

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

FULMER CREEK
HERKIMER COUNTY, NEW YORK

April 2014

MMI #5231-01



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

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In cooperation with the New York State Department of Environmental Conservation.*

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ABBREVIATIONS/ACRONYMS

CFS	Cubic Feet per Second
CME	Creighton Manning Engineering
DART	Damage Assessment Response Team
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FTP	File Transfer Protocol
GIS	Geographic Information System
HEC-RAS	Hydrologic Engineering Center – River Analysis System
LiDAR	Light Detection and Ranging
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
STA	River Station
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

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 and MacBroom, Inc. (MMI) through a subconsultant agreement with Creighton Manning Engineering (CME) to undertake a comprehensive water basin assessment of thirteen watersheds in Herkimer, Oneida and Montgomery Counties, including Fulmer Creek. Prudent Engineering was also contracted through CME to provide support services, including field survey of stream cross sections.

Work conducted for this study included field assessment of the watersheds, streams, and rivers; analysis of flood mitigation needs in the affected areas; hydrologic assessment; hydraulic modeling; and identification of long-term recommendations for mitigation of future flood hazards.

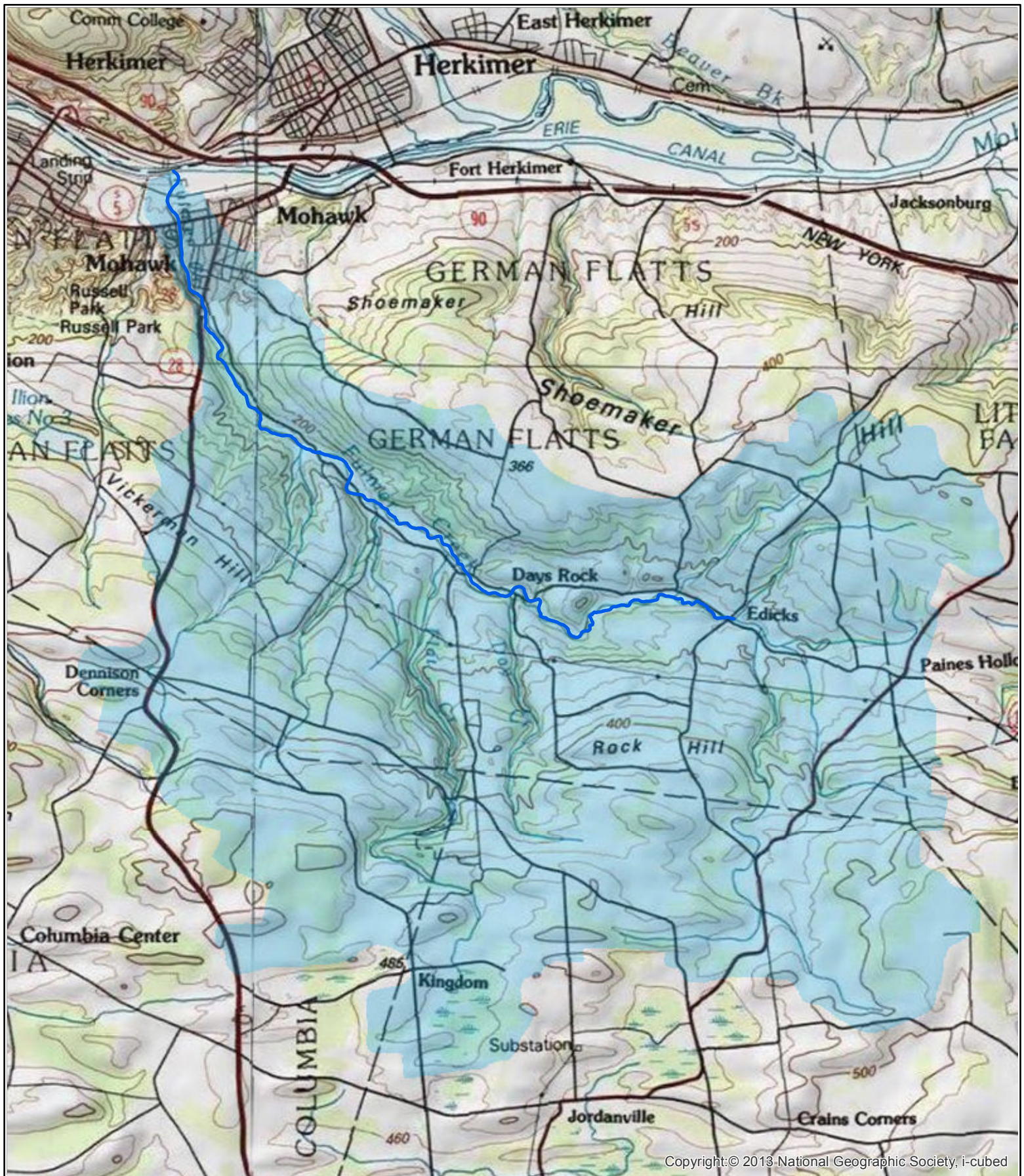
Fulmer Creek is located primarily in the Town of German Flatts and the Village of Mohawk in Herkimer County, New York. Smaller portions of the basin are located in the towns of Warren, Columbia, Stark and Little Falls. The creek drains an area of 26.2 square miles. The drainage basin is 54% forested with a mix of rural residential and agriculture uses, with residential and commercial land uses concentrated in the lower part of the basin in the Village of Mohawk. The Creek has an average slope of 2.1% over its entire stream length of 12.7 miles, with a very steep section in the middle reach. Figure 1 depicts the contributing watershed of Fulmer Creek.

Fulmer Creek generates a significant amount of stream power during high flow events. A number of steep slopes and high banks along the watercourse are prone to sliding, slumping and failure, and contribute a substantial sediment load to the creek. As the sediment is transported and deposits downstream, it restricts channel and bridge capacity.

Compounding the problems with sediment transport and stream hydraulics, commercial and residential development in the village of Mohawk occurs in the alluvial fan type of floodplain, in many cases to within 20 feet of the edge of the stream. When the channel exceeds its hydraulic capacity or becomes clogged with sediment and debris, it floods adjacent properties and erodes banks, leaving them at risk for further degradation and failure.

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.



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SOURCE(S):

Figure 1: Fulmer Creek Drainage Basin Location

LOCATION:
Herkimer County, New York



**NYDOT: Emergency Transportation
Infrastructures Recovery**

Map By: CMP
MMI#: 5231-01
Original: 01/02/2014
Revision: 4/10/2014
Scale: 1 inch = 5,000 feet

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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 mouth of Fulmer Creek at station 0+00 and continues upstream to STA 380+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 Fulmer 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

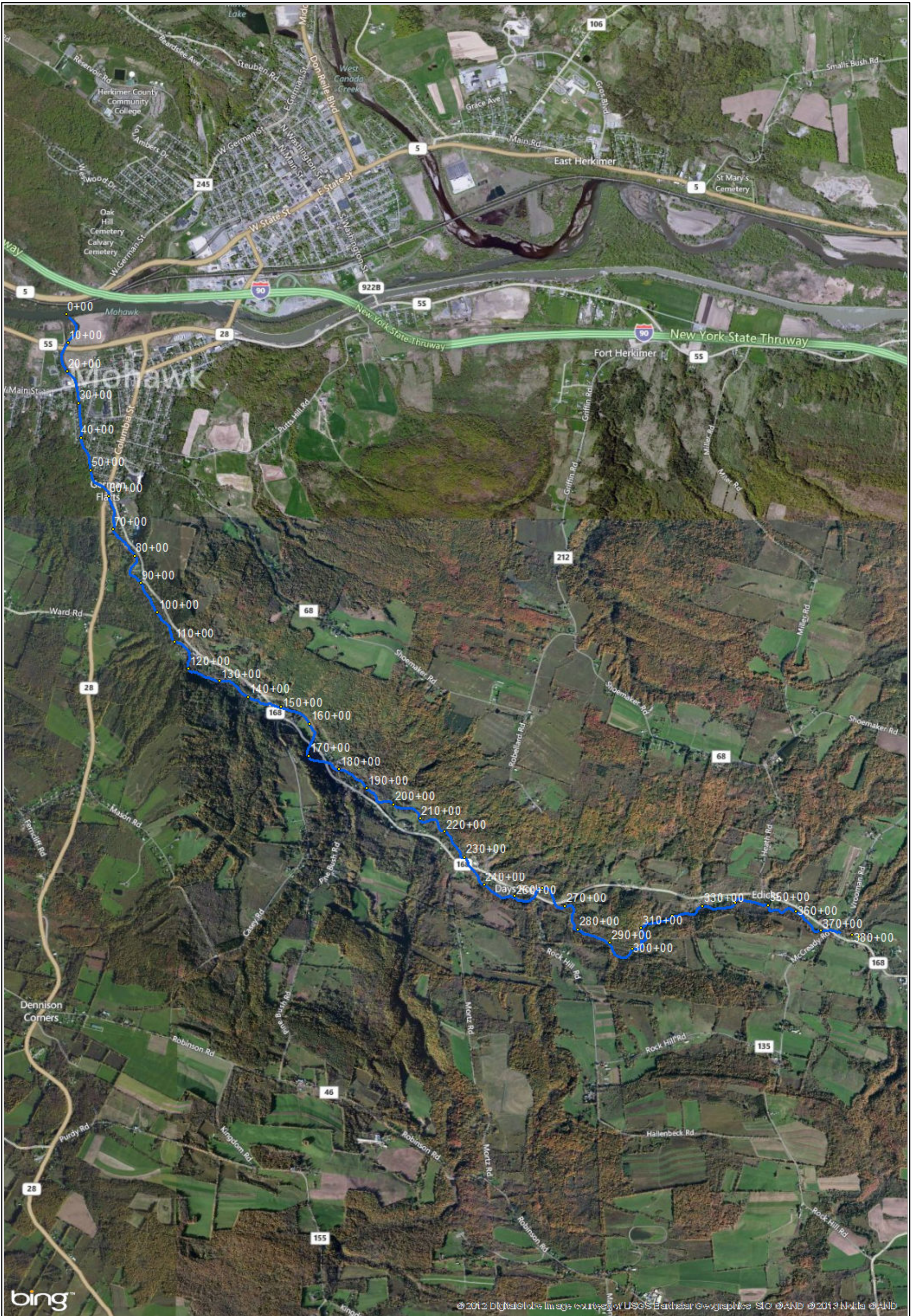
Public information pertaining to Fulmer Creek was collected from previously published documents as well as through meetings with municipal, county, and state officials. Data collected includes reports, photographs, newspaper articles, Federal Emergency Management Agency (FEMA) Flood Insurance Studies (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 kick-off 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 held in the Village of Mohawk to discuss Fulmer Creek. These meetings provided more detailed, first-hand 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:



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SOURCE(S):

Figure 2: Fulmer Creek Watershed Stationing

Location:
Herkimer County, New York

N

NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\Figure 2 Maps\Figure 2 Fulmer Creek.mxd
1st Version: 01/06/2014
Revision: 3/3/2014
Scale: 1 in = 2,500 ft

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- 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
- 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

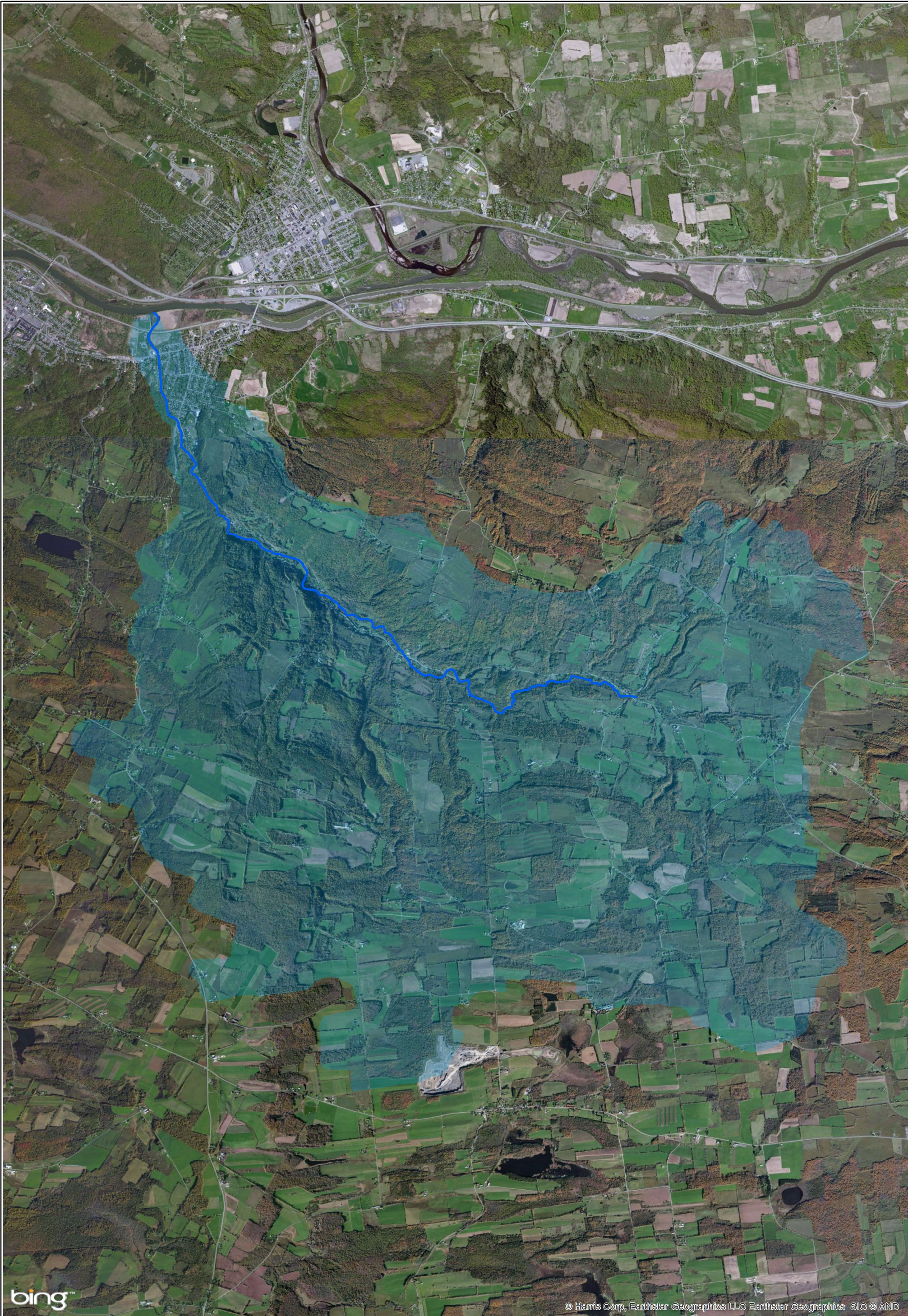
Included in Appendix B is a copy of the River Assessment Reach Data Form, River Condition Assessment Form, Bridge Waterway Inspection Form, and Wolman Pebble Count Form. Appendix C is a photo log of select locations within the river corridor. Field Data Collection Index Summary mapping has been developed 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 Fulmer Creek. The drainage basin is 54% forested, with a mix of rural residential and agriculture uses throughout the basin. Residential and commercial land uses are concentrated in the lower part of the basin, in the Village of Mohawk. Fulmer Creek originates at its headwaters near the hamlet of Paines Hollow, in the town of Little Falls. From here the creek flows west and northwest through the town of German Flatts, where it parallels Route 168 and crosses under it several times. As it flows into the Village of Mohawk, the Fulmer Creek corridor becomes more densely developed.

2.5 Geomorphology

Fulmer Creek drains an area of 26.2 square miles and has an average slope of 2.1% over its length of 12.7 miles. A number of steep tributaries join Fulmer Creek from the south as it flows through German Flatts, including Day Creek, Flat Creek and several unnamed watercourses. There is evidence of high sediment load in the main channel and tributaries of Fulmer Creek. 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 onto the adjacent stream banks or on the floodplain, where it may block the dispersion of future flood flows. Subsequent work in response to the floods during 2013 may have reworked and/or regraded side castings in some of these locations.



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SOURCE(S):


Figure 3: Fulmer Creek Drainage Basin Aerial

Location:
Herkimer County, New York



NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\Figure 3 Maps\Figure 3 Fulmer Creek.mxd
1st Version: 01/06/2014
Revision: 1/6/2014
Scale: 1 in = 4,000 ft

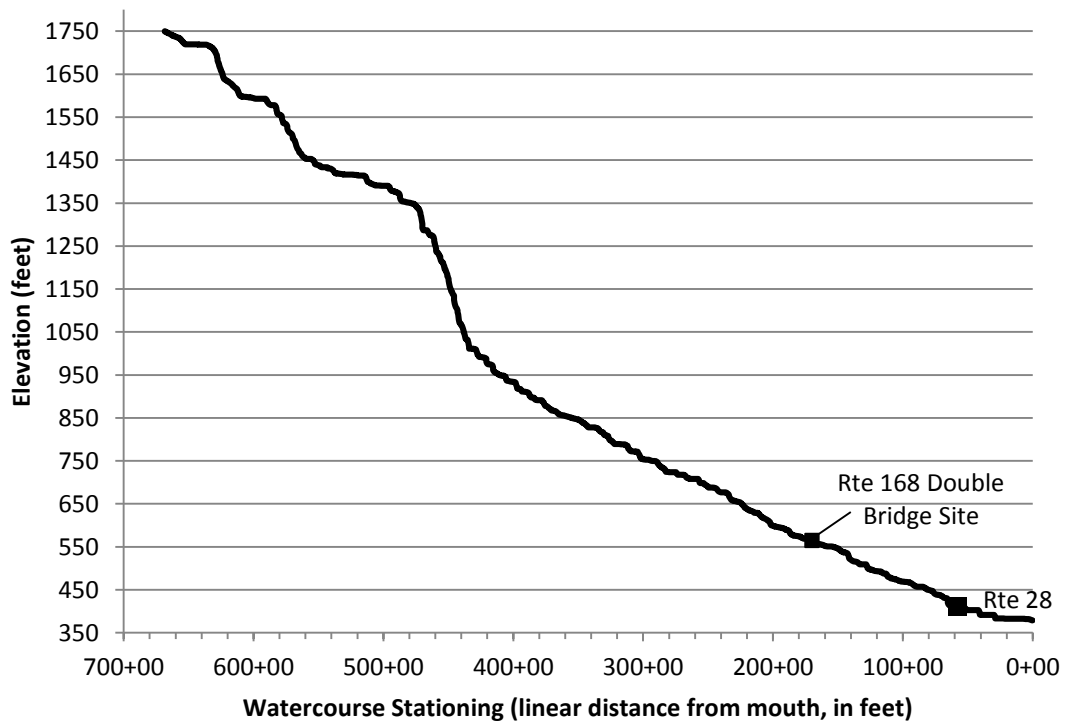
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Unusual sediment sources to Fulmer Creek include bedload that moves along the bottom of the channel from higher in the watershed and eroding banks, combined with specific point sources including two severe high bank failures. The largest failure is known as the Route 168 Double Bridge Site. This consists of a high bank failure adjacent to Route 168 that is actively contributing fine and course grained sediments and threatening the home and property located at the top of the bank failure on Casey Road. The site is located between STA 162+00 and STA 182+00. In this area, Fulmer Creek crosses under Route 168, passes below the high bank failure on a sharp right bend, and then crosses under Route 168 again. A private residential dwelling is located on the inside of the bend.

At various points along its length, Fulmer Creek has been lined by stacked rock and concrete block walls. A stacked rock wall and flood control berm has recently been constructed along the right bank just upstream of Route 28. In the vicinity of West Main Street, the creek has been channelized and is confined by vertical concrete walls and riprap banks.

Figure 4 presents a profile of Fulmer Creek, showing the watercourse elevation versus the linear distance from the mouth of the watercourse. The Route 168 Double Bridge Site and the Route 28 crossing are shown on the profile to provide reference points. The creek drops a total of 1,370 vertical feet, from an elevation of 1,750 feet above sea level at its headwaters, to 380 feet at its outlet at the Mohawk River.

FIGURE 4
Fulmer Creek Channel Profile



Steeper stream reaches, such as is those in the upper reaches of Fulmer Creek, have more energy, with higher velocities that can carry more sediment. As the slope declines downstream, the previously mobilized sediments are then deposited in lower gradient reaches lower in the watershed, where they fill the channel, reduce hydraulic capacity and exacerbate flooding.

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 the channel forming or bankfull discharge in specific regions is primarily a function of watershed area and soil conditions. The bankfull width and depth of alluvial channels represent long-term equilibrium conditions and are important geophysical criteria that are used for design. Table 1 below lists estimated bankfull discharge, width, and depth at several points along Fulmer Creek, as derived from the United States Geological Survey (USGS) *StreamStats* program.

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

Location along Fulmer Creek	Station	Watershed Area (sq. mi.)	Discharge (cfs)	Bankfull Width (ft)	Bankfull Depth (ft)
D/S Rte 168 and Rock Hill Rd	255+00	12.9	404	42.6	2.13
U/S High Bank Failure	189+00	21.0	614	53.0	2.55
At Mohawk River	0+00	26.2	742	58.5	2.77

Actual bankfull and channel widths measured by MMI at various points along Fulmer Creek were compared to the regional bankfull channel dimensions reported above. The comparisons suggest that the channel is undersized over much of its lower reaches, with the exception of in the vicinity of the West Main Street bridge (between approximately STA 28+00 and STA 22+00), where the channel is oversized. The wide channel in this reach is a depositional zone for sediments that have been transported down the creek during high flow events. The deposited sediments accumulate under the West Main Street bridge, which reduces channel capacity and leads to flooding. The bridge is also prone to ice jams.

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

A FEMA FIS was published for the Village of Mohawk, with an effective date of October, 1977 and a revision date of September 8, 1999. A preliminary draft FIS for all of Herkimer County was issued on September 30, 2011, but had not been formally

approved as of the publication of the subject document. According to the 2011 draft FIS, the most recent hydraulic modeling for Fulmer Creek dates from December, 2004.

The hydrologic analysis methods employed in the FEMA study used standardized regional regression equations detailed in USGS publication 90-4197 *Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island*, (USGS, 1991). This regression analysis uses parameters such as mean annual precipitation and other watershed characteristics to estimate flow frequencies. FEMA applied these discharges in a backwater analysis of Fulmer Creek, 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 FIRM for Herkimer County.

Others have published estimated peak discharges for various events using the HEC-HMS model. HEC-HMS is a useful tool for analyzing hydrology and is widely used on a variety of applications; however, the model often over-estimates flows, in some cases yielding results that are substantially higher than field observations. For small scale projects, the added factor of safety is not remarkable; however, high factors of safety on large scale flood control improvements can translate to substantial increases in capital requirements.

Estimated peak discharges for various frequency events were calculated by MMI using *StreamStats* and were then compared to peak discharges reported in the FEMA FIS and results published by others. The *StreamStats* data is higher than the reported FEMA discharges, but lower than the HEC-HMS derived values.

It is not uncommon for hydrologic analysis to vary from one method of computation to another, as it is a complex process that is a function of many factors. A typical range of flow generated on a per square mile basis for the 100-year event is between 100 and 250 cubic feet per second per square mile (cfs/sm). Numbers below this range are often associated rural watersheds with a low density of development; numbers above this range are often associated with watersheds that have a high density of development. The *StreamStats* data translates to approximately 155 cfs/sm, which is within the expected range. The HEC-HMS derived data translates to 411 cfs/sm, which appears to be high.

For the purposes of the subject alternatives analysis, the *StreamStats* data was utilized. This is consistent with the analyses for nearby basin assessments and within the expected range of unit flows. However, as part of any future detailed design effort, an attempt should be made to reconcile the variations in hydrology data, such that appropriate design values are used.

Table 2 lists estimated peak flows at Fulmer Creek at its confluence with the Mohawk River, located at STA 0+00. The drainage area at this location is reported in the FEMA FIS to be 25.9 square miles and by *StreamStats* to be 26.2 square miles.

TABLE 2
Fulmer Creek Peak Discharges at confluence with Mohawk River
(Station 0+00)

Frequency	FEMA (cfs)	StreamStats (cfs)
10-Yr	1,850	2,400
50-Yr	2,710	3,490
100-Yr	3,090	4,040
500-Yr	3,980	5,310

Table 3 lists estimated peak flows at a point 100 feet downstream of the intersection of Route 168 and Rock Hill Road, at station 255+00. The drainage area is reported in the FEMA FIS to be 12.8 square miles and by *StreamStats* to be 12.9 square miles.

TABLE 3
Fulmer Creek Peak Discharges 100 feet D/S of Route 168 and Rock Hill Rd
(Station 255+00)

Frequency	Peak Discharge, FEMA (cfs)	Peak Discharge, StreamStats (cfs)
10-Yr	1,060	1,270
50-Yr	1,570	1,860
100-Yr	1,800	2,160
500-Yr	2,340	2,850

StreamStats flood projections for the 100-year frequency flood event exceed those estimated by FEMA at STA 0+00 and STA 255+00 by 31% and 12%, respectively. Both sets of flow data were used in a preliminary hydraulic model to determine which set would better represent known flooding conditions. The results of this comparison led to the conclusion that the larger flows produced by *StreamStats* appear to better reflect conditions during the June 2013 flooding as compared to the lesser flows estimated by FEMA. *StreamStats* flows were generated at relevant locations in the model and at confluences with larger tributaries. Table 4 reflects the flows that were used in the HEC-RAS model.

TABLE 4
Final Hydrology for HEC-RAS Modeling of Fulmer Creek

River Station	Bankfull Flow (cfs)	10-Yr Peak Flow (cfs)	50-Yr Peak Flow (cfs)	100-Yr Peak Flow (cfs)	500-Yr Peak Flow (cfs)
39+85	732	2,360	3,430	3,970	5,210
86+95	712	2,290	3,340	3,860	5,070
177+30	624	1,990	2,900	3,350	4,400

2.7 Infrastructure

Bridge spans and heights were measured as part of the 2013 field investigations. Table 5 summarizes the bridge measurements collected. For purposes of comparison, estimated bankfull widths at each structure are also included. This data indicates that the Vrooman Road crossing (STA 373+50), the Route 168 bridge crossing north of Casey Road (STA 146+25), the two residential driveway bridges (STA 114+00 and STA 82+50), and the bridge at Route 28 (STA 58+00) are not wide enough to span the bankfull width of Fulmer Creek.

TABLE 5
Summary of Stream Crossing Data

Roadway Crossing	BIN	Station	Height (ft)	Width (ft)	Bankfull Width (ft)
Vrooman Rd	000000003307690	373+50	8.5 – 9.0	26.0	33.3
Route 168 N of McCready Road	000000001051340	372+00	5.7 – 9.7	59.0	33.3
Route 168 E of Rock Hill Road	000000001039010	266+00	5.0 – 10.9	48.5	39.8
Route 168 W of Rock Hill Road	000000001039000	257+00	4.0 – 11.0	56.0	39.8
Route 168 E of Mortz Road	000000001038990	233+00	2.3 – 11.3	105.5	43.0
Route 168 at Crouch Road	000000001038980	175+00	1.5 – 6.3	67.5	53.0
Route 168 S of Casey Road	000000001038970	166+00	5.5 – 14.0	100.5	53.0
Route 168 N of Casey Road	000000001038960	146+25	10.5 – 15.0	47.0	53.6
Residential Drive off Route 168	---	114+00	9.0 – 10.0	39.3	56.7
Residential Drive off Fulmer Drive	---	82+50	12.0 – 13.5	33.0	57.3
Route 28 (Columbia Street)	000000001020020	58+00	13.5 – 15.5	47.0	57.5
West Main Street	000000001002730	24+50	10.0 – 10.5	79.0	58.2
Route 5S	000000001074520	12+00	10.0-18.0	123.0	58.5

Flood profiles published in the FEMA FIS were reviewed to determine which bridges on Fulmer Creek are acting as hydraulic constrictions during large flood events, and which bridges overtop during these events. The profiles indicate that three of the Route 168 bridge crossings at STA 175+00, STA 166+00 (near the double bridge site), and STA 146+25 (near Monahan property) act as substantial hydraulic constrictions during the 500-year frequency storm event.

Two bridges at private road crossings over Fulmer Creek at STA 114+00 (Verenich) and STA 82+50 (Emerich) also act as hydraulic constrictions during the 10-year and larger events. The Route 28 bridge (Columbia Street) acts as a minor hydraulic constriction during the 50-year flood and larger events. The West Main Street and Route 5S bridges are not acting as hydraulic constrictions. None of the bridges are shown to overtop during any of the storm events modeled by FEMA.

3.0 FLOODING HAZARDS AND MITIGATION ALTERNATIVES

3.1 Flooding History along Fulmer Creek

The most severe flood related damages on Fulmer Creek have occurred where the creek parallels Route 168, where multiple trailers at two mobile home parks have been damaged by past floods. Further downstream, just upstream of Columbia Street (Route 28), water overtops Route 168 during flood events and flows through the village. Flooding also occurs in the area between Firman Street and West Main Street on the right bank of Fulmer Creek. Other areas of concern include two high bank failures on Fulmer Creek along Route 168 (near STA 170+00 and near STA 71+00), both of which are contributing to sediment loads and channel instability.

Municipal officials provided a detailed history of flooding events, ice jams, and related activities in the Fulmer Creek Basin, from 1921 to the present. Several ice jam events at the Main Street bridge are documented. On January 20, 1996, the Brookhaven Trailer Park (aka Leatherstocking Trailer Park) was evacuated due to floodwaters. In early February, 2014, an ice jam occurred on Fulmer Creek adjacent to the Leatherstocking Trailer Park, near STA 85+00.

The FEMA FIS reports that Fulmer Creek is a major area of flood concern in the village of Mohawk. Flooding has threatened and damaged homes and businesses in the past. According to the FEMA study, flooding problems on Fulmer Creek are often the result of ice jams, usually in the area of the West Main Street bridge. In 1963, the West Main Street Bridge was raised and widened and a pier was removed from the center of the span. This improvement diminished ice related flooding at this location, but not entirely. Just upstream of the West Main Street bridge, the creek widens and sediment tends to build up in the streambed, causing ice to catch and jam. FEMA reports that this was the cause of a serious flood in February 1971, as well as several less severe ice related floods.

The FEMA flood insurance study lists dates of major flood events on Fulmer Creek as September 1921, March 1936, August 1950, March 1952, January 1962, and February 1971. In February 1994, an ice jam occurred at the West Main Street bridge, causing flooding on Lock, Charles, Erie, Harter and Devendorf streets. Residents on the affected streets were evacuated. Ice jams have also occurred at the Route 5S bridge, and at the railroad bridge, although damage associated with these floods has been less severe. On January 18, 1996, an ice-related flood resulted in the evacuation of approximately 100 people from their homes, and the closing of both Erie and Warren Streets. Three mobile homes in the Brookhaven Trailer Park (aka Leatherstocking) were threatened by floodwaters. The combination of a wider channel, a bend, and a reduced slope alters the flow regime, contributing to ice accumulation near STA 85+00.

FEMA FIRM maps for Fulmer Creek are available for the village of Mohawk and the town of German Flatts. FEMA mapping (Figure 5) indicates that, during a 100-year frequency flood event, waters from Fulmer Creek inundate the trailer park on Fulmer

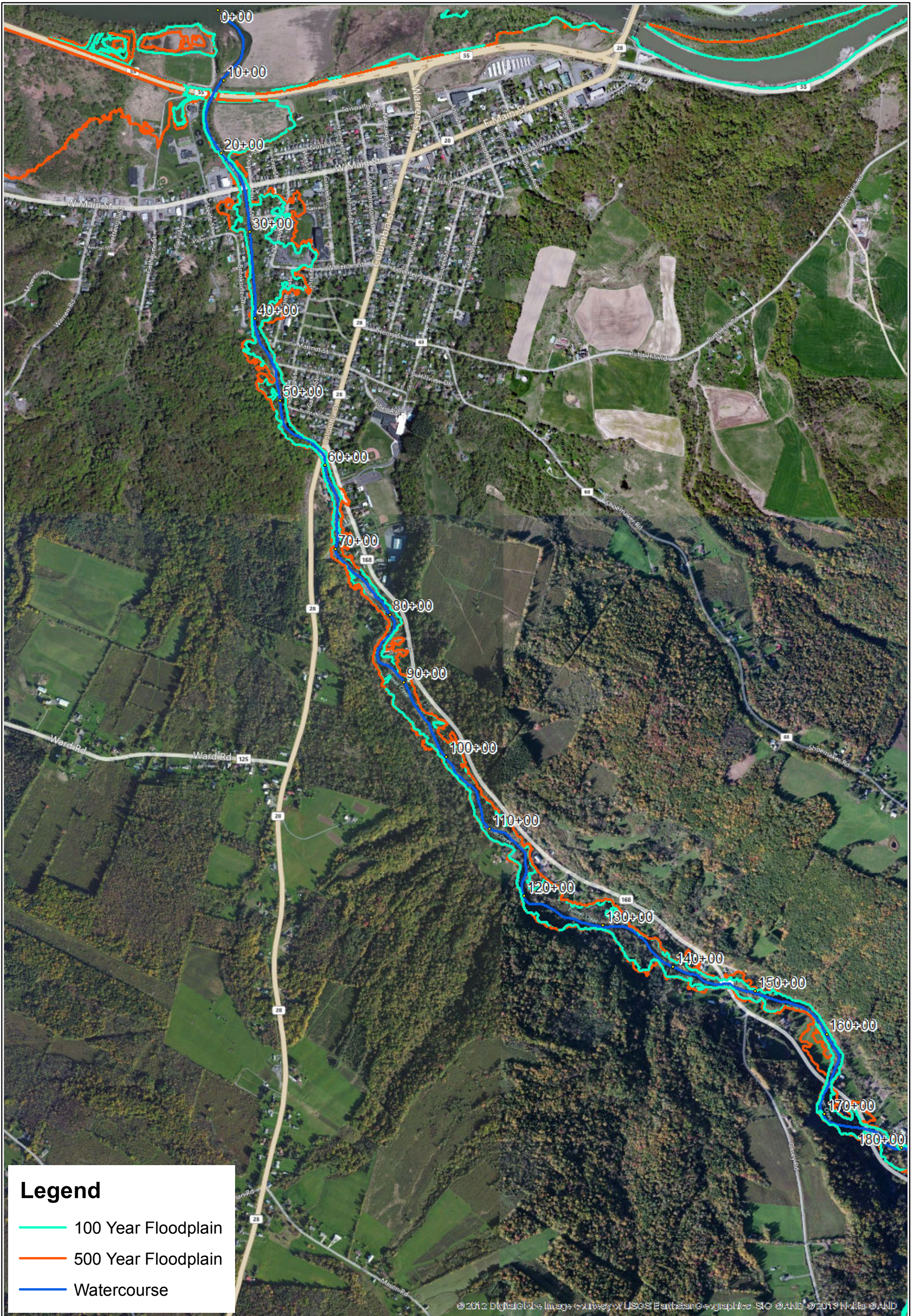
Drive (Leatherstocking Trailer Park) at STA 85+00 and the trailer park located between STA 69+00 and 65+00 (Creekside Trailer Park). The maps indicate that water from Fulmer Creek floods Route 168 at two locations, in the vicinity of STA 64+00 and STA 59+00. This condition has subsequently been altered with the construction of a landform near the Route 28 bridge. Local officials have also noted high water marks that indicate Fulmer Creek has inundated Route 168 at several points upstream, such as near the Town Barn and Leatherstocking Trailer Park. Further downstream, an extensive area between STA 41+00 and STA 27+00, including Firman Street, West Center Street, Devendorf Street, and Charles Street are flooded on the right bank, while some of the homes along Brookside Drive and Petrie Avenue are flooded on the left bank.

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 Fulmer Creek basin. Because rainfall across the region was highly varied and rainfall information is limited, it is not possible to determine exact rainfall amounts within the Fulmer Creek basin.

Historic records on the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) Advanced Hydrologic Prediction Service website indicate that the village of Mohawk 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 June 14; 5.5 to 8.5 inches between June 24 and June 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, preventing soils from drying out between the larger rain events.

Reports from municipal officials indicate that in the Fulmer Creek basin, approximately 4.0 to 4.5 inches of rain fell within an eight hour period on June 28, 2013. Fulmer Creek overflowed its banks upstream of the junction of Route 168 and Route 28. Where the creek flows parallel to Route 168, pavement was damaged, retaining walls failed, and extensive debris was washed onto the roadway. Tributaries to Fulmer Creek transported large amounts of debris and sediment. Damage occurred at several homes and at the two trailer parks along Route 168, and extensive flooding occurred in the village of Mohawk.

Damage Assessment Response Team (DART) reports and mapping compiled after the June 2013 floods indicate that the actual area of flooding associated with this storm event was more widespread than the area of the 100-year floodplain delineated on the FIRM maps. Reports of damage extend along Fulmer Creek, from Days Rock near STA 257+00 downstream to the Main Street bridge area. Flooding occurred along Route 28; however, the most extensive area of flooding occurred along Route 168 near Devendorf, Main, and Erie Streets.



SOURCE(S):

Figure 5: Fulmer Creek FEMA Floodzones

Location:
Herkimer County, New York

N
 NYDOT: Emergency Transportation
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According to reports from municipal officials, during the June 2013 flood event, water overtopped the Fulmer Creek channel between STA 59+00 and STA 60+00, upstream of Route 28, and ran across Route 168 and across Columbia Street. The DART mapping shows that extensive flooding occurred along Bushnell Street, Spring Street, Garden Street, Fulmer Street, Firman Street, John Street, Devendorf Street, Charles Street, Harter Avenue, Lock Street, Main Street, and Erie Street. Mohawk Central Valley School was also flooded.

3.2 Post-Flood Community Response

Following the heavy flooding in June 2013 along Fulmer Creek, the Town of German Flatts and the Village of Mohawk implemented numerous temporary repairs. Private property owners throughout the village implemented repairs to individual sections of streambank as well. Between public and private efforts, 1.5 miles of the lower reaches of Fulmer Creek were heavily manipulated in response to the flood, as well as channel realignment of approximately 800 feet of Fulmer Creek at the confluence of Mohawk River to regain portions agricultural field that were eroded during the floods, re-establish the historical channel alignment, reduce jamming of debris, reduce impacts to residential homes and the electric substation, eliminate a bend that catches ice and debris stabilize the east bank, and promote sediment mobility through this reach.

Dredging and sediment removal (disposal off-site) occurred beginning approximately 300 feet downstream of the West Main Street bridge (Station 22+00) and ending approximately 300 feet upstream at (Station 28+00). Upstream of that, dredging continued, but excavated material appears to have been side cast onto the banks rather than removed from the stream channel. This work continued to just downstream of the Route 28 bridge (Station 58+00).

Post-flood related work that was initiated in response to Tropical Storm Lee and other historic events was completed upstream of the Route 28 crossing near the Route 168 intersection (Station 58+00). As with other historic flooding events, floodwaters in June 2013 overtopped the right bank upstream of the bridge and traveled down the road, causing damage to many homes along the road and within the Village of Mohawk. At the time of field inspections in October and November 2013 associated with the subject analysis, a berm was being constructed in the upstream direction along Route 168.

Other recent flood response included the following:

- Repairs were undertaken at the Creekside Trailer Park along Creekside Drive (Station 68+00) to modify a retaining wall along the right bank and to repair and replace damaged trailers.
- Damage to a bridge at Route 168 (Station 166+00) near the double bridge site directly downstream of a massive bank slide was repaired with stacked stone wall and bank armoring, although no work on massive bank slide was performed.

- Finally, channel relocation and floodplain stabilization was performed at a channel avulsion site along Fulmer Creek near and upstream of Pine Bush Road (Station 194+00 to 200+00). At this location, the channel appears to have been straightened and armored the toe of the Route 168 roadway embankment was armored with stacked stone.

3.3 Flood Mitigation Analysis

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

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 generated by FEMA as part of a 2004 study of Fulmer Creek was obtained and used as a starting point for the subject analysis. Given the significant flood damages (including both erosion and deposition), along with post-storm activities, it can be assumed that conditions have significantly changed since the date of the FEMA 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 19 stream cross sections, plus the survey of five bridges/culverts. These data were 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 analyze certain alternatives, described further in the report sections that follow. Model input and output files have been uploaded onto the NYSDOT ProjectWise site and delivered electronically to NYSDEC.

3.4 High-Risk Area #1 - High Bank Failure at the Route 168 Double Bridge Site

Figure 6 is a location plan of High Risk Area #1. This area, labeled in previous reports as the Route 168 Double Bridge Site, is the most visually remarkable site along Fulmer Creek. It consists of a high bank failure adjacent to Route 168 that is actively contributing fine and coarse grained sediments and threatening the home and property located at the top of the bank failure on Casey Road. The affected reach occurs between STA 162+00 and STA 182+00. In this area, Fulmer Creek crosses under Route 168 at STA 175+00, passes below the high bank failure on a sharp right bend between STA 171+00 and STA 167+00, then crosses under Route 168 again at STA 166+00.

The high bank failure is nearly 500 feet long at its base, and is approximately 220 feet high at its highest point. The failing hillside has a slope in the range of 75% to 85%. The failing material is composed of glacial till that is silty clay intermixed with coarser, cobble-sized rock. The failure of the hillslope is being triggered by lateral erosive action at the toe of the slope, which is occurring along the outside of the bend on Fulmer Creek, combined with local surface runoff that creates gullies.

The following alternatives were evaluated at this high risk area.

Alternative 1-1: Realign Fulmer Creek and Stabilize Hill Slope

This alternative involves moving the Fulmer Creek channel eastward away from the bank failure, and stabilizing the channel to eliminate erosion at the toe of the bank. This alternative is presented in Figure 7, and involves the following actions:

- a) Acquiring and removing the existing house at the base of the bank failure;
- b) Moving the creek channel eastward, away from the bank failure;
- c) Constructing a revetment wall 600 feet in length along the channel at the outside of the bend along the toe of the slope;
- d) Diverting runoff at the top of the slope to prevent further erosion of the slope;
- e) Creating a floodplain bench on the inside of the bend; and
- f) Seeding the slope to promote the growth of vegetation to further stabilize the slope.

Relocating the active flow of water away from the failing bank will eliminate the driving force that is causing erosion and allow the bank to begin self-stabilizing. In order to accomplish this, an 850-foot reach of Fulmer Creek would be relocated up to 175 feet to the east. This will require the procurement removal of an existing home, but will provide enough room to construct a low wall or riprap bank along the base of the high bank failure to protect it from future erosion.



SOURCE(S):

Figure 6: Fulmer Creek High Risk Area #1

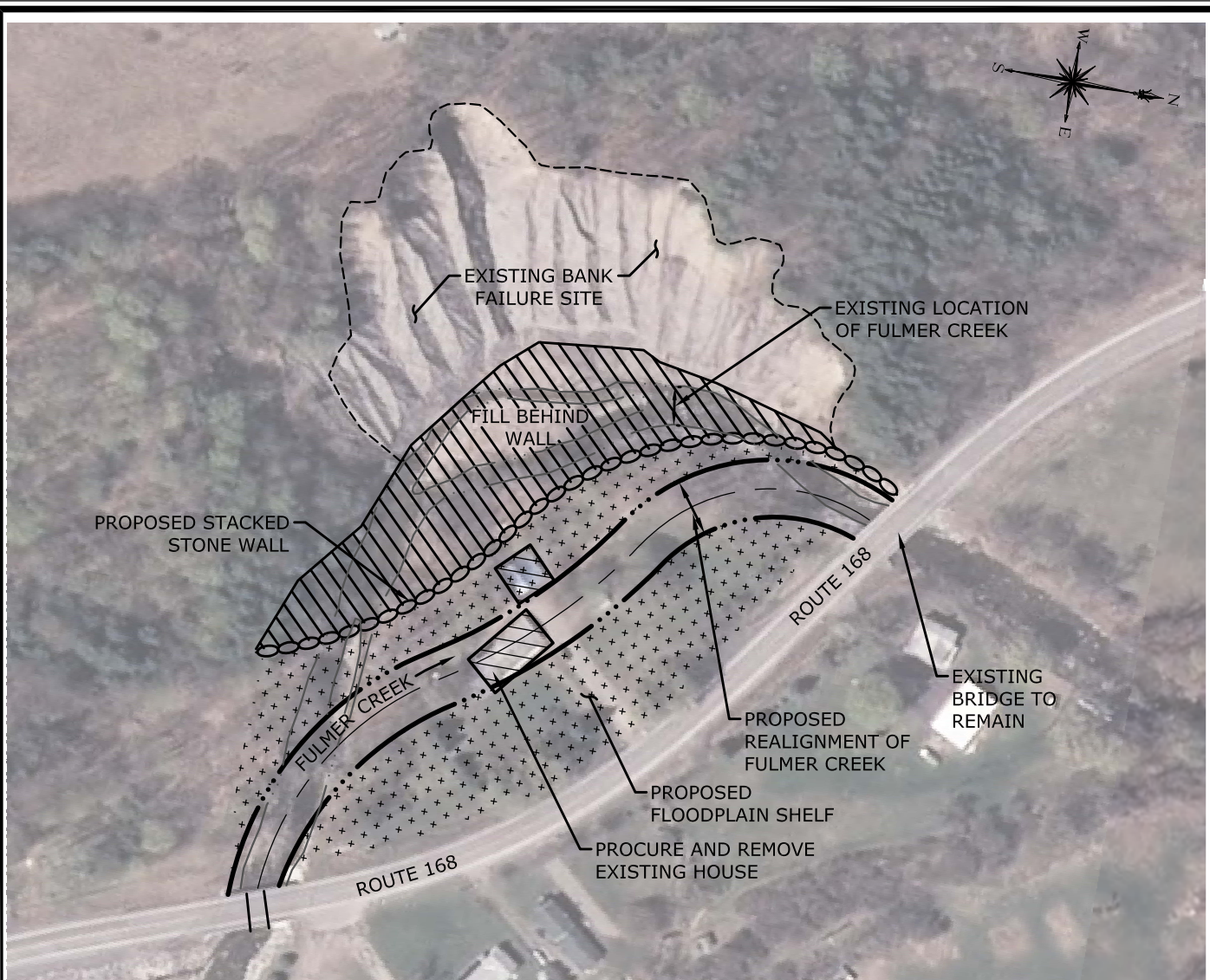
Location:
Herkimer County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
 MMI#: 5231-01
 MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Fulmer Creek High Risk #1.mxd
 1st Version: 01/06/2014
 Revision: 3/25/2014
 Scale: 1 in = 150 ft

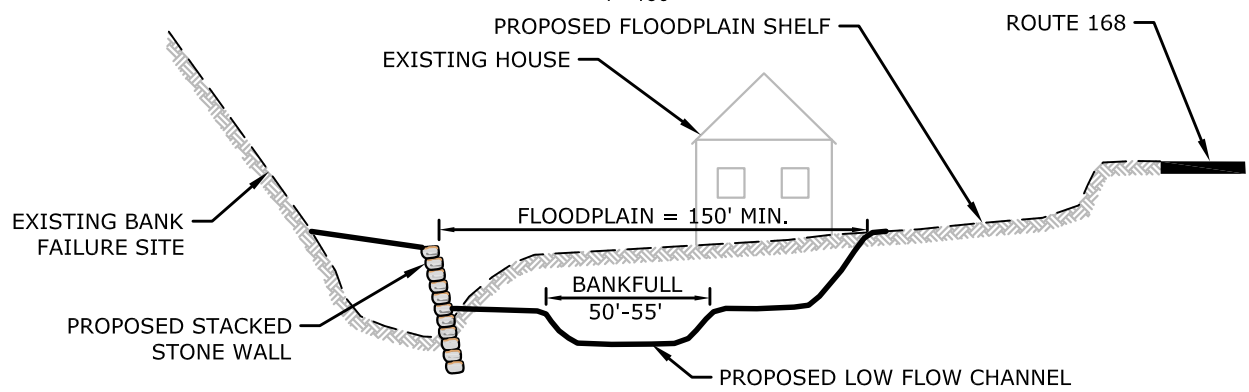
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Drawing: W:\DESIGN\5231-01-DE\CAD\CONCEPT\FULMER CONCEPT DESIGN.DWG Layout Tab:FIG 7



FULMER CREEK PLAN VIEW

1"=150'



TYPICAL CROSS SECTION

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**FULMER CREEK HIGH RISK AREA #1
 ALTERNATIVE 1-1**
**WATER BASIN ASSESSMENT
 AND FLOOD HAZARD MITIGATION ALTERNATIVES**
**FULMER CREEK
 MOHAWK, NEW YORK**

DATE	2/25/2014		
SCALE	AS NOTED		
PROJ. NO.	5231-01		
DESIGNED	DRAWN	CHECKED	
JCM	DRM	DRM	

DRAWING NAME:
FIG. 7

Plotted by: DANNE On this date: Wed, 2014 February 26 - 2:57pm

The new alignment will reduce the length of the meander bend; the length of the channel will be shortened by 205 feet and the bed slope increased from 1.8% to 2.2%. The increase in slope will encourage higher velocities to form during flood flows, which could be mitigated through an increase in roughness on the channel bed through stone armoring of sufficient size.

Modeling results indicate that peak channel velocities in Fulmer Creek can be limited to 4.7 to 10.2 feet per second in the area of the reconstructed channel during the 100-year flow, which is within the ability of standard rock armoring to protect against. Modeling also indicates that peak water surface elevations will not negatively impact any adjacent homes, roads, or bridges.

Alternative 1-2: Realign Fulmer Creek and Route 168

This alternative involves the realignment of Fulmer Creek away from the bank failure to eliminate erosion at the toe of the bank as well as a realignment of Route 168 to allow for better channel alignment with the two bridges. The created channel would be sized to convey Fulmer Creek's bankfull discharge, as in the previous alternative. The design under this alternative would include a revetment wall to prevent creek migration towards the base of the bank failure, as described for alternative 1-1.

Upon inspection of bridge crossings at Route 168, both bridges appear to be in good condition and both span the bankfull width of the channel. Neither bridge is acting as a substantial hydraulic constriction based on the FEMA profiles. For these reasons, replacement of the bridges is not believed to be warranted.

Alternative 1-3: Relocate Fulmer Creek Channel Across Route 168

This option would involve moving the Fulmer Creek channel to the northeast side of Route 168, eliminating the need for the two Route 168 bridge crossings. The removal of several houses and driveways would be required as well. This alternative does not provide additional benefits as compared to Alternative 1-1, would result in greater property impacts, and would significantly steepen the channel. For these reasons, Alternative 1-1 is favored as a better solution.

Recommendation

Alternative 1-1 is recommended as a comprehensive, long-term solution to reduce a major source of sediment in this reach and reduce the erosive water forces on the high bank failure.

3.5 High-Risk Area #2 – Flooding Problems Along Route 168 (STA 58+00 to STA 91+00)

Figure 8 is a location plan of High Risk Area #2. This reach includes the Leatherstocking Trailer Park on Fulmer Lane Drive at STA 91+00, downstream to where Fulmer Creek

crosses under Route 28 at STA 58+00. The trailers on Fulmer Lane Drive (STA 91+00) were substantially damaged during the June, 2013 flood. Some were completely destroyed. Flooding also occurred in this area in February 2014 as a result of an ice jam on Fulmer Creek. Trailers at the Creekside Trailer Park (STA 69+00) were also substantially damaged, as were automobiles and infrastructure, including roadways, retaining walls, and utility service. The three primary flooding risks in this reach are as follows:

High Bank Failure Near STA 70+00

A high bank failure (STA 70+00) is eroding the left bank, which contributes sediment to Fulmer Creek. This bank failure is approximately 140 feet high, and extends 300 feet long. It is similar in character to the bank failure at High Risk Area #1, but less severe. If this failure continues to erode, it will threaten the run-away truck ramp located along Route 28 and eventually Route 28 itself. Stabilization of this area would eliminate a substantial sediment source in Fulmer Creek, much of which appears to deposit in High Risk Area #3 just upstream of West Main Street.

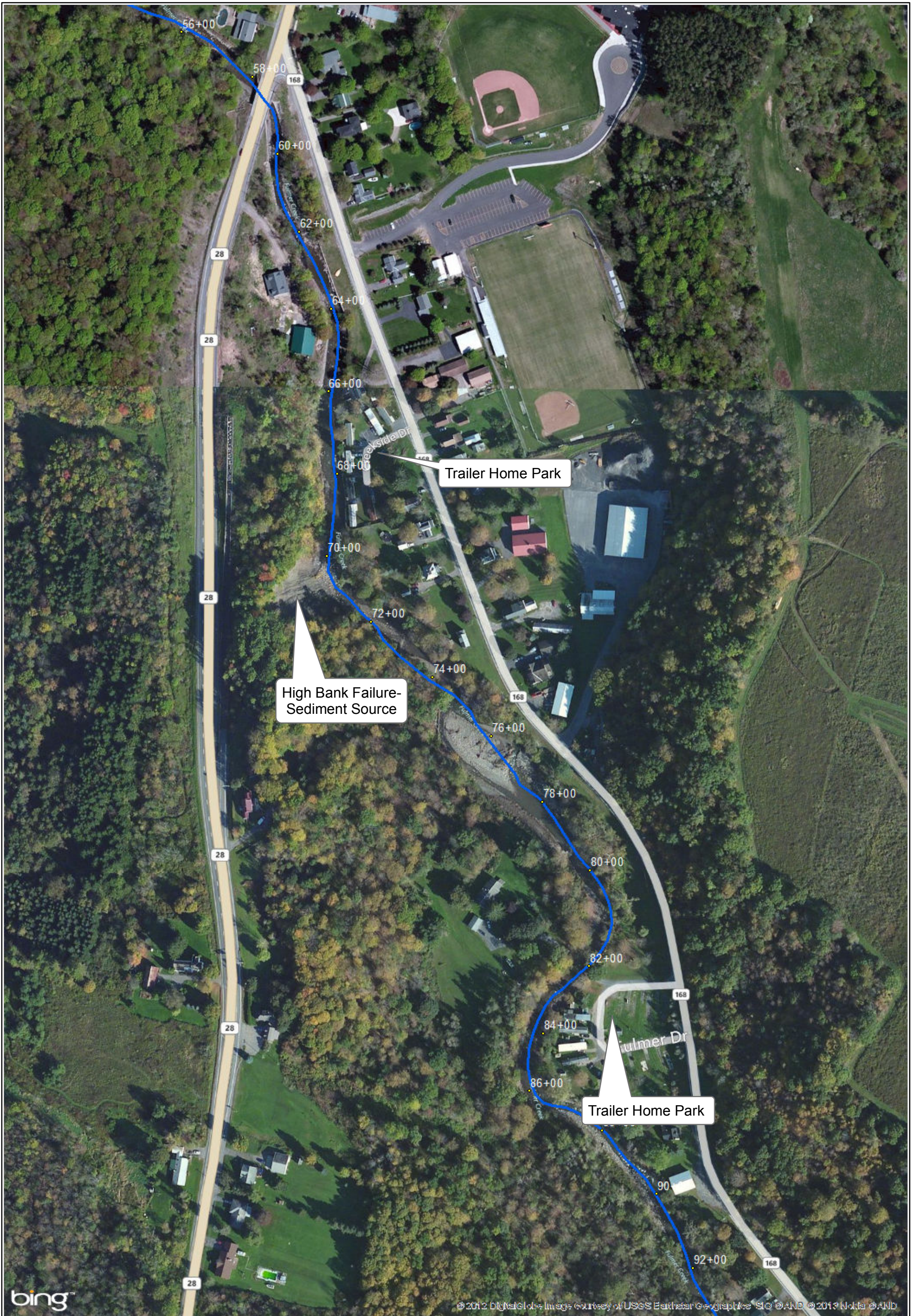
The favored approach to stabilizing this bank failure would be to design a bank treatment similar to that proposed in Alternative 1-1. Relocating the channel to lessen the severity of the meander bend and stabilizing the toe of the bank failure will arrest the active erosion, and allow the bank to begin vegetating and self-healing.

Floodplain Development Between STA 65+00 and STA 86+00

Continuing downstream, the Creekside Trailer Park is located between STA 69+00 and 65+00 on the right bank. These trailers appear to have been located in an area of fill within the floodplain, and have also been damaged during numerous flood events, including in the June 2013 flood. Portions of some structures appear to be located within the regulatory floodway that is identified by FEMA as the area of highest depth and velocity during flood events. A second set of trailers located between STA 86+00 and 82+00 (Leatherstocking Trailer Park) also appear to have been placed in a filled area of the floodplain, and were damaged during the June 2013 floods.

To avoid repetitive loss to these mobile homes, and to maintain the safety of their occupants, relocation is recommended. Floodplain development can endanger the lives and homes of those who live there. Additionally, the presence of these structures in the floodplain encroaches on the natural flood storage and worsens flooding conditions for those upstream and downstream. There is also a concern about the buoyancy of these structures during floods and the associated threat to life and property downstream.

Development in the floodplain can be better managed through improved policy and land use laws enacted locally. Many communities prohibit development in the floodplain as a matter of acceptable land use.



SOURCE(S):

Figure 8: Fulmer Creek High Risk Area #2

Location:
Herkimer County, New York

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 NYDOT: Emergency Transportation
 Infrastructure Recovery

Map By: CMP
 MMI#: 5231-01
 MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Fulmer Creek High Risk #2.mxd
 1st Version: 01/06/2014
 Revision: 3/3/2014
 Scale: 1 in = 208 ft

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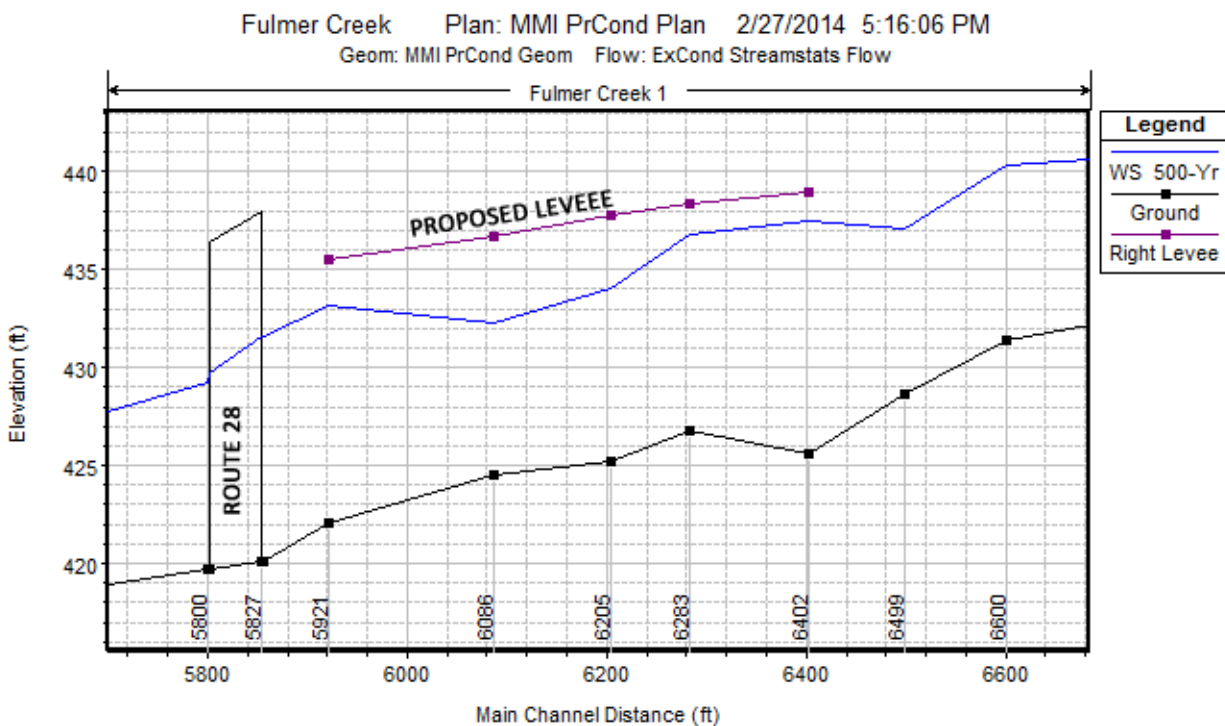
Route 28 Bridge Near STA 58+00

According to reports of the flooding experienced during the June 2013 flood event, water overtopped the Fulmer Creek banks between STA 59+00 and STA 60+00, ran across Route 168, and down Route 28 (Columbia Street), causing extensive flooding. At the time of field inspections in late 2013, a bank stabilization and levee project including the construction of a stacked rock wall and a flood control berm were under construction along the right bank from STA 64+00 downstream to STA 58+50, a length of 650 feet.

The design plans for the aforementioned project (referenced as *Fulmer Creek Bank Stabilization, Town of German Flatts/Village of Mohawk, Herkimer County, New York, April 2013*, prepared by: Barton & Loguidice, P.C.) were reviewed. The grading associated with the flood control berm was input into the MMI hydraulic model of Fulmer Creek to assess its effectiveness at protecting the roadway from overtopping during flood events.

Based upon modeling results using *StreamStats* flow data, the current design of the berm appears to be sufficient to prevent water from overtopping the banks of Fulmer Creek upstream of the Route 28 bridge for flows up to and including the 500-year flood event. Figure 9 presents a profile of Fulmer Creek upstream of the Route 28 bridge for the 500-year flow, under fully constructed conditions.

**FIGURE 9
Fulmer Creek HEC-RAS Modeling Results**



Despite modeling results, local reports indicate that water has overtopped the banks of Fulmer Creek upstream of STA 66+00, damaging residences, businesses, and infrastructure within the Town of German Flatts and more extensively in the Village of Mohawk. Such damages have occurred outside of the delineated FEMA floodplain. This may be an indication that the FEMA flows are, in fact, underestimated. Possible additional flood mitigation measures include removal or relocation of retaining walls or other barriers that prevent the stream from accessing its floodplain, re-establishment or creation of natural buffer areas and flood benches, establishment of natural vegetation, and/or continuation of the flood control berm upstream of STA 66+00 adjacent to Route 168 but outside of the regulated floodplain.

3.6 High-Risk Area #3 – Devendorf Street to Downstream of West Main Street (STA22+00 to STA 52+00)

Figure 10 is a location plan of High Risk Area #3. This area includes Devendorf Street at STA 52+00 to downstream of West Main Street at STA 22+00. Extensive sediment accumulation within the channel was observed in this area, especially where the channel widens between STA 28+00 and STA 22+00. Sediments are reportedly removed annually from this area and taken off-site. Houses have been flooded along Firman Street and Mohawk Central Valley School has received extensive flood damage. Ice accumulations also contribute to flooding in this area, including ice that jams at the Main Street bridge and downstream.

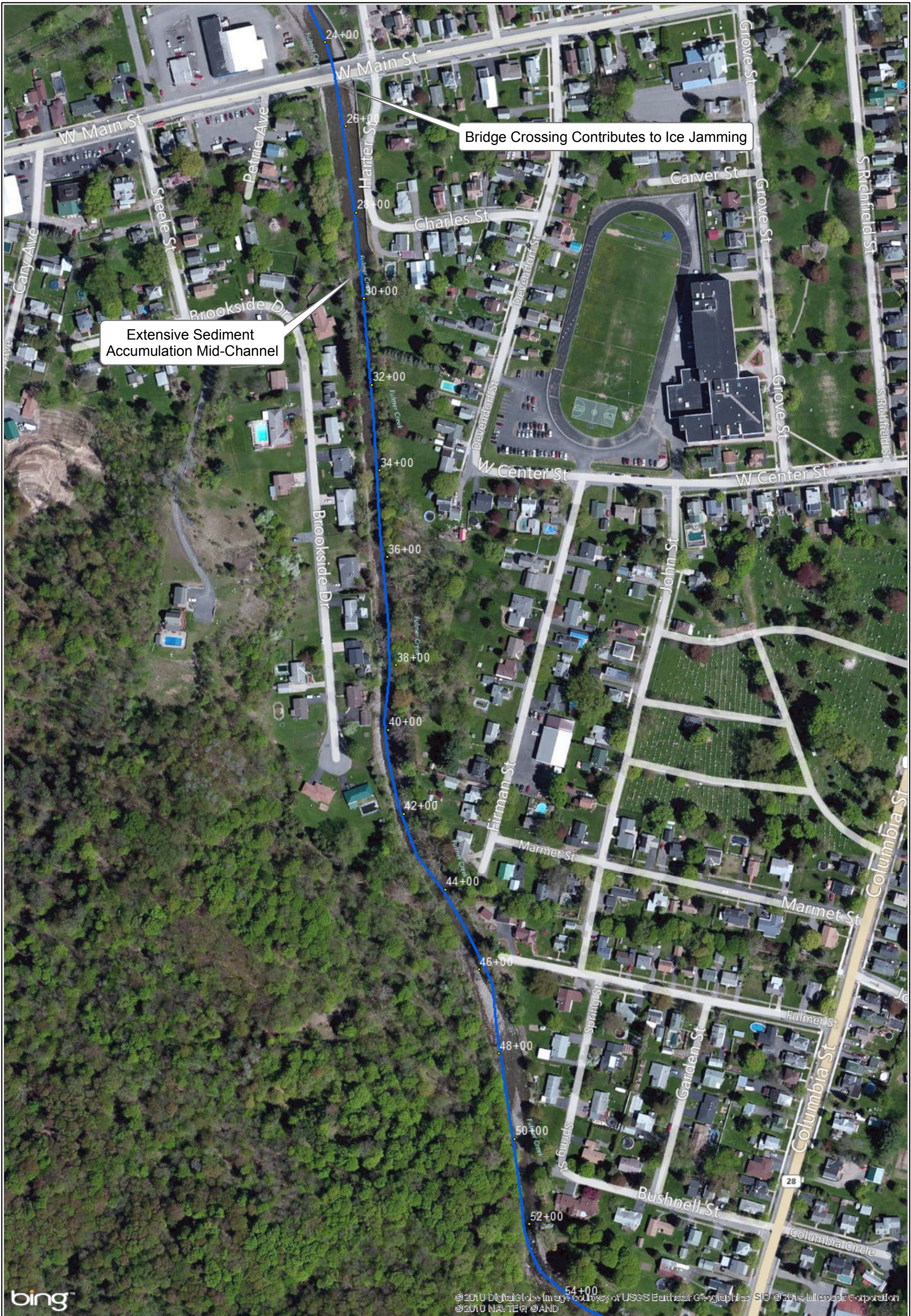
Channel measurements indicate that the Fulmer Creek channel through the upper portion of this high risk area between STA 52+00 and 28+00 is undersized. In contrast, the channel in the vicinity of West Main Street from STA 28+00 downstream to STA 22+00 is overly wide or poorly shaped and prone to sediment deposition, which necessitates dredging, promotes ice jams, and exacerbates flooding.

Post-flood dredging was performed in an effort to restore some of the channel's capacity. However, much of the material that was dredged from the channel was sidecast to the banks. This practice does not increase the cross sectional area of the channel, because material is simply being moved from one floodprone spot to another. It does, however, remove any natural armoring that has developed, changes the hydraulics of the watercourse, and leaves the channel and banks susceptible to future sediment erosion/deposition.

Alternative 3-1: Create a Naturalistic Channel and Floodplain Bench

This alternative involves widening the Fulmer Creek channel to better accommodate bankfull flows, and removing fill from the floodplain to create a floodplain bench. This alternative is presented in Figure 11, and involves the following actions:

- a) Acquiring and removing four houses constructed on the banks of the creek.



bing™

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SOURCE(S):

Figure 10: Fulmer Creek High Risk Area #3

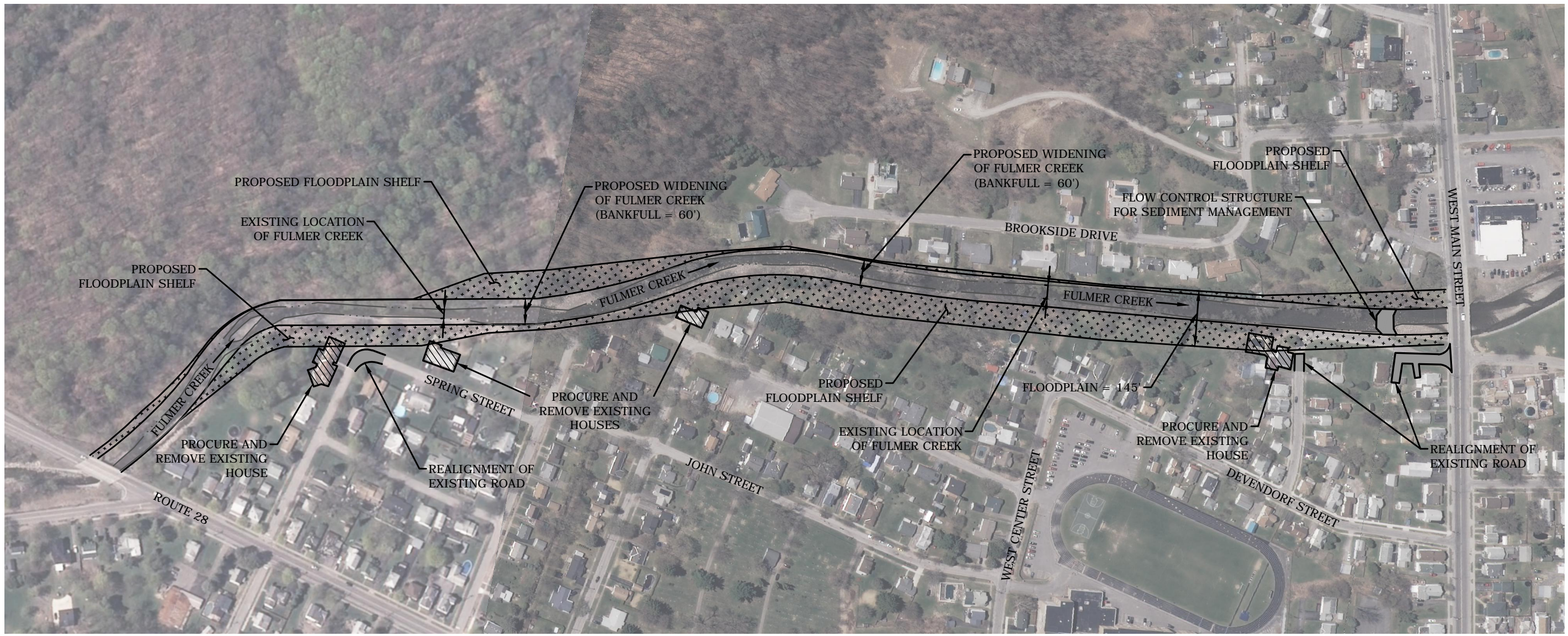
Location:
Herkimer County, New York

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 NYDOT: Emergency Transportation
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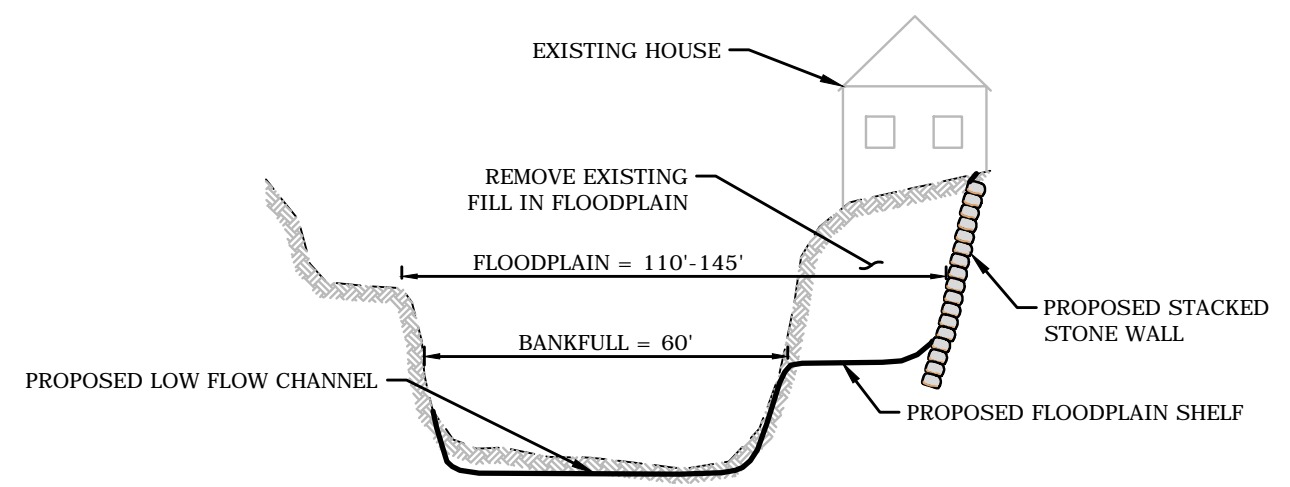
Map By: CMP
 MMI#: 5231-01
 MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Fulmer Creek High Risk #3.mxd
 1st Version: 01/06/2014
 Revision: 4/10/2014
 Scale: 1 in = 200 ft

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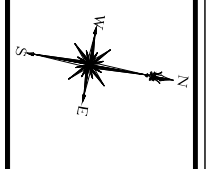
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 Plotted by: COREYR On this date: Mon, 2014 March 3 - 2:19pm
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FULMER CREEK PLAN VIEW
1"=250'



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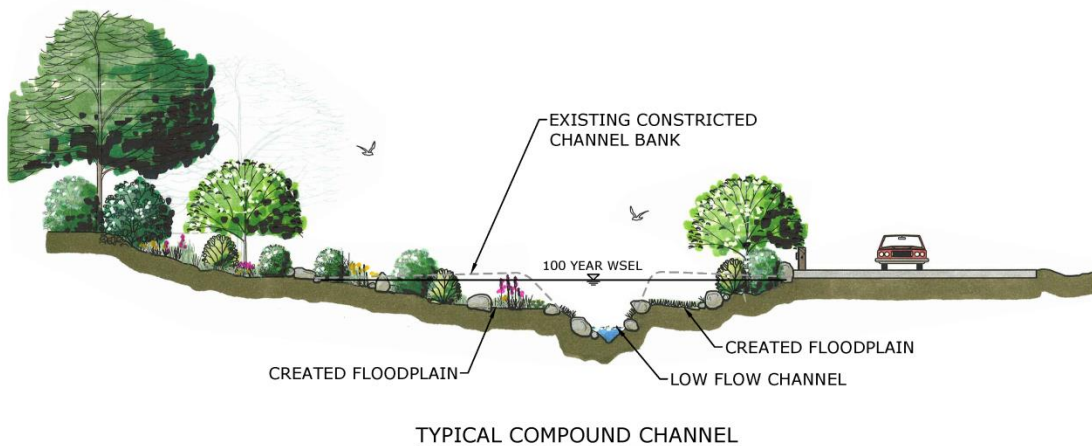
FULMER CREEK HIGH RISK AREA #3 ALTERNATIVE 3-1
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
 FULMER CREEK
 MOHAWK, NEW YORK

JCM DESIGNED	DRM DRAWN	DRM CHECKED
SCALE AS NOTED		
DATE 2/26/2014		
PROJECT NO. 5231-01		

FIG.11

- b) Restoration of 3,300 linear feet of the creek channel (from Route 28 to West Main Street) to create a floodplain bench and create a more natural channel configuration. The estimated bankfull dimensions would be 60 feet wide by three feet deep; a floodplain bench would range in width between 110 feet and 145 feet wide. Figure 12 is a cross section of a typical compound channel.

FIGURE 12
Typical Cross Section of a Compound Channel



- c) Construction of flow control structures (such as j-hooks or cross vanes) upstream of the West Main Street bridge to promote sediment mobility through flatter reach of channel;
- d) Development of parameters for maintenance dredging of accumulated sediment.

This alternative involves widening the Fulmer Creek channel to better accommodate flood flows without overtopping the banks. In doing so, residential development that was originally constructed upon filled floodplain would be removed to allow for sufficient capacity in the channel to mitigate future flooding. The bankfull width of the existing channel ranges from 30 feet (undersized) to 80 feet (oversized). Undersized channel reaches are causing flood flows to overtop the creek banks and flood the surrounding area, and the oversized channel reaches are encouraging continued sediment deposition, which reduces the capacity of the channel to convey floodwaters through the site.

Beginning at Route 28, the bankfull channel should be resized to approximately 60 feet wide by three feet deep based upon the predicted bankfull flows in the area. A floodplain bench of up to 145 feet wide will mitigate flooding in the area. Such a floodplain can be constructed with minimal impact to surrounding development, restricted to those structures that severely encroach on the creek. This work involves the restoration of

3,300 linear feet of channel, ending at West Main Street. This would protect the surrounding areas against the 100-year flood.

The slope of the channel downstream of Route 28 is 1.1%, and then flattens to 0.7% just upstream of the West Main Street bridge. This reduction in slope encourages heavy sediment deposition upstream of the bridge, which fills the channel and reduces its water conveyance capacity. The channel upstream of the bridge should be properly sized to bankfull dimensions in combination with construction of a structure or combination of in-stream features to increase velocities and concentrate flow such that sediment is not allowed to settle at this location.

Alternative 3-2: Channel Dredging

Dredging (specifically lowering) Fulmer Creek would further divorce the stream from its natural floodplain, disrupt sediment transport, potentially cause upstream bank/channel scour conditions, and encourage additional downstream sediment deposition. Such a condition is likely to exacerbate flooding on a long-term basis.

Because no approach can fully mitigate sediment accumulation due to the natural gradient of the creek, a maintenance sediment management program should be implemented. This should involve 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.

The need for targeted sediment removal on Fulmer Creek can be reduced by reducing the sediment load at its sources (i.e., by repairing bank failures and headcuts and reducing erosion) and by improving sediment transport. Fulmer Creek is a steep, high-energy watercourse, and sediments will continue to be transported downstream regardless of what actions are taken to control sediments in the upper reaches. These sediments are prone to depositing in the lower reaches, thus reducing channel capacity and contributing to flooding in the village of Mohawk.

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 should involve 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 excavation of sediment from 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. Sediment 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 Fulmer 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. The estimated annual sediment yield of Fulmer Creek is 1,310 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.

4.0 RECOMMENDATIONS

1. Stabilize Bank Failure and Creek at Double Route 168 Crossing – Stabilize the massive bank failure to the west of Route 168 between STA 167+00 to 172+00. This involves the relocation and armoring of 850 linear feet of Fulmer Creek up to

175 feet to the east, procurement and removal of an existing home, and construction of a wall along the toe of the existing bank failure.

2. Remove Trailers from Floodplain along Route 168 – Mobile homes in the floodplain remain at risk for flooding and creation of hazardous conditions. To avoid repetitive losses and maintain the safety of occupants, relocation of trailer parks is recommended.
3. Repair Bank Failure Below Run-Away Truck Ramp – Stabilize the left bank failure to the south of Route 28 between STA 69+00 to 72+00. This will involve the armoring of 250 linear feet of Fulmer Creek, the construction of a wall along the toe of the existing bank failure and the revegetation of the failing slope.
4. Restore and Resize Channel Between Devendorf and Main (STA22+00 to STA 52+00) – To reduce flooding of the Mohawk Central Valley School and surrounding area, restoration of this reach of Fulmer Creek to its pre-development dimensions is recommended for the purpose of increasing flood flow conveyance and reducing bank overtopping. This will involve acquiring and removing four houses constructed on the banks of the creek; restoration of 3,300 linear feet of the creek channel (from Route 28 to West Main Street), construction of a floodplain bench; and construction of flow control structures upstream of the West Main Street bridge to promote sediment mobility through flatter reach of channel. This improvement would protect the surrounding areas against the 100-year flood.
5. Adopt Sediment Management Standards – Fulmer Creek is a high energy watercourse for much of its length, with areas where eroding banks and high bank failures are contributing to the sediment load. Large volumes of coarse grained sediments will continue to be transported downstream during high flow events, regardless of what actions are taken to control sediments in the upper reaches. These sediments will be deposited in the lower reaches, reducing channel capacity and contributing to flooding in the village. 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.
6. Monitor Minor Bank Failures and Erosion – Several areas of eroding banks, minor bank failures and slumping hill slopes were observed along Fulmer Creek. These are of low to moderate severity, appear to be relatively stable, and at the time of the field visits were not contributing a large amount of sediment to the channel. It is recommended that these sites be monitored periodically, and stabilized as necessary.

7. Evaluate Floodplain Regulations – A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements. Local floodplain regulations should be consistent with the National Flood Insurance Program (NFIP) and FEMA regulations. 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.
8. Install and Monitor a Stream Gauge – There is currently no stream gauge on Fulmer Creek, making statistical analysis difficult. Installation of a permanent stream gauge is recommended.
9. 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

Fulmer Creek Recommendations	Approximate Cost Range				
	< \$100k	\$100k-\$500k	\$500k-\$1M	\$1M-\$5M	>\$5M
Stabilize Bank Failure and Creek at Double Route 168 Crossing			X		
Remove Trailers from Floodplain along Route 168		X			
Repair Bank Failure at Run-Away Truck Ramp		X			
Restore and Resize Channel Between Devendorf and Main Street					X
Install and Monitor a Stream Gauge	X				

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

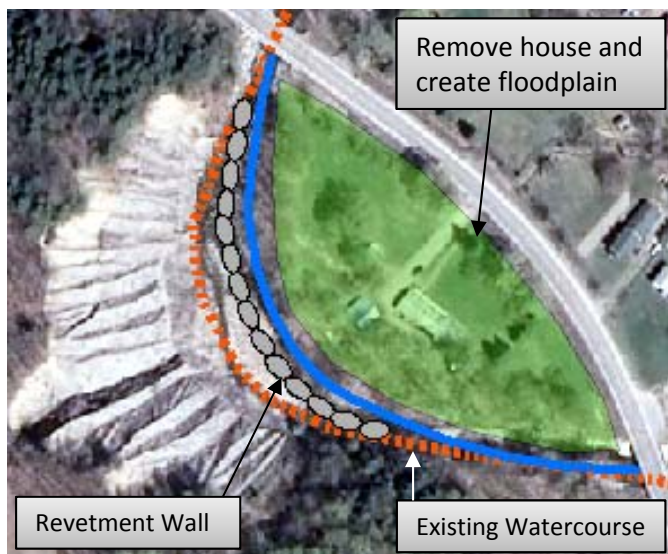
High-Risk Area #1 - Route 168 Double Bridge Site (STA 171+00 to 167+00)

Site Description: The site consists of a high bank failure that is contributing sediments to the creek and threatening a home and property located at the top. The bank failure is 400 feet long and 200 feet high at its highest point, has a slope in the range of 75% to 85%, and is composed of clay intermixed with cobble.



Recommended Alternative:

- Acquiring and removing the existing house at the base of the bank failure;
- Moving the creek channel eastward, away from the bank failure;
- Constructing a revetment wall 600 feet in length along the channel at the outside of the bend along the toe of the slope;
- Diverting runoff at the top of the slope to prevent further erosion of the slope;
- Creating a floodplain bench on the inside of the bend; and
- Seeding the slope to promote the growth of vegetation to further stabilize the slope.



BENEFITS	
✓	Improve safety
✓	Stabilize slope
✓	Reduce sediment load at source

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

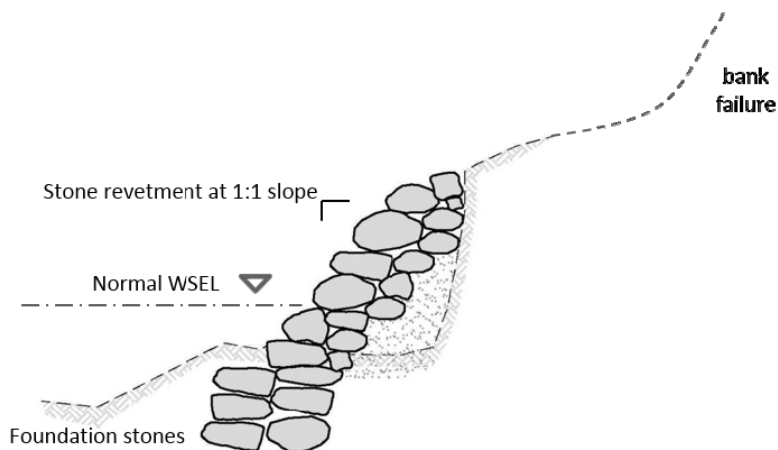
High-Risk Area #2 - High Bank Failure at STA 70+00

Site Description: The site consists of a high bank failure that is actively contributing sediments to the creek. If this bank failure continues to erode, it will threaten a run-away truck ramp located along Route 28, and eventually Route 28 itself. The bank failure is approximately 160 feet long and 90 feet high.



Recommended Alternative:

- Acquire properties and remove structures across from bank failure, as necessary for stream alignment;
- Move the creek laterally away from the bank failure;
- Construct 400 ft long revetment wall along toe of slope on left bank, from STA 72+00 to STA 68+00;
- Create floodplain along right bank;
- Once stabilized at its base, seed slope to promote the growth of vegetation.



BENEFITS

- ✓ Improve safety
- ✓ Stabilize slope
- ✓ Reduce sediment load at source

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

High-Risk Area #3 – Devendorf Street to W. Main Street

Site Description: Severe flooding has occurred in the vicinity of Devendorf Street downstream to the West Main Street Bridge, between STA 52+00 down to STA 25+00.

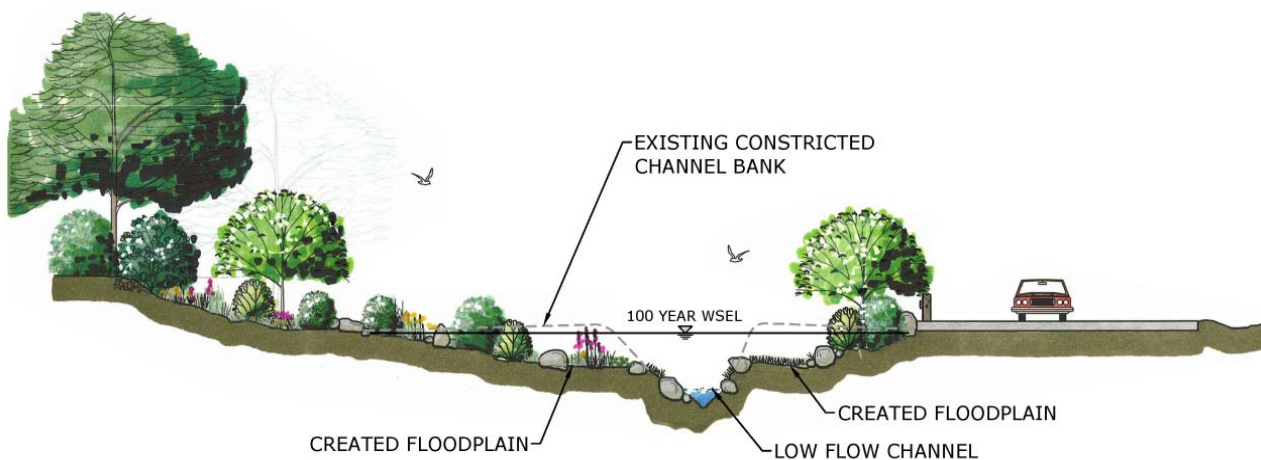


Recommended Alternative:

Restoration of this reach of Fulmer Creek to its pre-development dimensions is recommended for the purpose of increasing flood flow conveyance and reducing bank overtopping.

This will involve:

- acquiring and removing four houses constructed on the banks of the creek;
- restoration of 3,300 linear feet of the creek channel (from Route 28 to West Main Street);
- construction of a floodplain bench;
- construction of flow control structures upstream of the West Main Street Bridge to promote sediment mobility through flatter reach of channel;
- development of parameters for maintenance dredging of accumulated sediment.



TYPICAL COMPOUND CHANNEL

BENEFITS

- ✓ Reduction in ice and debris jams
- ✓ Improved hydraulic capacity
- ✓ Reduced flood hazard

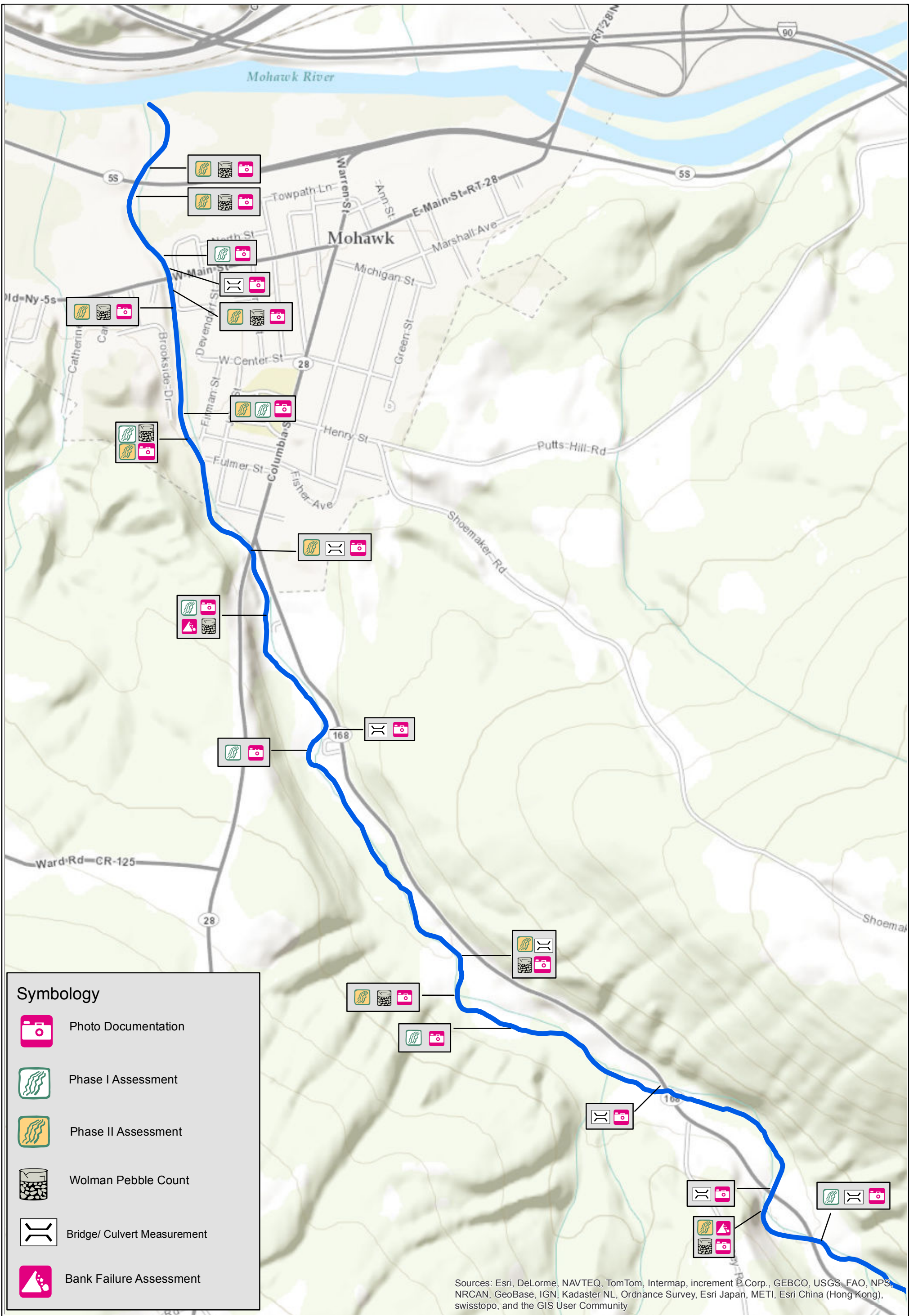
APPENDIX A

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, Albany 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 Environmental 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



Symbology

-  Photo Documentation
-  Phase I Assessment
-  Phase II Assessment
-  Wolman Pebble Count
-  Bridge/ Culvert Measurement
-  Bank Failure Assessment

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

SOURCE(S):

Appendix B-1: Fulmer Creek Data Collection Points

Location:
Herkimer County, New York







NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
 MMI#: 5231-01
 MXD: Y:\5231-01\GIS\Maps\Phase II Icon Maps\Fulmer 3-1.mxd
 1st Version: 12/10/2013
 Revision: 12/13/2013
 Scale: 1 in = 1,333 ft

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 99 Realty Drive Cheshire, CT 06410
 (203) 271-1773 Fax: (203) 272-9733
 www.miloneandmacbroom.com



Symbology

-  Photo Documentation
-  Phase I Assessment
-  Phase II Assessment
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SOURCE(S):

Appendix B-2: Fulmer Creek Data Collection Points
NYDOT: Emergency Transportation Infrastructure Recovery
Herkimer County, NY

Map By: CMP
 MM# 5231-01
 MXD: Y:\5231-01\GIS\Map\Phase II Icon Maps\Fulmer 3-2.mxd
 1st Version: 12/11/2013
 Revision: 12/13/2013
 Scale: 1 in = 1,333 ft

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P. Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Figure 3-2

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

	<u>Left Side</u>	<u>Right Side</u>
Natural floodplain	_____ %	_____ %
Developed floodplain	_____ %	_____ %
Terrace	_____ %	_____ %

Floodplain Land Use _____

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

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

Cascades _____	Alluvial _____	<u>Channel Transport</u>
Steep Step/Pool _____	Semi Alluvial _____	Sed. Source Area
Fast Rapids _____	Non Alluvial _____	Eroding
Tranquil Run _____	Channelized _____	Neutral
Pool & Riffle _____	Incised _____	Depositional
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:

Bedrock _____	Sand _____	Riprap _____
Boulders _____	Silt and Clay _____	Concrete _____
D50 _____	Cobble and Boulder _____	
	Gravel and Cobble _____	
	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)		Tally	Count	Percent	Cumulative
	lower	upper			Passing	% 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	-

(Wentworth, 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 (%)

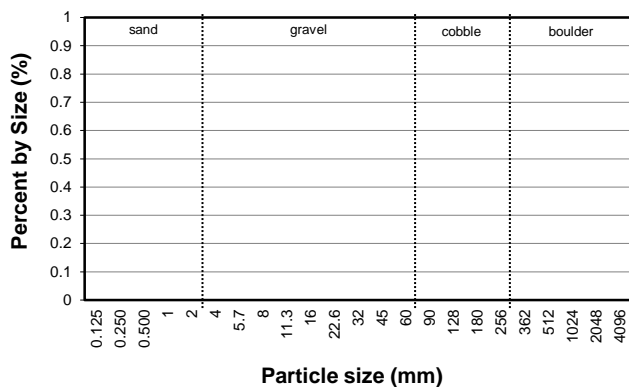
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(Kappesser, 2002)

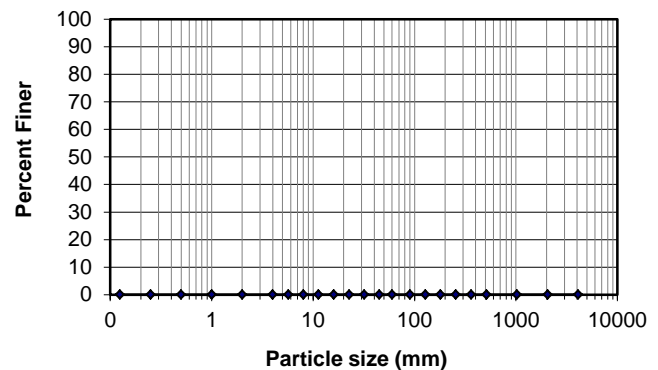
Notes

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Particle Size Histogram



Gradation Curve



APPENDIX C
Fulmer Creek Photo Log

PROJECT PHOTOS

PHOTO NO.:

1

DESCRIPTION:

This is the high bank failure known as the Route 168 Double Bridge Site, viewed looking upstream from the bridge on Route 168 (at STA 166+00).



PHOTO NO.:

2

DESCRIPTION:

A private property at the top of the Route 168 Double Bridge Site bank failure.



PHOTO NO.:

3

DESCRIPTION:

Bank failure located behind Fulmer Lane Drive (STA 71+00) acting as a sediment source during high flows, and the trailer park to the left that became flooded out during the June 2013 flood event.



PHOTO NO.:

4

DESCRIPTION:

Looking downstream Fulmer Creek towards the Route 28 bridge (STA 58+00), at this location the channel has overtopped and flowed towards the village, creating flood damage. An stacked rock wall and earthen berm is under construction in the photo along the right bank.



PHOTO NO.:

5

DESCRIPTION:

Recently redged channel just upstream of Devondorf Street, near STA 36+00, an example of the undersized channel along this section of Fulmer Creek.



PHOTO NO.:

6

DESCRIPTION:

View from the end of Charles Street (STA 28+00), looking downstream towards the W Main Street bridge (STA 25+00). This section of channel is overly wide and ice and debris jams occur in this area.

