EMERGENCY TRANSPORTATION INFRASTRUCTURE RECOVERY
WATER BASIN ASSESSMENT
AND FLOOD HAZARD MITIGATION ALTERNATIVES

OTSQUAGO CREEK
MONTGOMERY COUNTY, NEW YORK

April 2014

MMI #5231-01

Photo Source: Milone & MacBroom, Inc. (2013)

This document was prepared for the New York State Department of Transportation, in cooperation with the New York State Department of Environmental Conservation.

Prepared by:

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS/ACRONYMS

BCA	Benefit-Cost Analysis
BCR	Benefit-Cost Ratio
BIN	Bridge Identification Number
CFS	Cubic Feet per Second
CME	Creighton Manning Engineering
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FT	Feet
FTP	File Transfer Protocol
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
LiDAR	Light Detection and Ranging
MMI	Milone & MacBroom, Inc.
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
PDM	Pre-Disaster Mitigation
SFHA	Special Flood Hazard Area
SQ. MI.	Square Mile
STA	River Station
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WSEL	Water Surface Elevation
YR	Year

1.0 INTRODUCTION

1.1 Project Background

A severe precipitation system in June 2013 caused excessive flow rates and flooding in a number of communities in the greater Utica region. As a result, the New York State Department of Transportation (NYSDOT) in consultation with the New York State Department of Environmental Conservation (NYSDEC) retained Milone & MacBroom, Inc. (MMI) through a subconsultant agreement with Creighton Manning Engineering (CME) to undertake an emergency transportation infrastructure recovery water basin assessment of 13 watersheds in Herkimer, Oneida, and Montgomery Counties, including the Otsquago Creek watershed. Prudent Engineering was also contracted through CME to provide support services, including field survey of stream cross sections.

Otsquago Creek flows through the town of Stark, in Herkimer County, and the town of Minden and the village of Fort Plain, in Montgomery County. The creek drains an area of 61.3 square miles. The contributing watershed is approximately 33.9 percent forested, with a mix of rural residential and agriculture land uses and several small hamlets located in the upper basin, and a dense mix of residential and commercial uses concentrated in the lower part of the basin in the village of Fort Plain. Otsquago Creek has an average slope of 1.5 percent over its entire length. Figure 1 depicts the contributing watershed of the creek.

Flooding has occurred in many areas along Otsquago Creek, including in the hamlets of Van Hornesville, Starkville, and Hallsville, and in the village of Fort Plain. Extensive flooding and flood-related damage to roads, bridges, and private property have occurred, and a number of homes have been destroyed. Large volumes of coarse-grained sediment originating in the upper reaches are conveyed downstream in Otsquago Creek during large flood events and are subsequently deposited in and along the channel where they clog bridges and exacerbating flooding.

The goals of the subject water basin assessment were to:

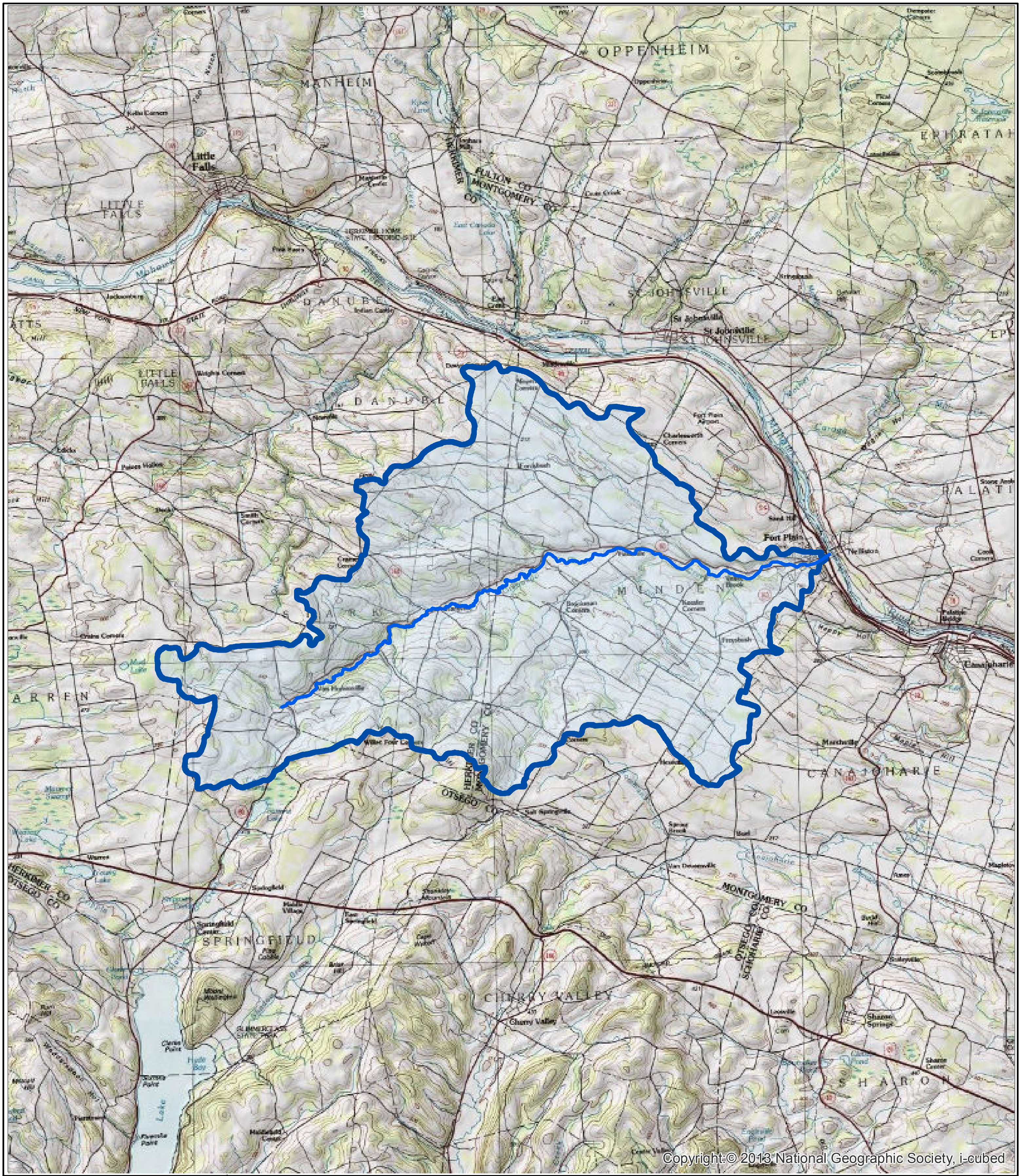
1. Collect and analyze information relative to the June 28, 2013 flood and other historic flooding events.

2. Identify critical areas subject to flood risk.

3. Develop and evaluate flood hazard mitigation alternatives for each high risk area within the stream corridor.

1.2 Nomenclature

In this report and associated mapping, stream stationing is used as an address to identify specific points along the watercourse. Stationing is measured in feet and begins at the



SOURCE(S):	Figure 1: Otsquago Creek Watershed Location Map	LOCATION: Herkimer-Montgomery Counties, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

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Map By: CMP
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mouth of Otsquago Creek at STA 0+00 and continues upstream to STA 810+00. As an example, STA 73+00 indicates a point in the channel located 7,300 linear feet upstream of the mouth. Figure 2 depicts the stream stationing along Otsquago Creek. 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.

2.0 DATA COLLECTION

2.1 Initial Data Collection

Public information pertaining to Otsquago Creek was collected from previously published documents as well as through meetings with municipal, county, and state officials. Data collected includes reports, photographs, newspaper articles, Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS), aerial photographs, and geographic information system (GIS) mapping. Appendix A is a summary listing of data and reports collected.

2.2 Public Outreach

An initial project kickoff meeting was held in early October 2013 with representatives from NYSDOT and NYSDEC, followed by public outreach meetings held in the affected communities, including a meeting that was held at Stark Community Hall. These meetings provided more detailed, firsthand accounts of past flooding events; identified specific areas that flooded in each community and the extent and severity of flood damage; and provided information on post-flood efforts such as bridge reconstruction, road repair, channel modification, and dredging. This outreach effort assisted in the identification of target areas for field investigations and future analysis.

2.3 Field Assessment

Following initial data gathering and outreach meetings, field staff from Prudent Engineering and MMI undertook field data collection efforts, with special attention given to areas identified in the outreach meetings. Initial field assessment of all 13 watersheds was conducted in October and November 2013. Selected locations identified in the initial phase were assessed more closely by multiple field teams in late November 2013. Information collected during field investigations included the following:

- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas
- Measurement and rapid hydraulic assessment of bridges, culverts, and dams
- Geomorphic classification and assessment, including measurement of bankfull channel widths and depths at key cross sections
- Field identification of potential flood storage areas
- Wolman pebble counts
- Cohesive soil shear strength measurements

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SOURCE(S):

Figure 2: Otsquago Creek Watercourse Stationing

NYDOT: Emergency Transportation Infrastructure Recovery

Herkimer-Montgomery Counties, New York

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Figure 2

- Characterization of key bank failures, headcuts, bed erosion, aggradation areas, and other unstable channel features
- Preliminary identification of potential flood hazard mitigation alternatives, including those requiring further analysis

Included in Appendix B is a copy of the River Assessment Reach Data Form, River Condition Assessment Form, Bridge Waterway Inspection Form, and Wolman Pebble Count Form. Appendix C is a photo log of select locations within the river corridor. Field Data Collection Index Summary mapping has been developed to graphically depict the type and location of field data collected. Completed data sheets, field notes, photo documentation, and mapping developed for this project have been uploaded onto the NYSDOT ProjectWise system and the project-specific file transfer protocol (FTP) site at MMI. The data and mapping were also provided electronically to NYSDEC.

2.4 Watershed Land Use

Figure 3 is a watershed map of Otsquago Creek. The creek flows through the town of Stark, in Herkimer County, and the town of Minden and the village of Fort Plain, in Montgomery County, east central New York State. The drainage basin is approximately 34 percent forested, with rural residential and agriculture uses throughout the upper basin and a dense mix of residential and commercial land uses concentrated in the lower part of the basin in the village of Fort Plain.

Otsquago Creek originates upstream of the state fish hatchery and flows in a northeasterly direction through the hamlet of Van Hornesville, where the creek parallels Route 80 and is lined by several residences and businesses. The creek passes behind Owen D. Young Central School and through a wooded ravine as it flows toward the hamlet of Starkville. The creek corridor is lined by homes as it passes through Starkville and then becomes increasingly agricultural as it flows toward the village of Fort Plain. The creek continues to parallel Route 80 as it flows through the more densely developed village of Fort Plain to its outlet at the Mohawk River.

2.5 Geomorphology

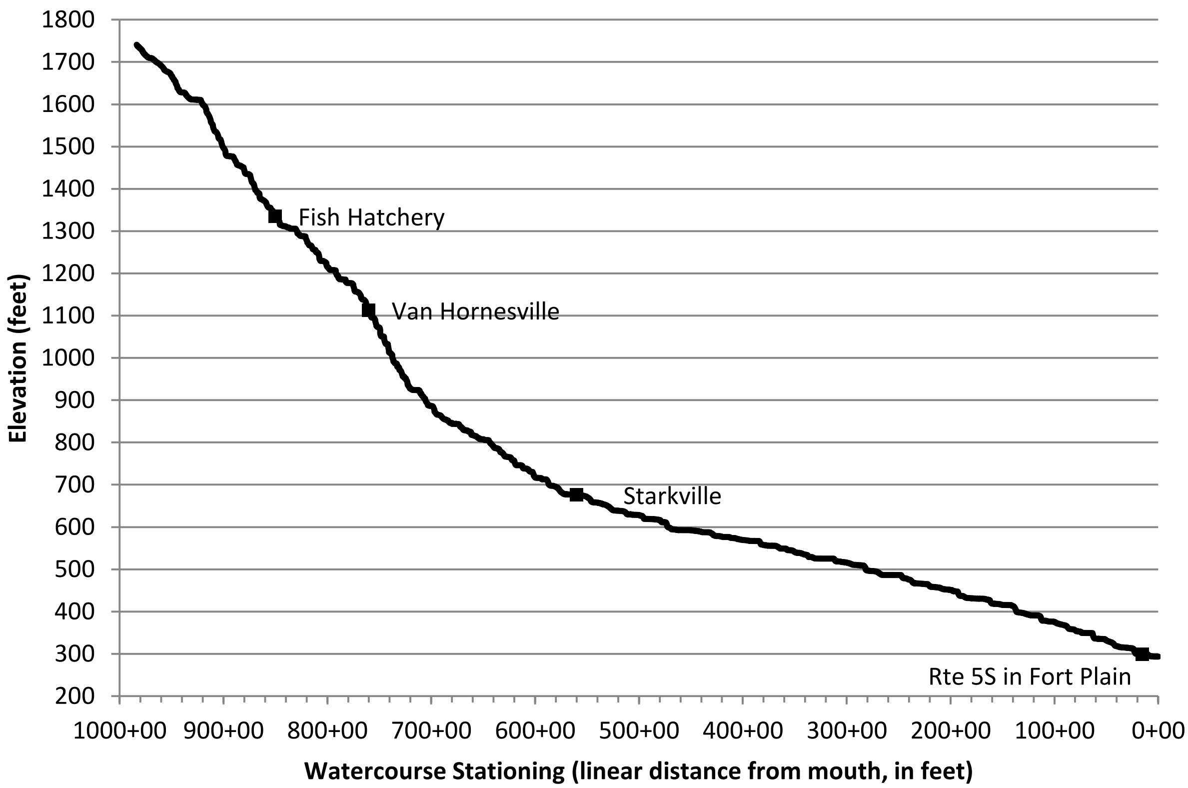
Otsquago Creek drains an area of 61.3 square miles and flows for a distance of 18.6 miles from its headwaters above the state fish hatchery to where it meets the Mohawk River in the village of Fort Plain. During high flow events, sediment is transported downstream from points higher in the watershed and is deposited within the channel lower in the basin, where it reduces hydraulic capacity and exacerbates flooding. It is evident that the stream channel has been recently dredged within some reaches to remove accumulated sediment. In some of these areas, dredged materials have been placed directly on the stream banks or in the floodplain.

SOURCE(S):	**Figure 3: Otsquago Creek Drainage Basin Aerial**		Location: **Herkimer-Montgomery Counties, New York**
	N **NYDOT: Emergency Transportation Infrastructure Recovery**	**Map By:** CMP **MMI#:** 5231-01 **MXD:** Y:\5231-01\GIS\Maps\Figure 3 Maps\Figure 3 Otsquago Creek.mxd **1st Version:** 01/07/2014 **Revision:** 3/26/2014 **Scale:** 1 in = 8,500 ft	MILONE & MACBROOM **99 Realty Drive Cheshire, CT 06410** **(203) 271-1773 Fax: (203) 272-9733** **www.miloneandmacbroom.com**

The banks of Otsquago Creek have been lined by vertically stacked rock or concrete walls at various points along its length, especially in the vicinity of bridge crossings and in areas where bank erosion has occurred. During field investigations in the fall of 2013, bank erosion, high bank failures, and bank slides were observed at various points along the creek. An earthen levee lines the left bank of the creek just upstream of its outlet at the Mohawk River, approximately between STA 11+00 and STA 4+00.

Figure 4 is a profile of Otsquago Creek, showing the watercourse elevation versus the linear distance from the mouth. The Otsquago Creek channel has an average slope of 1.5 percent over its entire length of 18.6 miles. The creek is steeper in its upper reaches, with a slope of 3.0 percent as it flows from its headwaters downstream to where it passes through the hamlet of Starkville. From Starkville downstream to the village of Fort Plain, the creek has a gentler slope of 0.8 percent. The downstream-most 1,000 feet of channel, from just downstream of the Route 5S bridge (STA 15+00) to the Mohawk River, are subject to backwater flooding from the Mohawk River during large flood events.

FIGURE 4
Otsquago Creek Channel Profile



2.6 Hydrology

Alluvial river channels adjust their width and depth around a long-term dynamic equilibrium condition that corresponds to "bankfull" conditions. Extensive data sets indicate that the channel forming or bankfull discharge in specific regions is primarily a function of watershed area. The bankfull width and depth of alluvial channels represent long-term equilibrium conditions and are important design criteria. Table 1 below lists estimated bankfull discharge, width, and depth at several points along Otsquago Creek, as derived from the United States Geological Survey (USGS) *StreamStats* program.

TABLE 1
Estimated Bankfull Discharge, Width, and Depth
(Source: USGS *StreamStats*)

Location	Station	Watershed Area (sq. mi.)	Discharge (cfs)	Bankfull Width (ft)	Bankfull Depth (ft)
Near Chyle Road	815+00	6.52	225	31.3	1.65
At Moyer Lane	491+00	19.9	586	51.7	2.5
Near Pickle Hill Road	214+00	44.1	1,160	73.9	3.37
Along Spring Street	156+00	57.3	1,450	83.1	3.71
Along Abbott Street	49+00	60.8	1,520	85.4	3.79

It is informative to compare the actual bankfull widths measured on Otsquago Creek to the regional bankfull channel dimensions. The measured bankfull width near Chyle Road (near STA 815+00) was 25 feet, compared to the regional bankfull channel width of 31.3 feet. The measured bankfull width near Moyer Lane (STA 491+00) was 32 feet, in contrast to the regional bankfull channel width of 51.7 feet, indicating that the channel is undersized at this location. In contrast, measurements taken near Pickle Hill Road (STA 214+00) showed a bankfull width of 90 feet, and measured bankfull width along Spring Street (STA 156+00) was 95 feet, indicating that the channel is overly wide at these locations. The measured bankfull width along Abbott Street (STA 49+00) was 53 feet, in contrast to the regional bankfull channel width of 85.4 feet, indicating that the channel is undersized at this location.

There are no USGS stream gauging stations on Otsquago Creek. Hydrologic data on peak flood flow rates are available from the FEMA FIS and from *StreamStats* regional data.

A preliminary draft FEMA FIS is available for all of Montgomery County, which was issued September 30, 2011 but was not formally approved as of the publication date of the subject document. According to the draft FIS, the most recent hydraulic modeling for Otsquago Creek dates from September 2000 for the village of Fort Plain and June 1981 for the town of Minden.

The hydrologic analysis methods employed in the FEMA study used the methods outlined in the USGS publication WRI 79-83, *Techniques for Estimating Magnitude and Frequency of Floods on Rural Unregulated Streams in New York State Excluding Long Island* (USGS, July 1979). This method of calculating discharges utilizes a log-Pearson Type III (LPIII) analysis to construct discharge-frequency curves. The discharge-frequency data and various basin characteristics are used to develop multiple linear regression equations for the floods of selected recurrence intervals. The peak discharges for the 0.2-percent annual chance flood were extrapolated from these results.

FEMA applied computed hydrology in a backwater analysis on Otsquago Creek and compared the resulting water-surface elevations with historical elevations and checked for reasonableness. The results were published in the FIS, and the resulting mapping was published as the effective Flood Insurance Rate Map (FIRM) for Montgomery County.

Estimated peak discharges for various frequency events were calculated by MMI using *StreamStats* and compared to peak discharges reported in FEMA's draft FIS. Table 2 lists estimated peak flows at Otsquago Creek's confluence with the Mohawk River, which is located at MMI STA 0+00. FEMA reports the basin size at this location to be 59.2 square miles while *StreamStats* indicates that the basin size is 61.3 square miles.

TABLE 2
Otsquago Creek FEMA and *StreamStats* Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr	50-Yr	100-Yr	500-Yr
		FEMA Peak Discharges			
Confluence with Mohawk	59.2	8,400	12,700	14,800	20,400
		StreamStats Peak Discharges			
Confluence with Mohawk	61.3	6,770	9,980	11,600	15,400
Kellogg Street	61.2	6,750	9,950	11,600	15,300
Reid Street	60.9	6,710	9,890	11,500	15,200
Route 80	60.1	6,650	9,790	11,400	15,100
Spring Street	58.1	6,440	9,490	11,000	14,600
Brookmans Corners Road	27.5	2,790	4,110	4,760	6,300
Route 80 – Starkville	14.3	1,440	2,120	2,460	3,250

The peak discharges reported by FEMA at the confluence of the Mohawk River are in the range of 25 percent to 30 percent higher than those estimated using *StreamStats*.

In the 2011 Preliminary FEMA FIS, the only flow provided for Otsquago Creek is at the confluence with the Mohawk River. Comparing this to *StreamStats* peak discharges for the same location, the drainage area is larger from *StreamStats* at 61.3 square miles versus 59.2 miles in the FEMA FIS. Although reported as a larger area, the *StreamStats* peak flow values are lower that the FEMA values, with a maximum difference of 5,100 cubic feet per second (cfs) in the 500-year flood.

The USGS New York Water Science Center reports that high water marks are being surveyed along Otsquago Creek in Fort Plain to document the flooding in that community and to estimate the peak discharge of the June 28, 2013 event. A former stream gauge on Otsquago Creek at Fort Plain was operated from October 1949 to September 1989. During that period, the maximum recorded stage and associated discharge of 12.24 feet and 10,400 cfs occurred on Oct. 28, 1981. High water marks obtained at the former stream gauge on July 2 for the June 28, 2013 event surveyed at 19.60 feet, and a preliminary estimate of the associated discharge is 28,000 cfs. This far exceeds the 500-year flow projections from FEMA or *StreamStats*.

FEMA analysis conducted in preparation of the FIS and FIRM was completed for the lower portion of Otsquago Creek. Van Hornesville was not included in the area of study and, therefore, no FEMA information is available for comparison. For the purpose of hydraulic analysis, *StreamStats* flows were used in that area. Flows were obtained at relevant locations in the model and at confluences with larger tributaries. Table 3 reflects the flows that were used in the hydraulic model.

TABLE 3
Final Hydrology for HEC-RAS Modeling of Otsquago Creek

Station	Bankfull Flow (cfs)	10-Yr Flow (cfs)	50-Yr Flow (cfs)	100-Yr Flow (cfs)	500-Yr Flow (cfs)
809+00	242	912	1,360	1,580	2,110
46+80	1,520	6,700	9,870	11,500	15,200

2.7 Infrastructure

Otsquago Creek parallels Route 80 for much of its length and crosses under it several times. Bridge spans and heights were measured as part of the field investigations performed for this study and are summarized in Table 4.

Comparing the bridge measurements to estimated bankfull widths presented in Table 4, many of the bridge crossings along Otsquago Creek are adequately sized to span the bankfull width. Several crossings appear to be undersized, including Kellogg Street, Casler Road, Moyer Road, Route 168 and, in the most upstream reaches, Wiltse Hill Road and Route 80 west of Jordanville Road. The spans of these bridges are lower than the regional bankfull widths provided by *StreamStats* and are therefore may act as a hydraulic constriction even during somewhat frequent (i.e., 1.5- to 2-year frequency) flood events.

TABLE 4
Summary of Stream Crossing Data

Location	Station	BIN	Width (ft)	Height (ft)	Bankfull Width (ft)
Rte 80 West of Jordanville Rd (7)	810+00	000000001030870	24.5	7.0 – 8.0	32.9
Wiltse Hill Road	782+00	---	15.0	4.5 – 7.0	33.0
Private Driveway	687+75	---	39.5	5.5 – 11.0	36.0
Rte 80 West of Prim Rose Ln (6)	676+50	000000001030880	44.0	11.3 – 17.5	38.6
Rte 80 East of Primrose Lane (5)	658+00	000000001030890	39.0	5.9 – 8.0	38.6
Route 80 Crossing 4	596+50	000000001030900	43.0	11.5 – 12.5	45.0
Route 168	581+50	000000001051360	34.0	12.3 – 14.5	45.0
Rte 80 East of Elwood Road (3)	569+00	000000001030910	79.5	2.0 – 8.5	45.0
Moyer Road	491+00	000000002204890	40.0	7.5 – 9.5	51.2
H Moyer Road	431+75	000000002205240	43.5	5.0 – 7.5	53.1
Casler Road	383+00	000000003309430	53.0	14.0 – 17.8	53.6
Brookmans Corners Road	276+50	000000003309490	67.0	12.8 – 20.0	59.8
Spring Street	130+00	000000003309680	86.0	15.5 – 20.0	83.6
Route 80 Crossing 2	89+00	000000001030940	131.0	5.5 – 14.5	84.9
Route 80 Crossing 1	46+50	000000001030950	139.4	---	85.0
Kellogg Street	25+25	000000001038840	80.0	10.0 – 23.0	85.6
Route 5S (Hancock Street)	15+00	000000001002800	123.5	7.5 – 14.3	85.6
I-90	4+00	000000005515979	154.9	---	85.7

Flood profiles published in the FEMA FIS were evaluated to determine which bridges on Otsquago Creek may be acting as hydraulic constrictions during large flood events and which bridges overtop during these events, based on FEMA modeling. The 2011 FEMA FIS report includes profiles for Otsquago Creek upstream to Brookmans Corners Road at approximate MMI STA 277+00.

According to the FEMA profiles, the Spring Street bridge (STA 130+00) acts as a hydraulic constriction during the 50-, 100-, and 500-year events and may overtop during the 500-year event. FEMA profiles indicate that the Route 80 bridge (STA 89+00) acts as a minor constriction during the 10-year event and as a more substantial restriction during larger flood events; and the Kellogg Street bridge (STA 25+25) acts as a hydraulic constriction during all flood events modeled. According to FEMA, none of the remaining crossings up to Brookmans Corners Road act as hydraulic constrictions below a 50-year event, and some not until a 100-year event.

Community officials report that during the June 2013 flood, Otsquago Creek overflowed its banks at the Route 80 bridge (STA 89+00) and at the Kellogg Street bridge (STA 25+25.

3.0 FLOODING HAZARDS AND MITIGATION ALTERNATIVES

3.1 Flooding History along Otsquago Creek

Flooding has occurred in many areas along Otsquago Creek, from the hamlet of Van Hornesville downstream to the Mohawk River at the village of Fort Plain. The most severe flood-related damages on Otsquago Creek have occurred in Van Hornesville, Starkville, and Fort Plain, where extensive flooding and property damage occurred.

According to FEMA, flooding in Montgomery County typically occurs in the late winter and early spring months as a result of ice blockages accompanied by the spring rainfall and snowmelt. Flooding may also occur during the late summer months as a result of tropical storms tracking northward along the Atlantic coastline or due to regional thunderstorms.

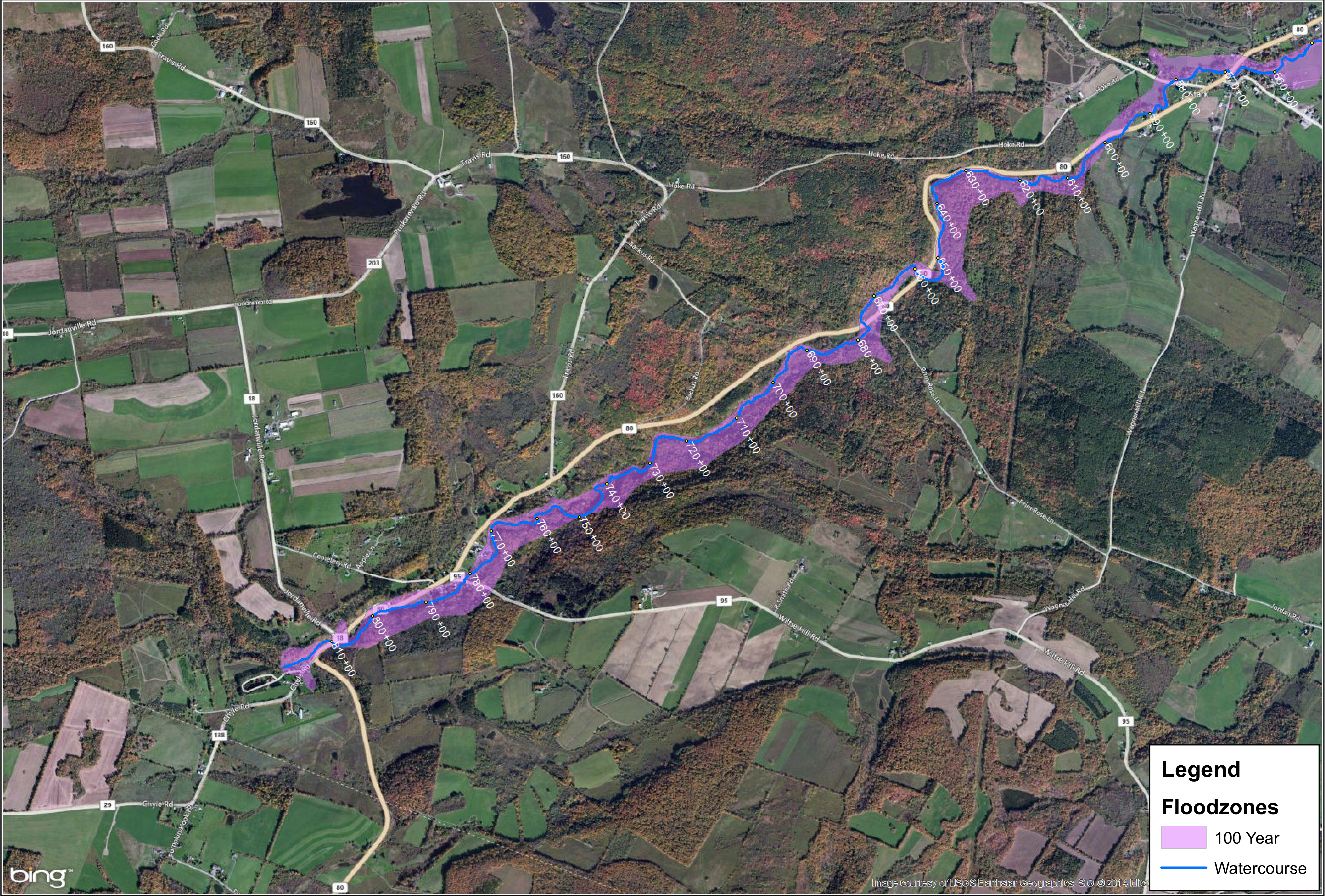
FEMA FIRMs are available for Otsquago Creek's upper reaches in Herkimer County down to the Montgomery County line. The maps show that the area of inundation in the 100-year frequency flood event extends in a wide band along the creek, from the town of Van Hornesville to Stark. Running parallel to Route 80 for this entire stretch, the extents of the 100-year storm flooding include several residential homes and properties, the Owen C. Young Central School, and Route 80 itself in many locations.

The FEMA FIS provides a history of recent and historic flooding events on Otsquago Creek. Figures 5, 6, and 7 depict the FEMA floodplain along Otsquago Creek. According to FEMA, major floods in the area occurred on September 22, 1938, October 2, 1945, October 17, 1955, and March 11, 1976.

On March 5, 1979, a combined flood event due to ice jamming caused the Mohawk River and Otsquago Creek to overtop their banks and caused extensive damage in the town of Minden in the village of Fort Plain. Floodwaters were reported to be four feet deep in the area of the shopping center on River Street and along Hancock Street in the village of Fort Plain. FEMA reports that ice jam flooding on Otsquago Creek was reduced after the washout of the aqueduct downstream of Route 5S.

A severe storm caused catastrophic flooding in the Otsquago Creek region between June 26 and June 29, 2006.

In mid to late June and early July of 2013, a severe precipitation system caused excessive flow rates and flooding in a number of communities in the greater Utica region, including in the Otsquago Creek basin. Because rainfall across the region was highly varied, it is not possible to determine exact rainfall amounts within the Otsquago Creek basin.



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SOURCE(S):

Figure 5: Otsquago Creek Floodzone

NYDOT: Emergency Transportation Infrastructure Recovery

Herkimer-Montgomery Counties, New York

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Figure 5

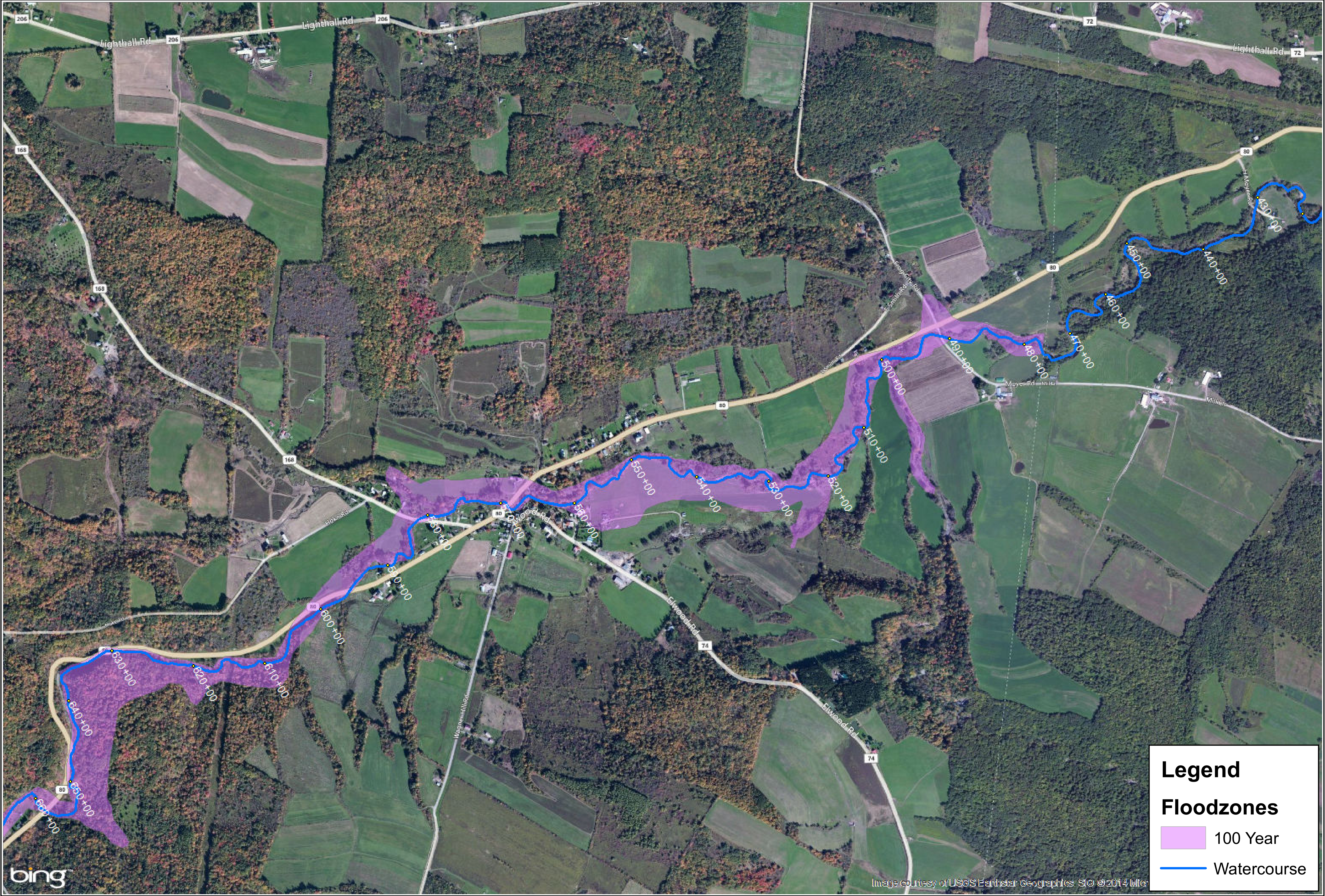

Figure 6: Otsquago Creek Floodzone

NYDOT: Emergency Transportation Infrastructure Recovery

Montgomery County, New York

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Figure 6

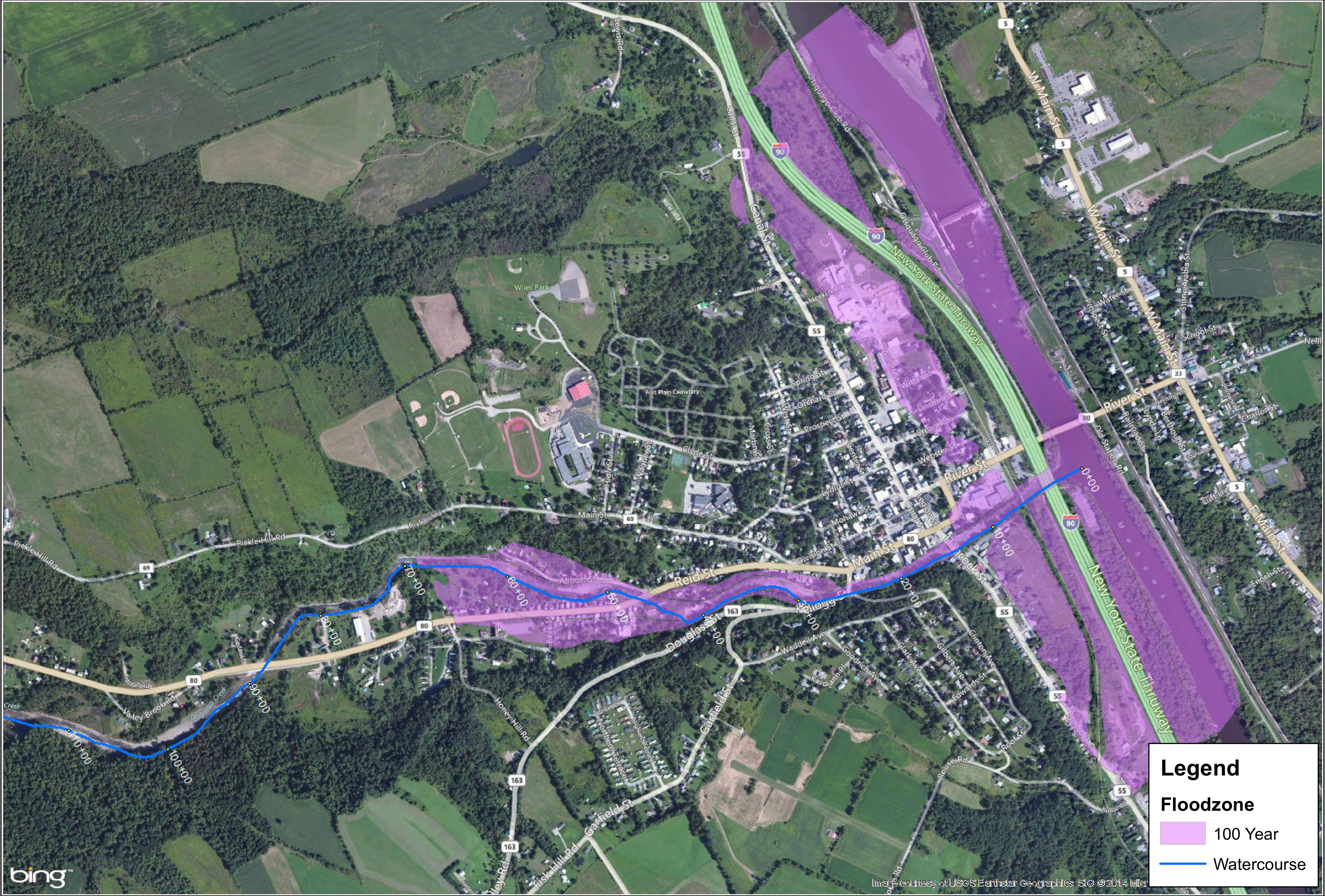

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Figure 7: Otsquago Creek Floodzone

NYDOT: Emergency Transportation Infrastructure Recovery

Montgomery County, New York

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Figure 7

Historic records on the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Advanced Hydrologic Prediction Service website indicate that the area received between 10 and 15 inches of rainfall in the month of June and an additional 5 to 8 inches in July, 2013. Much of this rainfall occurred over several storm events that dropped between 3.5 and 4.5 inches of rain between June 11 and 14; 5.5 to 8.5 inches between June 24 and 28; and 1.5 to 2.0 inches on July 2. In between these more severe rain events were a number of smaller rain showers that dropped trace amounts of precipitation, which prevented soils from drying out between the larger rain events.

According to news reports, floodwaters on June 27, 2013 submerged the entire downtown area of the village of Fort Plain, from Abbott and Reid Streets on Route 80, past the Fort Plain Fire Department on Route 5S. Save-A-Lot Plaza, which includes Daylight Donuts and Family Dollar, was still submerged even after the floodwaters receded due to the levee preventing waters from draining. Flooding extended up Otsquago Creek as far as Van Hornesville. Homes along Abbott Street were heavily damaged.

Community officials reported that flood-related bank erosion and damage to a culvert occurred at Chyle Road, near the state fish hatchery (STA 815+00). Flood damage occurred in Van Hornesville, where Otsquago Creek overtopped its banks, causing damage to structures and washing out a bridge (at STA 796+00).

The Owen C. Young Central School (STA 775+00) was damaged by floodwaters. Bank slides occurred along the left bank as the creek parallels Route 80 between Van Hornesville and Browns Hollow (from STA 748+00 downstream to STA 678+00). In the vicinity of Primrose Lane (STA 677+00), residential structures were damaged by flooding, and Route 80 was damaged in the vicinity of STA 633+00.

Flooding occurred in the hamlet of Starkville, where the banks overtopped near STA 569+00. Bank erosion and channel avulsions occurred as Otsquago Creek passes through an area of farmland, approximately between STA 544+00 and STA 388+00). At Moyer Road (STA 491+00), the bridge was severely damaged.

Road damage occurred in the hamlet of Hallsville (STA 277+00). High bank slides and bank failures occurred between STA 234+00 and STA 114+00. A tributary entering Otsquago Creek at STA 174+00 delivers large quantities of sediment to the creek. In the village of Fort Plain, extensive damage to structures occurred along Abbott Street (STA 62+00 downstream to STA 47+00), especially along the left bank of Otsquago Creek, and large amounts of sediment were deposited in the channel between STA 32+00 and STA 15+00. Downstream of STA 14+00, extensive flooding occurred in the vicinity of the Save-A-Lot grocery store.

3.2 Post-Flood Community Response

Following the heavy flooding in June 2013 along Otsquago Creek, the village of Fort Plain implemented temporary repairs. Private property owners throughout the village attempted repairs to individual sections of stream bank as well. A residential section along Abbott Street underwent significant flooding, between STA 62+00 and STA 47+00, impacting and destroying numerous structures. This stretch of channel was reconstructed to have riprap-armored banks throughout. Another reach of channel between STA 180+00 and STA 164+00 was similarly armored.

3.3 Flood Mitigation Analysis

Hydraulic analyses of key reaches along Otsquago Creek were conducted using the HEC-RAS program. The HEC-RAS computer program entitled "River Analysis System" was written by the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) and is considered appropriate for riverine flood studies. 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.

Water surface profiles are computed 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.

Hydraulic modeling that was originally generated by FEMA as part of its 2000 study of Otsquago Creek was obtained and used as a starting point for the current analysis. It can be assumed that conditions have changed since the date of this study and, for that reason, updated cross sections were surveyed as part of the subject analysis. The updated survey information was incorporated into the hydraulic model in order to better characterize and understand modern flooding risks and causes.

The survey effort included the wetted area (within bankfull elevation) of 26 stream cross sections, plus the survey of seven bridges/culverts and one dam. This data was combined with countywide light detection and ranging (LiDAR) data provided by the NYSDEC to develop sufficient model geometry such that existing conditions flooding up to and including the 100-year recurrence interval could be modeled.

The model of existing conditions was then used to hydraulically model certain alternatives, described further in the report sections that follow. Model input and output files have been uploaded onto the NYSDOT ProjectWise site and have been delivered electronically to NYSDEC.

3.4 High-Risk Area #1 – Van Hornesville (STA 825+00 to STA 767+00)

Figure 8 is a location plan of High Risk Area #1. This area encompasses the homes and businesses along Otsquago Creek in the hamlet of Van Hornesville, from STA 825+00 downstream to STA 767+00. Anecdotal reports of flooding in this area and observations in the field by MMI staff indicate that the homes and businesses along Route 80 and Otsquago Creek are subject to flooding, including the Van Hornesville Fire Department, the Van Horne Mills Feed Store, a bowling alley, the Owen D. Young Central School, and numerous homes along the creek.

This reach of channel was surveyed, and a hydraulic model was developed in order to evaluate the river and floodplain hydraulics under existing and proposed conditions. A number of issues were revealed that contribute to the flooding of the area, and the effectiveness of numerous flood mitigation measures was evaluated. The following provides a summary of the problem flooding areas and the associated mitigation measures.

Alternative 1-1: Address Undersized Channel and Floodplain Development – STA 809+00 to STA 794+00

This 1,500-linear-foot reach of Otsquago Creek has been heavily encroached upon by development. The stream in this reach is characterized by nearly vertical banks, and either roadway or buildings constructed on both banks of the channel reduce or entirely eliminate the floodplain. Flooding here occurs at the Fire Department and multiple homes along Route 80. Figure 9 is a photograph of the existing channel in this reach.

A home constructed on the right bank of Otsquago Creek at STA 796+00 uses a small driveway bridge for access from Route 80. This bridge is approximately 15 feet in span and has a clear opening height of approximately three feet. The 100-year flood generates enough water to cover a 50-foot-wide by five-foot high area. This bridge is a severe hydraulic restriction. Bridge modification is not feasible because the required span to prevent flooding would extend to the current location of the house. The home is situated against the valley wall. Bridge removal alone would not correct flooding in this reach, as the existing channel is undersized. The banks of the channel are predicted to overtop during a 10-year storm event and, because no floodplain exists, floodwaters inundate the roadway and surrounding homes.

Bridge removal in combination with creation of a 35-foot-wide floodplain bench was evaluated. The floodplain was modeled at a consistent height of 3 feet above the channel bed elevation. Modeling indicates that the combination can mitigate flooding up to the 100-year flood event. This approach would require the acquisition and removal of up to three houses (including the home with the bridge access) and would impact the yard area and smaller outbuildings of another four houses.

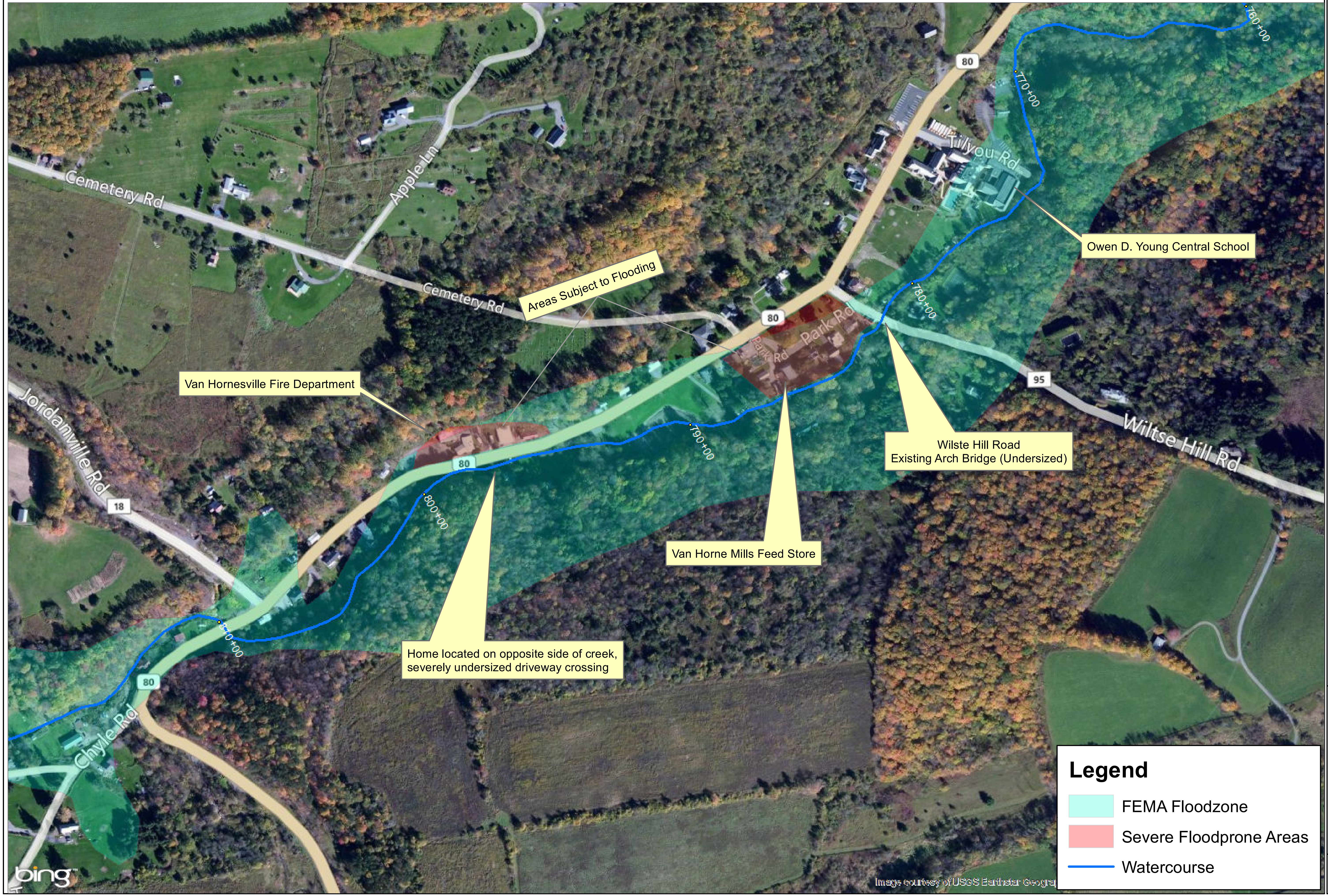

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Figure 8: Otsquago Creek High Risk Area #1

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Figure 8

FIGURE 9
Existing Channel, Otsquago Creek STA 797+00

Alternative 1-2: Removal of Dam

At the downstream end of this reach is a dam (at STA 788+50), behind which the impoundment forms a small pond. A bridge built across the crest of this dam provides access to a home on the right bank of Otsquago Creek. Although this bridge and dam cause an increase in water surface elevations during a flood, the higher floodwaters do not appear to impact any other homes, roads, or infrastructure. Therefore, removal or replacement of this structure is not part of the recommendations to provide flood mitigation.

Alternative 1-3: Replacement of the Undersized Bridge at Wiltse Hill Road (STA: 782+00)

An existing bridge located at Wiltse Hill Road (STA 782+00) is undersized. Hydraulic modeling predicts that the bridge overtops during a 10-year flood and causes backwater to flood the Van Horne Mill Feed Store and at least two neighboring residences. The bridge is located on a stretch of stream where the bankfull channel width is approximately 33 feet, but the bridge span is only 15 feet.

The bridge is old and may require replacement due to its condition. Bridge replacement was modeled. Analysis suggests that a bridge with a 50-foot span could be constructed without modifying the upstream or downstream channel and would be adequate for passing flows up to and including the 100-year flow without causing inundation. Replacement of this bridge with a hydraulically adequate structure is recommended.

Alternative 1-4: Owen D. Young Central School (STA 775+00)

Anecdotal reports of flooding of the Owen D. Young Central School indicate that the June 2013 event caused over $2 million worth of flood damage, with more than four feet of water in the lowest levels of the school. The gymnasium building is located closest to the stream, which is approximately 15 feet away from the creek bank at its closest point. This building underwent the most severe flood damage.

The regional school serving the town of Stark and surrounding areas was built in 1931, before the existence of FEMA and before the modern practices of floodplain management and stream corridor hydraulic analysis, although it is unknown when the gymnasium was constructed. Construction of the school took place in what was likely the natural floodplain of Otsquago Creek. Retaining walls along the creek were constructed along its banks so that buildings and parking areas could be expanded and as much building area as possible could be utilized, creating a very narrow, steep, constricted section of channel.

Otsquago Creek is bedrock controlled through much of the reach behind the school and has slopes as steep as seven percent. Velocities in this section are predicted to be erosively high during the 10-year and larger storm events. In some cases, predicted velocities are outside of the ability of HEC-RAS to effectively model, as they are mathematically possible but unlikely to occur in real life conditions. However, the modeling does indicate that this section of creek is highly susceptible to shear strengths and erosive forces during a flood, which will continue to cause bank erosion. This condition is exacerbated by the heavy encroachment and entrenchment caused by the school building.

Due to the size of the structure and historic nature of the school, it may be impractical to relocate the gymnasium further away from the creek. Floodproofing measures are therefore recommended.

Recommendations

Alternatives 1-1, 1-3, and 1-4 are all recommended. Alternative 1-2 would not reduce flooding and is not recommended.

3.5 High-Risk Area #2 – Starkville Bridges (STA 594+00 to STA 470+00)

Figure 10 is a location plan of High Risk Area #2. This area includes STA 594+00 downstream to STA 470+00. According to reports, flooding in this area occurs at the Route 168 crossing (STA 581+50) and at the Moyer Road crossing (STA 491+00). Both of these bridges are in poor condition and fail to span the estimated bankfull width of Otsquago Creek.

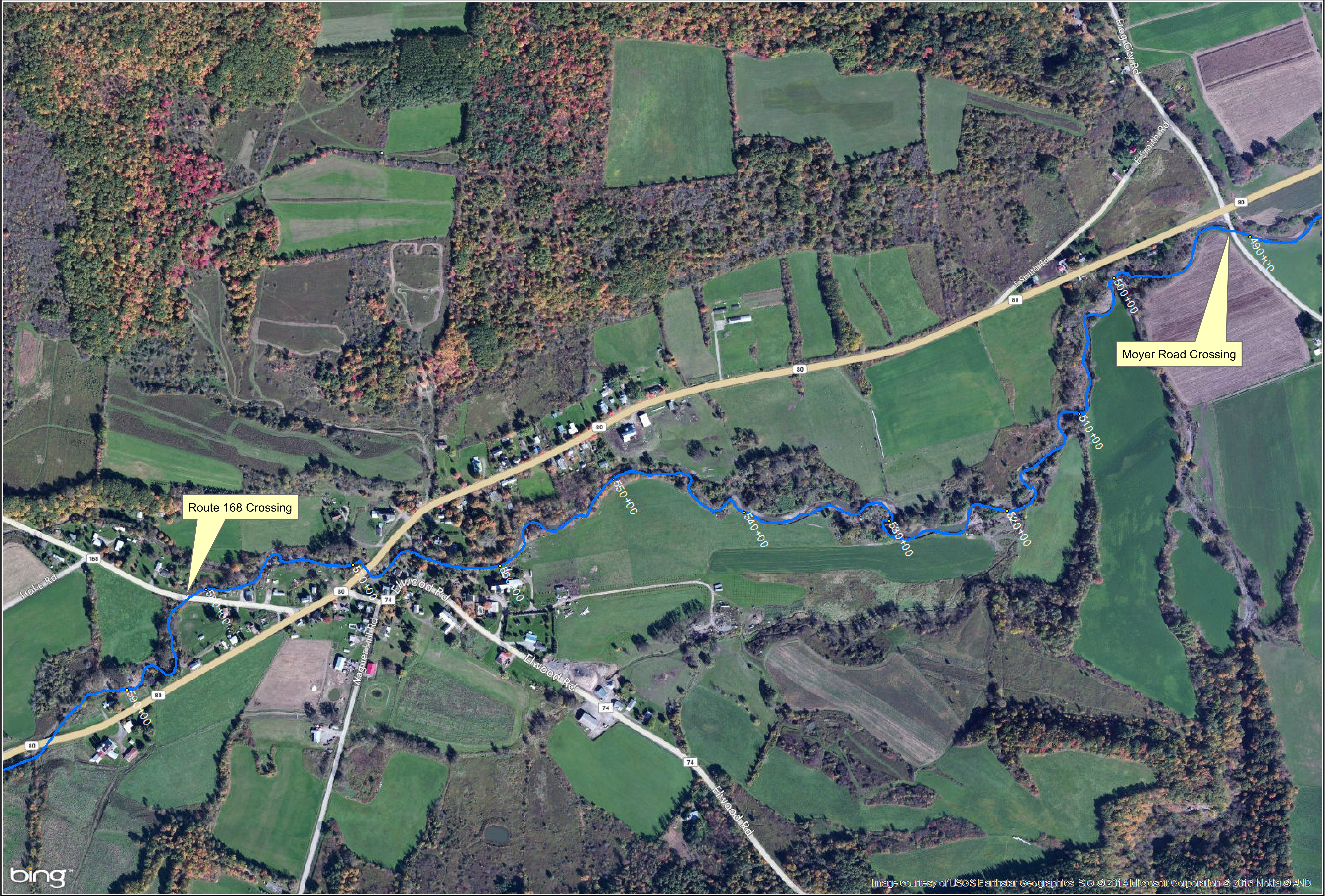

Figure 10: Otsquago Creek High Risk Area #2

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Figure 10

The Route 168 bridge was one of the bridges identified for replacement in Governor Cuomo's Scour Critical Bridge Replacement Program. The state website states the following: "*This bridge carries NY Route 168 over Otsquago Creek in the Town of Stark, Herkimer County. The highway at this location carries an average of 160 vehicles a day. This 41 ft. span concrete slab bridge on concrete high abutments founded on earth was constructed in 1932, and connects Paines Hollow with Starkville. The bridge serves a residential and farming community.*"

Alternative 2-1: Replacement of Route 168 and Moyer Road Bridges

Modeling was not conducted within this reach of Otsquago Creek; however, field measurements and available data indicates both of these structures act as hydraulic constrictions. Replacement of the Route 168 bridge (STA 581+50) and the Moyer Road bridge (STA 491+00) with larger structures that span the full bankfull width of the creek are recommended. Design criteria should be established relative to the target storm event, and a detailed hydraulic analysis should be undertaken.

Recommendations

Replacement of bridges at STA 581+50 and STA 491+00 is recommended.

3.6 High Risk Area #3 – Tributary at STA 174+00

Figure 11 is a location plan of High Risk Area #3. An unnamed tributary crosses beneath Cooperstown Road (Route 80) and joins Otsquago Creek at a sharp bend in the creek. The confluence of this tributary corresponds with the upstream limit of heavy bank armoring and channel dredging work that was recently completed along Otsquago Creek. The extent of damage caused by the June 2013 flooding is not known but was likely due in part to excessive sediment aggradation.

Historic aerial photographs show evidence of severe sediment aggradation downstream of the confluence of the unnamed tributary. It is likely that the sediment began filling the channel, which limited the hydraulic capacity of the channel and allowed floodwaters to access unarmored portions of the banks more regularly.

Field investigation of this tributary revealed it to be a major source of gravel and cobble sediment. The channel is underlain with clay but carries a substantial bedload of large sediment. Most of this appears to be generated from a 500-foot reach of channel that is underlain by bedrock. The images in Figure 12 represent three distinctly different channel types, which may explain where much of the sediment is generated. The photos in Figure 12 represent the evolution of bed morphology and substrate in the unnamed tributary, over the span of approximately 1,800 linear feet directly upstream of the confluence with Otsquago Creek.

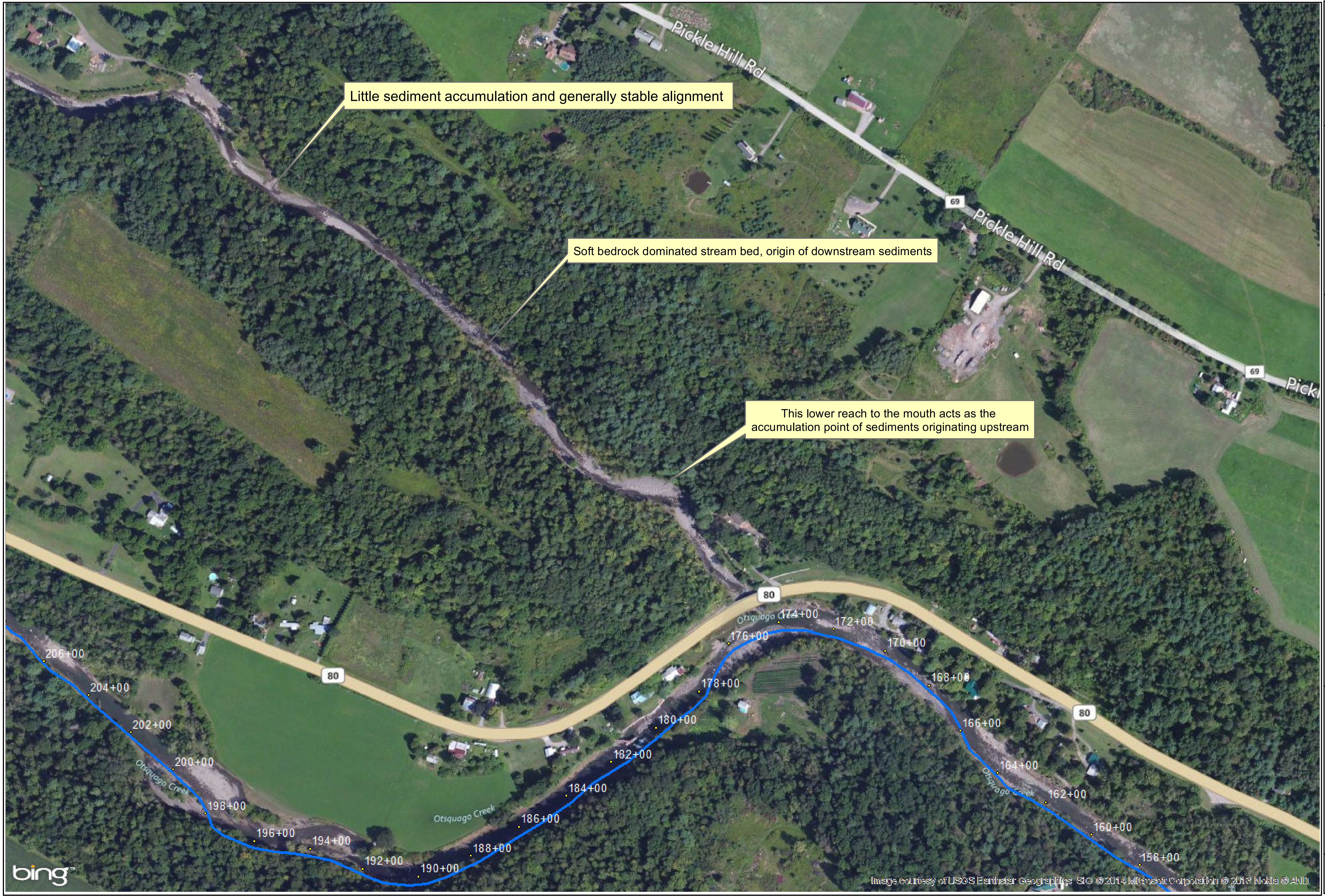

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Figure 11: Otsquago Creek High Risk Area #3

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Figure 11

FIGURE 12
Photo Evolution of Sediment Generation in Unnamed Tributary

- Photo 1 represents the tributary at the upstream end of this area, with very little sediment accumulation and a generally stable alignment. The natural bed substrate in this reach is sandy gravel, with some cobble.

- Photo 2 reflects a 500-foot reach of channel that flows over soft, sedimentary shale bedrock. The natural striations in the rock are estimated to dip southeasterly at a 20-degree angle, striking northeast and southwest. This causes the rock layers to be pointed directly upstream, which allows flowing water access to penetrate and break the layers during floods or freeze/thaw cycles and "flip" large flat sections of broken bedrock over.

- Photo 3 shows the result of the bedrock exposure, where large flat pieces of rock are transported downstream and broken into smaller and smaller pieces.

- Photo 4 is taken directly upstream of the confluence, where this bedrock mixed with other sorted glacial outwash becomes movable sediment that is deposited in the bigger, slower-moving Otsquago Creek.

<u>Alternative 3-1: Sediment Management</u>

The sediment transport process that occurs along the unnamed tributary to Otsquago Creek at STA 174+00 is natural and not unusual, but it is also very difficult to mitigate. The most practical method of addressing sediment that is generated in this way is to initiate a sediment management plan. This may involve the creation of a designated sediment settling area that will be subject to regular maintenance, in conjunction with targeted sediment management.

Dredging is often the first response to sediment deposition and clogging of the stream channel or bridge openings; however, over-widening or over-deepening through dredging can initiate headcutting, foster poor sediment transport, result in low habitat quality, and not necessarily provide significant flood mitigation. Dredging 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.

A sediment management program involves the development of standards to delineate how, when, and to what dimensions sediment excavation should be performed. It will also require the proper regulatory approval, as well as budgetary considerations to allow the work to be funded on an ongoing or as-needed basis as prescribed by the standards to be developed.

Conditions in which active sediment management should be considered include:

- Situations where the channel is confined, without space in which to laterally migrate
- For the purpose of infrastructure protection
- At bridge openings where hydraulic capacity has been compromised
- In reaches with low habitat value

In cases where sediment management of the stream channel is necessary, a methodology should be developed that would allow for proper channel sizing and slope. The following guidelines are provided:

1. Maintain the original channel slope and do not overly deepen or widen the channel. Excavation should not extend beyond the channel's estimated bankfull width unless it is to match an even wider natural channel. Estimated bankfull widths on Otsquago Creek are provided in Table 1 of this report.

2. Sediment management should be limited in volume to either a single flood's deposition or to the watershed's annual sediment yield in order to preclude downstream bed degradation from lack of sediment. Annual sediment yields vary, but one approach is to use a regional average of 50 cubic yards per square mile per

year unless a detailed study is made. Based upon this average, the estimated annual sediment yield of Otsquago Creek is 3,065 cubic yards.

3. Excavation of fine-grain sediment releases turbidity. Best available practices should be followed to control sedimentation and erosion.

4. Sediment excavation requires regulatory permits. Prior to initiation of any in-stream activities, NYSDEC should be contacted, and appropriate local, state, and federal permitting should be obtained.

5. Disposal of excavated sediments should always occur outside of the floodplain. If such materials are placed on the adjacent bank, they will be vulnerable to remobilization and redeposition during the next large storm event.

6. No sediment excavation should be undertaken in areas where rare or endangered species are located.

Recommendation

Undertake a sediment management program within High Risk Area #3, applying the sediment management techniques described.

3.7 High-Risk Area #4 – Abbott Street (STA 66+00 to STA 39+00)

Figure 13 is a location plan of High Risk Area #4. This area includes STA 66+00 downstream to STA 39+00. Anecdotal descriptions of the flooding near Abbott Street indicate that the street and surrounding houses were almost completely destroyed during the June 2013 flood. Sediment aggradation was described to have limited the channel capacity and to have caused the creek to overtop its banks. Portions of this reach may be receiving sediment from the tributary described in High Risk Area #3, and active sediment management upstream may help to mitigate sediment deposition in this reach. However, it is not likely to fully mitigate flooding.

Development along Otsquago Creek in this area has encroached heavily on the floodplain of the creek and in some cases appears to occur within the FEMA designated floodway. Tall, steep, heavily armored banks have been constructed to the edge of the creek. Therefore, the higher flows generated during a flood do not have sufficient floodplain area to effectively convey the flows downstream and, instead, they overtop the banks. Abbott Street is located along the northern bank of Otsquago Creek from STA 62+00 to STA 46+00. Much of the roadway was destroyed, and many of the homes were damaged during the June 2013 flood.

Figure 13: Otsquago Creek High Risk Area #4

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Figure 13

Alternative 4-1: Assessment of Newly Constructed Channel and Potential Floodplain Creation

At the time of field investigations in late fall 2013, a channel reconstruction project was underway in this reach. Figure 14 shows this area.

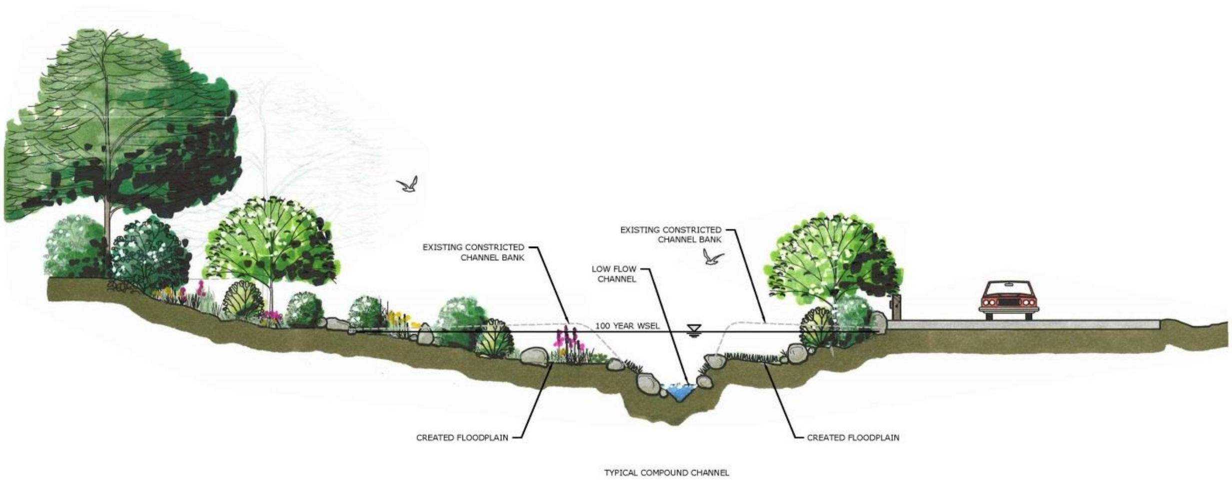
FIGURE 14
Flood Damage and Stabilization Project Along Abbott Road

The hydraulic adequacy of the completed channel work is unknown and was not surveyed or modeled as part of the subject analysis. However, assessment of the work as it neared completion and assessment of historic aerials indicate that the channel was widened in this reach to increase the hydraulic capacity. A trapezoidal channel with sloped riprap banks was constructed and will likely reduce flooding in the area.

Given the extent of surrounding infrastructure and development, a broad approach to flooding control is warranted. Once this project is complete (which may have occurred as of April 2014), a post-construction assessment is recommended to: (a) evaluate the flood mitigation achieved as a result of the project; and (b) understand if additional measures, including further channel modifications and/or creation of a flood bench along this reach, are warranted. Ideally, a compound channel similar to that depicted in Figure 15 is recommended.

The ability to recreate a floodplain and fully mitigate flooding through this reach will require modeling beyond that which may have occurred prior to construction of recent channel modifications. It is likely that such an approach will require property easements and potentially acquisition of entire parcels along the route. In some cases, it is unrealistic to undertake comprehensive stream corridor improvement projects all at once; however, a long-range plan can help guide future acquisitions and potential FEMA buyouts over time.

FIGURE 15
Typical Compound Channel



<u>Alternative 4-2: Strategic Acquisition of Repetitive Loss Properties</u>

In areas along Otsquago Creek where dwellings have suffered repeated losses due to flooding, such as the Abbott Street area, property acquisition is a potentially viable mitigation alternative either through a FEMA buyout program or governmental buyout. Such properties can be converted to passive, non-intensive land uses such as streamside parks, picnic areas, fishing access sites, or wildlife observation areas.

Property acquisitions may be funded by FEMA under three grant programs: the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA). The PDM Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act) and provides funds for hazard mitigation planning and mitigation projects. The HMGP is authorized under Section 404 of the Stafford Act and provides grants to implement hazard mitigation measures after a major disaster declaration. 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 FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 with the goal of reducing or eliminating claims under the National Flood Insurance Program (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 NFIP provides the funding for the FMA program. The PDM and 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. FEMA is the entity that dispenses funds for all three programs.

Historically, acquisitions and elevations of structures have been eligible for funding only when the project is found to be cost effective using FEMA's benefit-cost analysis (BCA) program. The BCA utilizes data from the FIS or previous flood damage claims to calculate the benefit-cost ratio (BCR) associated with the acquisition. The project cost (acquisition fees plus site restoration) must be known to determine the BCR. While this process has proved effective for funding many property acquisitions nationwide, there were many instances where BCRs above 1.0 were not computed due to site-specific challenges or data gaps.

The Biggert-Waters Flood Insurance Reform Act of 2012 made several changes to the mitigation programs, and the new Hazard Mitigation Assistance (HMA) guidance was released in July 2013. One potentially important change to the PDM, HMGP, and FMA programs is that green open space and riparian area benefits can now be included in the project BCR once the project BCR reaches 0.75 or greater. This is one potential method of bridging the gap between a BCR of 0.75 and a BCR of 1.0.

On August 15, 2013, FEMA issued new guidance for acquisitions and elevations of structures within Special Flood Hazard Areas (SFHAs). According to the guidance, acquisitions with a project cost lower than $276,000 and elevations with a project cost lower than $175,000 may be considered *automatically cost-effective for structures in SFHAs*. Although this is a new interpretation of cost effectiveness, it could mean that acquisitions and elevations may be more easily funded without consideration of the BCA.

Once a structure has been acquired and demolished, the property must remain as open space. The intent of the mitigation programs is that structures will not be built in the open space although passive recreation is permitted. To offset the loss of the structure and its occupant, the community should strive to facilitate relocation nearby in areas outside of the floodplain.

Alternative 4-3: Flood Protection Measures of Individual Properties

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 1 percent annual chance flood level. 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 first-floor level.

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

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.

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 1 percent annual chance flood elevation.

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

- Relocate valuable belongings above the 1 percent annual chance flood elevation to reduce the amount of damage caused during a flood event.
- 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 the 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.
- 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.

Encouraging property owners to purchase flood insurance under the 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.

Alternative 4-4: Creation of an Upstream Floodwater and Sediment Storage Area

The feasibility of storing floodwater upstream of the floodprone areas on Otsquago Creek was investigated. This would involve the construction of a berm, the excavation of a detention area, or a combination of both of these options within a large, flat area within the basin. One area that could potentially be used for this purpose is at STA 215+00, in a flat area along Route 80. The option that included both the excavation of a detention area and the construction of a berm provided the largest storage potential. Allowing for one foot of freeboard, the total volume of storage during a 100-year frequency flood event at this location would equal 45,412 cubic yards, or approximately one percent of the total storm runoff. The goal or "rule of thumb" for a feasible, cost-effective flood detention area is to store at least 10 percent of the runoff during the 100-year event. Therefore, this alternative is not considered to be feasible and is not recommended at this location. Calculations are included in Appendix D.

Recommendations

Post-construction analysis of the Abbott Street area as well as the entire floodplain area along the Otsquago from STA 66+00 to STA 39+00 is recommended as described in Alternative 4-1. Concurrent with such an analysis and implementation of further flood mitigation measures, Alternatives 4-2 and 4-3 are recommended on a case-by-case basis.

3.8 High Risk Area #5 – Fort Plain Downtown (STA 30+00 to STA 0+00)

Figure 16 is a location plan of High Risk Area #5. The Fort Plain downtown is situated near the mouth of Otsquago Creek as it flows into the Mohawk River. This densely developed village center experienced severe flooding during the June 2013 flood event. Tall, near vertical, heavily armored banks have been constructed right to the edge of the creek, and low-lying floodplain areas have been filled to support the development of the village. Therefore, the higher flows generated during a flood do not have sufficient floodplain area to effectively convey the flows downstream and, instead, they overtop the banks. Two distinct sections in this reach are subject to flooding and are described in more detail below.

The Kellogg Street bridge (STA 25+25) deck is approximately 20 feet higher than the streambed at its center and does not appear to cause backwater behind it. However, the creek banks are high and steep, cutting off the creek from its floodplain area. Narrow channels do not have area for floodwaters to spread out and slow down and, instead, water is concentrated into deep, highly erosive stream channels. The water depth in narrow channels is also more sensitive to flow increases where minor flow increases can elevate water surfaces.

Representative river sections were surveyed through this reach, and a hydraulic model was developed to assess the flooding behavior of this area. The model predicts that water surface elevations approximately 175 feet downstream of the Kellogg Street bridge overtop the banks during flows greater than the 25-year event. This appears to be consistent with descriptions of flooding that occurred on Main Street, which indicate that water overtopped the banks of Otsquago Creek near an existing Valero gas station and continued to flow down Main Street and into the center of the village.

Figure 17 presents photographs of the flooding that occurred when floodwaters overtopped the banks of Otsquago Creek, flowed through the parking area of the Valero gas station, and traveled north along Main Street toward the center of town.

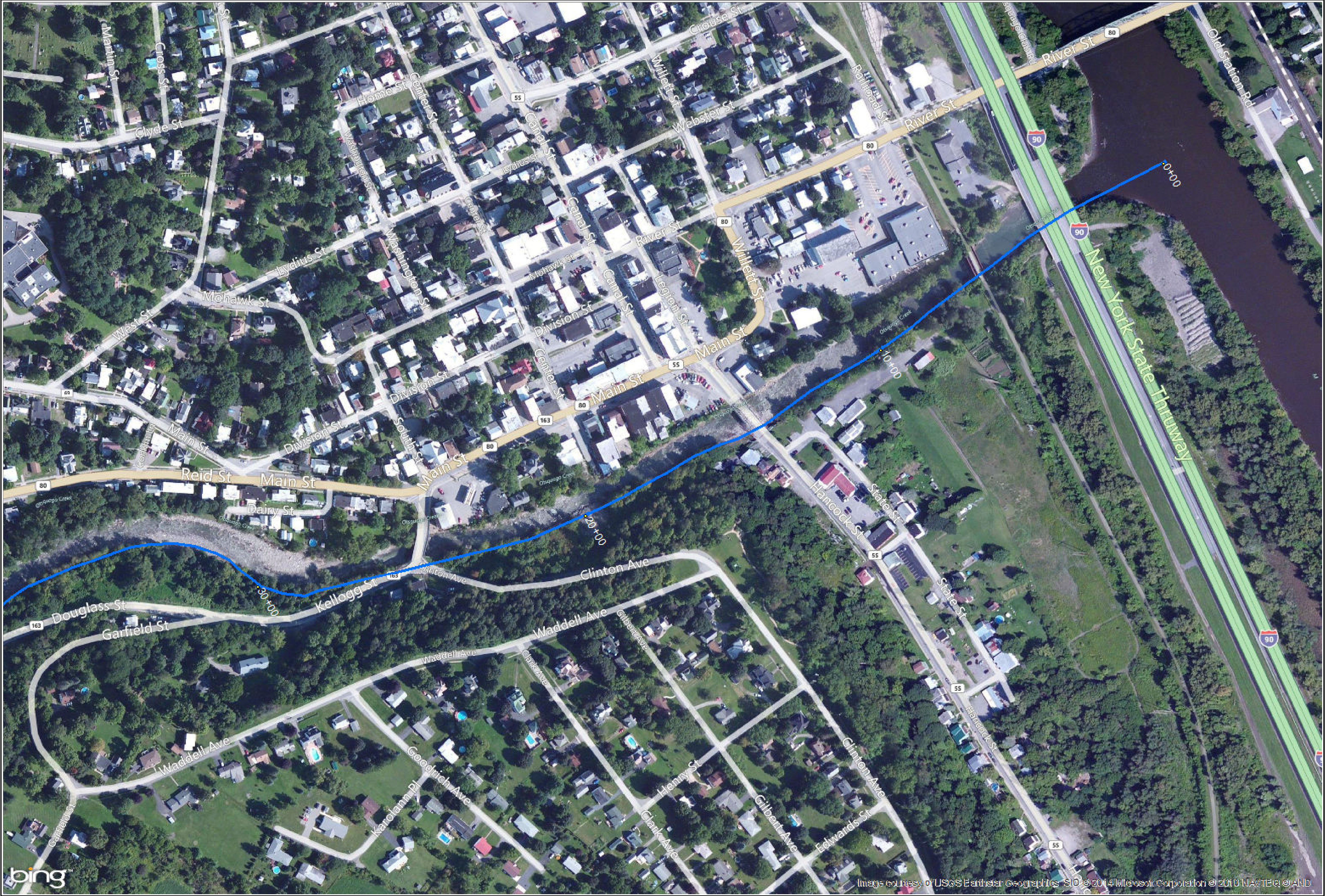


Figure 16: Otsquago Creek High Risk Area #5

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Figure 16

FIGURE 17
Flooding Along Main Street, East of Kellogg Street

Alternative 5-1: Channel Modification and Floodplain Creation from STA 24+00 to STA 14+00

This alternative involves widening the channel to create a floodplain bench. Hydraulic modeling indicates that a 90-foot floodplain bench installed along the left bank of Otsquago Creek from near Kellogg Street to Hancock Street would accommodate floodwaters up to and including the 500-year flood. Construction of such a floodplain bench may require modification of up to seven waterfront properties along the left bank.

Floodplain restoration can be an effective approach to flood mitigation but is often carried out over time with long-term planning goals as funding and regulatory purview allow. Acquisition and regulatory prohibition of floodplain development can begin to create open space where floodplain restoration projects can be developed and implemented.

Alternative 5-2: Mitigation Downstream of Hancock Street Bridge

While upstream flooding near Kellogg Street (STA 25+25) is controlled primarily by the size of the channel, flooding downstream of Hancock Street (14+00) is driven by backwater from the Mohawk River. Flooding elevations in the Mohawk at the River Street (Route 80) crossing from the FEMA FIS are presented in Table 5.

TABLE 5
FEMA FIS Flood Elevations

Recurrence	WSEL (NAVD88)
10-Year	303.8 ft
50-Year	306.9 ft
100-Year	307.3 ft
500-Year	309.2 ft
Levee Elevation	305.5 ft

A levee was constructed along the northern bank of Otsquago Street, starting downstream of Hancock Street, which was intended to protect a commercial section including a Save-A-Lot grocery store and other smaller stores. However, its crest was surveyed at elevation 305.5 feet NAVD. Hydraulic modeling indicates that the levee overtops during a flood of a 25-year severity, controlled primarily by backwater effects from the Mohawk. Figure 18 presents a comparison of flood flows in Otsquago with and without the effects of backwater from the Mohawk River.

Given the effects of the backwater, short of modifying the levee to fully contain the 100-year or higher flood, there is little otherwise that can be undertaken within the Otsquago Creek within this reach to mitigate flooding. A modified levee would need to encompass the entire area of flooding in this reach, be at least three to four feet higher than the existing levee, and would likely require stormwater pumping stations and other controls. This would be a massive and costly undertaking.

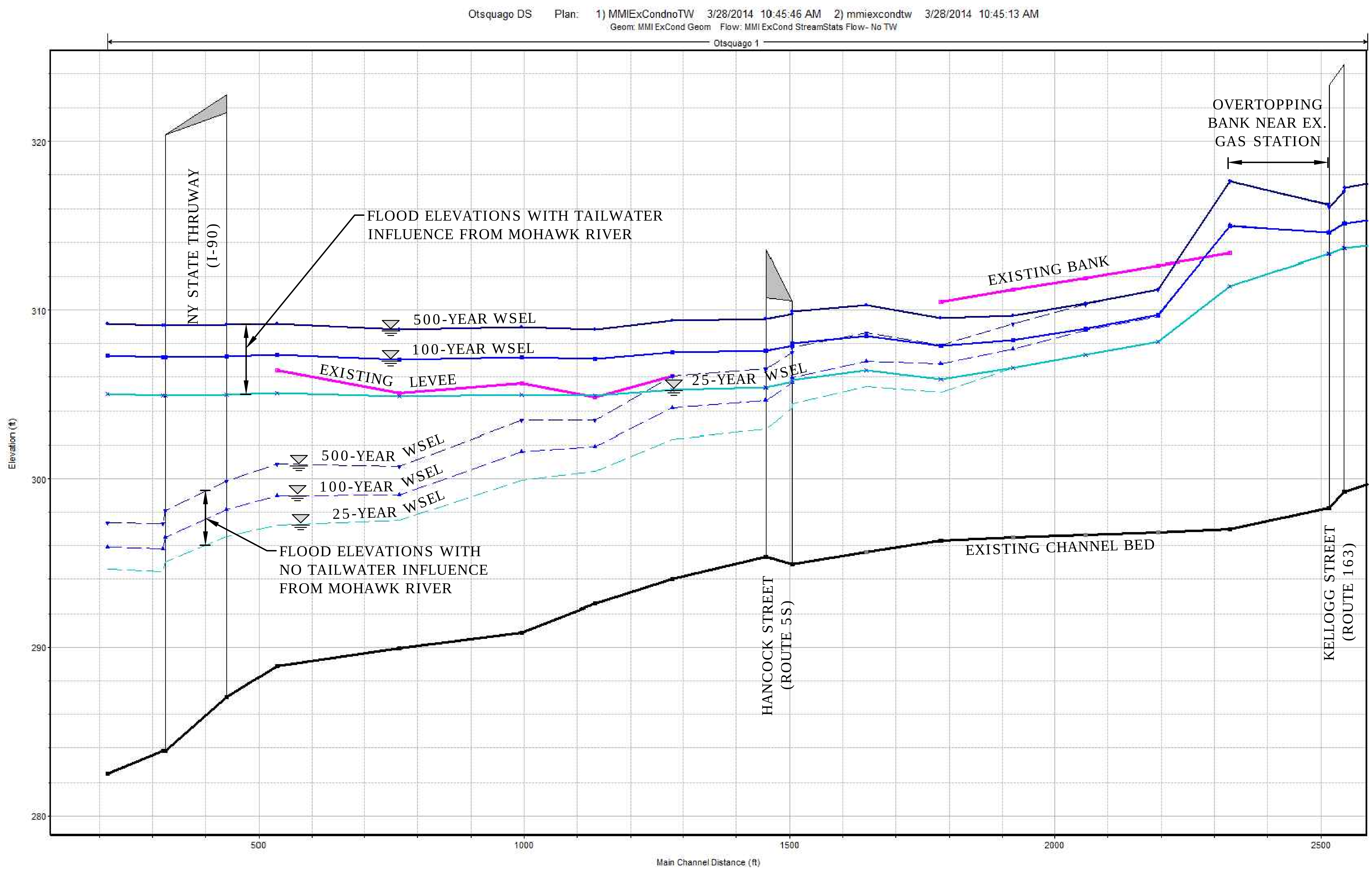
Recommendations

Alternative 5-1 is recommended to mitigate flooding in the vicinity of Kellogg Street (STA 24+00) to Hancock Street (STA 14+00), including Main Street. Alternative 5-2 would be a substantial and costly undertaking. Given the influence of the backwater from the Mohawk River, if nothing is done, this area will be vulnerable to periodic flooding.

4.0 RECOMMENDATIONS

1. *Restore Channel and Create Floodplain Bench at STA 809+00 to STA 794+00* – A 1,500-linear-foot reach of Otsquago Creek has been heavily encroached upon by development, with nearly vertical banks and obstructions that reduce or entirely eliminate the floodplain. A single-lane access bridge near STA 796+00 provides access to a residence. This bridge causes a severe hydraulic restriction. Bridge modification is not feasible because the required span to prevent flooding would extend to the current location of the house. Bridge removal in combination with creation of a 35-foot-wide floodplain is recommended to mitigate flooding up to the 100-year flood event. This approach requires the acquisition and removal of up to three houses (including the home with the bridge access) and would impact the yard area and smaller outbuildings of another four houses.

2. *Replace Undersized Bridge at Wiltse Hill Road (STA 782+00)* – An existing bridge located at Wiltse Hill Road (STA 782+00) is undersized. Hydraulic modeling predicts that the bridge overtops during a 10-year flood and causes backwater to flood the Van Horne Mill Feed Store and at least two neighboring residences. The bridge is old and may need replacement due to its condition. Replacement of this bridge is recommended with a structure that spans approximately 50 feet to pass flows up to and including the 100-year flow without causing inundation.



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REVISIONS

Flood Flows in Otsquago with and without Backwater Effects

WATER BASIN ASSESSMENT
AND FLOOD HAZARD MITIGATION ALTERNATIVES

OTSQUAGO CREEK
FORT PLAIN, NEW YORK

JCM	DRM	JCM
DESIGNED	DRAWN	CHECKED

SCALE N.T.S.

DATE 3/28/2014

PROJECT NO. 5231-01

SHEET NO. **FIG. 18**

3. *Investigate Floodproofing Measures at the Owen D. Young Central School Near STA 775+00* – A significant portion of the Owen D. Young Central School is located within the FEMA designated floodplain. The gymnasium building is located closest to the stream and is subject to severe flood damage. Due to the size of the structure and the history of the facility, relocation of the gymnasium may be impractical. Individual floodproofing measures are recommended.

4. *Replacement of Route 168 and Moyer Road Bridges* – The bridges at Route 168 and Moyer Road are undersized and in poor condition. The Route 168 bridge has been identified for replacement through the Governor's Scour Critical Bridge Replacement Program. Replacement of both the Route 168 bridge (STA 581+50) and the Moyer Road bridge (STA 491+00) with larger structures is recommended. Design criteria should be established relative to the target storm event such that the new structures do not act as hydraulic constrictions or cause flooding. A detailed hydraulic analysis should be undertaken as part of the detailed design process.

5. *Sediment Management in the Unnamed Tributary at STA 174+00* – An unnamed tributary that discharges into Otsquago Creek is a major source of gravel and cobble sediment. The sediment transport process that occurs along this tributary is natural and not unusual, but it is also very difficult to mitigate. Development of a sediment management plan is recommended. This may involve the creation of a designated sediment settling area that will be subject to regular maintenance in conjunction with targeted sediment excavation.

6. *Adopt Sediment Management Standards* – Large volumes of coarse-grained sediments will continue to be transported into Otsquago Creek during high flow events regardless of what actions are taken to control sediments in the upper reaches and tributaries. These sediments will be deposited in the lower reaches, reducing channel capacity and contributing to flooding. When excavation of depositional areas is necessary, it should be undertaken in a manner that maintains channel stability, avoiding over-widening and/or over-deepening the channel. Development of sediment management standards is recommended to provide guidance to contractors and local municipal and county public works departments on how to maintain proper channel sizing and slope as well as the application of best practices.

7. *Evaluate Newly Constructed Channel Project and Undertake Long-Term Flood Mitigation near STA 66+00 to STA 39+00* – At the time of field investigations in late fall 2013, a channel reconstruction project was underway in this reach. The hydraulic adequacy of the completed channel work is unknown and was not surveyed or modeled as part of the subject analysis. Given the extent of surrounding infrastructure and development, a broad approach to flooding control is recommended, including an evaluation of the flood mitigation achieved as a result of the project and assessment of further channel modifications and/or creation of a flood bench along this reach. It is likely that such an approach will require property easements and potentially acquisition of entire parcels along the route.

8. *Acquisition of Floodprone Properties* – Undertaking flood mitigation alternatives that reduce the extent and severity of flooding is generally preferable to property acquisition. However, it is recognized that flood mitigation initiatives can be costly and may take years or even decades to implement. Where properties are located within the FEMA designated flood zone and are repeatedly subject to flooding damages, strategic acquisition, either through a FEMA buyout or other governmental programs, may be a viable alternative. There are a number of grant programs that make funding available for property acquisition. Such properties could be converted to passive, non-intensive land uses.

9. *Protect Individual Properties* – A variety of measures are available to protect existing public and private properties from flood damage, including elevation of structures, construction of barriers, floodwalls and earthen berms, dry or wet floodproofing, and utility modifications within the structure. While broader mitigation efforts are most desirable, they often take time and money to implement. On a case-by-case basis, where structures are at risk, individual floodproofing should be explored. Property owners within FEMA delineated floodplains should also be encouraged to purchase flood insurance under the NFIP and to make claims when damage occurs.

10. *Modify the Channel from STA 24+00 to STA 14+00* – Channel restoration, including increased capacity and creation of a floodplain bench, is recommended in this reach. Hydraulic modeling indicates that a 90-foot floodplain bench installed along the left bank of Otsquago Creek from Kellogg Street (STA 24+00) to Hancock Street (STA 14+00) can carry floodwaters beyond the 100-year flood. Construction of such a floodplain bench may require modification of up to seven waterfront properties along the left bank.

11. *Evaluate Levee Modification Near Fort Plain Downtown* – The Fort Plain downtown is situated near the mouth of Otsquago Creek as it flows into the Mohawk River. This densely developed village center experienced severe flooding during the June 2013 flood event. Given the effects of the backwater from the Mohawk River, short of modifying the levee to fully contain the 100-year or higher flood, there is little action that can be taken within the Otsquago Creek corridor to mitigate flooding. A modified levee would need to encompass the entire area of flooding in this reach, be at least three to four feet higher than the existing levee, and would likely require stormwater pumping stations and other controls. This would be a substantial and costly undertaking. As such, it should be carefully evaluated in comparison to leaving the area at risk for periodic flooding.

12. *Evaluate Floodplain Regulations* – A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements. Identification of a floodplain coordinator and development of a detailed site plan review process for all proposed development within the floodplain

would provide a mechanism to quantify floodplain impacts and ascertain appropriate mitigation measures.

13. *Install and Monitor a Stream Gauge* – There is currently no stream gauge on Otsquago Creek, making statistical analysis difficult. Installation of a permanent stream gauge is recommended.

14. *Develop Design Standards* – There is currently no requirement to design stream crossings to certain capacity standards. For critical crossings such as major roadways or crossings that provide sole ingress/egress, design to the 50- or 100-year storm event may be appropriate. Less critical crossings in flat areas may be sufficient to pass only the 10-year event. Crossings should always be designed in a manner that does not cause flooding. When a structure that is damaged or destroyed is replaced with a structure of the same size, type, and design, it is reasonable to expect that the new structure will be at risk for future damage as well. Development of design standards is recommended for all new and replacement structures.

The above recommendations are graphically depicted on the following pages. Table 6 provides an estimated cost range for key recommendations.

TABLE 6
Cost Range of Recommended Actions

	Approximate Cost Range				
Otsquago Creek Recommendations	< $100k	$100k-$500k	$500k-$1M	$1M-$5M	>$5M
Restore Channel and Create Floodplain Bench				X	
Replace Undersized Bridge at Wiltse Hill Road				X	
Replacement of Route 168 and Moyer Road Bridges				X	
Sediment Management Plan in the Unnamed Tributary	X				
Evaluate Newly Constructed Channel Project	X				
Modify the Channel from STA 24+00 to STA 14+00				X	
Evaluate Levee Modification near Fort Plain Downtown	X				
Install and Monitor a Stream Gauge	X				

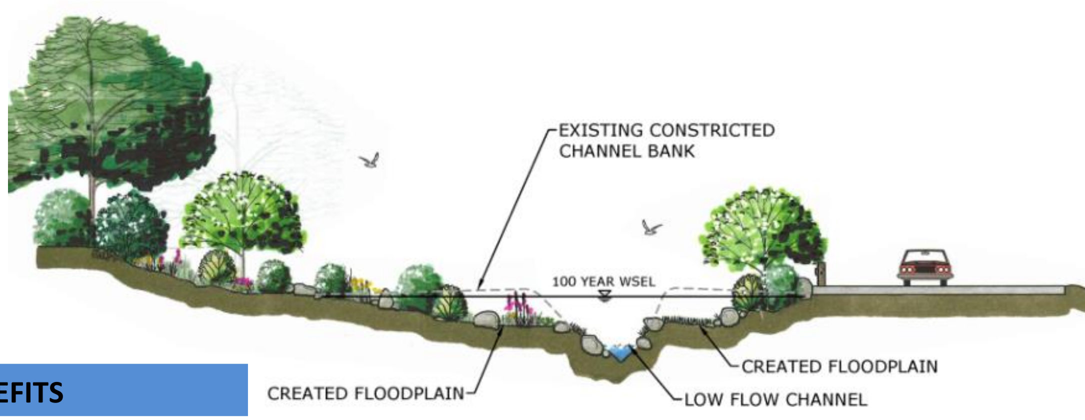
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES OSTQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #1: Homes and Businesses of Van Hornsville

Site Description: Along Otsquago Creek in the Hamlet of Van Hornsville, many homes and businesses are located in close proximity to the channel banks and are at risk during low frequency floods. The channel is undersized, causing overbank flooding and putting the adjacent structures at risk.

Recommendations:

- Remove the bridge at STA 796+00.
- Modify the existing channel and create a floodplain bench to mitigation flooding up to the 100-year flood event.



TYPICAL COMPOUND CHANNEL

	BENEFITS
✓	Improved safety
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved Ecological Connectivity

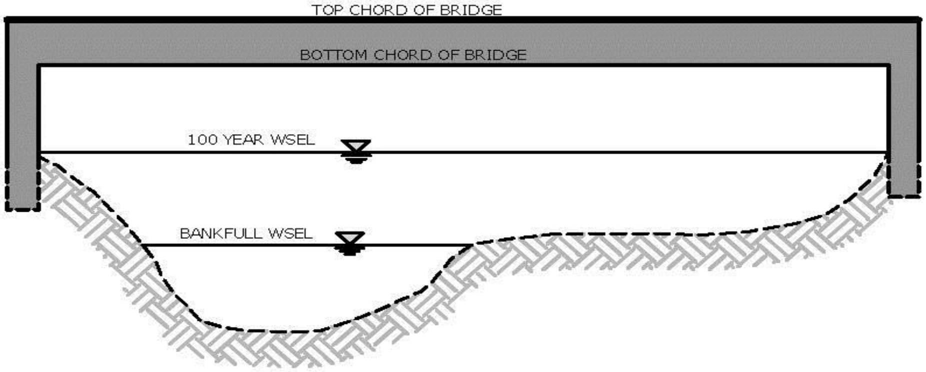
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
OSTQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #2 – Undersized Bridge at Wiltse Hill Road (STA 781+85)

Site Description: This bridge is undersized and is predicted to overtop during 10-year and larger flood events. The bridge is old and may soon need to be replaced due to its condition.

Recommendations:

- Replace bridge with a new structure with an approximate 50-foot span and is designed such that it does not create a hydraulic constriction during flood events.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
✓	Improved safety
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard

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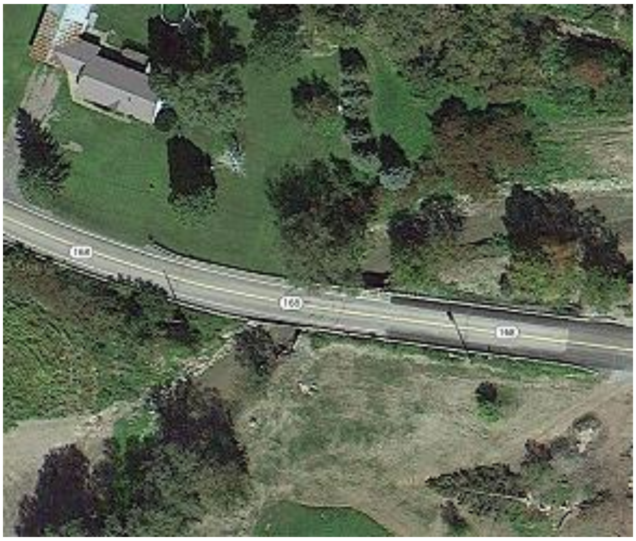
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES OSTQUAGO CREEK, HERKIMER COUNTY, NEW YORK

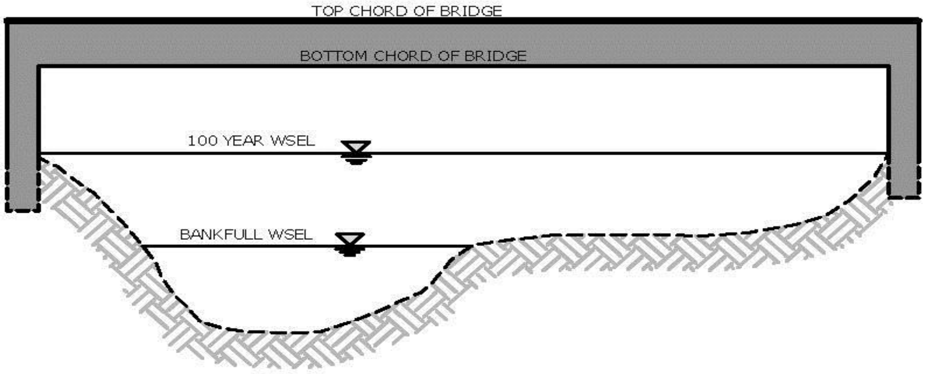
High-Risk Area #3 – Starkville Bridges – Route 168 Bridge (STA 581+50)

Site Description: This bridge is undersized and in poor condition. The measured span of the bridge is 34 feet, well under Oriskany Creek's estimated bankfull width of 45 feet at this location. The current bridge is also prone to debris jams, which exacerbate flooding.



Recommendation:

- Replace bridge with a new structure that spans the bankfull width of Otsquago Creek and does not create a hydraulic constriction during flood events.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
	Improved safety
	Reduction in debris jams
	Improved hydraulic capacity
	Reduced flood hazard

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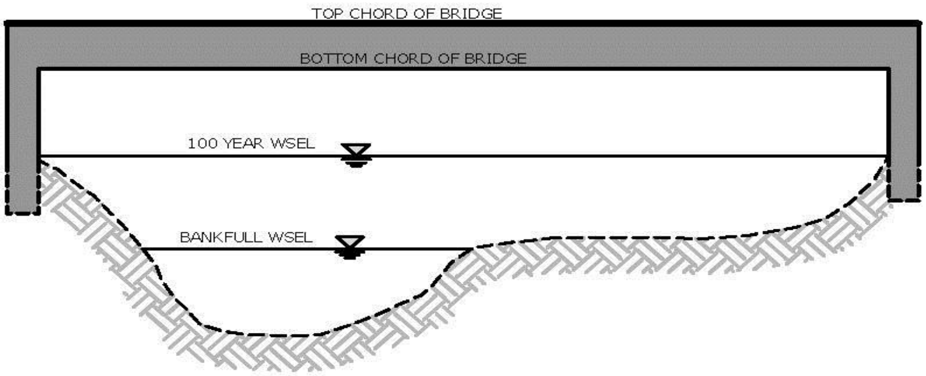
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES OTSQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #3 – Starkville Bridges – Moyer Road Bridge (STA 491+00)

Site Description: This bridge is undersized an in poor conditionThe measured span of the bridge is 40 feet, well under Oriskany Creek's estimated bankfull width of 51.2 feet at this location. The bridge is also very low, ranging in height from 7.5 to 9.5 feet above the creek bed, which makes it prone to debris jams.

Recommendation:

- Replace bridge with a new structure that spans the bankfull width of Otsquago Creek and does not create a hydraulic constriction during flood events.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
✓	Improved safety
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard

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WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
OTSQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #4 – Tributary at STA 174+00

Site Description: Beginning above the upstream end of Abbott Street at STA 66+00 and moving downstream beyond the Route 80 Bridge to STA 39+00, flooding has been extensive. The channel in this reach is overly wide, inducing excessive deposition of large sediments during high flows.

Recommendation:

- Develop a sediment management plan for the high bed load being transported into Otsquago Creek. This may involve creation of a designated sediment settling area that is subject to regular maintenance, in conjunction with a targeted sediment management plan.

	BENEFITS
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard

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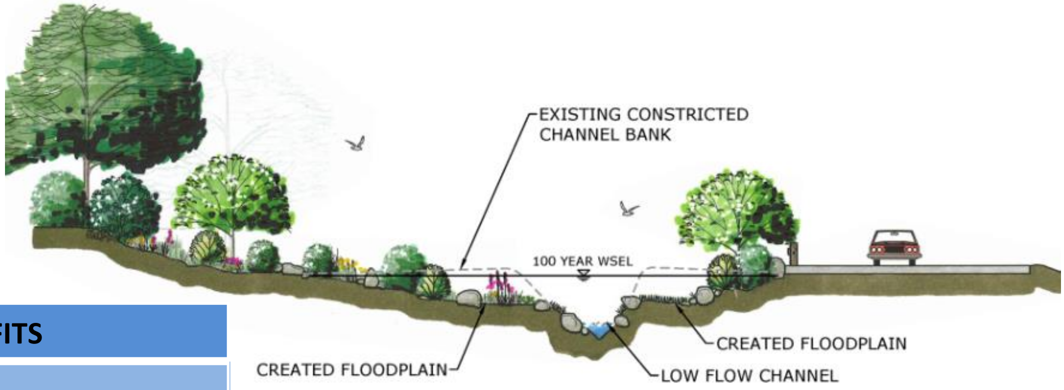
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
OTSQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #4 – Abbott Street Reach

Site Description: Beginning above the upstream end of Abbott Street at STA 66+00, downstream beyond the Route 80 Bridge to STA 39+00, flooding has been extensive, impacting structures and roads. The area is heavily developed, with homes and businesses in the both the floodplain and the floodway.

Recommendations:

- Evaluate the flood mitigation achieved as a result of the recently completed stream reconstruction.
- Assess further channel modifications and/or creation of a flood bench.
- Flood protection measures should be put in place to prevent flooding of the roads and adjacent structures.
- Acquire floodprone properties and flood proof properties on a case-by-case basis.



TYPICAL COMPOUND CHANNEL

	BENEFITS
✓	Improved safety
✓	Reduction in debris jams
✓	Improved hydraulic capacity
✓	Reduced flood hazard
✓	Improved ecological connectivity

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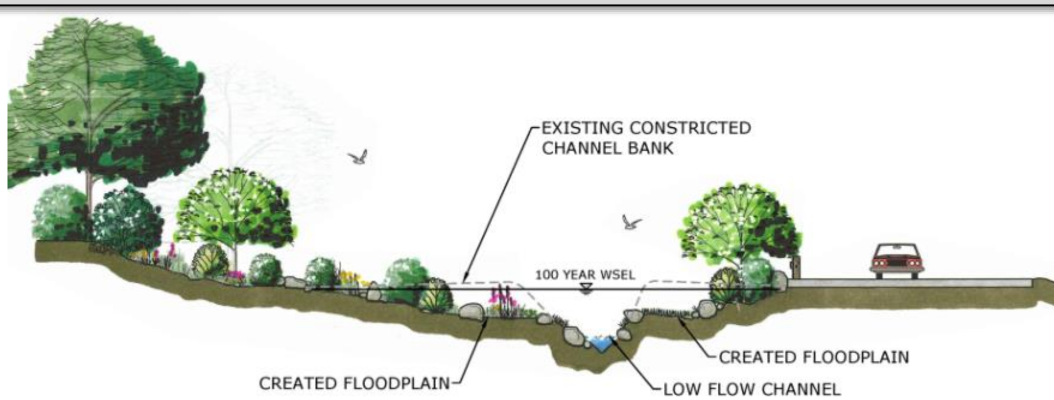
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES OTSQUAGO CREEK, HERKIMER COUNTY, NEW YORK

High-Risk Area #5 – Fort Plain Downtown

Site Description: The Fort Plain downtown is situated near the mouth of Otsquago Creek as it flows into the Mohawk River. This densely developed village center experienced severe flooding during the June 2013 flood event. Tall, near vertical, heavily armored banks have been constructed right to the edge of the creek, and low lying floodplain areas have been filled to support the development of the village.

Recommendations:

- Modify the channel from STA 24+00 to STA 14+00, including increased capacity and creation of a floodplain bench.
- Evaluate levee modification near Fort Plain downtown. This would be a substantial and costly undertaking. As such, it should be carefully evaluated in comparison to leaving the area at risk for periodic flooding.



TYPICAL COMPOUND CHANNEL

	BENEFITS
✓	Improved safety
✓	Improved hydraulic capacity
✓	Reduced flood hazard

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APPENDIX A

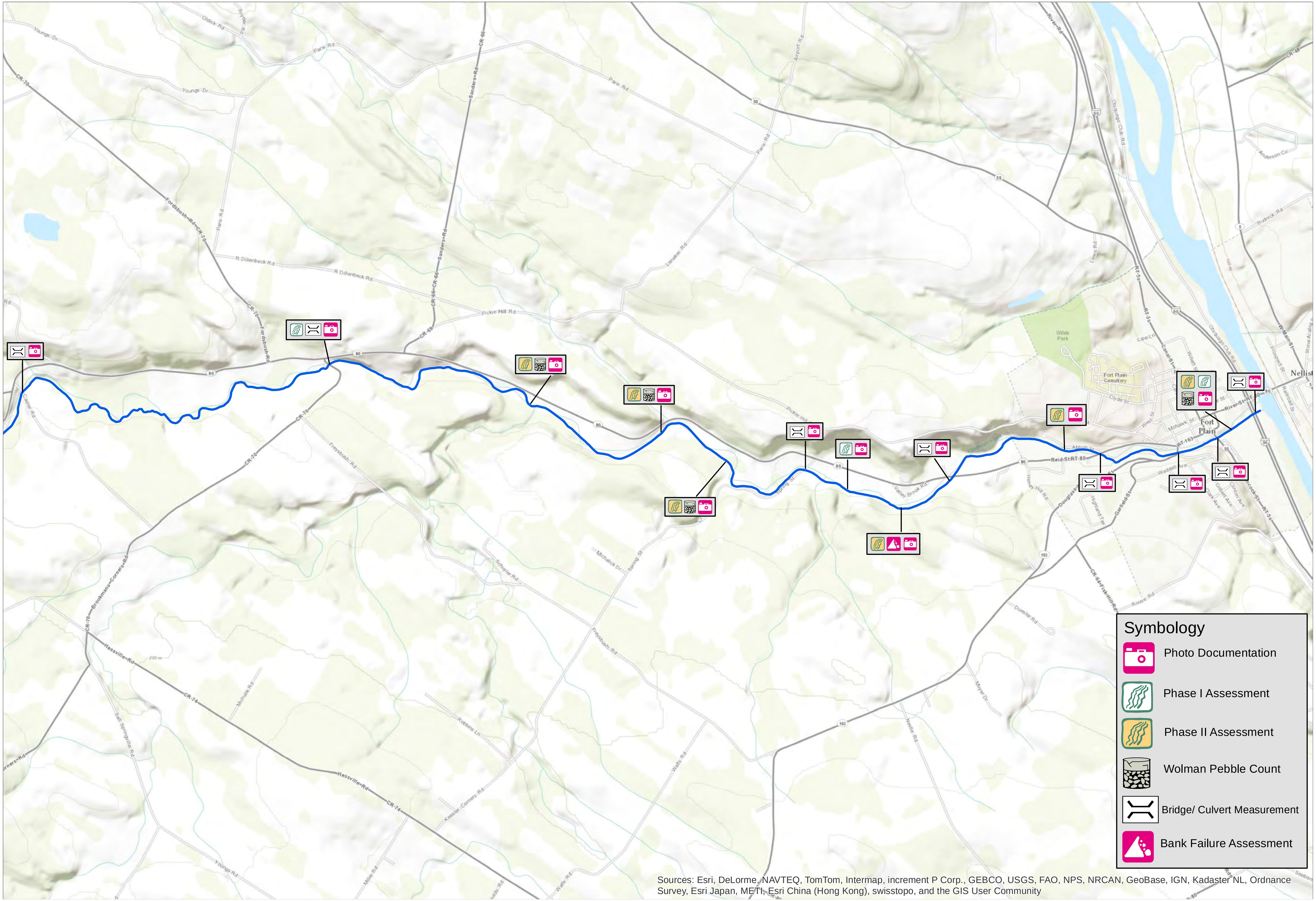
Summary of Data and Reports Collected

ATTACHMENT A: DATA INVENTORY

Year	Data Type	Document Title	Author
2013	Presentation	Flood Control Study for Fulmer Creek	Schnabel Engineering
2012	Map	Sauquoit Creek Watershed/Floodplain Map	Herkimer-Oneida Counties Comprehensive Planning Program
2011	Report	Oriskany Creek Conceptual Plan and Feasibility Study for Watershed Project	Oneida County SWCD
2009	Presentation	Ice Jam History and Mitigation Efforts	National Weather Service, Albay NY
2007	Report	Cultural Resources Investigations of Fulmer, Moyer, and Steele Flood Control Projects	United States Army Corps of Engineers (USACE)
2006	Report	Riverine High Water Mark Collection, Unnamed Storm	Federal Emergency Management Agency (FEMA)
2005	Report	Fulmer Creek Flood Damage Control Feasibility Study	United States Army Corps of Engineers (USACE)
2005	Report	Steele Creek Flood Damage Control Feasibility Study	United States Army Corps of Engineers (USACE)
2004	Report	Fulmer Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2004	Report	Moyer Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2004	Report	Steele Creek Basin Flood Hazard Mitigation Plan	Herkimer-Oneida Counties Comprehensive Planning Program
2003	Report	Fulmer, Moyer, Steele Creek - Stream Bank Erosion Inventory	Herkimer-Oneida Counties Comprehensive Planning Program
1997	Report	Sauquoit Creek Watershed Management Strategy	Herkimer-Oneida Counties Comprehensive Planning Program
2011	Report	Flood Insurance Study (FIS), Herkimer County	Federal Emergency Management Agency (FEMA)
2011	Report	Flood Insurance Study (FIS), Montgomery County	Federal Emergency Management Agency (FEMA)
2013	Report	Flood Insurance Study (FIS), Oneida County	Federal Emergency Management Agency (FEMA)
2010	Report	Bridge Inspection Summaries, Multiple Bridges	National Bridge Inventory (NBI)
2002	Hydraulic Models	Flood Study Data Description and Assembly - Rain CDROM	New York Department of Enviromental Conservation (NYDEC)
2013	Data	June/July 2013 - Post-Flood Stream Assessment	New York State Department of Transportation (NYSDOT)
2013	GIS Data	LiDAR Topography, Street Mapping, Parcel Data, Utility Info, Watersheds	Herkimer-Oneida Counties Comprehensive Planning Program
2013	GIS Data	Aerial Orthographic Imagery, Basemaps	Microsoft Bing, Google Maps, ESRI
2011	GIS Data	FEMA DFIRM Layers	Federal Emergency Management Agency (FEMA)
2013	Data	Watershed Delineation and Regression Calculation	US Geological Survey (USGS) - Streamstats Program

APPENDIX B

Field Data Collection Forms



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SOURCE(S):

Otsquago Creek Data Collection Points

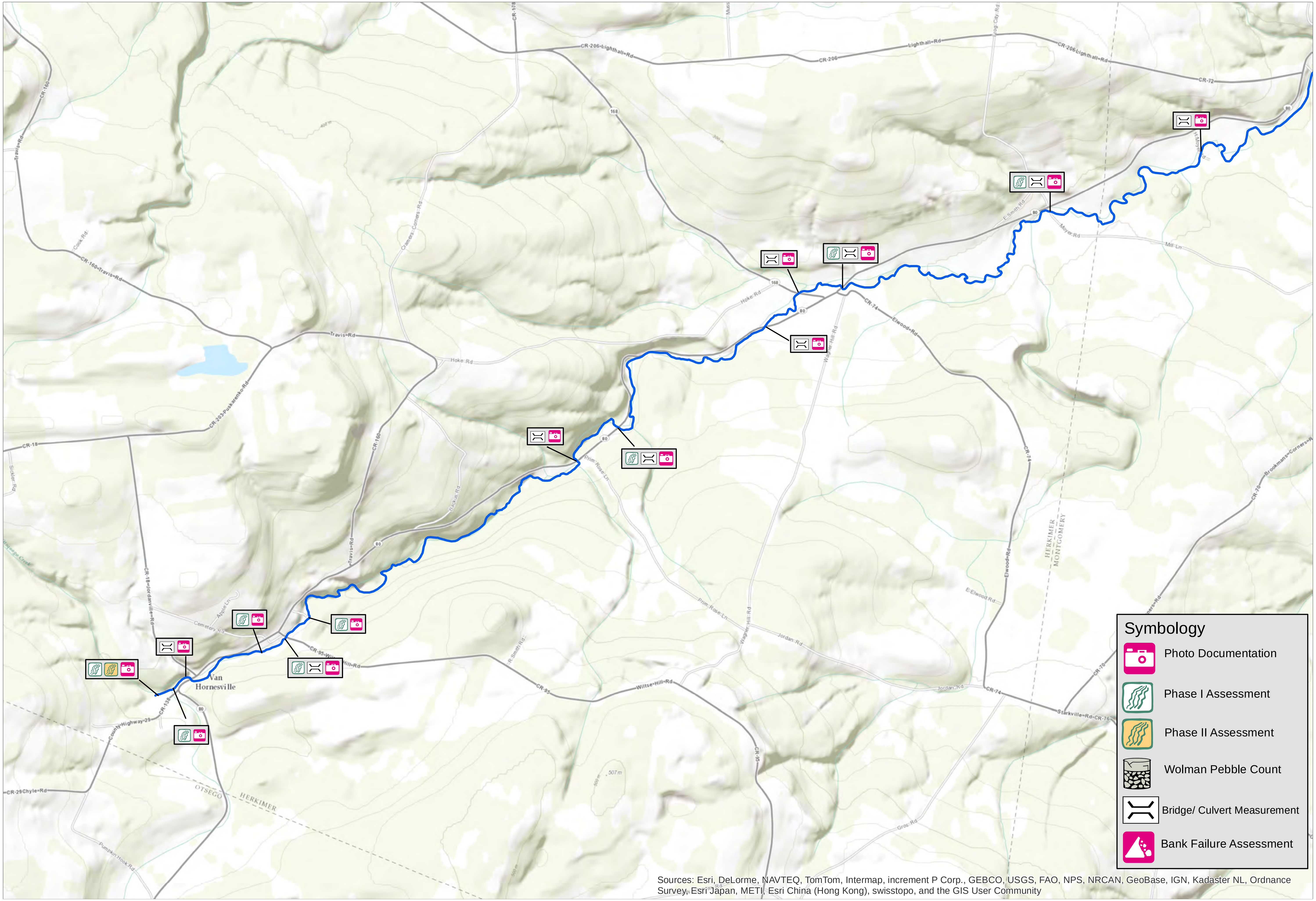
NYDOT: Emergency Transportation Infrastructure Recovery

Herkmer/Mongomery Counties, New York

MXD: Y:\5231-01\GIS\Maps\Phase II Icon Maps\Otsquago7-1.mxd

Map By: CMP
MM#: 5231-01-02
1st Version: 12/5/2013
Revision: 12/12/2013
Scale: 1 in = 2,083 ft

Figure 7-1



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SOURCE(S):

Otsquago Creek Data Collection Points

NYDOT: Emergency Transportation Infrastructure Recovery

Herkimer/Mongomery Counties, New York

MXD: Y:\5231-01\GIS\Maps\Phase II Icon Maps\Otsquago7-2.mxd

Map By: CMP
MM#: 5231-01-02
1st Version: 12/5/2013
Revision: 12/12/2013
Scale: 1 in = 2,083 ft

Figure 7-2

MMI Project #5231-01 Phase I River Assessment Reach Data

River ________________ Reach _____________ U/S Station _______________ D/S Station ___________

Inspectors __________________ Date ______________ Weather ____________________________________

Photo Log ____

A) Channel Dimensions: Bankfull
Width (ft) __________
Depth (ft) __________

Watershed area at D/S end of reach (mi^2) ___________

B) Bed Material: Bedrock Boulders Cobble
Gravel Sand Clay
Concrete Debris Riprap

Notes: ____

C) Bed Stability: Aggradation Degradation Stable Note: __________________

D) Gradient: Flat Medium Steep Note: __________________

E) Banks: Natural Channelized Note: ________________

F) Channel Type: Incised Colluvial Alluvial Bedrock Note: __________

G) Structures: Dam Levee Retaining Wall Note: _______________

H) Sediment Sources: ____

I) Storm Damage Observations: ____

____

J) Vulnerabilities: Riverbank Development Floodplain Development Road Trail Railroad

Utility Bridge Culvert Retaining Wall Ball field Notes: ________________

K) Bridges: Structure # _____________ Inspection Report? Y N Date ________________

Notes: ____

Record span measurements if not in inspection report: ____

Damage, scour, debris: ____

L) Culverts: complete culvert inspection where necessary. Size: ____

Type: ________________ Notes: ____

____

Phase II River Assessment
Reach Data

River ____________________ Reach ____________ Road _____________ Station ______________

Inspector _________________ Date _____________ Town ____________ County ______________

Identification Number _____________________ GPS # ________________ Photo # ________________

A) River Reach ID _________________________ Drainage Area, sm ________________________
D/S Boundary ______________________________, U/S Boundary ____________________________
D/S STA __________________________________, U/S STA _______________________________
D/S Coordinates ___________________________, U/S Coordinates __________________________

B) Valley Bottom Data:

Valley Type (Circle one)	Confined >80% L	Semiconfined 20-80%	Unconfined <20%
Valley Relief	<20'	20-100'	>100
Floodplain Width	<2 W_b	2-10 W_b	>10 W_b

	Left Side	Right Side
Natural floodplain	_______%	_______%
Developed floodplain	_______%	_______%
Terrace	_______%	_______%
Floodplain Land Use	____________	____________

C) Pattern: Straight S=1-1.05; Sinuous S=1.05 – 1.25; Meanders S=1.25 – 2.0; Highly Meandering S>2.0; Braided; Wandering; Irregular

D) Channel Profile Form: (Percent by Class in Reach)

				Channel Transport
Cascades	__________	Alluvial	__________	Sed. Source Area
Steep Step/Pool	__________	Semi Alluvial	__________	Eroding
Fast Rapids	__________	Non Alluvial	__________	Neutral
Tranquil Run	__________	Channelized	__________	Depositional
Pool & Riffle	__________	Incised	__________	
Slow Run	__________	Headcuts	__________	

E) Channel Dimensions (FT):

	Bankfull	Actual Top of Bank	Regional HGR
Width	__________	__________	__________
Depth	__________	__________	__________
Inner Channel Base Width	__________		
W/D Ratio	__________		

F) Hydraulic Regime:
Mean Bed Profile Slope ________________ Ft/Ft
Observed Mean Velocity ______________________ FPS

G) Bed Controls:

Bedrock	Weathered Bedrock	Dam
Static Armor	Cohesive Substrate	Bridge
Boulders	Dynamic Armor	Culvert
Debris	Riprap	Utility Pipe/Casing

Overall Stability _______________________

H) Bed Material:

D50 __________

Bedrock	__________	Sand	__________	Riprap	__________
Boulders	__________	Silt and Clay	__________	Concrete	__________
Cobble and Boulder	__________	Glacial Till	__________		
Gravel and Cobble	__________	Organic	__________		
Sand and Gravel	__________				

I) Flood Hazards:

Developed Floodplains	Bank Erosion
Buildings	Aggradation
Utilities	Sediment Sources
Hyd. Structures	Widening

Bridge Waterway Inspection Summary

River ____________________ Reach ____________ Road _____________ Station ______________

Inspector _________________ Date _____________ NBIS Bridge Number ____________________

NBIS Structure Rating _____________________ Year Built __________________________________

Bridge Size & Type _______________________ Skew Angle ________________________________

Waterway Width (ft) ______________________ Waterway Height (ft) _________________________

Abutment Type (circle) Vertical Spill through Wingwalls

Abutment Location (circle) In channel At bank Set back

Bridge Piers _____________________________ Pier Shape __________________________________

Abutment Material ________________________ Pier Material _________________________________

Spans % Bankfull Width ____________________ Allowance Head (ft) __________________________

Approach Floodplain Width _________________ Approach Channel Bankfull Width _______________

Tailwater Flood Depth or Elevation ___________ Flood Headloss, ft ____________________________

	Left Abutment	Piers	Right Abutment
Bed Materials, D_{50}			
Footing Exposure			
Pile Exposure			
Local Scour Depth			
Skew Angle			
Bank Erosion			
Countermeasures			
Condition			
High Water Marks			
Debris			

Bed Slope	Low	Medium	Steep
Vertical Channel Stability	Stable	Aggrading	Degrading
Observed Flow Condition	Ponded	Flow Rapid	Turbulent
Lateral Channel Stability	________________________		
Fish Passage	________________________		
Upstream Headwater Control	________________________		

Project Information

Project Name	
Project Number	
Stream / Station	
Town, State	
Sample Date	
Sampled By	
Sample Method	Wolman Pebble Count

Particle Distribution (%)

silt/clay	
sand	
gravel	
cobble	
boulder	
bedrock	

Sample Site Descriptions by Observations

Channel type	
Misc. Notes	

Particle Sizes (mm)

D16	
D35	
D50	
D84	
D95	

(Bunte and Abt, 2001)

Particle Name	Size Limits (mm) lower	upper	Tally	Count	Percent Passing	Cumulative % Finer
silt/clay	0	**0.063**			0.0	0.0
very fine sand	0.063	**0.125**			0.0	0.0
fine sand	0.125	**0.250**			0.0	0.0
medium sand	0.250	**0.500**			0.0	0.0
coarse sand	0.500	**1**			0.0	0.0
very coarse sand	1	**2**			0.0	0.0
very fine gravel	2	**4**			0.0	0.0
fine gravel	4	**5.7**			0.0	0.0
fine gravel	5.7	**8**			0.0	0.0
medium gravel	8	**11.3**			0.0	0.0
medium gravel	11.3	**16**			0.0	0.0
coarse gravel	16	**22.6**			0.0	0.0
coarse gravel	22.6	**32**			0.0	0.0
very coarse gravel	32	**45**			0.0	0.0
very coarse gravel	45	**60**			0.0	0.0
small cobble	60	**90**			0.0	0.0
medium cobble	90	**128**			0.0	0.0
large cobble	128	**180**			0.0	0.0
very large cobble	180	**256**			0.0	0.0
small boulder	256	**362**			0.0	0.0
small boulder	362	**512**			0.0	0.0
medium boulder	512	**1024**			0.0	0.0
large boulder	1024	**2048**			0.0	0.0
very large boulder	2048	**4096**			0.0	0.0
bedrock	4096	**-**			0.0	0.0
			Total	0	0.0	-

(Wenthworth, 1922)

F-T Particle Sizes (mm)

F-T n-value	0.5
D16	
D5	

(Fuller and Thompson, 1907)

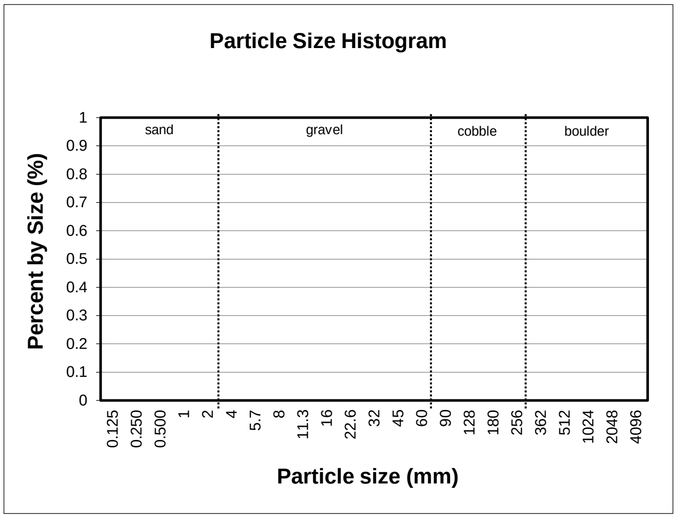
D (mm) of the largest mobile particles on bar

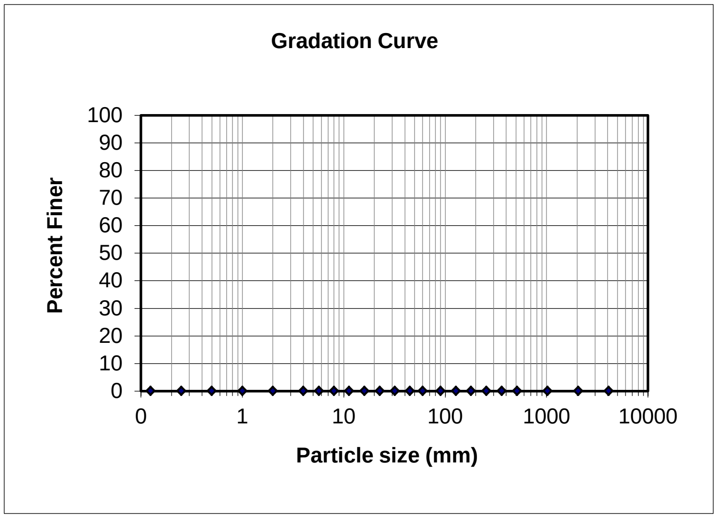
Mean	

Riffle Stability Index (%)

(Kappesser, 2002)

Notes





APPENDIX C

Otsquago Creek Photo Log

Engineering, Landscape Architecture and Environmental Science
MILONE & MACBROOM®
99 Realty Drive
Cheshire, Connecticut 06410
(203 271-1773

Otsquago Creek Photo Log

MMI# 5231-01
NYDOT
January 2014

PROJECT PHOTOS

PHOTO NO.: **1** DESCRIPTION: Located at STA 796+00 in Van Hornesville, Otsquago Creek flows adjacent to the road and when flooded, overtops the road and nearby buildings.	
PHOTO NO.: **2** DESCRIPTION: Looking downstream fromapproximate STA 799+00, to the left are buildings that become severely flooded during low frequency events.	

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NYDOT
January 2014

PHOTO NO.:	
3	
DESCRIPTION:	
This photo shows behind Owen D. Young Central School where a stacked rock wall has been constructed to armor the inner bank.	

PHOTO NO.:	
4	
DESCRIPTION:	
Upstream is the Moyer Road Bridge at STA 491+00, which contributes to flooding in the town of Starkville.	

PHOTO NO.:	
5	
DESCRIPTION:	
At STA 174+00, an unnamed tributary enters Ostquago Creek. Shown here is the extensive deposition of sediments just upstream of the confluence.	

PHOTO NO.:	
6	
DESCRIPTION:	
Looking downstream, the unnamed tributary enters from the left of the image, just before the heavy bank armoring.	

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NYDOT
January 2014

PHOTO NO.:

7

DESCRIPTION:

Looking downstream from the Reid Street (Route 80) Bridge crossing with Abbott Street on the right, this area has undergone extensive construction since the 2013 flood.

PHOTO NO.:

8

DESCRIPTION:

Looking upstream from approximate STA 11+00, this downtown region of Fort Plain experiences heavy flooding due to the lack of floodplains to mitigate floodwaters.

APPENDIX D

Detention Basin Computations

Engineering, Planning,
Landscape Architecture
and Environmental Science
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99 Realty Drive
Cheshire, Connecticut 06410
(203) 271-1773 Fax (203) 272-9733

JOB 5231-01
SHEET NO. OF
CALCULATED BY JCS DATE 2/5/14
CHECKED BY DATE
SCALE

Otsquago Creek 215+00

Total Watershed Contributing to Storage Area without Trib.

$A = 28\ mi^2 = 780,595,200\ ft^2$

Assume 7in rainfall & 30% runoff over entire watershed:

$V = 780,595,200\ ft^2 \times 7in \times \frac{ft}{12in} \times 0.3$

$= 136,604,160$ CF

$= 5,059,413$ CY

Available Storage at Site

Alt. 1 Grade & Berm

Storage	Storage (% of V)
45,412 CY	1%

1% < 10% therefore not feasible

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JOB 5231-01
SHEET NO. ____ OF ____
CALCULATED BY JCS DATE 2/5/14
CHECKED BY ____ DATE ____
SCALE ____

Otsquago Creek 215+00

Total watershed contributing to Potential Storage Area: with Tributary

$A = 44.1 \ mi^2 = 1{,}229{,}437{,}440 \ ft^2$

Assume 7 in rainfall & 30 % runoff over entire watershed:

$$V = 1{,}229{,}437{,}440 \ ft^2 \times 7 in \times \frac{ft}{12 in} \times 0.3$$

$$= 215{,}151{,}552 \ CF$$

$$= 7{,}968{,}576 \ CY$$

Available Storage at Site

Alt. 1 Grade & Berm @ 11

Storage	Storage (% of V)
45,412 CY	0.6 %

0.6 % < 10 % therefore not feasible

USGS New York StreamStats

Streamstats Ungaged Site Report

Date: Wed Feb 5 2014 09:54:46 Mountain Standard Time
Site Location: New_York
NAD27 Latitude: 42.9324 (42 55 57)
NAD27 Longitude: -74.6851 (-74 41 07)
NAD83 Latitude: 42.9325 (42 55 57)
NAD83 Longitude: -74.6847 (-74 41 05)
ReachCode: 02020004000544
Measure: 0.61
Drainage Area: 28 mi2
Percent Urban: 0.22 %

Peak Flows Region Grid Basin Characteristics

100% 2006 Full Region 1 (28 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	28	0.54	4500
Lag Factor (dimensionless)	0.24	0.004	15.229
Percent Storage (percent)	0.11	0	28.92
Percent Forest (percent)	46.7	23.83	99.61
Mean Annual Precipitation (inches)	40.6	29.49	56.1

Bank Full Region Grid Basin Characteristics

100% Bankfull Region 5 SIR2009 5144 (28 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	28	0.7	332

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK1_25	1030	32	2.2		
PK1_5	1240	30	2		
PK2	1510	29	2.1		
PK5	2260	27	3.6		
PK10	2820	27	5.1		
PK25	3570	28	6.9		
PK50	4150	29	8		
PK100	4810	31	8.8		
PK200	5410	33	9.4		
PK500	6360	35	9.8		

Bank Full Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
BFAREA	168	24		88.9	316
BFDPTH	2.84	20		1.56	5.18
BFFLOW	785	36		235	2620
BFWDTH	60.3	27		31	117

USGS New York StreamStats

Streamstats Ungaged Site Report

Date: Wed Feb 5 2014 10:01:00 Mountain Standard Time
Site Location: New_York
NAD27 Latitude: 42.9323 (42 55 56)
NAD27 Longitude: -74.6847 (-74 41 05)
NAD83 Latitude: 42.9324 (42 55 57)
NAD83 Longitude: -74.6842 (-74 41 03)
ReachCode: 02020004000543
Measure: 98.96
Drainage Area: 44.1 mi2
Percent Urban: 0.23 %

Peak Flows Region Grid Basin Characteristics

100% 2006 Full Region 1 (44.1 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	44.1	0.54	4500
Lag Factor (dimensionless)	0.24	0.004	15.229
Percent Storage (percent)	0.0991	0	28.92
Percent Forest (percent)	38.7	23.83	99.61
Mean Annual Precipitation (inches)	40.4	29.49	56.1

Bank Full Region Grid Basin Characteristics

100% Bankfull Region 5 SIR2009 5144 (44.1 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	44.1	0.7	332

Peak Flows Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK1_25	1750	32	2.2		
PK1_5	2110	30	2		
PK2	2580	29	2.1		
PK5	3870	27	3.6		
PK10	4820	27	5.1		
PK25	6110	28	6.9		
PK50	7110	29	8		
PK100	8250	31	8.8		
PK200	9300	33	9.4		
PK500	11000	35	9.8		

Bank Full Region Grid Streamflow Statistics

Statistic	Flow (ft^3/s)	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
BFAREA	244	24		123	483
BFDPTH	3.37	20		1.75	6.46
BFFLOW	1160	36		323	4150
BFWDTH	73.9	27		36.2	151

Otsquago Creek
Stage Storage Analysis

Computed By: JCS 2/5/14
Checked By:________________
MMI# 5231-01

Existing Conditions
Stage vs. Storage

Existing conditions calculations could not be completed due to lack of existing berm.

Alt. 1 - Berm and Grading
Stage vs. Storage

Distance Below Spillway (ft)	Elevation (ft.)	Area (s.f.)	Incremental Volume (c.f.)	Incremental Volume (c.y.)	Incremental Volume with 1 ft Freeboard (c.y.)
0	471	523,089	469,778	17,399	0
1	470	416,466	358,038	13,261	13,261
2	469	299,610	267,843	9,920	9,920
3	468	236,076	200,878	7,440	7,440
4	467	165,680	139,616	5,171	5,171
5	466	113,551	93,891	3,477	3,477
6	465	74,231	61,497	2,278	2,278
7	464	48,762	40,760	1,510	1,510
8	463	32,758	28,592	1,059	1,059
9	462	24,426	19,693	729	729
10	461	14,959	11,103	411	411
11	460	7,247	4,220	156	156
12	459	1192	0	0	0
		Total:	**1,695,907**	**62,811**	**45,412**