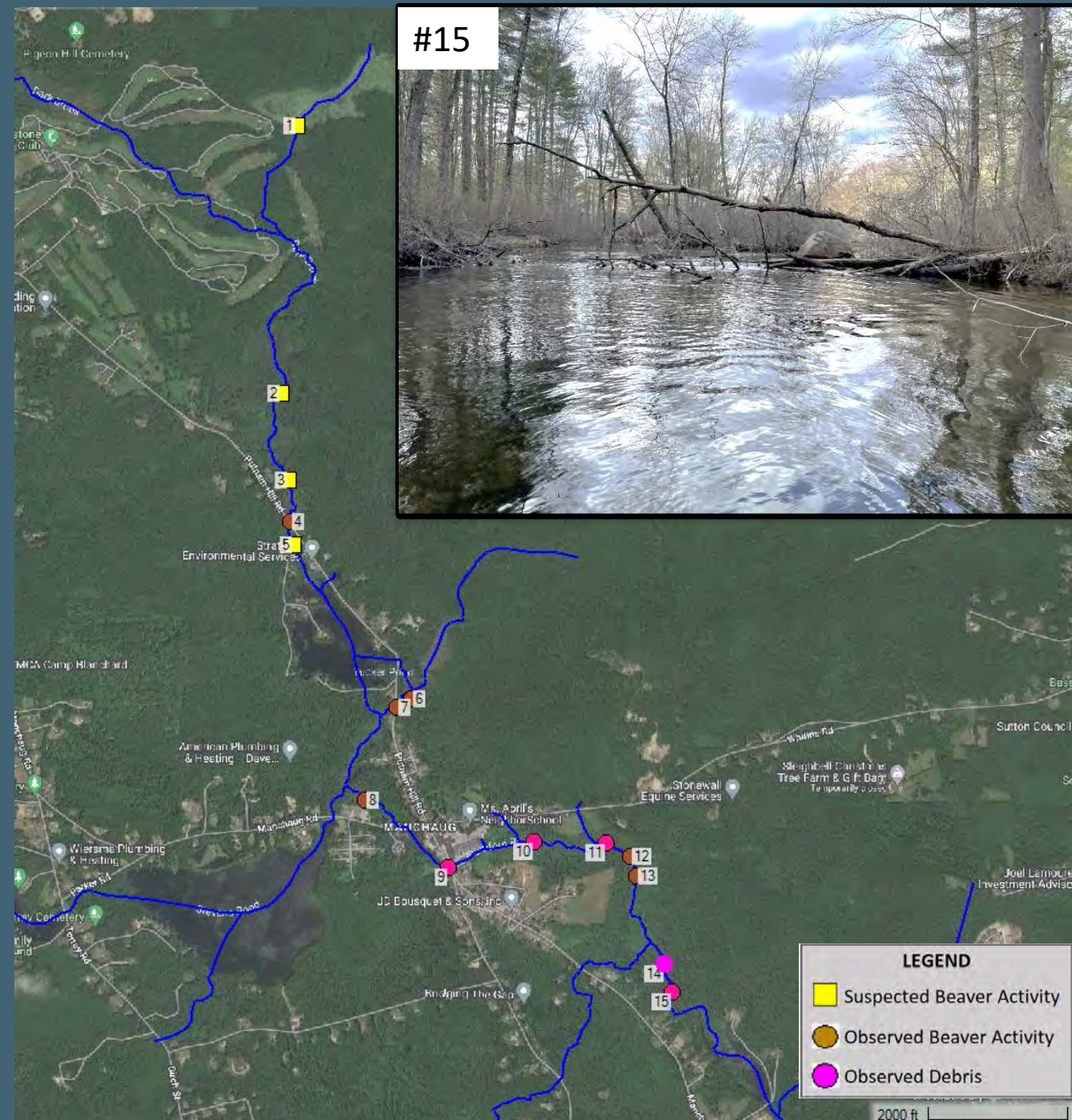
Beaver and River Maintenance (The Problem)

- Problem

- Beaver & debris dams at numerous (15+) locations along the rivers in the watershed

- Impacts

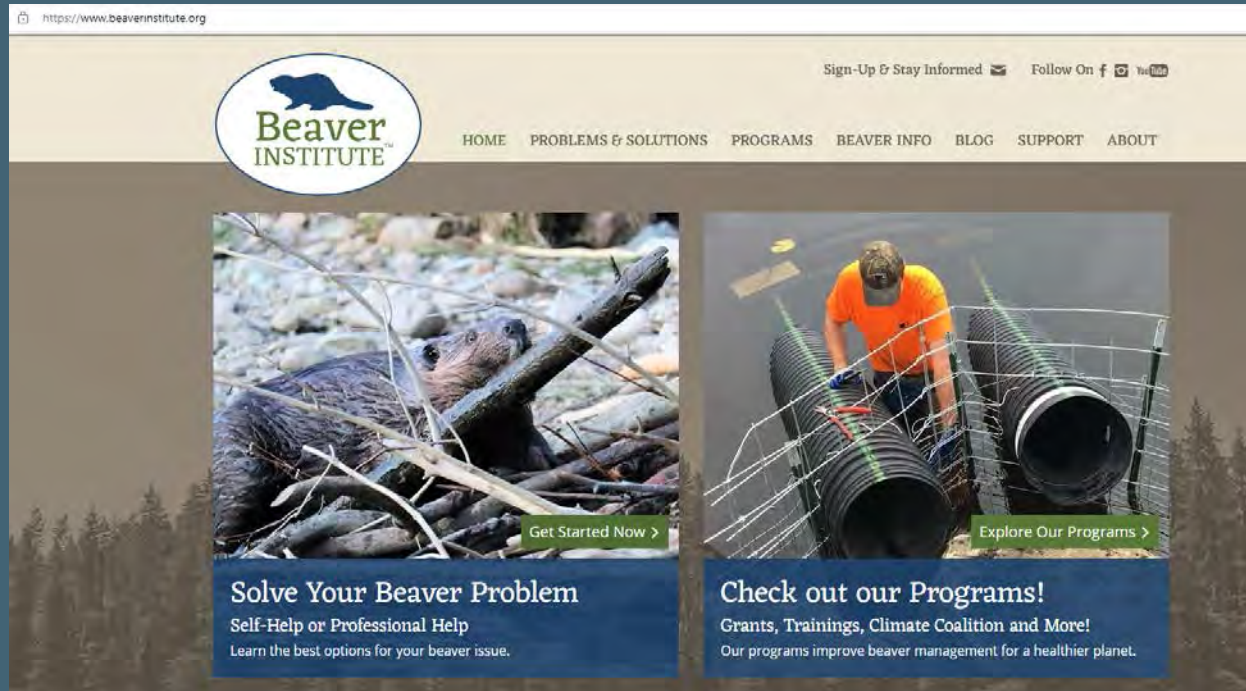
- Elevated river levels that could lead to flooding issues
- Beaver and debris dams are prone to failure; Failure of these dams could generate notable flood waves that could lead to quick developing flooding issues
- Degradation of some of the ecological & functional values of river & its floodplain



Beaver and River Maintenance (The Solution)

Goal: Remove high risk/impact beaver/debris dams along the river to restore free flowing rivers while balancing the ecological benefit of naturally occurring processes.

- **Relocate Beavers:** To less populated areas that would benefit from beaver activity
- **Remove/Modify Beaver Dams:** In high risk/impact areas along the river
- **Remove Debris:** Remove debris dams, fallen trees (in specific areas), other debris
- **Monitor & Maintain (M&M):** Recurrent M&M to limit the reoccurrence of beaver/debris dams in high risk/impact areas of the river



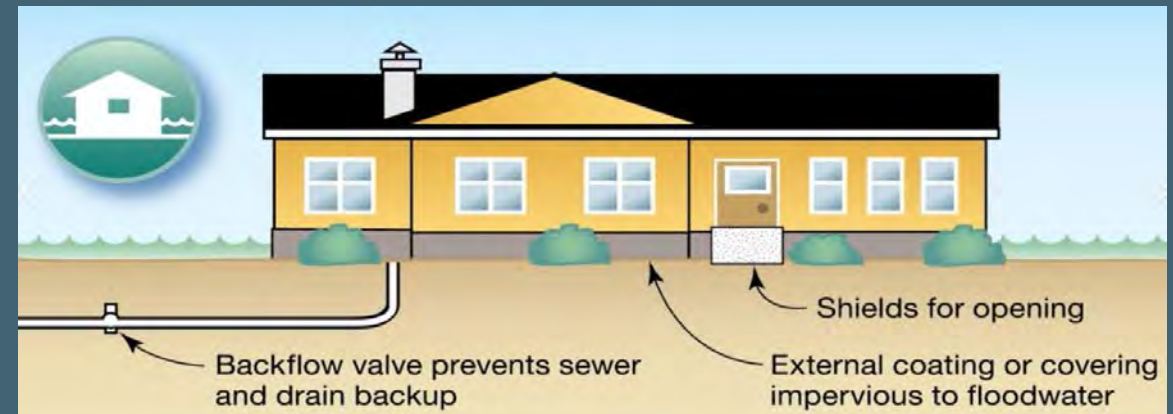
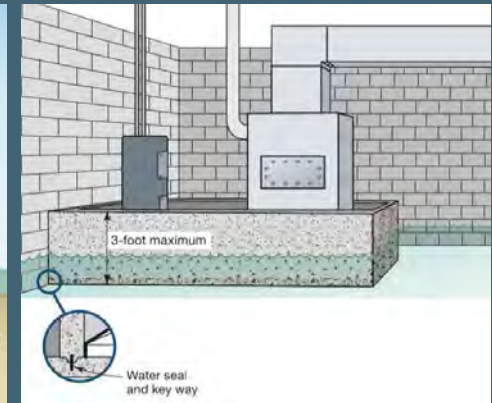
Reach Specific Solutions

- Recap of the problem for each reach
- Present solution strategies for each reach
- General strategies include:
 - Modify Buildings
 - Reduce flood damage at individual buildings
 - Modify Dams
 - Comply with regulations, reduce failure potential, increase flood attenuation, lower flood elevations (upstream & downstream), improve ecosystem services (stream connectivity, fish/wildlife passage)
 - Remove Dams
 - Eliminate failure potential, lower flood elevations upstream, improve ecosystem services
 - Replace Roadway Crossings
 - Lower flood elevations upstream, reduce frequency of roadway overtopping (less damage & use limitations), reduce failure potential, improve ecosystem services



Building Modifications

- **Sump Pumps**: Provide backup power for sump pumps; replace aging/ineffective systems
- **Wet Floodproofing**: Relocating/protecting utilities & content below flood elevations
- **Dry Floodproofing**: Structure improvements to limit entrance of flood waters
- **Elevation**: Raise first floor elevation (FFE) of structure above flood levels
- **Retreat**: Restore parcel to natural floodplain & relocate to a less flood prone area



Reach A

(Upper Mumford)

Model Results

Dams

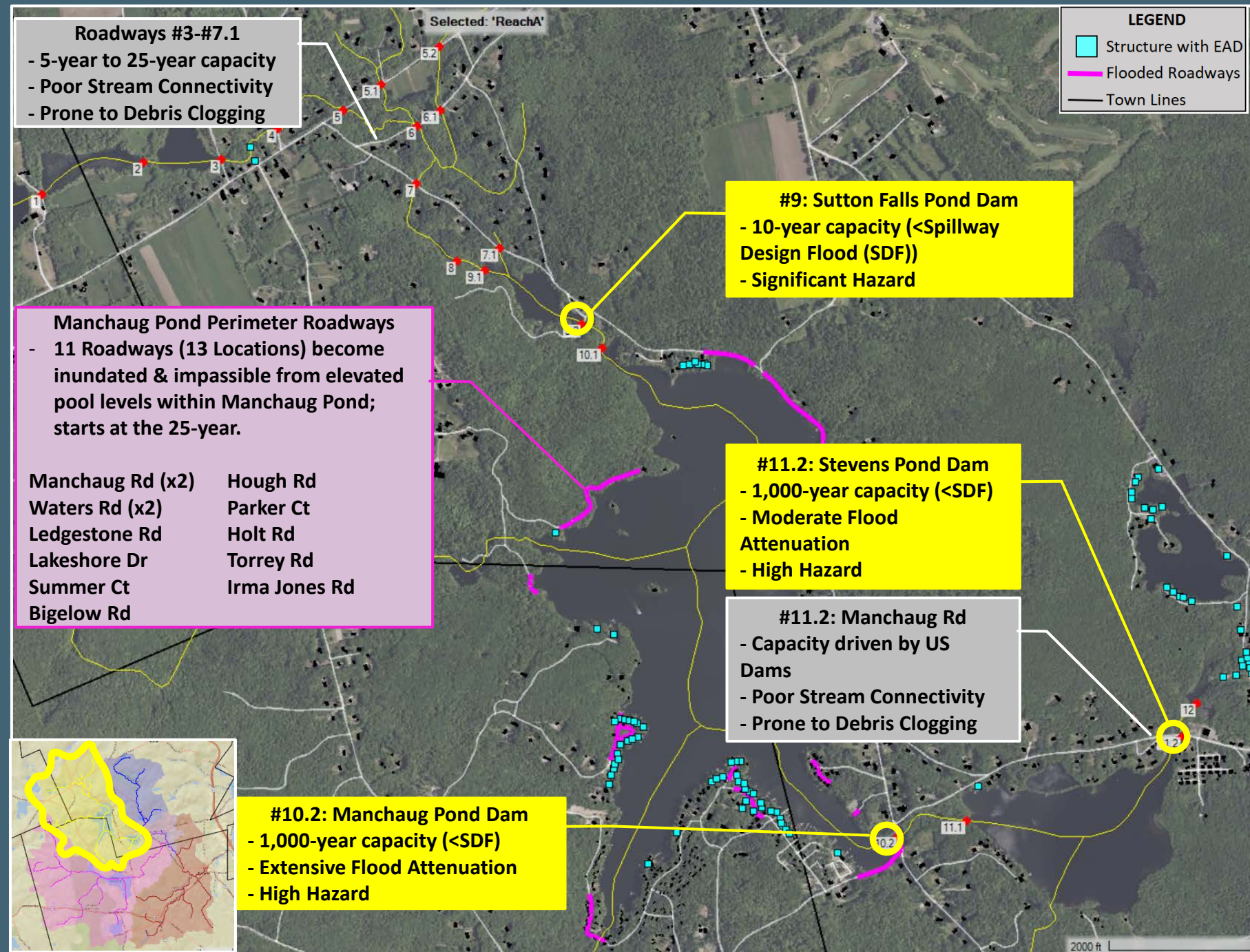
- #9 Sutton Falls Pond Dam (SFPD)
- #10 Manchaug Pond Dam (MPD)
- #11 Stevens Pond Dam (SPD)

Roads

- All upstream (US) of Sutton Falls Pond Dam
- Manchaug Pond Perimeter
- Manchaug Road downstream (DS) of SPD

Buildings

- 58 with potential for Equivalent Annual Damage (EAD)
- 4 US of Manchaug Pond
- 53 along Manchaug Pond



Reach A (Upper Mumford) Solutions

Dam Modifications

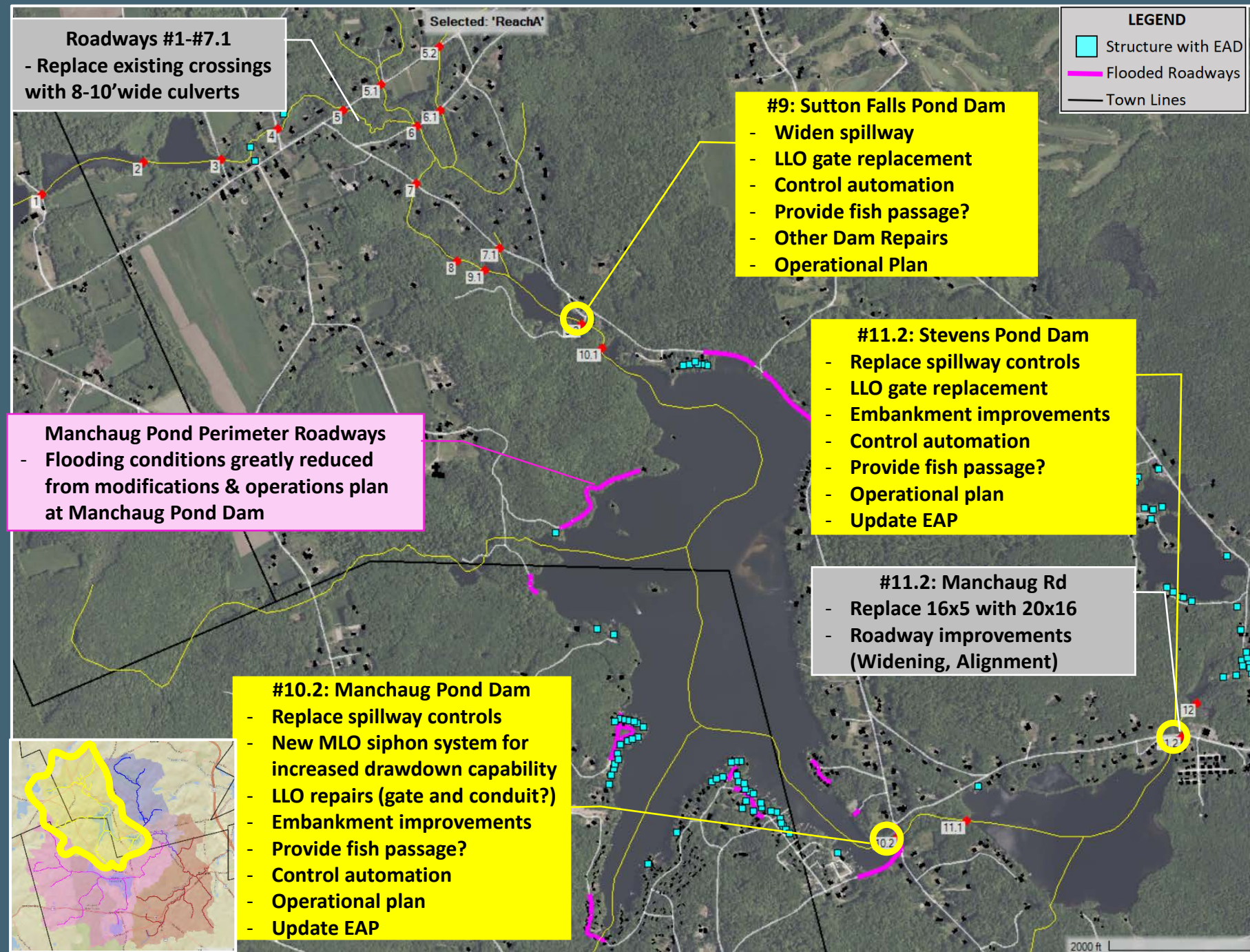
- SFPD: From 10yr to 500
- MPD: From 1,000 to >1/2PMF
- SPD: From 1,000 to >1/2PMF

Culvert Replacements

- #1-#7.1: From 5-25 to 100
- MPP Roads
- #11.2: SPD Capacity

Buildings

- Modifications at most 58
- 55 along ponds benefit greatly from dam modifications
- 3 US greatly benefited by culvert replacements



Reach A (Upper Mumford)

Manchaug Pond Dam Modifications

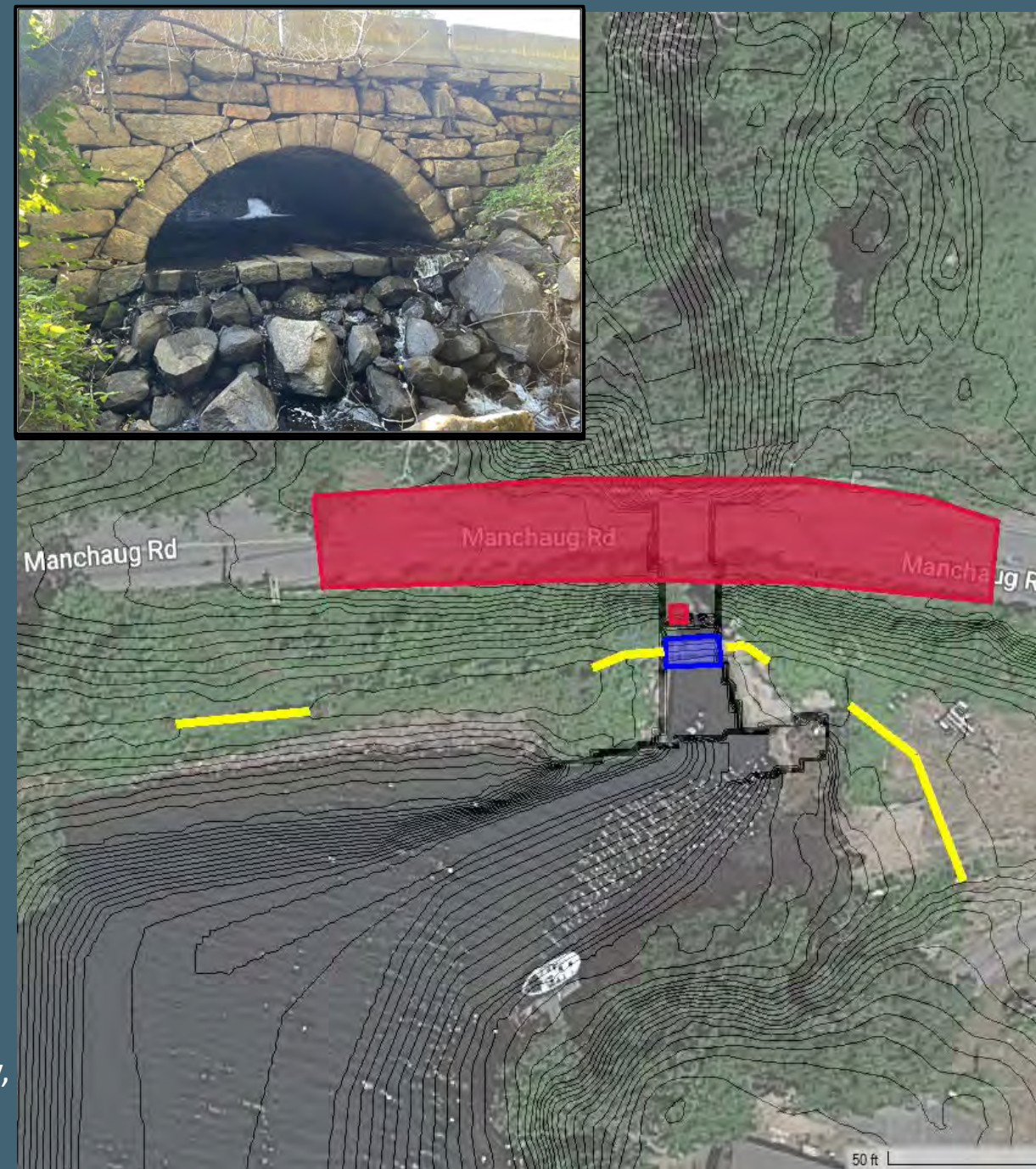
1. **Replace Spillway Controls:** Replace stop logs with 10'w x 4'h rotary/tainter gate; automate operations
2. **Low Level Outlet (LLO) Controls:** Replace gate with 2' square upward operating orifice gate; automate operations
3. **LLO Conduit:** Inspect conduit. If replacement is warranted, install a larger conduit
4. **Siphon System:** If new LLO conduit is not needed, install a siphon system to provide improved drawdown capacity; conceptually developed as three 18" diameter conduits at the right abutment
5. **Other Dam Repairs and Modifications:** If Needed
6. **Operational Plan:** Pre-storm (1/2 PMF) drawdown to El. 517 (~1.8' below normal pool – El. 518.8); Other operational procedures to limit outflows & pool level rises



Reach A (Upper Mumford)

Stevens Pond Dam Modifications

1. **Replace Spillway Controls:** Remove flash boards & top 2' of concrete control section; replace with 16'w x 3'h rotary/tainter gate; automate operations
2. **Low Level Outlet (LLO) Controls:** Remove existing gate; Square DS end of conduit & install 3' square upward operating orifice gate; automate operations
3. **Crest Elevation:** Establish a consistent crest elevation of El. 475 (Current mins El. 474.2)
4. **Embankment Improvements:** Upstream slope riprap, regrade crest & downstream slope, toe drain system, grass vegetation
5. **Other Dam Repairs and Modifications:** If Needed
6. **Operational Plan:** Pre-storm (1/2 PMF) drawdown to El. 467 (~2.5' below normal pool – El. 469.5); Other operational procedures to limit outflows
7. **Manchaug Road Improvements:** Replace bridge, widen roadway, improve site distance



Reach B (Dark Brook)

Model Results

Beaver Activity

- #12 & Other Areas

Dams

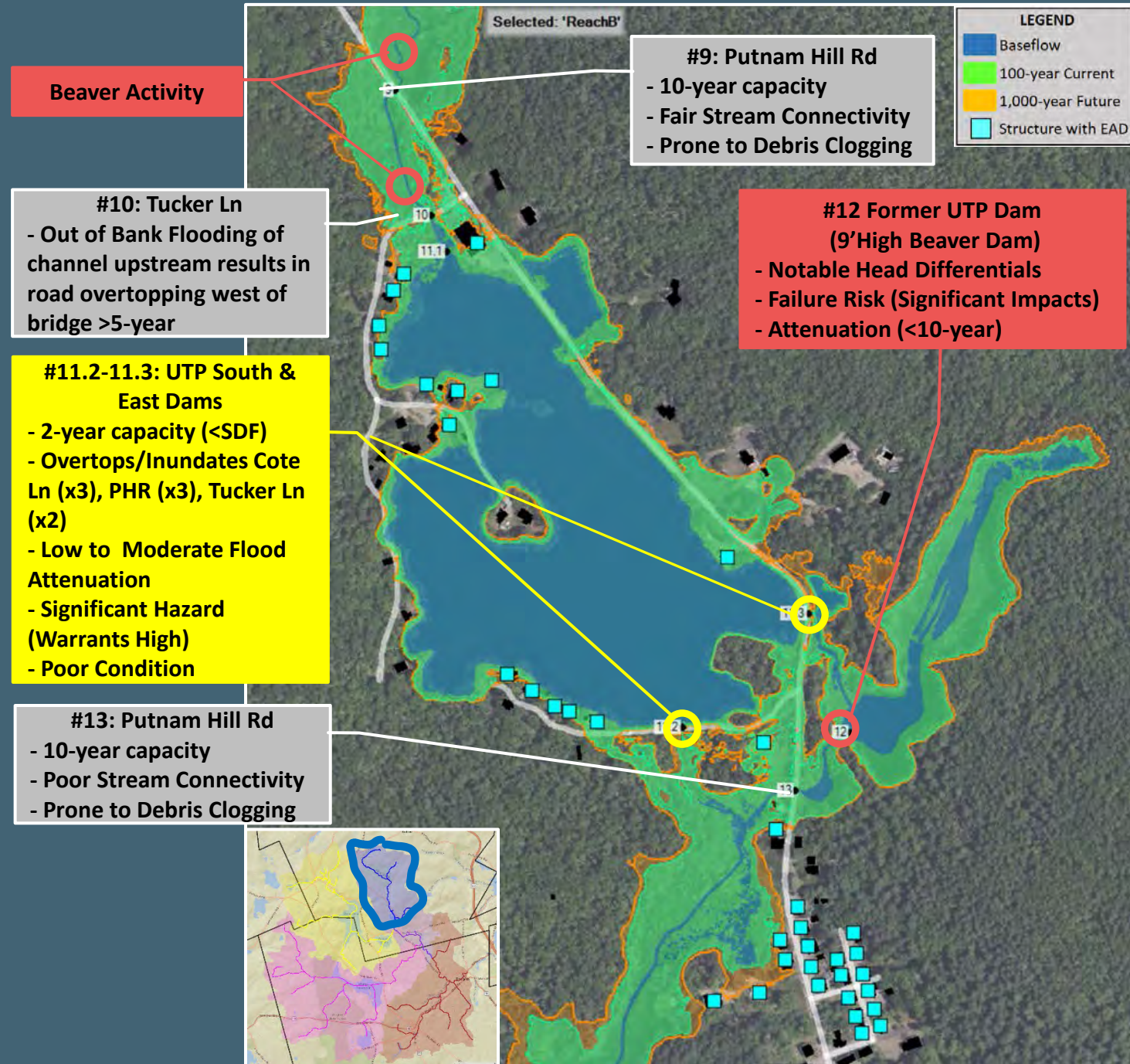
- #11.2 Upper Tucker Pond (UTP) South Dam
- #11.3 UTP East Dam

Roads

- Putnam Hill Road (5 locations)
- Tucker Lane (3 locations)
- Cote Lane (3 locations)

Buildings

- 37 with potential for EAD
- 15 along Upper Tucker Pond
- 11 downstream of UTP



Reach B (Dark Brook) Solutions

Beaver/River M&M

Dam Modifications

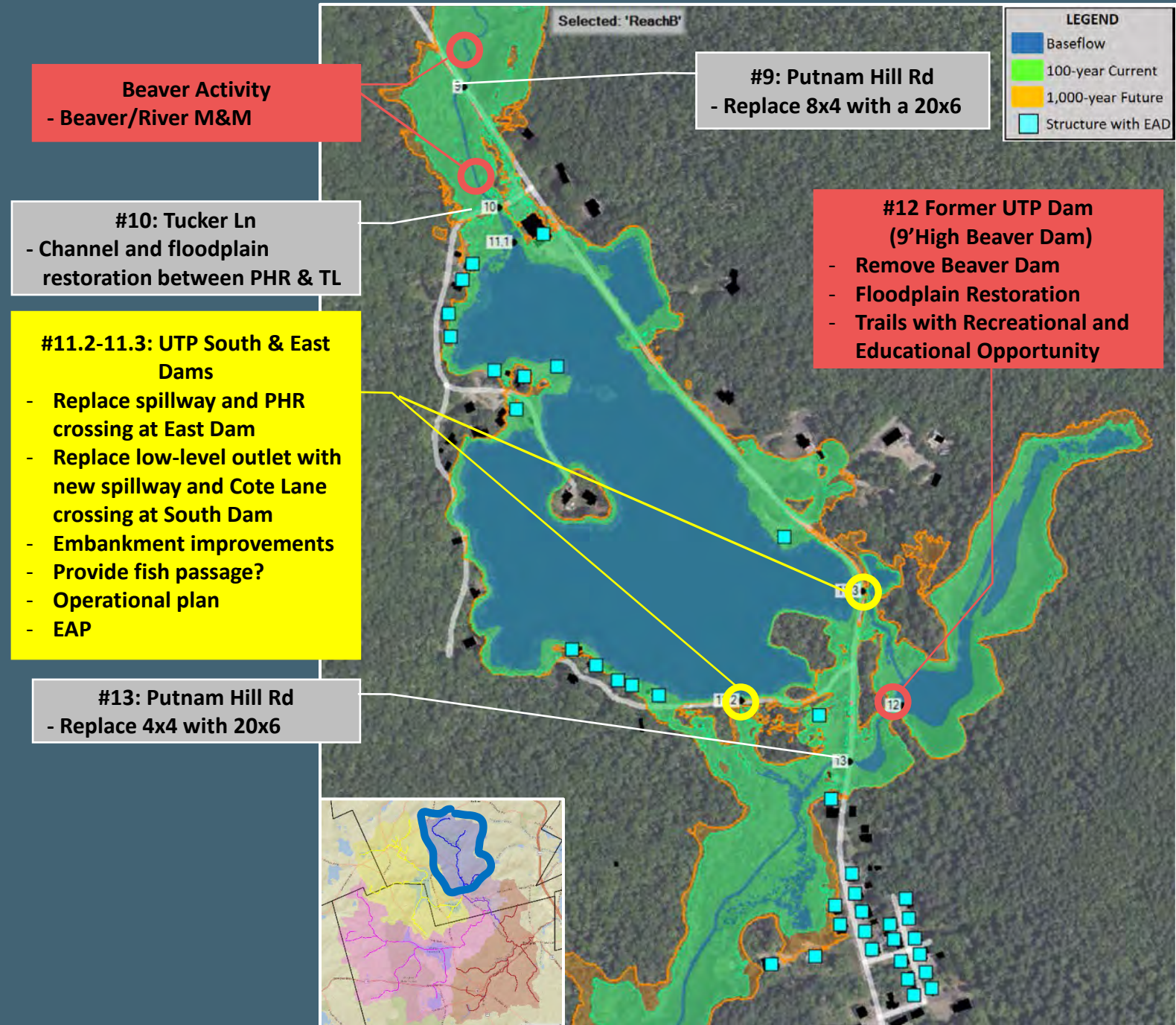
- **UTPD: From 5yr to 1/2 PMF**

Culvert Replacements

- **PHR #9: From 25 to 100**
- **TL: From 5 to 100**
- **PHR#13: From 10 to 200**

Building Modifications

- **Modifications at most 37**
- **15 along UTP greatly benefited by UTPD modifications**
- **11 downstream of UTP greatly benefited by UTPD modifications, #12 & #13 improvements, & river/beaver M&M**



Reach B (Dark Brook)

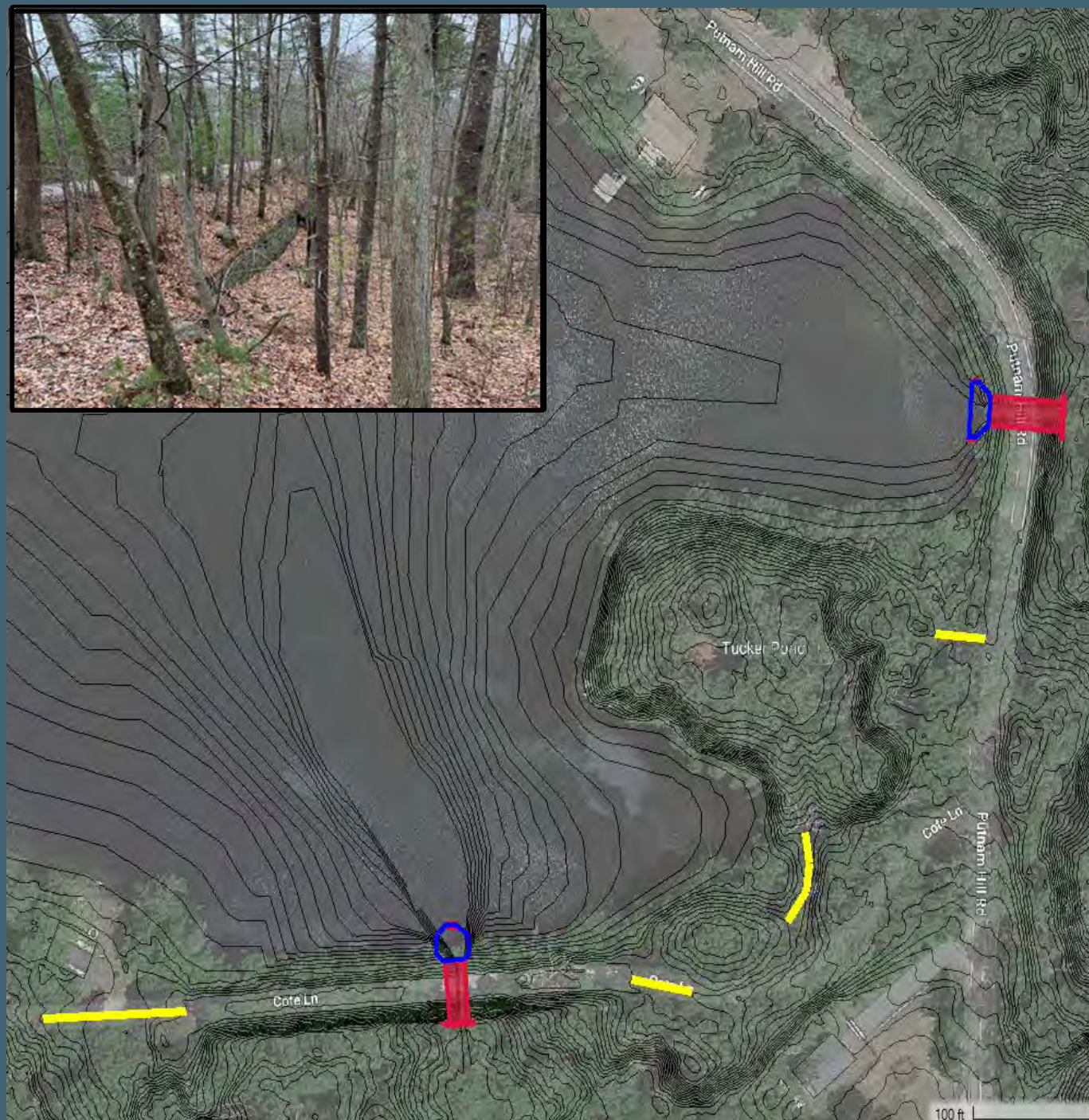
UTP East and South Dam Modifications

East Dam

1. **New Spillway:** 40'w x 15'd x 10'h trapezoidal concrete spillway
2. **Operations:** Two 4'w x 5'h MLO gates; automate operations
3. **Putnam Hill Road Crossing:** New 20'w x 12'h bridge
4. **Crest Elevation:** Regrade low RA area
5. **Embankment Improvements:** US slope riprap, DS slope riprap/veg, toe drain system/rock toe, grass vegetation

South Dam

1. **New Spillway:** 35'w x 35'd x 17'h octagon concrete spillway
2. **Operations:** One 2' square LLO gate and one 8'w x 6'h MLO gate built into new spillway; automate operations
3. **Cote Lane Crossing:** New 14' square concrete culvert
4. **Crest Elevation:** Regrade all low areas
5. **Embankment Improvements:** Sheetpile cutoff wall, US slope riprap, DS slope buttress, blanket & toe drain system, grass vegetation



Reach C (Village)

Model Results

Beaver Activity

- #1 & Other Areas

Dams

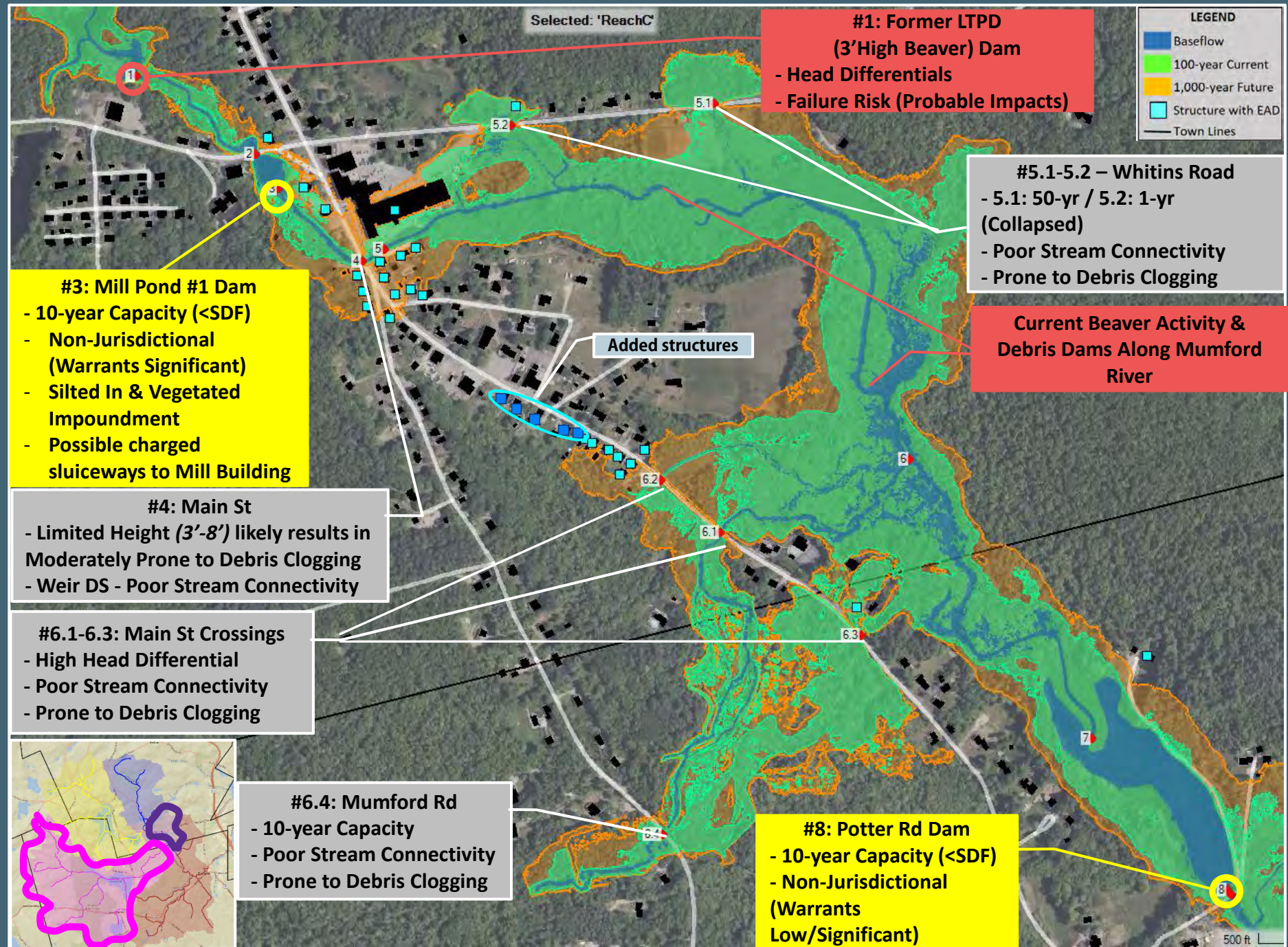
- #3 Mill Pond Dam
- #8 Potter Road Dam

Roads

- #4 Main Street
- #9 Potter Road
- All 6 Tribs (3 Main Street, 2 Whitins Road, 1 Mumford Road)

Buildings

- 25 w/ potential for EAD
- + 5 from Mtg Input
- Mill Site #1



Reach C (Village) Solutions

Beaver/River M&M

- Previously Discussed;
#1, #4, & #5 Specifics

Dam Modifications

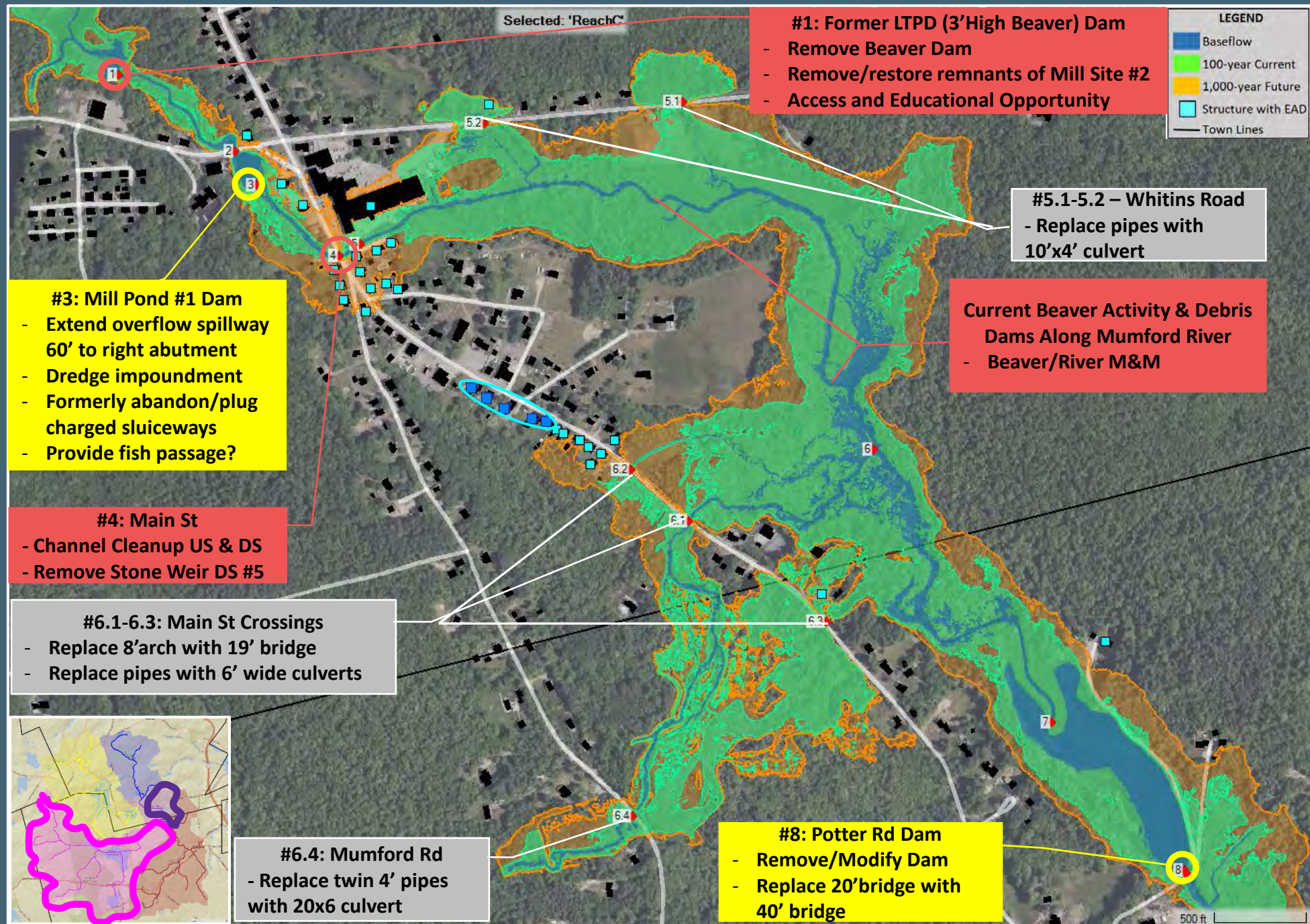
- #3: From 10 to 500
- #8: Removed / Modified

Culvert Replacements

- #5.1-5.2: From 1-50 to 1,000
- #6.1-6.3: From 50-200 to 1,000
- #6.4: From 10 to 500

Buildings

- Modifications at most 30



Reach C (Village)

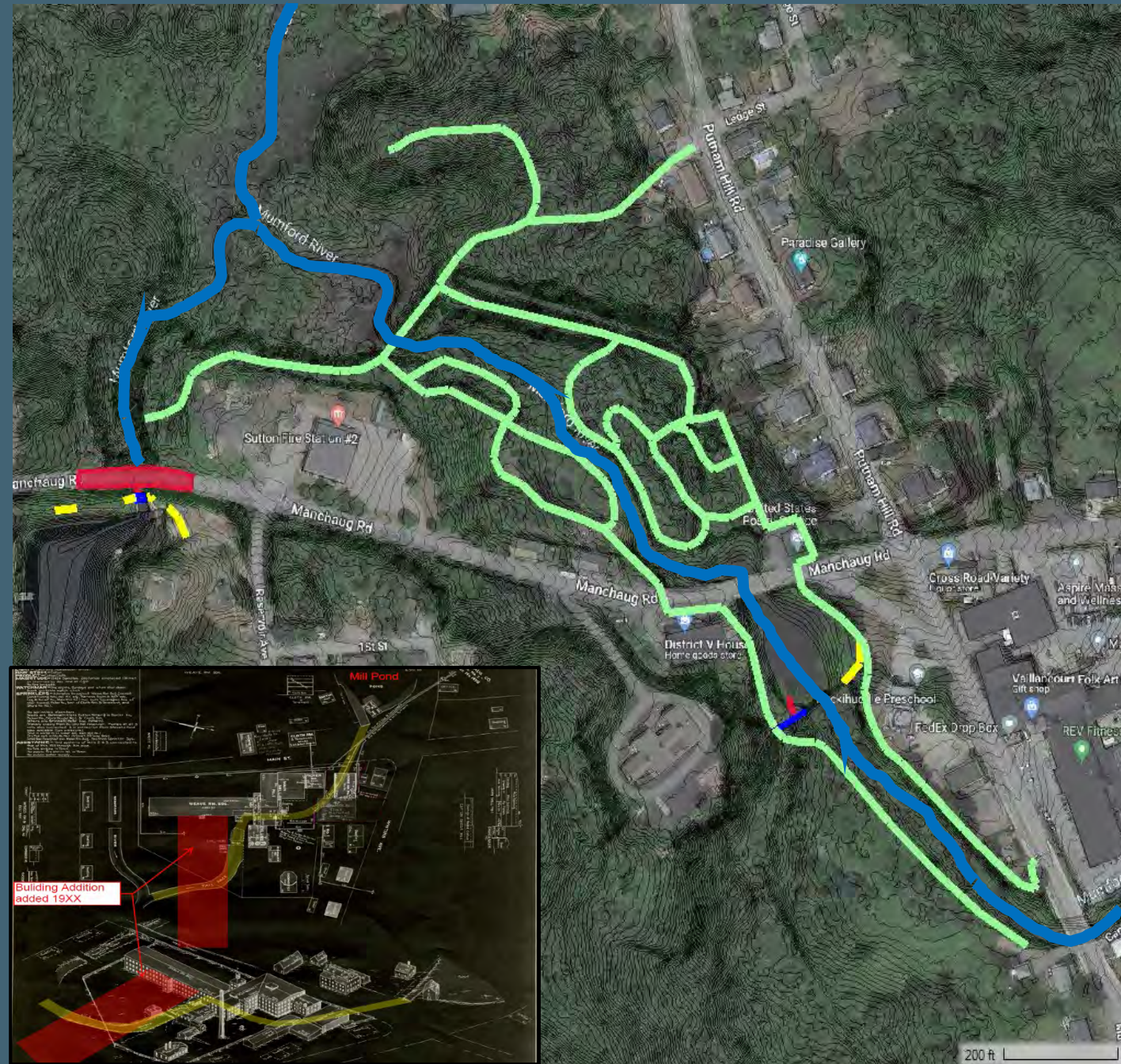
Mill Site Trails & Mill Pond Dam #1 Modifications

Mill Site Trails with Recreational, Educational, GSI

1. **Trails:** Establish trails with educational & recreational amenities throughout the historic mill sites
2. **Mill Site Restoration:** Restore certain features of Mill Sites #2 and #3 with educational amenities
3. **GSI:** Incorporate GSI along trails with educational amenities: Fire Station, Post Office, others

Mill Pond Dam #1 Modifications

1. **Extend "Waterfall Spillway":** Extend the waterfall spillway 60 feet right to the right abutment.
2. **Low Level Outlet (LLO) Controls:** Install new upward operating orifice gate; automate operations.
3. **Impoundment Dredging:** Dredge impoundment
4. **Abandon Sluiceway:** Formally plug/abandon sluiceway to Mill Building #1



Reach D (Middle Mumford) Model Results

Dams

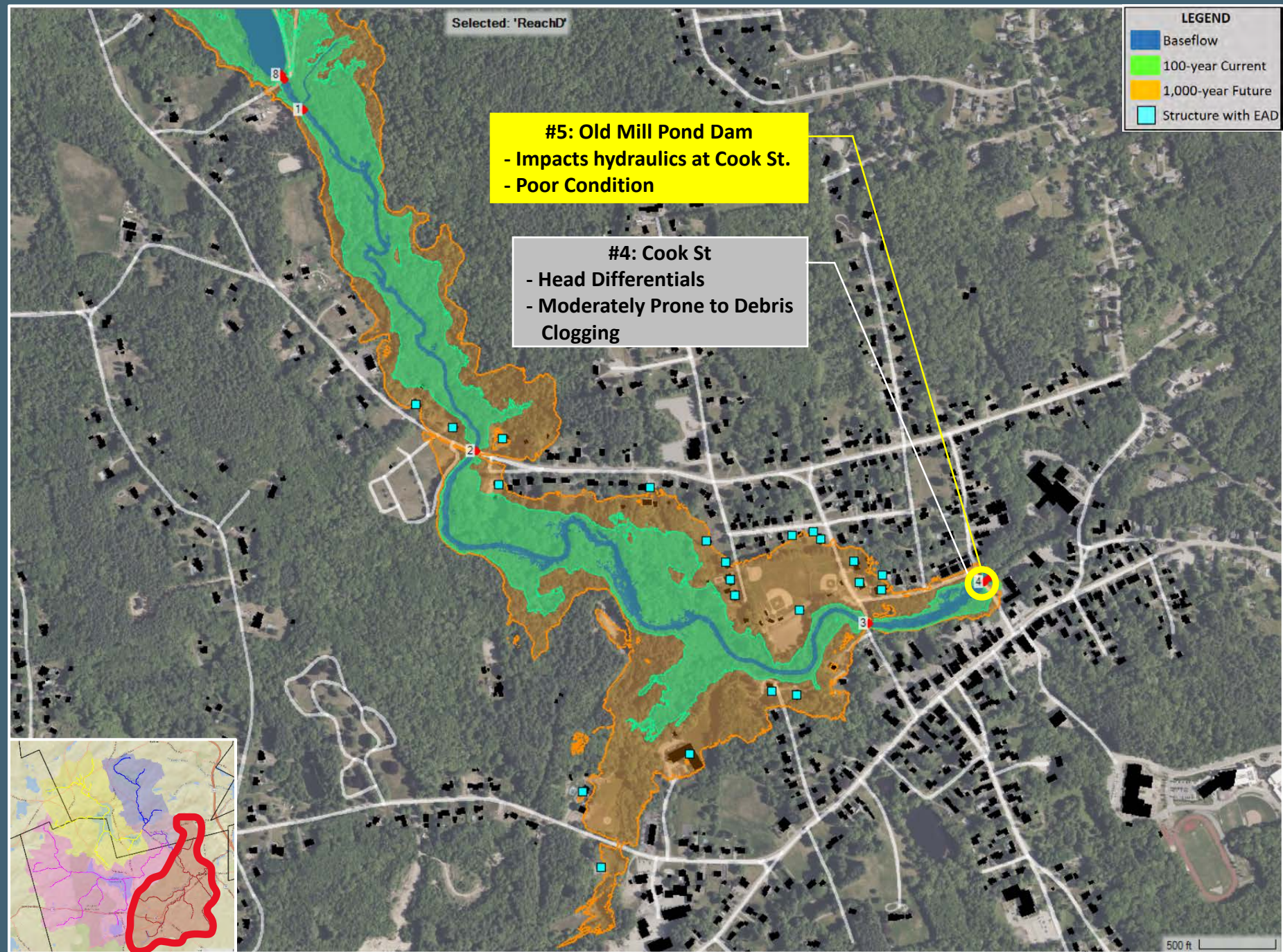
- #5 Old Mill Pond Dam

Roads

- #4 Cook Street

Buildings

- 22 with potential for EAD



Merge and Recap of Solutions

Potential Flood Damage Reduction / Mitigation Solution Concepts - Mumford River & Dark Brook Watershed												
#	Location				Action Item	Capacity - Current		Capacity - CCIPF		Estimate Range (\$K's)		Potential Funding
	Reach	#	Name	Owner		EC	PC	EC	PC	Lower	Higher	
1	All	-	Watershed Wide	Private, Town, State	Emergency Action Plan	-	-	-	-	\$ 50	\$ 75	EOEEA, FEMA
2	All	-	Watershed Wide	Private, Town, State	Land Cover Preservation	-	-	-	-	\$ 50	\$ 150	EOEEA, FEMA
3	All	-	Watershed Wide	Private, Town, State	Land Cover Conversion	-	-	-	-	\$ 200	\$ 1,000	EOEEA, FEMA
4	All	-	Watershed Wide	Private, Town, State	Green Stormwater Infrastructure	-	-	-	-	\$ 100	\$ 5,000	EOEEA, FEMA
5	All	-	River Wide	Private, Town, State	Beaver Dam and River Debris Removal, Monitoring & Maintenance (M&M)	-	-	-	-	\$ 750	\$ 2,500	MADER, NOAA
6	A	-	Reach A Buildings	Private	Building Modifications (58EA)	1	-	1	-	\$ 1,000	\$ 2,500	FEMA
7	B	-	Reach B Buildings	Private	Building Modifications (37EA)	1	-	1	-	\$ 500	\$ 1,000	FEMA
8	C	-	Reach C Buildings	Private	Building Modifications (30EA)	10	-	5	-	\$ 400	\$ 800	FEMA
9	B	11.2&11.3	Upper Tucker Pond (UTP) East and South Dams	Private, State	Hazard Reclassification, Spillway Design Flood (SDF) Modifications & Operational Plan	5	>1/2 PMF	2	>1,000	\$ 6,000	\$ 9,000	EOEEA, FEMA
10	A	11.2	Stevens Pond Dam (SPD)	Town	SDF Modifications & Operational Plan	>1,000	>1/2 PMF	200	>1,000	\$ 2,000	\$ 3,000	EOEEA, FEMA
11	A	10.2	Manchaug Pond Dam (MPD)	Town	SDF Modifications & Operational Plan	>1,000	>1/2 PMF	500	>1,000	\$ 1,500	\$ 2,500	EOEEA, FEMA
12	B	13	Putnam Hill Road	State	Crossing Replacement	10	200	5	50	\$ 1,500	\$ 2,500	MADER
13	B	9	Putnam Hill Road	State	Crossing Replacement	25	100	10	25	\$ 1,500	\$ 2,500	MADER
14	B	10	Tucker Lane Channel	Private	Channel and Floodplain Regrading Upstream of Crossing	5	100	2	50	\$ 500	\$ 1,000	MADER, NOAA
15	A	1-7.1	Crossings US of SFPD	Town, Private	Crossing Replacements (11EA)	5-25	100	2-10	25-50	\$ 6,000	\$ 12,000	MADER
16	C	1	Mill #2 Site	Town, Private	Floodplain Restoration at Mill #2 Site	-	-	-	-	\$ 500	\$ 1,000	EOEEA, MADER
17	C	3	Mill Pond Dam #1	Private	Modifications at Mill Pond Dam #1	10	500	5	100	\$ 1,000	\$ 1,500	EOEEA
18	C	5	Channel Weir	Private	Remove Weir and Restore Channel	-	-	-	-	\$ 50	\$ 100	MADER, NOAA
19	A	9	Sutton Falls Pond Dam (SFPD)	Private	SDF Modifications & Operational Plan	10	500	5	100	\$ 1,500	\$ 2,500	EOEEA, FEMA
20	C	5.2	Whitins Road	Town	Crossing Replacement	1	>1,000	<1	1,000	\$ 1,000	\$ 1,500	MADER
21	C	5.1	Whitins Road	Town	Crossing Replacement	50	>1,000	25	1,000	\$ 1,000	\$ 1,500	MADER
22	C	6.1-6.3	Main Street	State	Crossing Replacements (3EA)	50-200	1,000	25-50	500	\$ 2,500	\$ 4,000	MADER
23	A	11.2	Manchaug Road	Town	Crossing Replacement	-	-	-	-	\$ 2,500	\$ 4,500	MassDOT, MADER
24	C	8-9	Potter Road Dam & Bridge	Town, Private	Dam Removal/Modification and Crossing Replacement	10	200	5	50	\$ 2,000	\$ 4,000	EOEEA, MADER, MassDOT
25	C	6.4	Mumford Street	Town	Crossing Replacement	10	500	5	100	\$ 1,500	\$ 2,500	MassDOT,MADER
26	D	-	Reach D Buildings	Private	Building Modifications (22EA)	200	-	50	-	\$ 300	\$ 500	FEMA
Channel / Ecosystem Restoration										\$ 36	\$ 69	\$M's
Infrastructure Upgrade with Ecosystem Benefit										\$ 35,900,000	\$ 69,125,000	\$
Dam Modifications												
Structure Floodproofing												

Next Steps:

- ☐ Refine solutions based upon feedback
- ☐ Resiliency Action Plan Report – Draft
 - Available to Public – May 22nd Target date
 - Public Comment Period Until – May 31st
- ☐ Select Board Meeting – Present Draft of Action Plan
 - June 6th, 6:00pm, Sutton Town Hall
- ☐ Resiliency Action Plan Report – Finalized
 - June 30th

Contact Information:

Jen Hager: j.hager@town.sutton.ma.us
(508)-865-8729

Discussion

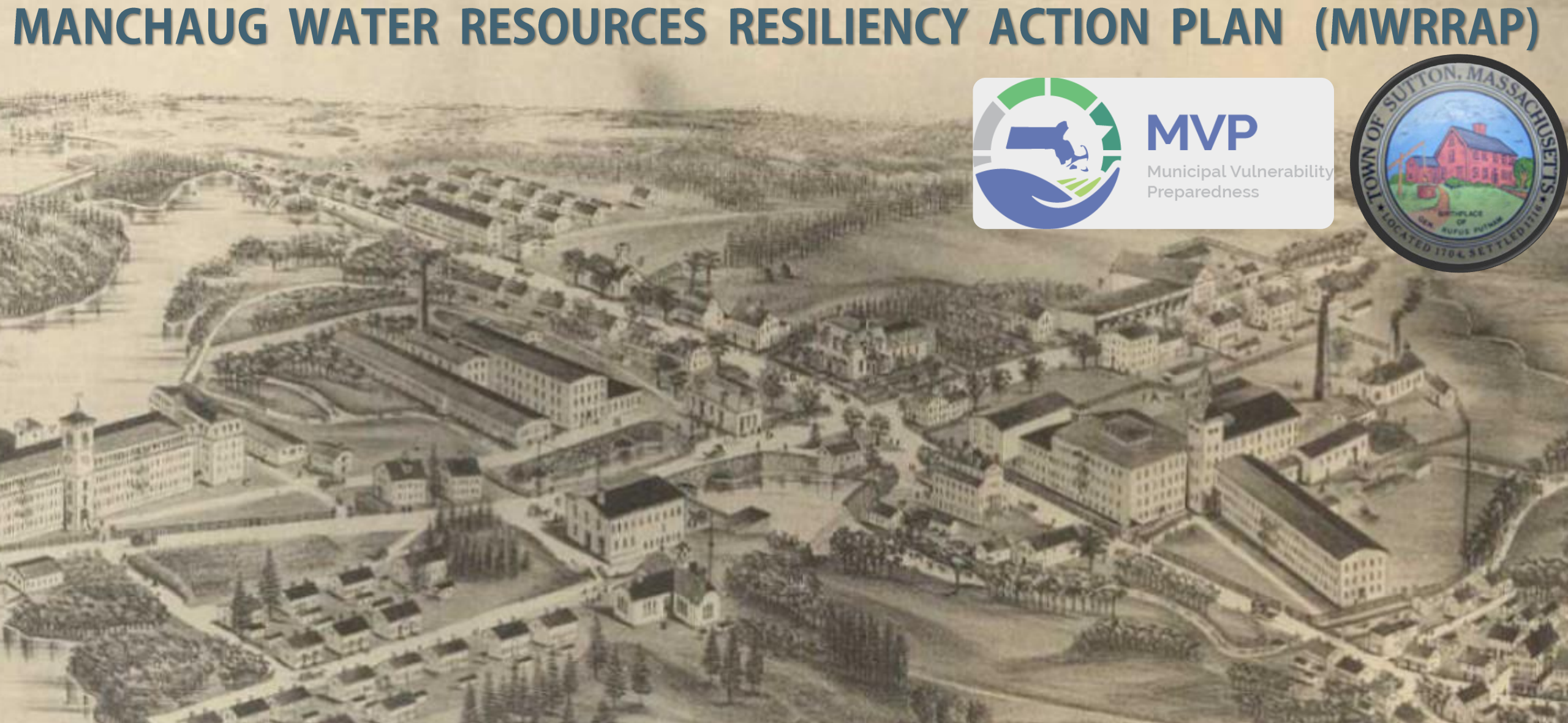


MANCHAUG WATER RESOURCES RESILIENCY ACTION PLAN (MWRRAP)



MVP

Municipal Vulnerability
Preparedness

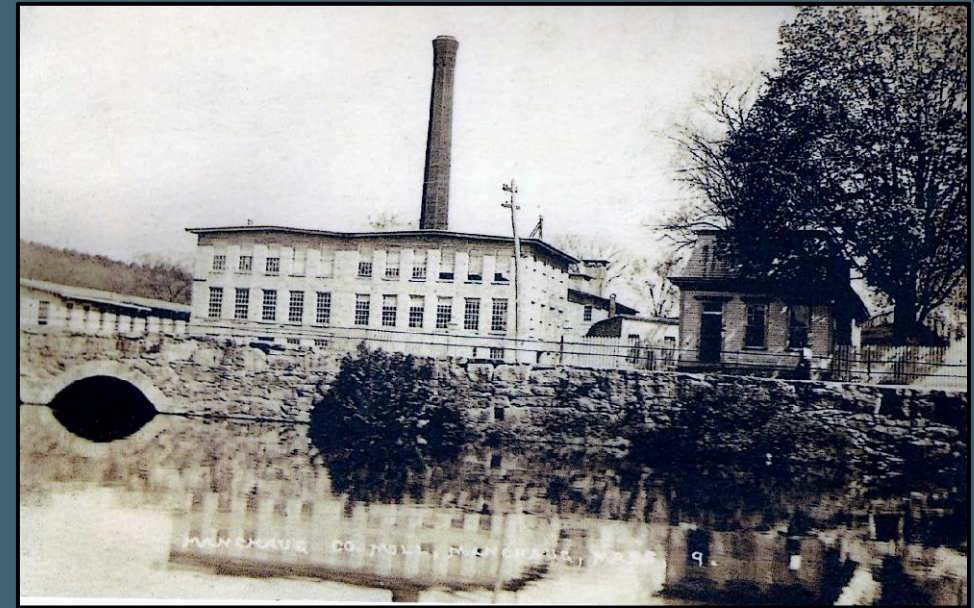


Select Board Meeting
June 6, 2023



Select Board Meeting - Agenda

- MWRRAP Process & Project Team
- Project Phases and Public Involvement
 - Phase I: Data Collection & Inventory
 - *The Listening Session*
 - Phase II: Existing Conditions Evaluations
 - *The Problem Meeting*
 - Phase III: Solution Strategy Development
 - *The Solutions Meeting*
 - Phase IV: Report Development
 - *The Select Board Meeting*
 - Next Steps (Phase V: Report Finalization)
- Discussion



MWRRAP Process

- **Overview:**

- Resiliency Action Plan for the Mumford River/Dark Brook watershed & river corridor
- Specific focus on the issue of riverine flooding within Manchaug Village
- A master plan for the Town to prioritize and seek funding for future individual projects.

- **Funding:**

- \$75K Grant from Municipality Vulnerability Program (MVP) through the Executive Office of Energy and Environmental Affairs (EOEEA)
- \$25K Match from Sutton



Project Team

- **Project Lead (Town of Sutton)**

- **Lead:** Jennifer Hager
- **MVP Team:** Pamela Nichols, Lee Dillard Adams, Robin Dresser, Paul Maynard, Bill Wence, Matthew Stencil, Cheryl Rawinski, Sara Plutnicki (CMRPC)
- **EOEEA:** Hilary King, MVP Central Regional Coordinator

- **Project Consultants:**

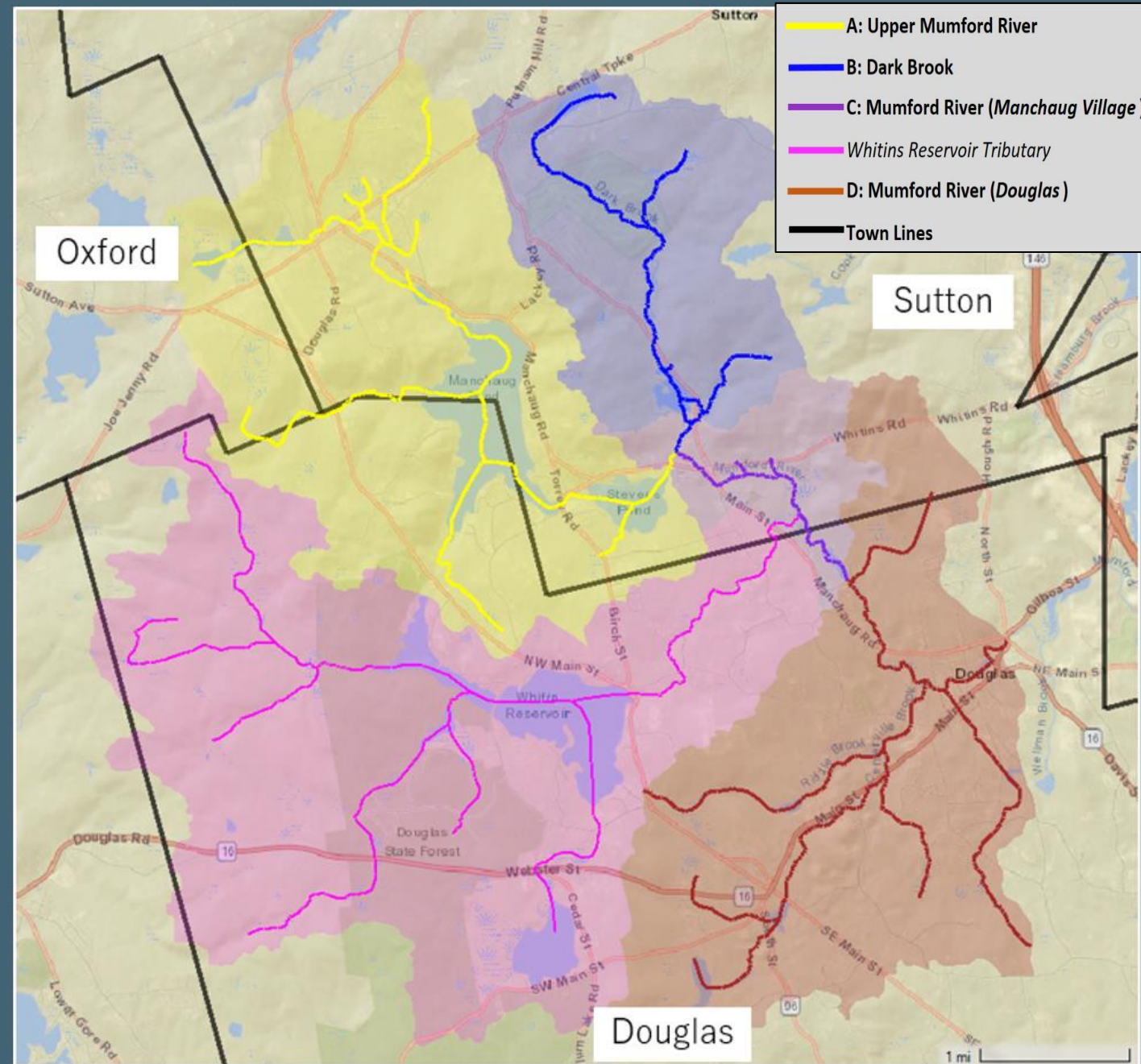
- Pare Corporation
- Traverse Landscape Architects

- **Project Stakeholders:**

- Residents of Manchaug Village and the Town of Sutton
- Manchaug Pond Foundation
- Blackstone Watershed Collaborative (BWC)
- Blackstone River Watershed Association (BRWA)
- Central Mass Regional Planning Commission (CMRPC)
- State Agencies: (EOEEA, MassDOT, MADCR, MADER)

Phase I: Data Collection & Inventory

- Inventoried all major stream crossings along river corridors
 - Dams and Roadway Crossings
 - File Review & Data Collection
 - Geometry, Condition, Hazard
- River Corridor Subdivided into Four Reaches (A-D)
 - A. Upper Mumford River
 - B. Dark Brook
 - C. Mumford River (*Manchaug Village*)
 - D. Mumford River (*Douglas*)
- Section 1 of Report



The Listening Session

- **First Public Meeting – November 17th**
 - Process and Scope Overview
 - Overview of Phase I
 - Open Discussion
- Open Discussion from 30+ attendees generated valuable feedback both during the meeting and weeks after
- Feedback utilized to:
 - Refine Phase II scope
- **Site Walk Meeting – December 6th**
 - Feedback received from MVP Team as well as Local and State Officials

VILLAGE MEETING
Manchaug Water Study Project – Meeting #1

 **Thursday, November 17th at 6 PM**
Manchaug Mills
9 Main Street – 1st Floor Wing

The Town of Sutton received a \$75,000 Municipal Vulnerability Preparedness (MVP) Grant from the Executive Office of Energy and Environmental Affairs (EOEEA) (www.resilientma.org/MVP). The natural and manmade drainage and water flow systems in the Village of Manchaug will be assessed and strategies developed to prevent future flooding and other water induced damage.

THIS IS YOUR VILLAGE. PLEASE COME SHARE YOUR THOUGHTS AND KNOWLEDGE!

- Meeting #1 – Our consultant will share information and gather your input about the natural and manmade water flow systems in Manchaug.

UP NEXT:

- Meeting #2 – March 2023 – Share and discuss field work and identified problems.
- Meeting #3 – April 2023 – Share and discuss possible strategies and solutions.
- June 2023 - Final report presented to the Select Board.

If you have questions, want to be added to the stakeholder list, or need more information, please reach out to Jen Hager at j.hager@town.sutton.ma.us or 508-865-8729.

Planning Study - Manchaug Village Flooding
Listening Session 11/17/22 - Handout Packet
Page 1 of 30
General Outline

Listening Meeting General Outline

1. Meeting Kickoff	Town	6:00
2. Overview of the General Scope of the Study	Pare	6:10
3. Present Supporting Figures & Site Photographs	Pare	6:15
4. Open Discussion	All Attendees	6:30 – 7:30

General Scope: Planning Study for the Mumford River / Dark Brook watershed and river corridor with particular focus on flooding issues within the Manchaug Village area.

The Listening Session

a) Hydrologic and Hydraulic (H&H) Analyses of Existing Conditions (EC)

- Data Collection – Completed September
- Develop HydroCAD Model of Entire Watershed and Adjoining Watersheds
- Develop HEC-RAS Hydraulic Model of Flooding Area of Interest
- Run all storms (1-year through 1,000-year) through the Hydraulic Model
- Review and Refine the Model and Model Inputs as needed

b) Decipher EC Model Results & Identify Strengths & Vulnerabilities

- Structures Vulnerable to Flood Damage
- Hydraulic Structure Performance
 - Dams
 - Upper Tucker Pond Dams
 - Manchaug Pond Dam
 - Stevens Pond Dam
 - Roadway Crossings
 - Putnam Hill Road (2 each)
 - Tucker Lane
 - Manchaug Road (4 each)
- Other
 - Beaver Dams along Dark Brook (2 for sure; possibly as many as 6 total)
 - Former Dams Partially Removed/Breached (Mill Site #1, Upstream of Putnam Hill Road)
 - River and Floodplain Performance
 - Watershed Characteristics (Land Cover and Soils)

The Problem Meeting

c) Develop & Evaluate Potential Alternatives

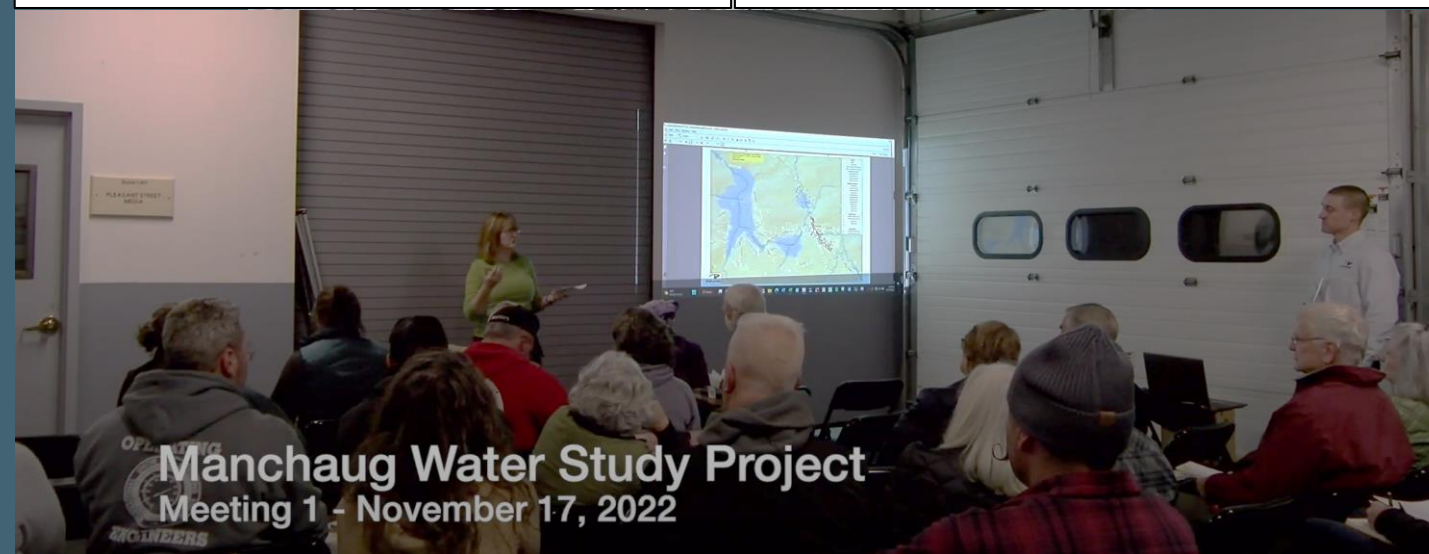
- Structure Floodproofing
- Dam Modifications
- Dam Removals
- Roadway Crossing Replacements
- River & Floodplain Restoration

The Solutions Meeting

d) Summary Report

The Closing Meeting





Phase II: Existing Conditions Evaluations

- Hydrologic and Hydraulic Evaluations

- 1-yr through 1,000-year storm events
- Current and Future¹ Rainfall

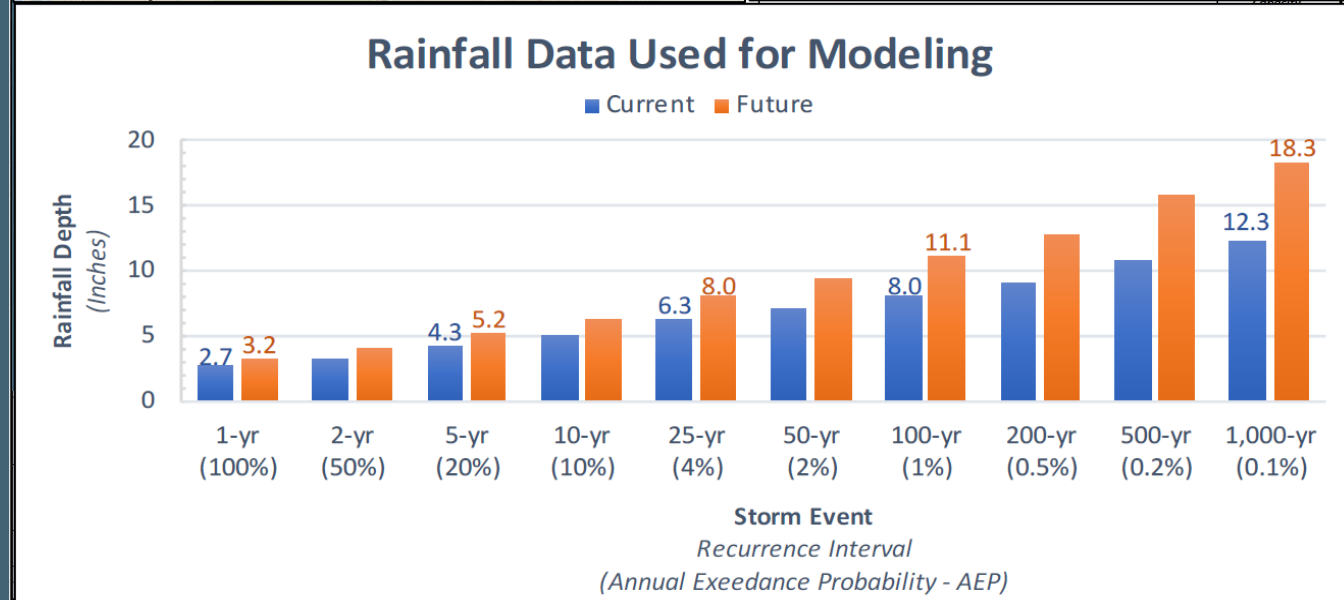
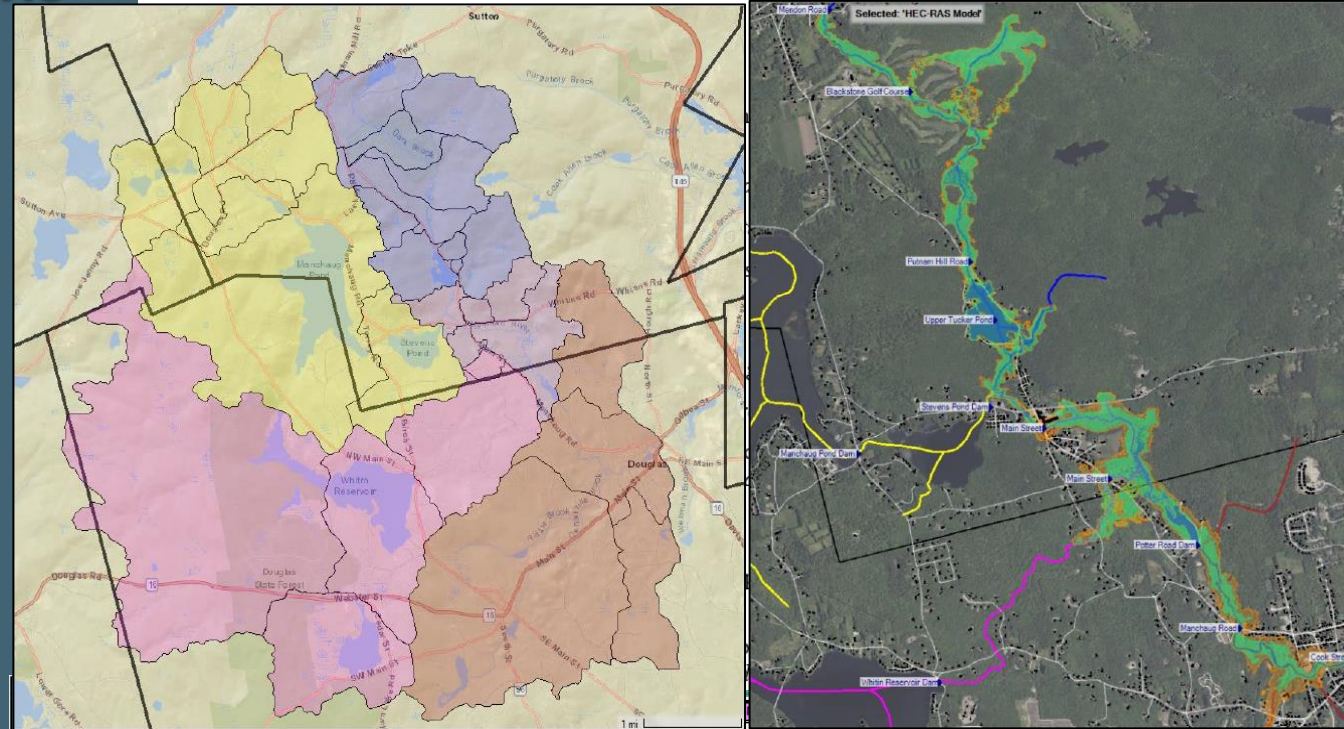
1. Climate Change Informed Predicted Future (CCIPF)

- Identify Strengths & Vulnerabilities of Assets within each Reach (A-D)

- Dams / Roadways / Buildings

- Report Sections

2. Detailed Results for Each Reach
3. Damage Assessment for Buildings
4. Overview Results for Each Reach



The Problem Meeting

- Second Public Meeting – March 16th
 - Evaluations Overview
 - Results Overview
 - Open Discussion
- Open Discussion from 25+ attendees generated valuable feedback both during the meeting and weeks after
- Feedback utilized to:
 - Refine Phase II findings and reporting
 - Refine scope of Phase III

VILLAGE MEETING

Manchaug Water Study Project – Meeting #2



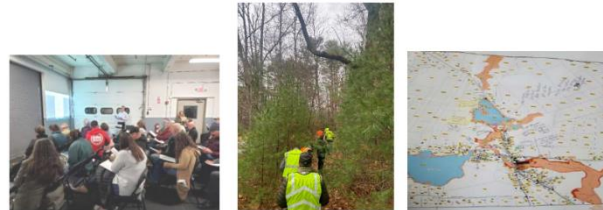
Thursday, March 16th at 6 PM
Manchaug Mills, Blaxton Hall

The Town of Sutton received a \$75,000 Municipal Vulnerability Preparedness (MVP) Grant from the Executive Office of Energy and Environmental Affairs (EOEEA) (www.resilientma.org/MVP) to assess and mitigate issues with the natural and manmade water flow systems in and around the Village. At Meeting #1 we discussed the overall project and received the knowledge and input of residents and stakeholders about these systems. We've used this input and completed the assessment of the water flow systems in the Village.

Meeting #2 – Learn what we found and provide your feedback!

UP NEXT:

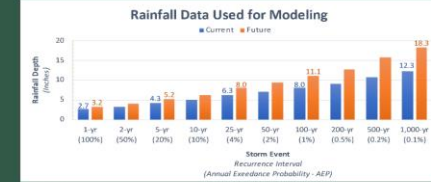
- Meeting #3 – April 27, 2023 – Share and discuss possible strategies and solutions.
- June 2023 - Final report presented to the Select Board.



If you have questions, want to be added to the stakeholder list, or need more information, please reach out to Jen Hager at j.hager@town.sutton.ma.us or 508-865-8729.

Evaluations

- ▶ Hydrologic¹ & Hydraulic² (H&H) Modeling
- ▶ Current and Future³ Rainfall Scenarios
- ▶ Decipher Model Results
- ▶ Identify Strengths & Vulnerabilities of Assets
- ▶ Dams
- ▶ Roadways
- ▶ Structures (EAD⁴)
- ▶ Watershed-Wide Assessment



Definitions:

1. Hydrologic Modeling: Used to determine how rainfall interacts with the ground surface.
 - ▶ How much of the rain is absorbed by the ground surface?
 - ▶ How much of the rain runs off to rivers and streams? And how much does it runoff?
2. Hydraulic Modeling: Used to determine what the runoff does to the river, its floodplain, and nearby infrastructure.
 - ▶ How high and wide does the water level reach? And how fast is it flowing?
 - ▶ What is expected to be impacted by those water levels?
3. Climate Change Informed Predicted Future Rainfall Data
4. EAD: Equivalent Annual Damage

Reach C (Village) Model Results

Beaver Activity

- #1 & Other Areas

Dams

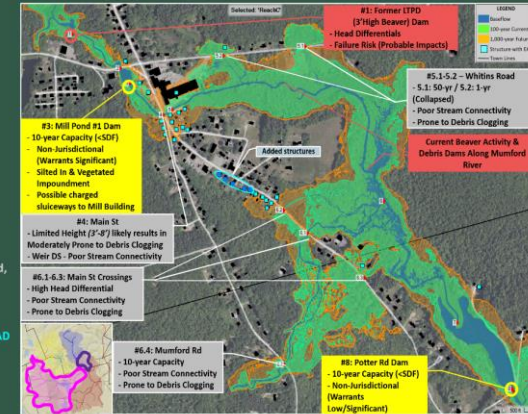
- #3 Mill Pond Dam
- #8 Potter Road Dam

Roads

- #4 Main Street
- #9 Potter Road
- All 6 Tribes (3 Main Street, 2 Whitins Road, 1 Mumford Road)

Buildings

- 25 w/ potential for EAD
- + 5 from Mtg Input
- Mill Site #1



MVP 2nd Meeting
March 16, 2023

Phase III: Solution Strategy Development

- **General Improvement Strategies**

- **Section 5 of Report**
- **Watershed-Wide, Building-Level, In-Stream**

- **Watershed-Wide Strategies**

- **Section 6 of Report**
- **EAP, Land Cover Interventions, River Obstructions**

- **Building-Level Strategies**

- **Section 7 of Report**
- **Sump Pumps, Floodproofing, Elevation, Retreat**

- **In-Stream Strategies**

- **Section 8 of Report**
- **Dam Modifications/Removals, Culvert Replacements**

- **Summary of All Strategies**

- **Section 9 of Report**

#	Location		Report Section	Action Item	Capacity - Current		Capacity - CCIPF		Estimate Range (\$K's)			Potential Funding	
	Reach	#			Name	Owner	EC	PC	EC	PC	Lower		Higher
1	All	-	Watershed Wide	Private, Town, State	6.1	Emergency Action Plan	-	-	-	-	\$ 50	\$ 100	EOEEA, FEMA
2	All	-	Watershed Wide	Private, Town, State	6.2.1	Land Cover Preservation	-	-	-	-	\$ 50	\$ 300	EOEEA, FEMA
3	All	-	Watershed Wide	Private, Town, State	6.2.2	Land Cover Conversion	-	-	-	-	\$ 200	\$ 2,000	EOEEA, FEMA
4	All	-	Watershed Wide	Private, Town, State	6.2.3	Green Stormwater Infrastructure	-	-	-	-	\$ 100	\$ 5,000	EOEEA, FEMA
5	All	-	River Wide	Private, Town, State	6.3.3	Beaver Dam and River Debris Removal, Monitoring & Maintenance (M&M)	-	-	-	-	\$ 750	\$ 3,000	MADER, NOAA
6	A	-	Reach A Buildings	Private	7.6	Building Modifications (59EA)	1	-	1	-	\$ 1,000	\$ 3,000	FEMA
7	B	-	Reach B Buildings	Private	7.6	Building Modifications (37EA)	1	-	1	-	\$ 500	\$ 1,000	FEMA
8	C	-	Reach C Buildings	Private	7.6	Building Modifications (30EA)	10	-	5	-	\$ 500	\$ 1,000	FEMA
9	B	11.2&11.3	Upper Tucker Pond (UTP) East and South Dams	Private, State	8.2.1.1	Hazard Reclassification, Spillway Design Flood (SDF) Modifications & Operational Plan	5	>1/2 PMF	2	>1,000	\$ 6,000	\$ 9,000	EOEEA, FEMA
10	A	11.2	Stevens Pond Dam (SPD)	Town	8.1.1.1	SDF Modifications & Operational Plan	>1,000	>1/2 PMF	200	>1,000	\$ 2,000	\$ 3,000	EOEEA, FEMA
10	A	11.2	Manchaug Road	Town	8.1.1.1	Crossing Replacement	-	-	-	-	\$ 2,500	\$ 5,000	MassDOT, MADER
11	A	10.2	Manchaug Pond Dam (MPD)	Town	8.1.1.2	SDF Modifications & Operational Plan	>1,000	>1/2 PMF	500	>1,000	\$ 1,500	\$ 4,000	EOEEA, FEMA
12	B	13	Putnam Hill Road	State	8.2.2	Crossing Replacement	10	200	5	50	\$ 2,000	\$ 3,000	MADER
13	B	9	Putnam Hill Road	State	8.2.2	Crossing Replacement	25	100	10	25	\$ 2,000	\$ 3,000	MADER
14	B	10	Tucker Lane Channel	Private	6.3.3 #5	Channel and Floodplain Regrading Upstream of Crossing	5	100	2	50	\$ 500	\$ 1,000	MADER, NOAA
15	A	1-7.1	Crossings US of SFPD	Town, Private	8.1.2	Crossing Replacements (11EA)	5-25	100	2-10	25-50	\$ 8,000	\$ 12,000	MADER
16	C	1	Mill #2 Site	Town, Private	6.3.3 #8	Floodplain Restoration at Mill #2 Site	-	-	-	-	\$ 500	\$ 1,000	EOEEA, MADER
17	C	3	Mill Pond Dam #1	Private	8.3.1.1	Modifications at Mill Pond Dam #1	10	500	5	100	\$ 1,000	\$ 1,500	EOEEA
18	C	5	Channel Weir	Private	8.3.1.3	Remove Weir and Restore Channel	-	-	-	-	\$ 50	\$ 100	MADER, NOAA
19	A	9	Sutton Falls Pond Dam (SFPD)	Private	8.1.1.3	SDF Modifications & Operational Plan	10	500	5	100	\$ 1,500	\$ 3,000	EOEEA, FEMA
20	C	5.2	Whitins Road	Town	8.3.2	Crossing Replacement	1	>1,000	<1	1,000	\$ 1,000	\$ 1,500	MADER
21	C	5.1	Whitins Road	Town	8.3.2	Crossing Replacement	50	>1,000	25	1,000	\$ 1,000	\$ 1,500	MADER
22	C	6.1-6.3	Main Street	State	8.3.2	Crossing Replacements (3EA)	50-200	1,000	25-50	500	\$ 3,000	\$ 5,000	MADER
23	C	8-9	Potter Road Dam & Bridge	Town, Private	8.3.1.2	Dam Removal/Modification and Crossing Replacement	10	200	5	50	\$ 2,000	\$ 4,000	EOEEA, MADER, MassDOT
24	C	6.4	Mumford Street	Town	8.3.2	Crossing Replacement	10	500	5	100	\$ 2,000	\$ 3,000	MassDOT,MADER
25	D	-	Reach D Buildings	Private	7.6	Building Modifications (22EA)	200	-	50	-	\$ 300	\$ 500	FEMA
Channel / Ecosystem Restoration											\$ 40	\$ 77	\$M's
Infrastructure Upgrade with Ecosystem Benefit											\$ 40,000,000	\$ 76,500,000	\$
Dam Modifications													
Structure Floodproofing													

The Solutions Meeting

- Third Public Meeting – April 27th
 - Solutions Overview
 - Watershed-Wide
 - Reach-Specific
 - Open Discussion
- Open Discussion from 25+ attendees generated valuable feedback both during the meeting and weeks after
- Feedback utilized to:
 - Refine Phase III findings and reporting
 - Refine the content of the Plan/Report

VILLAGE MEETING

Manchaug Water Study Project – Meeting #3



Thursday, April 27th at 6 PM
Manchaug Mills, Blaxton Hall

The Town of Sutton received a \$75,000 Municipal Vulnerability Preparedness (MVP) Grant from the Executive Office of Energy and Environmental Affairs (EOEEA) (www.resilientma.org/MVP) to assess and mitigate issues with the natural and manmade water flow systems in and around the Village. At Meeting #1 we discussed the overall project and received the knowledge and input of residents and stakeholders about these systems. At Meeting #2 we learned about the evaluation of the water flow systems in the Village and the issues discovered within the system.

Meeting #3 – Discuss possible solutions and provide your feedback!

UP NEXT:

- June 2023 - Final report presented to the Select Board.

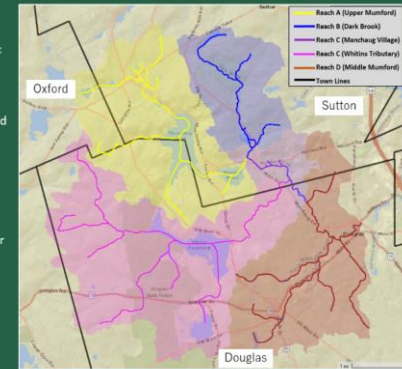


If you have questions, want to be added to the stakeholder list, or need more information, please reach out to Jen Hager at j.hager@town.sutton.ma.us or 508-865-8729.



Watershed-Wide Solutions

- **Emergency Action Plan** – Watershed specific emergency action/response plan developed from the results of this study & intended to improve both public knowledge of the hazard (riverine flooding) as well as emergency preparedness & response to that hazard
- **Land Cover Interventions** – Policy & action aimed at maintaining & improving land cover conditions throughout the watershed
- **Beaver/River Maintenance** – Action to clear the watershed's rivers of beaver & debris dams at high risk/impact areas



Reach C (Village) Solutions

- **Beaver/River M&M**
 - Previously Discussed #1, #4, & #5 Specifics

Dam Modifications

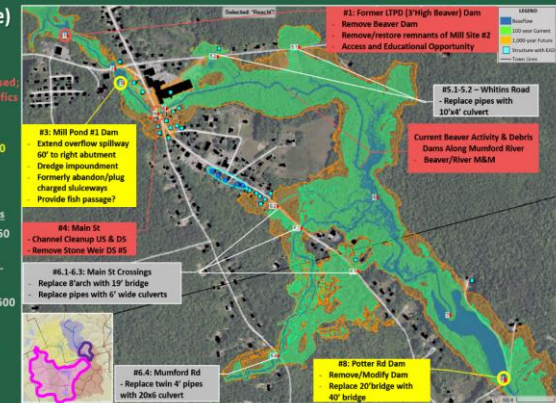
- #3: From 10 to 500
- #8: Removed / Modified

Culvert Replacements

- #5.1-5.2: From 1-50 to 1,000
- #6.1-6.3: From 50-200 to 1,000
- #6.4: From 10 to 500

Buildings

- Modifications at most 30



MVP 3rd Meeting
April 27, 2023

Phase IV: Report Development

- **Draft Report (194 Pages)**
 - **Report Body (1-53)**
 - 9 Sections (1.0 – 9.0)
 - **Appendix A: Supporting Graphics (54-83)**
 - **Appendix B: Corridor Photographs (84-119)**
 - **Appendix C: Meeting Materials (120-193)**
 - The Listening Session Handout (121-150)
 - The Problem Meeting Slides (151-169)
 - The Solution Meeting Slides (170-193)
 - **Appendix D: Report Limitations (194)**

PREPARED FOR: TOWN OF SUTTON

MANCHAUG WATER RESOURCES RESILIENCY ACTION PLAN Sutton, Massachusetts



PREPARED BY:

PARE CORPORATION
10 LINCOLN ROAD, SUITE 210
FOXBORO, MASSACHUSETTS 02035

PARE PROJECT NUMBER 22153.00

DRAFT Report – May 2023



Next Steps

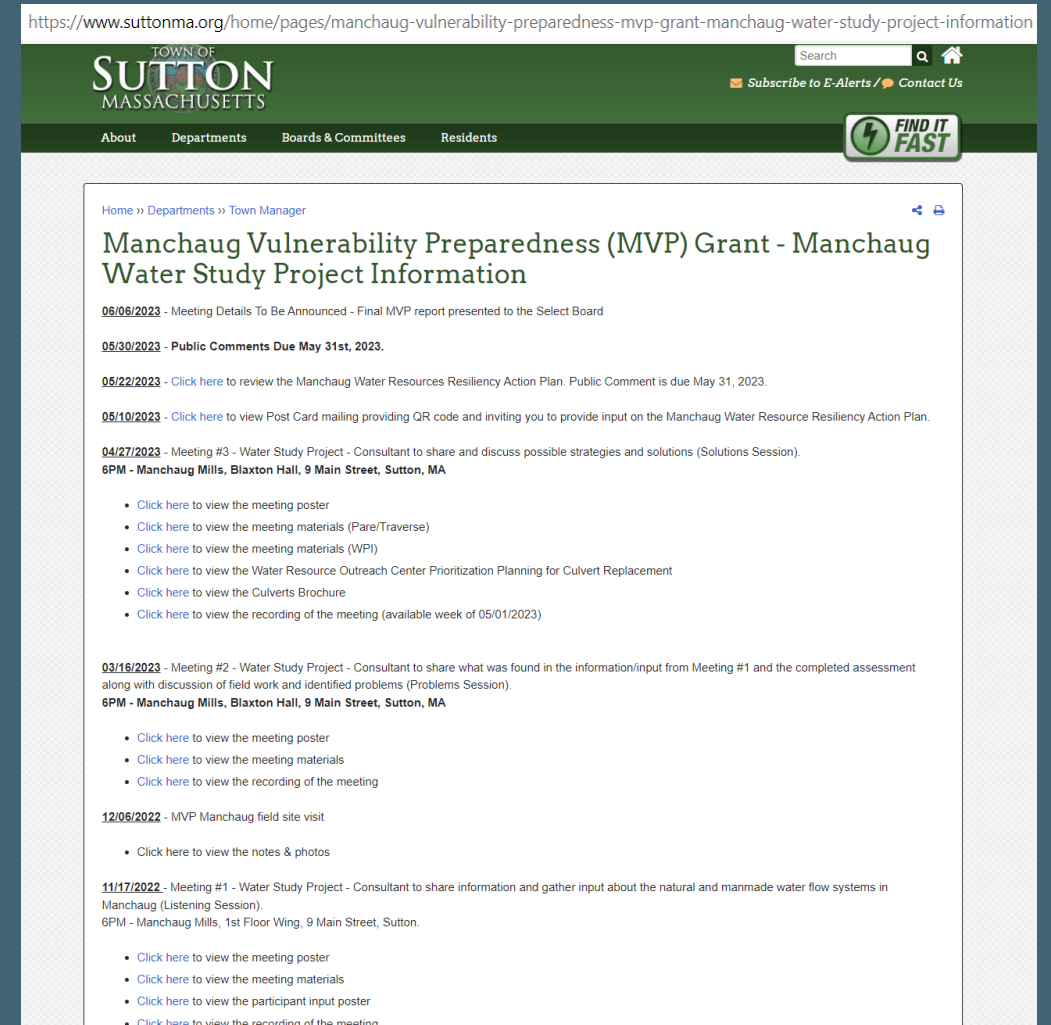
- Phase V: Report Finalization
 - Comments from Public – June 14th
 - Comments from Select Board – June 14th
 - Incorporate Comments Received
 - Issue Final Report – June 30th

Contact

- Contact: Jennifer Hager
 - j.hager@town.Sutton.ma.us
 - 508-865-8729

Online Materials

<https://www.suttonma.org/home/pages/manchaug-vulnerability-preparedness-mvp-grant-manchaug-water-study-project-information>



Discussion

