LOCAL FLOOD ANALYSIS

VILLAGE OF FLEISCHMANNS

July 2016

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ABBREVIATIONS/ACRONYMS

BFE	Base Flood Elevation
CFS	Cubic Feet per Second
CWC	Catskill Watershed Corporation
CY	Cubic Yards
DCSWCD	Delaware County Soil and Water Conservation District
DFIRM	Digital Flood Insurance Rate Map
FEMA	Federal Emergency Management Agency
FHMIP	Flood Hazard Mitigation Implementation Program
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FTP	File Transfer Protocol
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMP	Hazard Mitigation Plan
LFA	Local Flood Analysis
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NRCS	Natural Resource Conservation Service
NYCDEP	New York City Department of Environmental Protection
PMR	Physical Map Revision
SFHA	Special Flood Hazard Area
SMP	Stream Management Plan
STA	River Station
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

EXECUTIVE SUMMARY

The subject Local Flood Analysis (LFA) was undertaken in partnership with the East Branch Flood Commission and the Village of Fleischmanns to evaluate potential flood mitigation options along Vly Creek, Emory Brook, Bush Kill, Little Red Kill, and Big Red Kill. Flooding has long been a problem in the community, evidenced most recently by the devastation during the flood of Tropical Storm Irene. The Village guided this LFA through a number of Village Board meetings and public meetings from 2014 through 2016.

The LFA study area along was selected to coincide with the majority of the developed area in the Village of Fleischmanns including the Hamlet of Clovesville, extending slightly downstream of the village boundary into the Town of Middletown. Vly Creek, Emory Brook, Little Red Kill, and Big Red Kill are tributaries to Bush Kill. Downstream of Fleischmanns in the Arkville section of Middletown, Bush Kill joins Dry Brook. Dry Brook subsequently discharges into the East Branch Delaware River only a short distance further downstream. The East Branch discharges into the Pepacton Reservoir, a drinking water supply source to the New York City water system. Therefore, flooding in Fleischmanns and Clovesville has the direct potential to impact water quality in the Pepacton Reservoir.

Sources of information that informed this LFA included the effective FEMA Flood Insurance Study (FIS), the preliminary updated FIS, the Stream Corridor Management Plan for the East Branch Delaware River, the Delaware County Hazard Mitigation Plan including annex reports for the Village of Fleischmanns, and accounts of flood events that have impacted Fleischmanns.

The primary objective identified by the East Branch Flood Commission and the Village was to develop a set of flood mitigation alternatives that would at least reduce the risk of flood damage to businesses and homes in Fleischmanns if elimination of the risk was not possible. A secondary objective was to keep as much water off Main Street as possible, making the road more resilient to floods.

Three general types of flood mitigation options were considered in Fleischmanns – hydraulic, hydrologic, and property-specific. Hydraulic options change the water surface elevation of a flood whereas hydrologic options change the timing or volume of water flowing downstream. Over the course of the LFA, initial alternatives were modified and adjusted to maximize the reduction of flood water surface elevations. In addition, other alternatives were suggested by the East Branch Flood Commission and the Village, and subsequently evaluated for the LFA. A total of 30 hydraulic alternatives were considered. Many of the alternatives analyzed sought to reduce the flooding caused by hydraulic constriction at the numerous bridges in the study area.

In particular, the following bridge replacement options were initially identified for the LFA study area (with the prefix "1" denoting a bridge replacement). The bridge locations are shown on Figure 2-1.

- Alternative 1A: replacement of the Main Street Bridge on Emory Brook
- Alternative 1B: replacement of Wagner Avenue Bridge over Emory Brook
- Alternative 1C: replacement of Mill Street Bridge over Vly Creek
- Alternative 1D: replacement of Main Street Bridge over Vly Creek
- Alternative 1E: replacement of Snyder Avenue Bridge over Little Red Kill
- Alternative 1F: replacement of driveway bridge over Little Red Kill
- Alternative 1G: replacement of Main Street Bridge over Little Red Kill
- Alternative 1H: replacement of Bridge Street Bridge over Little Red Kill
- Alternative 1I: replacement of Bridge Street Bridge over Bush Kill (this was primarily an assessment of the choice of a new pedestrian bridge at the former Bridge Street Bridge location over Bush Kill)
- Alternative 1J: replacement of Depot Street Bridge over Bush Kill
- Alternative 1K: replacement of Old Route 28 Bridge over Big Red Kill

Ultimately, only Alternative 1A was modeled by itself. Alternatives 1B, 1C, 1D, 1I, and 1K were mainly considered in combination with floodplain alternatives. Alternatives 1E, 1F, 1G, and 1H on the Little Red Kill were addressed together.

Alternatives 2 and 3 were hydrologic alternatives that considered, respectively, the detention of floodwaters in Lake Switzerland and the diversion of water from Vly Creek to Emory Brook on the east side of the Main Street/Wagner Avenue intersection through a "bypass" channel.

Alternatives 4 through 10 represented mainly floodplain projects:

- Alternative 4: Upstream area (Emory/Vly confluence)
- Alternative 5: Bridge Street area of Bush Kill
- Alternative 6: Middle area of Bush Kill (west end of Wagner Avenue, Depot Street, Wadler/True Value)
- Alternative 7: Downstream area of Bush Kill (along Route 28); Includes the downstream area of Bush Kill with Big Red Kill
- Alternative 8: Vly Creek at Mill Street
- Alternative 9: Emory Brook at Wagner Road
- Alternative 10: Near park off Wagner Avenue

Hydraulic analysis of the Bush Kill, Emory Brook, Vly Creek, Big Red Kill, and Little Red Kill was conducted using the HEC-RAS program. The HEC-RAS software (*River Analysis System*) was written by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center

(HEC) and is considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one-dimensional, steady-state, or time-varied flow. The model utilized for this analysis originated with the preliminary FIS published in 2014 and its supporting documentation (FEMA contract number HSFEHQ-09-D-0369, task order HSFE02-11-J-0002).

In general, the evaluated flood mitigation alternatives will reduce flood water surface elevations, but still predict water reaching roads and properties. The majority of the properties in the study area that are currently in the SFHA associated with Vly Creek, Emory Brook, Bush Kill, Little Red Kill, and Big Red Kill *will remain* in the SFHA, and therefore will be subject to continued flood risk and flood insurance coverage requirements. However, a reduction of flood water surface elevations may lead to reduced time and costs for clean-up and recovery after floods; and may reduce flood insurance premiums for some properties if flood maps are modified.

A Benefit-Cost Analysis (BCA) was conducted to validate the cost-effectiveness of proposed hazard mitigation projects. A BCA is a method by which the future benefits of a project are estimated and compared to its cost. The end result is a benefit-cost ratio (BCR), which is derived from a project's total net benefits divided by its total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered to be cost effective when the BCR is 1.0 or greater, indicating the long-term benefits of the project are sufficient to justify the up-front and long-term costs. A BCA was conducted for the proposed 1A, 4A, 4B, 5A, 5B, 6A, 6B, 6C, 6D, 6E, 7A, 7B, 8B, 8B Combination, 9A Combination, 10A, and Big Red Kill Combination 2. Costs and benefits[1] are compared in Table ES-1 below.

TABLE ES-1
Comparison of Costs and Benefits

Alternative		Cost Estimates	Total Benefits*	BCR	BCR > 1?
1A	❑ Replace Main Street Bridge over Emory Brook ❑ Widen constricted channel	$527,000	$57,000	0.1	No
4A	❑ Creation of floodplain south of Vly Creek and north of Wagner Avenue ❑ Removal of buildings	$1,386,000	$1,067,000	0.8	No

[1] Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The building acquisition benefits for 6B, 6D, and 6E include these buildings. For the purpose of completeness, this LFA report retains these benefits. If these alternatives are pursued, benefits will need to be recalculated.

Alternative		Cost Estimates	Total Benefits*	BCR	BCR > 1?
4B	❑ Includes 4A and expands floodplain creation to Emory Brook ❑ Removal of buildings	$2,702,000	$1,074,000	0.4	No
5A	❑ Create floodplain near Bridge Street ❑ Removal of buildings	$962,000	$103,000	0.1	No
5B	❑ Create floodplain near Bridge Street, but leave 45 and 46 Bridge Street ❑ Removal of buildings	$684,000	$70,000	0.1	No
6A	❑ Create floodplain west of Depot Street ❑ Removal of buildings including hardware store	$4,133,000	$1,043,000	0.3	No
6B	❑ Includes 6A and extends floodplain upstream of Depot Street	$5,375,000	$1,655,000	0.3	No
6C	❑ Same as 6A, but hardware store remains	$2,649,000	$1,144,000	0.4	No
6D	❑ Create floodplain upstream of Depot Street and path across Depot Street to river ❑ Removal of buildings	$1,436,000	$380,000	0.3	No
6E	❑ Same as 6B, but hardware store remains	$3,887,000	$1,104,000	0.3	No
7A	❑ Remove existing berm and create confluence at confluence of Big Red Kill and Bush Kill ❑ Removal of building	$1,039,000	$156,000	0.2	No
7B	❑ Includes 7A and also extends floodplain creation upstream along Route 28 ❑ Removal of buildings south of Old Route 28	$3,225,000	$700,000	0.2	No
8B+1C	❑ Create floodplain near Mill Street ❑ Expand floodplain to reroute Mill Street and remove Mill Street Bridge	$334,000	$29,000	0.1	No

Alternative		Cost Estimates	Total Benefits*	BCR	BCR > 1?
10A	❑ Creation of floodplain near park ❑ Removal of outbuildings	$268,000	$218,000	0.8	No
Big Red Kill Combination 2	❑ Includes 7A plus replacement of Route 28 Bridge ❑ Berm removal on right side of Big Red Kill and floodplain creation on left side of Big Red Kill	$2,134,000	$3,286,000	1.5	Yes
8B Combination (8B+1C+1D+4A)	❑ Includes 8B plus 4A and replacement of Main Street Bridge over Vly Creek ❑ Removal of buildings	$2,520,000	$2,402,000	0.9	No
9A Combination (9A+1B+4B)	❑ Includes 4B plus creation of floodplain along Vly Creek south of Wagner Avenue ❑ Replacement of Wagner Avenue Bridge ❑ Removal of buildings	$3,693,000	$455,000	0.1	No

* Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The building acquisition benefits for 6B, 6D, and 6E include these buildings. For the purpose of completeness, this LFA report retains these benefits. If these alternatives are pursued, benefits will need to be recalculated.

Based on the BCA conducted for this LFA, one flood mitigation project (Big Red Kill Combination 2) has a BCR above 1.0. One flood mitigation project (the 8B Combination [8B+1C+1D+4A]) has a BCR above 1.0 if a "water quality benefit" multiplier of 1.2 is applied. This project would make sense to pursue, as it would connect to the work already completed (and planned) for the Mill Street area on the right bank of Vly Creek.

The two hydrologic alternatives discussed in this LFA report (flood retention at Lake Switzerland and construction of a bypass from Vly Creek to Emory Brook) are not recommended, as they would not be effective when most needed. Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal throughout the Village of Fleischmanns. Widespread removal of buildings from the downtown area is also not supported by the LFA, as the community would suffer from the disruption to its central business district.

Individual property owners will be required to elevate or floodproof their properties over time if substantial damage or substantial improvement thresholds are triggered for their properties. However, optional elevations and floodproofing may be desired in strategic locations where unacceptable flood risk remains after flood mitigation projects are implemented. This will have the dual benefit of reducing flood risks while reducing flood insurance premiums for those properties that are insured.

Finally, anchor businesses, critical facilities, and some residents may wish to relocate out of zones of unacceptable flood risk. One example is the fire house. This LFA includes a recommendation for the relocation of the fire house.

In summary, the LFA completed for Fleischmanns has demonstrated that many flood mitigation projects have merit because they will reduce flood water surface elevations in the village. These projects largely depend on the enhancement of floodplains and creation of lower floodplains coupled with a handful of bridge replacements and strategic building removals and business relocations. The following flood mitigation recommendations are offered:

1. Proceed with further study and apply for funding for the Big Red Kill Combination 2 and the 8B Combination.

2. Pursue floodproofing of commercial buildings where viable in the village. Floodproofing should include sealing of lower portions of buildings including doors and other openings, and elevation of building utilities. Ensure that floodproofing is viable under a set of potential future conditions.

3. Pursue elevation of homes outside the floodway on a case-by-case basis as property owners approach the Village about mitigation. Ensure that elevations are conducted in accordance with the effective BFE at the time of the work.

4. Relocate the fire house.

5. Implement components of other alternatives when opportunities arise (for example, a property is up for sale or a bridge is ready for replacement due to its age).

6. Install real-time precipitation gauges in the Emory Brook and Vly Creek watersheds in order to provide ample real-time warning time before floods as opposed to relying on downstream stream gauges. The precipitation gauges should be fully automated and able to provide advance warning in short time frames when needed.

Numerous projects described in this report will not likely have BCRs above 1.0. However, many of these are appropriate flood mitigation projects. Table ES-2 summarizes the recommended action for each project.

TABLE ES-2
Recommended Action

Alternative		BCR	BCR > 1?	Recommended Action
1A	❑ Replace Main Street Bridge over Emory Brook ❑ Widen constricted channel	0.1	No	Unless washouts at this bridge are a significant concern, do not pursue at this time. Consider when bridge is ready for replacement due to its age.
4A	❑ Creation of floodplain south of Vly Creek and north of Wagner Avenue ❑ Removal of buildings	0.8	No	Pursue in connection with other projects; see the 8B combination below.
4B	❑ Includes 4A and expands floodplain creation to Emory Brook ❑ Removal of buildings	0.4	No	Pursue in connection with other projects; see the 9A combination below.
5A	❑ Create floodplain near Bridge Street ❑ Removal of buildings	0.1	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to acquire properties.
5B	❑ Create floodplain near Bridge Street, but leave 45 and 46 Bridge Street ❑ Removal of buildings	0.1	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to acquire properties.
6A	❑ Create floodplain west of Depot Street ❑ Removal of buildings including hardware store	0.3	No	Select components of these alternatives to pursue, as the benefits are important. Obtain and incorporate revenue figures from Wadler/ True Value to bolster benefits in the future.
6B	❑ Includes 6A and extends floodplain upstream of Depot Street	0.3	No	
6C	❑ Same as 6A, but hardware store remains	0.4	No	
6D	❑ Create floodplain upstream of Depot Street and path across Depot Street to river ❑ Removal of buildings	0.3	No	
6E	❑ Same as 6B, but hardware store remains	0.3	No	
7A	❑ Remove existing berm and create confluence at confluence of Big Red Kill and Bush Kill ❑ Removal of building	0.2	No	Do not pursue floodplain projects here. It would be more effective to relocate or elevate buildings as owners request.

Alternative		BCR	BCR > 1?	Recommended Action
7B	❑ Includes 7A and also extends floodplain creation upstream along Route 28 ❑ Removal of buildings south of Old Route 28	0.2	No	
Big Red Kill Combination 2	❑ Includes 7A plus replacement of Route 28 Bridge ❑ Berm removal on right side of Big Red Kill and floodplain creation on left side of Big Red Kill	1.5	Yes	Pursue
8B+1C	❑ Create floodplain near Mill Street ❑ Expand floodplain to reroute Mill Street and remove Mill Street Bridge	0.1	No	Pursue in connection with the 8B combination below if possible.
8B Combination (8B+1C+1D+4A)	❑ Includes 8B plus 4A and replacement of Main Street Bridge over Vly Creek ❑ Removal of buildings	0.9	Yes (with a multiplier applied)	Pursue
9A Combination (9A+1B+4B)	❑ Includes 4B plus creation of floodplain along Vly Creek south of Wagner Avenue ❑ Replacement of Wagner Avenue Bridge ❑ Removal of buildings	0.1	No	Select components of these alternatives to pursue, as the benefits are important. Significantly upsize the bridge when it is ready for replacement due to its age.
10A	❑ Creation of floodplain near park ❑ Removal of outbuildings	0.8	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to utilize private properties.

The profile of Fleischmanns along Vly Creek, Emory Brook, and Bush Kill is relatively steep in relation to its length, making the individual alternatives (numbers 4, 5, 6, 7, 8, 9, and 10) relatively independent. Because they do not adversely affect one another, they may be pursued individually.

Several funding sources may be available to the East Branch Flood Commission, the Village, and Delaware County and its departments for the implementation of recommendations. These are listed below. Descriptions are provided in Section 6.4.

Table ES-3
Potential Funding Sources for Components of Mitigation Projects

Alternative		Federal	State	Other
1A	Bridge Replacement	None	NYSDOT	DCSWCD SMP, CWC
	Widen channel downstream	ACOE	NYSDOS	DCSWCD SMP, CWC
4A	Acquisition and removal of cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain on south side of Vly Creek	ACOE	NYSDOS	DCSWCD SMP, CWC
4B	Acquisition and removal of school and cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Vly Creek and Emory Brook	ACOE	NYSDOS	DCSWCD SMP, CWC
5A	Acquisition and removal of 45 and 46 Bridge Street plus rear buildings along south side of Main Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near Bridge Street	ACOE	NYSDOS	DCSWCD SMP, CWC
5B	Acquisition and removal of rear buildings along south side of Main Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near Bridge Street	ACOE	NYSDOS	DCSWCD SMP, CWC
6A	Acquisition and removal of hardware store, building north of 125 Depot Street, and buildings at 139 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28, Depot Street, and Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC
6B	Acquisition and removal of the hardware store, buildings at 139 Depot Street, 125 Depot Street, building north of 125 Depot Street, and 102 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28 and Route 28 extending upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Lower Depot Street to allow floodwater to pass	None	None	DCSWCD SMP, CWC
6C	Acquisition and removal of building north of 125 Depot Street and buildings at 139 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28, Depot Street, and Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC

Alternative		Federal	State	Other
6D	Acquisition and removal of 125 Depot Street, 102 Depot Street, and the building north of 125 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Flood pathway across Depot Street to the river	None	None	DCSWCD SMP, CWC
6E	Acquisition and removal of buildings at 139 Depot Street, 125 Depot Street, building north of 125 Depot Street, and 102 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28 and Route 28 extending upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Lower Depot Street to allow floodwater to pass	None	None	DCSWCD SMP, CWC
7A	Removal of existing berm between Route 28 and the Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of 544 Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near the junction of Big Red Kill Road and Old Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC
7B	Acquisition and removal of 16 buildings on the southern side of Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near the junction of Big Red Kill Road and Old Route 28 and along northern bank of Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
8B	Bridge replacement	None	NYSDOT	DCSWCD SMP, CWC
	Acquisition and removal of two properties on Mill Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain upstream of Mill Street	ACOE	NYSDOS	DCSWCD SMP, CWC
10A	Removal of outbuildings	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near park on Wagner Avenue	ACOE	NYSDOS	DCSWCD SMP, CWC
8B Combo	Remove Mill Street Bridge	None	NYSDOT	DCSWCD SMP, CWC
	Reroute Mill Street	None	NYSDOT	DCSWCD SMP, CWC
	Replace Main Street Bridge over Vly Creek	None	NYSDOT	DCSWCD SMP, CWC
	Acquisition and removal of two properties on Mill Street, cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplains near Mill Street and Wagner Avenue	ACOE	NYSDOS	DCSWCD SMP, CWC

Alternative		Federal	State	Other
9A Combo	Replace Wagner Avenue Bridge over Vly Creek	None	NYSDOT	DCSWCD SMP, CWC
	Removal of berm along Emory Brook	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of school and cottages behind school, buildings at auto repair shop and junk yard, and buildings upstream of Wagner Avenue	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplains near the school on Wagner Avenue and on the north side of Emory Brook east of the Wagner Avenue Bridge	ACOE, FEMA	NYSDOS	DCSWCD SMP, CWC
Big Red Kill Combo 2	Replace Route 28 Bridge	None	NYSDOT	DCSWCD SMP, CWC
	Berm removal on Big Red Kill and between Route 28 and the Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of 544 Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Floodplain creation on left bank of Big Red Kill and near the junction of Big Red Kill Road and Old Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC

Table ES-4 lists potential funding sources for property mitigation and relocations.

Table ES-4
Potential Funding Sources for Other Mitigation Projects

Option	Federal	State	Other
Floodproofing of individual non-residential buildings	FEMA	NYSDOS	None
Elevation of individual non-residential buildings in floodway	None	None	None
Elevation of individual residential buildings in floodway	None	None	None
Elevation of individual non-residential buildings outside of floodway	FEMA	NYSDOS	None
Elevation of individual residential buildings outside of floodway – Copy to Conclusion	FEMA, NFIP ICC	None	None
Relocation of anchor businesses and critical facilities such as firehouse	FEMA	NYSDOS	NYCDEP Buyout, CWC*

*CWC funding may be available only if off-site flood levels are reduced as a result of the action

As this LFA plan is implemented, the East Branch Flood Commission and Village of Fleischmanns will need to work closely with potential funders to ensure that the best combinations of funds are secured for the modeled alternatives and for the property-specific mitigation such as floodproofing, elevations and relocations.

1.0 INTRODUCTION

1.1 Project Background

The East Branch Flood Commission and Village of Fleischmanns, utilizing funding provided by NYCDEP through the Delaware County Soil and Water Conservation District (DCSWCD), has retained Milone & MacBroom, Inc. (MMI) to complete a Local Flood Analysis (LFA) in the Village of Fleischmanns, New York. The LFA builds upon Federal Emergency Management Agency (FEMA) modeling to evaluate flood risks along Bush Kill Creek and its tributaries, and assess potential mitigation measures aimed at reducing flood inundation and the associated damages and water quality impairment that may occur due to floods.

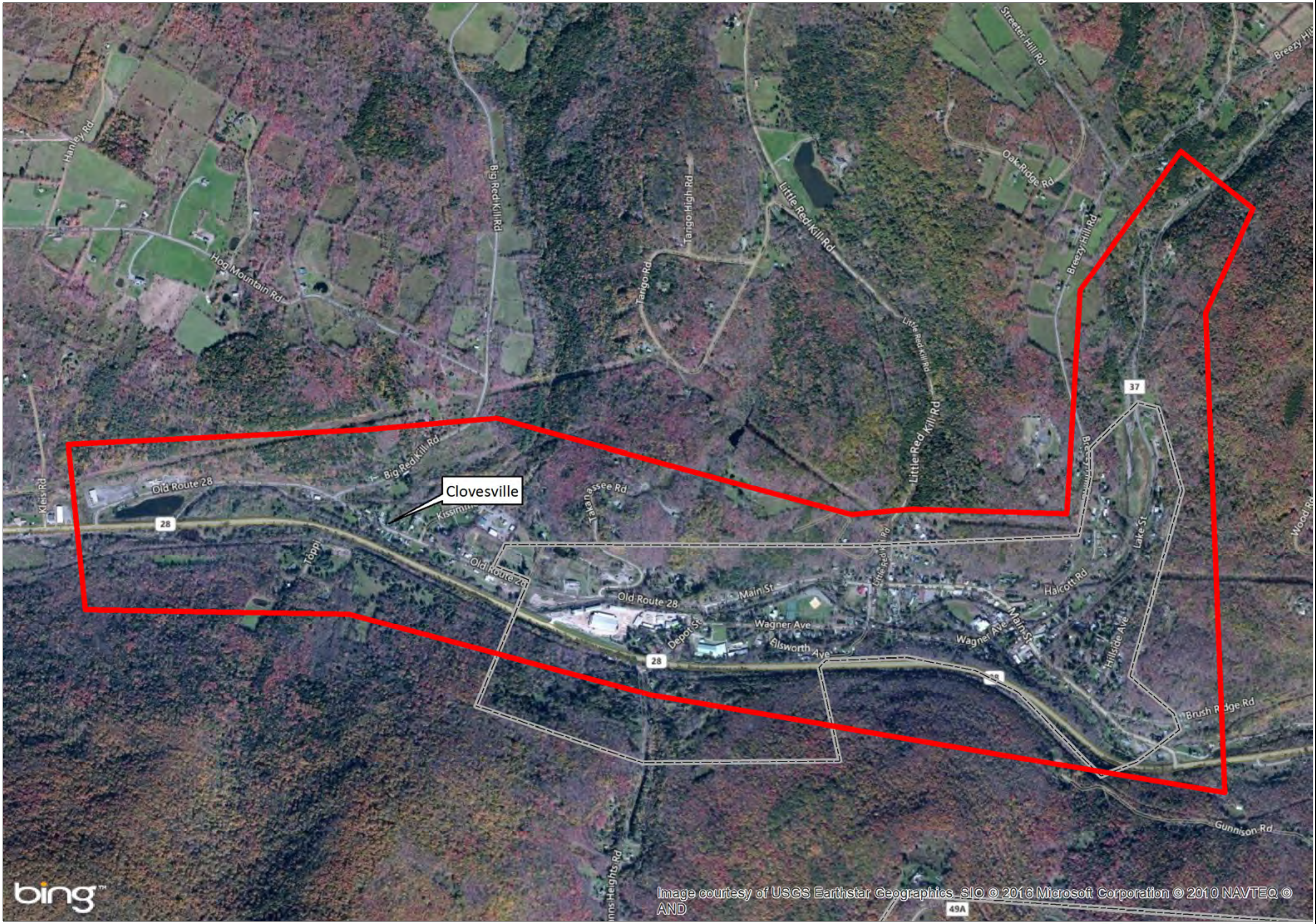
The LFA is a program within in the New York City water supply watersheds, initiated following Tropical Storm Irene to help communities identify long term, cost effective projects to mitigate flood hazards. The DCSWCD is implementing the LFA program in the watershed communities associated with the West Branch and East Branch Delaware River watersheds.

The subject LFA was undertaken separately from the New York Rising Community Reconstruction (NYRCR) program. The NYRCR program was intended to provide rebuilding and resiliency assistance to communities severely damaged by Hurricane Irene, Tropical Storm Lee, Superstorm Sandy, and the summer floods of 2013. The subject LFA is an engineering feasibility analysis that develops a range of flood hazard mitigation alternatives, with the primary focus of identifying options that reduce flood elevations and inundation.

1.2 Study Area

The study area largely coincides with the Village of Fleischmanns boundary. The East Branch Delaware discharges into the Pepacton Reservoir, a drinking water supply source to the New York City public water system. The graphic to the right depicts the West Branch and the East Branch relative to Delaware County and adjacent counties.

Figure 1-1 is a location plan of the study area. The study area is situated along Vly Creek, Emory Brook, Bush Kill Creek, Little Red Kill, and Big Red Kill through the Village of Fleischmanns.



SOURCE(S): BING	N	FIGURE 1-1: STUDY AREA	FLEISCHMANNS LOCAL FLOOD ANALYSIS	Map By: JCS	MILONE & MACBROOM
	MXD: Y:\5197-03\GIS\Maps\Location Map.mxd		LOCATION: FLEISCHMANNS, NY	MMI#: 5197-03 Original: 1/28/2016 Revision: 7/19/2016 Scale: 1 in = 1,500 ft	99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

The Village of Fleischmanns is located in the town of Middletown in Delaware County, only a few miles from the Ulster County boundary. The Hamlet of Clovesville is located within Fleischmanns near Big Red Kill Road. The area now known as Fleischmanns was initially settled by Europeans in the early 18th century and was originally named Griffin Corners. From 1890 to 1912 the community was known by two separate names. The east end of the village was referred to as Griffin Corners while the west end was known as Fleischmanns. In 1913 the two areas were consolidated into the Village of Fleischmanns. The Village of Fleischmanns Comprehensive Plan (2009) includes a historical profile of the village. Portions of this profile are reprinted in the box to the right.

The village is primarily situated along the Bush Kill which parallels State Route 28. It is the only major population center located on the stream (DCSWCD 2007). The Bush Kill is formed from Vly Creek and Emory Brook which both flow into the village and have their confluence approximately 390 feet upstream of the intersection of Bridge Street and Main Street. Vly Creek is the larger of the streams and flows from a northerly direction while Emory Brook flows into Fleischmanns from the east. A notable feature of Vly Creek is the former Lake Switzerland which is located approximately 0.7 miles upstream from the confluence with Emory Brook and stretches upstream approximately 0.2 miles. The lake was completed in 1907 to be used for boating and swimming in the summer and harvesting ice in the winter. The dam was demolished due to safety concerns, and Vly Creek now flows unimpeded to its confluence with Emory Brook (DCSWCD 2007). Two other streams of note included in the project area are the Big Red Kill and the Little Red Kill which flow into the Bush Kill from the north.

Historical profile from Fleischmanns Comprehensive Plan

"Early settlers made their way to the area in wagons drawn by horses or oxen along trails that followed river valleys such as the East Branch of the Delaware River and/or the Esopus Creek. Early industries included forestry and tanneries but as the settlers slowly cleared the forest, the timber industry slowly gave way to agriculture.

In 1870, the first rail service arrived to the Griffin's Corner Station via the Rondout & Owego railroad that was being constructed to run from Kingston to Oneonta, New York. Many farmers soon opened guesthouses to accommodate city residents during the summer. This trend would soon give rise to the Golden Age of the Western Catskills Resort industry.

Fleischmanns' popularity as a resort area peaked in the 1940s. Following WWII, Americans embraced the freedom of automobile and air travel that made it possible for them to see the country by car or to reach exotic destinations. No longer dependent on passenger rail to reach their vacation destination, they began to seek other places to visit. Soon the resort community that once had 4,200 hotel beds found it difficult to compete with other tourist destinations or to adapt to changing consumer preferences. As a result, tourism visitation dropped dramatically."

The upstream project boundaries extend 1.45 miles upstream along Vly Creek and 0.76 miles upstream along Emory Brook from their confluence. The LFA extends downstream on the Bush Kill 1.8 miles from its origin at the confluence of Vly Creek and Emory Brook. The project also reaches 0.28 miles upstream along the Red Kill and 0.21 miles upstream along the Little Red Kill.

The Comprehensive Plan describes a general decrease in Fleischmann's population from 450 in 1960 to 328 in 2007. As of the 2007 census, 8% of the population in Middletown resides in the Village of Fleischmanns. In 2007, the county's population loss was -2.2% and the Town of Middletown's population loss was -4.1%. Fleischmanns' population loss was somewhat higher at -6.5%. However, the Comprehensive Plan speaks of a significant part-time population of second homeowners in the village. The part-time residents of Fleischmanns are important components of the demographic and economy. As of the 2000 census, 145 housing units were located in Fleischmanns. According to the Town of Middletown Comprehensive Plan (2011), the number of housing units in Middletown in 2000 was 3,013. Accordingly, 4.8% of the housing units in Middletown are located in Fleischmanns.

1.3 Community Involvement

The East Branch Flood Commission and Village of Fleischmanns guided the LFA process and advised MMI regarding which mitigation alternatives to evaluate. Table 1-1 lists the members of the Flood Commission and Village that participated in the LFA.

TABLE 1-1
Flood Commission Members

Committee Member	Affiliation
Marjorie Miller	Former Middletown Town Supervisor
Patrick Davis	Current Middletown Town Supervisor
Todd Pascaralla	Former Village Mayor
Don Kearney	Current Village Mayor
Timothy Cox	Catskill Watershed Corporation
Graydon Dutcher	Delaware County Soil and Water Conservation District
Rick Weidenbach	Delaware County Soil and Water Conservation District
Jessica Rall	Delaware County Soil and Water Conservation District
Bill Willis	Delaware County Economic Development Department
Steve Hood	Delaware County Department of Emergency Services
Dean Frazier	Delaware County Watershed Affairs Commissioner
Wayne Reynolds	Delaware County Department of Public Works
Molly Oliver	Delaware County Department of Watershed Affairs
Kristin Schneider	Delaware County Planning Department

Committee Member	Affiliation
Kent Manual	Delaware County Planning Department
Nate Hendricks	NYCDEP
Phil Eskeli	NYCDEP

Table 1-2 lists Village meeting dates that occurred when this particular LFA was on the agenda for discussion.

TABLE 1-2
Meeting Dates

Date	Purpose
July 28, 2014	Review Bridge Street pedestrian bridge in the context of the LFA
August 11, 2014	Review Bridge Street pedestrian bridge in the context of the LFA
November 18, 2014	Review preliminary modeling of alternatives
February 24, 2015	Review additional modeling of alternatives and benefit cost analysis (BCA) concepts
May 11, 2015	Review BCA for flood mitigation alternatives

The LFA process included two public meetings. These were held near the beginning and end of the LFA project as noted below.

TABLE 1-3
Public Meeting Dates

Date	Purpose
May 19, 2014	Present LFA background, purpose, types of flood mitigation, and model concepts
May 11, 2015	Present an update of the project, review BCA

Appendix A contains copies of the power point presentations used at meetings listed in Table 1-2 and Table 1-3, along with meeting notes.

1.4 Nomenclature

In this report and associated mapping, stream stationing is occasionally used as an address to identify specific points along the Bush Kill, Emory Brook, Vly Creek, Big Red Kill and Little Red Kill. Stationing is typically measured in feet from downstream to upstream. To simplify the nomenclature, the FEMA cross section stationing was used for the LFA. All references to right bank and left bank in this report refer to "river right" and "river left," meaning the orientation assumes that the reader is standing in the river looking downstream. The datum used throughout this report is NAVD88.

In order to provide a common standard, FEMA's National Flood Insurance Program (NFIP) has adopted a baseline probability called the base flood. The base flood has a one percent (one in 100) chance of occurring in any given year, and the base flood elevation (BFE) is the elevation of this level. For the purpose of this report, the one percent annual chance flood is referred to as the ***100-year flood event***. Other reoccurrence probabilities used in this report include the ***2-year flood event*** (50 percent annual chance flood), the ***10-year flood event*** (10 percent annual chance flood), the ***25-year flood event*** (4 percent annual chance flood), the ***50-year flood event*** (2 percent annual chance flood), and the ***500-year flood event*** (0.2 percent annual chance flood). The Special Flood Hazard Area (SFHA) is the area inundated by flooding during the 100-year flood event. The floodway is a portion of the SFHA that must be reserved in order to discharge the base flood without increasing the water surface elevation more than a designated height.

2.0 WATERSHED FACTS AND CHARACTERISTICS

2.1 Initial Data Collection

Initial data collected for this study and analysis included publicly available data as well as input from DCSWCD representatives. Chapter 7.0 includes a full listing of resource material gathered. A brief summary of key documents follows.

Flood Insurance Study (FIS)

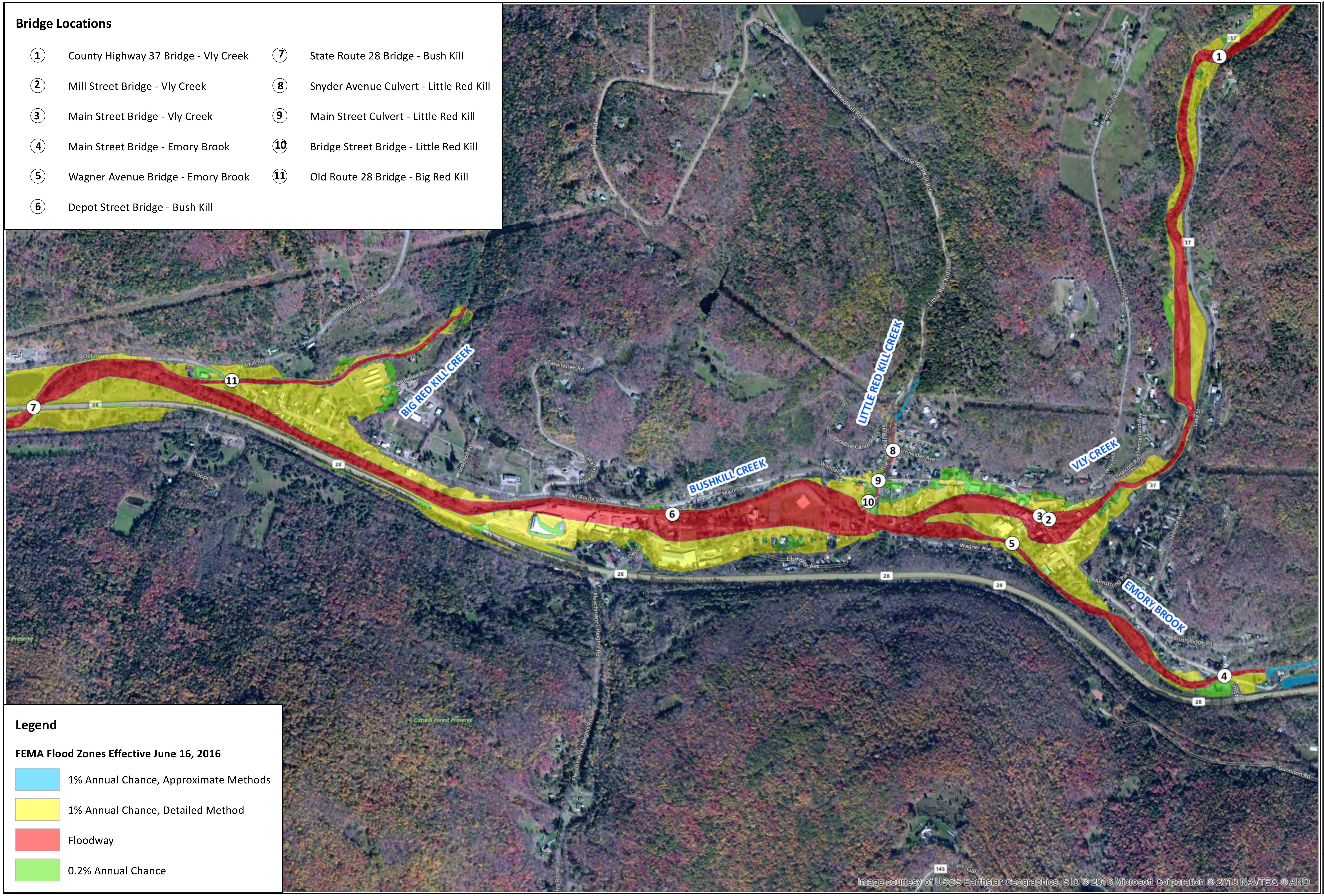
The Flood Insurance Study (FIS) for Delaware County that was dated June 19, 2012 was effective throughout this study. The FIS covers all jurisdictions in the county, inclusive of the village of Fleischmanns. The FIS covering Fleischmanns resulted in FIRM panels that were also effective on June 19, 2012. Within months of the adoption of this report, the new effective FIRM was adopted. This FIRM has a date of June 16, 2016. A copy of the FIRM is presented on the next page as Figure 2-1.

Stream Management Plan

Central to maintaining NYCDEP's FAD is a series of partnership programs between New York City and the upstate communities along with the set of rules and regulations administered by the NYCDEP. As required in the FAD, Stream Corridor Management Plans are developed and implemented under the Stream Management Program (SMP). The East Branch Delaware River Stream Corridor Management Plan (SCMP) was developed by DCSWCD and the DCPD under contract with NYCDEP. One component of the SCMP is the preservation of water quality through effective management of the streams and associated floodplains that feed water supply reservoirs.

The SCMP also describes geomorphic types based on the Vermont Agency of Natural Resources Stream Geomorphic Assessment (SGAT) protocol. Both Bush Kill and Vly creek are primarily C type streams. Some sections of Vly Creek are C/B, B, and A type. The stream types of the Big Red Kill, Little Red Kill, and Emory Brook tributaries were not identified.

The SCMP states that streambank erosion is the primary problem facing Vly Creek and the Bush Kill. The principle recommendation for Vly Creek is to "use fluvial geomorphic principles to address any issues concerning stream performance that may arise. The goal would be to not upset the system or introduce disequilibrium to an otherwise well-functioning stream system."



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www.miloneandmacbroom.com

SOURCE(S):
Bing, ESRI, FEMA NFHL Published 6/27/2016

Figure 2-1: FEMA FIRM MAPPING
FLEISCHMANNS LOCAL FLOOD ANALYSIS
FLEISCHMANNS, NY

Map By: JCS
MMI#: 5197-03
MXD: Y:\5197-03\GIS\Maps\Figure 2-1 FEMA.mxd
1st Version: 7/19/2016
Revision: 7/19/2016
Scale: 1 in = 844 ft

Figure 2-1

It is important to note that the current version of the SCMP was published in December 2007, before Hurricane Irene. Recommendations of the SCMP include the following (with **bold text** added for emphasis relative to this LFA):

- ❑ Scientifically-based post-flood emergency stream intervention
- ❑ Technical assistance to local highway departments
- ❑ Implement streamside assistance program
- ❑ **Education and outreach efforts**
- ❑ Annual floodplain development permit training for municipal officials
- ❑ Enhance local land use laws and ordinances
- ❑ Adopt principles of stream stewardship at the municipal level
- ❑ Streamline stream work permitting
- ❑ Selective stream gravel management
- ❑ Provide assistance to community watershed groups/associations and government entities
- ❑ Participation with the Delaware County Action Plan
- ❑ Debris management
- ❑ Prioritization of identified stream intervention projects
- ❑ Enhancement of East Branch Watershed fisheries
- ❑ Enhance recreation opportunities
- ❑ Invasive species management
- ❑ **Flood hazard mitigation**
- ❑ Flood response and recovery
- ❑ Utilize existing funding sources
- ❑ Develop a process for updating the EBDR Stream Corridor Management Plan

The SCMP provides a framework for general stream management decision making in the watershed. The plan provides documentation of current stream conditions along the Bush Kill and its tributaries as well as a broad assessment of the condition of existing infrastructure.

Multi-Jurisdiction Hazard Mitigation Plan

The Delaware County Hazard Mitigation Plan Update was developed in 2012 by Tetra Tech and became effective March 2013. The plan includes annex reports for the Town of Middletown and the Village of Fleischmanns. The following discussions are taken from the hazard mitigation plan annexes.

Town of Middletown – It is estimated that in the Town of Middletown, 317 residents live within the 1% annual chance (100-year) and 0.2% chance (500-year) floodplains. Of the town's total land area, 3.9 square miles are located within the 1% annual chance flood boundary and 0.2% annual chance flood boundary.

The computer model HAZUS-MH 2.0 estimates that for a 1% annual chance flood event 212 people may be displaced, and 86 people may seek short-term sheltering, representing 6.6% and 2.7% of the town's population, respectively. For the 0.2% annual chance event, it is estimated that 228 people may be displaced, and 95 people may seek short-term sheltering, representing 7.1% and 3.0% of the town's population, respectively.

The town of Middletown has a total of 492 parcels located within the 1% annual chance flood boundary and 493 parcels located within the 0.2% annual chance flood boundary. There is $113,391,914 of total assessed property (structure and land) exposed to the 1% annual chance flood in the town of Middletown. For the 0.2% annual chance event, it is estimated that $113,627,614 of total assessed property is exposed in the town of Middletown.

The program calculates the estimated potential damage to the general building stock inventory associated with the 1% annual chance and 0.2% annual chance flood events. HAZUS-MH 2.0 estimates approximately $7,758,000 and approximately $9,558,000 of potential general building stock loss as a result of the 1% and 0.2% annual chance mean return period (MRP) events, respectively.

The plan notes that the town has zoning, subdivision, and flood damage prevention ordinances as well as a comprehensive plan and a highway management plan. Two feet of freeboard above the BFE is required for new construction in flood zones per the New York State Building Code. **Recommendations of the annex that are consistent with the focus of this LFA include:**

- "Retrofit structures located in hazard-prone areas to protect structures from future damage."
- "Acquire and demolish or relocate structures located in hazard-prone areas to protect structures from future damage."

<u>Village of Fleischmanns</u> – It is estimated that in the village of Fleischmanns, 82 residents live within the 1% annual chance floodplain. Of the village's total land area, 0.1 square miles are located within the 1% annual chance flood boundary. **These areas are largely coincident with the LFA study.**

HAZUS-MH 2.0 estimates that for a 1% annual chance event 75 people may be displaced and 19 people may seek short-term sheltering, representing 24.4% and 62% of the village's population, respectively. For the 0.2% annual chance event, it is estimated that

84 people may be displaced, and 29 people may seek short-term sheltering, representing 27.3% and 9.4% of the village's population, respectively.

The village of Fleischmanns has a total of 330 parcels located within the 1% annual chance flood boundary. There is $19,796,400 of total assessed property (structure and land) exposed to the 1% annual chance flood in the village of Fleischmanns. For the 0.2% annual chance event, it is estimated that there is $19,796,400 of total assessed property exposed in the village.

The 1% annual chance flood losses estimated by HAZUS for the Village are a good representation of the potential flood losses in the LFA study area.

HAZUS-MH 2.0 calculates the estimated potential damage to the general building stock inventory associated with the 1% annual chance and 0.2% annual chance flood events. HAZUS-MH 2.0 estimates approximately $4,507,000 and approximately $5,244,000 of potential general building stock loss as a result of the 1% and 0.2% annual chance MRP events, respectively.

The plan notes that the village has zoning, flood damage prevention ordinances, and a comprehensive plan. Two feet of freeboard above the BFE is required for new construction in flood zones per the New York State Building Code. **Recommendations of the village's annex are similar to those listed in the town's annex.**

Water Quality Reports

In order to fulfill requirements of the Federal Clean Water Act, the NYSDEC must provide periodic assessments of the quality of the water resources in the state and their ability to support specific uses. These assessments reflect monitoring and water quality information drawn from a number of programs and sources both within and outside the Department. This information has been compiled by the NYSDEC Division of Water and merged into an inventory database of all water bodies in New York State. The database is used to record current water quality information, characterize known and/or suspected water quality problems and issues, and track progress toward their resolution.

Biological (macroinvertebrate) assessments of Bush Kill in Arkville were conducted in 1999 and 2000. Sampling results for both years indicated non-impacted water quality conditions. In 1999 the sample satisfied field screening criteria and was returned to the stream. The 2000 sample was returned to the lab for analysis.

NYSDEC Rotating Intensive Basin Studies (RIBS) Intensive Network monitoring of the Bush Kill in Arkville (at Route 28) was conducted in 2000. Chemical sampling of the river identified no significant parameters of concern. Overall water quality at this site is considered to be fully supporting of uses.

This inventory of water quality information is the division's Waterbody Inventory/Priority Waterbodies List (WI/PWL). The Delaware River Basin WI/PWL was last published in December 2002. The lower Bush Kill and its tributaries are listed as having "no known impact." Emory Brook, the Big Red Kill, and Vly Creek are listed as "unassessed." The discussion in the text box to the right is provided in the WI/PWL report. The Hamlet of Clovesville is the next population center downstream of Fleischmanns, followed by Arkville.

NYSDEC has been working on an update to the WI/PWL, but a formal draft has not been published as of the date of this plan.

The New York State Section 303(d) List of Impaired Waters (September 2014) identifies those waters that do not support appropriate uses and that may require development of a Total Maximum Daily Load (TMDL). **The streams within the project area are not listed in this document.**

The NYSDEC Water Quality Standards and Classifications program is responsible for setting New York State ambient water quality standards and guidance values for surface water and groundwaters. The program is also responsible for the classification of surface waters for their best usage. The water quality standards program is a state program with EPA oversight. New York's longstanding water quality standards program predates the federal Clean Water Act and protects both surface waters and groundwaters. All waters in New York State are assigned a letter classification that denotes their best uses. Letter classes such as A, B, C, and D are assigned to fresh surface waters. Within the project area, Bush Kill, Vly Creek, Emory Brook, Big Red Kill, and Little Red Kill are assigned water quality classification B.

Flood Damage Prevention Codes

Town of Middletown – The Town of Middletown has adopted a local law for flood damage prevention. Revisions were adopted in 2012 to be consistent with the guidance provided by the state in 2007 for counties where new FEMA studies were being conducted. The town adopted the recommended revisions. These are identical to the revisions adopted in the village, as described below.

Village of Fleischmanns – The Village of Fleischmanns has adopted a local law for flood damage prevention. Local Law No. 2 of 2012 is the Flood Damage Prevention code. Revisions were adopted in 2012 to be consistent with the guidance provided by the state in 2007 for counties where new FEMA studies were being conducted.

The stated purposes of this local law are to:

- Regulate uses that are dangerous to health, safety, and property due to water or erosion hazards, or that result in damaging increases in erosion or in flood heights or velocities;
- Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
- Control the alteration of natural floodplains, stream channels, and natural protective barriers that are involved in the accommodation of flood waters;
- Control filling, grading, dredging and other development that may increase erosion or flood damages;
- Regulate the construction of flood barriers that will unnaturally divert flood waters or that may increase flood hazards to other lands, and;
- Qualify and maintain for participation in the National Flood Insurance Program.

The stated objectives of the local law are:

- To protect human life and health;
- To minimize expenditure of public money for costly flood control projects;
- To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- To minimize prolonged business interruptions;
- To minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, sewer lines, streets and bridges located in areas of special flood hazard;
- To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas;
- To provide that developers are notified that property is in an area of special flood hazard; and,
- To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.

The Town of Middletown Building Inspector/Code Enforcement Officer is empowered as the Local Administrator for administering and implementing the Flood Damage Prevention local law. The primary responsibility of the Local Administrator is the granting or denying of floodplain development permits. The Local Administrator must conduct a thorough permit application review prior to approval and must make periodic inspections during the construction phase of a project after permit approval. Finally, upon completion of a project, the Local Administrator must issue a Certificate of Compliance stating that the project conforms to all requirements of the local law.

The local law identifies a series of Construction Standards for development in the floodplain, broken down into General Standards, Standards for All Structures, Residential Structures, Non-Residential Structures, and Manufactured Homes and Recreational Vehicles.

The General Standards section is broken down into standards for subdivision proposals and encroachments. All new subdivision proposals and other development proposed in a SFHA must be consistent with the need to minimize flood damage, minimize flood damage to utilities, and provide adequate drainage. When encroaching on zones A1-A30 and AE along streams without a regulatory floodway, development must not increase the base flood elevation by more than one foot. Along streams with a regulatory floodway, development must not create any increase in the base flood elevation.

Standards for All Structures include provisions for anchoring, construction materials and methods, and utilities. New structures must be anchored so as to prevent flotation, collapse, or lateral movement during the base flood. Construction materials must be resistant to flood damage, and construction methods must minimize flood damage. Enclosed areas below the lowest floor in zones A1-A30, AE or AH, and, in some cases, Zone A must be designed to allow for the entry and exit of floodwaters. Utility equipment such as electrical, HVAC and plumbing connections must be located at a minimum of two feet above the base flood elevation. Water supply and sanitary sewage systems must be designed to minimize or eliminate the infiltration of floodwaters.

The elevation of residential and nonresidential structures is required in areas of special flood hazard. **In zones A1-A30, AE and AH, and, in some cases, Zone A, new residential construction and substantial improvements must have their lowest floor elevated at or above two feet above the base flood elevation.** In cases where base flood elevation data is not known for Zone A, new residential construction and substantial improvements must have their lowest floor elevated at or above three feet above the highest adjacent grade.

For nonresidential structures in zones A1-A30, AE and AH, and, in some cases, Zone A, developers have the option of either elevating the structure or improvements by a minimum of two feet above the base flood elevation or floodproofing the structure so that it is watertight below two feet above the base flood elevation. All elevations and floodproofing may require engineering analysis to determine the structural integrity of the building and the elevation limits to floodproofing. In cases where base flood elevation data is not known for Zone A, new construction and substantial improvements must have their lowest floor elevated at or above three feet above the highest adjacent grade.

2.2 Watershed and Stream Characteristics

The project watershed area is located within four townships: Middletown and Roxbury in Delaware County, Halcott in Greene County and Shandaken in Ulster County. The entire watershed of the Bush Kill is 47.2 square miles in size with a northeast to southwest orientation. Sub-watersheds associated with streams that form the project boundaries include: Vly Creek (22.5 mi^2), Emory Brook (6.9 mi^2), the Big Red Kill (8.8 mi^2) and the Little Red Kill (1.7 mi^2).

The Bush Kill watershed is slightly symmetrical in shape being broad towards the headwaters and narrow towards the confluence with Dry Brook. The valley floor is moderately broad within the project area. Downstream of the project area, the valley floor narrows slightly and then expands significantly as it approaches the confluence with Dry Brook. The valley has steep, mountainous slopes, especially along its southern boundary where the watershed divide follows the summits of Meade Hill, Fleischmann Mountain and Belle Ayr Mountain. Valley slopes to the north rise less steeply. The Bush Kill flows along the south side of the watershed with most of its tributaries entering from the northern portion of the basin.

Since the early part of the 20th Century, the Bush Kill drainage basin has experienced a gradual increase in forested land as agricultural lands were abandoned and open fields were encroached upon by woody vegetation (DCSWCD, 2007). The basin is now over 90 percent forested (*StreamStats*, 2014). Agriculture has also declined over the last 40 years and farm lands have been sub-divided into multiple parcels for residential development; a trend supported by a demand for second homes as well as a decline in the dairy industry. Residential and commercial land uses in the basin are concentrated in and around the Village of Fleischmanns (DCSWCD, 2007). Outside of the village there is a mix of rural residences and agriculture.

The underlying bedrock geology of the project area consists of sandstone, conglomerates and shale. Along the Bush Kill and lower Vly Creek valley floors, surficial material consists of recent alluvium with some kame deposits on the south facing hillslopes. Surficial material in the Big Red Kill, Little Red Kill and Emory Brook basins consist of glacial till. Courser lacustrine deposits also occur in some areas, however, they are often overlain by more recent floodplain deposits (DCSWCD 2007). When exposed by the erosive action of the river, these lacustrine clays are mobilized, resulting in high turbidity and contributing to water quality issues.

Bush Kill

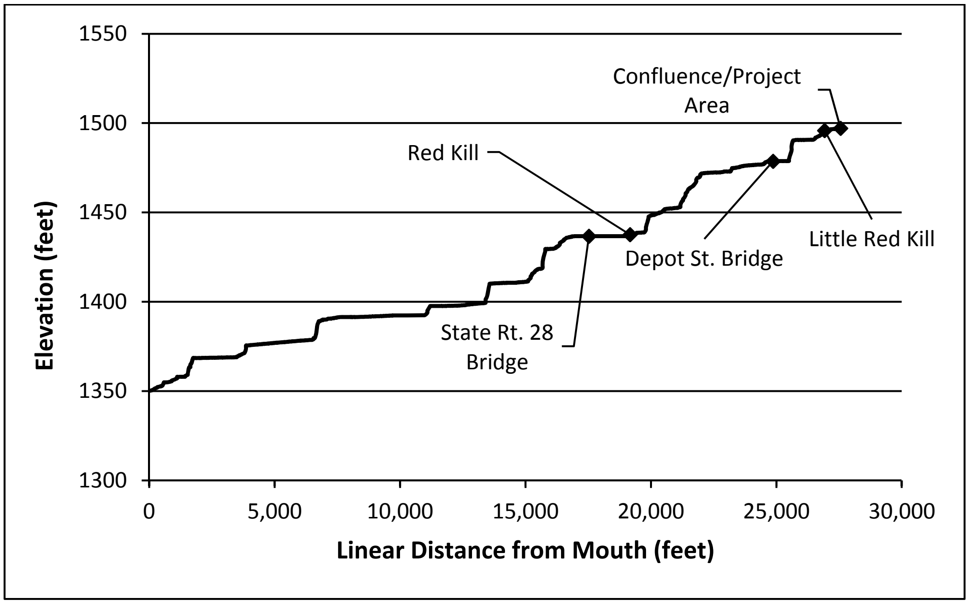
The primary creek within the project area is the Bush Kill. It is a fourth order stream with a channel that is highly constrained within the project boundaries by Main Street on the north and by Wagner Avenue and State Route 28 to the south. A significant portion of the stream is bermed and revetted further contributing to its confinement. As a result the sinuosity is low, ranging between 1.00 and 1.13 (DCSWCD 2007).

The total length of the Bush Kill from the confluence of Vly Creek and Emory Brook to its confluence with Dry Brook is 5.3 miles. Along this course the slope is 0.5%. Within the project area, from its origin to the Route 28 Bridge, the Bush Kill is 1.8 miles in length and generally flows in a western direction with a slope of 0.6%. The Bush Kill can be characterized as an alluvial river, meaning its channel is located on sediment previously placed by the river. Alluvial rivers adjust their shape, size, and slope in response to flow rates and sediment loads. The channel bed sediments are primarily gravel and cobble.

For descriptive purposes, the Bush Kill can be divided into two distinct sections within the project area. The first section extends from its origin in Fleischmanns to a distance 0.8 miles downstream. This section flows through the main residential and commercial section of the village. About 500 feet downstream of its origin, the Little Red Kill enters on the right bank. The second section begins 0.8 miles downstream from the origin and extends another 0.8 miles to the State Route 28 Bridge. This section is almost perfectly straight until it reaches its confluence with the Big Red Kill; a distance of about half a mile. After the confluence with the Big Red Kill, the stream turns to the left before passing under the State Route 28 Bridge.

After leaving the project area, the Bush Kill flows for an additional 3.5 miles before reaching the confluence with Dry Brook. Over this course, the stream is slightly more sinuous and several large gravel point bars become evident. Although the stream has some limited flood plain access, it still remains fairly confined due to State Route 28 on the right bank and steep, valley walls on the left. Figure 2-2 presents a profile of the Bush Kill showing its elevation versus linear distance from its origin at the confluence of Vly Creek and Emory Brook to the confluence with Dry Brook, as well as the locations of important tributaries and bridges.

FIGURE 2-2
Bush Kill Channel Profile

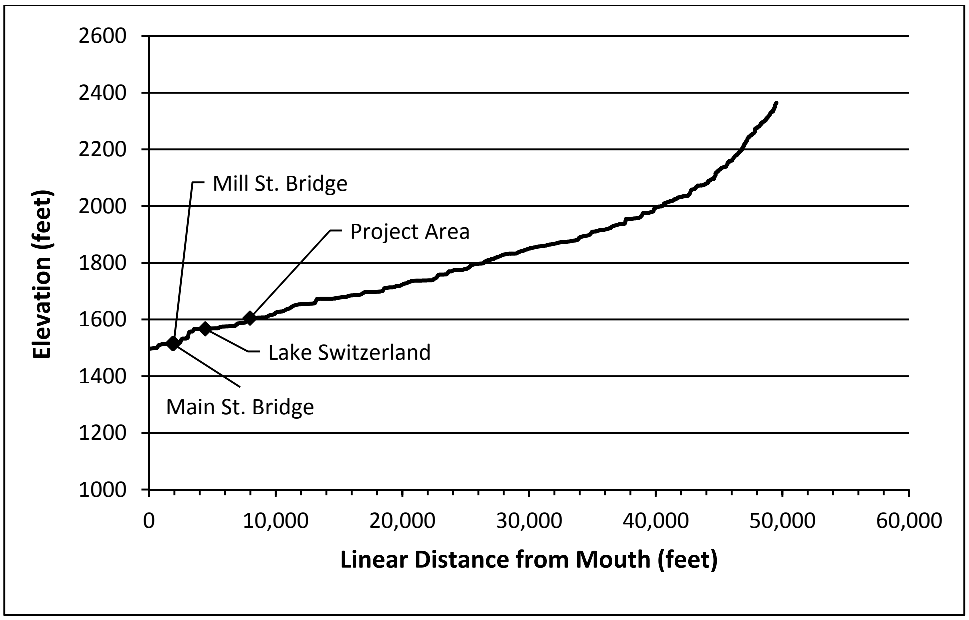


<u>Vly Creek</u>

Vly Creek is the larger of the two streams that form the Bush Kill and may be considered the headwaters. According to USGS Stream Stats, its total length is 10.1 miles. Land use consists primarily of forested hillslopes with hay fields bordering the stream channel. Along its course, the slope varies from 1.0% to 1.5% except at the upper headwaters where slopes are steeper. Sinuosity ranges between 1.00 and 1.17 and the stream bed consists mostly of cobble (DCSWCD 2007). The stream channel is not particularly confined in the upper reaches above the intersection between Breezy Hill Road and Lake Street. As a result, the creek has some access to its flood plain. Below the intersection of Breezy Hill Road and Lake Street, the valley narrows and the stream is confined by steep hillslopes on the left bank and Lake Street on the right bank.

The project area includes the lower portion of Vly Creek from the confluence with Emory Brook to the bridge on County Highway 37/Lake Street. The length and slope of the stream are 1.5 miles and 1.4%. This section consists of three distinct reaches. The most upstream reach begins at the County Highway 37/Lake Street Bridge and extends approximately 0.4 miles to the upstream end of the former Lake Switzerland. The channel in this reach consists of a single thread that is tightly constrained by County Highway 37 and steep hillslopes. The second reach is about 0.35 miles in length and flows through the former Lake Switzerland. The channel is much wider in this section and much of the streambed is made up of finer sediments deposited on the lake bottom. The final reach starts at the downstream end of the former Lake Switzerland and stretches about 0.68 miles to the confluence with Emory Brook. The stream corridor is primarily urban with bridges at Mill Street and Main Street which cross the stream in close proximity. Although the valley widens in this reach, the stream is entrenched in the lower half and much of the channel contains some form of revetment, many of which are in poor condition (DCSWCD 2007). Figure 2-3 is a profile of Vly Creek showing its elevation versus linear distance from its headwaters to the confluence with Emory Brook.

FIGURE 2-3
Vly Creek Channel Profile

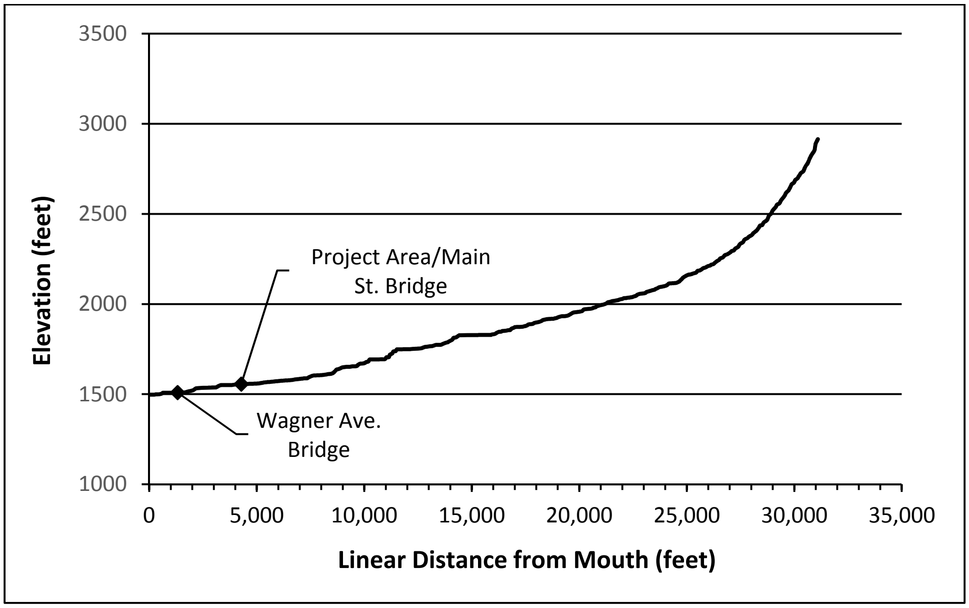


Emory Brook

Emory Brook is the second stream that forms the Bush Kill. The total length of the creek as given by USGS StreamStats is 6.27 miles with a corresponding slope of 4.6%. The length in the project area is 0.76 miles beginning upstream at the Main Street Bridge and extending to the confluence with Vly Creek. The slope in this region is 1.4%. Upstream of the project area, the stream is confined within a narrow, forested valley with steep hillslopes on both banks. About one mile above the project area the valley opens significantly and the stream gains some access to the floodplain on its left bank. As the stream approaches the project area, the valley narrows again although there is still some floodplain access.

Within the project area, the stream consists of two reaches. The first extends from the Main Street Bridge to the bridge at Wagner Avenue. In this area, the stream is confined on the right bank by Main Street and various buildings/properties that abut the stream. On the left bank, Emory Brook is bordered by State Route 28. As a result, the stream is fairly confined with little ability to move laterally. The second reach begins at the Wagner Avenue Bridge and continues to the confluence with Vly Creek. The stream widens noticeably in this reach and has access to the flood plain located between its right bank and Vly Creek. The profile of Emory Brook from its headwaters to the confluence with Vly Creek is shown in Figure 2-4.

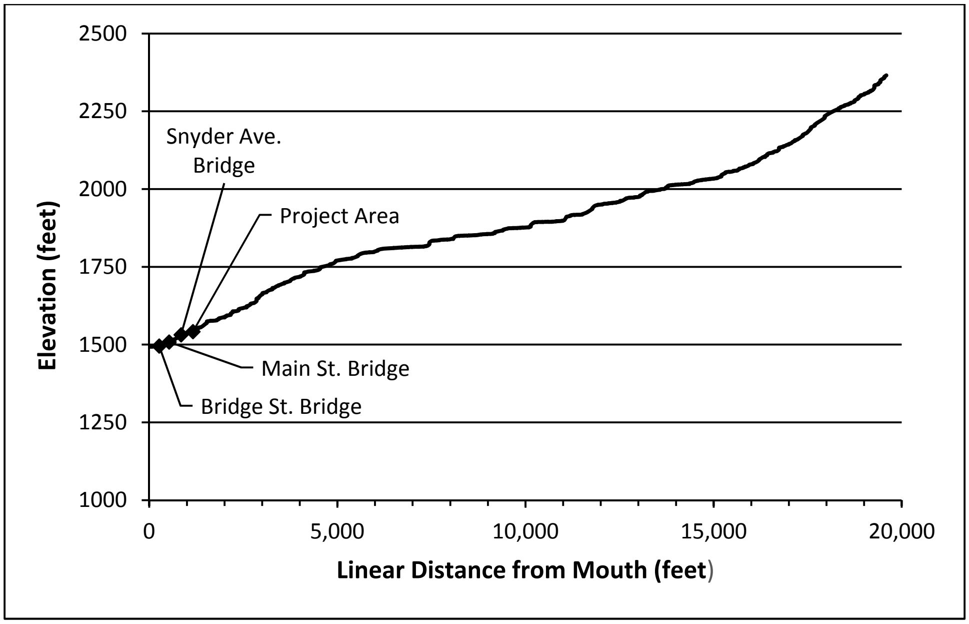
FIGURE 2-4
Emory Brook Channel Profile



Little Red Kill

The total length of the Little Red Kill is about 4 miles but only 0.2 miles is included in the project area. The Little Red Kill is a small, single thread stream that flows through several ponds in its upper reaches. The headwaters are fairly unconfined and the creek has access to its floodplain. Approximately one mile above its confluence with the Bush Kill, the valley narrows and the stream is confined between steep hillslopes and Little Red Kill Road. Within the project area, the creek is bordered by residential dwellings with culverts at Snyder Avenue and Main Street and a bridge at Bridge Street (Figure 2-5). The slope in this region is 4.2%.

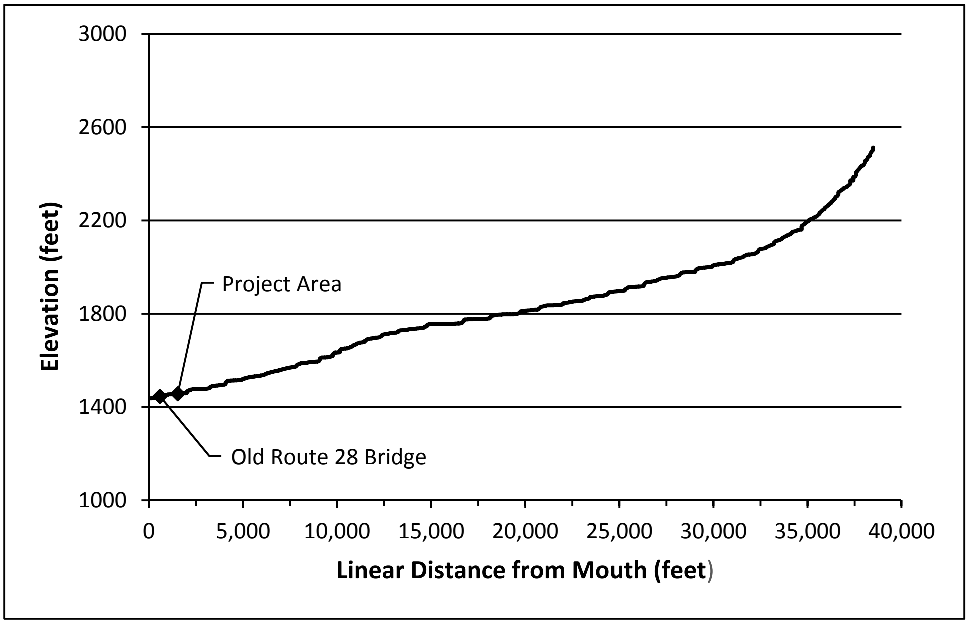
FIGURE 2-5
Little Red Kill Channel Profile



Big Red Kill

The Big Red Kill enters the Bush Kill 0.3 miles upstream of the project's lower boundary at the State Route 28 Bridge. The total length of the channel is 7.9 miles according to USGS StreamStats. However, only the lower 0.3 miles are included in the project area. As with Vly Creek and the Little Red Kill, it appears less confined in most of its upper reaches and more confined as it approaches the Bush Kill and the valley narrows. Immediately upstream of its confluence with the Bush Kill, the valley widens and the stream has some access to its floodplain. Within the project area, the village is less developed and the stream only abuts a few properties. Just prior to the confluence, the Big Red Kill passes under a bridge at Old Route 28. Between the bridge and the confluence with the Bush Kill, the channel slope is 0.1%. The slope upstream of the bridge is approximately 1.8%.

FIGURE 2-6
Big Red Kill Channel Profile



2.3 Field Assessment

MMI staff conducted visual inspections of Bush Kill Creek and its tributaries for this LFA. In general, the inspections were focused on (1) the river channel and its banks (bank and channel conditions, sediment bars, vegetation along the stream corridor) and (2) development in the floodplains.

One-hundred ninety nine structures located in or near the SFHA were observed on foot. Channel reaches within the project area were photo-documented. Visual inspections were conducted throughout 2014 and 2015, often coinciding with (but not limited to) meeting dates. The iterative nature of the inspections was necessary to help refine and reality-check the modeling of alternatives and the BCA.

When observing the stream channel and adjacent floodplains, the following were noted:

- ❑ Does the stream profile match the profile in the FIS and model?
- ❑ Do stream cross sections match the cross sections in the model?
- ❑ Do the manning n values in the model represent current riverbank and floodplain conditions?
- ❑ Do hydraulic variances in the model make sense relative to the field conditions, such as channel restrictions and bridges?

When observing structures, the following were noted:

- ❑ Do the property and building(s) match the parcel data provided by the Delaware County Planning Department?
- ❑ Is the property in the SFHA or 500-year flood zone? Is the structure in the SFHA or 500-year flood zone?
- ❑ What is the current land use and building use?
- ❑ Does the building have a basement?
- ❑ Is the building vacant or occupied?
- ❑ What is the elevation of the first floor in relation to adjacent grade?
- ❑ For single-family homes, how many feet (vertical) above the adjacent grade is the first floor?
- ❑ Are any unique features present in the building or property that would increase or decrease vulnerability to flooding?
- ❑ Is there any direct evidence of past flooding such as mud in a window sill?

Information gathered from field inspections was invaluable for aiding the modeling of alternatives and the BCA.

2.4 Infrastructure

The five streams included in the project are crossed by nine bridges and two culverts. In some cases the distance between structures is extremely close. On the Little Red Kill there are two culverts and a bridge along a 600 foot stretch of stream. On Vly Creek, the Mill Street and Main Street bridges are only separated by 58 feet.

Flood profiles published in the FEMA FIS indicate that most of the bridges/culverts cannot pass the 100 year storm event while a few are only able to pass flows generated by the 10 year storm event. In the worst case, the bridge at Wagner Avenue which spans Emory Brook is topped even by the 10 year storm event.

Table 2-1 lists the bridges in the project area and the streams they are located on. The bridges are listed from upstream to downstream and their locations are shown on Figure 2-1.

TABLE 2-1
Bridges Crossing the Fleischmanns LFA Study Area

Bridge Number on Figure 2-1	Bridge Crossing	Creek	Predicted 100-Year WSEL at Upstream Face	Bridge Deck Elevation*
1	County Highway 37 Bridge	Vly	1599.77	1597.10
2	Mill Street Bridge	Vly	1521.23	1520.35
3	Main Street Bridge	Vly	1520.79	1520.70
4	Main Street Bridge (upper end of Fleischmanns)	Emory	1551.50	1549.63
5	Wagner Avenue Bridge	Emory	1513.69	1513.17
6	Depot Street Bridge	Bush Kill	1486.69	1485.10
7	State Route 28 Bridge	Bush Kill	1444.22	1450.80
8	Snyder Avenue Culvert	Little Red Kill	1532.67	1532.34
9	Main Street Culvert	Little Red Kill	1514.63	1514.08
10	Bridge Street Bridge	Little Red Kill	1503.35	1505.30
11	Old Route 28 Bridge (at Clovesville)	Big Red Kill	1452.43	1456.37

*Elevation from HEC-RAS model

2.5 Hydrology

Surface water hydrologic studies are conducted to understand historic and potential future river flow rates using data measured at stream gauging stations and those developed from predictive models. They inform communities of how much water flows in the river at a specific time and place.

Hydrologic data on peak flood flow rates for the tributaries of the East Branch of the Delaware River is available from FEMA's contractors and *StreamStats* regional data. *StreamStats* is a USGS website that uses Geographic Information System (GIS) data and regional regression equations to predict peak flood flow rates (Lumia, et al, 2006 & Mulvihill et al, 2009).

Pertinent data for this LFA was primarily taken from work completed by FEMA contractors and received as part of each HEC-RAS hydraulic model developed for the FEMA restudy conducted from 2012 to 2014 (contract number HSFEHQ-09-D-0369, Task order HSFE02-11-J-0002). The models included the 10-year, 25-year, 50-year, 100-year, and 500-year flows. The 1.5-year and 2-year flow profiles were estimated for use in the hydraulic model. These flows were not published with the FEMA models. The 2-year flow values for Big Red Kill, Little Red Kill, and Emory Brook were taken from the report

"East Branch Delaware River Hydrology Methodology Report" (Gomez and Sullivan Engineers, P.C., July 31, 2012, submitted to RAMPP- Dewberry as part of the Delaware County FIS update). A copy of the report can be found in Appendix B. This copy is marked "Preliminary Draft." The 1.5-year and 2-year flows not taken from the Hydrology Methodology Report were calculated using *StreamStats*. Discharges are listed in the tables below.

TABLE 2-2
Published Discharge Data for Bush Kill

Location	River Station	Discharge (cfs)					
		1.5-yr	2-yr	10-yr	50-yr	100-yr	500-yr
Upstream of depot street	25095	1616	2120	4866	8231	9929	14446
Approx 2,275 ft ds of Depot St	22688	1650	2160	5076	8591	10363	15080
Upstream of confluence of Big Red Kill	19846	1730	2270	5101	8639	10422	15172
Downstream of confluence of Red Kill	18012	1730	2270	6273	10676	12870	18744
Downstream of confluence of Tributary 3 to Bush Kill	16657	2110	2760	6528	11125	13409	19532
Upstream of confluence of Tributary 3 to Bush Kill	10905	2210	2900	6659	11355	13686	19937
USGS Gage 1413398	9990	2210	2900	6906	11789	14206	20694
At confluence with Dry Brook in Arkville	3890	2270	2970	6955	11868	14301	20828

TABLE 2-3
Published Discharge Data for Vly Creek

Location	River Station	Discharge (cfs)					
		1.5-yr	2-yr	10-yr	50-yr	100-yr	500-yr
Approx. 2,800 ft DS Ursum Way	18076	1120	1460	3262	5510	6654	9678
Approx. 2,500 ft US HW 37	9717	1170	1530	3413	5765	6963	10130
Approx. 1,750 ft DS HW 37	5862	1190	1560	3468	5855	7072	10288
At Confluence with Bush Kill	3556	1200	1570	3492	5896	7120	10356

TABLE 2-4
Published Discharge Data for Emory Brook

Location	River Station	Discharge (cfs)					
		1.5-yr	2-yr	10-yr	50-yr	100-yr	500-yr
Approx. 1,520 ft DS of Main Street	4264	384	541	1192	2028	2451	3568
At Confluence with Bush Kill	2082	416	550	1212	2062	2492	3627

TABLE 2-5
Published Discharge Data for Little Red Kill

Location	River Station	Discharge (cfs)					
		1.5-yr	2-yr	10-yr	50-yr	100-yr	500-yr
Approx. 240 ft US Schneider Ave.	1126	87.4	114	257	449	547	805
At Main Street	884	89	116	263	460	560	827

TABLE 2-6
Published Discharge Data for Big Red Kill

Location	River Station	Discharge (cfs)					
		1.5-yr	2-yr	10-yr	50-yr	100-yr	500-yr
Approx. 1,180 ft US Old Route 28	3235	388	511	1153	1975	2392	3496
At Confluence with Bush Kill	1376	416	541	1222	2092	2533	3702

The discharges provided in the above tables provide the baseline data for the flood mitigation alternatives that involve hydrologic assessment, as well as the baseline date for the flood mitigation alternatives that involve hydraulic assessment.

3.0 DESCRIPTION OF FLOOD HAZARDS

3.1 Flood History in the East Branch Delaware River Watershed

Fleischmanns typically experiences mild summers and cold winters with precipitation occurring year-round. The long-term mean annual precipitation in the watershed is reported to be 46.7 inches per year (DCSWCD, 2006). However, precipitation is not always distributed uniformly throughout the year, and several significant and devastating floods have occurred. Beginning with the flood of 1996, these are described below. A summary of peak discharges and associated stages is provided in Table 3-1 and Table 3-2. The discharges and stages are from USGS Gauges #01413400 and #01413398 on the Bush Kill near Arkville, just downstream of Fleischmanns and therefore appropriate for demonstrating flood conditions in Fleischmanns.

Flood of 1996 – On January 19 and 20, 1996, Delaware County suffered a devastating flood caused by heavy rain combined with rapid snowmelt. Damages within Delaware County exceeded $20 million. In nearby Arkville, downstream of Fleischmanns, flood discharges on the Bush Kill exceeded the 100-year storm (USGS 1998).

TABLE 3-1
Recent Flood Discharges at Gauge #01413400 on
Bush Kill at Arkville New York

Date	Discharge	RI* (years)
January 19-20, 1996	7,600 cfs	>100

*RI as reported by USGS for the period of record available at the date of the flood

Flood of 2006 – In June 2006, a stalled weather front caused flooding in the Delaware River basin from June 26 to 29, 2006. Rainfall varied from 2 inches to over 13 inches in southern New York (USGS 2009). Fleischmanns received between six and eight inches of rainfall during the storm (USGS 2009). State-wide disaster recovery assistance for individuals and businesses totaled over $227 million. A state of emergency was declared in Delaware County and many others.

Floods of 2011 – In August and September 2011, Hurricane Irene and the remnants of Tropical Storm Lee resulted in record flooding in much of the Catskills. In eastern New York, rainfall was the greatest since 1895 (USGS 2014). High water marks with elevations of 1,515.9 and 1,485.5 feet NAVD88 were measured along the Bush Kill in Fleischmanns.

TABLE 3-2
Recent Flood Discharges at Gauge #01413398 on
Bush Kill near Arkville New York

Date	Discharge	Stage*	RI** (years)
June 28, 2006	4,520 cfs	10.51	Not Reported
August 28, 2011 (T.S. Irene)	13,800 cfs	16.26	>100 & <200
September 7-11, 2011 (T.S. Lee)	2,830 cfs	9.31	2

* Flood Stage = 9 feet
**RI as reported by USGS for the period of record available at the date of the flood

The recurrence intervals listed in the tables were published by USGS at the time of each flood and do not necessarily represent a continuous updating of the hydrologic record with calculation of new recurrence intervals.

3.2 FEMA Mapping

FEMA Flood Insurance Rate Maps are available for the study area and depict the SFHA. The maps also depict the FEMA designated floodway, which is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood. Floodwaters are typically deepest and swiftest in the floodway, and anything in this area is in the greatest danger during a flood (FEMA, 2008).

The Villages of Fleischmanns was studied for the first time in the June 19, 2012, countywide FIS. For the preliminary April 24, 2014 FIS, the hydrologic and hydraulic analysis for the East Branch Delaware River watershed was performed by Gomez and Sullivan Engineers, P.C. under subcontract with RAMPP. The task order was HSFE02-11-J0001, and the work was completed in September 2013. As of the date of this report, the effective FIS for Fleischmanns is the June 16, 2016 countywide FIS.

FEMA mapping indicates that during a 100-year frequency event, waters from Bush Kill Creek, Emory Brook, and Vly Creek inundate much of the village center. This was verified during some of the recent floods such as Tropical Storm Irene in 2011.

4.0 FLOOD MITIGATION ANALYSIS AND ALTERNATIVES

The purpose of hydrologic and hydraulic assessment is to evaluate historic and predicted water surface elevations, identify flood prone areas, and help develop mitigation strategies to minimize future flood damages and protect water quality. Hydraulic analysis techniques can also help predict flow velocities, sediment transport, scour, and deposition if these outcomes are desired.

Specific areas along the Bush Kill, Emory Brook, Vly Creek, Big Red Kill, and Little Red Kill have been identified as being at risk to flooding during severe rain events. Numerous alternatives were developed and assessed at each area where flooding is known to have caused extensive damage to homes and businesses. Alternatives were assessed with hydrologic evaluation and hydraulic modeling to determine their effectiveness. The sections below describe these alternatives and their results.

4.1 Analysis Approach

Two of the flood mitigation alternatives for Fleischmanns involve hydrologic evaluation – flood storage in Lake Switzerland and bypass of floodwaters from Vly Creek to Emory Brook. Hydrology was described in Section 2.5; the discharges listed in Table 2-2 through Table 2-4 provide the basis for the evaluation of these two hydrologic alternatives.

The majority of the flood mitigation alternatives for Fleischmanns involve hydraulic evaluation. Hydraulic analysis throughout the study area was conducted using the HEC-RAS program. The HEC-RAS software (*River Analysis System*) was written by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) and is considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one-dimensional, steady-state, or time-varied flow. The system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions.

The FEMA FIS (see Section 2.0) was based on a detailed study utilizing the HEC-RAS computer software. In order to develop hydraulic modeling to assess the alternatives, MMI obtained the preliminary FEMA HEC-RAS models for Bush Kill, Emory Brook, Big Red Kill, Little Red Kill, and Vly Creek from NYCDEP on May 20, 2014. These models were used in the preliminary April 24, 2014 FIS to create the regulatory floodplain and floodway boundaries. These FEMA models were created with all new survey data collected in May and June 2012, and therefore do not include changes to the river completed during subsequent construction and EWP restoration projects following flooding.

Water surface profiles are computed by HEC-RAS from one cross section to the next by solving the one-dimensional energy equation with an iterative procedure called the standard step method. Energy losses are evaluated by friction (Manning's Equation) and the contraction/ expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied, such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence.

4.2 Existing Conditions Analysis

For each of the five streams (Bush Kill, Vly Creek, Emory Brook, Big Red Kill, and Little Red Kill), a FEMA "Duplicate Effective" model was created by importing the FEMA preliminary model into HEC-RAS. The model was run in HEC-RAS v. 4.1.0 with no changes to the received models. The floodplain and floodway runs were completed in two different plans.

The Duplicate Effective models were checked for correct manning's n-values, site conditions, and expansion/contraction coefficients to ensure that the information in the model accurately reflects river and floodplain conditions. Some n-values in the overbank areas did not adequately represent site conditions. For each stream, a "Corrected Effective Model" was created[2] by copying the truncated Duplicate Effective model and making necessary changes. Minor n-value changes were included in the Corrected Effective Model to more appropriately represent overbank conditions. Some ineffective flow areas representing buildings were changed to obstructions in the models.

Gaps were identified between cross section locations in the Corrected Effective model in areas where the East Branch Flood Commission and Village officials desired evaluation of alternatives for flood mitigation. Additional cross sections were deemed necessary to better represent these possible future mitigation project areas. An "Existing Conditions" model was created by saving a copy of the Corrected Effective Model and adding cross sections in necessary locations. Additional flow profiles were added for the 2-year and 25-year recurrence intervals that were described in the Hydrology section of this report.

The models were updated to include recent river construction. The Vly Creek and Bush Kill cross sections were updated based on as-built surveys of the EWP projects

[2] Changes made to the FEMA model geometry were noted in the comments section in HEC-RAS. N-values for some cross sections were updated from the FEMA model in the Corrected Effective model. If a change was made, notes were added to the Cross Section Data Editor Description box where comments can be written for each cross section.

(November 18, 2013). Buildings along Bush Kill that were removed subsequent to the creation of the FEMA model were removed from the model.

The Vly Creek, Emory Brook, and Bush Kill models were combined into one HEC-RAS model, with separate reaches representing the previously separate models. The combination of models was necessary to adequately test alternatives in the vicinity of the point where Vly Creek and Emory Brook join to become Bush Kill, and the subsequent effect of alternatives on all three streams. The models were imported to a new combined model with no changes from the original FEMA model, except to alter the boundary conditions at the confluence to include a junction instead of separate downstream and upstream boundaries.

At several locations in the Village there are short sections where earth has been piled at the edge of the river to form a berm between the river channel and the floodplain. These berms are included in the hydraulic model geometry at cross sections crossing these locations. Berms are located on Bushkill near the park tennis courts and at the hardware store, on Emory upstream of Wagner Road, and on Vly near Main Street. These berms do not completely isolate the land behind them from the river and are therefore not modeled using the levee feature in HEC-RAS.

Three new cross sections were added to the Bush Kill model. The new cross sections used overbank geometry from the 2009 1-meter resolution LiDAR data collected by NYCDEP. Elevations were sampled from the LiDAR elevation data using HEC-GeoRAS GIS extension software. No new survey was collected as part of this model update. The wet channel sections were taken from the next closest cross section that was included in the FEMA model because the LiDAR data does not penetrate the water surface and therefore underestimates the depth of the channel bottom. The wet section shape was transferred and height adjusted to match the channel slope of the FEMA model in these new cross section locations. Manning's n-values were assigned using field observations and aerial photos.

This new Existing Conditions model was the baseline model used to evaluate hydraulic flood mitigation alternatives. For purposes of water surface elevation computations, the model was run in subcritical flow regime, which tends to use slower velocities but higher water surface elevations, and also provides the worst case scenario for flood surface elevations.

4.3 Channel and Floodplain Mitigation Approaches

A number of mitigation approaches have been evaluated for the streams within the study area. These are introduced in a more global manner in this section and are evaluated in specific instances in the subsequent analysis.

4.3.1 Sediment Management

A common sentiment in the Catskills region is that dredging, more broadly defined as removal of sediment from river channels, will alleviate flooding and should be pursued. The need for dredging can be minimized by reducing the sediment load at its source and by improving sediment transport through reaches that are vulnerable to deposition. Natural sediment transport is often disrupted by constrictions holding back sediment or channelization causing increased sediment transport, causing abnormal deposition that can be addressed in the long term by removal of constrictions and naturalization of channel and floodplain capacity.

Dredging is often the first response to flooding. However, over-widening or over-deepening through sediment removal can initiate instability (including bed and bank erosion), foster poor sediment transport, and not necessarily provide significant flood mitigation. Sediment removal can further isolate a stream from its natural floodplain, disrupt sediment transport, expose erodible sediments, cause upstream bank/channel scour, and encourage additional downstream sediment deposition. Improperly dredged stream channels often show signs of severe instability, which can cause larger problems after the work is complete. Such a condition is likely to exacerbate flooding on a long-term basis.

East Branch Flood Commission representatives and Village officials have reported a need to consider sediment removal in the lower reaches of Big Red Kill. This will be discussed in the context of the Big Red Kill in subsequent sections of this chapter.

4.3.2 Levee Construction

Under certain circumstances, levees can be constructed for the purpose of protecting properties and structures from flood damage. Levees often require considerable space for construction, interior drainage pump stations, use of removable panels at road crossings, and considerable maintenance. Use of such measures requires careful consideration and risk assessment, engineering design, and ongoing monitoring and maintenance.

Risks associated with levees include the potential to increase water surface elevations in the channel by cutting off the floodplain, and the danger of a flood event that exceeds the design storm and overtops or breaches the levee. As an example, peak flood stage in Fleischmanns exceeded the 100-year flood stage during Tropical Storm Irene. Under this scenario, it is possible that floodwaters would have overtopped a levee designed to protect structures and properties from flooding during the 100-year flood event. Once a levee has been overtopped, floodwaters can become trapped behind the levee, exacerbating flooding problems.

Finally, levees need to be certified by FEMA and maintained according to FEMA requirements in order for any flood mitigation benefits to be recognized on the Flood Insurance Rate Maps. A lapse in maintenance or certification can lead to sharp flood insurance increases for properties believed protected by the levee system.

Due to the issues described above, East Branch Flood Commission representatives and Village officials did not express any need to consider levee construction in Fleischmanns.

4.3.3 Bridge Replacement or Modifications

In some cases, bridges cause lateral or vertical restrictions that increase flood velocities and/or water surface elevations. The replacement of a bridge with a new structure that has a longer span will often remove the lateral constrictions, while a higher structure will remove vertical restrictions and often reduce water surface elevations on the upstream side. Bridge replacement must be carefully evaluated in combination with other alternatives, because other flood mitigation projects could change the velocity or height of flows approaching and passing under bridges.

Numerous bridges are located in Fleischmanns. All existing crossings of Vly Creek, Emory Brook, Bush Kill, Little Red Kill, and Big Red Kill were evaluated for this LFA. In addition, several choices of pedestrian bridge over Bush Kill and Vly Creek were evaluated over the course of this LFA, although not specifically within the scope of the study. This report will briefly address the pedestrian bridges although it recognized that they will be constructed prior to the timeframe of any projects that result from this LFA.

4.3.4 Natural Channel Design and Floodplain Enhancement

Historic settlement and human desire to build near water has led to centuries of development clustered along the banks of rivers all over the nation. Dense development and placement of fill in the natural floodplain of a river can severely hinder a river's ability to convey flood flows without overtopping its banks and/or causing heavy flood damages.

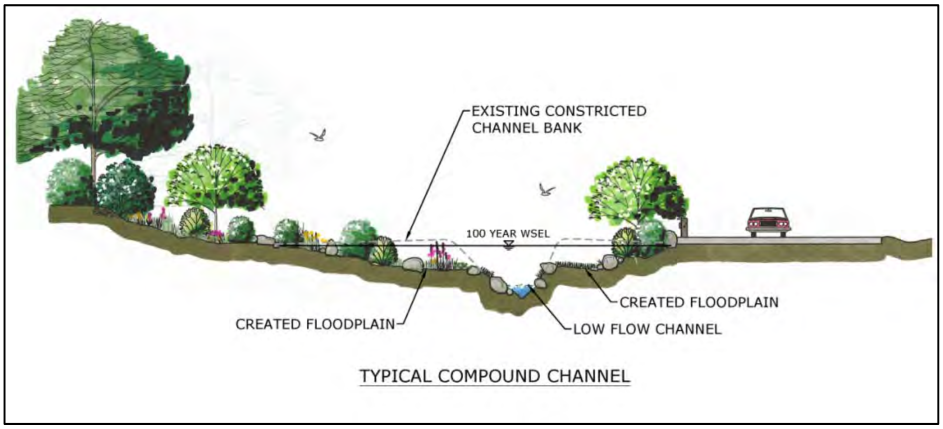
A river in flood stage must convey large amounts of water through a finite floodplain. When a channel is constricted or confined, velocities can become destructively high during a flood, with dramatic erosion and damage. When obstructions are placed in the floodplain, whether they are in the form of structures, infrastructure, or fill, they are vulnerable to flooding and damage. Reducing floodplain capacity also disrupts natural sediment deposition and may cause that sediment to accumulate elsewhere, causing a transfer of problems.

Natural channels are typically comprised of a compound channel whereby normal flow is conveyed in a low flow channel that is flanked by active floodplain, which is ideally a vegetated, undeveloped corridor at a slightly higher elevation that is able to convey high flows. Although rivers in their natural setting seem to be at their low-flow stage most often, the entire flood-prone corridor is part of the river, and the importance of the floodplain only becomes evident on rare, but extreme occasions.

The natural floodplain along Emory Brook, Vly Creek, Bush Kill, Big Red Kill, and Little Red Kill in some locations, has been built upon and in other locations has been filled. In certain instances, an existing floodplain can be altered through reclamation, creation, or enhancement, to increase flood conveyance capacity. Floodplain *reclamation* can be accomplished by excavating previously filled areas, removing berms or obstructions from the floodplain, or removal/relocation of structures. Floodplain *creation* can be accomplished by excavating land to create new floodplain where there is none today. Finally, floodplain *enhancement* can be accomplished by excavating within the existing floodplain adjacent to the river to increase flood flow conveyance. These excavated areas are sometimes referred to as floodplain benches. We also use the term floodplain bench when we create a floodplain at the foot of a high failing bank or hillslope as part of a restoration/stabilization project, creating a floodplain where one did not previously exist or was washed away.

Figure 4-1 shows a typical cross section of compound channel with excavated floodplain benches on both banks. The graphic shows flood benches on both banks; however, flood benches can occur on either or both banks of a river.

FIGURE 4-1
Typical Cross Section of a Compound Channel



When considering areas for floodplain reclamation, enhancement, or creation, it may make sense to target areas that were formerly providing better floodplain functions. A review of historical topographic mapping can be beneficial in providing clues about prior floodplain conditions on a macro scale. However, the Margaretville Quadrangle (USGS 15 Minute Series, 1904) depicts the primary roads in Fleischmanns as they are today, with no obvious signs of large floodplains that existed then but not today. It is likely that floodplain encroachments in Fleischmanns have occurred on a smaller scale in discrete locations.

4.4 Individual Property Flood Mitigation

A variety of measures are available to protect existing public and private properties from flood damage. While broader mitigation efforts are desirable such as those described above, they often take time and significant funding to implement. On a case-by-case basis, individual floodproofing should be explored where structures are at risk. Potential measures for property protection include the following:

Elevation of the structure. Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the level of the 100-year flood event. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the new elevated first-floor level.

Dry floodproofing of the structure to keep floodwaters from entering. Dry floodproofing refers to the act of making areas below the flood level watertight. Walls may be coated with compound or plastic sheathing. Openings such as windows and vents would be either permanently closed or covered with removable shields. Flood protection should extend only 2 to 3 feet above the top of the concrete foundation because building walls and floors cannot withstand the pressure of deeper water. Dry floodproofing is not appropriate for residential structures but is permissible for non-residential structures.

Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded. Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 100-year flood elevation. Wet floodproofing is not appropriate for residential structures unless accomplished by elevating the structure as described above, but is permissible for non-residential structures.

Construction of property improvements such as barriers, floodwalls, and earthen berms. Such structural projects can sometimes be used to prevent flooding. There may be properties within the Village where implementation of such measures will serve to protect structures.

Performing other home improvements to mitigate damage from flooding. The following measures can be undertaken to protect home utilities and belongings:

- ❑ Relocate valuable belongings above the 100-year flood elevation to reduce the amount of damage caused during a flood event.
- ❑ Elevate the electrical box or relocate it to a higher floor and elevate electric outlets to at least 12 inches above the high water mark.
- ❑ Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- ❑ Anchor a fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- ❑ Install a backflow valve to prevent sewer backup into the home.
- ❑ Install a floating floor drain plug at the lowest point of the lowest finished floor.

Encouraging property owners to purchase flood insurance under the National Flood Insurance Program (NFIP) and to make claims when damage occurs. While having flood insurance will not prevent flood damage, it will help a family or business put things back in order following a flood event. Property owners should be encouraged to submit claims under the NFIP whenever flooding damage occurs in order to increase the eligibility of the property for projects under the various mitigation grant programs.

4.5 Overview of Alternatives Analysis

Various alternatives have been evaluated to understand the potential for flood mitigation. These are presented in the sections that follow. **The evaluation commenced with several primary types of alternatives identified by the East Branch Flood Commission and the Village:**

1. Replacement of bridges that are contributing to flood damage, or elimination of stream crossings where possible.
2. Enhancement of floodplains and creation of floodplain benches where possible.
3. Hydrologic alternatives such as detaining floodwaters or re-routing floodwaters.

The primary objective identified by the East Branch Flood Commission and the Village was to develop a set of flood mitigation alternatives that would at least reduce the risk of flood damage to businesses and homes in Fleischmanns if elimination of the risk was not possible. A secondary objective was to keep as much water off Main Street as possible, making the road more resilient to floods.

4.6 Individual Hydraulic Alternatives

Over the course of the LFA, initial alternatives were modified and adjusted to maximize the reduction of flood water surface elevations. In addition, other alternatives were suggested by the East Branch Flood Commission and the Village, and subsequently evaluated for the LFA. A total of 30 hydraulic alternatives were considered.

In particular, the following bridge replacement options were initially identified for the LFA study area (with the prefix "1" denoting a bridge replacement):

- Alternative 1A: replacement of the Main Street Bridge on Emory Brook
- Alternative 1B: replacement of Wagner Avenue Bridge over Emory Brook
- Alternative 1C: replacement of Mill Street Bridge over Vly Creek
- Alternative 1D: replacement of Main Street Bridge over Vly Creek
- Alternative 1E: replacement of Snyder Avenue Bridge over Little Red Kill
- Alternative 1F: replacement of driveway bridge over Little Red Kill
- Alternative 1G: replacement of Main Street Bridge over Little Red Kill
- Alternative 1H: replacement of Bridge Street Bridge over Little Red Kill
- Alternative 1I: replacement of Bridge Street Bridge over Bush Kill (this was primarily an assessment of the choice of a new pedestrian bridge at the former Bridge Street Bridge location over Bush Kill)
- Alternative 1J: replacement of Depot Street Bridge over Bush Kill
- Alternative 1K: replacement of Old Route 28 Bridge over Big Red Kill

Ultimately, only Alternative 1A was modeled by itself. Alternatives 1B, 1C, 1D, 1I, and 1K were mainly considered in combination with floodplain alternatives. Alternatives 1E, 1F, 1G, and 1H on the Little Red Kill were addressed together.

Alternatives 2 and 3 were hydrologic alternatives and will be described in Sections 4.8.1 and 4.8.2.

Alternatives 4 through 10 represented mainly floodplain projects:

- Alternative 4: Upstream area (Emory/Vly confluence)
- Alternative 5: Bridge Street area of Bush Kill
- Alternative 6: Middle area of Bush Kill (west end of Wagner Avenue, Depot Street, Wadler/True Value)
- Alternative 7: Downstream area of Bush Kill (along Route 28); Includes the downstream area of Bush Kill with Big Red Kill
- Alternative 8: Vly Creek at Mill Street
- Alternative 9: Emory Brook at Wagner Road
- Alternative 10: Near park off Wagner Avenue

Because the profile of Fleischmanns along Vly Creek, Emory Brook, and Bush Kill is relatively steep in relation to its length, the individual alternatives are relatively independent and do not affect one another. For example, the overall substance of alternative 6 and the layouts of its various sub-alternatives do not have any impact on the next-nearest upstream alternative (alternative 10). This modular characteristic of the alternatives allows significant flexibility in their evaluation and the benefit cost analysis presented in Chapter 5.

4.6.1 Alternative 1 – Main Street Bridge on Emory Brook (STA 3844)

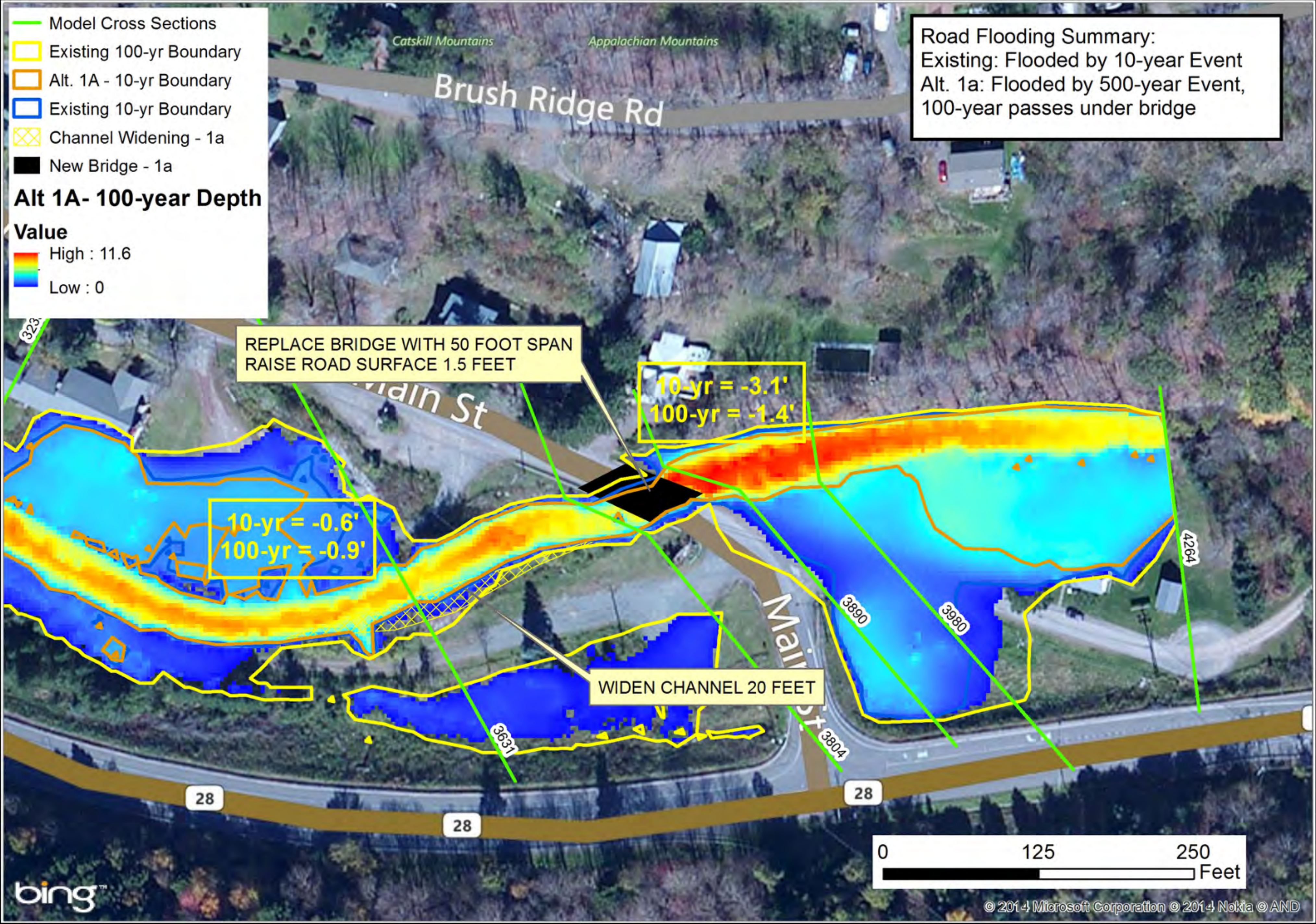
Alternative 1A is the replacement of the Main Street Bridge over Emory Brook with a 50-foot span, raising the road surface 1.5 feet, and regrading to widen the constricted stream channel. The existing bridge cannot convey the 10-year flood. The tested bridge can convey the 100-year flood but not the 500-year flood. Table 4-1 provides water surface elevations at cross sections upstream and downstream of the Main Street Bridge over Emory Brook. Table 4-2 provides velocity information. Figure 4-2 depicts the Main Street Bridge over Emory Brook alternative.

TABLE 4-1
Water Surface Elevations at
Main Street Bridge over Emory Brook (100-Year)
[feet NAVD88]

Station	Existing Conditions	Alternative 1A	Net Change
3980 (Upstream of Main Street)	1551.72	1550.66	-1.06
3890 (Immediately Upstream of Main Street Bridge)	1551.5	1550.12	-1.38
3804 (Immediately Downstream of Main Street Bridge)	1546.63	1546.61	-0.02
3631 (Downstream of Main Street)	1543.37	1542.51	-0.86

TABLE 4-2
Velocity at Main Street Bridge
over Emory Brook (100-Year)

	Velocity (ft/s)		
Station	**Existing Conditions**	**Alternative 1A**	**Net Change**
3980 (Upstream of Main Street)	5.42	6.47	1.05
3890 (Immediately Upstream of Main Street Bridge)	5.65	7.16	1.51
3804 (Immediately Downstream of Main Street Bridge)	12.87	12.92	0.05
3631 (Downstream of Main Street)	11.48	9.01	-2.47



SOURCE(S): BING MMI HECRAS	ALTERNATIVE 1 A MXD: Y:\5197-03\GIS\Maps\NOV ALTS\Emory-1a-Depth.mxd	DEPTH MAPPING LOCATION: FLEISCHMANNS, NY	Map By: JCL MMI#: 5197-03 Original: 11/14/2014 Revision: Scale: 1 in = 100 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

Modeling of Alternative 1A demonstrated the following:

- The existing bridge raises water surface elevations upstream of the crossing.
- Replacing the bridge with a longer, higher bridge and widening the constricted channel lowers flood water surface elevations upstream of the bridge by a maximum of 1.4 feet.
- Removing the bridge and adjacent fill reduces velocities downstream of the bridge but increases velocities upstream of the bridge.

Overall, the bridge replacement would be beneficial by improving the ability of the bridge to convey frequent floods, which makes Main Street more resilience and able to provide egress at the eastern end of the village. Given the results, a bridge replacement was advanced for consideration in the BCA.

4.6.2 Alternative 4 – Upstream Area at Confluence of Emory Brook and Vly Creek (STA 1526 to STA 0 on Vly Creek)

Alternative 4 involves lowering the floodplain between Vly Creek and Emory Brook, immediately upstream of their confluence. This area is already within the SFHA but can be regraded. Alternative 4 focuses on the area between the streams rather than looking at floodplain enhancement on the right bank of Vly Creek where the central business district is located. Two sub-alternatives were modeled in the vicinity of the Emory Brook and Vly Creek confluence:

- Alternative 4A involves the creation of a floodplain on the south side of Vly Creek, removal of the cottages behind the school, and removal of the remaining buildings at the auto repair shop and junk yard. The large school building would remain in place.
- Alternative 4B expands the floodplain created in Alternative 4A to reach Emory Brook. In order to create the floodplain, the school with apartments and cottages in the rear will be relocated and the remaining buildings at the auto repair shop and junk yard will be removed.

Figure 4-3 depicts the location of the grading for Alternative 4A. Figure 4-4 depicts the location of the grading for Alternative 4B. Table 4-3 provides water surface elevations at the floodplains and upstream.

TABLE 4-3
Comparison of Water Surface Elevations at
Confluence of Emory Brook and Vly Creek (100-Year)
[feet NAVD88]

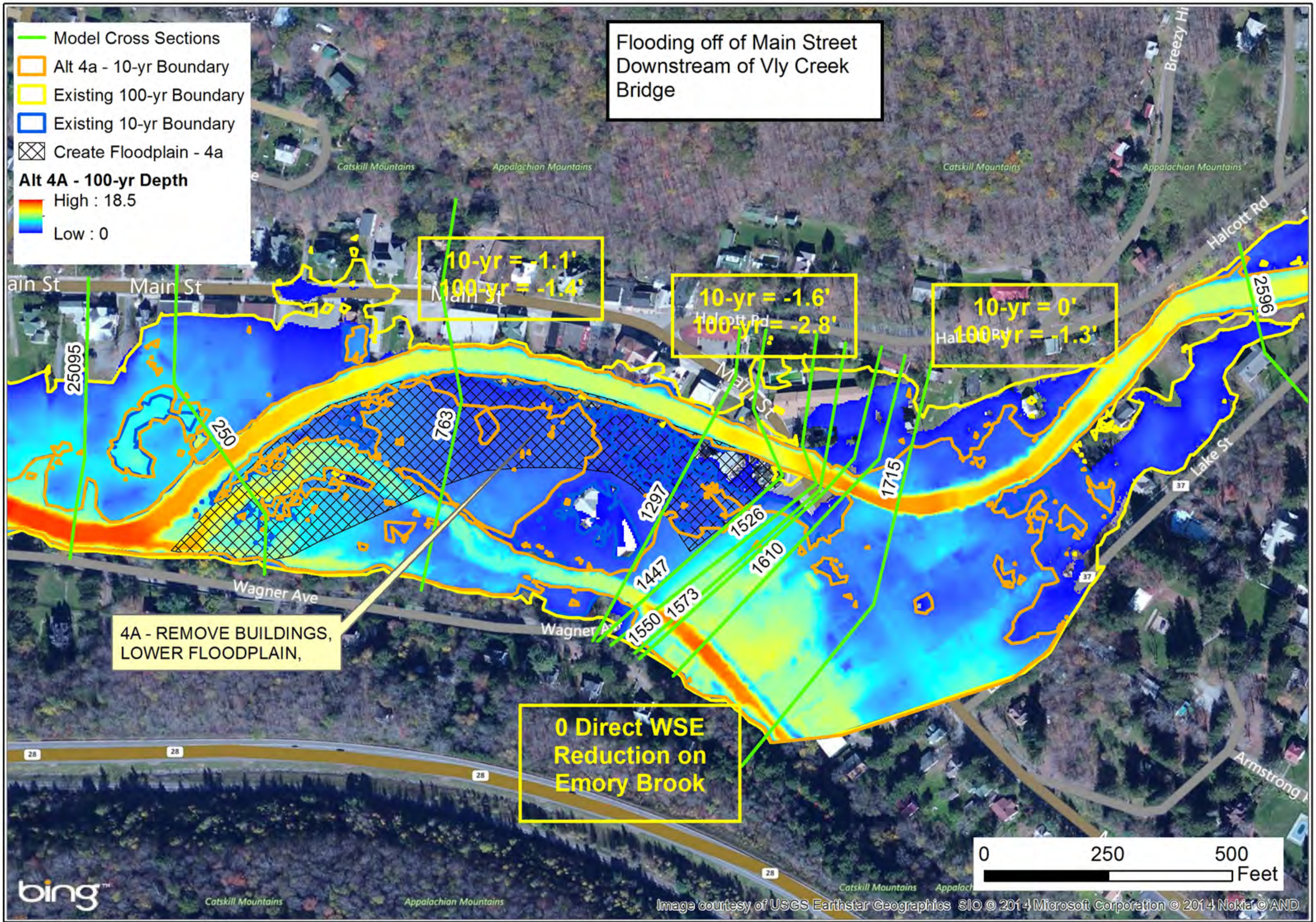
Station	Existing Conditions	Alternative 4A	Net Change Alternative 4A	Alternative 4B	Net Change Alternative 4B
1715 (Upstream of Mill Street)	1521.64	1520.31	-1.33	1520.31	-1.33
1610 (Immediately Upstream of Mill Street Bridge)	1521.44	1519.73	-1.71	1519.73	-1.71
1573 (Immediately Downstream of Mill Street Bridge)	1521.15	1518.38	-2.77	1518.38	-2.77
1550 (Downstream of Mill Street)	1521.08	1518.28	-2.80	1518.28	-2.80
1526 (Immediately Upstream of Main Street Bridge on Vly Creek)	1520.82	1517.91	-2.91	1517.91	-2.91
1447 (Immediately Downstream of Main Street Bridge on Vly Creek)	1517.67	1515.28	-2.39	1514.32	-3.35
1297 (Near Junk Yard)	1515.24	1513.41	-1.83	1513.05	-2.19
763 (Near School Cottages)	1509.57	1508.22	-1.35	1508.1	-1.47
250 (Near Confluence of Vly Creek and Emory Brook)	1505.93	1506.45	0.52	1506.45	0.52

Modeling demonstrated the following:

- Alternative 4A removes water from Main Street downstream of the Main Street Bridge over Vly Creek in the 100-year storm. It also reduces flooding at buildings along Main Street.
- Alternative 4B, which spans all of the width from Vly Creek to Emory Brook, provides greater benefit near the confluence than Alternative 4A.
- Upstream of the Main Street Bridge on Vly Creek, Alternatives 4A and 4B provide the same reduction in water surface elevation.
- Neither Alternative 4A nor Alternative 4B have any direct impact on the water surface elevations along Emory Brook upstream of Wagner Avenue.

> In Alternative 4A, the 100-year water surface elevation at the school changes from 1515.2 to 1513.4 and the water surface elevation at the motel changes from 1520.8 to 1517.9.

Alternatives 4A and 4B provided sufficient benefit to be analyzed further as parts of combinations and separately in the BCA.



SOURCE(S):

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ALTERNATIVE 4A

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DEPTH MAPPING
VLY CREEK & BUSHKILL ONLY

LOCATION: FLEISCHMANNS, NY

Map By: JCL
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Original: 11/14/2014
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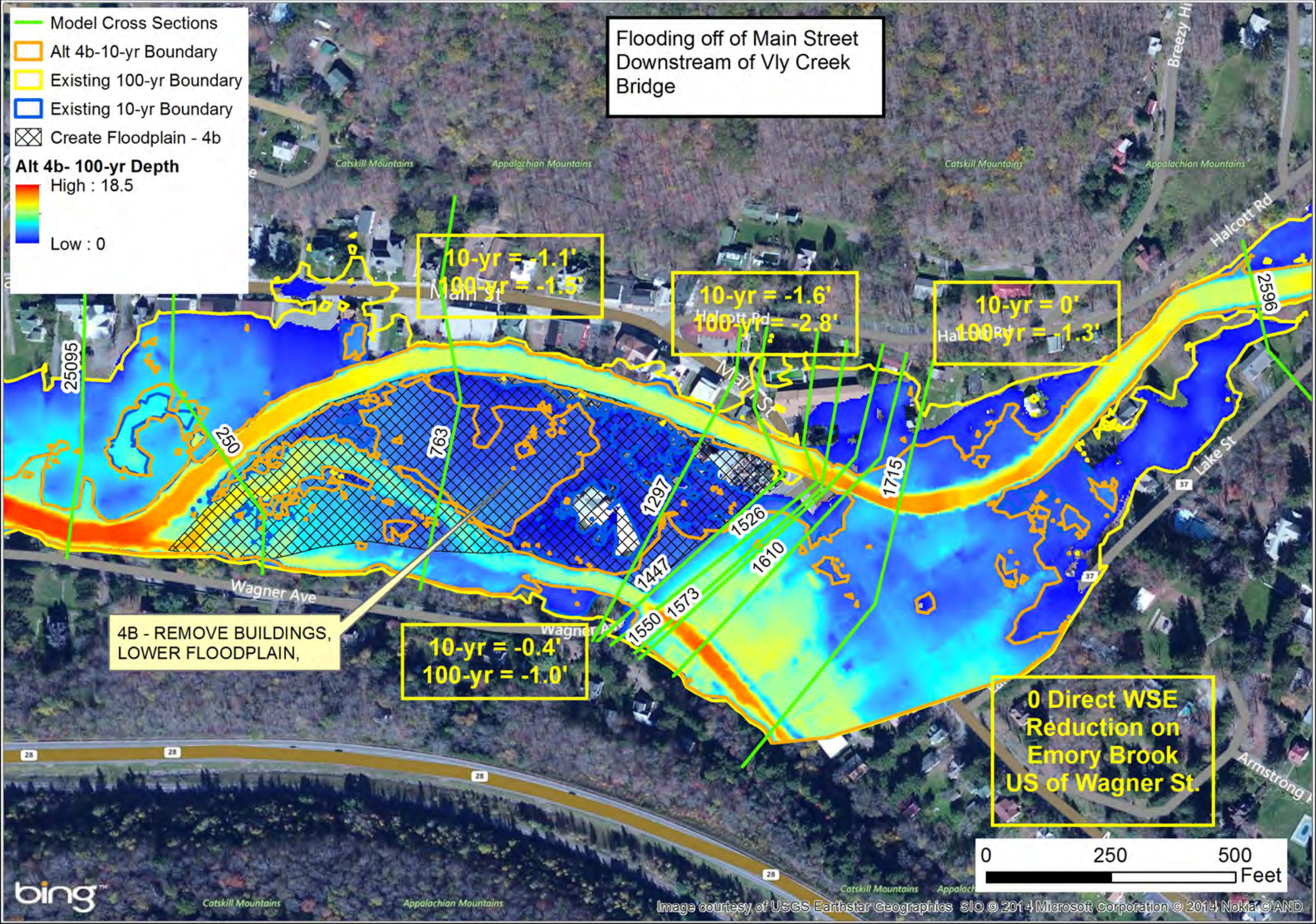

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4.6.3 Alternative # 5 – Bridge Street Area of Bush Kill (STA 24590 Bush Kill to STA 450 Vly Creek)

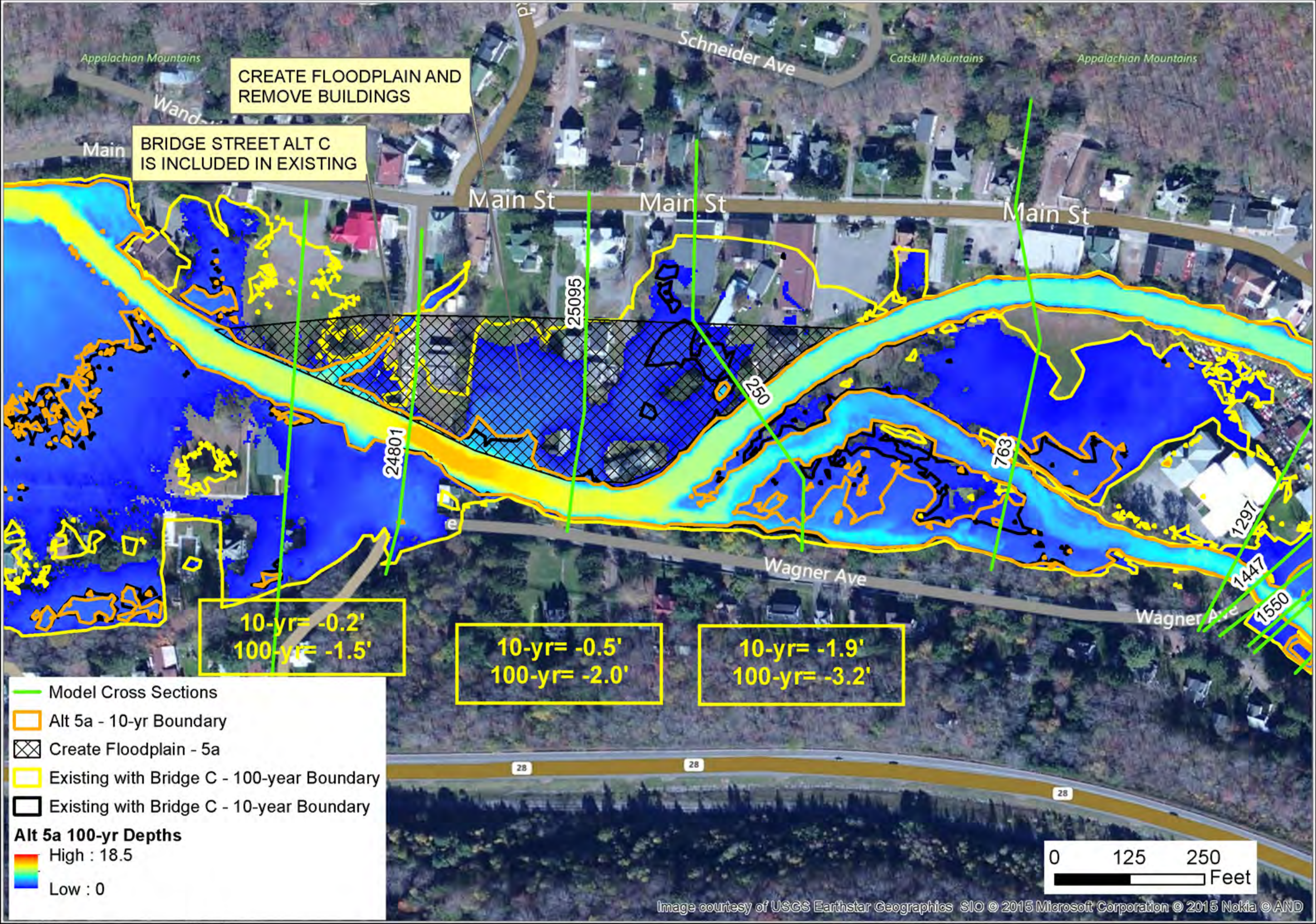
Alternative 5 involves lowering the floodplain on the right bank of Bush Kill in the vicinity of the former Bridge Street Bridge. Specifically, Alternatives 5A and 5B consist of floodplain creation between Main Street and Wagner Avenue near the intersection with Bridge Street. This area is already partly within the SFHA but can be regraded. Alternative 5 focuses on the right bank of Bush Kill rather than looking at floodplain enhancement on the left bank because the grades on the left bank rise too steeply for any meaningful floodplain enhancement to be pursued. Alternatives 5A and 5B assume that pedestrian bridge "C" has already been built and are therefore compared to an existing conditions model that includes pedestrian bridge "C." Two sub-alternatives were modeled:

- Alternative 5A consists of the removal of the buildings at 45 and 46 Bridge Street plus rear buildings along the south side of Main Street to create a continuous, wide floodplain.
- Alternative 5B does not involve the removal of the buildings at 45 and 46 Bridge Street, but does include the removal of rear buildings along the south side of Main Street in order to create a less extensive but wide floodplain.

Figure 4-5 depicts Alternative 5A. Figure 4-6 depicts Alternative 5B. Table 4-4 provides water surface elevations in the Bridge Street area and Table 4-5 provides velocity data.

TABLE 4-4
Comparison of Water Surface Elevations at Bridge Street Area of Bush Kill (100-Year)
[feet NAVD88]

Station	Existing Conditions	Alternative 5A	Net Change Alternative 5A	Alternative 5B	Net Change Alternative 5B
232 (Vly Creek Near Confluence with Emory Brook)	1505.99	1502.8	-3.19	1505.17	-0.82
25095 (Bush Kill Upstream of Bridge Street)	1504.0	1501.98	-2.02	1504.85	0.85
24801 (Immediately Upstream of Former Bridge Street Bridge)	1502.71	1501.53	-1.18	1502.71	0
24590 (Downstream of Former Bridge Street Bridge)	1498.5	1496.97	-1.53	1496.97	-1.53



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DEPTH MAPPING
BUSHKILL AND EMORY BROOK

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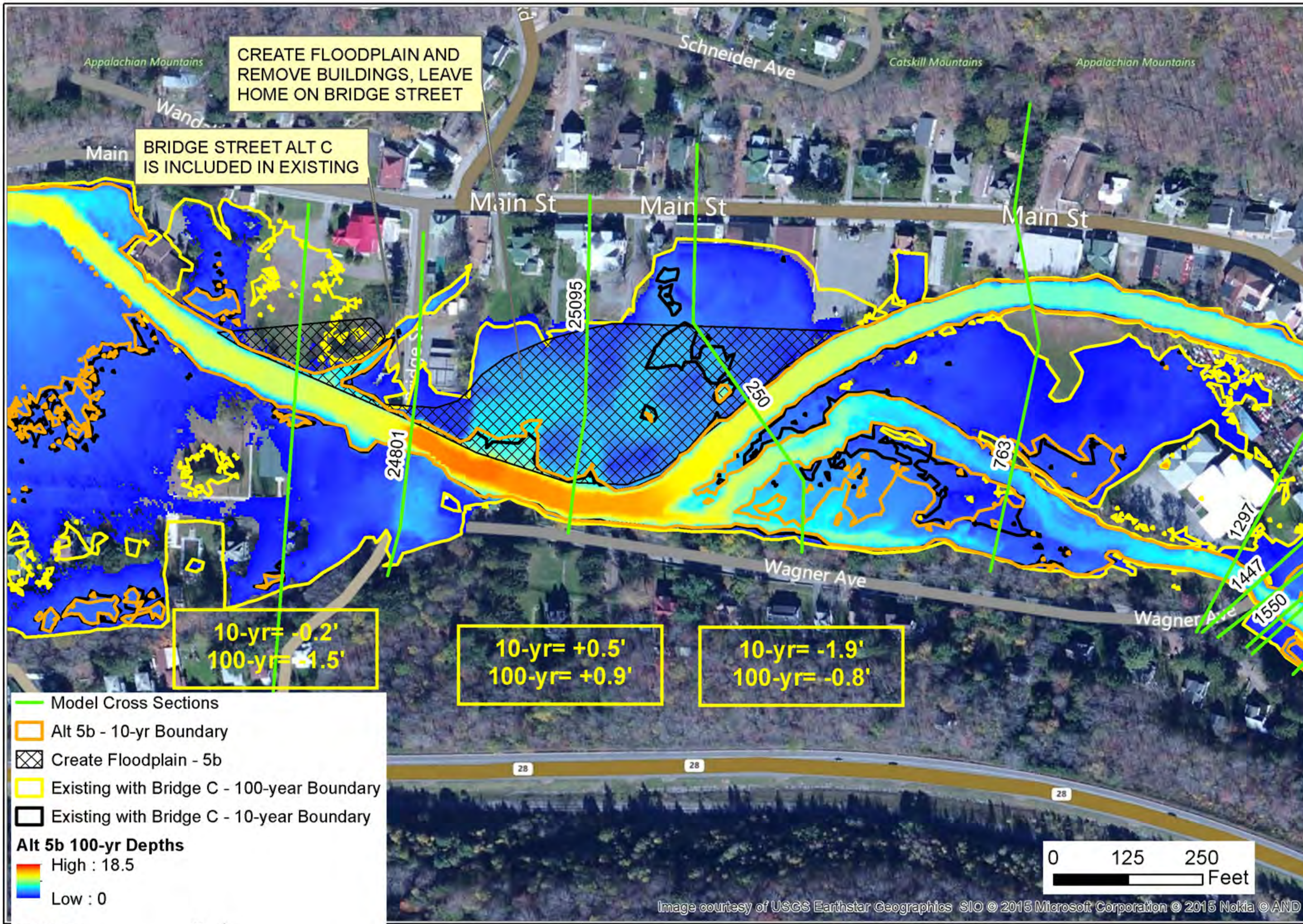

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DEPTH MAPPING
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TABLE 4-5
Comparison of Velocity at
Bridge Street Area of Bush Kill (100-Year)

	Velocity (ft/s)				
Station	**Existing Conditions**	**Alternative 5A**	**Net Change Alternative 5A**	**Alternative 5B**	**Net Change Alternative 5B**
232 (Vly Creek Near Confluence with Emory Brook)	3.02	6.86	3.84	3.56	0.54
25095 (Bush Kill Upstream of Bridge Street)	10.4	7.21	-3.19	4.81	-5.59
24801 (Immediately Upstream of Former Bridge Street Bridge)	10.96	6.82	-4.14	10.96	0
24590 (Downstream of Former Bridge Street Bridge)	12.46	13.58	1.12	13.58	1.12

Upstream of the Bridge Street Bridge in the vicinity of the Valkyrian Motel, the water surface elevation in the 100-year storm is decreased by 2 feet under Alternative 5A.

Modeling demonstrated the following:

- Alternatives 5A and 5B both lower water surface elevations.
- However, the water surface elevation immediately upstream of the former Bridge Street Bridge is not lowered in Alternative 5B.
- Alternative 5A decreases stream velocity on the Bush Kill between Bridge Street and the confluence of Vly Creek and Emory Brook. Stream velocity increases downstream of Bridge Street and on Emory Brook just upstream of the confluence with Vly Creek.
- Alternative 5B decreases stream velocity on the Bush Kill immediately downstream of the confluence of Vly Creek and Emory Brook and increases stream velocity downstream of Bridge Street.

Both Alternatives 5A and 5B provided sufficient benefit to be advanced to the BCA.

4.6.4 Alternative 6 – Middle Area of Bush Kill (STA 20745 Bush Kill to STA 450 Vly Creek)

Alternative 6 involves lowering the floodplain in a variety of configurations, with and without specific buildings removed[3], in the vicinity of Depot Street. This area is already partly within the SFHA but can be regraded. The following sub-alternatives were modeled:

- Alternative 6A consists of the creation of a floodplain between Old Route 28, Depot Street, and Route 28. The alternative includes removal of the Wadler hardware store, the building north of 125 Depot Street, and buildings at 139 Depot Street.
- Alternative 6B includes 6A and extends upstream of Depot Street as well as lowering Depot Street to allow floodwater to pass over the road. The alternative includes removal of the hardware store in addition to buildings at 139 Depot Street, 125 Depot Street, the building north of 125 Depot Street, and 102 Depot Street.
- Alternative 6C is the same as 6A, except the hardware store is not removed.
- Alternative 6D involves the creation of a floodplain upstream of Depot Street and a path across Depot Street to the river. It requires the removal of 125 Depot Street, 102 Depot Street, and the building north of 125 Depot Street. The Wadler property is minimally disturbed in Alternative 6D.
- Alternative 6E is the same as 6B, but the hardware store is not removed.

Table 4-6 provides water surface elevations in the Bridge Street area. Figure 4-7 depicts Alternative 6A. Figure 4-8 depicts Alternative 6B. Figure 4-9 depicts Alternative 6C. Figure 4-10 depicts Alternative 6D. Figure 4-11 depicts Alternative 6E.

[3] Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The descriptions for 6B, 6D, and 6E make reference to these buildings. For the purpose of completeness, this LFA report retains these alternatives.

TABLE 4-6
Comparison of Water Surface Elevations at Bridge Street Area of Bush Kill (100-Year)
[feet NAVD88]

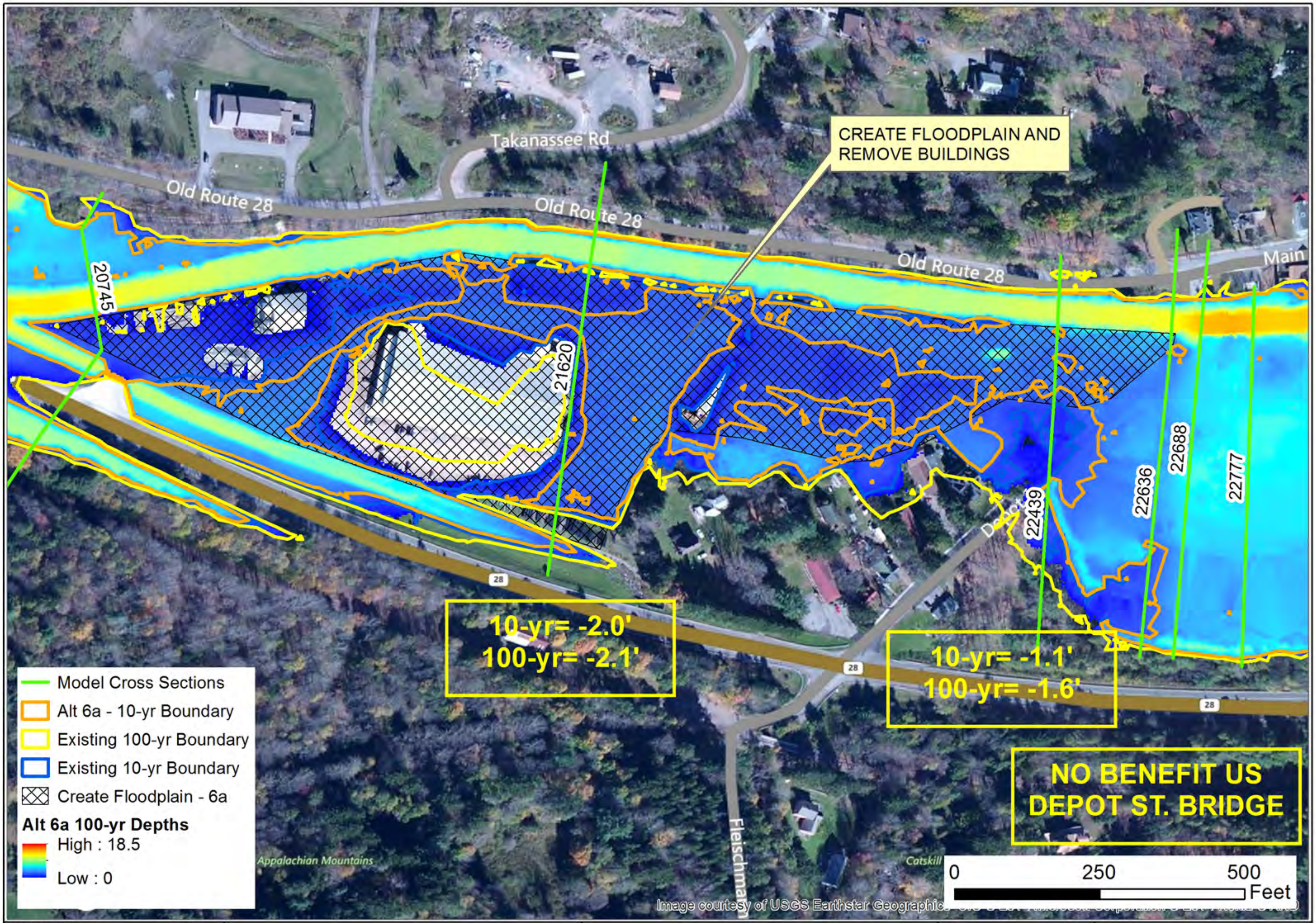
Station	Existing Conditions	Alt 6A	Net Change Alt 6A	Alt 6B	Net Change Alt 6B	Alt 6C	Net Change Alt 6C	Alt 6D	Net Change Alt 6D	Alt 6E	Net Change Alt 6E
23638 (near sports fields)	1491.22	1491.22	0	1491.34	0.12	1491.22	0	1491.36	0.14	1491.34	0.12
23257 (near 590 Main Street)	1488.13	1488.13	0	1487.94	-0.19	1488.13	0	1487.92	-0.21	1487.94	-0.19
22777 (near 102 Depot Street)	1487.24	1487.24	0	1484.22	-3.02	1487.24	0	1484.3	-2.94	1484.21	-3.03
22688 (upstream of Depot Street Bridge)	1486.61	1486.61	0	1483.11	-3.5	1486.61	0	1483.91	-2.7	1483.14	-3.47
22636 (downstream of Depot Street Bridge)	1484.44	1484.44	0	1482.14	-2.3	1484.44	0	1483.73	-0.71	1482.05	-2.39
22439 (near 125 Depot Street)	1483.66	1481.1	-2.56	1481.11	-2.55	1480.78	-2.88	1483.41	-0.25	1480.85	-2.81
22069 (near 139 Depot Street)	1479.81	1477.83	-1.98	1477.83	-1.98	1478.3	-1.51	1479.81	0	1478.3	-1.51
21620 (near hardware store)	1476.8	1474.05	-2.75	1474.05	-2.75	1474.52	-2.28	1476.8	0	1474.52	-2.28
21120 (downstream of hardware store)	1473.57	1472.63	-0.94	1472.63	-0.94	1472.63	-0.94	1473.57	0	1472.63	-0.94
20745 (downstream end of floodplain)	1471.49	1471.27	-0.22	1471.27	-0.22	1471.27	-0.22	1471.49	0	1471.27	-0.22

Modeling demonstrated the following:

- Alternatives 6A and 6C lower water surface elevations downstream of Depot Street on the left floodplain adjacent to the lumber yard. Some buildings on Depot Street may be removed from the 100-year floodplain. However, there are no benefits upstream of the Depot Street Bridge due to low conveyance at the bridge and the grade of the road. This section of the road floods during existing conditions between the 10-year and 2-year storm events.

- Alternatives 6B, 6D and 6E include lowering of the approach of Depot Street to the bridge. Under these alternatives, the road would be lowered an additional 0.5 feet and flooding would occur over a longer section of the road with greater frequency.
- Alternatives 6B, 6D, and 6E generate water surface elevation benefits along the west end of Wagner Avenue.

Alternatives 6A, 6B, 6C, 6D, and 6E provided sufficient benefit to be advanced to the BCA.



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ALTERNATIVE 6A

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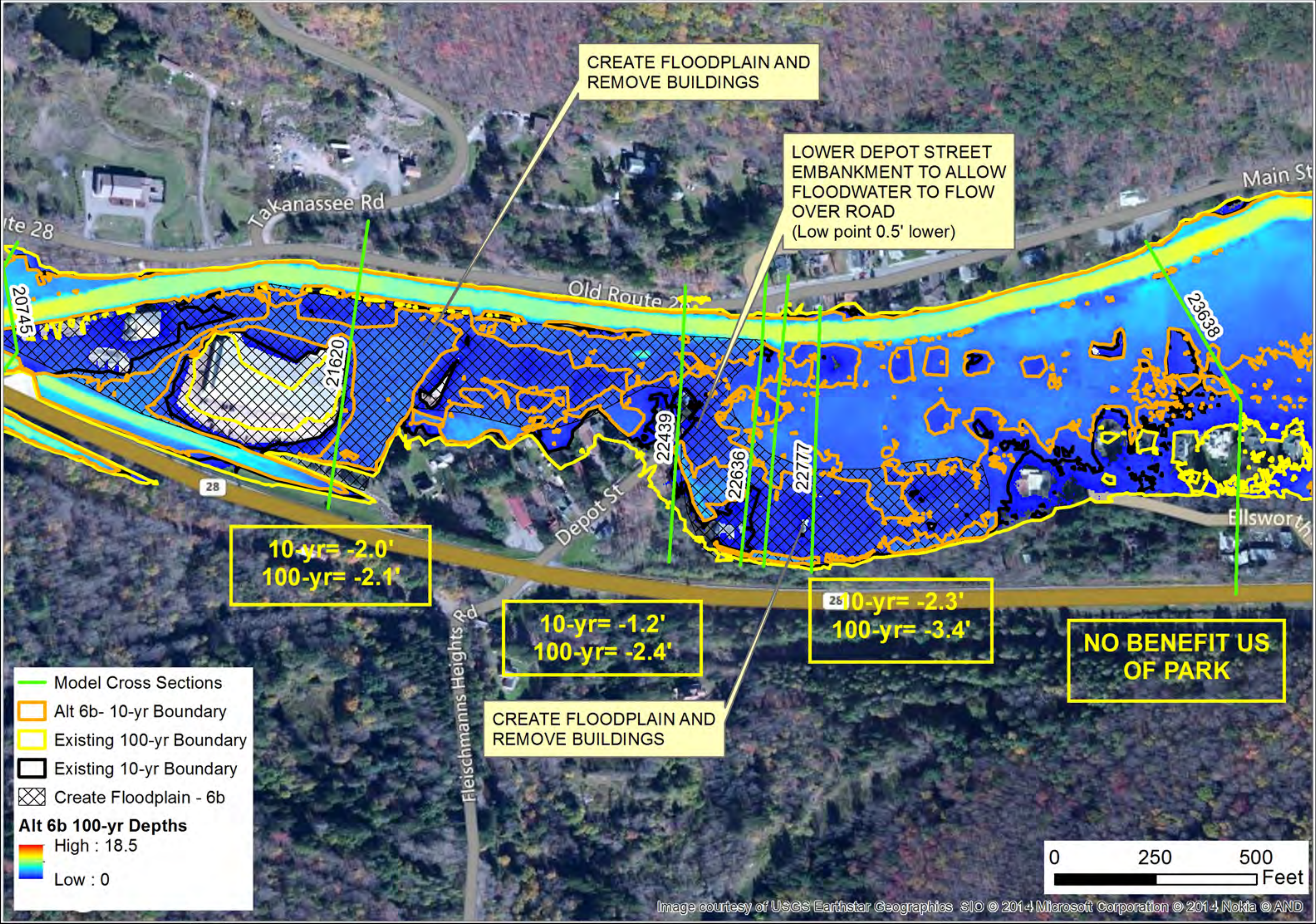

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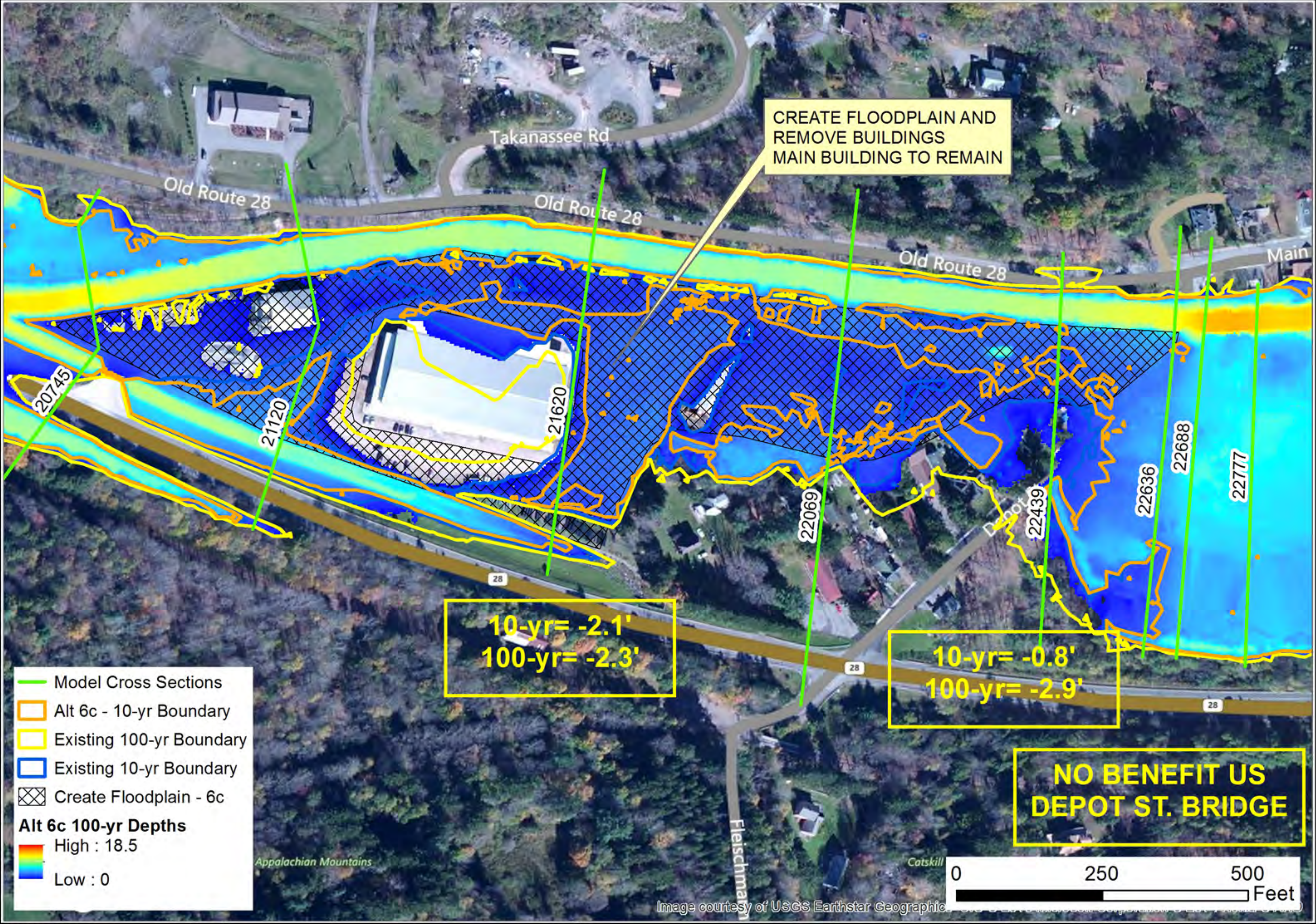

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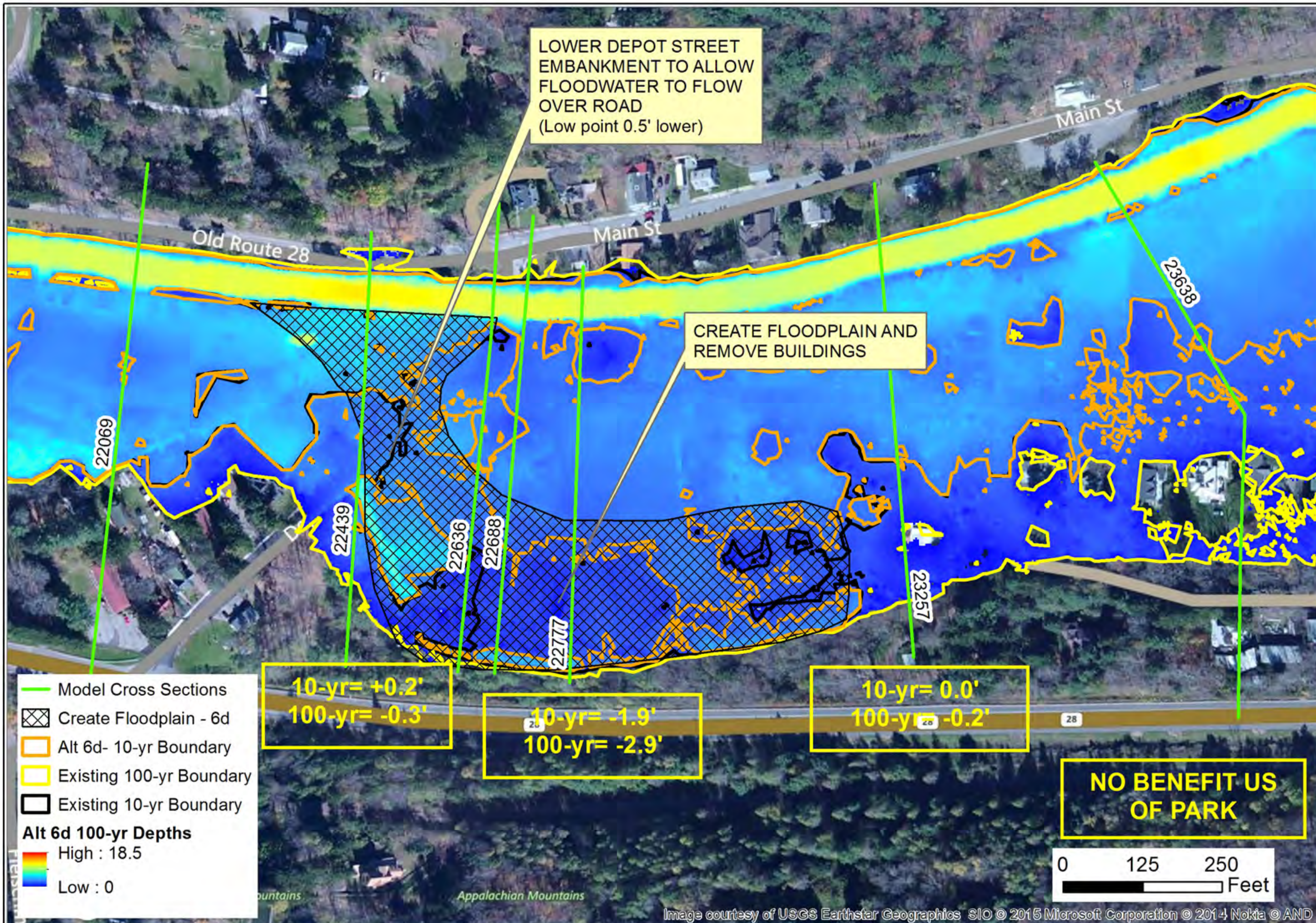

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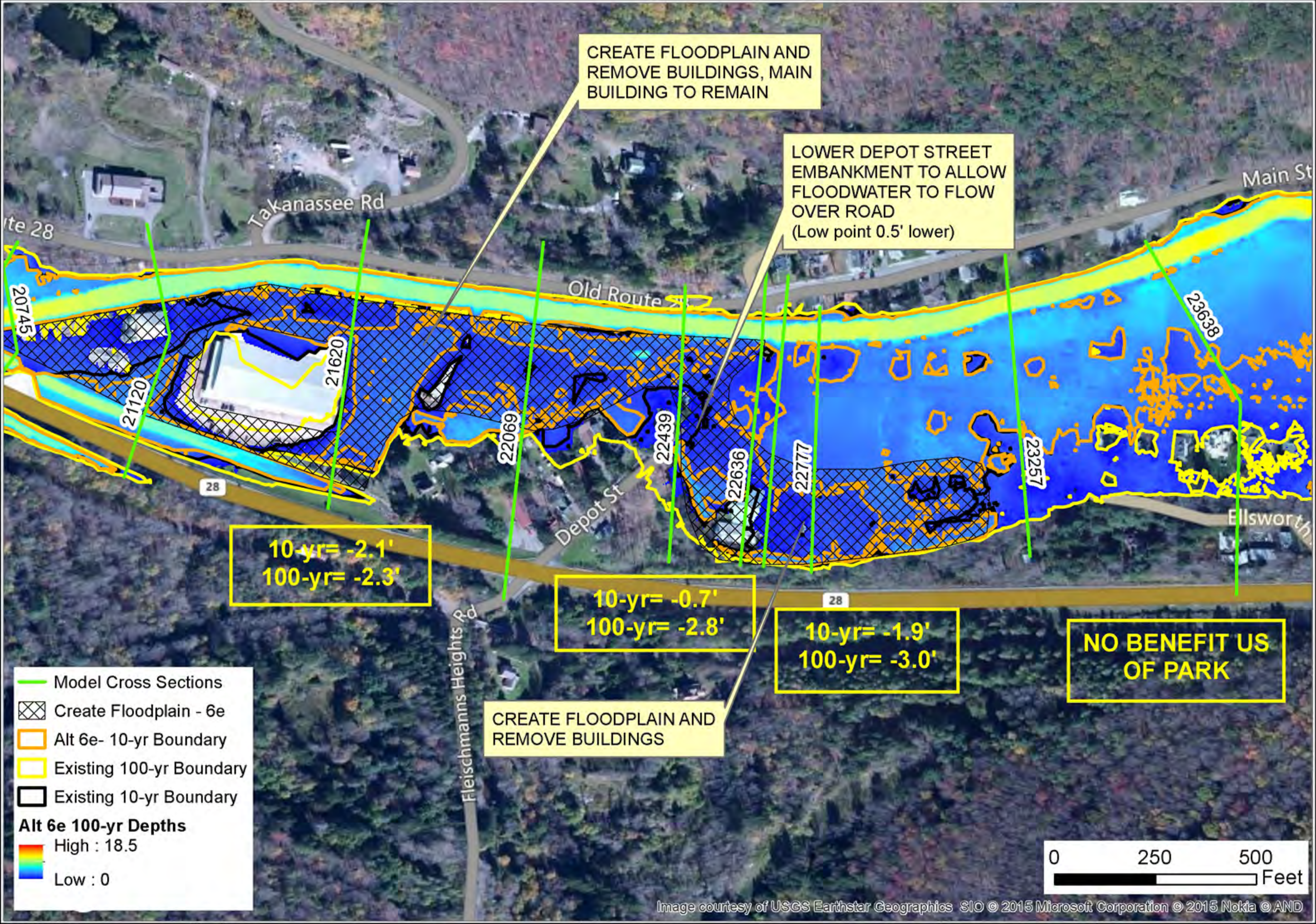


SOURCE(S): BING MMI HECRAS N	ALTERNATIVE 6E MXD: Y:\5197-03\GIS\Maps\April 2015\6E-Depth.mxd	DEPTH MAPPING BUSHKILL ONLY LOCATION: FLEISCHMANNS, NY	Map By: JCL MMI#: 5197-03 Original: 4/6/2015 Revision: Scale: 1 in = 309 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

4.6.5 Alternative # 7 – Downstream Area of Bush Kill (STA 17326 to STA 21120 Bush Kill)

Alternative 7 consists of floodplain creation near the confluence of the Big Red Kill and Bush Kill. The following floodplain options were modeled near the confluence of the Big Red Kill and the Bush Kill:

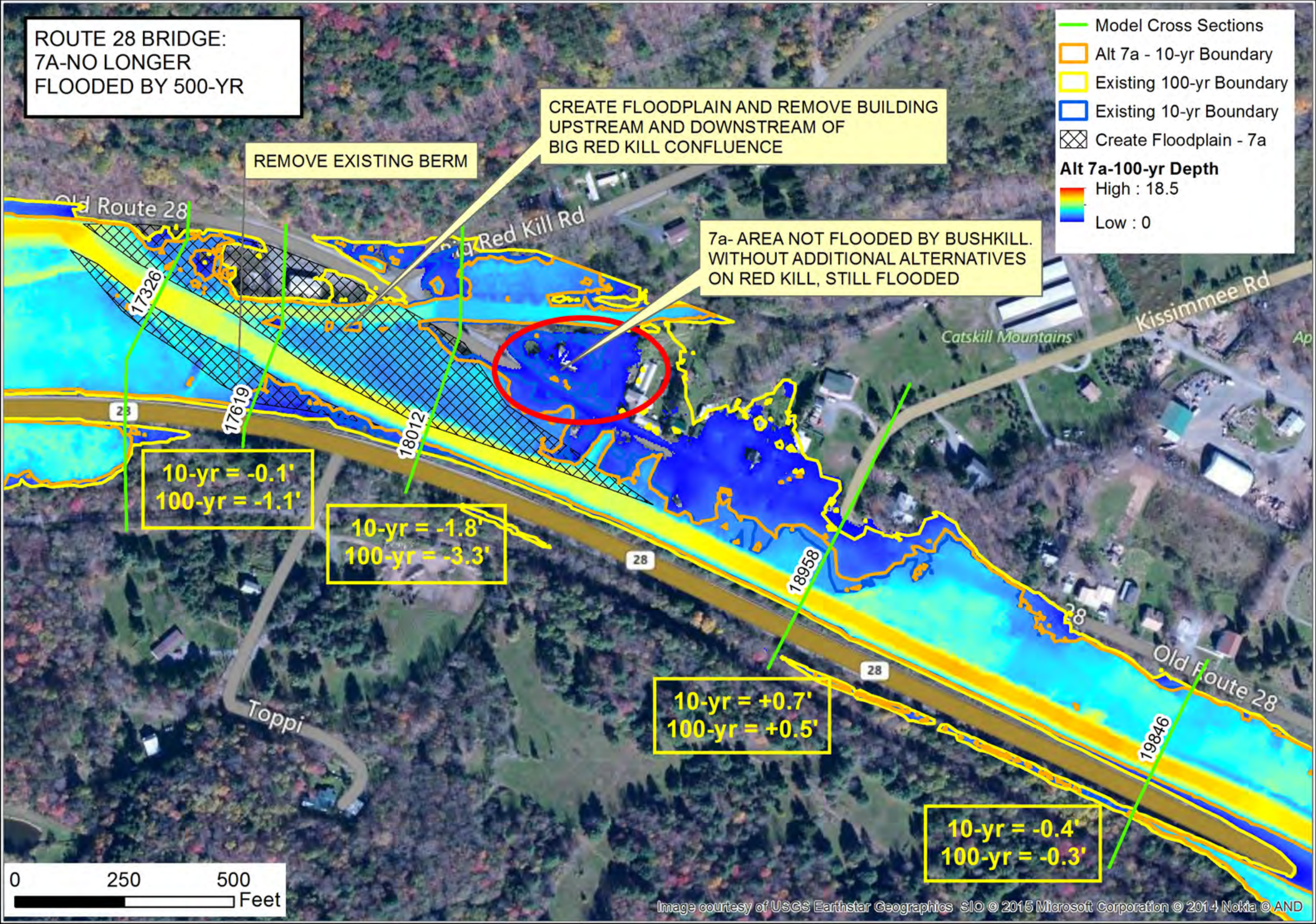
- Alternative 7A includes removal of the existing berm between Route 28 and the Bush Kill. A floodplain would be created near the junction of Big Red Kill Road and Old Route 28. The building at 544 Old Route 28 would be removed.
- Alternative 7B is similar to Alternative 7A, however the floodplain on the northern bank of the Bush Kill extends from 544 Old Route 28 to the area southwest of the cemetery on Old Route 28. Many buildings on the southern side of Old Route 28 would need to be removed to create this elongated floodplain.

Figure 4-12 depicts Alternative 7A. Figure 4-13 depicts Alternative 7B. When reviewing the maps, it is important to note that some of the properties on the north side of Old Route 28 between Bush Kill and Big Red Kill are not flooded by Bush Kill under Alternatives 7A and 7B, but are flooded by Big Red Kill.

Table 4-7 provides water surface elevations in the downstream area of the Bush Kill.

TABLE 4-7
Comparison of Water Surface Elevations in Downstream Area of Bush Kill (100-Year)
[feet NAVD88]

Station	Existing Conditions	Alternative 7A	Net Change Alternative 7A	Alternative 7B	Net Change Alternative 7B
21120 (downstream of hardware store)	1473.57	1473.59	0.02	1472.53	-1.04
20745 (near bend in Bush Kill)	1471.49	1471.58	0.09	1470.34	-1.15
19846 (near 985 Old Route 28)	1466.91	1466.59	-0.32	1465.04	-1.87
18958 (near Kissimmee Road)	1460.72	1461.19	0.47	1460.89	0.17
18012 (near junction of Big Red Kill Road and Old Route 28)	1457.34	1454.09	-3.25	1454.09	-3.25
17619 (near confluence of Big Red Kill and Bush Kill)	1453.29	1452.15	-1.14	1452.15	-1.14
17326 (downstream of confluence of Big Red Kill and Bush Kill)	1451.16	1451.15	-0.01	1451.15	-0.01



SOURCE(S):

BING
MMI HECRAS

N

ALTERNATIVE 7A

MXD: Y:\5197-03\GIS\Maps\Feb 2015 Meeting\7A-Depth.mxd

DEPTH MAPPING
BUSHKILL ONLY

LOCATION: FLEISCHMANNS, NY

Map By: JCL
MMI#: 5197-03
Original: 1/30/2015
Revision:
Scale: 1 in = 285 ft

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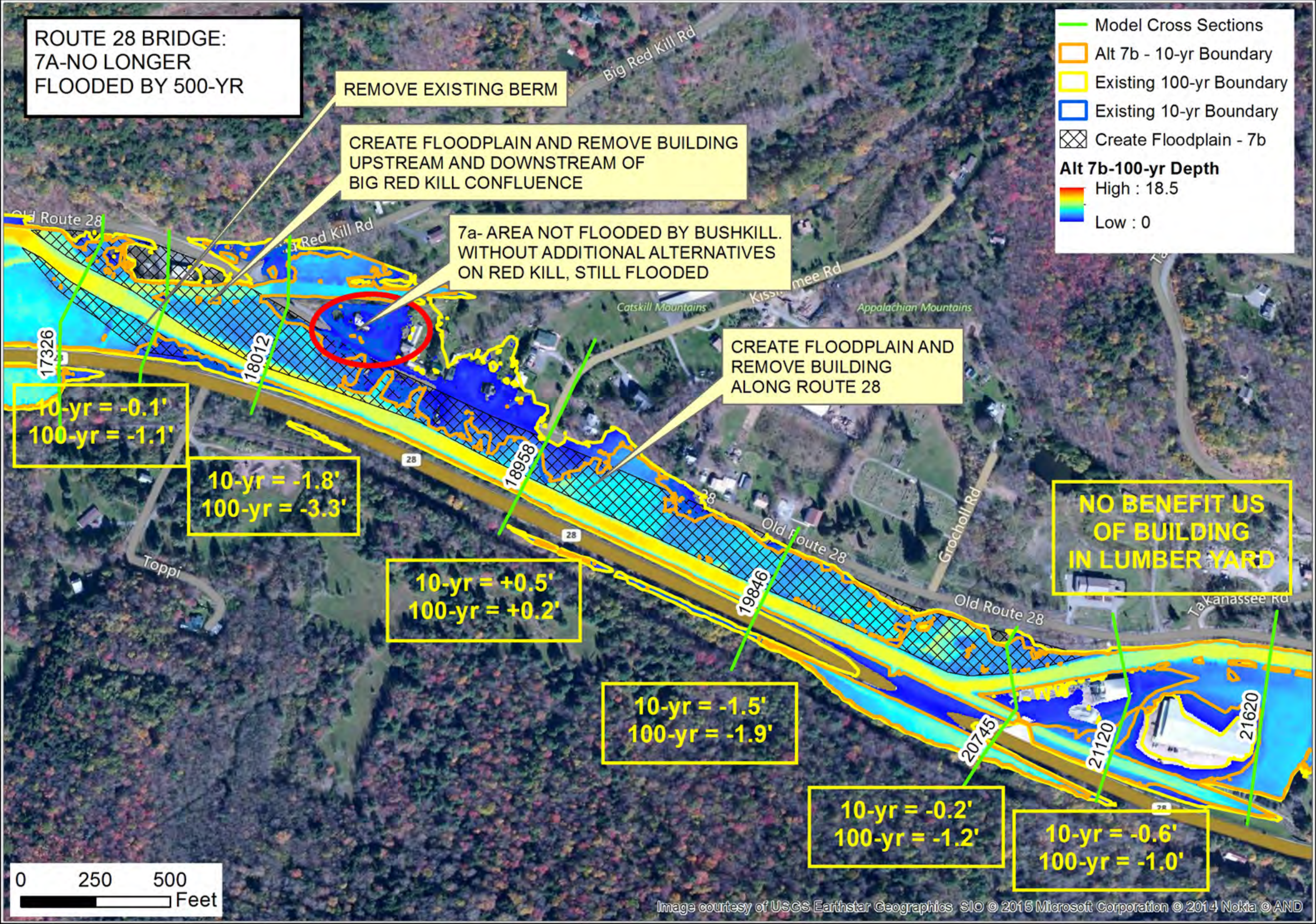

SOURCE(S):
BING
MMI HECRAS

N

ALTERNATIVE 7B

MXD: Y:\5197-03\GIS\Maps\Feb 2015 Meeting\7B-Depth.mxd

DEPTH MAPPING
BUSHKILL ONLY

LOCATION: FLEISCHMANNS, NY

Map By: JCL
MMI#: 5197-03
Original: 1/30/2015
Revision:
Scale: 1 in = 417 ft

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Modeling demonstrated the following:

- Alternative 7A reduced water surface elevations along Old Route 28 and at the confluence of the Big Red Kill. The alternative prevents the Bush Kill from flooding across Route 28 in the 100-year storm. Alternative 7A also reduces the backwater on Big Red Kill and reduces flooding at the Route 28 Bridge in the 500 year flood.
- Alternative 7B reduced water surface elevations upstream to the hardware store, however the improvements were not substantially better than Alternative 7A.

Alternatives 7A and 7B provided sufficient benefits to be advanced to the BCA.

4.6.6 Alternative #8 – Vly Creek at Mill Street (STA 1526 to STA 2596 Vly Creek)

Alternative 8 consists of floodplain creation on the right bank of Vly Creek near Mill Street. Buildings have already been removed from this area and some floodplain enhancement has already been conducted in the years following Tropical Storm Irene, but this alternative envisions additional grading. The following floodplain options near Mill Street were modeled:

- Alternative 8A consists of a larger enhancement of the floodplain upstream of Mill Street.
- Alternative 8B includes rerouting of Mill Street, removal of the Mill Street Bridge (Alternative 1C), and the creation of a somewhat longer floodplain extending to Main Street.

Figure 4-14 depicts the locations of Alternative 8A and Alternative 8B. Figure 4-15 depicts the depth grid for Alternative 8B. Table 4-8 provides water surface elevations near Mill Street.

TABLE 4-8
Comparison of Water Surface Elevations on Vly Creek near Mill Street (100-Year)
[feet NAVD88]

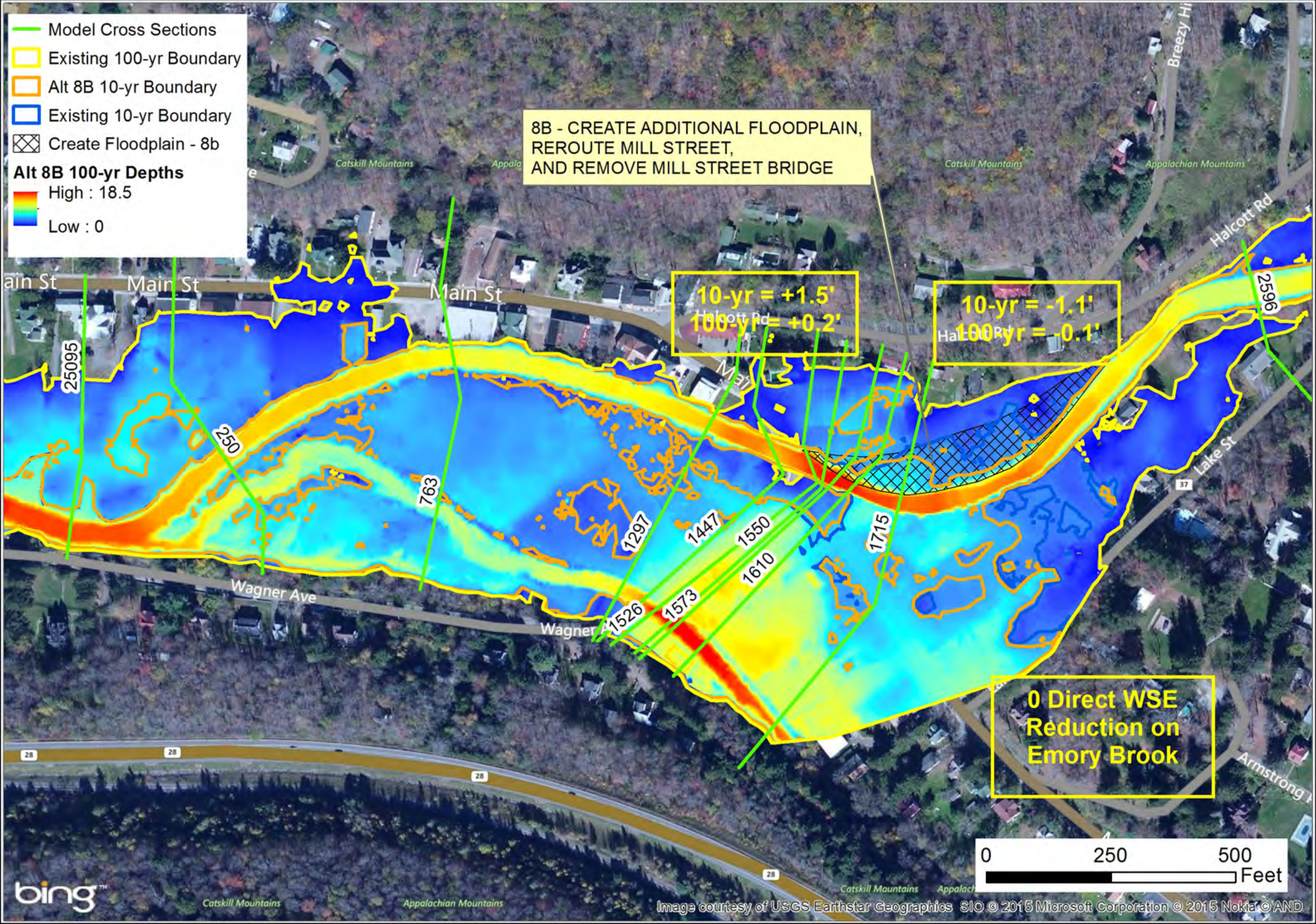
Station	Existing Conditions	Alternative 8A	Net Change Alternative 8A	Alternative 8B	Net Change Alternative 8B
1715 (upstream of Mill Street Bridge)	1521.64	1521.7	0.06	1521.52	-0.12
1610 (immediately upstream of Mill Street Bridge)	1521.44	1521.58	0.14	1521.41	-0.03
1573 (immediately downstream of Mill Street Bridge)	1521.15	1521.15	0	1521.35	0.2
1550 (between Mill Street and Main Street)	1521.08	1521.08	0	1521.19	0.11

Modeling demonstrated the following:

- Alternative 8A alone is not beneficial because the Mill Street Bridge creates a backwater condition upstream.
- Alternative 8B slightly decreases water surface elevations upstream of Mill Street Bridge and reduces water velocities. Water surface elevations increase slightly downstream of Mill Street. This alternative provides little benefit on its own except in the immediate vicinity.

Without any means to generate benefits in the BCA (i.e., no buildings impacted), Alternatives 8A and 8B were not advanced to BCA. In the long term, Alternative 8 should be pursued in combination with other alternatives. These combinations are discussed in Section 4.7.

SOURCE(S): BING MMI HECRAS	ALTERNATIVES 8 A & B	ALTERNATIVE LOCATION	Map By: JCL MMI#: 5197-03 Original: 1/28/2016 Revision: Scale: 1 in = 83 ft	MILONE & MACBROOM 99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com
	MXD: Y:\5197-03\GIS\Maps\OCT ALTS\Bushkill-8A-B-FP.mxd	LOCATION: FLEISCHMANNS, NY		



SOURCE(S):

BING
MMI HECRAS

N

ALTERNATIVE 8B

MXD: Y:\5197-03\GIS\Maps\April 2015\8B-DEPTH.mxd

DEPTH MAPPING
VLY CREEK & BUSHKILL ONLY

LOCATION: FLEISCHMANNS, NY

Map By: JCL
MMI#: 5197-03
Original: 5/7/2015
Revision:
Scale: 1 in = 250 ft

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4.6.7 Alternative 9 – Emory Brook at Wagner Avenue (STA 1526 to STA 2596 on Vly Creek)

Alternative 9 consists of removal of a berm along the right bank of Emory Brook, removal of buildings set back from Main Street, and lowering of the floodplain along Emory Brook. Similar actions were not considered along the left bank of Emory Brook due to the steep rise from the stream to the south. Alternative 9 alone was found to be ineffective due to backwater from the Wagner Avenue Bridge. Alternative 9 was considered in combination with other alternatives and is discussed further in Section 4.7.2.

4.6.8 Alternative 10 – Floodplain near Park off Wagner Avenue (STA 23257 to STA 23638 on Bush Kill)

Alternative 10 consists of the creation of a limited narrow floodplain bench near the park on Wagner Avenue. Several outbuildings would need to be removed from the rear yards of the homes on the north side of Wagner Avenue in order to create the floodplain.

Figure 4-16 depicts Alternative 10A. Table 4-9 provides water surface elevations near the park on Wagner Avenue. Table 4-10 provides velocity data.

TABLE 4-9
Comparison of Water Surface Elevations for Floodplain near Park (100-Year)
[feet NAVD88]

Station	Existing Conditions	Alternative 10A	Net Change
23638 (near park on Wagner Avenue)	1491.22	1490.8	-0.42
23257 (downstream of park)	1488.13	1488.29	0.16

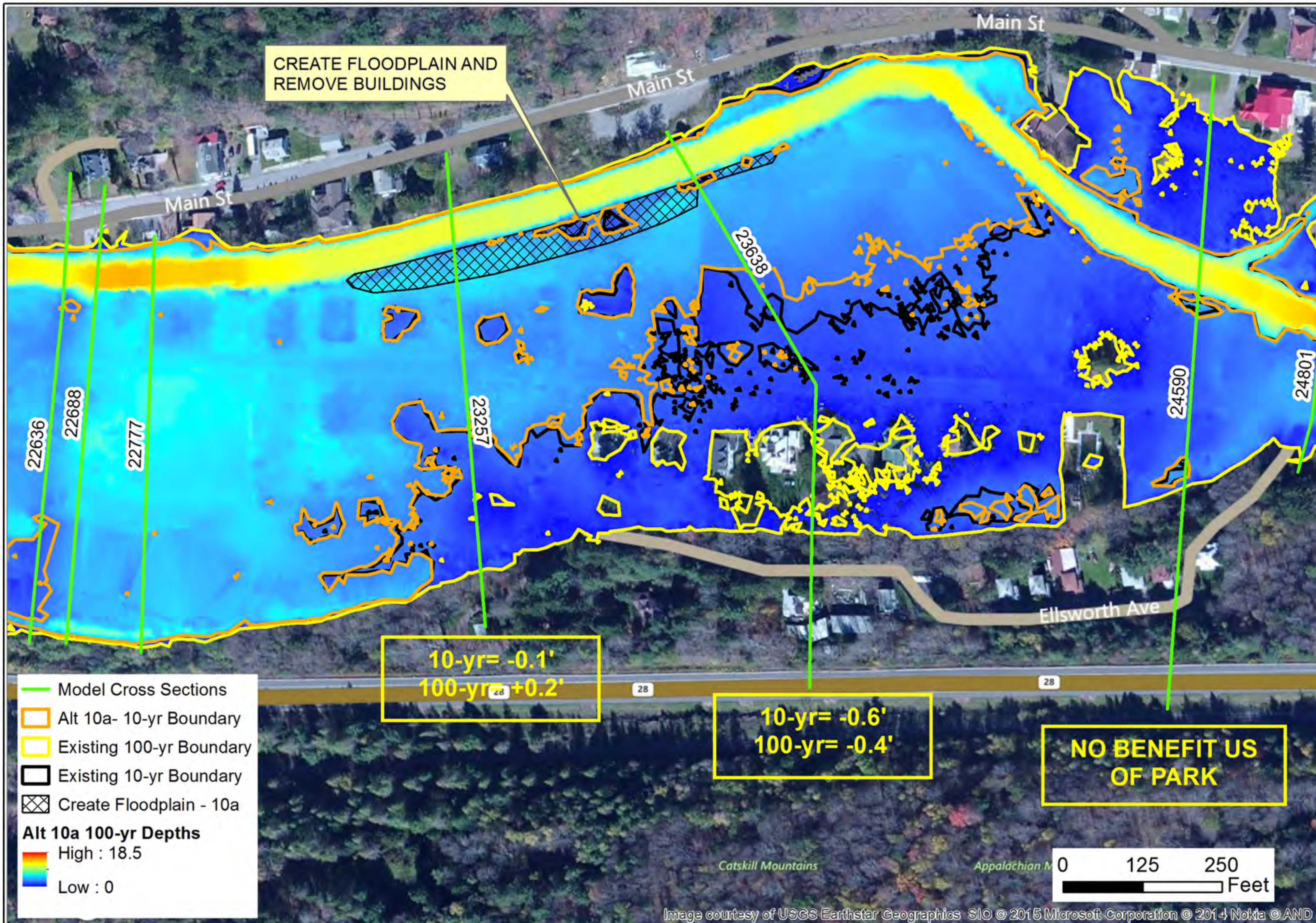
TABLE 4-10
Velocity for Floodplain near Park (100-Year)

	Velocity (ft/s)		
Station	**Existing Conditions**	**Alternative 10A**	**Net Change**
23638 (near park on Wagner Avenue)	10.81	11.66	0.85
23257 (downstream of park)	12.38	10.87	-1.51

Modeling demonstrated the following:

- Alternative 10A reduced the water surface elevation at a few homes on Wagner Avenue. There was not benefit upstream of the park whatsoever.
- Compared to existing conditions, Alternative 10A slightly increased velocity near the park on Wagner Avenue and slightly decreased the velocity downstream of the park in back of the homes.

This alternative provided sufficient benefits to be analyzed in the BCA.



SOURCE(S): BING MMI HECRAS	ALTERNATIVE 10A	DEPTH MAPPING BUSHKILL ONLY	Map By: JCL	MILONE & MACBROOM
	MXD: Y:\5197-03\GIS\Maps\Feb 2015 Meeting\10A-Depth.mxd	LOCATION: FLEISCHMANNS, NY	MMI#: 5197-03; Original: 1/30/2015; Revision: ; Scale: 1 in = 197 ft	99 Realty Drive Cheshire, CT 06410 (203) 271-1773 Fax: (203) 272-9733 www.miloneandmacbroom.com

4.7 Combinations of Hydraulic Alternatives

Alternatives were combined to determine the cumulative benefits of multiple actions. The individual alternatives described above were vetted through multiple public meetings including meetings listed in Table 1-2. In most cases, combinations were tested mainly due to the prior finding that individual components were not effective on their own (i.e., Alternative 9 without Alternative 1B). The following combinations of alternatives were modeled.

4.7.1 8B Combination (8B + 1C + 1D + 4A)

This alternative includes creation of a floodplain near Mill Street (8B), rerouting Mill Street, removing the Mill Street Bridge (1C), replacing the Main Street Bridge over Vly Creek (1D), and creating a lower floodplain near the school on Wagner Avenue (4A). Of the four components, Alternative 4A was previously described at length and found to cause extensive flood reduction benefits whereas 8B creates only localized benefits that do not extent to any buildings. Alternatives 1C and 1D are necessary to allow the hydraulic connectivity upstream and downstream of Main Street.

Figure 4-17 depicts Alternative 8B+1C+1D+4A. Table 4-11 provides water surface elevations near Mill Street and Wagner Avenue. Table 4-12 provides velocity information.

TABLE 4-11
Comparison of Water Surface Elevations for Combination 8B+1C+1D+4A (100-Year)
[feet NAVD88]

Station	Existing Conditions	8B Combo (8B+1C+1D+4A)	Net Change
1715 (upstream of Mill Street Bridge)	1521.64	1519.16	-2.48
1610 (immediately upstream of Mill Street Bridge)	1521.44	1518.97	-2.47
1573 (immediately downstream of Mill Street Bridge)	1521.15	1517.45	-3.7
1550 (between Mill Street and Main Street)	1521.08	1517.78	-3.3
1526 (immediately upstream of Main Street Bridge over Vly Creek)	1520.82	1517.13	-3.69
1447 (immediately downstream of Main Street Bridge over Vly Creek)	1517.67	1515.23	-2.44
1297 (near junkyard)	1515.24	1513.41	-1.83

Station	Existing Conditions	8B Combo (8B+1C+1D+4A)	Net Change
763 (near school on Wagner Avenue)	1509.57	1508.22	-1.35
250 (immediately upstream of confluence of Vly Creek and Emory Brook)	1505.93	1506.45	0.52

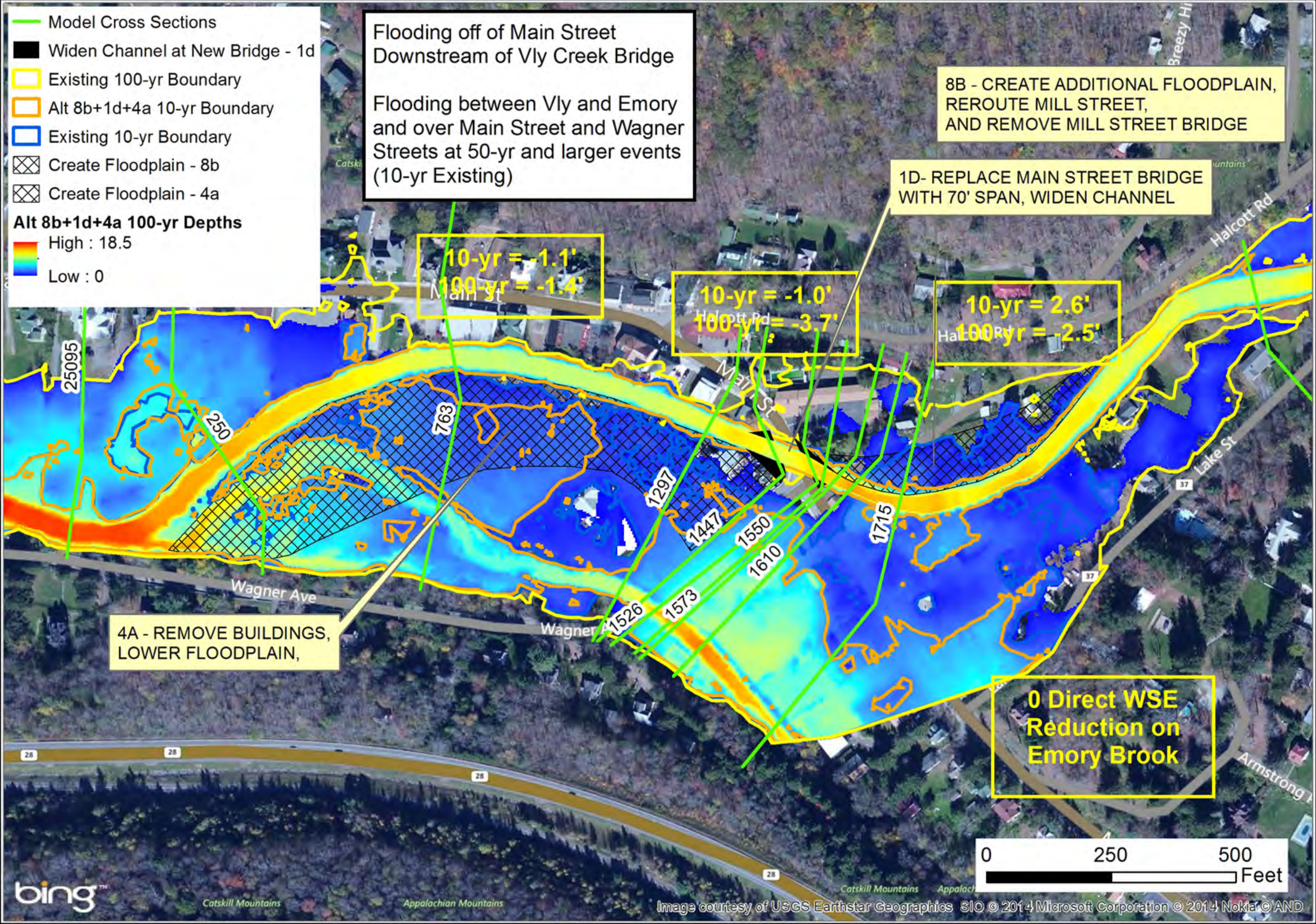
TABLE 4-12
Velocity for Combination 8B+1C+1D+4A (100-Year)

	Velocity (ft/s)		
Station	**Existing Conditions**	**8B Combo (8B+1C+1D+4A)**	**Net Change**
1715 (upstream of Mill Street Bridge)	6.36	9.21	2.85
1610 (immediately upstream of Mill Street Bridge)	6.44	8.02	1.58
1573 (immediately downstream of Mill Street Bridge)	7.25	11.62	4.37
1550 (between Mill Street and Main Street)	7.55	10.41	2.86
1526 (immediately upstream of Main Street Bridge over Vly Creek)	7.77	11.2	3.43
1447 (immediately downstream of Main Street Bridge over Vly Creek)	13.97	8.73	-5.24
1297 (near junkyard)	14.54	11.52	-3.02
763 (near school on Wagner Avenue)	12.12	11.93	-0.19
250 (immediately upstream of confluence of Vly Creek and Emory Brook)	10.2	5.8	-4.4

Modeling demonstrated the following:

> The 8B Combination reduces water surface elevations upstream of Main Street in the general vicinity of Wagner Avenue which would help reduce the frequency of floodwaters spilling southward toward Emory Brook.

- This combination brings flooding off of Main Street downstream of the Main Street Bridge over Vly Creek.
- The existing conditions model shows flooding between Vly Creek and Emory Brook and over Main Street and Wagner Avenue for the 10-year flood, whereas the 8B+1C+1D+4A combination shows flooding in this area in the 50-year flood and higher.
- Compared to existing conditions, velocity increased upstream of Main Street and generally decreased downstream of Main Street.



SOURCE(S):

BING
MMI HECRAS

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ALTERNATIVE 8B + 1D + 4A

MXD: Y:\5197-03\GIS\Maps\NOV ALTS\8b+1d+4a-DEPTH.mxd

DEPTH MAPPING
VLY CREEK & BUSHKILL ONLY

LOCATION: FLEISCHMANNS, NY

Map By: JCL
MMI#: 5197-03
Original: 11/17/2014
Revision:
Scale: 1 in = 250 ft

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4.7.2 9A Combination (9A + 1B + 4B)

This alternative consists of lowering the floodplain near the school on Wagner Avenue (4B), replacing the Wagner Avenue Bridge over Vly Creek (1B), and creating a floodplain on the right bank of Emory Brook upstream of the Wagner Avenue bridge (9A). Of the three components, Alternative 4B was previously described at length and found to cause extensive flood reduction benefits whereas 9A could not create benefits due to the backwater from the Wagner Avenue Bridge. Alternatives 1B is necessary to allow the hydraulic connectivity upstream and downstream of Wagner Avenue, connecting the floodplains tested for 4B and 9A.

Figure 4-18 depicts Alternative 9A+1B+4B. Table 4-13 provides water surface elevations near Wagner Avenue and Main Street. Table 4-14 provides velocity for this alternative.

TABLE 4-13
Comparison of Water Surface Elevations for Combination 9A+1B+4B (100-Year)
[feet NAVD88]

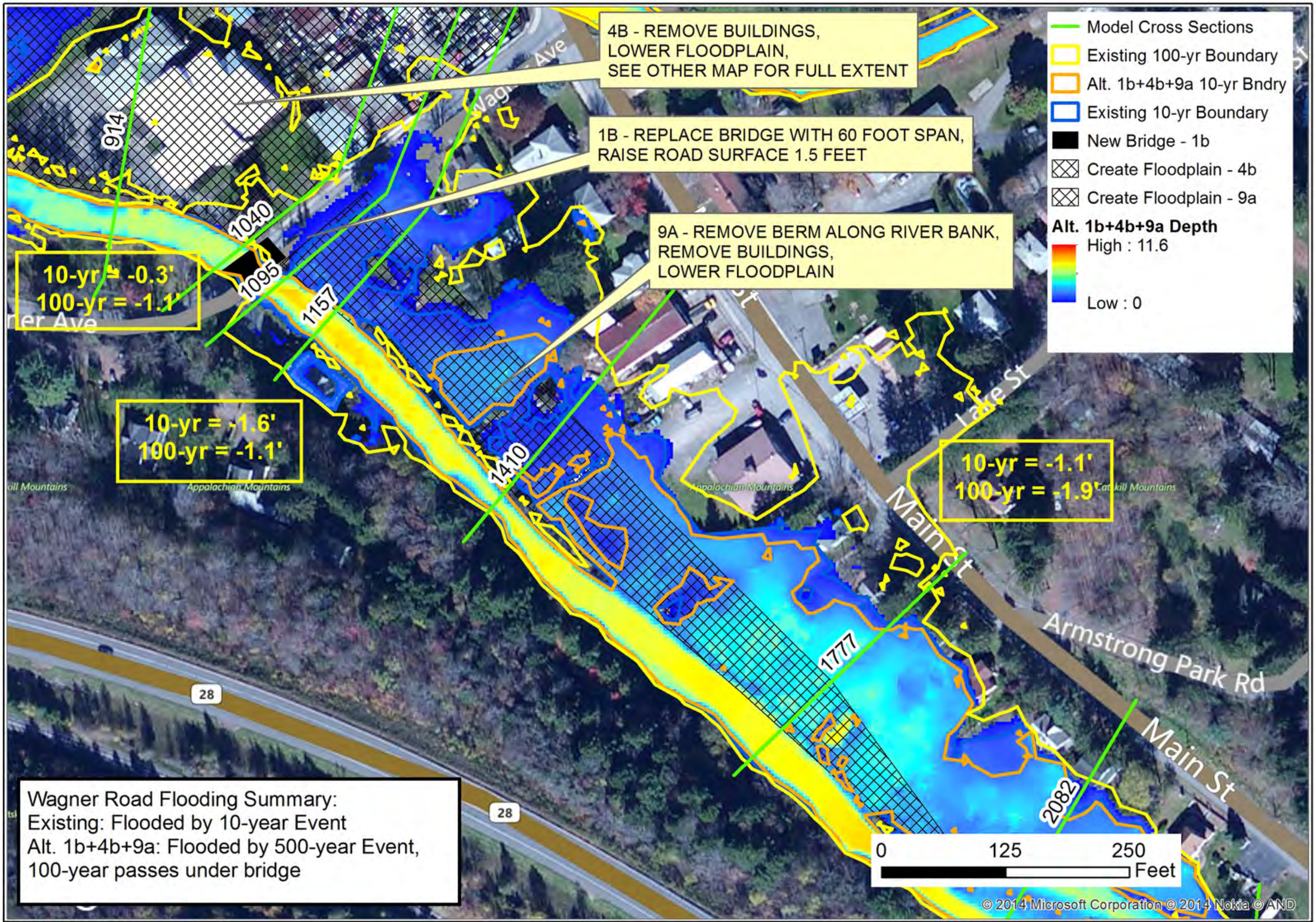
Station	Existing Conditions	Alternative 9A+1B+4B	Net Change
2735 (near intersection of Main Street and Brush Ridge Road)	1531.22	1531.1	-0.12
2343 (near 1398 Main Street)	1525.48	1525.81	0.33
2082 (near 1374 Main Street)	1523	1521.83	-1.17
1777 (near 1336 Main Street)	1520.8	1518.89	-1.91
1410 (near 1260 Main Street)	1516.07	1514.16	-1.91
1157 (upstream of Wagner Avenue Bridge)	1513.6	1512.55	-1.05
1095 (immediately upstream of Wagner Avenue Bridge)	1513.69	1512.53	-1.16
1040 (immediately downstream of Wagner Avenue Bridge)	1512	1510.89	-1.11
914 (near school on Wagner Avenue)	1510.65	1509.57	-1.08
610 (near the cottages behind the school on Wagner Avenue)	1506.85	1506.88	0.03
232 (upstream Emory Brook and Vly Creek Confluence)	1506.6	1506.59	-0.01

TABLE 4-14
Velocity for Combination 9A+1B+4B (100-Year)

	Velocity (ft/s)		
Station	**Existing Conditions**	**Alternative 9A+1B+4B**	**Net Change**
2735 (near intersection of Main Street and Brush Ridge Road)	6.07	6.27	0.2
2343 (near 1398 Main Street)	12.84	11.78	-1.06
2082 (near 1374 Main Street)	7.32	10.33	3.01
1777 (near 1336 Main Street)	8.75	8.46	-0.29
1410 (near 1260 Main Street)	12.31	10.05	-2.26
1157 (upstream of Wagner Avenue Bridge)	11.05	5.37	-5.68
1095 (immediately upstream of Wagner Avenue Bridge)	8.28	3.86	-4.42
1040 (immediately downstream of Wagner Avenue Bridge)	10.83	8.53	-2.3
914 (near school on Wagner Avenue)	10.83	9.35	-1.48
610 (near the cottages behind the school on Wagner Avenue)	10.45	7.1	-3.35
232 (upstream Emory Brook and Vly Creek Confluence)	2.71	3.18	0.47

Modeling demonstrated the following:

- In the existing conditions model, Wagner Road is flooded by the 10-year event.
- In combination 9A+1B+4B, the 100-year flood passes under the bridge, but the 500-year event causes flooding.
- The depth grid mapping in Figure 4-18 is based on the Emory Brook model. The depth grid shows that the water surface elevation at the Citgo station changes from 1520.8 to 1518.9 and the property appears to shift out of the flooded area, although flooding from Vly Creek may still affect the property.
- Velocity generally decrease in Combination 9A+1B+4B when compared to existing conditions.



SOURCE(S):
BING
MMI HECRAS

N

ALTERNATIVE 1B + 4B + 9A

MXD: Y:\5197-03\GIS\Maps\NOV ALTS\Emory-1b-4b-9a-Depth.mxd

DEPTH MAPPING
EMORY BROOK ONLY

LOCATION: FLEISCHMANNS, NY

Map By:	JCL
MMI#:	5197-03
Original:	11/14/2014
Revision:	
Scale:	1 in = 125 ft

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4.7.3 Big Red Kill Combination with Alternative 7A

This combination includes creation of the 7A floodplain at the confluence of the Big Red Kill and the Bush Kill as well as replacement of the Route 28 Bridge, berm removal on the right bank of the Big Red Kill and floodplain creation on the left bank of the Big Red Kill. The genesis of this combination was the realization that Alternative 7A would reduce flooding on the south side of Old Route 28, but not the north side of the road toward Big Red Kill.

Figure 4-19 depicts Big Red Kill Combination with Alternative 7A. Table 4-15 provides water surface elevations along Big Red Kill and Old Route 28.

TABLE 4-15
Comparison of Water Surface Elevations for Big Red Kill Combination 2 (100-Year)
[feet NAVD88]

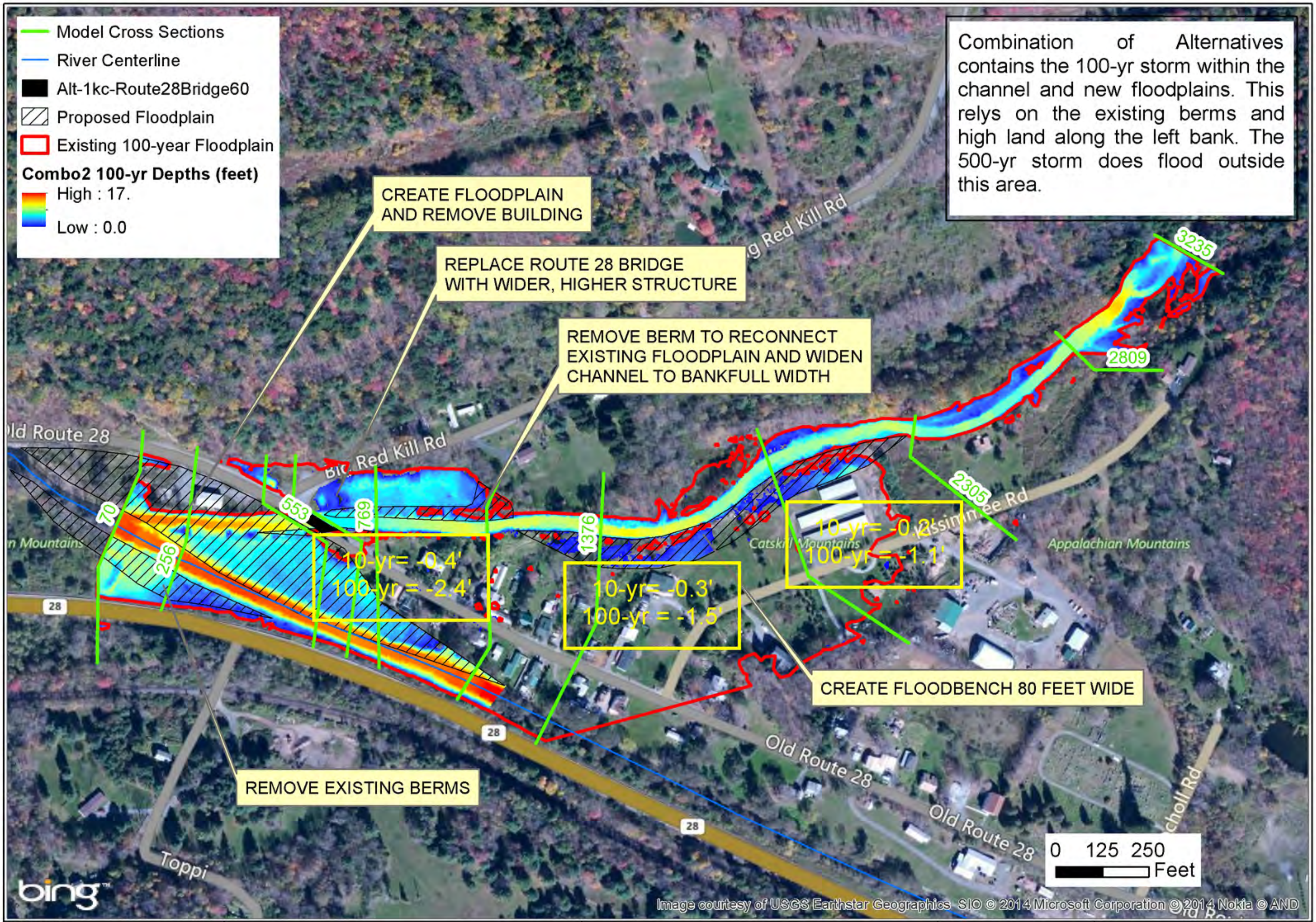
Station	Existing Conditions	Big Red Kill Combination 2	Net Change
1898 (near the self-storage facility on Kissimmee Road)	1473.9	1472.82	-1.08
1376 (on Big Red Kill upstream of the Route 28 Bridge)	1464.37	1462.92	-1.45
769 (on Big Red Kill upstream of Old Route 28 Bridge)	1456.25	1454.13	-2.12

Modeling demonstrated the following:

- This combination contains the 100-year storm within the channel of the Big Red Kill and the new floodplains. The alternative relies on the existing berms and high land along the left bank.
- This combination reduces water surface elevations by approximately 2.4 feet near the intersection of Big Red Kill Road and Old Route 28. Water surface elevations are reduced by between 1 and 1.5 feet west of Kissimmee Road.

4.7.4 Little Red Kill Combination

This combination represents bridge replacements 1E through 1G (replacements of the Snyder Avenue Bridge, the driveway bridge over Little Red Kill, and the Main Street Bridge over Little Red Kill). Although water surface elevations would be reduced at each crossing, the reductions in water surface elevations do not benefit the buildings and homes located along Little Red Kill because the channel is low relative to first floor elevations. Therefore, this combination was not analyzed in the BCA program.



SOURCE(S):	BIG RED KILL COMBINATION 2	FLOOD DEPTH MAPPING	Map By: JCL	MILONE & MACBROOM
BING			MMI#: 5197-03	99 Realty Drive Cheshire, CT 06410
MMI HECRAS			Original: 11/18/2014	(203) 271-1773 Fax: (203) 272-9733
			Revision:	www.miloneandmacbroom.com
N	MXD: Y:\5197-03\GIS\Maps\NOV ALTS\BigRedKillCombo2100-yrDepth.mxd	LOCATION: FLEISCHMANNS, NY	Scale: 1 in = 333 ft	

Modeling demonstrated the following:

- Individual flood mitigation projects such as floodplain benches, when they are combined in series, do not increase benefits throughout the village to a degree higher than if they were constructed individually. For example, conducting Alternative 4A or 4B with 5A or 5B does not cause greater benefits for 4A or 4B. This gives the village flexibility to pursue individual projects without being concerned about whether others will be constructed.
- Benefits associated with sub-alternatives 6A through 6E are confined to the immediate vicinity.
- Combination 8B+1C+1D+4A provides benefits without disrupting residential properties.
- Alternatives 7A and 7B would require significant funds to implement and would be disruptive to the same homes that need to be protected in that area. Removing the houses would be more economical and make more sense, if there was interest in pursuing a project in that area of the village.
- Some of the alternatives cause very slight local water surface *increases* in locations where the water surface elevation was dipping under existing hydraulic conditions.

Floodplain delineations and water depth mapping (Figures 4-2 through 4-19) have been created for the combinations of alternatives to best represent the changes that are expected in both flood extent and depth. Existing Conditions mapping has been provided as a baseline for comparisons of the results of the alternatives. The extents of the Existing Conditions 10-year and 100-year floodplains are also included on each map to faciliatate comparison of results. Flood depths in the areas where floodplain enhancement and lowering are specified (hatched areas) will be deeper than depicted on maps.

4.8 Hydrologic Alternatives

The following hydrologic alternatives were tested in addition to the hydraulic alternatives discussed above.

4.8.1 Alternative 2 – Floodwater Attenuation in Lake Switzerland and Replacement of Pedestrian Bridge

The alternatives described above mainly evaluate the effectiveness of dealing with floodwaters as they flow into and inundate portions of the Village. A more proactive attempt at mitigating the flood flows could potentially involve providing upstream storage areas to detain excess flood waters before they arrive at the village center. This approach would require a large, dry area which could be filled with water during a flood, creating a lake. During a storm, the lake would begin filling with water that would otherwise be causing flows downstream to increase. When the lake reaches capacity, flood flows would return to pre-detention rates.

The effectiveness of such an approach depends entirely on the availability of large open areas that can support a large flood control dam, can support being flooded during a severe flood event, and can provide an appreciable amount of storage volume relative to the watershed size.

One such area upstream of the Village of Fleischmanns is Lake Switzerland. Lake Switzerland is a man-made impoundment of Vly Creek located approximately one half-mile upstream of the Main Street/Mill Street intersection in the Village of Fleischmanns. The lake was used for recreational purposes in the village, such as boat rentals, fishing, and canoeing, by locals and tourists to the area. The dam was partially removed in the 1990s in an effort to promote fish passage, and the impoundment now exists as a dry lake bed. The lake bed has vegetated into a natural meadow with Vly Creek meandering down the center.

A rough order of magnitude assessment was performed to identify the potential of rebuilding a dam at the former location of Lake Switzerland and using the dry lake bed as a flood control storage area. The following describes the methodology and conclusions of that assessment.

The United States Geologic Survey (USGS) StreamStats application was used to determine the contributing watershed area to the former Lake Switzerland (22.3 square miles) and the estimated 100-year peak flow (7,050 cfs).

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) provides guidance on assessments of creating effective flood storage in the Technical Release TR-55 "Urban Hydrology for Small Watersheds." Approximations were made on rainfall and runoff for the purpose of this assessment. Based upon TR-55 Equation 6-1, the total volume of water flowing to the former lake impoundment as the result of rainfall runoff can be estimated using the rainfall/runoff amount, and the watershed area. Given the calculated volume, and a desired reduction in peak flows, Figure 6-1 provides a chart that illustrates the effectiveness of storage areas in mitigating peak flows based upon the volume provided. For the purpose of this assessment, a total reduction in peak flows of 10% was used as the minimum amount of flood control that would be considered economically effective. Table 4-16 presents the results of the assumptions and computations.

TABLE 4-16
Estimates of Storage for Former Lake Switzerland Based Upon TR-55

Rainfall (Estimated)	7 inches
Runoff from Rainfall (Estimated)	3 inches
Runoff Volume (Computed by Eqn 6-1)	2,497 acre-feet
Reduction in Flows Desired	10%
Volume of Storage Required	337 acre-feet
Volume of Storage Provided	131 acre-feet

Based on the above computations, constructing a new dam and utilizing the former Switzerland Lake impoundment for flood storage would not have an appreciable effect on the peak flows generated for the 100-year flow. The provided storage would only be 131 acre-feet as compared with the 337 acre-feet (or 38.9%) needed to obtain a 10% reduction in flows.

There are also many concerns in the construction of a dam from a regulatory perspective, in both the fisheries and dam safety respect. For the above reasons, use of Lake Switzerland for flood storage is not considered a practical alternative to flood mitigation for the Village of Fleischmanns. A BCA was not completed for this alternative.

4.8.2 Alternative 3 – Bypass from Vly Creek to Emory Brook

The confined character of Vly Creek coupled with the bend near the Mill Street bridge and the relatively "delayed" confluence of Vly Creek with Emory Brook (far downstream of Wagner Avenue) have hinted at a potential method of flood mitigation at the location where the two streams initial flow near one another. This particular alternative would involve the construction of a new bypass channel that would allow floods greater than the 10-year storm to spill over the left bank of Vly Creek prior to Main Street, in a controlled manner, and flow from Vly Creek into Emory Brook. This alternative would be prudent if (1) the bypass of flow could provide meaningful relief of floodwaters from the Vly Creek channel, and (2) the channel of Emory Brook could accommodate the additional floodwaters without adverse impacts upstream and downstream of Wagner Avenue.

The highest flood conveyed by Vly Creek under the Main Street Bridge is the 10-year flow. Thus, a bypass could potentially reduce the frequency of damage at Main Street for the 25 and 50-year floods, which are not conveyed by the bridge at Main Street. However, because the Wagner Avenue bridge over Emory Brook currently *does not* convey the 10-year flood of Emory Brook (and any higher flows, of course), it would not be feasible to bypass water from Vly Creek to Emory Brook at the present time because

Emory Brook could not accept it. In order to reasonably prepare Emory Brook for receiving water directly from Vly Creek, the Wagner Avenue Bridge would need to be replaced with a longer and higher span.

During higher flows such as the 100-year flood and greater, the entire Main Street/Wagner Avenue intersection is at risk of inundation. Indeed, this area was flooded during Tropical Storm Irene. Therefore, a bypass channel would be ineffective (essentially overwhelmed and submerged) during a 100-year flood and greater.

Given the narrow range of floods that would be targeted for improvement by this alternative (perhaps only the 25-to-50-year floods or thereabouts) and the need to address the Wanger Avenue bridge over Emory Brook anyhow, Alternative 3 is not considered prudent at this time. Plus, it would be highly disruptive to private properties located between Vly Creek and Emory Brook. A BCA was not completed for this alternative.

This LFA report supports the concept of addressing a bypass alternative in the future after other flood mitigation projects such as floodplain enhancements and bridge replacements have been pursued.

4.9 Property-Specific Building Flood Mitigation

Despite the flood water surface elevation reductions that may result from flood mitigation alternatives described in this report, many of the properties in the Fleischmanns LFA study area that are currently in the SFHA associated with the Bush Kill, Vly Creek, Emory Brook, Big Red Kill, and Little Red Kill *will remain* in the SFHA. Therefore, they will be subject to continued flood risk and flood insurance coverage requirements[4]. However, the reduction of flood water surface elevations has two benefits:

1. Depth of actual flooding may decrease in future floods, leading to reduced damages and reduced time and costs for clean-up and recovery.
2. Reduced water surface elevations can be used to support a Letter of Map Revision (LOMR[5]) or physical map revision (PMR[6]), which would formally reduce the BFE and may reduce flood insurance premiums for some properties.

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[4] Flood insurance requirements are dependent on status of the property relative to loans, mortgages, or other factors that are outside the scope of this plan.

[5] A LOMR is FEMA's modification to a FIRM. LOMRs are generally based on the implementation of measures that affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective BFEs, or the SFHA. The LOMR officially revises the FIRM without causing

To further reduce risk of flood damage in the future, property owners in Fleischmanns may wish to conduct site-specific mitigation actions to reduce flood risks. The fundamental choice is to determine whether a building should be removed and the parcel converted to open space; or mitigated through elevation, floodproofing, elevating utilities, etc. as described in Section 4.4 of this document[7].

If homes are elevated, they will need to be elevated two feet above the BFE. However, this will present an important question to property owners as they work with local authorities – should the current BFE be applied, or should the work be postponed to take advantage of a potential future (and lower) BFE defined by a LOMR or PMR? In many cases a property owner may not have time available to delay a building elevation, floodproofing project, or utility elevation. However if the property owner can delay a mitigation project until after the Village has secured a LOMR or PMR, then the design elevation may be lower. Other important considerations include the following:

- FEMA and many other grant funds will allow elevations in SFHAs but will not allow elevations in floodways.
- If mitigation is funded by the property owner then an elevation in a floodway is acceptable as long as the footprint of the structure is not expanded.
- If elevation or floodproofing is not a substantial improvement or is not the result of substantial damage, then it can be allowed in a floodway but the owner will see no benefit on flood insurance premiums.

The discussion in this section provides a reasonable description of the options that may be available to property owners under current conditions and potential future conditions if bridge replacement and floodplain enhancement projects are pursued. However, individual property owners should always work with the Village Code Enforcement official to determine what is legally required when an improvement is planned.

The LFA program addresses specific properties only when there is consensus to address them. One such property is located in Fleischmanns. The owner of the property at 45 Bridge Street has requested information about elevating her home. The 1996 flood reportedly surrounded this building but the structure was not flooded. The flood from

FEMA to re-publish the FIRM. The LOMR is generally accompanied by an annotated copy of the affected portions of the FIRM.

[6] A PMR is an action whereby one or more FIRM or DFIRM map panels are physically revised and republished. A PMR is used to change flood risk zones, floodplain and/or floodway delineations, flood elevations, and/or planimetric features. A LOMR accomplishes some of the same changes as the PMR, but the FIRM or DFIRM panels are not republished with the LOMR.

[7] Substantial damage or a substantial improvement will trigger elevation of residential buildings and either dry floodproofing or elevation of non-residential buildings.

Tropical Storms Irene reportedly caused damage at this property but the structure was not damaged. As of the date of the draft LFA report, the property at 45 Bridge Street was partly within the SFHA according to the effective FIRM (June 19, 2012). The current effective FIRM (June 16, 2016) shows this home as partly located within the floodway. Therefore, it is not eligible for an elevation.

4.10 Relocations

Alternatives 4A, 4B, 5A, 5B, 6A, 6B, 6C, 6D, 6E, 7A, 7B, 8B, 8B Combination, 9A Combination, 10A, and Big Red Kill Combination 2 all involve property acquisitions or relocations in order to execute the various floodplain projects.

Aside from the alternatives that were considered, there may be other key businesses, critical facilities, or residential buildings in Fleischmanns that can be relocated from zones of flood risk. The Village has expressed a desire to relocate the fire house. The fire house is currently located on Main Street within the SFHA on the right bank of Emory Brook. Relocating the fire house out of the flood zone would protect the building and critical equipment stored at the facility while allowing emergency services to continue in the event of flooding. This LFA supports the relocation of any such critical facility that is currently at risk of flooding or will continue to be exposed to residual risk after flood mitigation projects are conducted in the village.

If private property owners are interested in relocating elsewhere in the village, the buyout program could be used to facilitate relocations that are not part of the proposed alternatives.

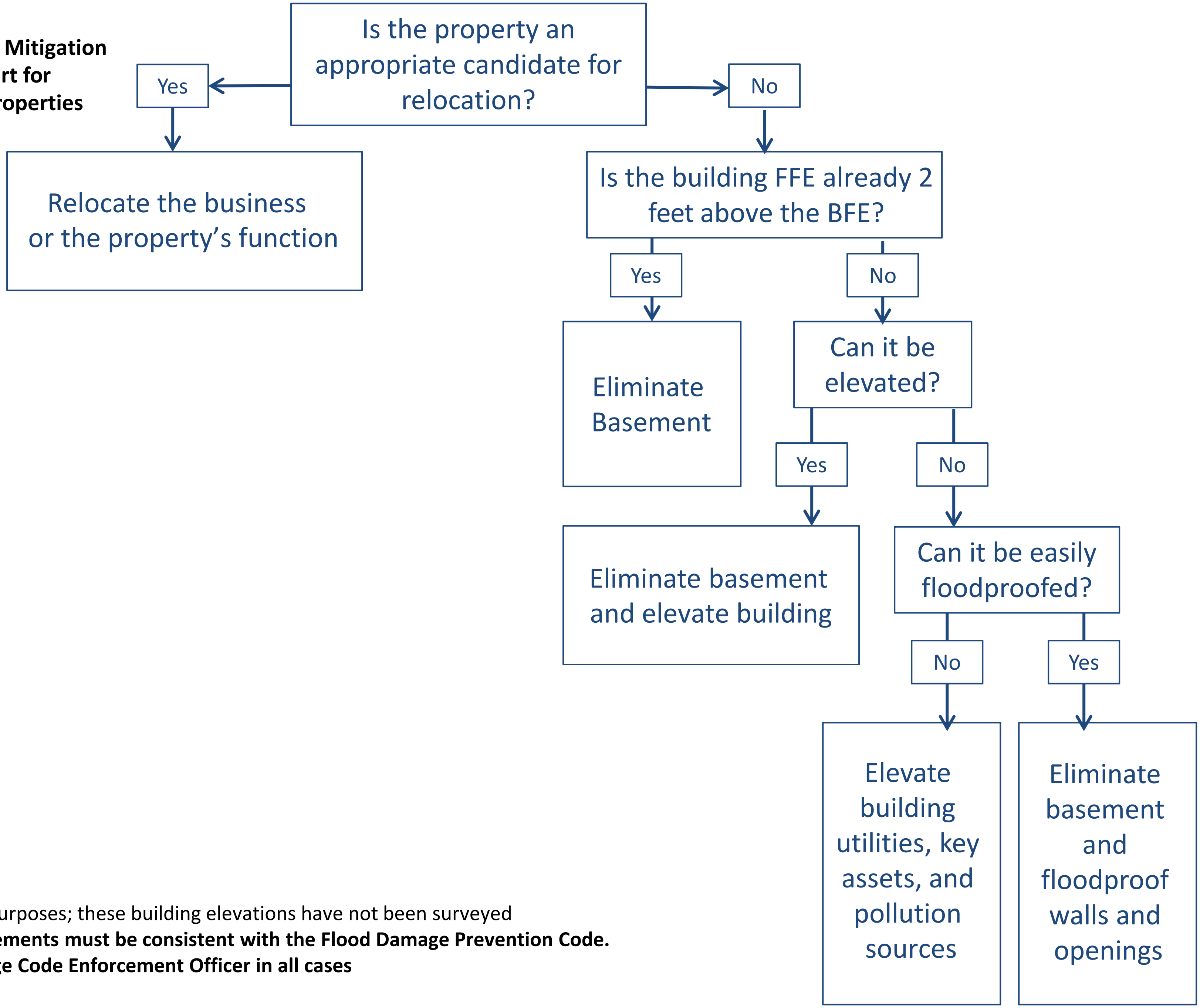
Relocation does not apply only to buildings. There may be other types of development that should be relocated from areas of flood risk, such as the automotive waste that was recently removed from the business at the east end of Wagner Avenue. The Village has expressed concern about the stockpiling of concrete in the floodplain near Depot Street on the left bank of the Bush Kill within the area that is part of Alternatives 6A, 6B, 6C, 6D, and 6E. The concrete has the potential to influence velocities and water surface elevations locally (on the site scale) during flood events and should be removed from the floodplain even if Alternatives 6A, 6B, 6C, 6D, or 6E are not pursued.

4.11 Decision Support for Property-Specific Building Flood Mitigation and Relocations

To aid the selection of future property-specific mitigation actions such as elevations and relocations, two decision support flowcharts are offered. The first chart (Figure 4-20) is applicable to non-residential properties and the second (Figure 4-21) is applicable to residential properties. In both cases, the underlying assumption is that properties are located in the SFHA associated with the Bush Kill, Emory Brook, Vly Creek, Little Red Kill and Red Kill. The specific design elevation (for example, the height of floodproofing) should always be determined on a case-by-case basis with reference to the BFE and whether a LOMR or PRM has been obtained in the future.

Figure 4-20

Property-Specific Mitigation Decision Flowchart for Nonresidential Properties

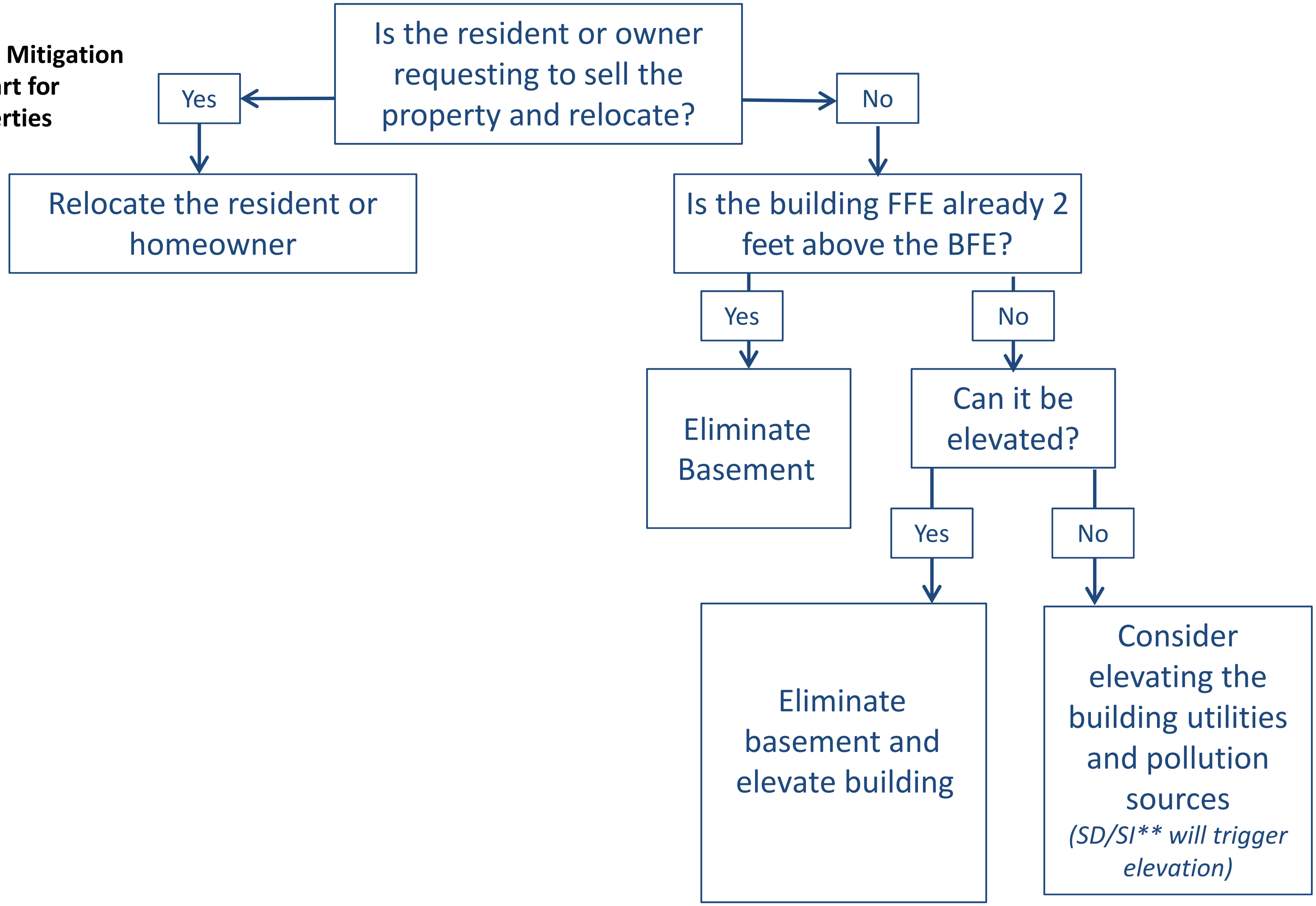


*For illustrative purposes; these building elevations have not been surveyed

Note: All improvements must be consistent with the Flood Damage Prevention Code. Consult the Village Code Enforcement Officer in all cases

Figure 4-21

Property-Specific Mitigation Decision Flowchart for Residential Properties



*For illustrative purposes; this building elevation has not been surveyed

**Substantial Damage/Substantial Improvement

Note: All improvements must be consistent with the Flood Damage Prevention Code. Consult the Village Code Enforcement Officer in all cases

5.0 BENEFIT COST ANALYSIS

5.1 Overview

A Benefit-Cost Analysis (BCA) is used to validate the cost-effectiveness of a proposed hazard mitigation project. A BCA is a method by which the future benefits of a project are estimated and compared to its cost. The end result is a benefit-cost ratio (BCR), which is derived from a project's total net benefits divided by its total project cost. The BCR is a numerical expression of the cost effectiveness of a project. A project is considered by FEMA to be cost effective when the BCR is 1.0 or greater, indicating the long-term benefits of the project are sufficient to justify the up-front and long-term costs.

A BCA was conducted for 17 potential flood mitigation alternatives on the Bush Kill, the Big Red Kill, the Little Red Kill, Vly Creek, and Emory Brook (1A, 4A, 4B, 5A, 5B, 6A, 6B, 6C, 6D, 6E, 7A, 7B, 8B, 8B Combination, 9A Combination, 10A, and Big Red Kill Combination 2). The benefits were then summed outside of the BCA program and compared to the costs of the 17 alternatives. The only weakness to this method is that it neglects the maintenance costs for mitigation projects, which are typically estimated (for example, $500 per year for floodplain bench "maintenance") and assigned a present value by the BCA program. However, the magnitude of the benefits and costs in Fleischmanns (discussed below) are so much greater than the present value of maintenance costs that they can be neglected.

Other factors and assumptions for the BCA include the following:

- Benefits for acquired/relocated properties were determined as "acquisitions" in the BCA program. An acquisition benefit is computed by comparing the current condition (flood damage could occur) to a future condition where damage cannot occur because the building has been removed.
- Benefits for all other properties (the majority of those considered) were generated as local flood reduction projects. A local flood reduction benefit is computed by comparing the current condition (flood damage could occur) to a future condition where damage is lower because a mitigation project has been completed.
- Lost revenue data for businesses affected by flooding was not obtained by Village officials and therefore not utilized in the BCA.
- Default depth-damage curves were used in the program.
- Existing and future water surface elevations were determined from the HEC-GeoRAS surfaces created for the proposed alternatives.

- First floor elevations were taken directly from sewer system mapping provided by DCSWCD and NYCDEP (Wastewater Collection System Plans, Complete Record Plan, Delaware Engineering, PC, January 2007).
- When necessary, additional first floor elevations were estimated using LiDAR topographic mapping for properties not included in the sewer system mapping. Adjustments to the LiDAR topography were made for these buildings based on observations of first floors relative to adjacent grades.
- Building replacement values were based on the assessed values and square footages provided by the Delaware County Planning Department's GIS database[8].

The BCA does not include benefits that could have been generated for avoiding future street cleanup, avoided detours, avoided emergency response, etc. Also, this report recognizes that the contents of the hardware store and some other buildings may not be well-represented by defaults in the BCA program, but an effort to construct site-specific depth-damage functions was beyond the scope of the LFA and not conducted.

5.2 Property Acquisitions

The first critical piece of the benefits generation was to determine the benefits associated with the act of removing buildings with flood risk. The acquisition and relocation benefits[9] listed in Table 5-1 were generated in conjunction with the floodplain enhancement projects. A zero in the second column means that a *building* does not need to be acquired for the alternative and therefore cannot provide risk reduction benefits; however, acquisition of real estate may still be required for many alternatives.

TABLE 5-1
Benefits Provided by Acquisitions/Relocations

Alternate	Building Acquisition Benefits
1A	$0
4A	$673,000
4B	$692,000
5A	$31,000
5B	$23,000
6A	$1,027,000

[8] Property appraisals will be needed for any application developed for FEMA mitigation programs.
[9] Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The building acquisition benefits for 6B, 6D, and 6E include these buildings. For the purpose of completeness, this LFA report retains these benefits. If these alternatives are pursued, benefits will need to be recalculated.

Alternate	Building Acquisition Benefits
6B	$1,325,000
6C	$658,000
6D	$298,000
6E	$777,000
7A	$7,000
7B	$522,000
Big Red Kill Combination 2	$7,000
8B	$0
8B Combination (8B+1D+4A)	$673,000
9A Combination (9A+1B+4B)	$342,000
10A	$153,000

The benefits are greater for the buildings with the lowest elevations and greatest flood damage potential and lower for the smaller buildings located at higher elevations. The alternatives in Table 5-1 were advanced for use in computing total benefits.

5.3 Benefits Associated with Floodplain Enhancement and Creation Projects

Benefits from water surface reduction were calculated using the drainage improvement option in the BCA Flood module. Benefits from the 17 alternatives are shown in Table 5-2. For alternatives 4A, 4B, 6A, 6B, 6C, 6D, 6E, 7B, 9A Combination, and 10A the majority of the benefits come from property acquisitions and not from reductions in water surface elevations.

TABLE 5-2
Summary of Benefits

Alternate	Acquisition Benefits*	Benefits from Water Surface Reductions at Buildings that Remain	Total Benefits
1A	$0	$57,000	$57,000
4A	$673,000	$394,000	$1,067,000
4B	$692,000	$382,000	$1,074,000
5A	$31,000	$72,000	$103,000
5B	$23,000	$47,000	$70,000
6A	$1,027,000	$16,000	$1,043,000
6B	$1,325,000	$330,000	$1,655,000
6C	$658,000	$486,000	$1,144,000

Alternate	Acquisition Benefits*	Benefits from Water Surface Reductions at Buildings that Remain	Total Benefits
6D	$298,000	$82,000	$380,000
6E	$777,000	$327,000	$1,104,000
7A	$7,000	$149,000	$156,000
7B	$522,000	$178,000	$700,000
Big Red Kill Combination 2	$7,000	$3,279,000	$3,286,000
8B	$0	$29,000	$29,000
8B Combination (8B+1D+4A)	$673,000	$1,729,000	$2,402,000
9A Combination (9A+1B+4B)	$342,000	$113,000	$455,000
10A	$153,000	$65,000	$218,000

* Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The building acquisition benefits for 6B, 6D, and 6E include these buildings. For the purpose of completeness, this LFA report retains these benefits. If these alternatives are pursued, benefits will need to be recalculated.

5.4 Comparison of Benefits and Costs

The individual cost estimates in Table 5-3 were summed and are listed in the third column of Table 5-4 below. The individual benefits in Table 5-2 were summed and are listed in the fourth column of Table 5-4. When benefits exceed costs, the alternative is considered to have a BCR greater than 1.0.

TABLE 5-3
Summary of Costs for Individual Components

Alternative		Partial Cost Estimates
1A	Replace Main Street Bridge over Emory Brook	$500,000
	Widen constricted channel	$27,000
4A	Creation of floodplain south of Vly Creek and north of Wagner Avenue	$627,000
	Acquisition and removal of buildings	$759,000
4B	Includes 4A and expands floodplain creation to Emory Brook	$897,000
	Acquisition and removal of buildings	$1,805,000
5A	Create floodplain near Bridge Street	$374,000
	Acquisition and removal of buildings	$588,000
5B	Create floodplain near Bridge Street, but leave 45 and 46 Bridge Street	$299,000

Alternative		Partial Cost Estimates
	Acquisition and removal of buildings	$385,000
6A	Create floodplain west of Depot Street	$1,941,000
	Acquisition and removal of buildings including hardware store	$2,192,000
6B	Floodplain includes 6A and extends floodplain upstream of Depot Street	$2,541,000
	Acquisition and removal of buildings including hardware store	$2,834,000
6C	Floodplain Same as 6A, but hardware store remains	$1,506,000
	Acquisition and removal of buildings, not including hardware store	$1,143,000
6D	Create floodplain upstream of Depot Street	$700,000
	Acquisition and removal of buildings	$736,000
6E	Floodplain same as 6B, but hardware store remains	$2,102,000
	Acquisition and removal of buildings, not including hardware store	$1,785,000
7A	Remove existing berm and create floodplain at confluence of Big Red Kill and Bush Kill	$814,000
	Acquisitions and removal of building	$225,000
7B	Floodplain includes 7A and also extends upstream along Route 28	$1,770,000
	Acquisition and removal of buildings south of Old Route 28	$1,455,000
8B+1C	Remove Mill Street Bridge	$125,000
	Creation of floodplain upstream of Mill Street	$162,000
	Acquisition and removal of two properties on Mill Street	$47,000
10A	Creation of floodplain near park	$89,000
	Acquisition and removal of outbuildings	$179,000
8B Combination (8B+1D+4A)	Remove Mill Street Bridge	$125,000
	Replace Main Street Bridge over Vly Creek	$750,000
	Creation of floodplains near Mill Street and Wagner Avenue	$839,000
	Acquisition and removal of buildings	$806,000
9A Combination (9A+1B+4B)	Replace Wagner Avenue Bridge over Vly Creek	$500,000
	Removal of berm along Emory Brook and creation of floodplain	$1,029,000
	Acquisition and removal of buildings	$2,164,000
Big Red Kill Combination 2	Replace Route 28 Bridge	$750,000
	Berm removal and floodplain creation	$1,159,000
	Acquisition and removal of buildings	$225,000

TABLE 5-4
Comparison of Costs and Benefits

Alternative		Cost Estimates	Total Benefits*	BCR	BCR > 1?
1A	❑ Replace Main Street Bridge over Emory Brook ❑ Widen constricted channel	$527,000	$57,000	0.1	No
4A	❑ Creation of floodplain south of Vly Creek and north of Wagner Avenue ❑ Removal of buildings	$1,386,000	$1,067,000	0.8	No
4B	❑ Includes 4A and expands floodplain creation to Emory Brook ❑ Removal of buildings	$2,702,000	$1,074,000	0.4	No
5A	❑ Create floodplain near Bridge Street ❑ Removal of buildings	$962,000	$103,000	0.1	No
5B	❑ Create floodplain near Bridge Street, but leave 45 and 46 Bridge Street ❑ Removal of buildings	$684,000	$70,000	0.1	No
6A	❑ Create floodplain west of Depot Street ❑ Removal of buildings including hardware store	$4,133,000	$1,043,000	0.3	No
6B	❑ Includes 6A and extends floodplain upstream of Depot Street	$5,375,000	$1,655,000	0.3	No
6C	❑ Same as 6A, but hardware store remains	$2,649,000	$1,144,000	0.4	No
6D	❑ Create floodplain upstream of Depot Street and path across Depot Street to river ❑ Removal of buildings	$1,436,000	$380,000	0.3	No
6E	❑ Same as 6B, but hardware store remains	$3,887,000	$1,104,000	0.3	No
7A	❑ Remove existing berm and create confluence at confluence of Big Red Kill and Bush Kill ❑ Removal of building	$1,039,000	$156,000	0.2	No

Alternative		Cost Estimates	Total Benefits*	BCR	BCR > 1?
7B	❑ Includes 7A and also extends floodplain creation upstream along Route 28 ❑ Removal of buildings south of Old Route 28	$3,225,000	$700,000	0.2	No
8B+1C	❑ Create floodplain near Mill Street ❑ Expand floodplain to reroute Mill Street and remove Mill Street Bridge	$334,000	$29,000	0.1	No
10A	❑ Creation of floodplain near park ❑ Removal of outbuildings	$268,000	$218,000	0.8	No
Big Red Kill Combination 2	❑ Includes 7A plus replacement of Route 28 Bridge ❑ Berm removal on right side of Big Red Kill and floodplain creation on left side of Big Red Kill	$2,134,000	$3,286,000	1.5	Yes
8B Combination (8B+1C+1D+4A)	❑ Includes 8B plus 4A and replacement of Main Street Bridge over Vly Creek ❑ Removal of buildings	$2,520,000	$2,402,000	0.9	No
9A Combination (9A+1B+4B)	❑ Includes 4B plus creation of floodplain along Vly Creek south of Wagner Avenue ❑ Replacement of Wagner Avenue Bridge ❑ Removal of buildings	$3,693,000	$455,000	0.1	No

* Subsequent to the issuance of the Draft LFA Report the buildings on the east side of Depot Street and on the south side of Wagner Road were removed. The building acquisition benefits for 6B, 6D, and 6E include these buildings. For the purpose of completeness, this LFA report retains these benefits. If these alternatives are pursued, benefits will need to be recalculated.

The Big Red Kill Combination 2 appears to have a BCR greater than 1.0 but the other alternatives do not. One word of caution for Big Red Kill Combination 2 is that it includes a bridge replacement, which is typically a challenging cost estimate to develop.

The BCA does not include consideration of water quality benefits that could be provided by flood mitigation projects. Water quality benefits should be used to increase benefits when the BCR is poorly represented by the flood reduction benefits generated by the

BCA program or when stratification or prioritization of mitigation projects is difficult due to a calculation of similar BCRs.

Appendix D includes a memorandum that discusses two potential approaches that can be used to include water quality benefits in future BCA. With reference approach #1 (refer to the bottom of page 3 of the memorandum), three alternatives have BCRs above 0.75 and may be appropriate candidates for assistance from water quality benefits. These are Alternatives 4A, the 8B Combination (8B+1C+1D+4A), and 10A. However of those three, only the 8B Combination (8B+1C+1D+4A) would have a BCR above 1.0 if the greatest possible multiplier[10] (1.2) were to be applied:

$$(1.2 \times \$2,402,000)/\$2,520,000 = 1.14$$

Alternatives 4A and 10A would fall short, with BCRs between 0.9 and 1.0.

5.5 Benefit Cost Analysis for Individual Property Mitigation

Section 4.9 of this document discusses property-specific flood mitigation through elevations and floodproofing. Many of these projects may be eligible for grants, but cost-effectiveness is required to secure certain grant funds. The FEMA BCA program can be used in a straightforward manner to evaluate BCRs associated with property-specific elevations and floodproofing. The required information includes pertinent land surface and building elevations, the flood elevations published in the FIS and noted on the FIRM, the stream channel elevation published in the FIS, and project costs for elevating or floodproofing buildings.

Like all projects evaluated through BCA, the highest benefits will be generated for projects that reduce flooding from frequent events and infrequent events, as opposed to projects that reduce flooding from only infrequent events. Therefore, higher BCRs will tend to be calculated for the buildings at lower elevations.

One potential pathway toward rapid cost effectiveness determination is to utilize the interpretation from FEMA that was effective as of August 15, 2013. Under this interpretation, acquisitions and elevations are considered cost-effective if the project costs are less than $276,000 and $175,000, respectively. To be eligible for this automatic

[10] With reference to the Environmental Benefits Worksheet dated October 16, 2012 (draft, not adopted) the sum of the scores for the 8B Combination would be greater than 7. This is due to the large number of potential contaminant sources that would have reduced flood risk and the enhancement of riparian wetland systems. The project also reduces the potential for sediment transport, although a score cannot be determined with available information.

determination, structures must be located in SFHAs. The figure of $175,000 for a building elevation is likely sufficient for elevating many of the residential buildings in Fleischmanns.

Costs for floodproofing of individual non-residential buildings could vary widely in Fleischmanns. Consider the following:

- A low door shield costs approximately $1,500[11]. Dewberry[12] reports a range of $500-$1,500 for door gaskets and seals. Fully floodproofed doors can cost more, up to $4,000 per door, but may be excessive given many of the existing door elevations in the downtown area.

- Dewberry reports a range of $500-$1,500 to elevate an electrical service and meter, a range of $500-$1,500 to floodproof electrical service and meter, a range of $500-$1,500 to elevate HVAC equipment, and a range of a range of $500-$1,500 (and up) to floodproof HVAC equipment. FEMA reports a range of $1,500-$2,000 to include outlets and switches in the elevation of electric service and meter in a house. Given the uncertainty related to actions that business owners may choose, a range of $1,500-$2,000 is reasonable for all utility-related costs.

Total costs to retrofit a single business to make it more flood-resilient in the long term are rarely reported in the literature. In the New York Rising Community Reconstruction Plan[13] for the Red Hook section of Brooklyn, New York, total cost estimates per small business in this community ranged from $6,000 to $50,000 for implementing a variety of floodproofing measures. Given the number of doors, openings, and utilities associated with some of the businesses in Fleischmanns, this range may be reasonable for a group of buildings along Main Street or Wagner Avenue.

[11] Typical vendor "PS Doors" (http://www.psdoors.com/)
[12] http://www.sbidc.org/documents/RedHookCaseStudyFindingsReportFINAL.pdf
[13] http://stormrecovery.ny.gov/sites/default/files/crp/community/documents/redhook_nyrcr_plan_20mb_0.pdf

6.0 FINDINGS, RECOMMENDATIONS, AND IMPLEMENTATION

6.1 Summary of Findings

The LFA completed for Fleischmanns has demonstrated that many flood mitigation projects have merit because they will reduce flood water surface elevations in the village. These projects largely depend on the enhancement of floodplains and creation of lower floodplains coupled with a handful of bridge replacements and strategic building removals and business relocations.

- Based on the BCA conducted for this LFA (and its underlying assumptions), one flood mitigation project (Big Red Kill Combination 2) has a BCR above 1.0. If this project is supported by the Village and there is consensus to pursue its execution, then it may be advanced for further design and funding.

- One flood mitigation project (the 8B Combination [8B+1C+1D+4A]) has a BCR above 1.0 if a multiplier of 1.2 is applied. This project would make sense to pursue, as it would connect to the work already completed (and planned) for the Mill Street area on the right bank of Vly Creek. If this project is supported by the Village and there is consensus to pursue its execution, then it may be advanced for further design and funding.

- The other projects described in this LFA report will not likely have BCRs above 1.0. However, many of these are appropriate flood mitigation projects. Table 6-1 summarizes the recommended action for each project.

TABLE 6-1
Recommended Action

Alternative		BCR > 1?	Recommended Action
1A	❑ Replace Main Street Bridge over Emory Brook ❑ Widen constricted channel	No	Unless washouts at this bridge are a significant concern, do not pursue at this time. Consider when bridge is ready for replacement due to its age.
4A	❑ Creation of floodplain south of Vly Creek and north of Wagner Avenue ❑ Removal of buildings	No	Pursue in connection with other projects; see the 8B combination below.
4B	❑ Includes 4A and expands floodplain creation to Emory Brook ❑ Removal of buildings	No	Pursue in connection with other projects; see the 9A combination below.

Alternative		BCR > 1?	Recommended Action
5A	❑ Create floodplain near Bridge Street ❑ Removal of buildings	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to acquire properties.
5B	❑ Create floodplain near Bridge Street, but leave 45 and 46 Bridge Street ❑ Removal of buildings	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to acquire properties.
6A	❑ Create floodplain west of Depot Street ❑ Removal of buildings including hardware store	No	Select components of these alternatives to pursue, as the benefits are important. Obtain and incorporate revenue figures from Wadler/ True Value to bolster benefits in the future.
6B	❑ Includes 6A and extends floodplain upstream of Depot Street	No	
6C	❑ Same as 6A, but hardware store remains	No	
6D	❑ Create floodplain upstream of Depot Street and path across Depot Street to river ❑ Removal of buildings	No	
6E	❑ Same as 6B, but hardware store remains	No	
7A	❑ Remove existing berm and create confluence at confluence of Big Red Kill and Bush Kill ❑ Removal of building	No	Do not pursue floodplain projects here. It would be more effective to remove, relocate, or elevate buildings as owners request.
7B	❑ Includes 7A and also extends floodplain creation upstream along Route 28 ❑ Removal of buildings south of Old Route 28	No	
Big Red Kill Combination 2	❑ Includes 7A plus replacement of Route 28 Bridge ❑ Berm removal on right side of Big Red Kill and floodplain creation on left side of Big Red Kill	Yes	Pursue
8B+1C	❑ Create floodplain near Mill Street ❑ Expand floodplain to reroute Mill Street and remove Mill Street Bridge	No	Pursue in connection with the 8B combination below if possible.
8B Combination (8B+1C+1D+4A)	❑ Includes 8B plus 4A and replacement of Main Street Bridge over Vly Creek ❑ Removal of buildings	Yes (with a multiplier applied)	Pursue

Alternative		BCR > 1?	Recommended Action
9A Combination (9A+1B+4B)	❑ Includes 4B plus creation of floodplain along Vly Creek south of Wagner Avenue ❑ Replacement of Wagner Avenue Bridge ❑ Removal of buildings	No	Select components of these alternatives to pursue, as the benefits are important. Significantly upsize the bridge when it is ready for replacement due to its age.
10A	❑ Creation of floodplain near park ❑ Removal of outbuildings	No	Too intrusive relative to the benefits; do not pursue unless opportunities arise to utilize private properties.

As explained in Section 4.6, the profile of Fleischmanns along Vly Creek, Emory Brook, and Bush Kill is relatively steep in relation to its length, making the individual alternatives (numbers 4, 5, 6, 7, 8, 9, and 10) relatively independent. Because they do not adversely affect one another, they may be pursued individually.

The two hydrologic alternatives discussed in this LFA report (flood retention at Lake Switzerland and construction of a bypass from Vly Creek to Emory Brook) are not recommended. The rationale can be found in Section 4.8.

Creation of extensive floodwalls and levees is not supported by this LFA, nor is extensive sediment removal throughout the Village of Fleischmanns. Widespread removal of buildings from the downtown area is also not supported by the LFA, as the community would suffer from the disruption to its central business district.

Individual property owners will be required to elevate or floodproof their properties over time as substantial damage or substantial improvement thresholds are triggered. However, optional elevations and floodproofing may be desired in strategic locations where unacceptable flood risk remains after flood mitigation projects are implemented. This will have the dual benefit of reducing flood risks while reducing flood insurance premiums for those properties that are insured.

Finally, key anchor businesses and critical facilities may wish to relocate out of zones of unacceptable flood risk. One example is the fire house. This LFA is supportive of a relocation of the fire house.

6.2 Flood Mitigation Recommendations

The following flood mitigation recommendations are offered:

1. Proceed with further study and apply for funding for the Big Red Kill Combination 2 and the 8B Combination.

2. Pursue floodproofing of commercial buildings where viable in the village. Floodproofing should include sealing of lower portions of buildings including doors and other openings, and elevation of building utilities. Ensure that floodproofing is viable under a set of potential future conditions.

3. Pursue elevation of homes outside the floodway on a case-by-case basis as property owners approach the Village about mitigation. Ensure that elevations are conducted in accordance with the effective BFE at the time of the work.

4. Relocate the fire house.

5. Implement components of other alternatives when opportunities arise (for example, a property is up for sale or a bridge is ready for replacement due to its age).

6. Install real-time precipitation gauges in the Emory Brook and Vly Creek watersheds in order to provide ample real-time warning time before floods as opposed to relying on downstream stream gauges. The precipitation gauges should be fully automated and able to provide advance warning in short time frames when needed.

6.3 Programmatic Recommendations

The Village Board and East Branch Flood Commission expressed interest in precipitation gauges in the Emory and Vly watersheds in order to provide ample warning time before floods as opposed to relying on downstream stream gauges. The precipitation gauges should be fully automated and able to provide as little advance warning as an hour. A flood warning system was installed in the City of Norwich, New York in 2008 that incorporated stream level monitoring and rain gauges. The monitoring stations provide real-time data monitoring for flood warning systems. The gauges allowed Norwich to warn residents during floods in 2011. This type of system could give Fleischmanns residents valuable time to prepare for flooding.

6.4 Descriptions of Funding Sources

Several funding sources may be available to the East Branch Flood Commission, the Village of Fleischmanns, and Delaware County and its departments for the implementation of recommendations of this plan.

Local Flood Analysis (LFA) and Stream Management Program (SMP)

The LFA program that funded this study and report is likely to be the primary funding vehicle for some of the projects described in this report through the SMP. As described in the LFA rules, "Stream Management Programs in the NYC water supply watersheds and the Catskill Watershed Corporation are supporting the analysis of flood conditions and the identification of hazard mitigation projects. The process consists of two steps: 1) an engineering analysis of flood conditions and identification of potential flood mitigation projects articulated in a plan and 2) project design and implementation. The engineering analysis and plan are termed 'Local Flood Analysis.' These program rules (Section C) define the process for municipalities to apply for funding to complete a Local Flood Analysis (LFA). These program rules (Section D) also define the process for municipalities to seek funding from the Stream Management Program [managed by the DCSWCD] to implement projects that involve streams, floodplains and adjacent infrastructure to reduce flood hazards."

NYCDEP Buyout Program

The buyout program is used to acquire individual properties in the water supply watersheds and convert them to open space in order to reduce future flood damages. Although large-scale buyouts in Fleischmanns are not supported by this LFA at the present time, several properties have been identified in this LFA as targeted for acquisition. The buyout program could potentially be used for some of these acquisitions.

Catskills Watershed Corporation (CWC) Flood Hazard Mitigation Implementation Program (FHMIP)

The Catskill Watershed Corporation is a not-for-profit local development corporation established to protect the water resources of the New York City watershed west of the Hudson River (WOH); to preserve and strengthen communities located in the region; and to increase awareness and understanding of the importance of the NYC water system. CWC administers a number of programs under this mission, such as:

- Septic Repair and Maintenance – Funds residential septic system repairs, replacements, and maintenance.
- Stormwater Planning and Control – Funds planning, assessment, design, and implementation of stormwater and erosion controls for existing conditions, as well as stormwater requirements for new construction.
- Education – Provides grants to schools and organizations.
- Community Wastewater Management – Funds a program to evaluate and build community-specific wastewater solutions, which may include septic maintenance districts, community septic systems, or wastewater treatment plants.
- Local Technical Assistance Program – Provides grants to communities conducting watershed protection and land use planning initiatives.

The FHMIP is a new CWC program that is open for applications on a rolling basis. This program specifically allows funding of certain categories of projects identified in LFA reports, subject to various restrictions that are listed in the CWC's FHMIP rules.

Emergency Watershed Protection Program (EWP)

Through the EWP program, the U.S. Department of Agriculture's NRCS can help communities address watershed impairments that pose imminent threats to lives and property. Most EWP work is for the protection of threatened infrastructure from continued stream erosion. NRCS may pay up to 75% of the construction costs of emergency measures. The remaining costs must come from local sources and can be made in cash or in-kind services. EWP projects must reduce threats to lives and property; be economically, environmentally, and socially defensible; be designed and implemented according to sound technical standards; and conserve natural resources.

FEMA Pre-Disaster Mitigation (PDM) Program

The Pre-Disaster Mitigation Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 U.S.C. 5133. The PDM program provides funds to states, territories, tribal governments, communities, and universities for hazard mitigation planning and implementation of mitigation projects prior to disasters, providing an opportunity to reduce the nation's disaster losses through pre-disaster mitigation planning and the implementation of feasible, effective, and cost-efficient mitigation measures. Funding of pre-disaster plans and projects is meant to reduce overall risks to populations and facilities.

The PDM program is subject to the availability of appropriation funding, as well as any program-specific directive or restriction made with respect to such funds. In 2014, funds were extremely limited and FEMA provide strict constraints to the states on how many projects could be submitted for consideration.

FEMA Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.

The HMGP is one of the FEMA programs with the greatest potential fit to potential projects in this LFA. However, it is available only in the months subsequent to a federal disaster declaration in the State of New York. Because the state administers the HMGP directly, application cycles will need to be closely monitored after disasters are declared in New York.

FEMA Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the NFIP. FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to the FMA program:

- The definitions of repetitive loss and severe repetitive loss properties have been modified.
- Cost-share requirements have changed to allow more federal funds for properties with repetitive flood claims and severe repetitive loss properties.
- There is no longer a limit on in-kind contributions for the non-federal cost share.

One limitation of the FMA program is that it is used to provide mitigation for *structures* that are insured or located in SFHAs. Therefore, the individual property mitigation options described in this LFA are best suited for FMA funds. Like PDM, FMA programs are subject to the availability of appropriation funding, as well as any program-specific directive or restriction made with respect to such funds.

NYS Department of State

The Department of State may be able to fund some of the projects described in this report. In order to be eligible, a project should link water quality improvement to economic benefits.

U.S. Army Corps of Engineers

The Corps provides 100% funding for floodplain management planning and technical assistance to states and local governments under several flood control acts and the Floodplain Management Services Program (FPMS). Specific programs used by the Corps for mitigation are listed below.

- Section 205 – Small Flood Damage Reduction Projects: This section of the 1948 Flood Control Act authorizes the Corps to study, design, and construct small flood control projects in partnership with non-Federal government agencies. Feasibility studies are 100% federally-funded up to $100,000, with additional costs shared equally. Costs for preparation of plans and construction are funded 65% with a 35% non-federal match. In certain cases, the non-Federal share for construction could be as high as 50%. The maximum federal expenditure for any project is $7 million.

- Section 14 – Emergency Streambank and Shoreline Protection: This section of the 1946 Flood Control Act authorizes the Corps to construct emergency shoreline and streambank protection works to protect public facilities such as bridges, roads, public buildings, sewage treatment plants, water wells, and non-profit public facilities such as churches, hospitals, and schools. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $1.5 million.

- Section 208 – Clearing and Snagging Projects: This section of the 1954 Flood Control Act authorizes the Corps to perform channel clearing and excavation with limited embankment construction to reduce nuisance flood damages caused by debris and minor shoaling of rivers. Cost sharing is similar to Section 205 projects above. The maximum federal expenditure for any project is $500,000.

- Section 206 – Floodplain Management Services: This section of the 1960 Flood Control Act, as amended, authorizes the Corps to provide a full range of technical services and planning guidance necessary to support effective floodplain management. General technical assistance efforts include determining the following: site-specific data on obstructions to flood flows, flood formation, and timing; flood depths, stages, or floodwater velocities; the extent, duration, and frequency of flooding; information on natural and cultural floodplain resources; and flood loss potentials before and after the use of floodplain management measures. Types of studies conducted under FPMS include floodplain delineation, dam failure, hurricane evacuation, flood warning, floodway, flood damage reduction, stormwater management, floodproofing, and inventories of floodprone structures. When funding is available, this work is 100% federally funded.

In addition, the Corps provides emergency flood assistance (under Public Law 84-99) after local and state funding has been used. This assistance can be used for both flood response and post-flood response. Corps assistance is limited to the preservation of life and improved property; direct assistance to individual homeowners or businesses is not permitted. In addition, the Corps can loan or issue supplies and equipment once local sources are exhausted during emergencies.

Other Potential Sources of Funding

- Community Development Block Grant (CDBG) – The Office of Community Renewal administers the CDBG program for the State of New York. The NYS CDBG program provides financial assistance to eligible cities, towns, and villages (including the Village of Fleischmanns) in order to develop viable communities by providing affordable housing and suitable living environments, as well as expanding economic opportunities, principally for persons of low and moderate income. It is possible that CDBG funding program could be applicable for floodproofing and elevating residential and non-residential buildings, depending on eligibility of those buildings relative to the program requirements.

- Delaware County Industrial Development Agency (IDA) – The IDA works in conjunction with the Delaware County Department of Economic Development to "build a sustainable future for Delaware County" by meeting the needs of new and existing businesses through expertise, financial assistance, and continued support. The IDA offers a variety of programs and performance based incentives to encourage businesses to expand or locate within Delaware County and create new jobs. The program primarily helps secure low-interest loans and Industrial Revenue Bonds (tax-exempt financing alternatives for large-scale investments in facilities and equipment). It is possible that the program could be applicable for floodproofing, elevating, or relocating non-residential buildings, depending on eligibility of those businesses relative to the program requirements.

- Empire State Development – The State's Empire State Development program offers loans, grants and tax credits, as well as other financing and technical assistance, to support businesses and encourage their growth. It is possible that the program could be applicable for floodproofing, elevating, or relocating non-residential buildings, depending on eligibility of those businesses relative to the program requirements.

- Private Foundations – Private entities such as foundations are potential funding sources in many communities. The East Branch Flood Commission will need to identify the foundations that are potentially appropriate for some of the actions proposed in this report.

6.5 Potential Funding Sources for Mitigation Projects

Table 6-2 lists potential funding sources for the alternatives that were advanced to the BCA. Note that in all cases, federal funds cannot be duplicated for any particular project. Potential funding sources described under the heading "Other Potential Sources of Funding" (above) have not been listed, as additional evaluation may be needed to determine their applicability.

Table 6-2
Potential Funding Sources for Components of Mitigation Projects

Alternative		Federal	State	Other
1A	Bridge Replacement	None	NYSDOT	DCSWCD SMP, CWC
	Widen channel downstream	ACOE	NYSDOS	DCSWCD SMP, CWC
4A	Acquisition and removal of cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain on south side of Vly Creek	ACOE	NYSDOS	DCSWCD SMP, CWC

Alternative		Federal	State	Other
4B	Acquisition and removal of school and cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Vly Creek and Emory Brook	ACOE	NYSDOS	DCSWCD SMP, CWC
5A	Acquisition and removal of 45 and 46 Bridge Street plus rear buildings along south side of Main Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near Bridge Street	ACOE	NYSDOS	DCSWCD SMP, CWC
5B	Acquisition and removal of rear buildings along south side of Main Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near Bridge Street	ACOE	NYSDOS	DCSWCD SMP, CWC
6A	Acquisition and removal of hardware store, building north of 125 Depot Street, and buildings at 139 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28, Depot Street, and Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC
6B	Acquisition and removal of the hardware store, buildings at 139 Depot Street, 125 Depot Street, building north of 125 Depot Street, and 102 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28 and Route 28 extending upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Lower Depot Street to allow floodwater to pass	None	None	DCSWCD SMP, CWC
6C	Acquisition and removal of building north of 125 Depot Street and buildings at 139 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28, Depot Street, and Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC
6D	Acquisition and removal of 125 Depot Street, 102 Depot Street, and the building north of 125 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Flood pathway across Depot Street to the river	None	None	DCSWCD SMP, CWC

Alternative		Federal	State	Other
6E	Acquisition and removal of buildings at 139 Depot Street, 125 Depot Street, building north of 125 Depot Street, and 102 Depot Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain between Old Route 28 and Route 28 extending upstream of Depot Street	ACOE	NYSDOS	DCSWCD SMP, CWC
	Lower Depot Street to allow floodwater to pass	None	None	DCSWCD SMP, CWC
7A	Removal of existing berm between Route 28 and the Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of 544 Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near the junction of Big Red Kill Road and Old Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC
7B	Acquisition and removal of 16 buildings on the southern side of Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near the junction of Big Red Kill Road and Old Route 28 and along northern bank of Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
8B	Bridge replacement	None	NYSDOT	DCSWCD SMP, CWC
	Acquisition and removal of two properties on Mill Street	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain upstream of Mill Street	ACOE	NYSDOS	DCSWCD SMP, CWC
10A	Removal of outbuildings	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplain near park on Wagner Avenue	ACOE	NYSDOS	DCSWCD SMP, CWC
8B Combo	Remove Mill Street Bridge	None	NYSDOT	DCSWCD SMP, CWC
	Reroute Mill Street	None	NYSDOT	DCSWCD SMP, CWC
	Replace Main Street Bridge over Vly Creek	None	NYSDOT	DCSWCD SMP, CWC
	Acquisition and removal of two properties on Mill Street, cottages behind school, removal of buildings at auto repair shop and junk yard	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Creation of floodplains near Mill Street and Wagner Avenue	ACOE	NYSDOS	DCSWCD SMP, CWC
9A Combo	Replace Wagner Avenue Bridge over Vly Creek	None	NYSDOT	DCSWCD SMP, CWC
	Removal of berm along Emory Brook	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of school and cottages behind school, buildings at auto repair shop and junk yard, and buildings upstream of Wagner Avenue	FEMA	NYSDOS	NYCDEP Buyout, CWC

Alternative		Federal	State	Other
	Creation of floodplains near the school on Wagner Avenue and on the north side of Emory Brook east of the Wagner Avenue Bridge	ACOE	NYSDOS	DCSWCD SMP, CWC
Big Red Kill Combo 2	Replace Route 28 Bridge	None	NYSDOT	DCSWCD SMP, CWC
	Berm removal on Big Red Kill and between Route 28 and the Bush Kill	ACOE	NYSDOS	DCSWCD SMP, CWC
	Acquisition and removal of 544 Old Route 28	FEMA	NYSDOS	NYCDEP Buyout, CWC
	Floodplain creation on left bank of Big Red Kill and near the junction of Big Red Kill Road and Old Route 28	ACOE	NYSDOS	DCSWCD SMP, CWC

Table 6-3 lists potential funding sources for property mitigation and relocations.

Table 6-3
Potential Funding Sources for Other Mitigation Projects

Option	Federal	State	Other
Floodproofing of individual non-residential buildings	FEMA	NYSDOS	None
Elevation of individual non-residential buildings in floodway	None	None	None
Elevation of individual residential buildings in floodway	None	None	None
Elevation of individual non-residential buildings outside of floodway	FEMA	NYSDOS	None
Elevation of individual residential buildings outside of floodway	FEMA, NFIP ICC	None	None
Relocation of anchor businesses and critical facilities such as firehouse	FEMA	NYSDOS	NYCDEP Buyout, CWC*

*CWC funding may be available only if off-site flood levels are reduced as a result of the action

As this LFA plan is implemented, the East Branch Flood Commission and Village of Fleischmanns will need to work closely with potential funders to ensure that the best combinations of funds are secured for the modeled alternatives and for the property-specific mitigation such as floodproofing, elevations and relocations. The East Branch Flood Commission and Village of Fleischmanns may also work closely with local lenders and the chamber of commerce to facilitate the provision of loan services for property mitigation and floodproofing.

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APPENDICES

APPENDIX A

MEETING PRESENTATIONS AND NOTES

DATE: May 19, 2014
MMI #: 5197-03
PROJECT: Fleischmanns LFA

SUBJECT: Public Meeting

LOCATION: Skene Memorial Library, Fleischmanns

ATTENDEES:

Village of Fleischmanns
East Branch Flood Commission

The first public meeting for the Village of Fleischmanns LFA was held on Monday, May 19, 2014 at 6:00 p.m. at the Skene Memorial Library with the East Branch Flood Commission. The purpose of the meeting was to present an outline of the project, gather public input about flooding, and collect ideas for flood hazard mitigation options with emphasis on those that can be evaluated in HEC-RAS using the FEMA hydraulic model. Tropical storms Irene & Lee caused massive damage in 2012. Our challenge is to manage and reduce the risk of flooding and erosion in Fleischmanns.

Presenters from Milone & MacBroom, Inc. (MMI) were David Murphy, P.E., CFM [Certified Floodplain Manager] and Mark Carabetta, CFM, PWS [Professional Wetland Scientist]. Present were: Mayor Todd Pascarella, Deputy Mayor Benjamin Fenton, Village Trustee Harriet L. Grossman, and Graydon Dutcher and Rick Weidenbach from Delaware County Soil & Water. The Public included Bud Sife, Bob Makara, Herb Finch, Susanna Finch, Fred Woller, Bill Birns, Roy Todd, Roman Kossak, Irene Zola, H. Henry Hermann, Gloria Zola-Mulloy, and others.

One approach is to maintain the ability of streams to move water, sediment, and debris through populated areas while using the natural capacity of floodplains to store water and reduce hazards in the stream system. There may be potential to excavate certain areas of floodplain in order to increase their ability to convey high flows, thereby reducing flooding in flood prone areas of the village. Bridges that are acting as hydraulic constrictions and contributing to flooding will be identified.

Discussion was held about mitigation strategies to reduce potential exposure and losses, the mitigation planning approach, area mitigation goals and objectives.

Subjects discussed were modeling concepts, LFA process, flooding & damage, flood meeting measures and an evaluation of the costs and benefits of various flood mitigation scenarios.

Comments and ideas from the audience included the following:

- Comment that there is a plan in place for a new pedestrian bridge at Bridge Street over Bush Kill. Graydon Dutcher stated that he will provide MMI with the plans for the new bridge. Attendees asked if the bridge will be above flood levels.
- Statement that recently constructed EWP projects will remain in place. Attendees asked if any of the alternatives will evaluate removing or modifying EWP projects.
- Statement that the Main Street bridge over Emory Brook is undersized and causes flooding.
- Potential to make use of old Lake Switzerland to slow flows, store water or sediments. If the lake were always full, it would not help reduce flooding. However, it used to control sediment migration and debris transport. It's possible the former lake can be used to catch floodborne debris before it reaches the village. However if this option were pursued, the lake would need ongoing maintenance which would have costs going forward.
- Depot Street bridge creates flooding problems even during smaller storm events. The bridge opening may need to be increased in size/capacity.
- Potential to create bypass channel from Vly Creek to Emory Brook.
- Potential to put Little Red Kill back to its former location (it used to flow straight where it now takes a sharp bend at Bridge Street).
- Potential to manage floodplains with a goal of more open (less treed) vegetation to reduce roughness.
- Potential to move fire station (which was flooded by Irene) and DPW garage to new location near water treatment plant and use the area as restored floodplain. The 1996 flood did not reach the fire house.
- Aside from the fire station, there are no specific areas that were mentioned for relocations or removal of buildings. However, the evaluation may consider:
  - Potential for removal of other structures from floodplain.
  - Potential to elevate floodprone structures.
  - There is concern that removal of other structures would result in loss of tax base.
- Potential floodplain creation across from Evergreen Restaurant where there is village infrastructure for water system.
- In general, attendees prefer to make floodplains and floodplain benches without moving buildings.
- For example, the floodplain can be lowered between Vly Creek and Emory Brook behind the school where the land is relatively vacant.
- Flood channels through the lumber company yard may allow the company and its buildings to remain in that location.
- Attendees would like the modeling to demonstrate how far (upstream) the constrictions have typically caused flooding. For example, the backwater from the Route 28 bridge seems to be severe but may only be about 1,000 feet.
- Consider temporary and other types of non-traditional bridges.
- Consider additional cross vanes to control flow.

Additional ideas can be forwarded to Todd.

Attendees asked how many homes are in the current buyout program. Seven homes may be included. The Delaware County Planning Department can provide addresses. Those areas would provide immediate locations for lower floodplains.

Prior evaluations have demonstrated that removing the Mill Street bridge and lowering the floodplain there could reduce the 10-year flood water surface elevation by three feet. It is possible that there may be notable reductions in the water surface elevation for some flood events and not others.

MMI showed examples of the new FEMA mapping of the stream channels through Fleishmanns, which will be used for the hydraulic modeling analysis.

Graydon Dutcher showed a video of a successful floodplain enhancement project that helps mitigate flooding from a 10-year storm.

Rick explained that programs like the CWC and the buyout program can help, and new programs such as the one that keeps a property owner in the community will maintain the tax base.

Attendees were concerned about the time that the LFA and the recommended projects could take. What if a 10-year storm were to occur soon? Graydon explained that some projects could likely be done soon, like reconnecting some floodplains to the streams. Bridge replacements will take longer.

Phil noted that depth mapping can be used to analyze how flood depths vary across the building stock. This could be used to show how homeowners can be helped by different projects.

The 1996 flood surrounded the home at 45 Bridge Street but the structure was not flooded. Irene caused more damage in that area.

Graydon noted that climate change is affecting flood discharges. The flood discharge of Vly Creek is up 67%. Phil explained that FEMA's analysis must use the hydrologic record of past peak discharges.

There will be a follow-up public meeting where the results of MMI's analysis will be presented. Date of the meeting is TBD.

All were encouraged to attend the open house on May 27 in the Middletown Town Hall to review the new FIRM that will be adopted in 2014 or 2015. Phil indicated that the new FEMA modeling was validated with the peak flood from Irene.

MILONE & MACBROOM

Local Flood Analysis

Public Information Meeting

Village of Fleischmanns

David Murphy, P.E., CFM
Mark Carabetta, PWS, CFM

East Branch Flood Commission and Delaware County Soil & Water Conservation District | May 19, 2014

Purpose of Tonight's Workshop

- Explain the Local Flood Analysis (LFA) process
- Review our understanding and the specific concerns in Fleischmanns
- Review the study area
- Introduce modeling concepts and review existing model
- Review flood mitigation options
- Collect input from residents and property owners about flooding and damage
- Compile ideas for flood mitigation

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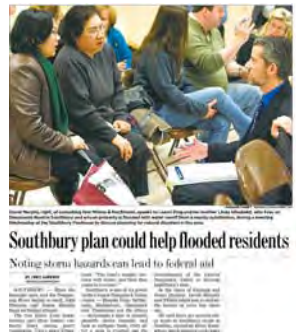
The LFA Process

- Uniform across communities yet can be customized
- Collect input about flooding and flood damage
- Build upon FEMA flood modeling efforts and the county hazard mitigation plan
- Identify and evaluate potential flood mitigation measures that protect water quality
- Through hydraulic modeling, assess potential magnitude of flood relief alternatives
- Refine alternatives through vetting of cost, feasibility, and public support
- Includes an implementation plan



Southbury plan could help flooded residents

Noting storm hazards can lead to federal aid

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Typical Water Quality Impacts of Flooding

- Mobilization of sediment
- Mobilization of pollutants
  - Basements and basement utilities
  - Materials stored at commercial and industrial sites
  - Gasoline service stations
  - Fuel oil
  - Swimming pools
  - Waste storage sites
  - Septic Systems
  - Vehicles

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Why Fleischmanns?

- Fleischmanns has been devastated by flooding, resulting in extensive damage
- Infrastructure, businesses, and homes remain vulnerable
- Located within the New York City public water supply watershed
- LFA funding provides a unique opportunity to assess the watershed under current conditions and plan for the future

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LHA Advisory Committee

- East Branch Flood Commission
- Village of Fleischmanns
- Town of Middletown
- Delaware County
- Delaware County Soil & Water Conservation District
- New York City Department of Environmental Protection
- Milone & MacBroom, Inc.

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LFA Advisory Committee

East Branch Flood Commission

- Middletown, Halcott, Hardenburgh, Roxbury, Fleischmanns, and Margaretville
- Identify Flood Risks
- Educate and Inform Residents, Businesses, Government Officials and Local Agencies of Flood Risks
- Work with Local, State and Federal Officials and Agencies to:
  - ✓ Identify projects and programs that reduce the incidence and impacts of flooding
  - ✓ Work together regionally and individually to fund and implement projects and associated programs throughout our area
  - ✓ Enhance and encourage economic development in flood safe areas
  - ✓ Educate the wider public regionally as to the mitigation and flood planning and recovery efforts that are in process
  - ✓ Work to coordinate and support local and regional communication and recovery efforts during declared disaster events across municipal boundaries

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Understanding

Community Planning and Regulations that Preceded T.S. Irene

- The Village Comp Plan was Updated in 2009. Includes the Strategy:
  - *"Regulate development of buildings, impervious surfaces or storage of materials within the 100-year floodplain"*
- The Village Zoning Map was updated in 2010
  - *A new district was created – "The Mixed Use Zoning District is established for the purpose of providing a compatible mixture of commercial, employment, residential, recreational, civic, and/or cultural uses on Main Street"*
- The Village Zoning Law was Updated in 2011
- Flood Damage Prevention is Partly Addressed with an Overlay District (FH)
  - *"Buildings and uses shall be in accordance with the U.S. Flood Disaster Protection Act, as well as with the requirements of the underlying district"*

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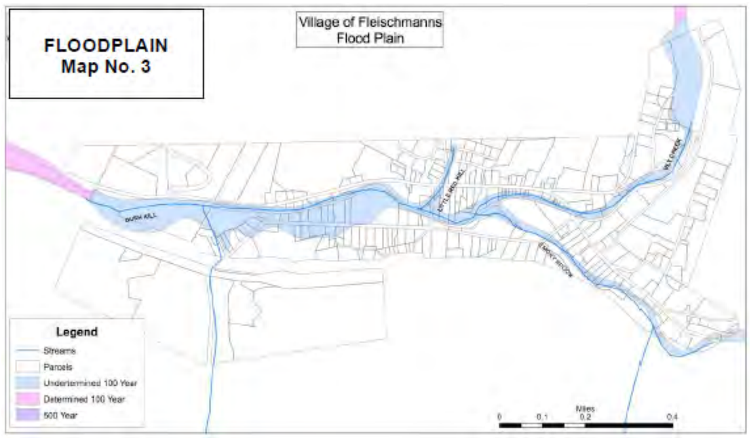
Understanding

FEMA Mapping



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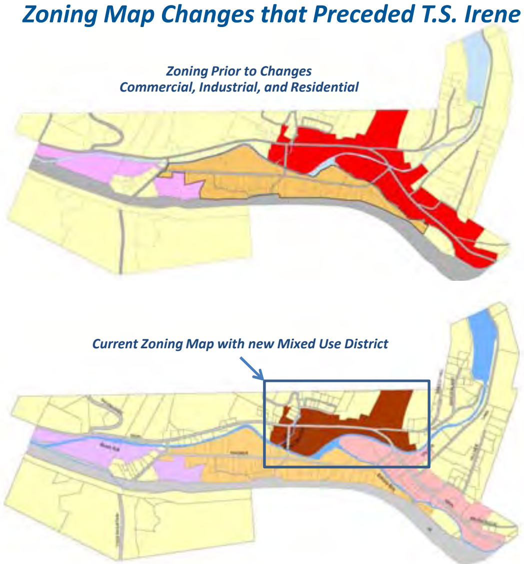
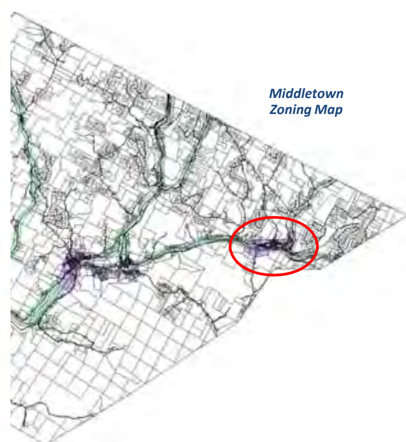
Understanding

Zoning Map Changes that Preceded T.S. Irene





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Understanding

Specific Concerns and Issues

- Changes in FEMA Mapping – Expansion of Homes and Businesses in the SFHA
- Some Property Owners Have Not Been Required to Have Flood Insurance, But May Be Required to Have It
- At the Same Time, Flood Insurance Premiums are Increasing as Actuarial Rates are Phased In
- Potential Community Rating System (CRS) Participation
- Property Owners can Make Changes to Their Structures and Utilities to Reduce Insurance Premiums
- Approximately Four Property Acquisitions in the Village are Pending

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Understanding

Specific Concerns and Issues

- Channelized Sections of Streams are Located in the Village
- Berms, Revetments, and Walls are Found Along the Streams in Some Locations
- Lack of Connection to Floodplain
- High Flows are Completely Contained (unless overbank) and Shear Stresses are High, Leading to Erosion
- EWP Streambank Projects have Been Completed but Largely Replicate Previous Conditions
- Flood Mitigation is Desired!

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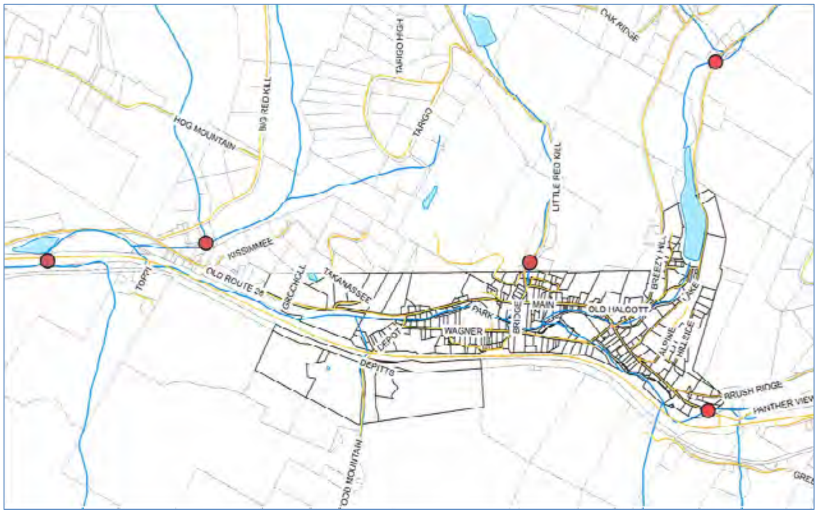
Project Area



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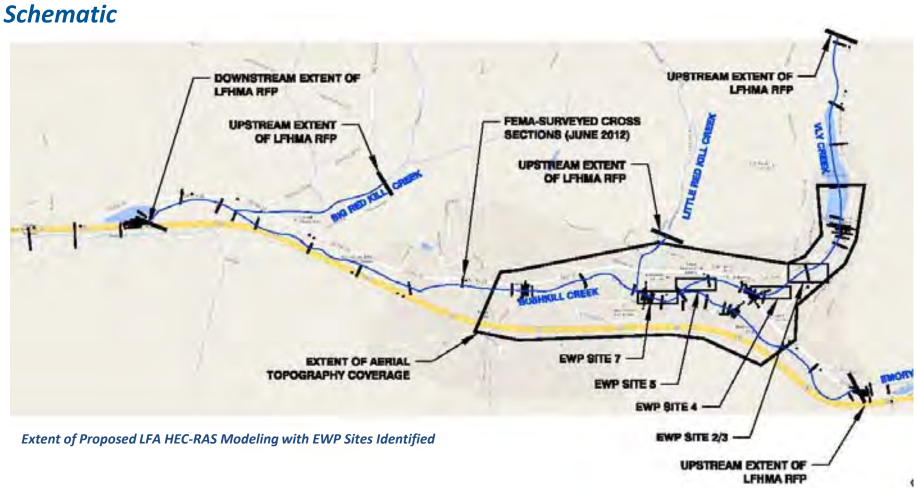
Project Area with EWP Sites

Schematic



Extent of Proposed LFA HEC-RAS Modeling with EWP Sites Identified

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Hydraulic Modeling Concepts

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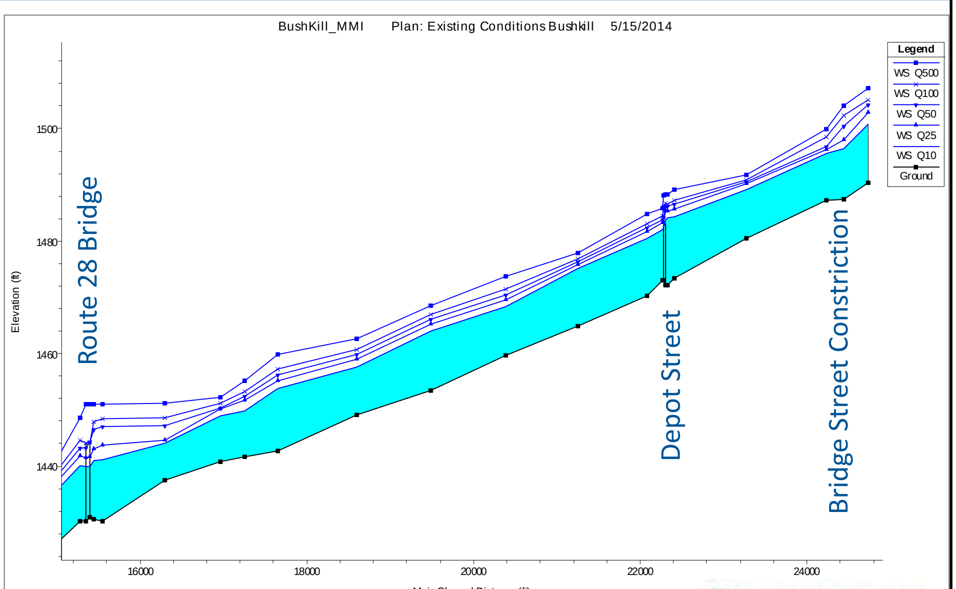
Hydraulic Modeling – Bush Kill Profile



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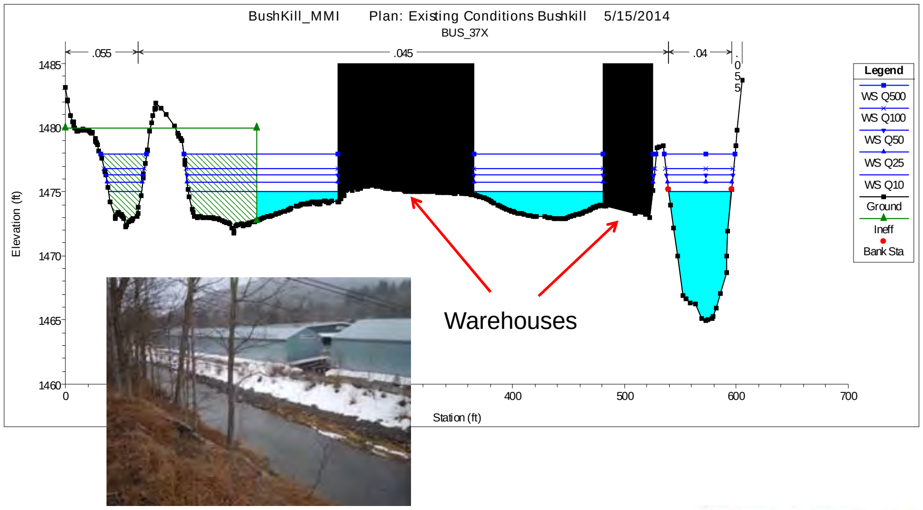
Hydraulic Modeling – Bush Kill Cross Section

Cross Section 21619 – Across Hardware Store



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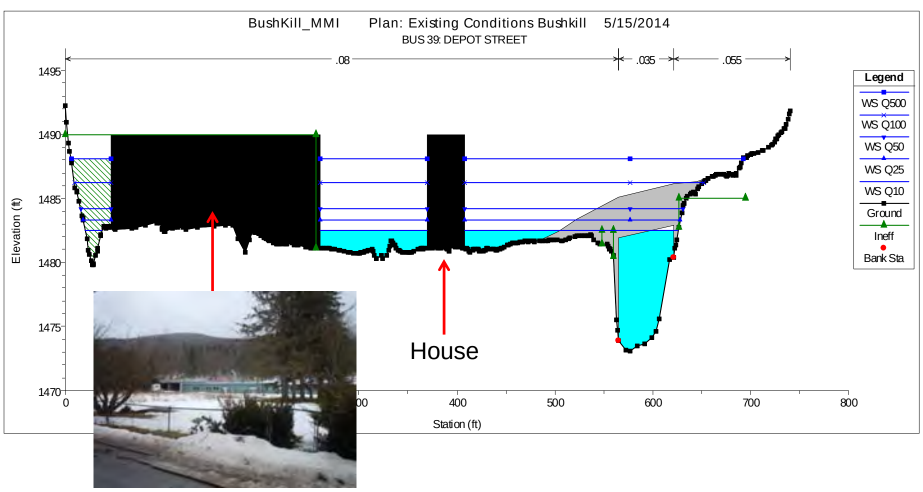
Hydraulic Modeling – Bush Kill Cross Section

Cross Section 22660 – Upstream of Depot Street Bridge



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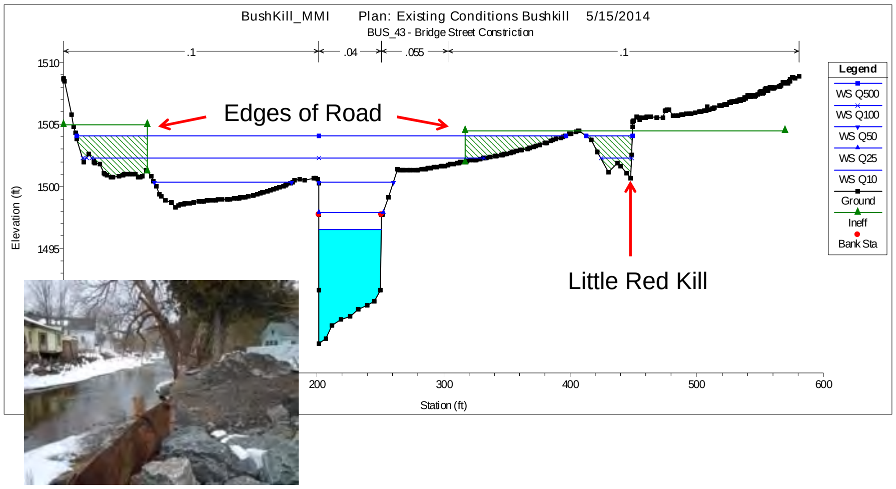
Hydraulic Modeling – Bush Kill Cross Section

Cross Section 24801 – Channel Constriction at Bridge St former Bridge Location



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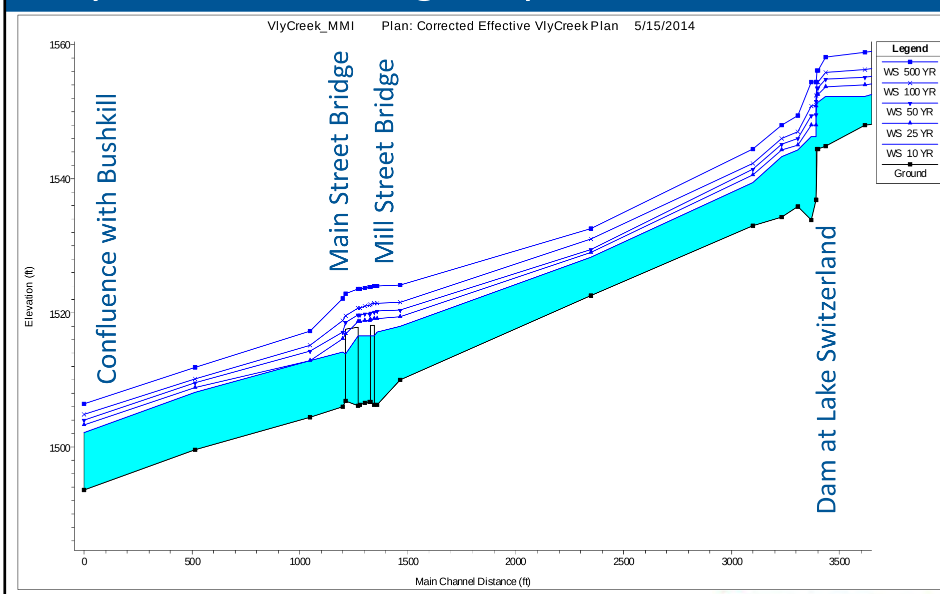
Hydraulic Modeling – Vly Creek Profile



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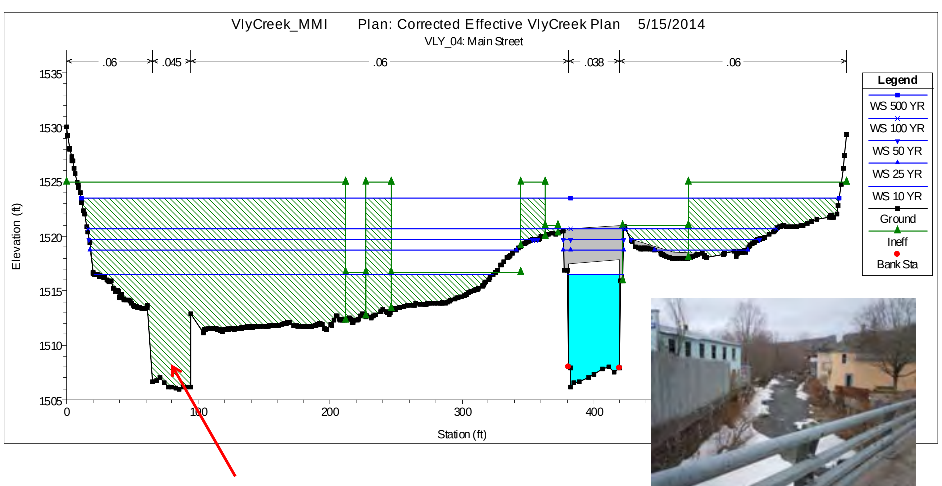
Hydraulic Modeling – Vly Creek Cross Section

Cross Section 1296 – Across Camp just downstream of Wagner Avenue

Emory Brook

Hydraulic Modeling – Vly Creek Cross Section

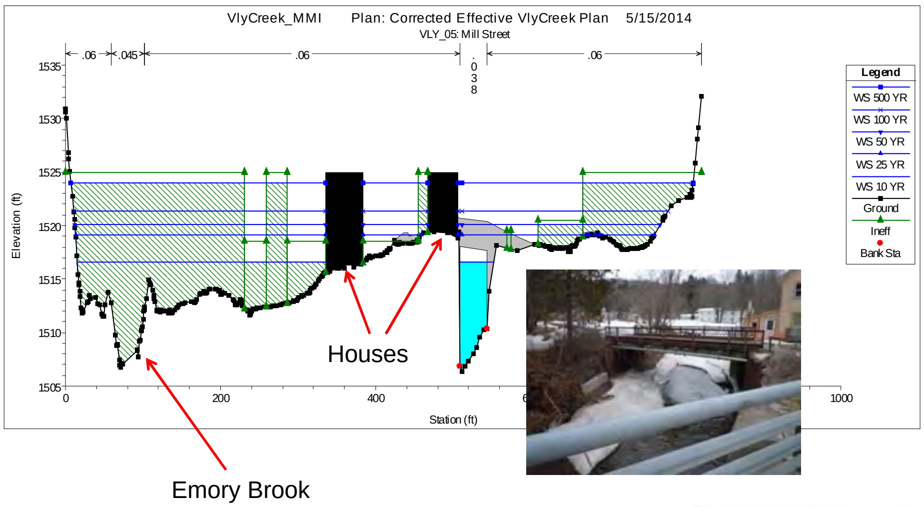
Cross Section 1494 – Main Street Bridge



Emory Brook

Hydraulic Modeling – Vly Creek Cross Section

Cross Section 1585 – Mill Street Bridge



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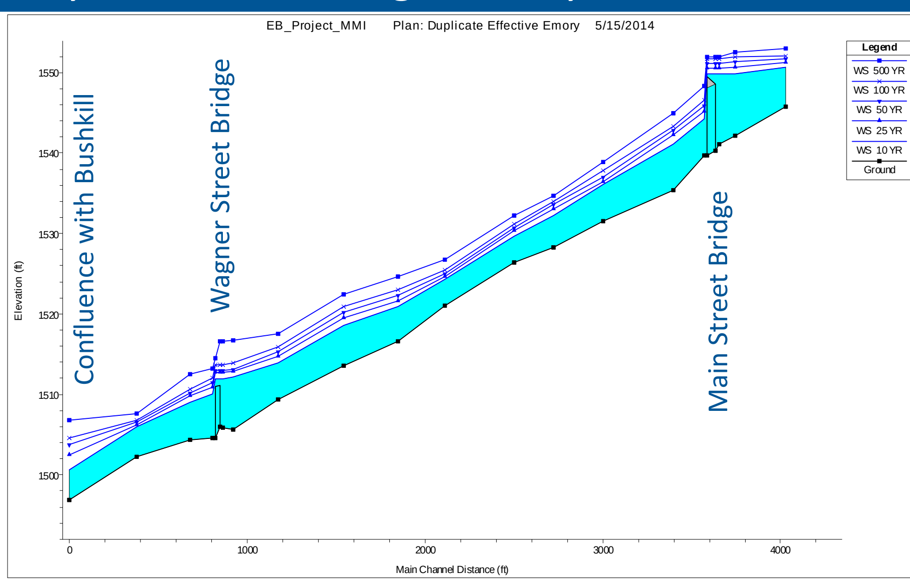
Hydraulic Modeling – Emory Brook Profile



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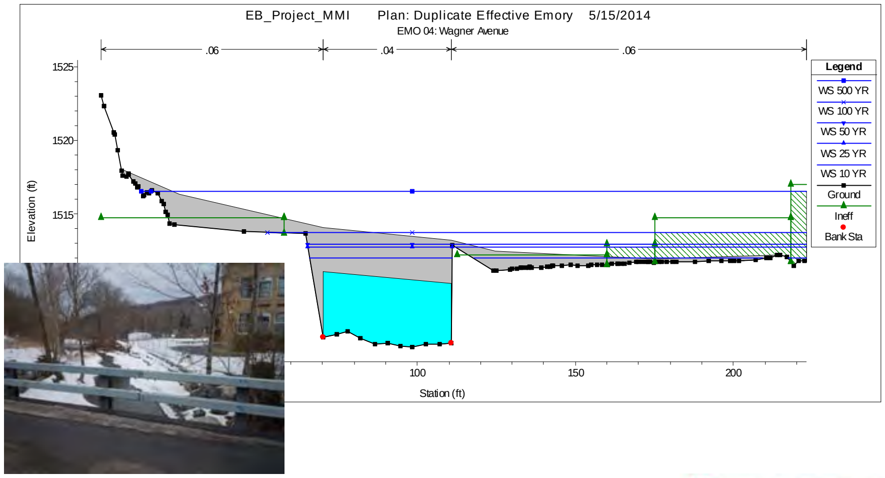
Hydraulic Modeling – Emory Cross Section

Cross Section 1068 – Wagner Avenue Bridge – Part of Floodplain is used by Vly Creek Floodwater



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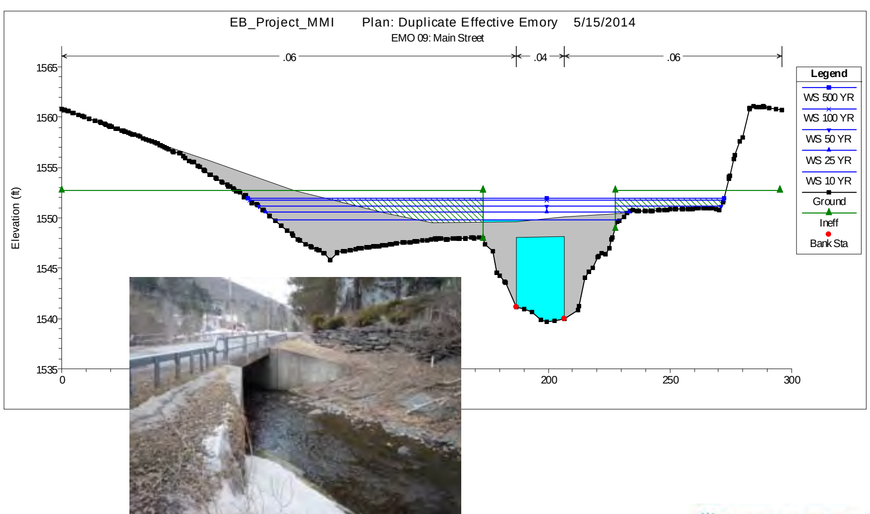
Hydraulic Modeling – Emory Cross Section

Cross Section 3843 – Main Street Bridge



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2013 FEMA Mapping (or FIRM)

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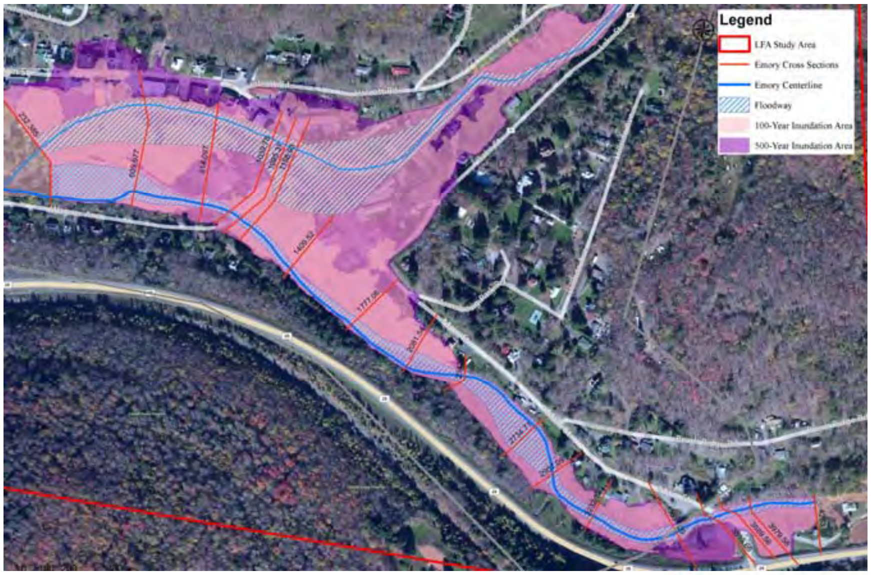
New FEMA Mapping

Milone & MacBroom

New FEMA Mapping



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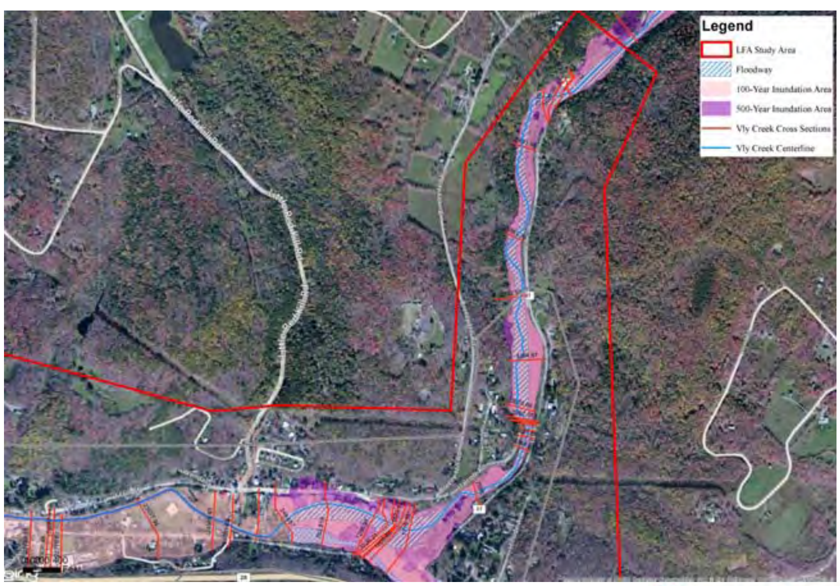
New FEMA Mapping



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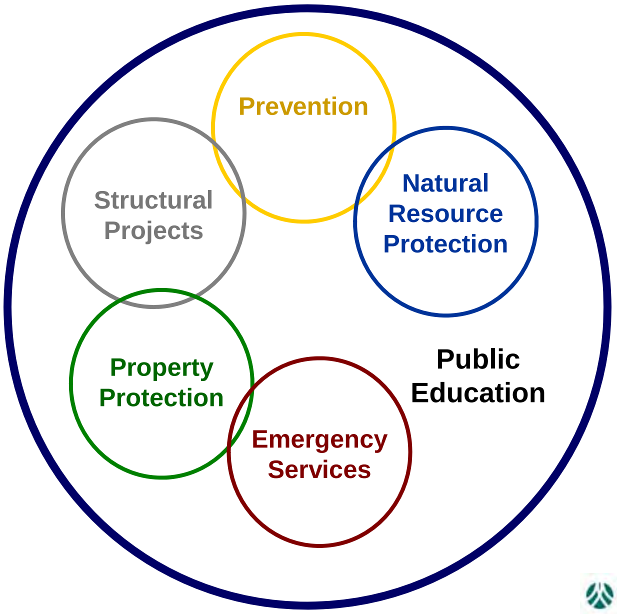
Types of Flood Mitigation



Flood Mitigation Strategies

Flood Mitigation

Structural Projects

- Replace Bridges and Culverts
- Remove In-Stream Dams
- Remove Obstructions
- Upstream Detention
- Install Stormwater Systems
- Create Floodways
- Enlarge Channels
- Reduce Flow Resistance
- Install Levees
- Install Flood Walls

Property Protection

- Wet Floodproofing
- Dry Floodproofing
- Elevate Buildings
- Relocate Buildings
- Secure Utilities
- Anchor Floatables
- Remove Hazardous Materials
- Re-Grade Properties
- Purchase Flood Insurance
- Join the Community Rating System (CRS)

Prevention

- Modify Zoning
- Modify Comp Plan
- Stormwater Management Regulations
- Increase Flood Damage Prevention Standards
- Freeboard
- Low Impact Development
- Minimize Impervious Cover

Flood Mitigation Strategies

Flood Mitigation

Natural Resources

- Acquire or Preserve Floodplain Land
- Acquire and Remove Structures from Floodplains and Convert to Open Space
- Acquire or Preserve Other Lands
- Increase Wetland Storage
- Re-Connect Streams to Floodplains

Emergency Services

- Build Local Capacities to Respond
- Move Critical Facilities from Flood Risk Areas
- Establish Emergency Shelters
- Elevate Roads or Bridges to Ensure Egress
- Develop Community Evacuation Plans
- Develop Site-Specific Evacuation Plans
- Establish Satellite Facilities in Areas Subject to Isolation

Public Education

- Newsletters
- Community Meetings
- Information Kiosks
- Web Site with Flood Risk Maps
- Education of Municipal Staff
- Leverage State and FEMA Education Programs
- Establish a Standing Committee or Board to Oversee Outreach

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Ideas for Flood Mitigation

- Modify or remove bridges?
- Remove channel constrictions?
- Create floodplains or floodplain benches?
- Home or business relocation?
- Home or business elevation?
- Create bypass channels?
- Modify regulations or zoning?
- Join CRS and encourage purchase of insurance?

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Next Steps

- Identification of additional alternatives
- HEC-RAS modeling of options
- Estimation of costs and flood mitigation benefits associated with these options
- Present preliminary findings at a public meeting

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Questions and Comments

Local Flood Analysis Meeting to Discuss Pedestrian Bridge

Village of Fleischmanns

Mark Carabetta, PWS, CFM

East Branch Flood Commission and Delaware County Soil & Water Conservation District | July 28, 2014

New Floodplain near Bridge Street

Mitigation of Bridge Street Constriction

Preliminary Results of Alternatives

Q100	Section 25095	Section 24801
	Upstream End	US of Bridge St.
Existing Conditions	1505.34	1502.26
Remove Constriction at Bridge Street (90')	1503.8	1499.9
Remove Constriction at Bridge Street (72')	1504.4	1500.6
Create Floodplain North Side near Bridge Street	1501.2	1500.0
Combined 72' Channel and Floodplain	1501.0	1499.8

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Preliminary Results of Alternatives

Q100	Section 25095	Section 24801
	Upstream End	US of Bridge St.
Existing Conditions	1505.34	1502.26
Remove Constriction at Bridge Street (90')	1503.8	1499.9
Remove Constriction at Bridge Street (72')	1504.4	1500.6
Create Floodplain North Side near Bridge Street	1501.2	1500.0
Combined 72' Channel and Floodplain	1501.0	1499.8

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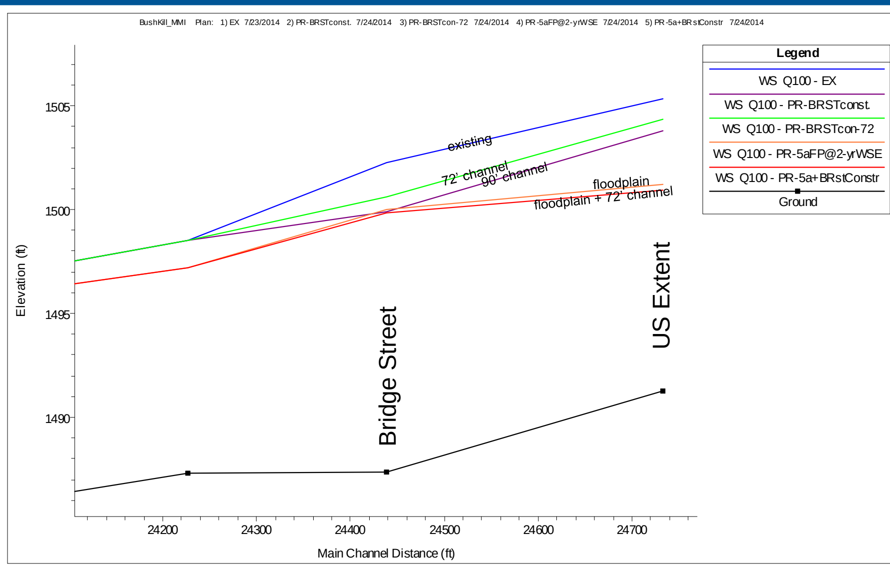
Preliminary Results of Alternatives



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Modeled Pedestrian Bridge Alternatives

- Began with MMI Existing Conditions as Base Model
- Removed Constriction at Bridge Street using 55' Bankfull channel for a top of bank width of 72 feet at the bridge sections
- Copied Bridge Street Cross Section to Bound new Bridge
- Added Bridges based on 10/1/2013 Plans from Modjeski and Masters
- Compared each Bridge Alternative to Existing Conditions, Non-Constricted Channel, and with expanded floodplain options
- Different base models result in different results than Bridge Consultant

100-year Flood	Listed on B-80 Plans	MMI Model
Magnitude (cfs)	9365	9929
Existing WSE (ft)	1500.1	1503.45
With Bridge WSE (ft)	1501.28	1502.26
Velocity Existing (ft/s)	15.96	10.75
Velocity With Bridge (ft/s)	14.62	14.21

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Preliminary Results- US Extent of Bushkill

Q100	Existing Conditions =	1505.3
	No Change Outside Channel	With Floodplain
No Bridge & No Constriction	1504.4	1501.0
Bridge A	1504.7	1502.5
Bridge B	1504.7	1504.9
Bridge C	1503.9	1502.1
Q50	Existing Conditions =	1504.3
	No Change Outside Channel	With Floodplain
No Bridge & No Constriction	1503.3	1500.1
Bridge A	1503.3	1501.6
Bridge B	1503.4	1503.5
Bridge C	1502.2	1501.2
Q10	Existing Conditions =	1500.7
	No Change Outside Channel	With Floodplain
No Bridge & No Constriction	1499.8	1498.4
Bridge A	1499.8	1499.2
Bridge B	1499.8	1499.7
Bridge C	1499.4	1499.0

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Local Flood Analysis

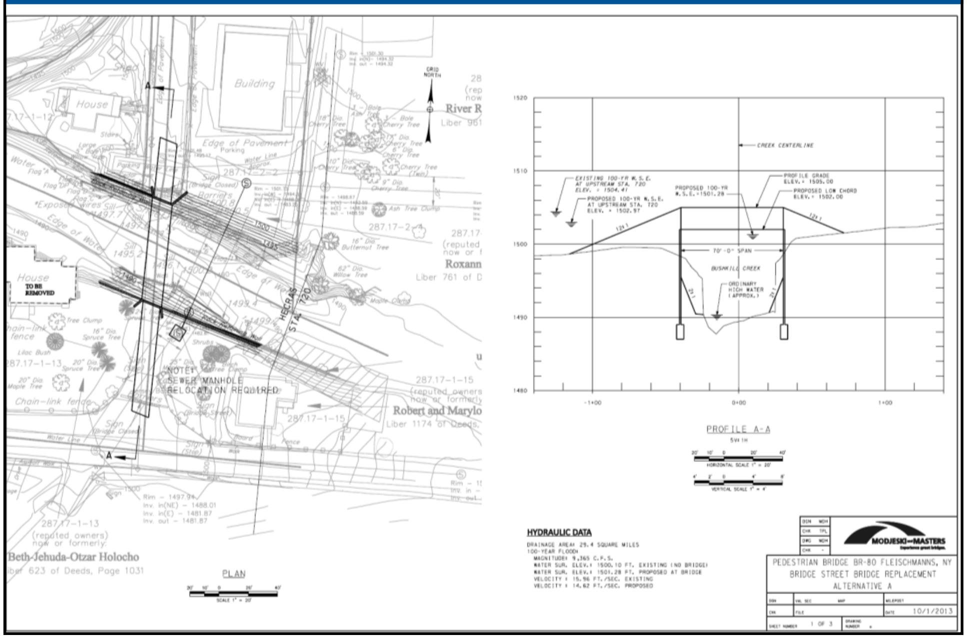
Information Meeting

Village of Fleischmanns

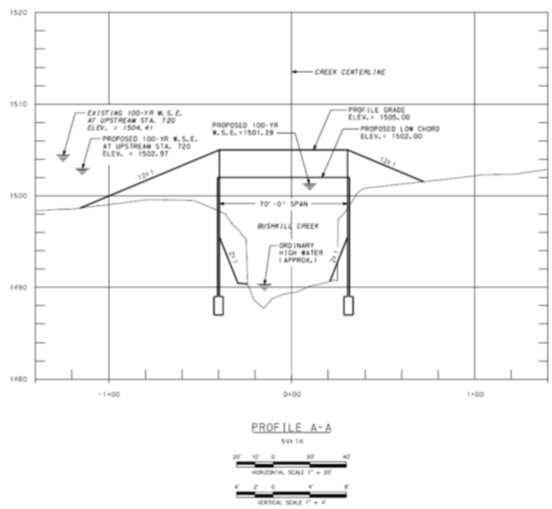
Mark Carabetta, PWS, CFM

Village Board | August 11, 2014

Bridge Street Pedestrian Bridge Alternatives

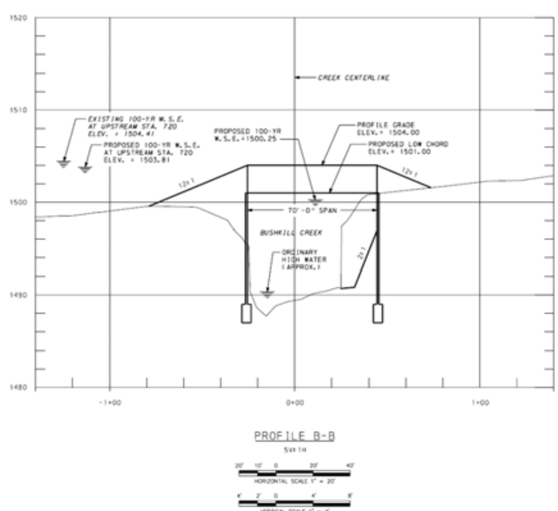


Bridge Street Pedestrian Bridge Alternatives



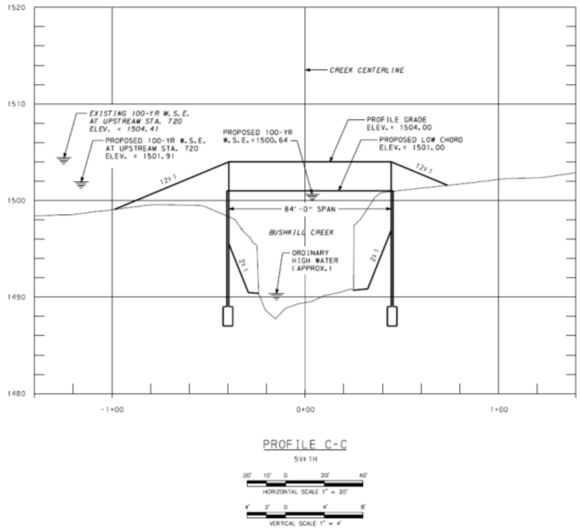
Bridge Option A: Low Chord at 1502' and span of 70'

Bridge Street Pedestrian Bridge Alternatives



Bridge Option B: Low Chord at 1501' and span of 70'

Bridge Street Pedestrian Bridge Alternatives



Bridge Option C: Low Chord at 1501' and span of 84'

Alternate #5: Floodplain near Bridge Street

New Floodplain near Bridge Street

Removal of Bridge Abutments

Mitigation of Bridge Street Constriction

Preliminary Results of Alternatives

Q100	Section 24801 at Bridge St.	Section 25095 ~300' u/s Bridge St.
Existing Conditions	1502.26	1505.34
Remove Constriction at Bridge Street (90')	1499.9	1503.8
Remove Constriction at Bridge Street (72')	1500.6	1504.4
Create Floodplain North Side near Bridge Street	1500.0	1501.2
Combined 72' Channel and Floodplain	1499.8	1501.0

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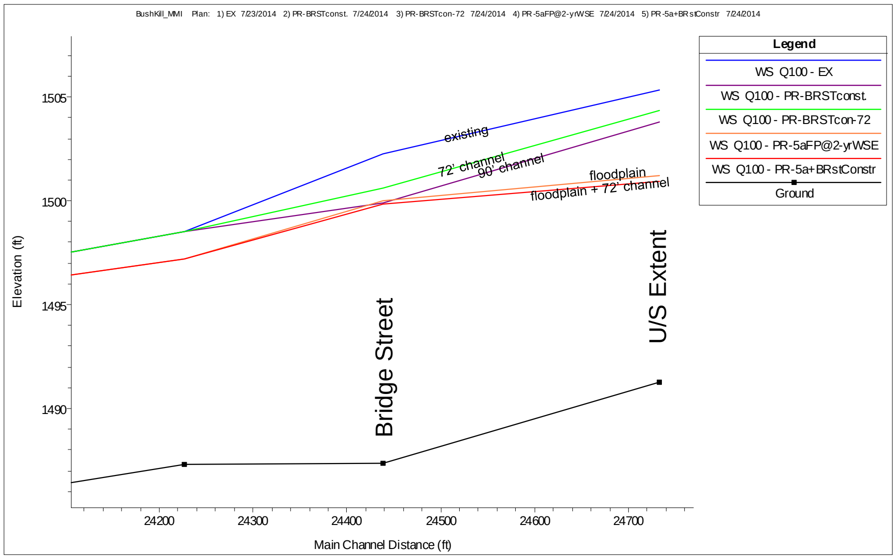
Preliminary Results of Alternatives



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Modeled Pedestrian Bridge Alternatives

- MMI existing conditions as base model
- Removed constriction at Bridge Street (55' W_{bf}; 72' TOB)
- Added pedestrian bridges (Modjeski & Masters, 10/1/2013)

- Different base models = different results

100-year Flood	Listed on B-80 Plans	MMI Model
Magnitude (cfs)	9365	9929
Existing WSE (ft)	1500.1	1503.45
With Bridge WSE (ft)	1501.28	1502.26
Velocity Existing (ft/s)	15.96	10.75
Velocity With Bridge (ft/s)	14.62	14.21

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Preliminary Results- US Extent of Bushkill

Q100	Existing Conditions = 1505.3	
	Without Floodplain	With Floodplain
No Bridge & No Constriction	1504.4	1501.0
Bridge A	1504.7	1502.5
Bridge B	1504.7	1504.9
Bridge C	1503.9	1502.1
Q50	Existing Conditions = 1504.3	
	Without Floodplain	With Floodplain
No Bridge & No Constriction	1503.3	1500.1
Bridge A	1503.3	1501.6
Bridge B	1503.4	1503.5
Bridge C	1502.2	1501.2
Q10	Existing Conditions = 1500.7	
	Without Floodplain	With Floodplain
No Bridge & No Constriction	1499.8	1498.4
Bridge A	1499.8	1499.2
Bridge B	1499.8	1499.7
Bridge C	1499.4	1499.0

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Minutes of Meeting

DATE: November 18, 2014
MMI #: 5197-03
PROJECT: Fleischmanns LFA

SUBJECT: Status Report

LOCATION: Skene Memorial Library, Fleischmanns

ATTENDEES:

Village of Fleischmanns
East Branch Flood Commission

A meeting of the East Branch Flood Commission was held on November 18, 2014 at 6:00 p.m. at the Skene Memorial Library. The purpose of the meeting was to present an update of the project, present a number of flood mitigation alternatives and their benefits in reducing flooding in the village, and gather feedback on the alternatives.

Presenters from Milone & MacBroom, Inc. (MMI) were David Murphy and Mark Carabetta. Present at the meeting were: Mayor Todd Pascarella, Graydon Dutcher from DCSWCD, Phil Eskeli from NYCDEP, and six members of the flood commission.

Comments and ideas from the audience included the following:

1. Graydon Dutcher stated that the Big Red Kill carries a very high sediment load and regular sediment removal is required to keep the channel clear. This is distinct from other communities where sediment removal is often desired but not technically feasible for flood mitigation.
2. Mayor Pascarella stated that the firehouse and DPW garage on Main Street are being considered for relocation. He would like to know the likelihood of reducing flooding at those locations under the alternatives being considered, which will help inform the decision of whether to relocate. His initial impression is that significant floodplain work is needed to reduce flood depths, and relocation may be more straightforward. Graydon noted that the LFA report will need a specific recommendation regarding the fire house.
3. Mayor Pascarella suggested that MMI provide a printed, large-scale map showing all of the proposed alternatives.
4. Phil Eskeli suggested that MMI divide the alternatives and recommendations into short term and long term categories, as was done in Walton.
5. Mayor Pascarella and Graydon Dutcher stated that a floodplain bench was recently constructed in the park/ballfield area and asked if a larger floodplain in this area would have any benefit. Specifically, the mayor would like to evaluate an alternative that extends a floodplain bench downstream from the park toward the next bridge.

6. Suggestion from several in group that the LFA report should include a recommendation regarding the stockpiled concrete in the floodplain near Depot Street, which may act like a dam during flood events.
7. Graydon and the other attendees requested that MMI evaluate an alternative that keeps the hardware store in place but relocates or removes the surrounding outbuildings and lowers the floodplain beneath the outbuildings.
8. Phil noted that the LFA report will need to definitely describe whether existing berms are included in the modeling.
9. Graydon suggested that additional cross sections should be added in several locations including the wide gaps depicted in alternative 6. These new cross sections might be helpful to evaluate how floodwaters move around the hardware store after outbuildings are removed (see #7 above).
10. Phil asked whether adding cross sections further downstream would be helpful. Attendees agreed that this may not be effective in providing more model detail.
11. Mayor Pascarella requested that the PowerPoint presentation be sent to him so that it could be posted on the village website.

There will be a follow-up meeting where additional results of the LFA will be presented. Date of the meeting is TBD.

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Local Flood Analysis
Project Meeting
Village of Fleischmanns

David Murphy, P.E., CFM
Mark Carabetta, PWS, CFM

East Branch Flood Commission and Delaware County Soil & Water Conservation District | November 18, 2014

Agenda

- Review study area and modeling concepts
- Overview of alternatives
- Review results of modeling
- Next steps

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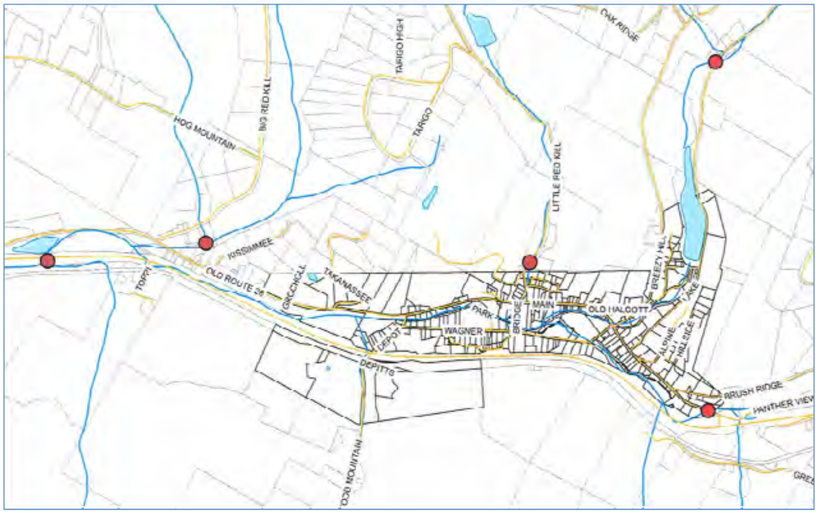
Project Area



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Hydraulic Modeling Concepts

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Overview of Alternatives

- Hydrologic (for future meetings)
  - Alt 2 – Storage of water in Lake Switzerland
  - Alt 3 – Vly/Emory bypass
- Hydraulic (focus for this meeting)
  - Alt 1 – Bridge replacements
  - Alts 4, 5, 6, 7, 8, 9 – Floodplain creation or enhancement

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Overview of Alternatives

1. Bridge Replacements
   a. Emory Brook at Main Street
   b. Emory Brook at Wagner Avenue
   c. Vly Creek at Mill Street
   d. Vly Creek at Main Street
   e. Little Red Kill at Snyder Avenue
   f. Little Red Kill at Main Street
   g. Little Red Kill at Bridge Street
   h. Bush Kill Creek at the former Bridge Street bridge **(subject of meetings in July and August 2014)**
   i. Bush Kill Creek at Depot Street
   j. Big Red Kill at Old Route 28

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Overview of Alternatives

- Floodplain Creation, Enhancement, etc.
  4. Upstream area (Emory/Vly confluence)
  5. Bridge Street area of Bush Kill (topic of previous meetings)
  6. Middle area of Bush Kill (west end of Wagner Avenue, Depot Street, and lumber yards)
  7. Downstream area of Bush Kill (along Route 28)
     - Downstream area of Bush Kill + Big Red Kill
  8. Vly Creek at Mill Street
  9. Emory Brook at Wagner Road

Most alternatives are relatively modular and don't affect one another

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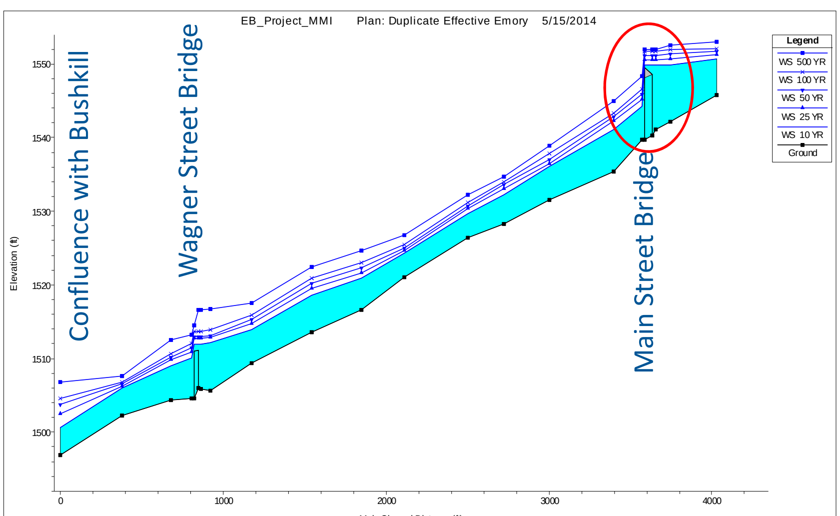
Review Results of Modeling

1a. Bridge Replacement – Emory Brook at Main Street



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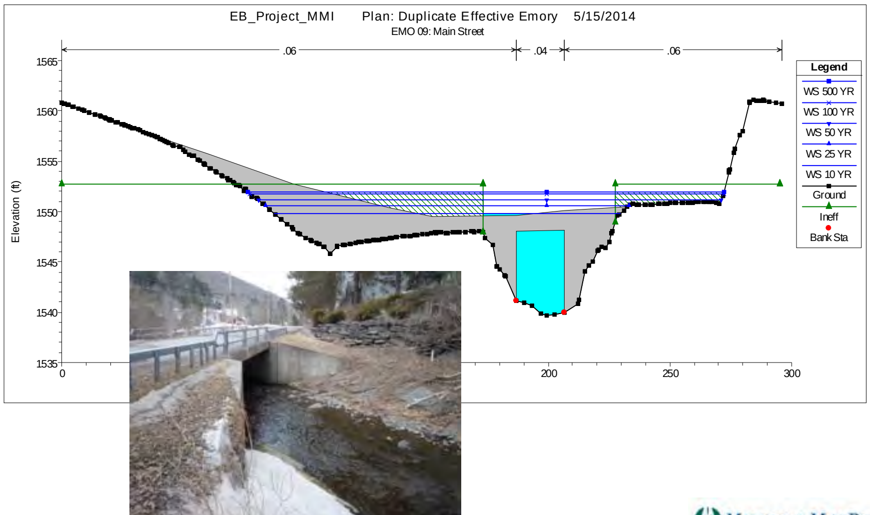
Review Results of Modeling

1a. Bridge Replacement – Emory Brook at Main Street



MILONE & MACBROOM

Review Results of Modeling

1a. Bridge Replacement – Emory Brook at Main Street

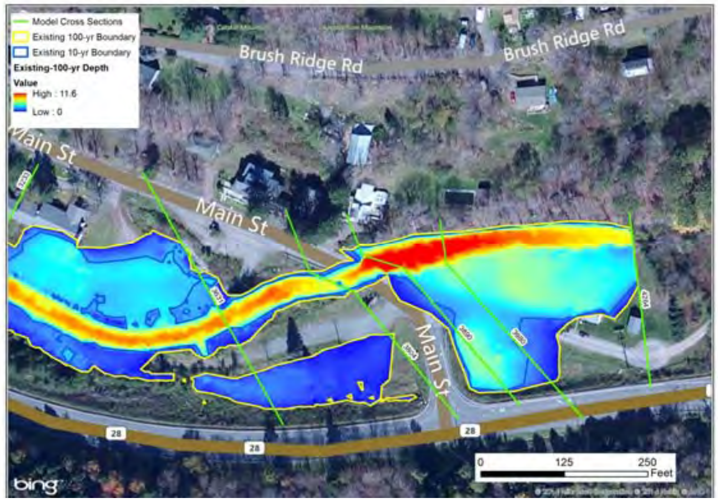
Proposed improvements

MILONE & MACBROOM

Review Results of Modeling

1a. Bridge Replacement – Emory Brook at Main Street

Current depths

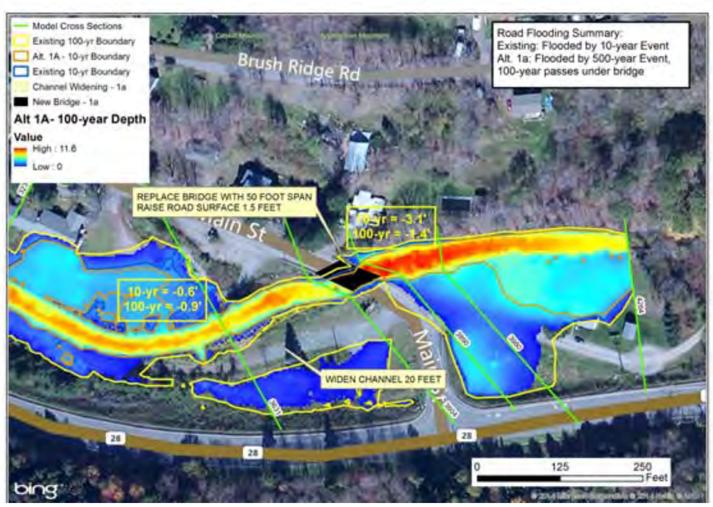


MILONE & MACBROOM

Review Results of Modeling

1a. Bridge Replacement – Emory Brook at Main Street

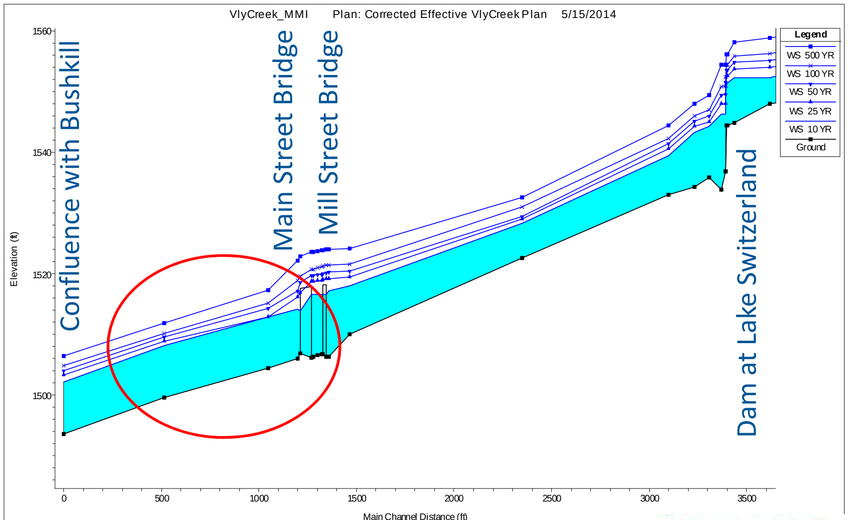
Depths after bridge replacement



MILONE & MACBROOM

Review Results of Modeling

4a and 4b. Floodplain Enhancement at Vly near Confluence



MILONE & MACBROOM

Review Results of Modeling

4a and 4b. Floodplain Enhancement at Vly near Confluence

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Review Results of Modeling

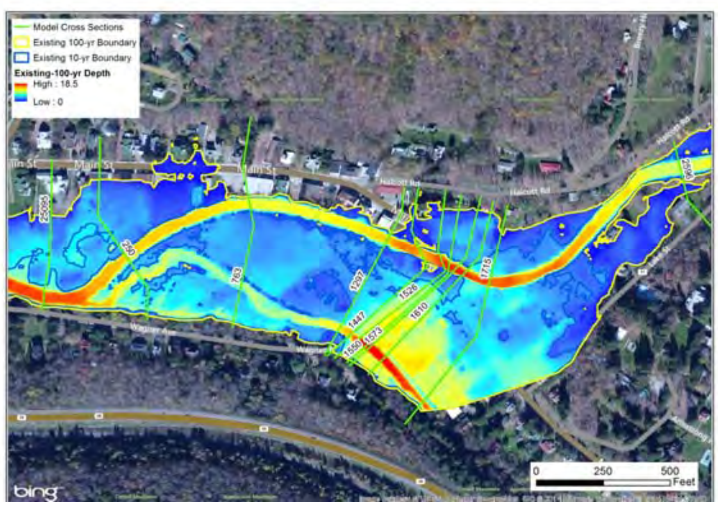
4a and 4b. Floodplain Enhancement at Vly near Confluence

MILONE & MACBROOM

Review Results of Modeling

4a. Floodplain Enhancement at Vly near Confluence

Current depths

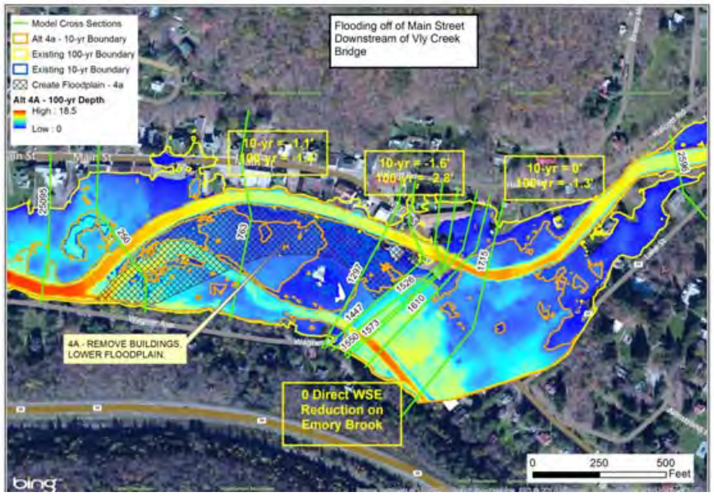


MILONE & MACBROOM

Review Results of Modeling

4a. Floodplain Enhancement at Vly near Confluence

Depths after floodplain project



MILONE & MACBROOM

Review Results of Modeling

4a. Floodplain Enhancement at Confluence

Comparison of inundated areas

Motel 100-yr WSE changes from 1520.8 to 1517.9 and it partly leaves the SFHA

School 100-yr WSE changes from 1515.2 to 1513.4

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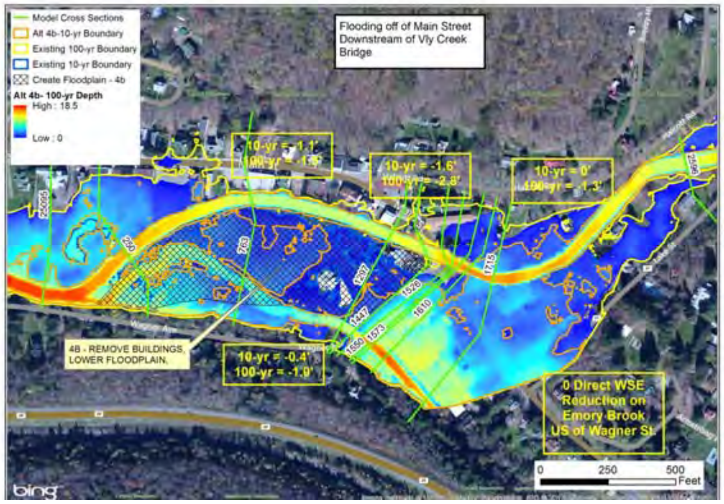
Review Results of Modeling

4b. Larger Floodplain Enhancement at Confluence

Depths after floodplain project



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Review Results of Modeling

4b. Larger Floodplain Enhancement at Vly near Confluence

Comparison of inundated areas

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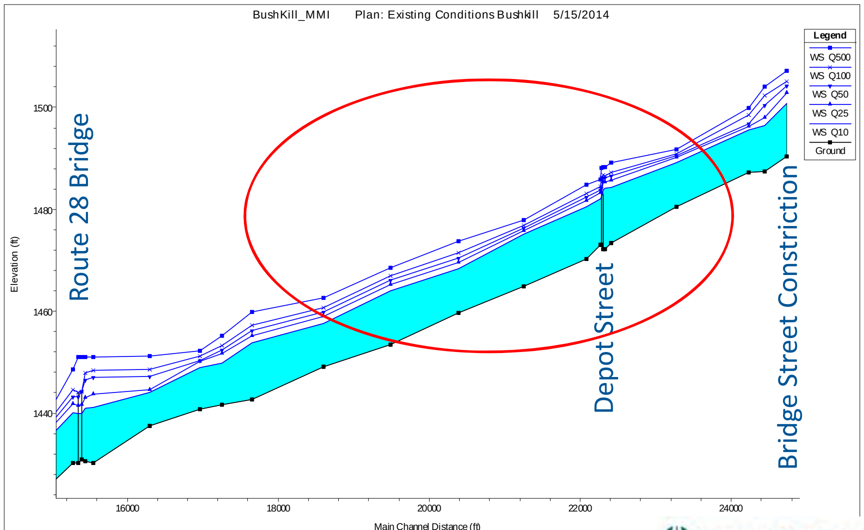
Review Results of Modeling

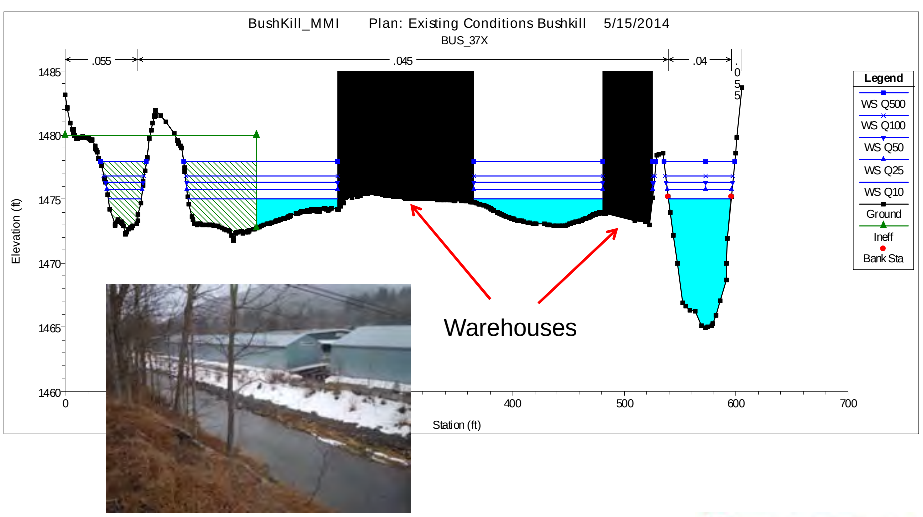
6a and 6b. Floodplain Enhancement near Depot Street



MILONE & MACBROOM

Review Results of Modeling

6a and 6b. Floodplain Enhancement near Depot Street



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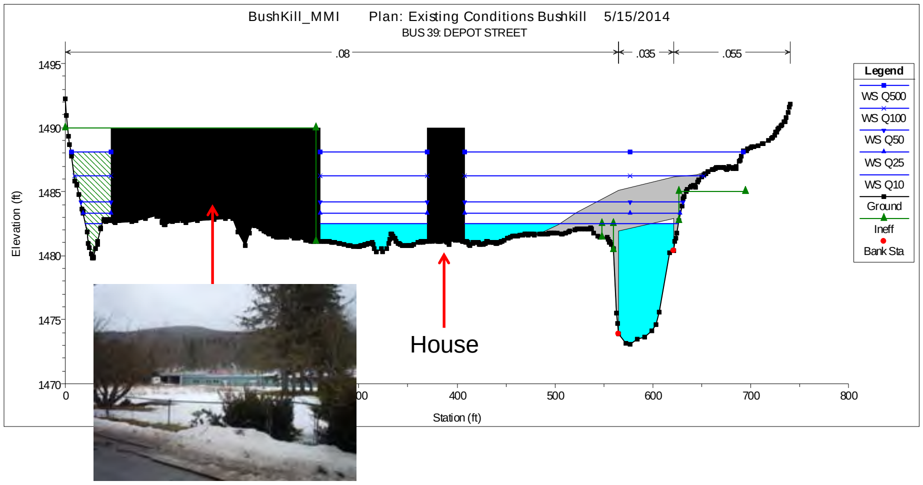
Review Results of Modeling

6a and 6b. Floodplain Enhancement near Depot Street



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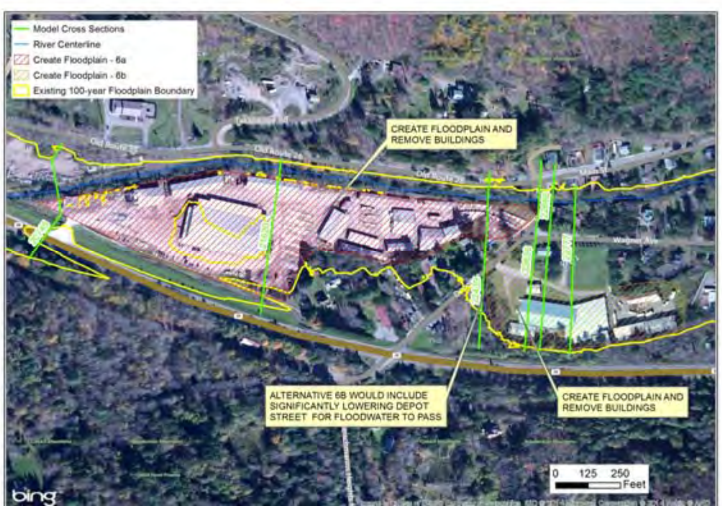
Review Results of Modeling

6a and 6b. Floodplain Enhancement near Depot Street



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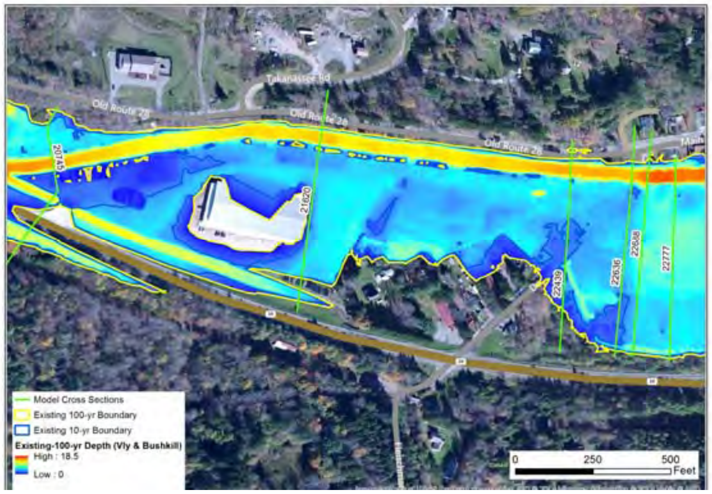
Review Results of Modeling

6a. Floodplain Enhancement at Depot Street

Current depths

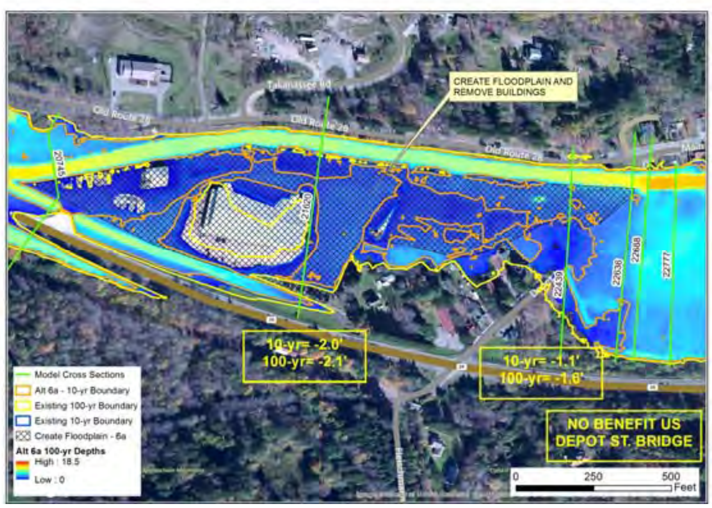


MILONE & MACBROOM

Review Results of Modeling

6a. Floodplain Enhancement at Depot Street

Depths after floodplain project



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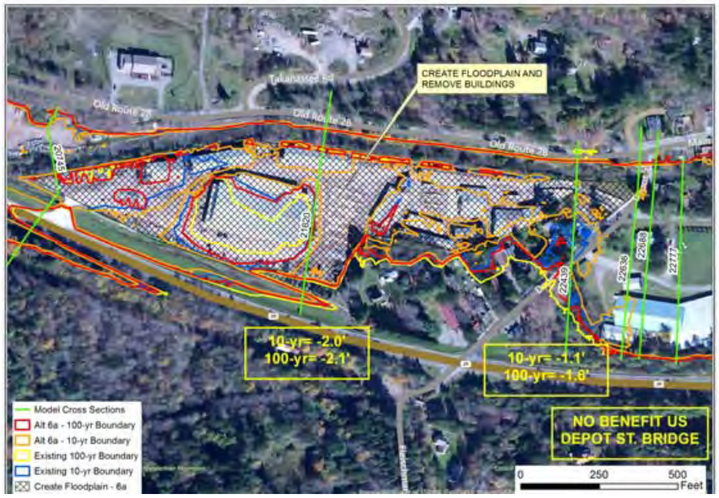
Review Results of Modeling

6a. Floodplain Enhancement at Depot Street

Comparison of inundated areas

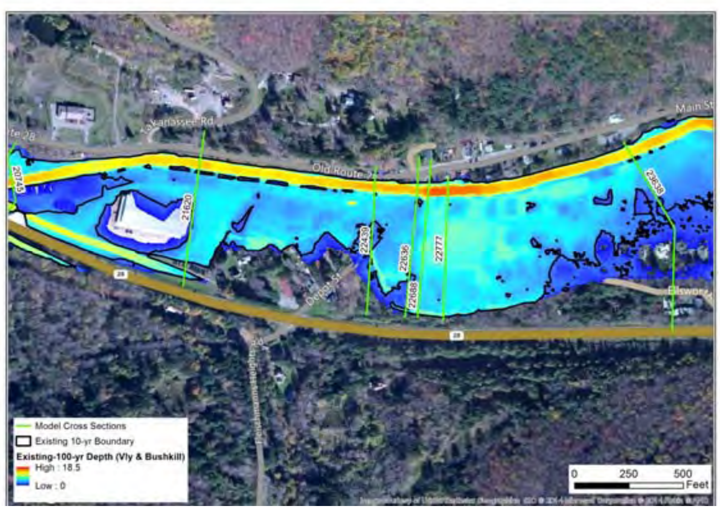


MILONE & MACBROOM

Review Results of Modeling

6b. Larger Floodplain Enhancement at Depot Street

Current depths



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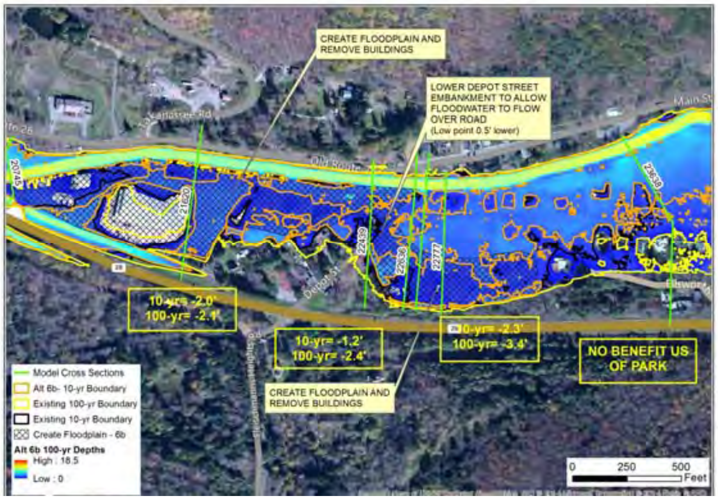
Review Results of Modeling

6b. Larger Floodplain Enhancement at Depot Street

Depths after floodplain project



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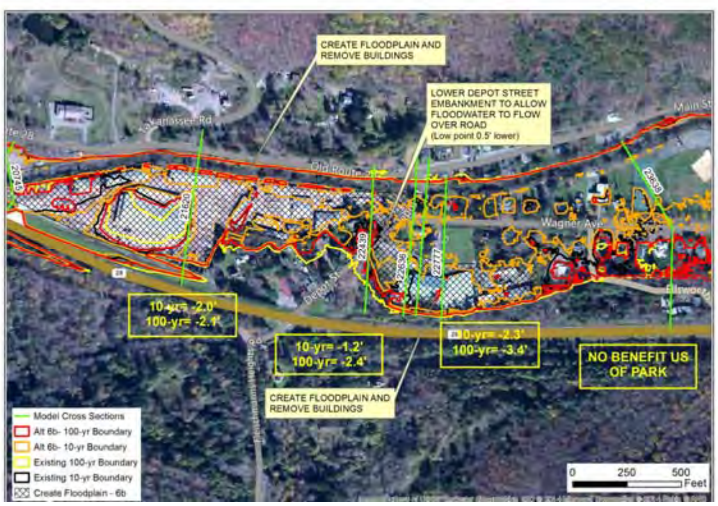
Review Results of Modeling

6b. Larger Floodplain Enhancement at Depot Street

Comparison of inundated areas

Homes at the west end of Wagner see a 100-yr WSE reduction from 1487.2 to 1483.8



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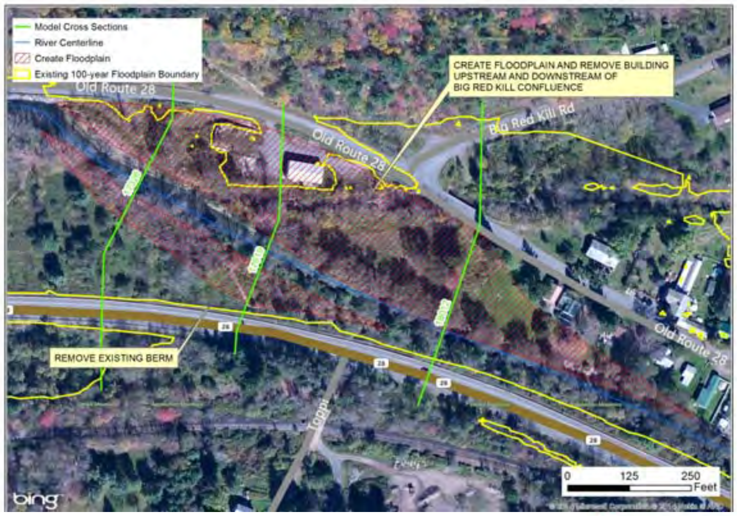
Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28

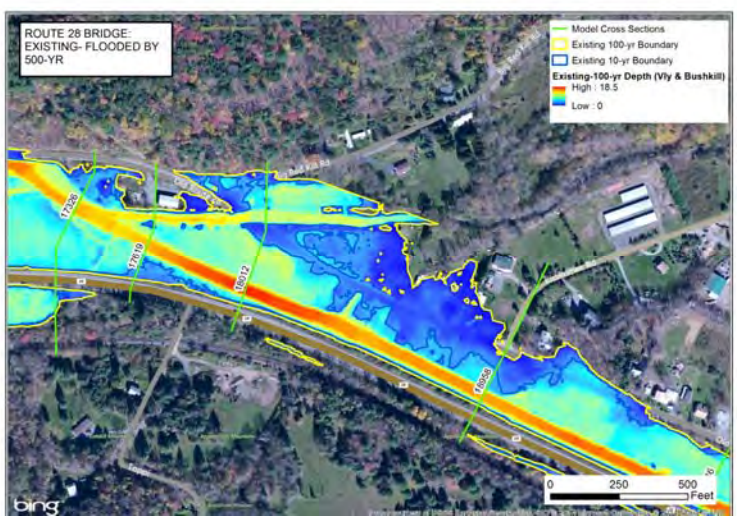


MILONE & MACBROOM

Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28

Current depths

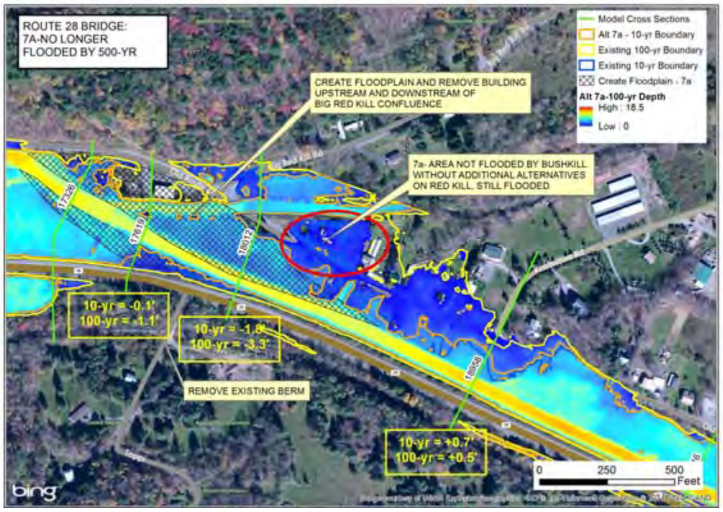


MILONE & MACBROOM

Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28

Depths after floodplain project



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Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28 + Big Red Kill

Current inundation area

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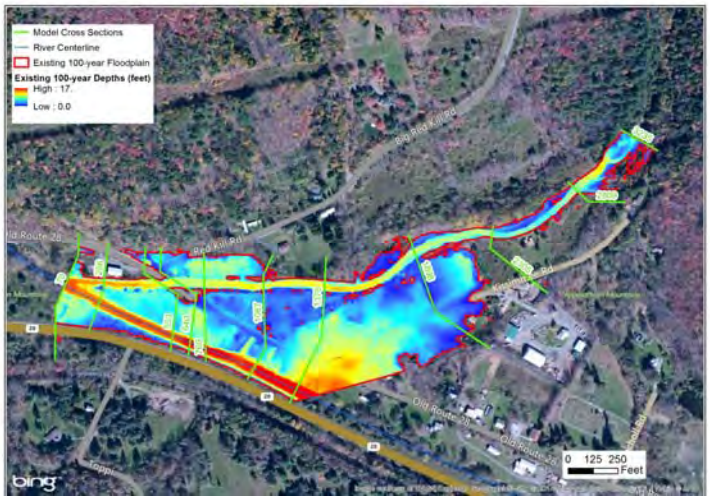
Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28 + Big Red Kill

Current depths



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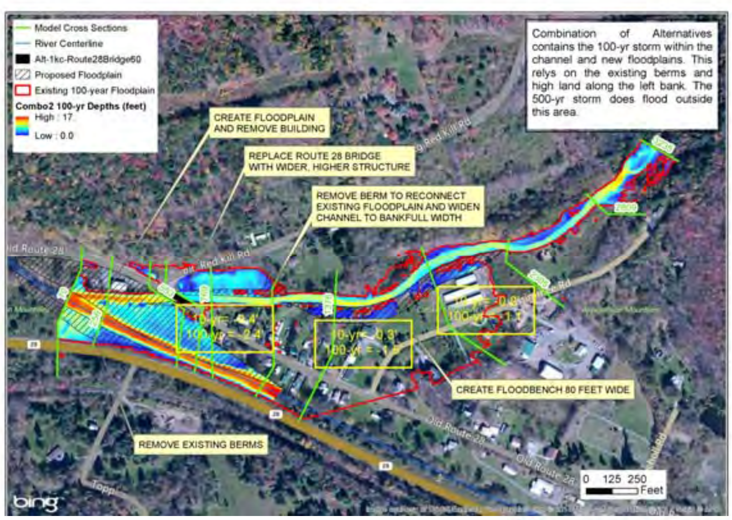
Review Results of Modeling

7a. Floodplain Enhancement at Old Route 28 + Big Red Kill

Depths after floodplain project

Self Storage 100-yr WSE changes from 1473.4 to 1472.5

At nearby homes, WSE changes from 1458.0 to 1457.0



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Review Results of Modeling

7b. Extensive Floodplain Enhancement at Old Route 28

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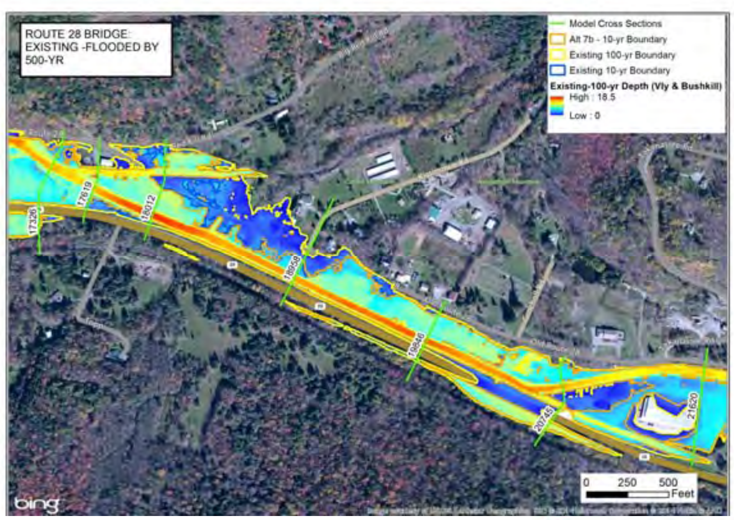
Review Results of Modeling

7b. Extensive Floodplain Enhancement at Old Route 28

Current depths



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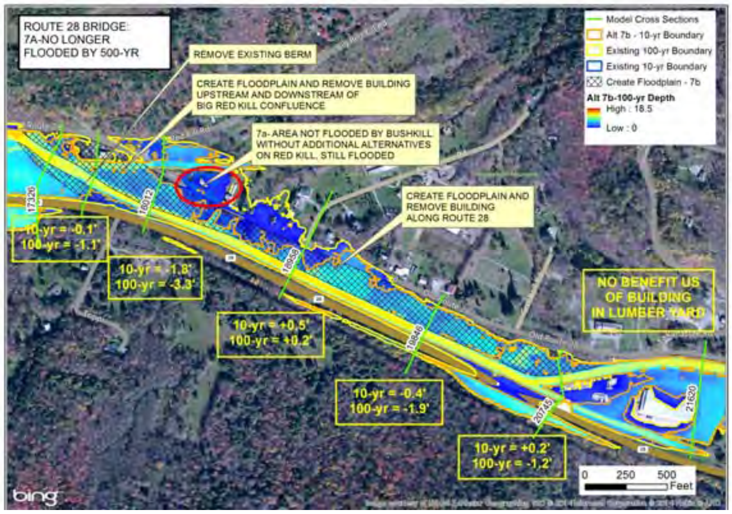
Review Results of Modeling

7b. Extensive Floodplain Enhancement at Old Route 28

Depths after floodplain project



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Review Results of Modeling

8. Floodplain Enhancement at Mill Street

Needs to be combined with other alternatives

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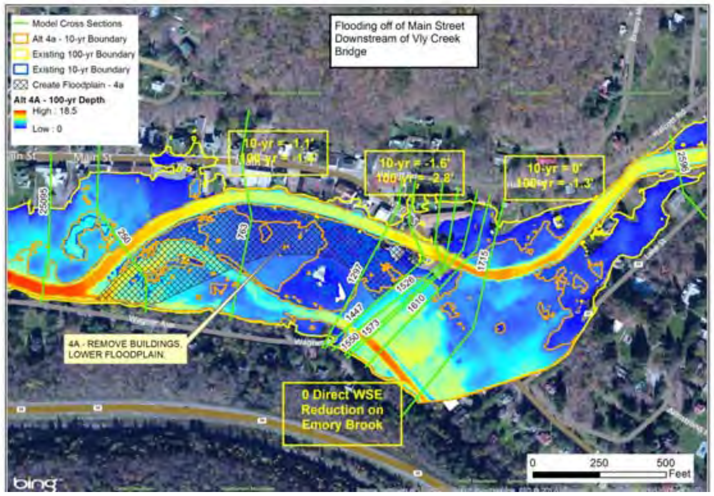
Review Results of Modeling

Reminder: 4a. Floodplain Enhancement at Vly

Depths after floodplain project



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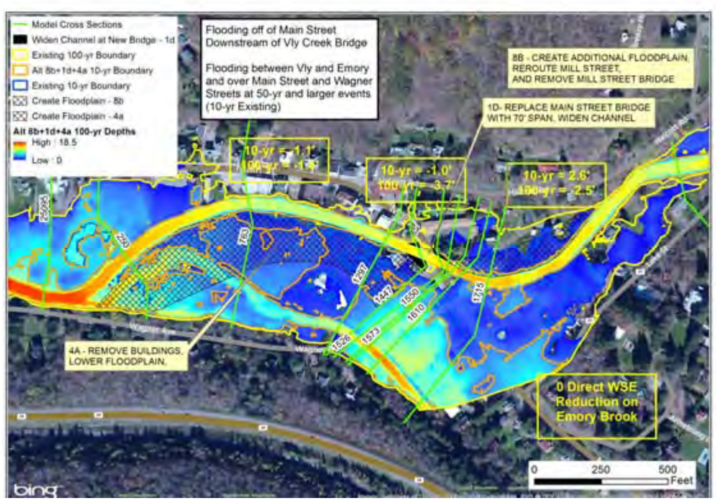
Review Results of Modeling

8b + 1d + 4a

4a is the Vly floodplain we discussed earlier

1d is the Main Street bridge

Assumes that Mill Street bridge is removed



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Review Results of Modeling

8b + 1d + 4a

Comparison of inundated areas

Motel 100-yr WSE changes from 1520.8 to 1517.1 and it partly leaves the SFHA

School 100-yr WSE changes from 1515.2 to 1513.4

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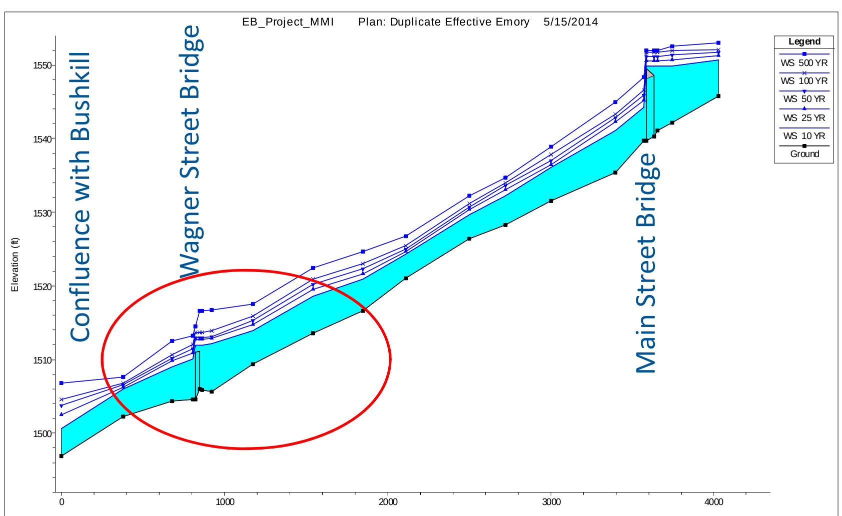
Review Results of Modeling

9. Emory Brook floodplain



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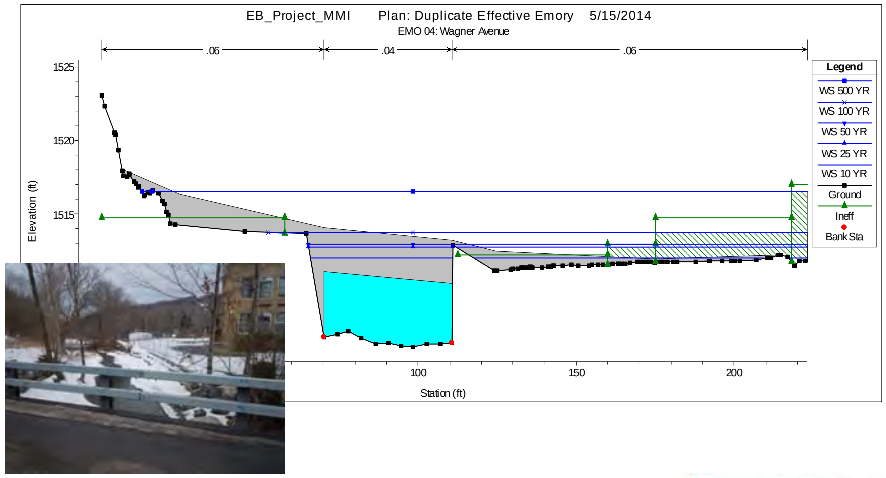
Review Results of Modeling

Cross Section 1068 – Wagner Avenue Bridge – Part of Floodplain is used by Vly Creek Floodwater



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Review Results of Modeling

9. Emory Brook floodplain

9 alone is not effective due to backwater at Wagner Rd bridge

1b replaces the Wagner Rd bridge

4b is the Vly floodplain we discussed earlier

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Review Results of Modeling

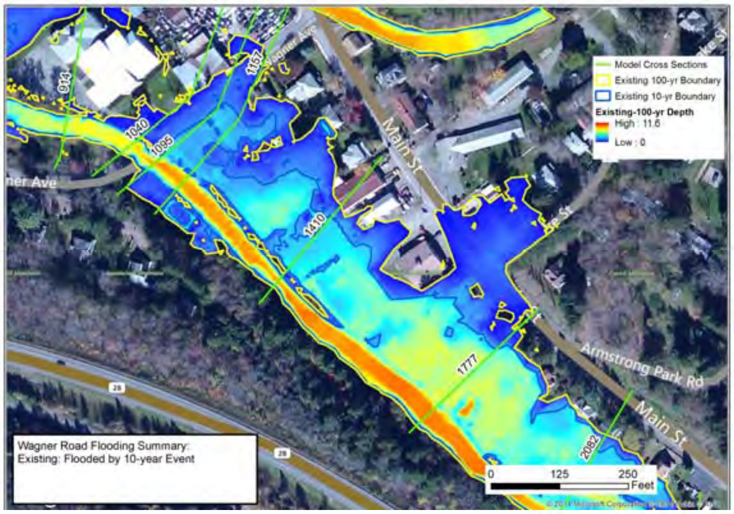
9. Emory Brook floodplain

Current depths

9 alone is not effective due to backwater at Wagner Rd bridge

1b replaces the Wagner Rd bridge

4b is the Vly floodplain we discussed earlier



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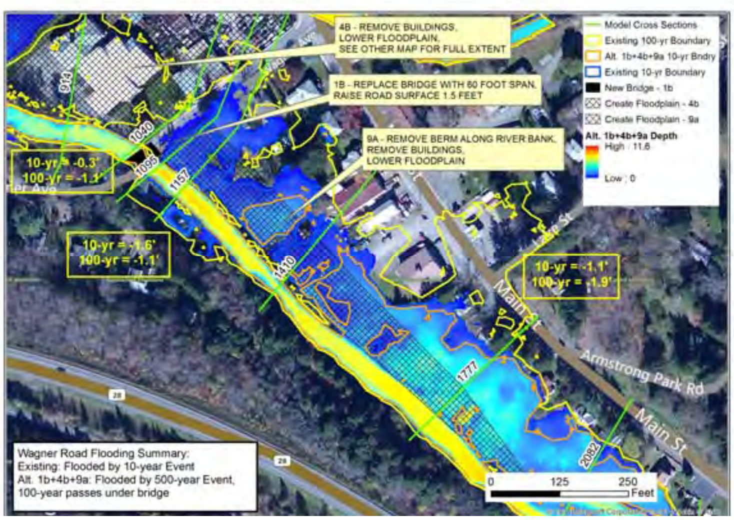
Review Results of Modeling

9. Emory Brook floodplain

Depths after floodplain project

Citgo 100-yr WSE changes from 1520.8 to 1518.9 and it appears to shift out of the SFHA, although flooding from Vly may still affect it



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Review Results of Modeling

Little Red Kill

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Next Steps

- Refine hydraulic alternatives that have merit
- Evaluate hydrologic alternatives
- Preliminary benefit-cost analysis
- Meet to review results

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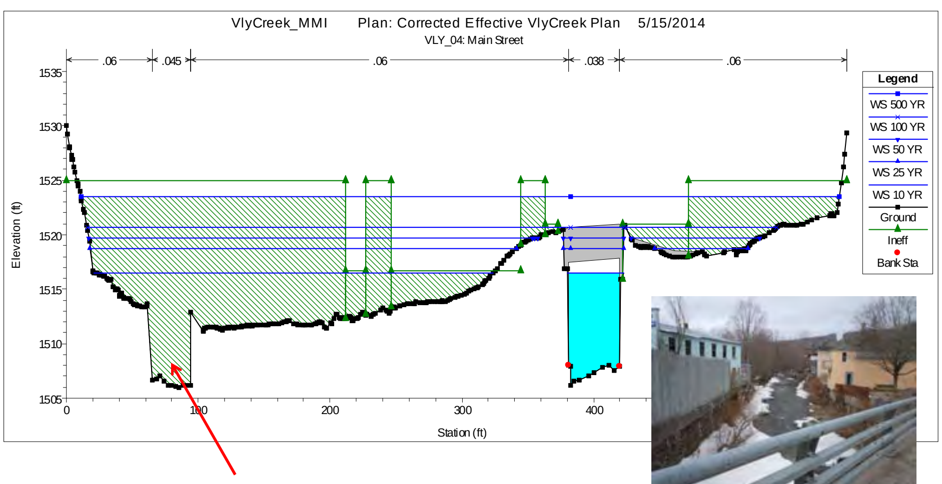
Hydraulic Modeling – Vly Creek Cross Section

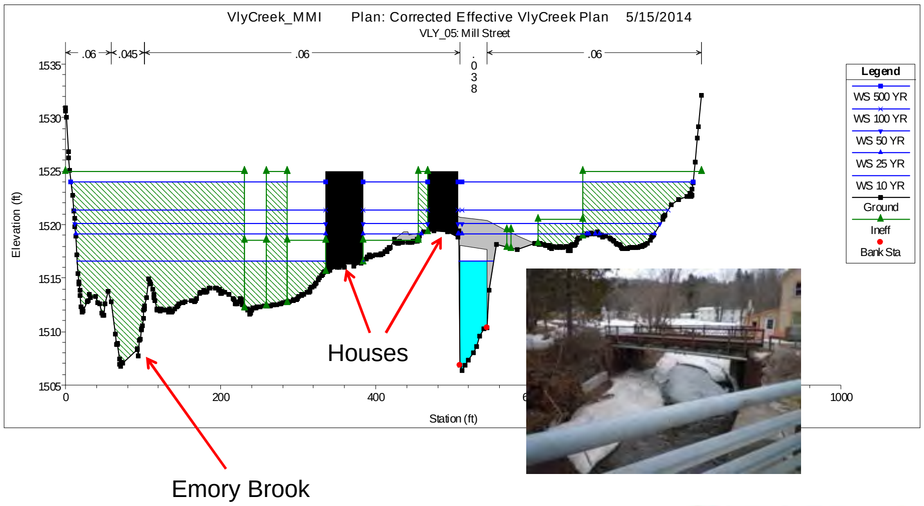
Cross Section 1494 – Main Street Bridge



Emory Brook

Hydraulic Modeling – Vly Creek Cross Section

Cross Section 1585 – Mill Street Bridge



MILONE & MACBROOM

DATE: February 24, 2015
MMI #: 5197-03
PROJECT: Fleischmanns LFA

SUBJECT: Status Report

LOCATION: Skene Memorial Library, Fleischmanns

ATTENDEES:

Village of Fleischmanns
Village Board and East Branch Flood Commission

A meeting of the Village Board was held on February 24, 2015 at 6:00 p.m. at the Skene Memorial Library. The purpose of the meeting was to present an update of the project, present a number of flood mitigation alternatives and their benefits in reducing flooding in the village, and gather feedback on the alternatives.

David Murphy was present from Milone & MacBroom, Inc. (MMI). Present at the meeting were: Mayor Todd Pascarella, Graydon Dutcher from DCSWCD, Phil Eskeli from NYCDEP, and members of the Village Board and flood commission. Mr. Murphy presented new hydraulic alternatives and the modeling results; introduced benefit-cost analysis (BCA); and provided limited BCA findings.

Discussions included the following topics:

1. The modeling conducted to date has demonstrated that individual flood mitigation projects such as floodplain benches, when they are combined, do not increase benefits throughout the village to a degree higher than if they were constructed individually. While this is somewhat disappointing, it gives the village some valuable flexibility and freedom to pursue individual projects without needing to be concerned with whether others will be constructed.
2. Benefits associated with the sub-alternatives within #6 (Wadler/True Value, Depot Street, furniture factory) are large confined to the immediate vicinity. Attendees would like one more sub-alternative (6E) which includes keeping the retail building but eliminating the former furniture factory.
3. Graydon reminded the attendees that if the village can't solve inundation-related problems through mitigation projects, then the LFA should evaluate methods of slowing velocities and removing debris from floodwaters. This is applicable to alternatives such as #10 (floodplain bench downstream of the park). Although this bench produces benefits of reduced water surfaces at only a few homes, it might help reduce velocities through this area. It would be helpful to know how velocities would change in the tennis courts.

4. Mayor Pascarella indicated that flood mitigation alternatives downstream of Bridge Street were of great interest before the LFA commenced, as these were areas that did not benefit from NRCS EWP projects and pending buyouts.
5. Alternatives 7A and 7B would require significant funds to implement and would be disruptive to the very homes that need to be protected in that area. Removing the houses would be more economical and make more sense, if there was interest in pursuing a project in that area of the village.
6. Precipitation gauges may be desired in the Emory and Vly watersheds. These would provide ample warning time before floods, as opposed to the downstream stream gauges.
7. The True Value retain store did not flood during Irene.
8. Attendees would like to hear about the effectiveness of putting the Lake Switzerland dam back in place for flood mitigation. Mayor Pascarella said that the lake bed might be feasible as a location for catching debris.
9. Alternative C was selected for the Bridge Street pedestrian bridge (84-ft span). This will allow MMI to run BCA for the alternatives that are nearby.
10. The hotels off Main Street are strictly commercial. Residential use is minimal.
11. There is interest in gathering revenue figures for some of the buildings, such as the Wadler/True Value. David will send a short list of businesses to the village for them to approach business owners.

There will be a follow-up meeting where additional results of the LFA will be presented. The date of the meeting will be during the week of March 23, 2015.

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Local Flood Analysis Project Meeting

Village of Fleischmanns

David Murphy, P.E., CFM

East Branch Flood Commission and Delaware County Soil & Water Conservation District | February 24, 2015

Agenda

- Discuss additional modeling that resulted from the last meeting
- Introduction to benefit cost analysis
- Results of limited benefit cost analysis
- Next steps

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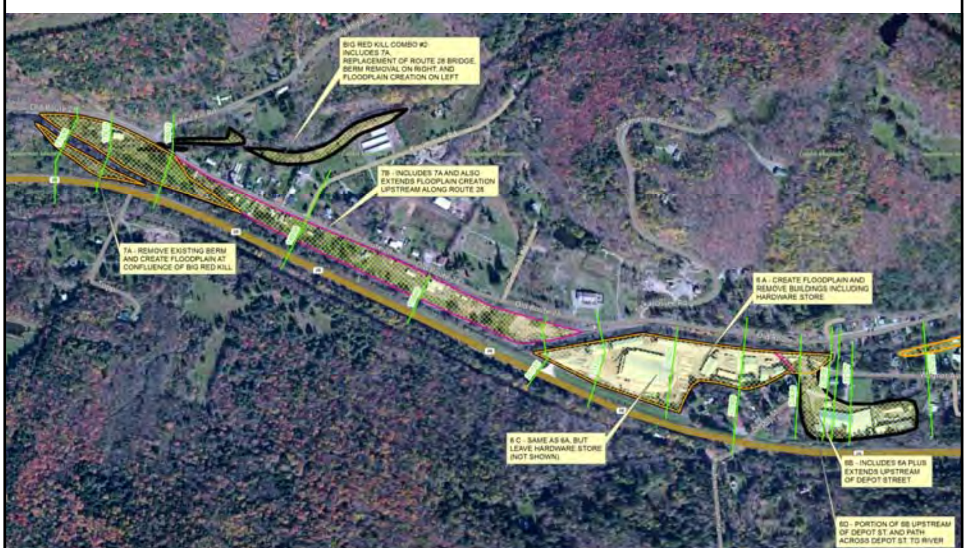
Map of Flood Mitigation Alternatives (to date)

Map of Flood Mitigation Alternatives (to date)



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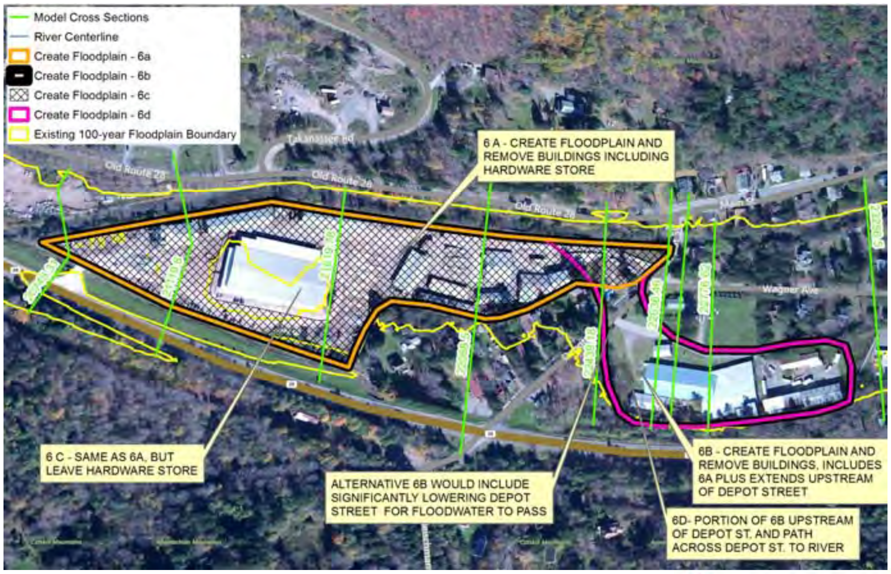
Revised Mitigation Alternatives (6A through 6D)



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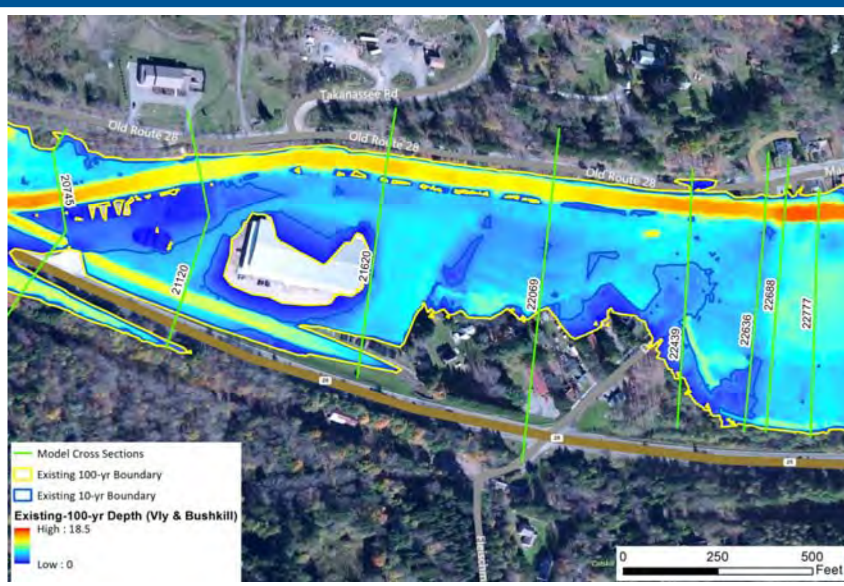
Revised Mitigation Alternative 6C (leave bldg)



Existing Conditions

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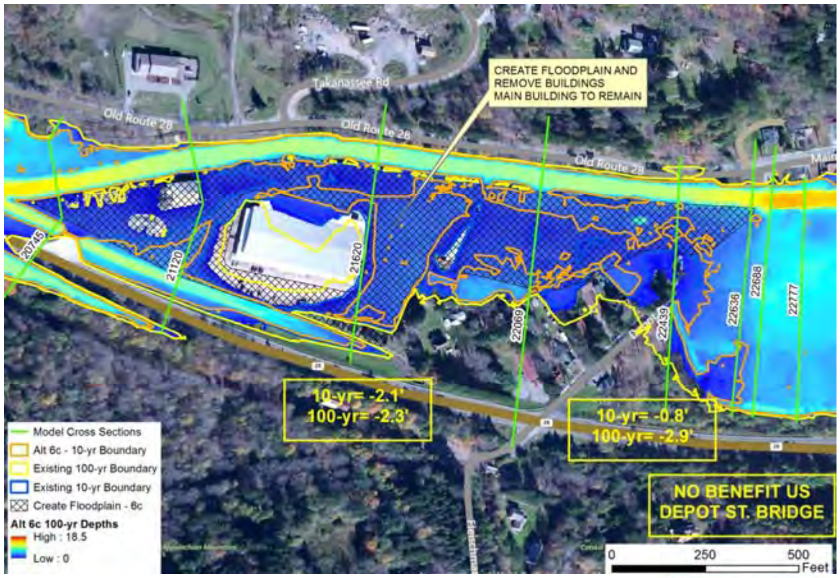
Revised Mitigation Alternative 6C (leave bldg)



Post-Mitigation Conditions

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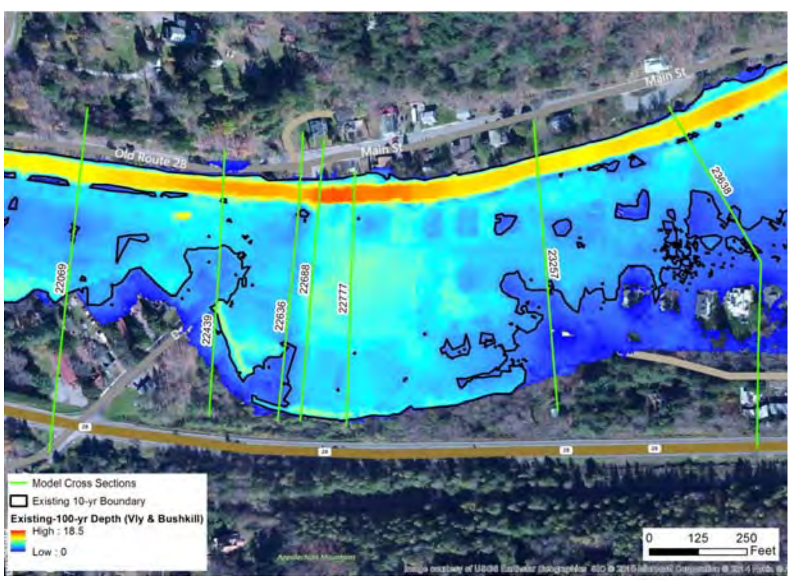
Revised Mitigation Alternative 6D (furn. site)



Existing conditions

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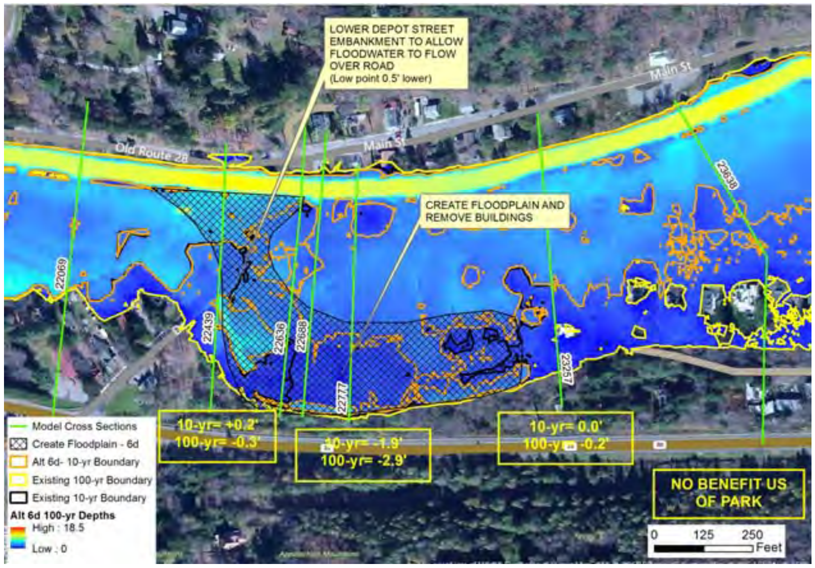
Revised Mitigation Alternative 6D (furn. site)



Post-Mitigation Conditions

MILONE & MACBROOM

New Mitigation Alternative at Park (10)

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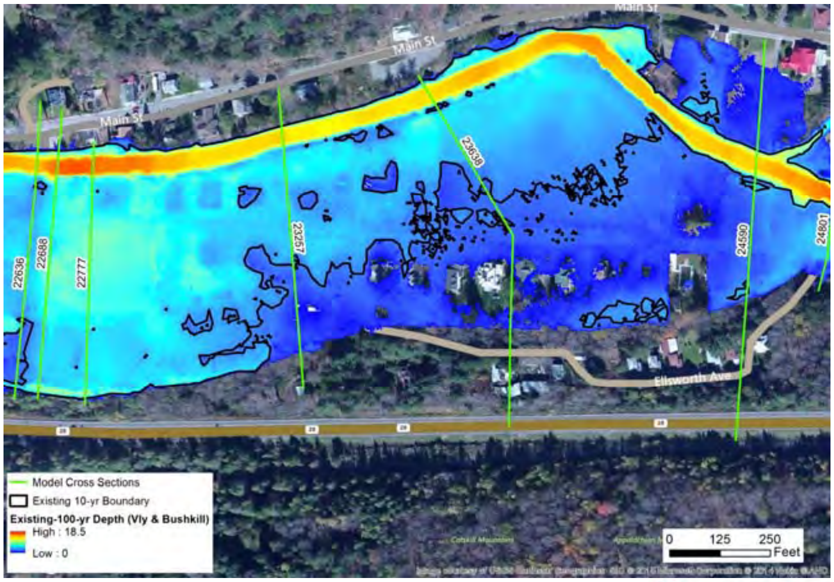
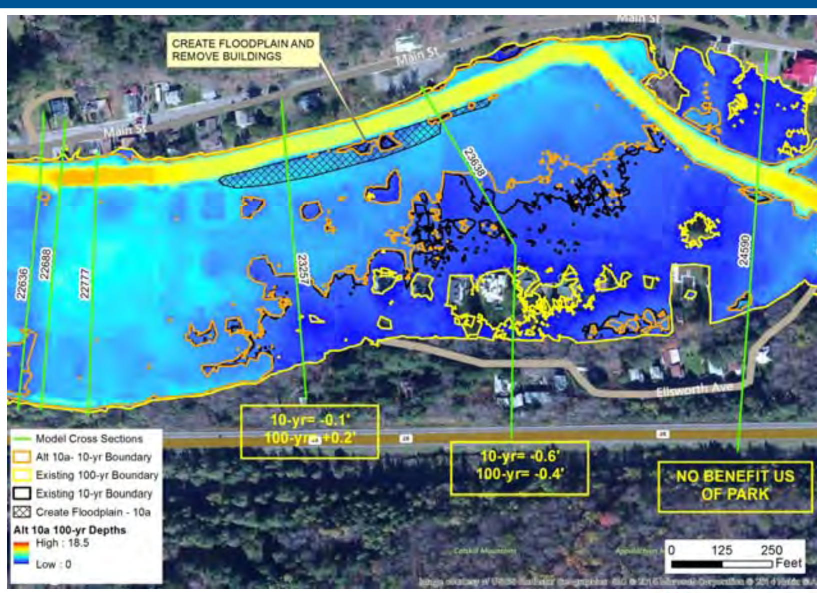
New Mitigation Alternative at Park (10)



Existing conditions

MILONE & MACBROOM

New Mitigation Alternative at Park (10)



Post-Mitigation Conditions

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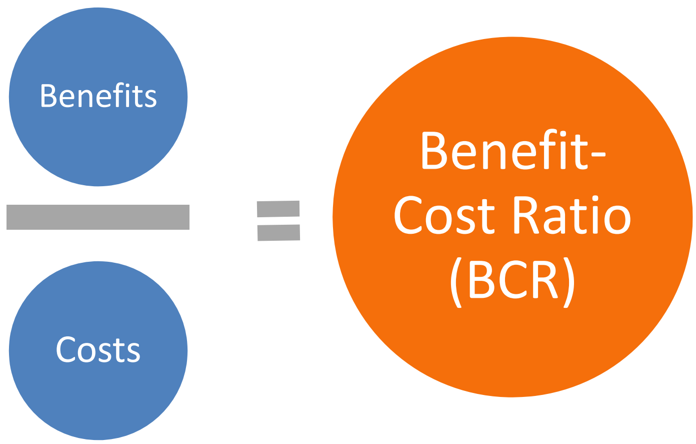
Introduction to BCA

- What is Benefit Cost Analysis (BCA)?
  - ✓ Process of determining the Benefit Cost Ration (BCR)
  - ✓ A mitigation project cannot be funded by FEMA unless it has a BCR greater than 1.0
    - Benefits = Damages Avoided, units of $
    - Benefits over the life span must exceed project cost
  - ✓ FEMA's BCA tool must be used

Introduction to BCA

Introduction to BCA



Introduction to BCA

- ✓ Many good projects that reduce flood damage and protect water quality do <u>not</u> have BCR >1.0
  - These projects can be funded by an entity that is not FEMA
- ✓ We can use BCA to evaluate projects that may not be appropriate for FEMA funding due to timing, logistics, project cost, or other factors
  - The LFA options are good examples

Introduction to BCA

- The BCA tool includes six modules:
  - ✓ Flood
  - ✓ Hurricane Winds
  - ✓ Wildfire
  - ✓ Tornado
  - ✓ Earthquake
  - ✓ Damage Frequency

Two can evaluate flood benefits

BCA Approach

- Buildings that may be removed are handled as acquisitions/ relocations
- All other properties are handled as flood reductions with a project life span of 50 years for nearby floodplain benches and floodplain enhancements
- Building values = total assessed values minus land assessments
- Annual revenue has not yet been included; this is something that we can use to increase benefit figures
- Default figures were used for all properties:
  - ✓ Depth-damage curves
  - ✓ Contents were figured as a percentage of building values for different kinds of non-residential buildings

BCA Approach

- Remember that the BCA tool tries to give us BCRs
- To derive benefits only, project costs were artificially entered as $1 for each building:

BCR = Benefit/Cost
Benefit = BCR if the Cost = 1

- *Then the benefits are summed outside the BCA tool*

Preliminary BCA Results for Alternative 6

- 6A and 6C – WSE reduction benefits generated only at Depot St
- 6B and 6D – WSE reduction benefits generated along Wagner Ave
- All sub-alternatives generated benefits from removal of buildings
- 6A would only be cost effective if the Wadler/True Value buildings are valued much lower than $1 million
- 6C may be cost effective due to reduced flood WSE at the main Wadler/True Value building
- 6D would only be cost effective if the factory buildings are valued much lower than $300,000
- In light of the above, 6B is not likely cost effective

Benefit	6A	6B	6C	6D
Acquisitions and Relocations	$1,027,080	$1,324,764	$807,511	$297,684
Water Surface Reductions at Buildings that Remain	$16,525	$327,173	$486,274	$82,479
Totals	$1,043,605	$1,651,937	$1,293,785	$380,163

Preliminary BCA Results for Alternative 7

- 7A – WSE reduction benefits generated along Old Route 28
- 7B – WSE reduction benefits generated along Old Route 28
- Both sub-alternatives generated benefits associated with removal of homes and other buildings
- The costs of making floodplain benches here are likely higher than the benefits
- Furthermore, the acquisitions do not justify themselves (the buildings have higher values than the acquisition benefits)

Benefit	7A	7B
Acquisitions and Relocations	$7,055 (one commercial building)	$522,117 (many buildings)
Water Surface Reductions at Buildings that Remain	$148,840 (along Old Route 28)	$178,331 (along Old Route 28)
Totals	$155,895	$700,448

Preliminary BCA Results for Alternative 10

- 10 – WSE reduction benefits generated only for a few homes on Wagner Ave
- The cost of making a floodplain bench here is likely higher than the benefit

Benefit	10
Acquisitions and Relocations (not calculated – only a few sheds may be displaced)	$0
Water Surface Reductions at Buildings that Remain	$72,587
Totals	$72,587

Next Steps

- Select a Bridge Street pedestrian bridge
- Evaluate hydrologic alternatives
- Collect some revenue figures and complete BCA
- Meet to review results

Milone & MacBroom

DATE: May 11, 2015
MMI #: 5197-03
PROJECT: Fleischmanns LFA

SUBJECT: Status Report

LOCATION: Skene Memorial Library, Fleischmanns

ATTENDEES:

Village of Fleischmanns
Village Board and East Branch Flood Commission

A meeting of the Village Board was held on May 11, 2015 at 6:00 p.m. at the Skene Memorial Library. The purpose of the meeting was to present an update of the project, present a number of flood mitigation alternatives and their benefits in reducing flooding in the village, and gather feedback on the alternatives.

David Murphy was present from Milone & MacBroom, Inc. (MMI). Present at the meeting were the Mayor, Graydon Dutcher from DCSWCD, members of the Village Board and flood commission, and members of the public. Mr. Murphy presented all of the hydrologic and hydraulic flood mitigation alternatives and provided the BCA findings.

Discussions included the following topics:

1. An attendee asked whether the individual flood mitigation projects can be pursued separately, or would they all be better accomplished together. Mr. Murphy explained that one of the unique things about Fleischmanns' flood profile is that the projects can be pursued separately and each will have its own localized benefits. There are pros and cons, for example it would be nice if they all acted together and the "sum of the parts" was more beneficial than individual projects. However, as this is not the case, each can be untethered from the others.
2. Attendees inquired about funding sources for implementation. Mr. Dutcher described the various funding programs and the Catskill Watershed Corporation (CWC) application process.
3. Mr. Murphy asked attendees to comment on the groups of alternatives that were presented. Is there consensus for any? The Mayor indicated that he favors the combination of 8B+1C+1D+4A, which would have benefits without disrupting residential properties. Mr. Dutcher noted that all of the combinations (such as 5C and 6E) need to be LFA recommendations. There may be support in the future, or after floods.
4. The Mayor explained that debris such as large trees was still a major concern. He inquired about whether a model ordinance was available to incorporate into the village's code. Mr.

Dutcher agreed and reminded attendees that a minor amount of debris management is allowed without permits. Mr. Dutcher also explained that Lake Switzerland was a possible area of channel and floodplain projects that could catch debris.

5. Anchoring floatables and tanks is something of concern in the village and should be addressed in the LFA.
6. As mentioned in the February meeting, early warning precipitation gauges are desired in the Emory and Vly watersheds. These would provide warning time before floods, as opposed to the downstream stream gauges which are not helpful. The warning system needs to be fully automated and able to provide as little advance warning as an hour.
7. Mr. Murphy asked about for consensus about projects in the LFA that pertain to individual properties. The Public Works and Fire Department buildings are good examples. CWC can fund relocations of these facilities. A short discussion proceeded about how to determine locations for critical facilities that are relocated. Mr. Dutcher described some tools, for example using the flood maps as the first cut. CWC can fund feasibility studies for relocations.
8. The owner of the house at 45 Bridge Street would like to include elevation in the LFA. Mr. Murphy said that was a good project to include as FEMA may be able to fund this, although CWC would not be able to fund it unless there were benefits to other properties. Another attendee asked how a building could be floodproofed.
9. The project schedule was discussed. This LFA cannot submit projects to the June 2015 CWC deadline, but the December deadline should be a goal. The Mayor was provided with a list of businesses to approach about revenue figures. The schedule is to wrap up the report in June/July, provided that the revenue figures are available by then.

Local Flood Analysis Project Meeting

Village of Fleischmanns

David Murphy, P.E., CFM

East Branch Flood Commission and Delaware County Soil & Water Conservation District | May 11, 2015

Agenda

- Overview of benefit cost analysis (BCA)
- Review flood mitigation alternatives and results
  - *Present BCA results within the review of alternatives*
- Next steps

BCA

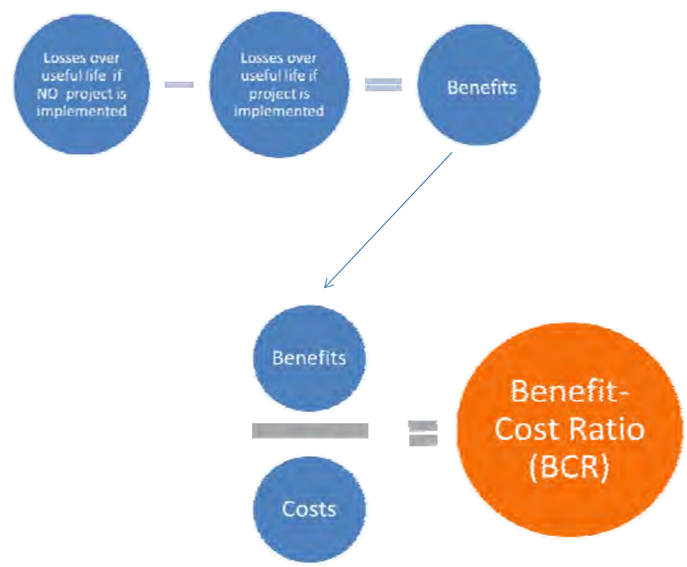
- What is BCA?
  - ✓ Process of determining the Benefit Cost Ratio (BCR)
  - ✓ A mitigation project cannot be funded by FEMA unless it has a BCR greater than 1.0
    - Benefits = Damages Avoided, units of $
    - Benefits over the life span must exceed project cost
  - ✓ FEMA's BCA tool must be used

BCA

- The BCA tool includes six modules:
  - ✓ Flood
  - ✓ Hurricane Winds
  - ✓ Wildfire
  - ✓ Tornado
  - ✓ Earthquake
  - ✓ Damage Frequency

Two can evaluate flood benefits

BCA



BCA

Generating Benefits from <u>Acquisitions/Removals</u>

- Buildings that may be removed are handled as acquisitions/ relocations
- Project life span = 100 years (standard for acquisitions)
- Only the FIS and FIRM are needed, as there is no comparison to future flood levels
- Include annual revenue of property if available
- Let the program generate benefits; these will be summed outside the program
- Key assumptions for LFAs:
  - Building elevations based on LiDAR or best available
  - Property values = total assessed values
  - Demolition costs range from $15,000 to $50,000
  - Default depth/damage curves used

BCA

Generating Benefits from Water Surface Reductions

- Handled as flood reductions with a project life span of 50 years for nearby floodplain benches and floodplain enhancements
- Include annual revenue per building if available
- Let the program generate benefits; these will be summed outside the program
- Key assumptions for LFAs:
  - Building elevations based on LiDAR or best available
  - Building values = total assessed values minus land assessments
  - Default depth/damage curves used

Review of Flood Mitigation Alternatives

1. Bridge Replacements

*Mainly considered in combination with floodplain alternatives

a. Emory Brook at Main Street
b. Emory Brook at Wagner Avenue*
c. Vly Creek at Mill Street*
d. Vly Creek at Main Street*
e. Little Red Kill at Snyder Avenue
f. Little Red Kill at driveway
g. Little Red Kill at Main Street
h. Little Red Kill at Bridge Street

→ *Addressed together* (e–h)

i. Bush Kill Creek at the former Bridge Street bridge* **(subject of pedestrian bridge meetings in July and August 2014)**
j. Bush Kill Creek at Depot Street (not needed)
k. Big Red Kill at Old Route 28*

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Review of Flood Mitigation Alternatives

Hydrologic Options

2. Storage of water in Lake Switzerland
3. Vly/Emory bypass

Floodplain Creation, Enhancement, etc.

4. Upstream area (Emory/Vly confluence)
5. Bridge Street area of Bush Kill
6. Middle area of Bush Kill (west end of Wagner Avenue, Depot Street, Wadler/True Value)
7. Downstream area of Bush Kill (along Route 28)
   - Downstream area of Bush Kill + Big Red Kill
8. Vly Creek at Mill Street
9. Emory Brook at Wagner Road
10. Near park off Wagner Avenue

Most of the alternatives are modular and don't affect one another

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Map of Flood Mitigation Alternatives

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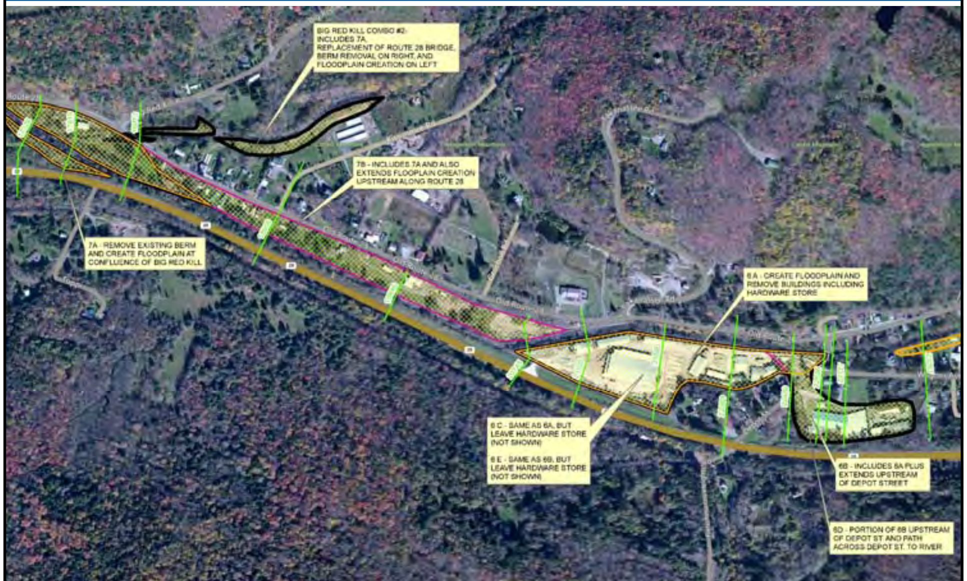
Map of Flood Mitigation Alternatives



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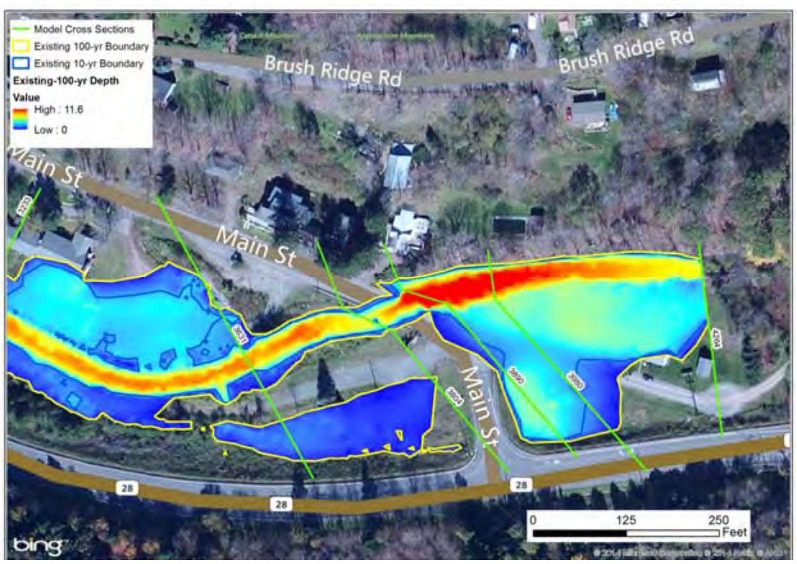
Review Mitigation Alternative #1A



Existing Conditions

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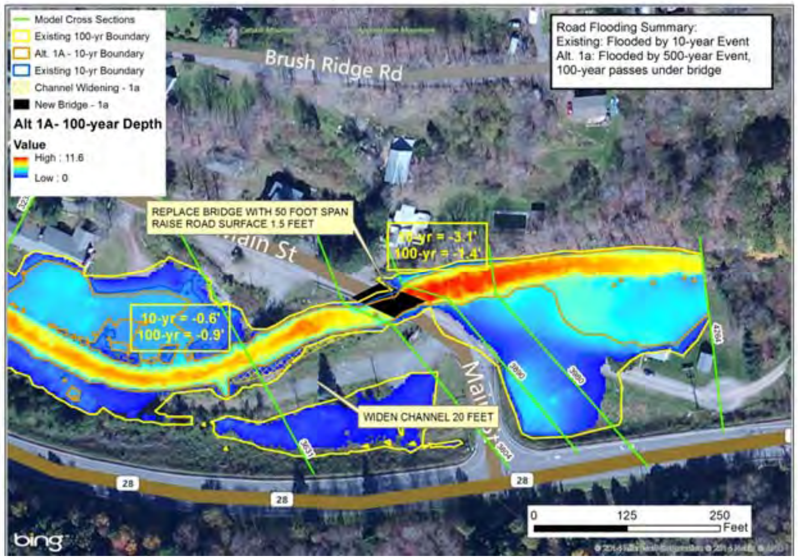
Review Mitigation Alternative #1A



Post-Mitigation Conditions

MILONE & MACBROOM

Review Mitigation Alternative #1A

- No property or building acquisitions
- Bridge replacement and re-grading

Benefit Cost Summary	1A
Benefits: Acquisitions and Relocations	$0
Benefits: Water Surface Reductions at Buildings that Remain	$57,000
Total Benefits	$57,000
Total Costs	$500,000
Benefit Cost Ratio	0.11

Recommendation: Unless washouts at this bridge are a significant concern, do not pursue at this time

Review Mitigation Alternative #2

Floodwater Attenuation in Lake Switzerland

- Rebuild former dam and utilize old lake bed
- Hydrologic analysis conducted
- Available storage would only be 131 acre-feet as compared with the 337 acre-feet needed to obtain a 10% reduction in 100-year flows
- Barely feasible, not prudent
- No BCA completed

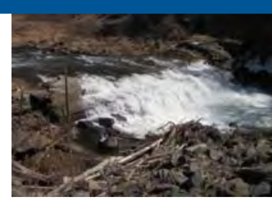
Recommendation: Do not pursue for flood mitigation, but consider projects that catch debris

Alternative #2 – Special Project

Replacement of Pedestrian Bridge

- Compared modeling results for the FEMA-proposed bridge and the desired longer span bridge
- Provided memo to County Public Works

Recommendation: Pursue the longer span bridge



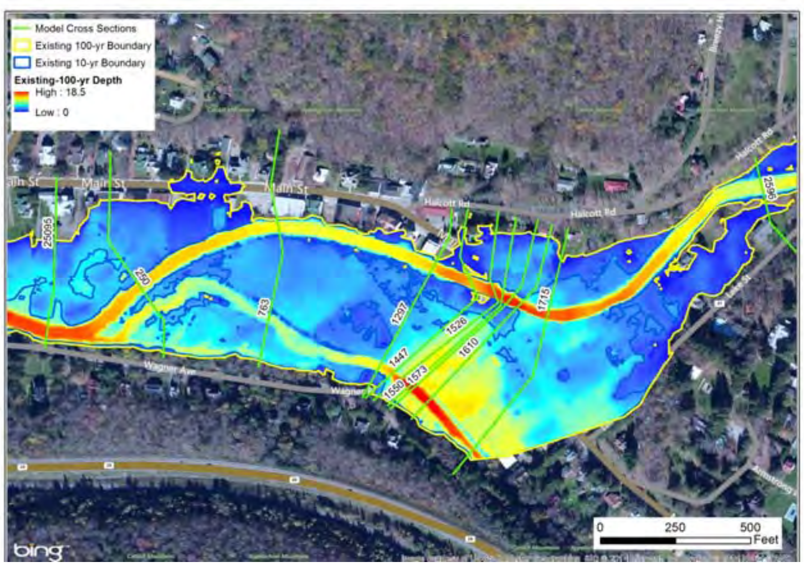
Review Mitigation Alternative #3

Bypass from Vly to Emory Brook

- Construct new channel to allow floods greater than the 10-year storms to spill over in a controlled manner and flow into Emory Brook
- Highly disruptive to private properties
- Does not lower flood damage immediately downstream at the confluence of Emory and Vly
- Barely feasible, not prudent

Recommendation: Too intrusive; better to make the existing stream channels and structures more resilient; do not pursue at this time

Review Mitigation Alternative #4



Existing Conditions

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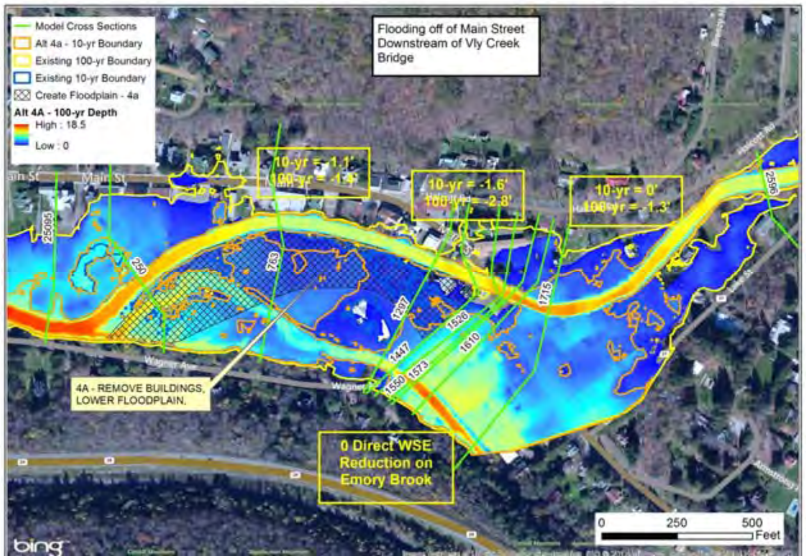
Review Mitigation Alternative #4A



Post-Mitigation Conditions

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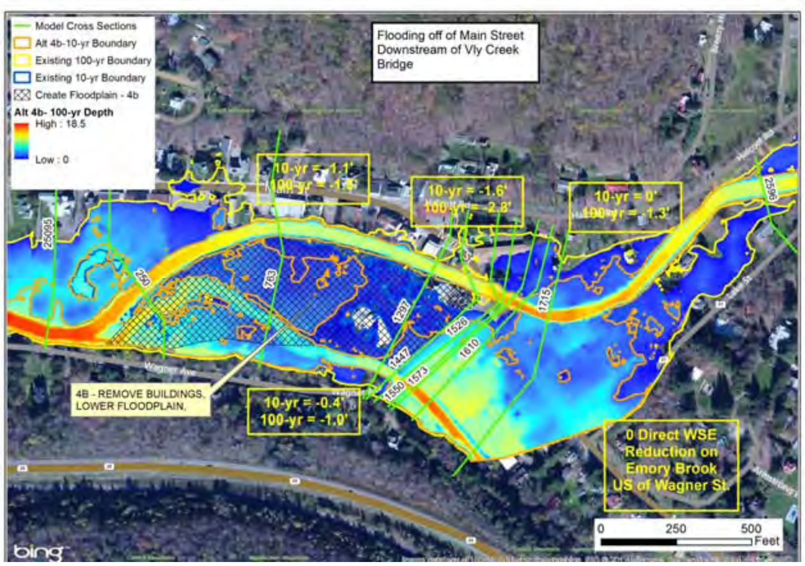
Review Mitigation Alternative #4B



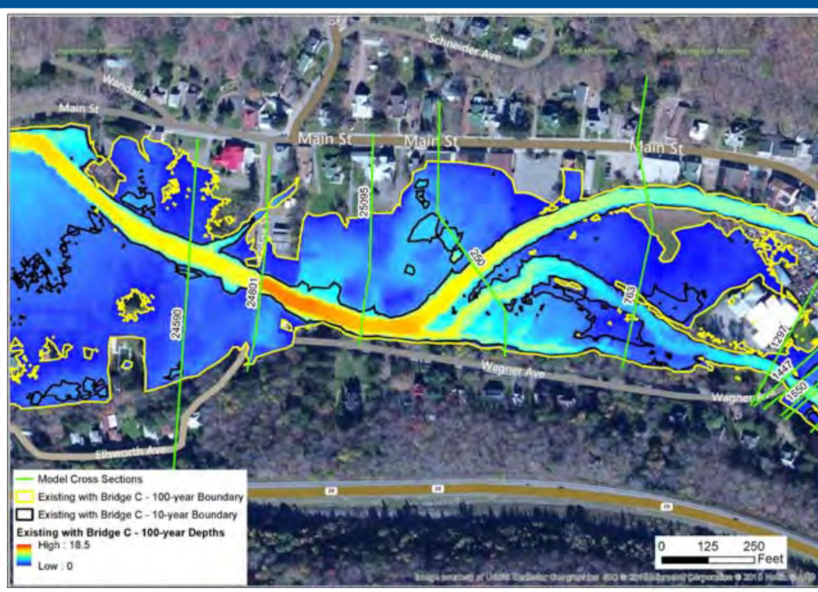
Post-Mitigation Conditions

MILONE & MACBROOM

Review Mitigation Alternatives #4A and 4B

- 4A involves the removal of the remaining buildings at the auto repair and junk yard
- 4B involves relocation of the school with apartments and cottages in the rear
- BCA results pending, but not believed favorable
- **These are addressed later as parts of combinations – sit tight**

Review Mitigation Alternative #5 with Bridge C



Existing Conditions

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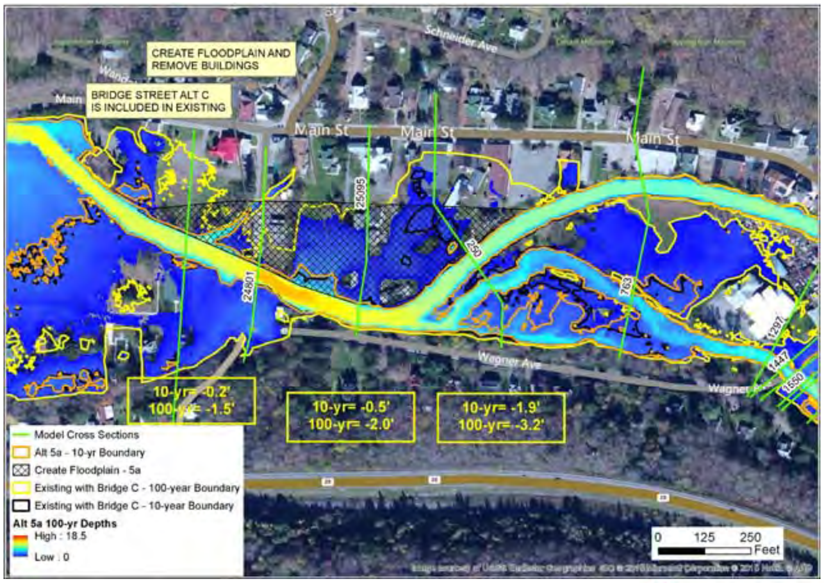
Review Mitigation Alternative #5A with Bridge C



Post-Mitigation Conditions

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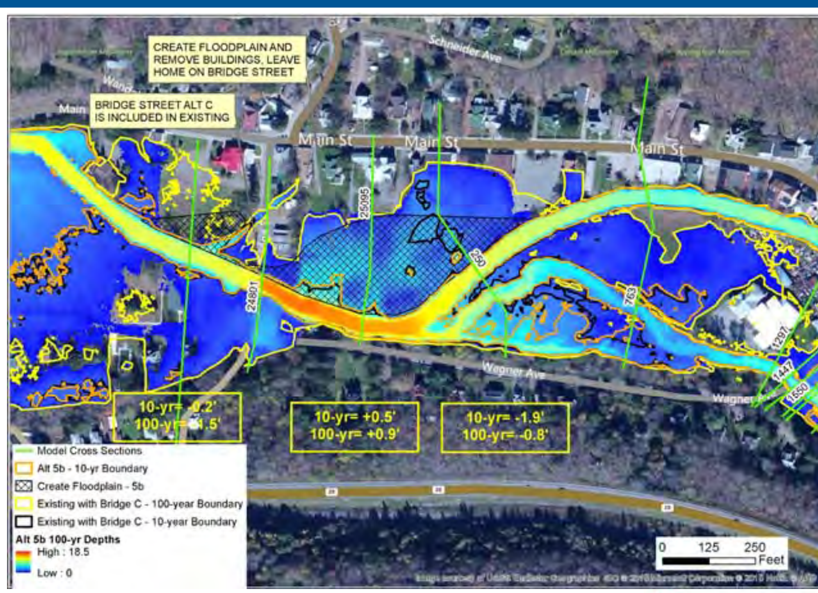
Review Mitigation Alternative #5B with Bridge C



Post-Mitigation Conditions

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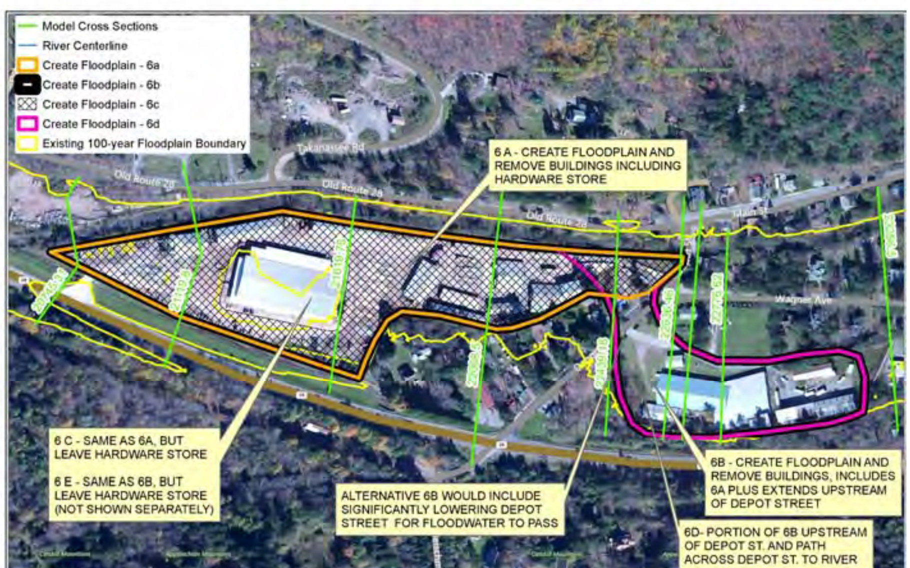
Review Mitigation Alternatives #5A and 5B

- Modeling assumes that Pedestrian Bridge C has been built (becomes "existing conditions" for this set of alternatives)
- 5A involves the removal of 45 and 46 Bridge Street plus the rear buildings along the south side of Main Street
- 5B keeps 45 and 46 Bridge Street but removes the rear buildings along the south side of Main Street

Benefit Cost Summary	5A	5B
Benefits: Acquisitions and Relocations	$31,000	$23,000
Benefits: Water Surface Reductions at Buildings that Remain	$72,000	$47,000
Total Benefits	$103,000	$70,000
Total Costs	$1,000,000	$700,000
Benefit Cost Ratio	0.10	0.10

Recommendation: Park this one; it makes sense but the benefits of flood reduction will not carry the costs

Review Mitigation Alternatives #6A–6E



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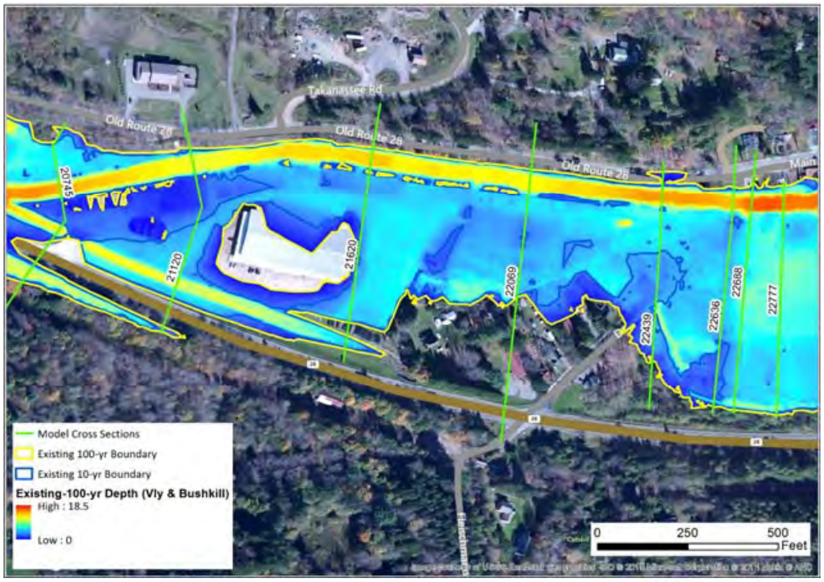
Review Mitigation Alternatives #6A & 6C



Existing Conditions

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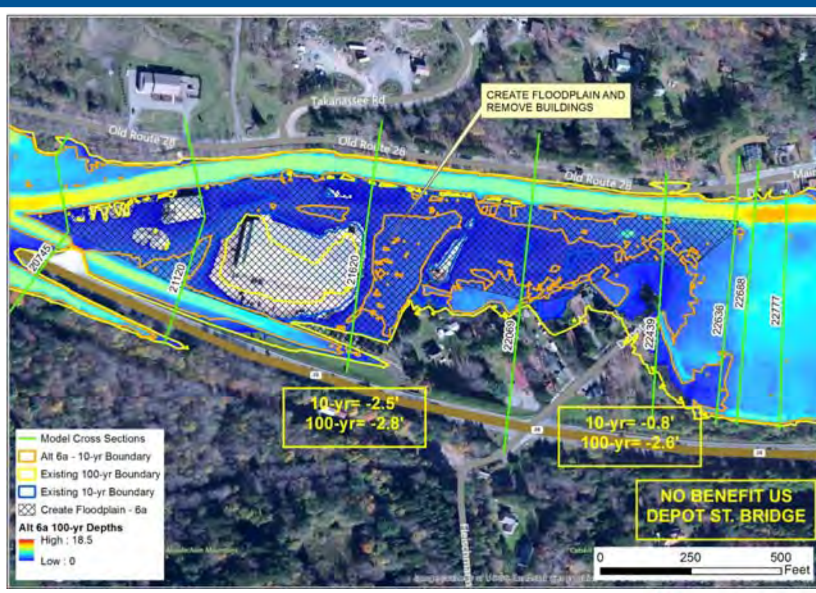
Review Mitigation Alternative #6A



Post-Mitigation Conditions

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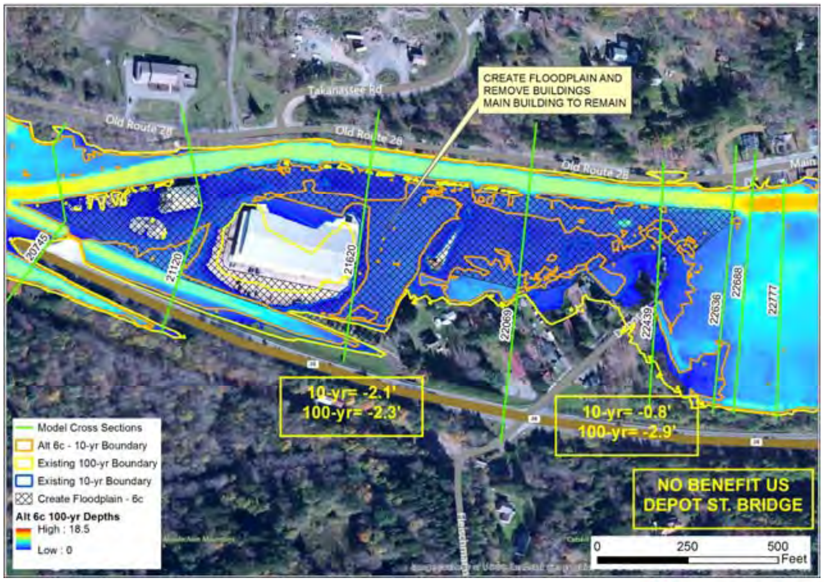
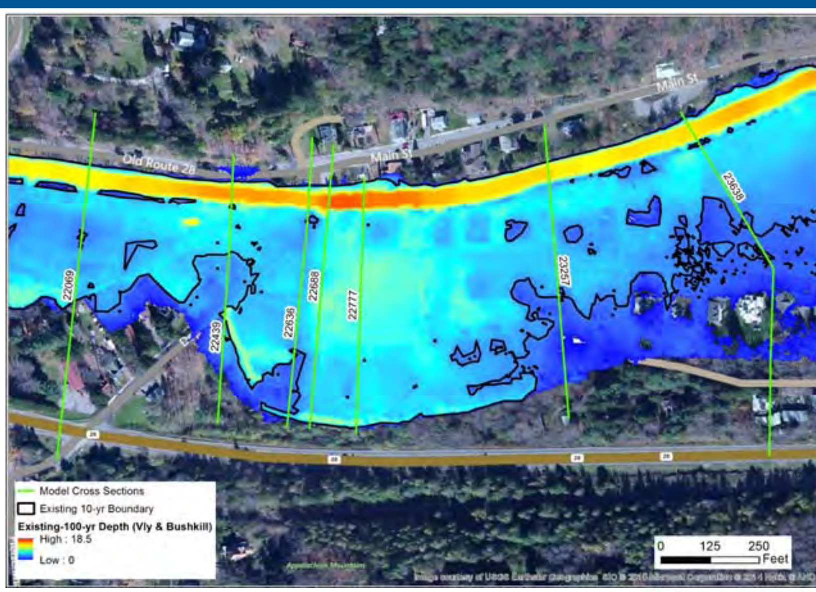
Review Mitigation Alternative #6C



Post-Mitigation Conditions

MILONE & MACBROOM

Review Mitigation Alternative #6D



Existing Conditions

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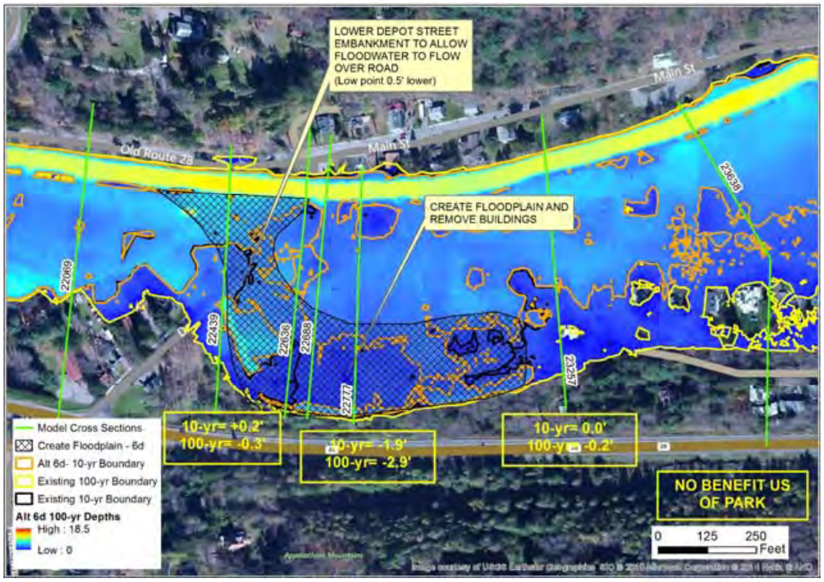
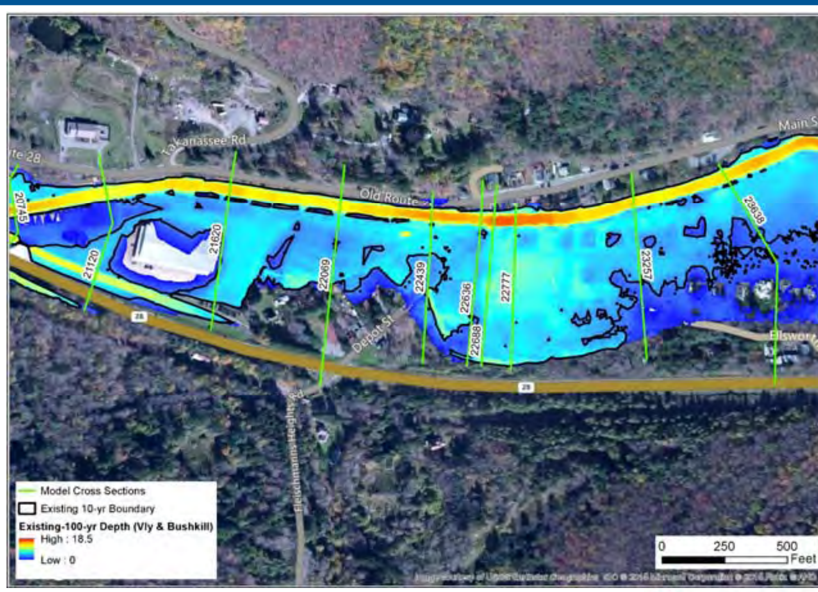
Review Mitigation Alternative #6D



Post-Mitigation Conditions

MILONE & MACBROOM

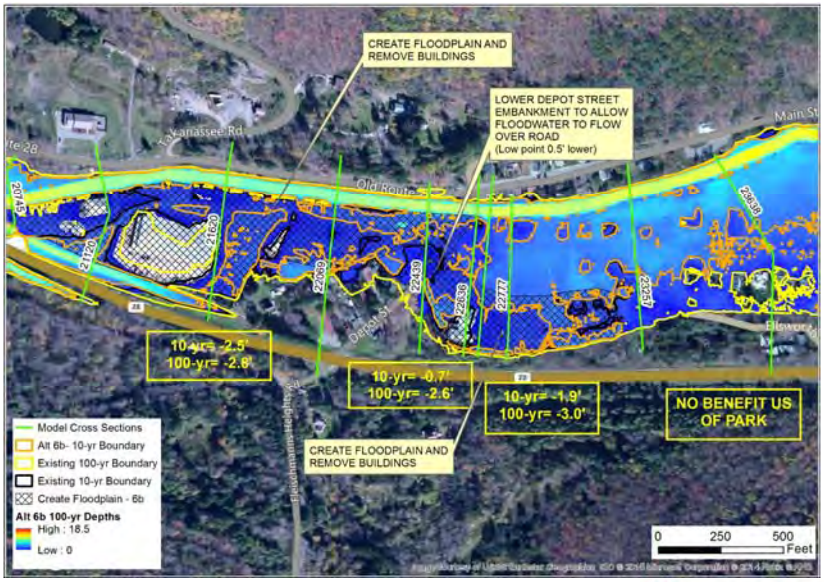
Review Mitigation Alternative #6B & 6E



Existing Conditions

MILONE & MACBROOM

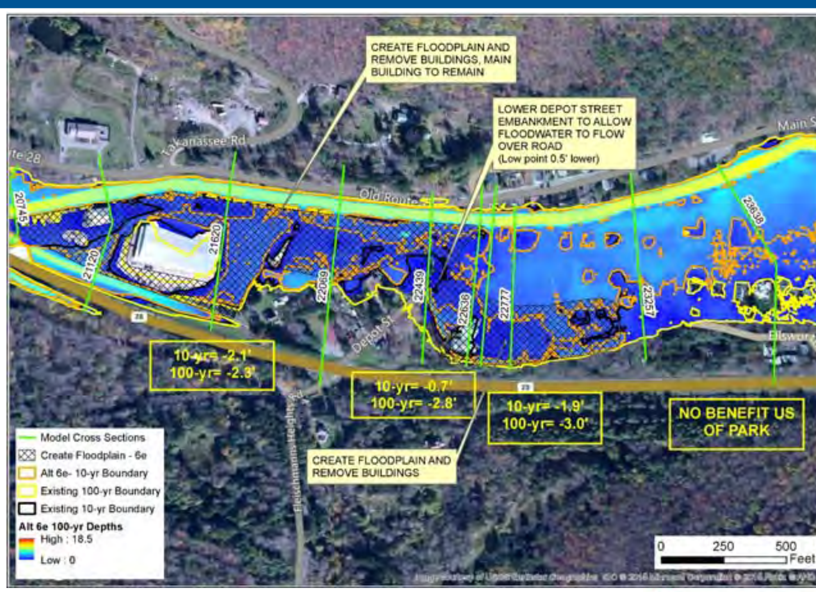
Review Mitigation Alternative #6B



Post-Mitigation Conditions

MILONE & MACBROOM

Review Mitigation Alternative #6E (leave bldg)



Post-Mitigation Conditions

MILONE & MACBROOM

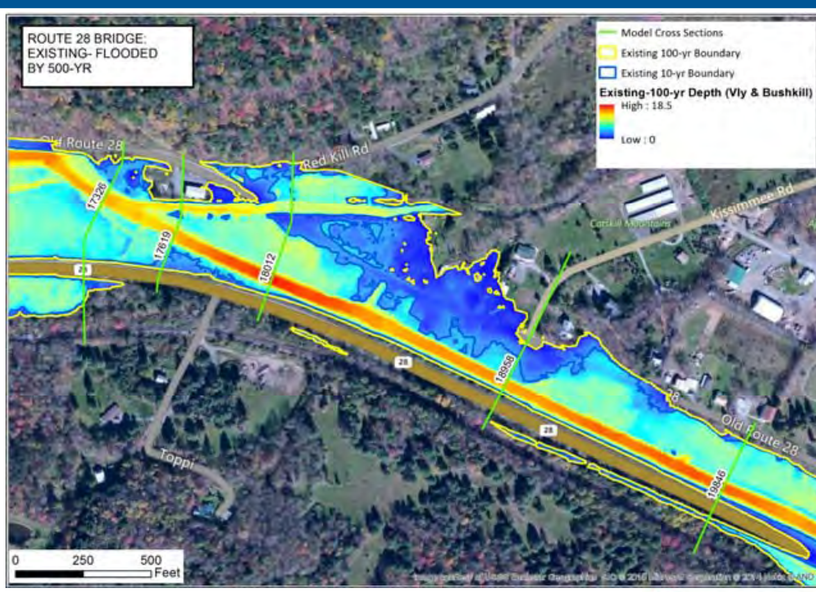
Review Mitigation Alternatives #6A–6E

- 6A and 6C – WSE reduction benefits generated only at Depot St
- 6B, 6D, 6E – WSE reduction benefits generated along Wagner
- All sub-alternatives generated benefits from removal of buildings
- 6C is most cost effective due to reduced flood WSE at the main Wadler/True Value building

Benefit	6A	6B	6C	6D	6E
Acquisitions and Relocations	$1,027,000	$1,325,000	$658,000	$298,000	$777,000
Water Surface Reductions at Buildings that Remain	$16,000	$330,000	$486,000	$82,000	$327,000
Benefit Totals	$1,043,000	$1,655,000	$1,144,000	$380,000	$1,104,000
Cost Totals	$4,133,000	$5,375,000	$2,649,000	$1,436,000	$3,887,000
Benefit Cost Ratio	0.25	0.31	0.43	0.24	0.28

Recommendation: Select components of these alternatives to pursue; obtain and incorporate revenue figures from True Value to bolster benefits

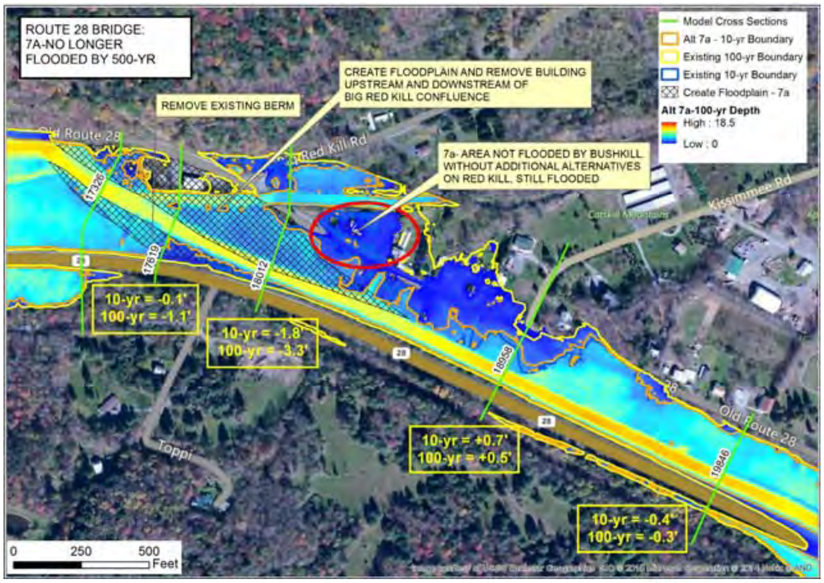
Review Mitigation Alternative #7A



Existing Conditions

MILONE & MACBROOM

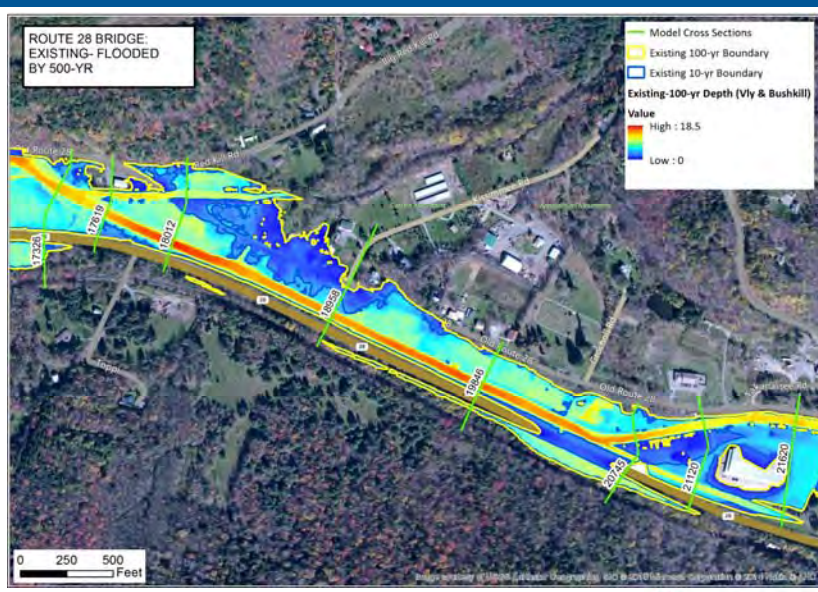
Review Mitigation Alternatives #7A



Post-Mitigation Conditions

MILONE & MACBROOM

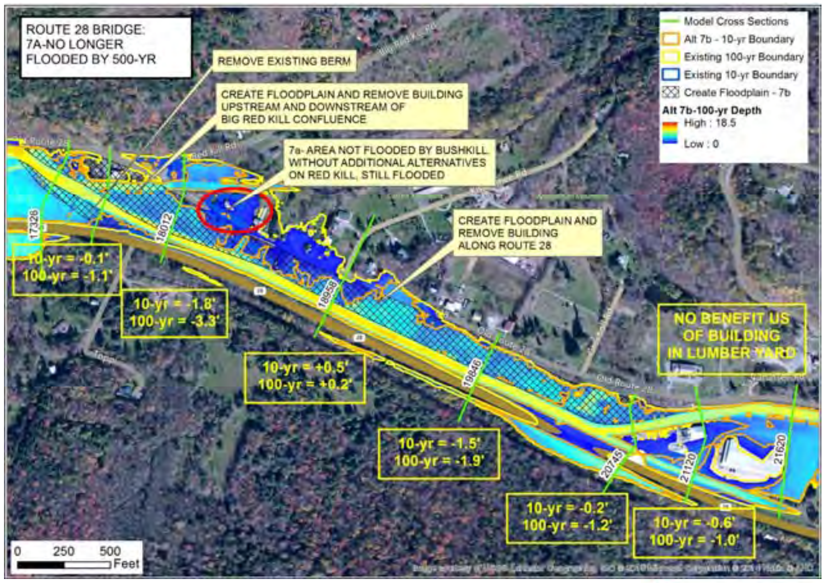
Review Mitigation Alternative #7B



Existing Conditions

MILONE & MACBROOM

Review Mitigation Alternative #7B



Post-Mitigation Conditions

MILONE & MACBROOM

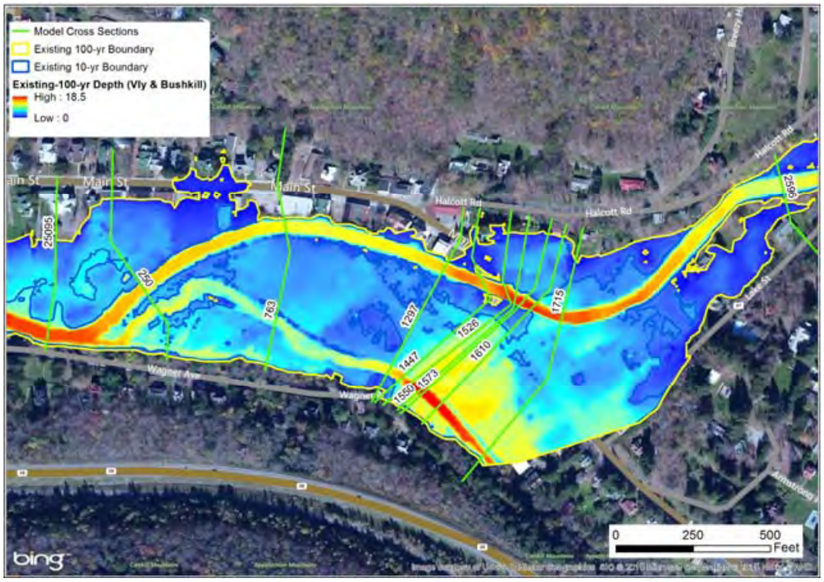
Updated BCA Results for Alternative 7

- 7A – WSE reduction benefits generated along Old Route 28
- 7B – WSE reduction benefits generated along Old Route 28
- Both sub-alternatives generated benefits associated with removal of homes and other buildings
- The acquisitions do not justify themselves (the buildings have higher values than the acquisition benefits)

Benefit Cost Summary	7A	7B
Benefits: Acquisitions and Relocations	$7,000 (one commercial building)	$522,000 (many buildings)
Benefits: Water Surface Reductions at Buildings that Remain	$149,000 (along Old Route 28)	$178,000 (along Old Route 28)
Total Benefits	$156,000	$700,000
Total Costs	$1,039,000	$3,225,000
Benefit Cost Ratio	0.15	0.22

Recommendation: Do not pursue floodplain projects here; better to remove or elevate buildings as owners request.

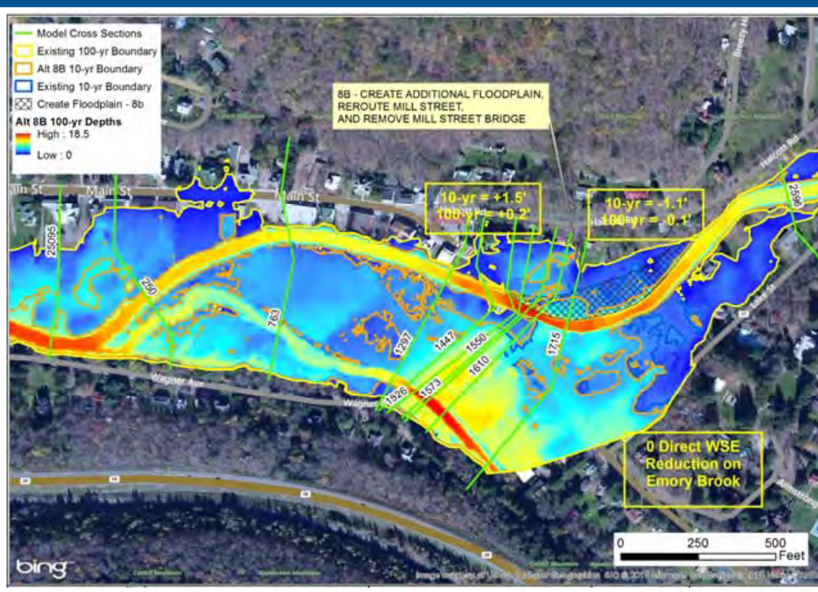
Review Mitigation Alternative #8 with others



Existing Conditions

MILONE & MACBROOM

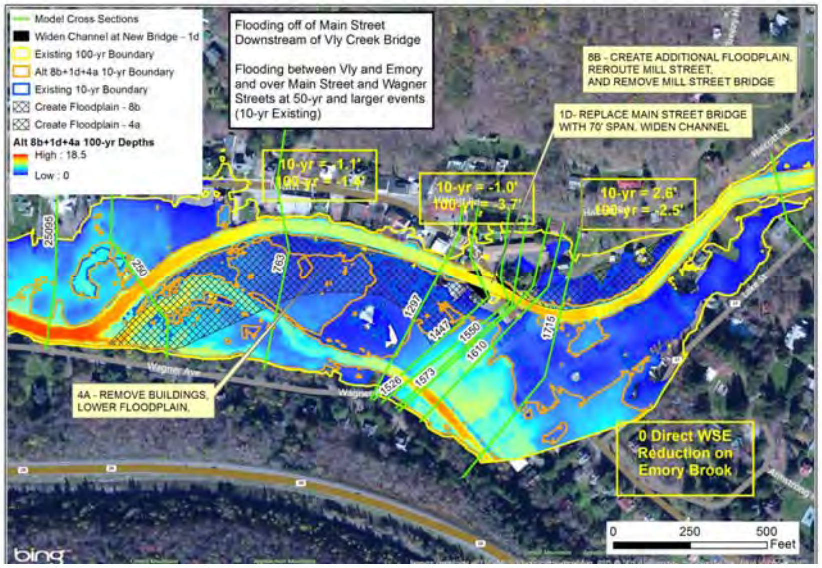
Review Mitigation Alternative #8B + 1C



Post-Mitigation Conditions

MILONE & MACBROOM

Review Mitigation Alternative #8B + 1C + 1D + 4A



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Review Mitigation Alternative #8 with others

- Mill Street bridge backs up the area upstream, eliminating any benefit of the crescent shaped floodplain alone (#8A)
- We understand that #8B + 1C (Mill Street bridge removal + floodplain enhancement) is already a desired project
- Combining with 4A and 1D (Main Street bridge) makes sense hydraulically

Benefit Cost Summary	8B + 1C	8B + 1C + 1D + 4A
Benefits: Acquisitions and Relocations	$0	$673,000
Benefits: Water Surface Reductions at Buildings that Remain	$29,000	$1,729,000
Total Benefits	$29,000	$2,402,000
Total Costs	$311,000	$2,061,000
Benefit Cost Ratio	0.09	1.17

Recommendation: Sharpen the pencil on 8B+1C+1D+4A; dive deeper into the cost estimates and double-check the benefits. ***Is this a desired project?***

Review Mitigation Alternative #9A + 1B + 4B

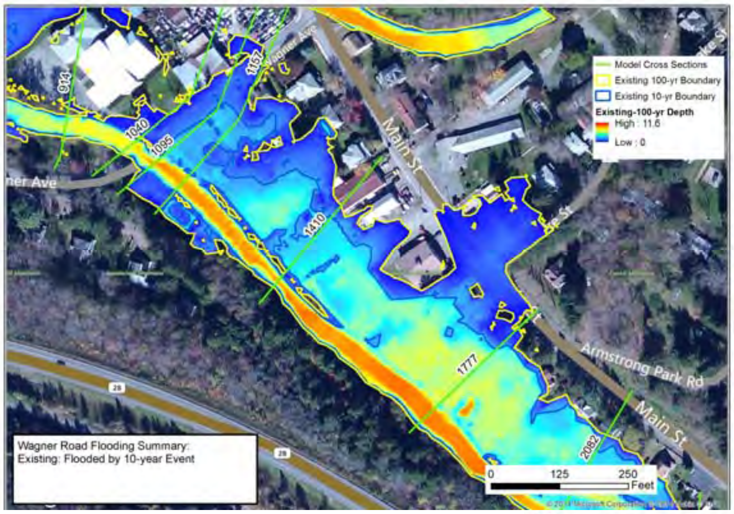
9. Emory Brook floodplain

Current depths

9 alone is not effective due to backwater at Wagner Rd bridge

1b replaces the Wagner Rd bridge

4b is the Vly floodplain we discussed earlier



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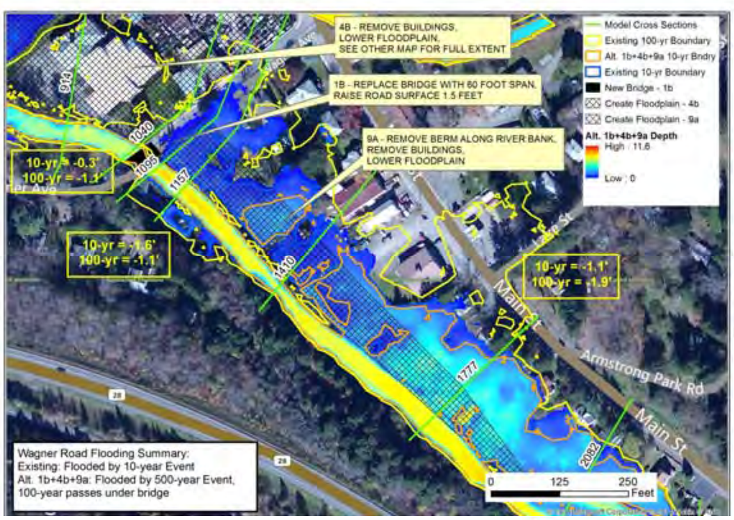
Review Mitigation Alternative #9A + 1B + 4B

9. Emory Brook floodplain

Depths after floodplain project

Citgo 100-yr WSE changes from 1520.8 to 1518.9 and it appears to shift out of the SFHA, although flooding from Vly may still affect it



MILONE & MACBROOM

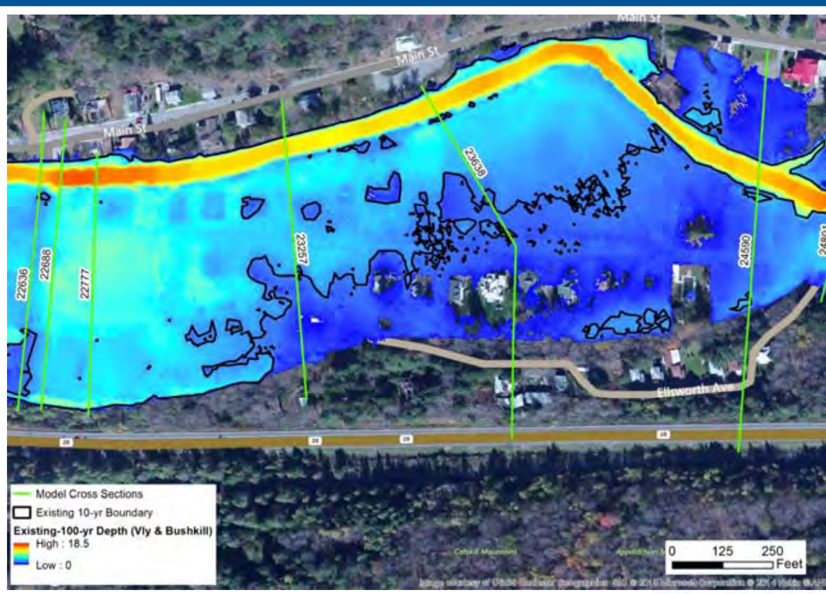
Review Mitigation Alternative #9A + 1B + 4B

- #9 (floodplain enhancement) is not effective due to backwater from Wagner Rd Bridge
- #1B – replaces Wagner Avenue Bridge over Emory Brook

Benefit Cost Summary	9A + 1B + 4B
Benefits: Acquisitions and Relocations	$342,000
Benefits: Water Surface Reductions at Buildings that Remain	$113,000
Total Benefits	$455,000
Total Costs	$3,600,000
Benefit Cost Ratio	0.13

Recommendation: Depends on what happens with 8B+1C+1D+4A. If part of the cost of 4B can be covered by 4A, it could help reduce overall costs for 9A+1B+4B. However, the gap between benefits and costs is pretty significant.

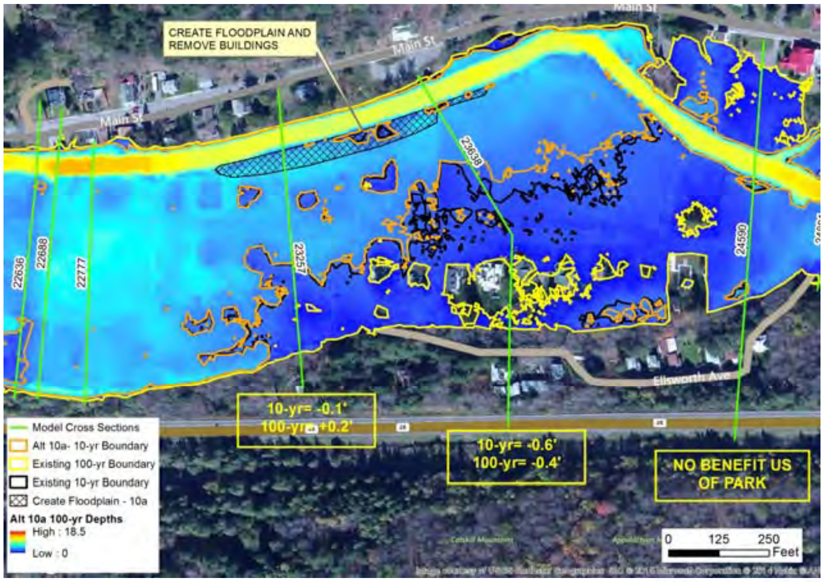
Review Mitigation Alternative #10 at Park



Existing conditions

Milone & MacBroom

Review Mitigation Alternative #10 at Park



Post-Mitigation Conditions

MILONE & MACBROOM

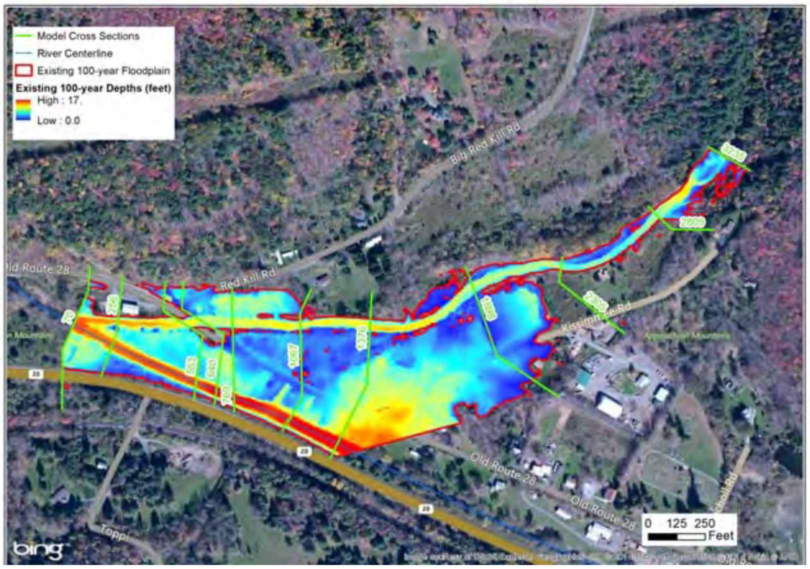
Review Mitigation Alternative #10 at Park

- 10 – WSE reduction benefits generated only for a few homes on Wagner Ave

Benefit Cost Summary	10
Benefits: Acquisitions and Relocations	$153,000 (three outbuildings)
Benefits: Water Surface Reductions at Buildings that Remain	$65,000 (along Wagner Avenue)
Total Benefits	$218,000
Total Costs	$268,000
Benefit Cost Ratio	0.81

Recommendation: Sharpen the pencil on #10; dive deeper into the cost estimates and double-check the benefits. ***Is this a desired project?***

Review Mitigation Alternative at Big Red Kill



Existing conditions

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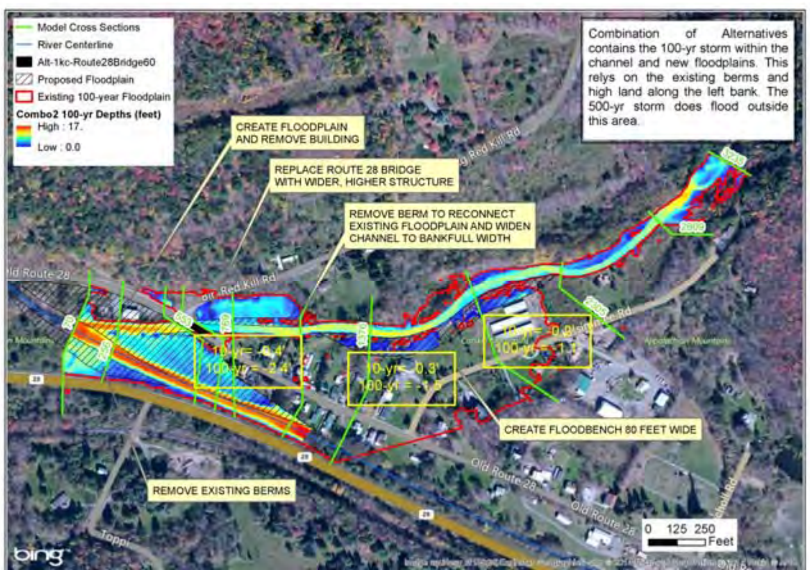
Review Mitigation Alternative at Big Red Kill



Post-Mitigation Conditions

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Review Mitigation Alternative at Big Red Kill

- Includes #7A for Bush Kill
- Includes #1k (bridge replacement over Big Red Kill)
- Includes various floodplain enhancements along Big Red Kill

Benefit Cost Summary	Big Red Kill Combination
Benefits: Acquisitions and Relocations	$7,000
Benefits: Water Surface Reductions at Buildings that Remain	$3,279,000
Total Benefits	$3,286,000
Total Costs	$2,789,000
Benefit Cost Ratio	1.18

Recommendation: Sharpen the pencil on the Big Red Kill combination; dive deeper into the cost estimates and double-check the benefits. ***Is this a desired project?***

Review Mitigation Alternatives at Little Red Kill

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Review Mitigation Alternatives at Little Red Kill

- These are collectively #1e through #1g
- Buildings, homes do not feel the reduced water surface elevations

Benefit Cost Summary	Little Red Kill Combination
Benefits: Acquisitions and Relocations	$0
Benefits: Water Surface Reductions at Buildings that Remain	$0
Total Benefits	$0
Total Costs	>$700,000
Benefit Cost Ratio	$0

Recommendation: Larger bridge and culvert openings will convey more debris and reduce potential for washouts. Consider pursuing as funds allow.

Discussion

- Is there preliminary consensus for alternatives that have greatest potential for BCRs > 1.0
  - ✓ 6C and 6E (both leave the True Value retail bldg)
  - ✓ 8B+1C+1D+4A (Vly Creek combination)
  - ✓ 10 (small floodplain bench downstream of park)
  - ✓ Big Red Kill combination
- Things that could be helpful:
  - ✓ Revenue figures
  - ✓ Operating budgets for public works and fire department facilities near Emory Brook

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Next Steps

- Develop other types of flood mitigation options:
  - ✓ Acquisitions
  - ✓ Elevations
  - ✓ Floodproofing
  - ✓ Critical facilities/emergency services
- Schedule for report and plan
- Schedule for presentation of results to the village

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APPENDIX B

EAST BRANCH DELAWARE RIVER HYDROLOGY AND METHODOLOGY REPORT
GOMEZ AND SULLIVAN, P.C.

East Branch Delaware River
Hydrology Methodology Report

Digital Flood Insurance Rate Map Production and Development of Updated Flood Data

Submitted to:
RAMPP - Dewberry

Submitted by:
Gomez and Sullivan Engineers, P.C.
288 Genesee Street
Utica, NY 13502

GS Project No. 1512

Revised July 31, 2012

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1. OVERVIEW

Hydrologic analyses performed within the East Branch Delaware River watershed consists of nominating discharges for the detailed (D), limited detailed (LD), lake (L), backwater (B) and approximate (A) study segments specified in RAMPP Task Order # HSFE02-11-J-001, Work Order #001. Discharge locations were chosen according to the guidelines provided in Attachments B, C and D to that Task Order and FEMA's "Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C; Guidance for Riverine Flooding Analyses and Mapping" (November 2009). Nominated discharges were compared with existing published flood discharges for the streams studied to determine if any new analysis has a statistically significant difference from prior analyses.

Hydrologic analyses were conducted for 35.47 detailed stream miles in 9 studies, 11.82 miles of limited detailed streams in 2 studies, 0.47 miles of lake in 1 study, 0.18 miles of backwater reaches in 1 study and 9.25 miles of approximate streams in 6 studies. Methods used for the hydrologic analysis of detailed studies, backwater reaches and lakes without significant flood storage capacity consist of gage analyses, the full New York State USGS Regional Regression equations, or a combination of these methods. The Rational Method was used to nominate discharges where the drainage area to the point is smaller than the limits of the regression equation. Peak flood discharges for the 50-, 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance storm events were calculated for detailed, backwater and lake studies. Hydrologic analysis of limited detailed and approximate study reaches consist of the use of the "area-only" New York State USGS Regional Regression equations and the Rational Method (where the drainage area is smaller than the limits of the regression equation). Peak flood discharges for the 50-, and 1-percent-annual-chance storm events were calculated for limited detailed and approximate study reaches.

Figure 1 contains a location map depicting the location of the drainage basin within New York State. The drainage basin encompasses portions of Delaware County, to the west; and Greene and Ulster Counties to the east.

Figure 1: Drainage Basin Location Map

Figure 1: Drainage Basin Location Map

2. NOMINATION METHODS FOR DETAILED STREAMS, AND DETAILED BACKWATER REACHES

Methods for nominating discharges for the detailed study streams include gage analysis, use of the full USGS 2006 New York State Regional Regression equations, the Rational Method, or a combination of these methods. The computed flood discharges were be compared along the stream to ensure internal consistency with regard to the variation of discharge with drainage area. This consistency check is especially important for streams where multiple nomination methods were employed.

Newly-calculated discharges were compared to the effective FIS discharges where they exist. The decision to revise a discharge value or reuse the effective value was based on standard practices described in Appendix C of FEMA “Guidelines and Specifications for Flood Hazard Mapping Partners” (November 2009) (Section C.2.2.2 under the heading “Determining Statistical Significance of Flood Discharges”). Differences between the new and effective discharges are discussed below, as appropriate.

The proposed discharge nomination methods are discussed in Sections 2.1 through 2.3, and more specifically addressed for each of the detailed study streams in Section 3.

In order to compare the various methods utilized in computing flows for detailed streams and backwater reaches, flows computed using the various methods were plotted versus drainage area.

Figure 2 contains a plot of the discharges computed for East Branch Delaware River using the various methods, a comparison of the effective FIS discharges is also included in the plot.

2.1 Nominate Discharges Using Gage Analysis

For the detailed study streams having a gage record of sufficient length (minimum 10 years of record [USGS, 1982]), a discharge-frequency gage analysis methodology was be used to nominate discharges. This methodology utilizes a log-Pearson Type III analysis (LP III) for the available records in accordance with United States Geological Survey (USGS) Bulletin 17B (USGS, 1982). The log-Pearson Type III analysis was be performed using the USGS Peak FQ computer program.

In rural and unregulated flow situations, the gage analysis was weighted with the 2006 New York State Regional Regression equations in accordance with the USGS Scientific Investigations Report (SIR) 2006-5112 "Magnitude and Frequency of Floods in New York" (Lumia, 2006). Within the area of influence of each stream gage (50% to 150% of the drainage area of the stream gage) the gage analysis was transferred to other flow nomination locations according to the method prescribed in "Magnitude and Frequency of Floods in New York".

Table 1 provides a summary of the years of available record by stream for the USGS gages in the East Branch Delaware River Watershed.

Table 1: Summary of USGS Gage Data for East Branch Delaware River Watershed

Gage Name	Gage No.	Period of Record	Comments
East Branch Delaware River at Roxbury, NY	01413088	2001 - Present	
East Branch Delaware River at Margaretville, NY	01413500	1937 - Present	
Bush Kill near Arkville	01413398	1998 - Present	January 1996 Historic Peak Not Used in Analysis
Dry Brook at Arkville	01413408	1996 - Present	January 1996 Historic Peak Not Used in Analysis

2.2 Nominate Discharges Using Regional Regression Equation

For streams where gage data IS lacking, discharges were nominated using the full Regional Regression equation method in accordance with the USGS Scientific Investigations Report 2006-5112 "Magnitude and Frequency of Floods in New York" (Lumia, 2006). For this method, the USGS Stream Stats online program was used to compute the regression equation parameters.

The entire portion of the East Branch Delaware River Watershed which is being studied is within Region 3 as defined for the Regional Regression equations. The Region 3 regression equation parameters include drainage area, basin lag factor, mean annual runoff, and seasonal maximum snow depth. The regression equations were used for nominating flows in basins as small as 0.41 mi^2, the lower limit for the Region 3 regression equations (maximum area is 3480 mi^2) (Lumia, 2006). For the other Region 3 parameters, the valid basin lag factor range is from 0.002 to 20.582; the valid mean annual runoff range is from 16.86 to 40.73 inches; and the valid maximum seasonal snow depth range is from 13.02 to 20.42 inches.

The 2006 New York Region 3 regression equations are provided in Appendix A.

2.3 Rational Method

The Rational Method was employed at discharge points where the drainage area is less than the 0.41 mi^2 lower limit of applicability of the Regional Regression equations. Time of concentration was computed for each basin using the NRCS Curve Number method as described in the "National Engineering Handbook" Chapter 15 (Kent 1972). Rainfall intensity was estimated using the data available from the "Extreme Precipitation in New York & New England Interactive Web Tool" from the Northeast Regional Climate Center (NRCC). Peak stream flows were computed using rainfall intensity for a storm with a duration equal to the time of concentration.

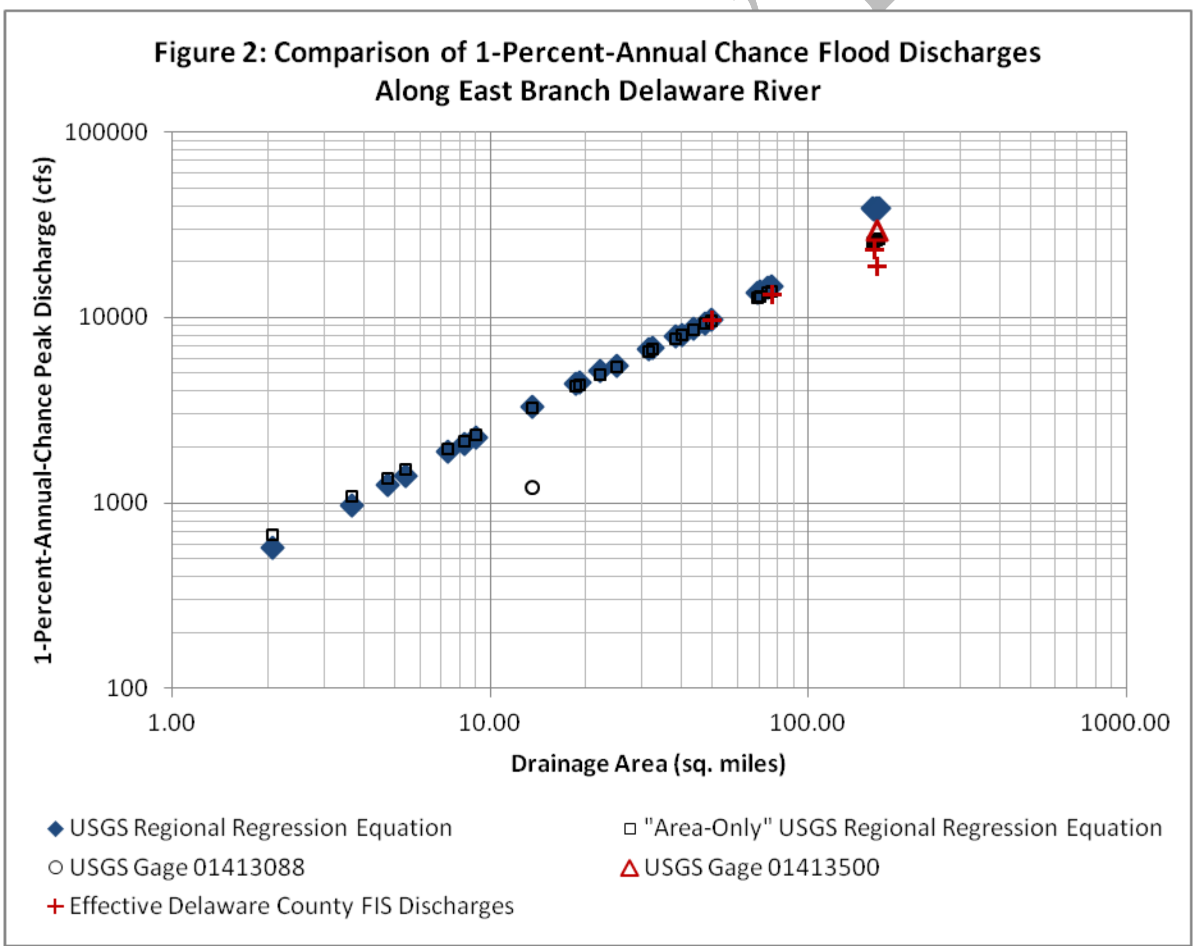

Figure 2: Comparison of 1-Percent-Annual Chance Flood Discharges Along East Branch Delaware River

3. DISCHARGE NOMINATION FOR DETAILED STUDY STREAMS

The detailed study streams, as provided in the Task Order from RAMPP, are listed in Table 2, followed by the proposed discharge nomination method for each stream.

Table 2: Detailed Study Reaches

Stream	Length (mi)	Study Limits
Bush Kill	4.80	From Its Confluence with Dry Brook to the Confluence of Vly Creek and Emory Brook
Tributary 3 to Bush Kill	1.71	From Its Confluence with Bush Kill to Hog Mountain Circle Road
Dry Brook	4.74	From Its Confluence with East Branch Delaware River to Approximately 450 Feet Downstream of Dry Brook Road
East Branch Delaware River	19.56	From Approximately 3,880 Feet Upstream of State Highway 28 to the Dam at Wawaka Lake and From Approximately 2,400 Feet Upstream of the Dam at Wawaka Lake to Approximately 6,225 Feet Upstream of Schuman Road
Emory Brook	0.82	From Its Confluence with Vly Creek to Approximately 400 Feet Upstream of Main Street
Lake Switzerland	0.15	From the Breached Dam at Lake Switzerland for Approximately 2,250 Feet
Little Red Kill	0.21	From its Confluence with Bush Kill to Approximately 240 Feet Upstream of Schneider Ave
Red Kill	0.59	From its Confluence with Bush Kill to Approximately 2,580 Feet Upstream of Old Route 28
Vly Creek	2.89	From Its Confluence with Emory Brook to the Breached Dam at Lake Switzerland and From Approximately 2,260 Feet Upstream of the Breached Dam at Lake Switzerland to Approximately 2,800 Feet Downstream of Ursum Way
Bragg Hollow	0.18	From Its Confluence with East Branch Delaware River to Approximately 210 Feet Upstream of Old River Road

<u>Bush Kill</u>

Based on the Delaware County, New York Flood Insurance Study (FIS) (FEMA, 2012), Bush Kill was previously analyzed using three regional analysis methods; the USGS Regional Regression Equations, the Stankowski Method and a USACE method based on gage data throughout the upper Delaware and Hudson River basins. The prior Flood Insurance Study only provided a discharge nomination at the downstream end of the stream.

A Log-Pearson Type III distribution was computed for USGS gage 01413398 and the gage analysis was weighted with the full Regional Regression Equations to compute the flood flows at the gage. The gage analysis was then transferred to the other discharge locations using the area transfer method given in "Magnitude and Frequency of Floods in New York".

Tributary 3 to Bush Kill

No flood discharge nominations are given for Tributary 3 to Bush Kill in the Delaware County FIS (FEMA, 2012).

The Rational Method was used to compute flows in the upper portion of the Tributary 3 to Bush Kill drainage basin. The full Regional Regression Equations were used to compute flows for drainage areas larger than 0.41 mi^2.

Dry Brook

Based on the Delaware County, New York FIS (FEMA, 2012), Dry Brook was previously analyzed using three regional analysis methods; the USGS Regional Regression Equations, the Stankowski Method and a USACE method based on gage data throughout the upper Delaware and Hudson River basins. The prior Flood Insurance Study only provided discharge nominations for the 1-percent-annual-chance event.

A log-Pearson Type III distribution was computed for USGS gage 01413408 and the gage analysis was weighted with the full Regional Regression Equations to compute the flood flows at the gage. The gage analysis was then transferred to the discharge locations downstream of the confluence of Bush Kill using the area transfer method given in "Magnitude and Frequency of Floods in New York". Upstream of the confluence of Bush Kill, the full Regional Regression Equations were used to compute flows.

East Branch Delaware River

According the Delaware County, New York FIS (FEMA, 2012), this portion of East Branch Delaware River was previously analyzed using a gage analysis of the USGS gages. Since the previous analysis was performed, a new flood of record was experienced on this portion of the East Branch Delaware River; therefore all flood discharges were re-computed.

A Log-Pearson Type III distribution was computed for USGS gages 01413088 and 01413500, the gage analyses were weighted with the full Regional Regression Equations to compute the flood flows at the gages. The gage analysis for USGS gage 01413088 was transferred to the discharge locations between the Railroad crossing and the Roxbury Central School driveway, using the area transfer method given in "Magnitude and Frequency of Floods in New York". The gage analysis for USGS gage 01413500 was transferred to the discharge locations downstream of the confluence of Dry Brook, using the area transfer method given in "Magnitude and Frequency of Floods in New York". The Full Regional Regression Equations were used to compute flows for all other discharge locations.

An initial review of data for USGS gage 01413088 suggested that the gage may not provide an accurate record of the peak flows, based on the extremely low flows which have been reported for considerable rainfall. Upon further review of the measurements that have been taken at the gage, for development of the rating curve, it was shown that two measurements have been taken which are at or near three of the top five flows. As it has been confirmed that the gage is accurately recording peak flows, the gage record was utilized in this analysis, despite the significant difference between observed and expected flows.

Emory Brook

No flood discharge nominations are given for Emory Brook in the Delaware County FIS (FEMA, 2012). The full Regional Regression Equations were used to compute flows for Emory Brook.

Little Red Kill

No flood discharge nominations are given for Little Red Kill in the Delaware County FIS (FEMA, 2012). The full Regional Regression Equations were used to compute flows for Little Red Kill.

Red Kill

No flood discharge nominations are given for Red Kill in the Delaware County FIS (FEMA, 2012). The full Regional Regression Equations were used to compute flows for Red Kill.

Vly Creek and Lake Switzerland

Based on the Delaware County, New York FIS (FEMA, 2012), Vly Creek was previously analyzed using three regional analysis methods; the USGS Regional Regression Equations, the Stankowski Method and a USACE method based on gage data throughout the upper Delaware and Hudson River basins. The prior Flood Insurance Study only provided a discharge nomination at the downstream end of the Vly Creek. No prior flow nominations are given for Lake Switzerland.

The dam at Lake Switzerland is breached, therefore the lake does not provide any storage capacity, the flows were computed for Lake Switzerland in conjunction with Vly Creek. The full Regional Regression Equations were used to compute flows for Vly Creek and Lake Switzerland.

Bragg Hollow

No flood discharge nominations are given for Bragg Hollow in the Delaware County FIS (FEMA, 2012). The full Regional Regression Equations were used to compute flows for Bragg Hollow.

Table 3 contains a summary of the flows computed for detailed stream segments and backwater reaches.

Table 4 contains a comparison of the flows computed for the prior FIS, with the proposed flows.

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Dry Brook							
Approximately 450 Feet Downstream of Dry Brook Road	28.56	2,442	5,056	6,696	8,128	9,633	13,457
Approximately 7,045 Feet Upstream of Erpf Road	31.32	2,570	5,355	7,103	8,630	10,240	14,342
Upstream of Confluence of Bush Kill	33.95	2,684	5,611	7,448	9,054	10,750	15,077
Downstream of Confluence of Bush Kill	81.24	5,453	12,552	16,865	20,506	24,404	34,732
USGS Gage 01413408	82.09	5,501	12,678	17,035	20,711	24,644	35,068
At Confluence with East Branch Delaware River	82.31	5,514	12,703	17,067	20,751	24,691	35,136
Vly Creek							
Approximately 2,800 Feet Downstream of Ursum Way	18.27	1,303	2,896	3,951	4,896	5,913	8,599
Approximately 2,500 Feet Upstream of County Highway 37							
Approximately 1,750 Feet Downstream of County Highway 37	21.97	1,535	3,413	4,654	5,765	6,963	10,130
At Old Halcott Road							

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
At Confluence with Bush Kill	22.60	1,572	3,492	4,760	5,896	7,120	10,356
Little Red Kill							
Approximately 240 Feet Upstream of Schneider Ave	1.63	114	257	358	449	547	805
At Main Street	1.65	116	263	366	460	560	827
At Confluence with Bush Kill	1.65	116	263	366	460	560	827
Emory Brook							
Approximately 400 Feet Upstream of Main Street	6.03	487	1,075	1,474	1,834	2,219	3,235
Approximately 1,520 Feet Downstream of Main Street	6.80	541	1,192	1,632	2,028	2,451	3,568
At Confluence with Bush Kill	6.92	550	1,212	1,659	2,062	2,492	3,627
Red Kill							
Approximately 2,580 Feet Upstream of Old Route 28	7.88	495	1,118	1,539	1,916	2,320	3,392
Approximately 1,180 Feet Upstream of Old Route 28	8.14	511	1,153	1,586	1,975	2,392	3,496
At Confluence with Bush Kill	8.65	541	1,222	1,681	2,092	2,533	3,702

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Tributary 3 to Bush Kill							
At Hog Mountain Circle Road	0.07	13	18	22	25	29	41
Approximately 165 Feet Downstream of Hog Mountain Road	0.14	21	30	37	43	50	72
Approximately 1,530 Feet Downstream of Somerset Lake Road	0.42	27	62	88	111	135	201
Approximately 1,525 Feet Upstream of State Highway 28	0.74	47	107	151	190	232	344
At Confluence with Bush Kill	0.79	50	114	160	202	247	366
Bush Kill							
At Confluence of Vly Creek and Emory Brook	29.60	1,994	4,543	6,218	7,700	9,299	13,532
Upstream of Depot Street	31.52	2,079	4,786	6,568	8,140	9,838	14,341
Approximately 2,275 Feet Downstream of Depot Street	32.99	2,147	4,978	6,841	8,481	10,251	14,951
Upstream of Confluence of Red Kill	33.25	2,153	5,000	6,874	8,524	10,306	15,038
Downstream of Confluence of Red Kill	42.05	2,489	6,038	8,380	10,413	12,604	18,437
Upstream of Confluence of Tributary 3 to Bush Kill	43.96	2,556	6,259	8,706	10,823	13,104	19,181

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Downstream of Confluence of Tributary 3 to Bush Kill	44.93	2,589	6,372	8,872	11,033	13,361	19,562
USGS Gage 1413398	46.77	2,651	6,583	9,185	11,428	13,841	20,273
At Confluence with Dry Brook	47.22	2,678	6,636	9,253	11,511	13,940	20,412
East Branch Delaware River							
Approximately 6,225 Feet Upstream of Schuman Road	2.07	130	283	387	478	573	819
Approximately 5,190 Feet Upstream of Schuman Road	3.68	224	487	662	816	977	1,391
Approximately 2,690 Feet Upstream of Schuman Road	4.75	286	623	845	1,040	1,244	1,770
At Schuman Road	5.42	324	705	956	1,177	1,407	2,000
Approximately 1,150 Feet Downstream of Railroad Crossing	7.38	426	941	1,283	1,583	1,898	2,708
Approximately 290 Feet Upstream of Teichman Road	8.26	448	1,011	1,390	1,723	2,073	2,968
At South Montgomery Hollow Road	9.03	463	1,066	1,478	1,840	2,219	3,188
At USGS Gage 1413088	13.51	486	1,314	1,932	2,472	3,038	4,451

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 175 Feet Downstream of State Highway 30	18.65	944	2,126	2,910	3,596	4,316	6,159
At Roxbury Central School Driveway	19.09	988	2,198	2,994	3,689	4,420	6,294
Approximately 3,420 Feet Upstream of Cross Road	22.25	1,221	2,639	3,546	4,342	5,181	7,350
Approximately 4,700 Feet Downstream of Cross Road	25.02	1,311	2,810	3,767	4,607	5,492	7,780
Approximately 6,220 Feet Downstream of Cross Road	31.53	1,618	3,455	4,619	5,637	6,708	9,473
Upstream of Confluence with Meeker Hollow	32.39	1,659	3,543	4,735	5,777	6,875	9,708
At Cold Spring Road	38.16	1,925	4,100	5,466	6,658	7,912	11,140
Approximately 1,820 Feet Upstream of Horse Farm Road	39.92	1,975	4,194	5,589	6,806	8,087	11,384
Upstream of Confluence of Bragg Hollow	43.57	2,117	4,492	5,985	7,293	8,672	12,230
Downstream of Confluence of Bragg Hollow	47.34	2,274	4,812	6,400	7,788	9,248	13,010
Upstream of Confluence of Batavia Kill	49.76	2,380	5,047	6,722	8,187	9,733	13,728
Downstream of Confluence of Batavia Kill	69.08	3,301	7,047	9,394	11,456	13,644	19,325

Table 3: Summary of Discharges – Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 1,375 Feet Downstream of State Highway 30	70.37	3,356	7,162	9,547	11,640	13,863	19,632
Approximately 2,105 Feet Upstream of County Highway 38	74.56	3,514	7,499	9,993	12,184	14,512	20,558
Upstream of Confluence of Dry Brook	76.47	3,567	7,610	10,142	12,367	14,731	20,877
Downstream of Confluence of Dry Brook	158.87	6,429	15,352	21,738	27,440	33,752	50,260
Approximately 795 Feet Downstream of Bridge Street	160.38	6,429	15,374	21,802	27,543	33,901	50,529
USGS Gage 1413500	163.33	6,429	15,443	21,962	27,789	34,247	51,138
Approximately 3,880 Feet Upstream of State Highway 28	167.50	6,699	15,998	22,656	28,600	35,177	52,371
Bragg Hollow							
Approximately 210 Feet Upstream of Old River Road	3.69	213	470	643	795	955	1,370
Downstream of Old River Road	3.70	213	471	645	797	957	1,374
At Confluence with East Branch Delaware River	3.74	215	476	651	805	967	1,388

Table 4: Comparison Between Computed and Effective Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PROPOSED DISCHARGES				EFFECTIVE DISCHARGES				CHANGE IN DISCHARGES			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Dry Brook													
Upstream of Confluence of Bush Kill	33.95	5,611	9,054	10,750	15,077	*	*	6,020	*	*	*	78.57%	*
At Confluence with East Branch Delaware River	82.31	12,703	20,751	24,691	35,136	*	*	11,970	*	*	*	106.28%	*
Vly Creek													
Approximately 1,750 Feet Downstream of County Highway 37 [1]	21.97	3,413	5,765	6,963	10,130	*	*	4,170	*	*	*	66.97%	*
Bush Kill													
At Confluence with Dry Brook	47.22	6,636	11,511	13,940	20,412	*	*	6,420	*	*	*	117.13%	*
East Branch Delaware River													
Upstream of Confluence of Batavia Kill	49.76	5,047	8,187	9,733	13,728	*	*	9,736	*	*	*	-0.03%	*
Upstream of Confluence of Dry Brook	76.47	7,610	12,367	14,731	20,877	*	*	13,414	*	*	*	9.82%	*
Approximately 795 Feet Downstream of Bridge Street [2]	160.38	15,374	27,543	33,901	50,529	*	*	23,330	*	*	*	45.31%	*
USGS Gage 1413500	163.33	15,443	27,789	34,247	51,138	10,600	16,200	19,000	26,600	45.69%	71.53%	80.25%	92.25%

Notes

[1] Location in Delaware County FIS is given as approximately 785 feet further downstream, however drainage area given in Delaware County FIS is approximately 0.07 mi^2 less, therefore drainage points are considered to be comparable.

[2] Location in Delaware County FIS is approximately 3,115 feet upstream, however drainage area of point in Delaware County FIS is only approximately 0.38 mi^2 less, therefore drainage points are considered to be comparable.

4. NOMINATION METHODS FOR LIMITED DETAILED STREAMS,

Methods used for nominating discharges for the limited detailed study streams include the "area-only" USGS 2006 New York State Regional Regression equations and the rational method, or a combination of these methods. The computed flood discharges were compared along the stream to ensure internal consistency with regard to the variation of discharge with drainage area. This consistency check is especially important for streams where multiple nomination methods were employed.

Newly-calculated discharges were be compared to the effective FIS discharges where they exist. The decision to revise a discharge value or reuse the effective value was be based on standard practices described in Appendix C of FEMA Guidelines and Specifications for Flood Hazard Mapping Partners (November 2009) (Section C.2.2.2 under the heading "Determining Statistical Significance of Flood Discharges"). Differences between the new and effective discharges are discussed below, as appropriate.

4.1 Nominate Discharges Using Regional Regression Equation

For limited detailed streams, discharges were be nominated using the "area-only" Regional Regression equation method in accordance with the USGS Scientific Investigations Report 2006-5112 "Magnitude and Frequency of Floods in New York" (Lumia, 2006). The entire portion of the East Branch Delaware River Watershed which is being studied is within Region 3 as defined for the Regional Regression equations. The regression equations were used for nominating flows in basins as small as 0.41 mi^2, the lower limit for the Region 3 regression equations (maximum area is 3480 mi^2) (Lumia, 2006).

The 2006 New York Region 3 "area-only" regression equations are provided in Appendix A.

4.2 Rational Method

The Rational Method was be employed at discharge points where the drainage area is less than the 0.41 mi^2 lower limit of applicability of the "area-only" Regional Regression equations. Time of concentration was computed for each basin using the NRCS Curve Number method as described in the "National Engineering Handbook" Chapter 15 (Kent 1972). Rainfall intensity was estimated using the data available from the "Extreme Precipitation in New York & New England Interactive Web Tool" from the Northeast Regional Climate Center (NRCC). Peak stream flows were computed using a rainfall intensity for a storm with a duration equal to the time of concentration.

5. DISCHARGE NOMINATION FOR LIMITED DETAILED STUDY STREAMS

The limited detailed study streams are listed in Table 3. The proposed discharge nomination method for each stream is detailed below.

Table 5: Limited Detailed Study Reaches

Stream	Length (mi)	Study Limits
Dry Brook	8.10	From Approximately 450 Feet Downstream of Dry Brook Road to Approximately 1,560 Feet Upstream of Eagle Lodge Road
Rider Hollow	3.72	From Its Confluence with Dry Brook to Approximately 6,780 Feet Upstream of Todd Brook Road

Dry Brook

No flood discharge nominations are given for this portion of Dry Brook in the Delaware County FIS (FEMA, 2012). The full Regional Regression Equations were used to compute flows for Dry Brook to ensure consistency with the portion of the stream studied by detailed methods. The Rational Method was employed for the two locations having drainage area less than 0.41 mi^2.

Rider Hollow

No flood discharge nominations are given for Rider Hollow in the Delaware County FIS (FEMA, 2012). The “area-only” Regional Regression Equations were used to compute flows for Little Red Kill.

Table 6 contains a summary of the flows computed for limited detailed stream segments.

Table 6: Summary of Discharges – Limited Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Rider Hollow							
Approximately 6,780 Feet Upstream of Todd Brook Road	0.76	72	*	*	*	292	*
Approximately 5,575 Feet Upstream of Todd Brook Road	0.95	87	*	*	*	352	*
Approximately 4,025 Feet Upstream of Todd Brook Road	1.15	102	*	*	*	412	*
Approximately 3,000 Feet Upstream of Todd Brook Road	1.68	141	*	*	*	566	*
Approximately 2,010 Feet Upstream of Todd Brook Road	1.94	160	*	*	*	639	*
Approximately 440 Feet Upstream of Todd Brook Road	2.06	168	*	*	*	672	*
Approximately 100 Feet Downstream of Todd Brook Road	2.88	224	*	*	*	889	*
Approximately 890 Feet Downstream of Rider Hollow Road	3.54	267	*	*	*	1,056	*
Approximately 2,600 Feet Downstream of Rider Hollow Road	4.00	296	*	*	*	1,169	*
Approximately 4,820 Feet Downstream of Rider Hollow Road	5.17	369	*	*	*	1,449	*

Table 6: Summary of Discharges – Limited Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 1,660 Feet Upstream of Todd Mountain Road	6.00	419	*	*	*	1,641	*
Approximately 530 Feet Upstream of Todd Mountain Road	7.90	529	*	*	*	2,066	*
At Confluence with Dry Brook	8.10	541	*	*	*	2,109	*
Dry Brook							
Approximately 15,060 Feet Upstream of Eagle Lodge Road	0.21	47	*	*	*	101	*
Approximately 14,250 Feet Upstream of Eagle Lodge Road	0.31	56	*	*	*	126	*
Approximately 13,160 Feet Upstream of Eagle Lodge Road	0.43	56	*	*	*	209	*
Approximately 12,300 Feet Upstream of Eagle Lodge Road	0.49	61	*	*	*	234	*
Approximately 11,900 Feet Upstream of Eagle Lodge Road	0.96	115	*	*	*	437	*
Approximately 10,000 Feet Upstream of Eagle Lodge Road	1.10	131	*	*	*	498	*
Approximately 9,520 Feet Upstream of Eagle Lodge Road	1.50	177	*	*	*	668	*

Table 6: Summary of Discharges – Limited Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Upstream of Confluence of Shandaken Brook	1.68	197	*	*	*	744	*
Downstream of Confluence of Shandaken Brook	3.12	356	*	*	*	1,338	*
Upstream of Confluence of Flatiron Brook	3.26	371	*	*	*	1,395	*
Downstream of Confluence of Flatiron Brook	4.25	475	*	*	*	1,773	*
Approximately 2,280 Feet Upstream of Eagle Lodge Road	5.11	564	*	*	*	2,108	*
Approximately 900 Feet Downstream of Eagle Lodge Road	6.00	656	*	*	*	2,451	*
Approximately 550 Feet Downstream of Dry Brook Road	7.76	822	*	*	*	3,042	*
Approximately 790 Feet Downstream of Erickson Road	8.61	903	*	*	*	3,350	*
Upstream of Confluence of Haynes Hollow	9.24	963	*	*	*	3,574	*
Downstream of Confluence of Haynes Hollow	13.60	1,348	*	*	*	5,047	*
Approximately 220 Feet Downstream of Dry Brook Road	14.26	1,402	*	*	*	5,261	*

Table 6: Summary of Discharges – Limited Detailed Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 2,850 Feet Upstream of Dry Brook Road	16.11	1,529	*	*	*	5,777	*
Upstream of Confluence of Rider Hollow	18.79	1,696	*	*	*	6,507	*
Downstream of Confluence of Rider Hollow	26.94	2,335	*	*	*	9,174	*

6. LAKE STUDY

A lake study is indicated for Wawaka Lake on East Branch Delaware River. An inspection of the lake shows that the lake does not provide any usable storage volume which would attenuate flood flows. Wawaka Lake was included in the hydrologic analysis for East Branch Delaware River as the lake does not affect flood flows. No nomination points were chosen in the lake, however in the area immediately downstream of Wawaka Lake, flows were computed using the full Regional Regression Equations.

7. DISCHARGE NOMINATION FOR APPROXIMATE STUDY STREAMS

Flow nominations for approximate study streams were computed using the "area-only" Regional Regression Equations and the Rational Method for drainage areas less than 0.41 mi^2. These methods were applied as described in Section 4: Nomination Methods for Limited Detailed Streams.

Table 7 contains a summary of the flows computed for approximate stream segments.

Table 7: Summary of Discharges – Approximate Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Montgomery Hollow							
Approximately 520 Feet Upstream of South Montgomery Hollow Road	3.72	278	*	*	*	1,101	*
Approximately 45 Feet Downstream of South Montgomery Hollow Road	3.75	280	*	*	*	1,108	*
At Confluence with East Branch Delaware River	3.76	281	*	*	*	1,111	*
Meeker Hollow							
Approximately 1,320 Feet Upstream of Henry Williams Road	5.48	387	*	*	*	1,522	*
Approximately 380 Feet Downstream of Henry Williams Road	5.68	400	*	*	*	1,568	*
At Confluence with East Branch Delaware River	5.73	403	*	*	*	1,579	*
Batavia Kill							
Approximately 610 Feet Upstream of George Lawrence Road	6.29	436	*	*	*	1,707	*
Approximately 1,460 Feet Downstream of George Lawrence Road	6.51	449	*	*	*	1,757	*

Table 7: Summary of Discharges – Approximate Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 2,190 Feet Downstream of George Lawrence Road	7.28	494	*	*	*	1,929	*
Approximately 1,940 Feet Upstream of Cartwright Road	9.04	594	*	*	*	2,312	*
Approximately 840 Feet Downstream of Cartwright Road	9.74	633	*	*	*	2,461	*
Approximately 1,010 Feet Downstream of Stewart Road	9.96	645	*	*	*	2,507	*
Approximately 130 Feet Downstream of County Highway 36	10.82	692	*	*	*	2,687	*
Approximately 2,860 Feet Downstream of County Highway 36	11.19	712	*	*	*	2,764	*
Approximately 2,450 Feet Upstream of County Highway 8	13.44	833	*	*	*	3,221	*
Approximately 670 Feet Downstream of County Highway 8	14.51	889	*	*	*	3,434	*
Approximately 865 Feet Upstream of County Highway 36	15.30	930	*	*	*	3,590	*
Tributary 1 to Emory Brook							
Approximately 380 Feet Downstream of Green Hill Road	0.34	35	*	*	*	84	*

Table 7: Summary of Discharges – Approximate Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 750 Feet Upstream of Moran Road	0.38	35	*	*	*	86	*
At Confluence with Emory Brook	0.48	49	*	*	*	199	*
Tributary 6 to Emory Brook							
Approximately 630 Feet Upstream of Townsend Hollow Road Spur	0.49	49	*	*	*	202	*
Approximately 300 Feet Upstream of Townsend Hollow Road Spur	0.50	50	*	*	*	206	*
At Confluence with Emory Brook	0.51	51	*	*	*	209	*
Emory Brook							
Approximately 1,605 Feet Upstream of Townsend Hollow Road	0.78	73	*	*	*	298	*
Downstream of Confluence of Tributary 6 to Emory Brook	1.29	113	*	*	*	454	*
Approximately 350 Feet Upstream of Townsend Hollow Road	1.65	139	*	*	*	558	*
Approximately 1,080 Feet Downstream of Townsend Hollow Road	1.92	158	*	*	*	633	*
Approximately 3,150 Feet Downstream of Townsend Hollow Road	2.29	184	*	*	*	734	*

Table 7: Summary of Discharges – Approximate Studies

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)					
		50-PERCENT	10-PERCENT	4-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Approximately 7,000 Feet Downstream of Townsend Hollow Road	2.90	225	*	*	*	894	*
Approximately 9,290 Feet Downstream of Townsend Hollow Road	3.69	277	*	*	*	1,093	*
Approximately 12,420 Feet Downstream of Townsend Hollow Road	4.52	329	*	*	*	1,295	*
Upstream of Confluence of Tributary 1 to Emory Brook	5.12	366	*	*	*	1,438	*

8. REFERENCES

Federal Emergency Management Agency (FEMA). June19, 2012. Flood Insurance Study, Delaware County, New York.

Kent, Kenneth M. 1972. National Engineering Handbook, Section4: Hydrology, Chapter 15: Travel Time, Time of Concentration and Lag. 16 p.

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U.S. Geological Survey. 1982. Guidelines for determining flood flow frequency. U.S. Water Resources Council, Interagency Advisory Committee of Water Data. Bulletin #17B of the Hydrology Subcommittee. Revised 1981. Reston, Virginia.

FEMA, April 2003, Guidelines and Specifications for Flood Hazard Mapping Partners; Appendix C: Guidance for Riverine Flooding Analyses and Mapping.

APPENDIX A: NEW YORK STATE REGION 3 REGRESSION EQUATIONS (SOURCE: LUMIA, 2006)

Regression equations for estimating peak discharges for rural, unregulated streams are assigned in each of six hydrologic regions of New York, excluding Long Island. The full and "area-only" Regression Equations for the East Branch Delaware River Watershed are included below.

Region 3 – Area Only

$$Q_{1.25} = 57.4\,(A)^{0.861}$$
$$Q_{1.5} = 71.8\,(A)^{0.0.857}$$
$$Q_{2} = 90.8\,(A)^{0.853}$$
$$Q_{5} = 144\,(A)^{0.850}$$
$$Q_{10} = 185\,(A)^{0.848}$$
$$Q_{25} = 249(A)^{0.843}$$
$$Q_{50} = 304\,(A)^{0.840}$$
$$Q_{100} = 367\,(A)^{0.836}$$
$$Q_{200} = 436\,(A)^{0.832}$$
$$Q_{500} = 539(A)^{0.827}$$

Region 3 – Full Regression

$$Q_{1.25} = 0.038\,(A)^{0.959}\,(LAG+1)^{-0.141}\,(RUNF)^{1.234}\,(MXSNO)^{1.037}$$
$$Q_{1.5} = 0.052\,(A)^{0.961}\,(LAG+1)^{-0.161}\,(RUNF)^{1.142}\,(MXSNO)^{1.110}$$
$$Q_{2} = 0.051\,(A)^{0.962}\,(LAG+1)^{-0.179}\,(RUNF)^{1.009}\,(MXSNO)^{1.360}$$
$$Q_{5} = 0.083\,(A)^{0.965}\,(LAG+1)^{-0.215}\,(RUNF)^{0.776}\,(MXSNO)^{1.632}$$
$$Q_{10} = 0.103\,(A)^{0.963}\,(LAG+1)^{-0.228}\,(RUNF)^{0.658}\,(MXSNO)^{1.794}$$
$$Q_{25} = 0.117\,(A)^{0.957}\,(LAG+1)^{-0.239}\,(RUNF)^{0.524}\,(MXSNO)^{2.016}$$
$$Q_{50} = 0.119\,(A)^{0.953}\,(LAG+1)^{-0.244}\,(RUNF)^{0.430}\,(MXSNO)^{2.195}$$
$$Q_{100} = 0.115\,(A)^{0.951}\,(LAG+1)^{-0.249}\,(RUNF)^{0.341}\,(MXSNO)^{2.375}$$
$$Q_{200} = 0.111\,(A)^{0.949}\,(LAG+1)^{-0.253}\,(RUNF)^{0.255}\,(MXSNO)^{2.547}$$
$$Q_{500} = 0.105\,(A)^{0.948}\,(LAG+1)^{-0.258}\,(RUNF)^{0.147}\,(MXSNO)^{2.759}$$

Subscript is recurrence interval; thus, Q_2 refers to discharge with 2-year recurrence interval

A = Drainage area, in square miles
Q = Flow, in cfs
LAG = Basin lag factor[1].
RUNF = Mean annual runoff, in inches
MXSNO = Seasonal maximum snow depth (50th percentile), in inches

[1] Basin Lag Factor calculated as: $$\frac{\text{Main Channel Length (in miles)} \div}{\sqrt{(\text{Slope of upper half of main channel (ft/mi)} \times (\text{Slope of lower half of main channel (ft/mi)})}}$$

APPENDIX C

COST ESTIMATES

Alt 1A

Properties to be purchased

Parcel #	**Address**	**Value**
*No acquisitions, bridge replacement only		

Cost of Bridge Replacement - Main Street Emory $500,000

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
3803.7	0	172.3684	9109.67
3631.293	105.7	398.5753	21064.7
3232.719	0		0
		Total CF:	30174.37

Excavation costs ($4/CY)	$4,470
Export costs ($20/CY)	$22,351
Total Costs:	$526,822

Alt 4A

Properties / structures to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
287.17-7-1	Wagner Ave	$225,180	$60,000
287.18-7-2	717 Wagner Ave	$373,600	$100,000
	Total:	$598,780	$160,000

Restoration

Area to restore (SF)	225573
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$104,432
Seedmix cost ($0.75/SF)	$169,180

Volume Calculations

XS		River	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
1494.652 DS		Vly	0	15.879	4879.6167
	1446.831	Vly	614.6	149.865	78154.5975
	1296.966	Vly	428.4	534.148	186711.433
	762.818	Vly	270.7	513.161	103915.103
	249.657	Vly	134.3	362	24308.3
	25095.38	Bushkill	0		
				Total CF:	397969.05

Excavation costs ($4/CY)	$58,958
Export costs ($20/CY)	$294,792
Total Costs:	$1,386,142

Alt 4B

Properties / structures to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
287.18-7-1	Wagner Ave	$1,172,000	$160,000
287.18-7-2	717 Wagner Ave	$373,600	$100,000
	Total:	$1,545,600	$260,000

Restoration

Area to restore (SF)	325611
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$150,746
Seedmix cost ($0.75/SF)	$244,208

Volume Calculations

XS	River	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
1494.652 DS	Vly	0	15.879	5170.99635
1446.831	Vly	651.3	149.865	106996.117
1296.966	Vly	776.6	534.148	300565.08
762.818	Vly	348.8	513.161	126083.658
249.657	Vly	142.6	362	25810.6
25095.38	Bushkill	0		0
			Total CF:	564626.45

Excavation costs ($4/CY)	$83,648
Export costs ($20/CY)	$418,242
Total Costs:	$2,702,444

Alt 5A

Properties / structures to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
287.17-2-9.22	966 Main Street B	$68,550	$20,000
287.17-2-12	952 Main Street B	$33,400	$20,000
287.17-2-9.1	Main Street	$6,400	$0
287.17-2-7	906 Main Street	$129,800	$40,000
287.17-2-5	890 Main Street B	$47,200	$20,000
287.17-2-2	46 Bridge Street	$99,800	$20,000
287.17-1-12	45 Bridge Street	$62,600	$20,000
	Total:	$447,750	$140,000

Restoration

Area to restore (SF)	131744
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$60,993
Seedmix cost ($0.75/SF)	$98,808

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)	
762.818	0	513.161	119130.33	Vly Creek
249.657	464.3	362	296351.30	Vly Creek
25095.38	1173	294.301	368623.77	
24801.08	1332.08	22	29279.58	
24779	1329.7	189.448	151889.93	
24589.63	273.8	651.691	89216.50	
23637.94	0		0.00	
		Total CF:	241106.43	
		Total CY:	8929.87	

Excavation costs ($4/CY)	$35,719
Export costs ($20/CY)	$178,597
Total Costs:	$961,867

Alt 5B

Properties / structures to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
287.17-2-9.22	966 Main Street B	$68,550	$20,000
287.17-2-12	952 Main Street B	$33,400	$20,000
287.17-2-9.1	Main Street	$6,400	$0
287.17-2-7	906 Main Street	$129,800	$40,000
287.17-2-5	890 Main Street B	$47,200	$20,000
	Total:	$285,350	$100,000

Restoration

Area to restore (SF)	131744
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$60,993
Seedmix cost ($0.75/SF)	$98,808

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
762.818	0	513.161	119540.855
249.657	465.9	362	285961.9
25095.38	1114	294.301	163925.657
24801.08	0	22	0
24779	0	189.448	25935.4312
24589.63	273.8	951.691	130286.4979
23637.94	0		0
		Total CF:	156221.9291
		Total CY:	5785.997374

Excavation costs ($4/CY)	$23,144
Export costs ($20/CY)	$115,720

Total Costs: $684,015

Alt 6A

Properties to be purchased

Parcel #	Address		Property Value	Demolition costs
286.20-2-20	47293 State Hwy 28		$1,113,300	$350,000
286.20-2-6	139 Depot Street		$284,000	$350,000
286.20-2-8	125 Depot Street		$48,400	$30,000
286.20-2-7	Depot Street		$16,300	$0
		Total:	$1,462,000	$730,000

Restoration

Area to restore (SF)	475950
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$220,347
Seedmix cost ($0.75/SF)	$356,963

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
22636.46	0	197.28	37473.336
22439.18	379.9	370.734	152353.1373
22068.5	442	448.67	401110.98
21619.78	1346	499.588	556216.2998
21119.8	880.7	374.88	230270.04
20745.31	347.8	898.98	156332.622
19846.33	0		0
		Total CF:	1533756.415

Excavation costs ($4/CY)	$227,223
Export costs ($20/CY)	$1,136,116
Total Costs:	$4,132,649

Alt 6B

Properties to be purchased

Parcel #	Address	Property Value	Demolition costs
286.20-2-20	47293 State Hwy 28	$1,113,300	$350,000
286.20-2-6	139 Depot Street	$284,000	$350,000
286.20-2-8	125 Depot Street	$48,400	$30,000
286.20-2-7	Depot Street	$16,300	$0
287.17-3-2	102 Depot Street	$291,600	$350,000
	Total:	$1,753,600	$1,080,000

Restoration

Area to restore (SF)	675179
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$312,583
Seedmix cost ($0.75/SF)	$506,384

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
23256.5	0	479.92	134857.52
22776.62	562	88.805	49548.74975
22687.81	553.9	51.347	37085.37075
22636.46	890.6	197.28	157350.528
22439.18	704.6	370.734	213728.151
22068.5	448.4	448.67	402771.059
21619.78	1347	499.588	554018.1126
21119.8	870.9	374.88	229351.584
20745.31	352.7	898.98	158535.123
19846.33	0		0
		Total CF:	1937246.198
		Total CY:	71749.85919

Excavation costs ($4/CY)	$286,999
Export costs ($20/CY)	$1,434,997
Total Costs:	$5,374,564

Alt 6C

Properties to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
286.20-2-20	47293 State Hwy 28 B	$88,067	$50,000
286.20-2-20	47293 State Hwy 28 C	$88,067	$50,000
286.20-2-20	47293 State Hwy 28 D	$88,067	$50,000
286.20-2-6	139 Depot Street	$284,000	$350,000
286.20-2-8	125 Depot Street	$48,400	$30,000
286.20-2-7	Depot Street	$16,300	$0
	Total:	$612,901	$530,000

Restoration

Area to restore (SF)	396093
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$183,376
Seedmix cost ($0.75/SF)	$297,070

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
22636.46	0	197.28	38153.952
22439.18	386.8	370.734	154818.5184
22068.5	448.4	448.67	221216.7435
21619.78	537.7	499.588	353458.51
21119.8	877.3	374.88	229595.256
20745.31	347.6	898.98	156242.724
19846.33	0		0
		Total CF:	1153485.704

Excavation costs ($4/CY)	$170,887
Export costs ($20/CY)	$854,434
Total Costs:	$2,648,668

Alt 6D

Properties to be purchased

Parcel #	Address	Property Value	Demolition costs
287.17-3-2	102 Depot Street	$291,600	$350,000
286.20-2-8	125 Depot Street	$48,400	$30,000
286.20-2-7	Depot Street	$16,300	$0
	Total:	$356,300	$380,000

Restoration

Area to restore (SF)	232034
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$107,423
Seedmix cost ($0.75/SF)	$174,026

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
23256.5	0	479.92	102988.4324
22776.62	429.19	88.805	43505.12548
22687.81	550.6	51.347	36944.1665
22636.46	888.4	197.28	156857.328
22439.18	701.8	370.734	130090.5606
22068.5	0		0
		Total CF:	470385.613
		Total CY:	17421.68937

Excavation costs ($4/CY)	$69,687
Export costs ($20/CY)	$348,434
Total Costs:	**$1,435,869**

Alt 6E

Properties to be purchased

Parcel #	Address	Property Value	Demolition costs
286.20-2-20	47293 State Hwy 28 B	$88,067	$50,000
286.20-2-20	47293 State Hwy 28 C	$88,067	$50,000
286.20-2-20	47293 State Hwy 28 D	$88,067	$50,000
286.20-2-6	139 Depot Street	$284,000	$350,000
286.20-2-8	125 Depot Street	$48,400	$30,000
286.20-2-7	Depot Street	$16,300	$0
287.17-3-2	102 Depot Street	$291,600	$350,000
	Total:	$904,501	$880,000

Restoration

Area to restore (SF)	595464
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$275,678
Seedmix cost ($0.75/SF)	$446,598

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
23256.5	0	479.92	133945.672
22776.62	558.2	88.805	49300.09575
22687.81	552.1	51.347	37146.98715
22636.46	894.8	197.28	158317.2
22439.18	710.2	370.734	215934.0183
22068.5	454.7	448.67	222114.0835
21619.78	535.4	499.588	349811.5176
21119.8	865	374.88	228020.76
20745.31	351.5	898.98	157995.735
19846.33	0		0
		Total CF:	1552586.069

Excavation costs ($4/CY)	$230,013
Export costs ($20/CY)	$1,150,064
Total Costs:	$3,886,853

Alt 7A

Properties to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
286.-1-34	630 Old Route 28	$18,200	$0
286.-1-35	Old Route 28	$400	$0
286.-1-33	544 Old Route 28	$165,800	$40,000
	Total:	$184,400	$40,000

Restoration

Area to restore (SF)	228273
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$105,682
Seedmix cost ($0.75/SF)	$171,205

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
18957.73	0	945.984	107047.5494
18011.75	226.32	392.982	235282.2532
17618.77	971.1	292.582	178583.2753
17326.18	249.64	669.049	83510.69618
16657.14	0		0
		Total CF:	604423.7742

Excavation costs ($4/CY)	$89,544
Export costs ($20/CY)	$447,721
Total Costs:	$1,038,552

Alt 7B

Properties to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
286.-1-34	630 Old Route 28	$18,200	$0
286.-1-35	Old Route 28	$400	$0
286.-1-33	544 Old Route 28	$165,800	$40,000
286.-1-36	664 Old Route 28	$63,100	$20,000
286.-1-37	672 Old Route 28	$79,000	$20,000
286.-1-49	690 Old Route 28	$57,200	$20,000
286.-1-48	714 Old Route 28	$168,500	$20,000
286.-1-46.1	736 Old Route 28	$46,800	$20,000
286.-1-46.22	746 Old Route 28	$47,100	$20,000
286.-1-46.21	770 Old Route 28	$80,300	$40,000
286.16-2-1	784 Old Route 28	$138,600	$20,000
286.16-2-2	790 Old Route 28	$147,600	$20,000
286.16-2-3	822 Old Route 28	$21,700	$30,000
286.16-2-4	Old Route 28	$8,200	$0
286.16-2-5	894 Old Route 28	$15,400	$30,000
286.16-2-6	Old Route 28	$47,400	$50,000
	Total:	$1,105,300	$350,000

Restoration

Area to restore (SF)	609352
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$282,107
Seedmix cost ($0.75/SF)	$457,014

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
21119.8	0	374.88	54263.88
20745.31	289.5	898.98	179580.2448
19846.33	110.02	888.6	180838.986
18957.73	297	945.984	247942.4064
18011.75	227.2	392.982	233327.1678
17618.77	960.27	292.582	178002.5001
17326.18	256.5	669.049	85805.53425
16657.14	0		0
		Total CF:	1159760.719
		Total CY:	42954.10071

Excavation costs ($4/CY)	$171,816
Export costs ($20/CY)	$859,082
Total Costs:	**$3,225,320**

Alt 8B+1D+4A

Properties to be purchased

Alternate	**Parcel #**	**Address**	**Value**	**Demolition costs**
8B	287.18-1-5	Mill Street	$18,700	$0
	287.18-1-7	86 Mill Street	$28,400	$0
1D	N/A			
4A	287.17-7-1	Wagner Ave	$225,180	$60,000
	287.18-7-2	717 Wagner Ave	$373,600	$100,000
		Total:	$645,880	$160,000

Replace Main Street Bridge Vly	$750,000
Remove Mill Street Bridge	$125,000

Restoration

Area to restore (SF)	275201
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$127,408
Seedmix cost ($0.75/SF)	$206,401

Volume Calculations

XS		XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
Start of Floodplain		0	466	68944.7
	1715.351	295.9	105.462	29640.1
	1609.889	266.2	36.749	12797.84
	1573.141	430.3	23.416	7473.216
	1549.725	208	23.515	5537.783
	1526.21	263	6	1575
1494.652 US		262	58.5	28489.5
1494.652 DS		712	14.9	10735.45
	1446.831	729	149.865	86771.84
	1296.966	429	534.148	186684.7
	762.818	270	513.161	104941.4
	249.657	139	362	25159
	25095.38	0		0
			Total CF:	568750.6
			Total CY:	21064.84

Excavation costs ($4/CY)	$84,259
Export costs ($20/CY)	$421,297
Total Costs:	$2,520,245

Alt 8B

Properties to be purchased

Parcel #	**Address**	**Value**	**Demolition costs**
287.18-1-5	Mill Street	$18,700	$0
287.18-1-7	86 Mill Street	$28,400	$0
	Total:	$47,100	$0

Remove Mill Street Bridge	$125,000

Restoration

Area to restore (SF)	46357
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$21,462
Seedmix cost ($0.75/SF)	$34,768

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
Start of Floodplain	0	466	68944.7
1715.351	295.9	105.462	29640.0951
1609.889	266.2	36.749	12797.83925
1573.141	430.3	23.416	6463.9868
1549.725	121.8	23.515	1432.0635
1526.21	0		0
		Total CF:	119278.6847

Excavation costs ($4/CY)	$17,671
Export costs ($20/CY)	$88,355
Total Costs:	$334,355

Alt 9A+1B+4B

Properties to be purchased

Alternate	Parcel #	Address	Property Value	Demolition costs
Alt 4B	287.18-7-1	Wagner Ave	$1,172,000	$160,000
	287.18-7-2	717 Wagner Ave	$373,600	$100,000
1B	Bridge - no properties purchased			
9A	287.18-6-1	684 Wagner Ave	$73,900	$20,000
	287.18-6-7	Main Street DPW	$0	$50,000
	287.18-6-9	1300 Main Street	$154,900	$20,000
	287.18-6-11	1322 Main Street	$20,000	$20,000
		Total:	$1,794,400	$370,000

Bridge Replacement - Wagner Street $500,000

Restoration

Area to restore (SF)	397228
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$183,902
Seedmix cost ($0.75/SF)	$297,921

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
2081.537	0	304.4871	563.301135
1777.055	3.7	1777.055	178505.1748
1409.516	197.2	252.5871	77758.93874
1156.929	418.5	61.56277	27395.43265
1095.366	471.5	55.58715	22126.46506
1039.777	324.6	125.6828	45717.1185
914.097	402.9	304.1222	141371.2047
609.9773	526.8	377.5926	121244.9839
232.3851	115.4	9.089826	524.4829602
25095.38	0		0
		Total CF:	615207.1023

Excavation costs ($4/CY)	$91,142
Export costs ($20/CY)	$455,709

Total Costs: $3,693,074

Alt 10A

Parcel #	Address	Property Value	Demolition costs
287.17-1-22	111 Wagner Ave	$79,000	$20,000
287.17-1-20	155 Wagner Ave	$20,000	$20,000
287.17-1-19	173 Wagner Ave	$20,000	$20,000
	Total:	$119,000	$60,000

Restoration

Area to restore (SF)	28494
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$13,192
Seedmix cost ($0.75/SF)	$21,371

Volume Calculations

XS	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
24589.63	0	951.691	27123.1935
23637.94	57	381.403	21167.8665
23256.5	54	479.92	12957.84
22776.62	0		0
		Total CF:	61248.9

Excavation costs ($4/CY)	$9,074
Export costs ($20/CY)	$45,370
Total Costs:	$268,006

Big Red Kill Combo 2: BR-1, BK-7A, 1KC, BR-2

Properties to be purchased

Parcel #	**Address**	**Property Value**	**Demolition costs**
286.-1-34	630 Old Route 28	$18,200	0
286.-1-35	Old Route 28	$400	0
286.-1-33	544 Old Route 28	$165,800	$40,000
	Total:	$184,400	$40,000

Replace Rte 28 Bridge on Red Kill	$750,000

Restoration

Area to restore (SF)	328058
Topsoil cost ($25/CY), assume 0.5 ft topsoil	$151,879
Seedmix cost ($0.75/SF)	$246,044

Volume Calculations

XS		River	XS Area Removed (SF)	Dist to next XS (FT)	Volume (CF)
	2304.948	Vly	0	406.6	29478.5
	1898.344	Vly	145	521.93	84813.63
	1376.414	Vly	180	309.18	57352.89
	1067.233	Vly	191	297.93	42603.99
	769.305	Vly	95	129.02	12514.94
	640.285	Vly	99	15.3	1575.9
598.4805 US		Vly	107	57.1	6166.8
598.4805 DS		Vly	109	15.24	1652.016
	552.6494	Vly	107.8	296.47	15979.73
	256.1819	Vly	0		0
	18957.73	Bush Kill	0	945.984	107047.5
	18011.75	Bush Kill	226.32	392.982	235282.3
	17618.77	Bush Kill	971.1	292.582	178583.3
	17326.18	Bush Kill	249.64	669.049	83510.7
	16657.14	Bush Kill	0		0
				Total CF:	856562.2

Excavation costs ($4/CY)	$126,898
Export costs ($20/CY)	$634,490
Total Costs:	$2,133,711

APPENDIX D

INCORPORATING WATER QUALITY BENEFITS INTO BENEFIT COST ANALYSIS

A DISCUSSION OF APPROACHES THAT CAN BE USED BY THE EAST BRANCH FLOOD COMMISSION

MILONE & MACBROOM®

Incorporating Water Quality Benefits into Benefit Cost Analysis (BCA)

A discussion of approaches that can be used by the East Branch Flood Commission

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Standard FEMA BCA relies on the reduction of flood inundation to calculate benefits (in units of dollars) from avoided losses and damages. Over the years, FEMA's BCA program has been modified to include other factors that can be quantified and summed with flood inundation benefits, such as open space and riparian benefits, mental health, and volunteer costs. As of 2015, calculation of water quality benefits has not been added to the BCA program. Nevertheless, flooding is known to cause impaired water quality. Therefore, reduction of flooding is believed to proportionally reduce water quality impairment by reducing the area of land and buildings exposed to floodwaters and by reducing the depth and velocity of floodwaters that mobilize pollutants. Two approaches to including water quality benefits are discussed in this memorandum.

Approach Number 1

When the Local Flood Hazard Mitigation Analysis (LFHMA) [now LFA] program was being discussed in 2012, discussions about incorporating water quality benefits focused on developing appropriate "scores" that would correspond to "multipliers" that would then be applied to the benefit cost ratio (BCR) when proposed flood mitigation projects would result in reduced water quality impairment if implemented. Discussions centered on a set of scores for "chemical release prevention" ranging from zero (no water quality benefits) to 2.0 ("will protect at least one but less than six contaminant sources") to 4.0 ("will protect more than six potential contaminant sources"). Separate scores were developed for sediment transport from properties (as opposed to sediment transport from stream banks) and wetland preservation.

During these early discussions, stakeholders understood that low BCRs such as 0.3 would have a low likelihood of increasing above 1.0 when multipliers corresponding to moderate benefit were applied (0.3 x 2.0 = 0.6) but would have a higher likelihood of increasing above 1.0 when multipliers corresponding to significant benefit were applied (0.3 x 4 = 1.2). For this reason, the multipliers were set as follows:

- If total score is less than 4, multiplier = 1.0
- If total score is between 4 and 7, multiplier = 1.1
- If total score is greater than 7, multiplier = 1.2

Although this approach gained modest traction, it was not incorporated into the final LFHMA rules.

Since 2012, the additional factors incorporated into the BCA tool (open space and riparian benefits, mental health, and volunteer costs) were programmed to become available only when flood inundation benefits alone were sufficient to generate a BCR of 0.75 or greater[1]. In other words, these benefits can help make a "nearly cost effective" project into a cost effective project. This has set a reasonable precedent and a benchmark for considering water quality benefits in the BCA completed for LFAs.

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[1] According to FEMA (2013), "green open space and riparian area benefits can now be included in the project benefit cost ratio (BCR) once the project BCR reaches 0.75 or greater."

In the last 24 months, the rollout of the LFA program has reflected a wide range in the number of buildings contributing to BCA for a particular community, from 20 or 30 (for Lexington Hamlet) to more than 180 (for the Village of Walton). Some of the properties are residential and therefore would be expected to contribute to water quality impairment from heating fuels, vehicles, and sanitary wastewater. Other properties are nonresidential and would be expected to contribute to water quality impairment from heating fuels, vehicles, sanitary wastewater, and pollutants that are associated with the land use such as gasoline, oils, chemicals, food products, fertilizers, herbicides, pesticides, etc. In light of the differences from community to community, the approach discussed in 2012 (a set of scores for chemical release prevention ranging from zero to 2.0 [will protect at least one but less than six contaminant sources] to 4.0 [will protect more than six potential contaminant sources]) seems somewhat arbitrary. A community like Walton will easily have more than six potential contaminant sources whereas a community like Lexington Hamlet may not. A community like Fleischmanns would be intermediate.

For this reason, it may be more appropriate to apply multipliers to the *individual* benefits associated with each property rather than apply multipliers to the sum of all benefits associated with a mitigation project. A new scoring system could be developed, with new multipliers associated with each sum of scores. Scores would be higher for commercial and industrial properties than they would be for residential properties, and the multipliers would therefore be greater for commercial and industrial properties than they would be for residential properties.

Approach Number 2

In a review of the literature, direct studies that provide an impact value to reduced water quality are limited. Turbidity and sediment loading are the issues most frequently studied in relation to water quality benefits in watersheds. Most studies use indirect methods, such as impact to tourism or "willingness to pay" surveys to compute the perceived value of water quality.

Three studies were reviewed to estimate a dollar figure ($) of water quality benefits per acre per year that could be utilized within the context of a BCA for LFAs.

- A study conducted by the State of New Hampshire focused on the potential impact to tourism from a perceived water quality reduction. The study predicted that the statewide impact would be $69 million per year, equivalent to a water quality value of $11.5/acre/year.

- A USDA study of New York State found that the societal benefits of reducing erosion are greater than $9/ton/year for all counties in the state. In other words, a one-ton reduction in soil erosion can increase societal benefits by $9/year. In an effort to apply this value to the West-of-Hudson region, the Upper Esopus Creek Management Plan was consulted. Using the long-term average sediment yield from Appendix III and applying the figure on an area basis, the societal benefits of reducing erosion in that watershed were $10.8/acre/year, reasonably close to the New Hampshire figure.

- Several "willingness to pay" studies were also reviewed. One of the studies summarized a significant amount of previous work nationwide. This study found an overall "willingness to pay" for improved water quality to range from $90 to $112 per person per year. In an effort to relate this value to the West-of-Hudson region, this data was applied to the Upper Esopus Creek Management Plan, resulting in a "willingness to pay" figure for water quality of $10.8/acre/year, in line with the USDA study.

The average of these three methods is approximately $11/acre/year. The range of figures is narrow and although this may be somewhat coincidental, it suggests that the average may be defensible in the West-of-Hudson region.

If per-acre figures were to be used to quantify water quality benefits, the calculation could be conducted on a parcel-by-parcel basis. As an alternative, it could be applied to the entire flooded area. Two additional choices are available: the per-acre figure could be allowed as a benefit on a "pass/fail" basis (either the land floods or it will not flood because a mitigation project has been completed in the future); or the per-acre figure could be used to generate a "depth-impact" function similar to the depth-damage curves currently used by the BCA. These depth-impact functions would then be combined with reductions in flood elevations to generate water quality benefits that vary from a minimum to a maximum according to depth of flooding avoided or reduced. Borrowing from approach #1 above, multipliers could still be applied to these calculations based on the type of parcel. For example, an industrial parcel should have the potential to have a greater impact on water quality than a residential parcel.

Ultimately, approach #2 may not generate sufficient benefits for use in LFAs. This is likely because per-acre benefits are typically estimated from watershed-scale studies or greater, including the three described above. In contrast to a watershed, the SFHA within any given watershed is only a fraction of the total area. If $11/acre/year were multiplied by the total acreage of downtown Walton in the SFHA (perhaps 300 acres), the result is only $3,300 per year. Projected over 50 years (the projection used by the BCA program for flood mitigation projects) without considering flood recurrence intervals, the benefit would be only $165,000. This is a nominal figure when compared to the benefits typically generated by the BCA program from flood reductions at numerous buildings.

Summary

Approach #1 appears to offer the most significant potential for quantifying water quality benefits, and it is most consistent with the approach discussed when the LFHMA rules were initially developed. Two recommendations are offered if this approach is used to generate water quality benefits:

- The BCR must be 0.75 or greater to allow water quality benefits.
- Multipliers should be applied to the individual benefits generated for each property, and should differ for residential vs. nonresidential properties.