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

WEST CANADA CREEK
HERKIMER 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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ABBREVIATIONS/ACRONYMS

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
FT	Feet
FTP	File Transfer Protocol
GIS	Geographic Information System
MMI	Milone & MacBroom, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
Sq. Mi.	Square Mile
STA	River Station
U/S	Upstream
USGS	United States Geological Survey
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 a comprehensive water basin assessment of 13 watersheds in Herkimer, Oneida, and Montgomery Counties, including West Canada Creek. Prudent Engineering was also contracted through CME to provide support services.

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; and identification of long-term recommendations for mitigation of future flood hazards.

West Canada Creek drains portions of Hamilton, Herkimer, and Oneida Counties, in east central New York State. Figure 1 is a basin location map. Its headwaters are in the Adirondack Mountains. The creek drains an area of 559 square miles and flows into the Mohawk River just east of the village of Herkimer. The drainage basin is approximately 77 percent forested, with sparse rural residential uses in the upper basin, agricultural uses in the lower basin, and residential and commercial land uses in towns and villages along the creek. West Canada Creek has an average slope of 0.47 percent over its entire stream length of 85.1 miles.

Field investigations focused on the section of West Canada Creek from upstream of the village of Middleville (STA 560+00) downstream to the creek's outlet to the Mohawk River (STA 0+00) near the village of Herkimer. The most severe flood-related damages on West Canada Creek have occurred in the village of Middleville, located on the boundary of the towns of Newport and Fairfield, where the creek has overtopped its banks on several occasions, flooding residential, commercial, and industrial areas within the village. The village of Middleville is situated on both sides of West Canada Creek, with Route 28 (Bridge Street) spanning the creek. Maltanner Creek enters West Canada Creek from the east in Middleville.

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.

SOURCE(S):

Figure 1: West Canada Creek Drainage Basin Location

LOCATION:

Herkimer County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

MXD: Y:\5231-01\GIS\Maps\Figure 1 Maps\Figure 1 West Canada Creek.mxd

Map By: CMP
MMI#: 5231-01
Original: 01/09/2014
Revision: 1/9/2014
Scale: 1 inch = 30,000 feet

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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 West Canada Creek at STA 0+00 and continues upstream to STA 560+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 West Canada 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

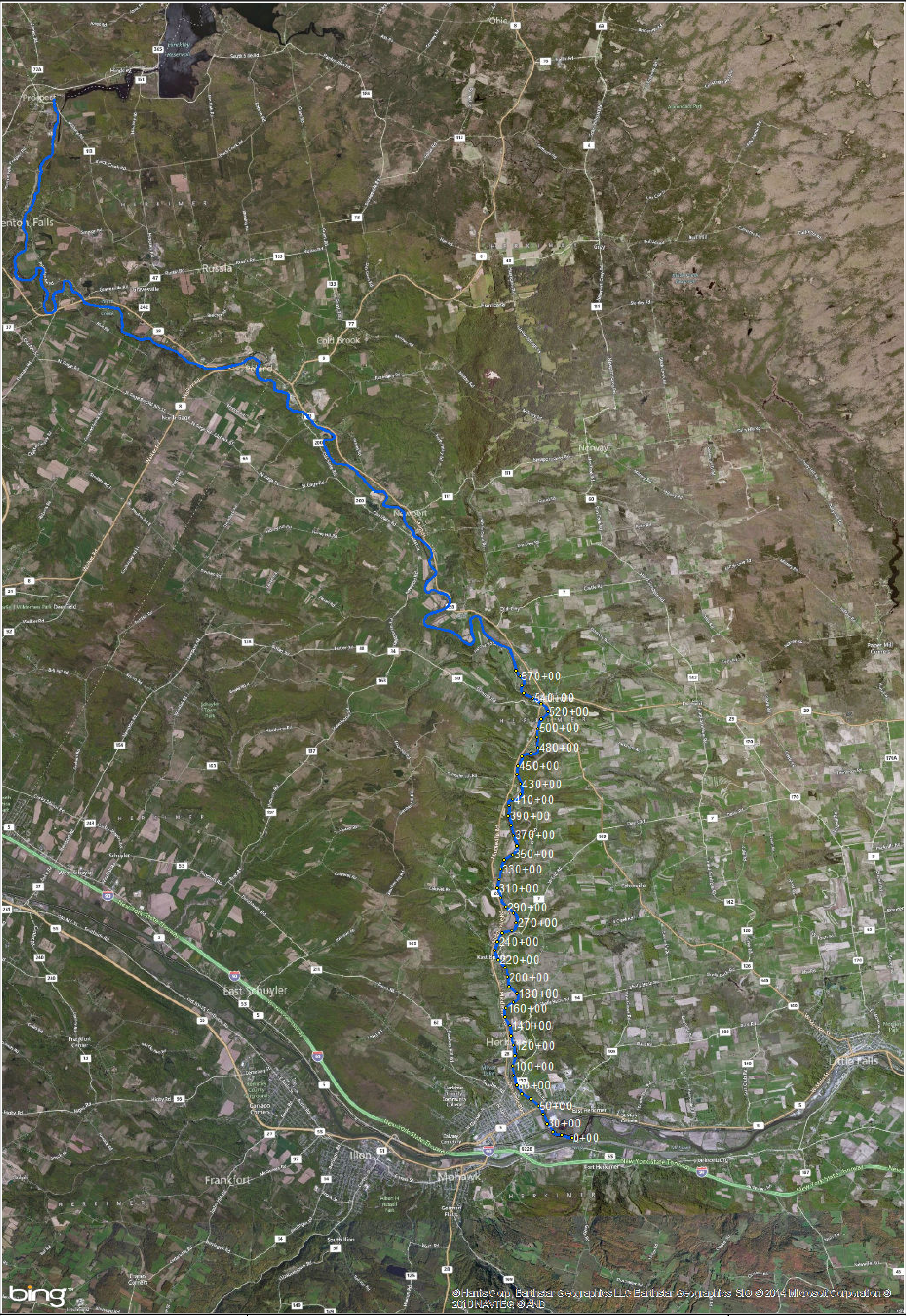
Public information pertaining to West Canada Creek was collected from previously published documents as well as through meetings with municipal, county, and state officials. Data collected includes reports, flood photographs, newspaper articles, Federal Emergency Management Agency (FEMA) Flood Insurance 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 held in October 2013 at the Middleville Judges Chambers to discuss West Canada Creek. 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:



SOURCE(S):	Figure 2: West Canada Creek Watercourse Stationing	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\Figure 2 Maps\Figure 2 West Canada Creek.mxd
1st Version: 01/09/2014
Revision: 3/17/2014
Scale: 1 in = 8,500 ft

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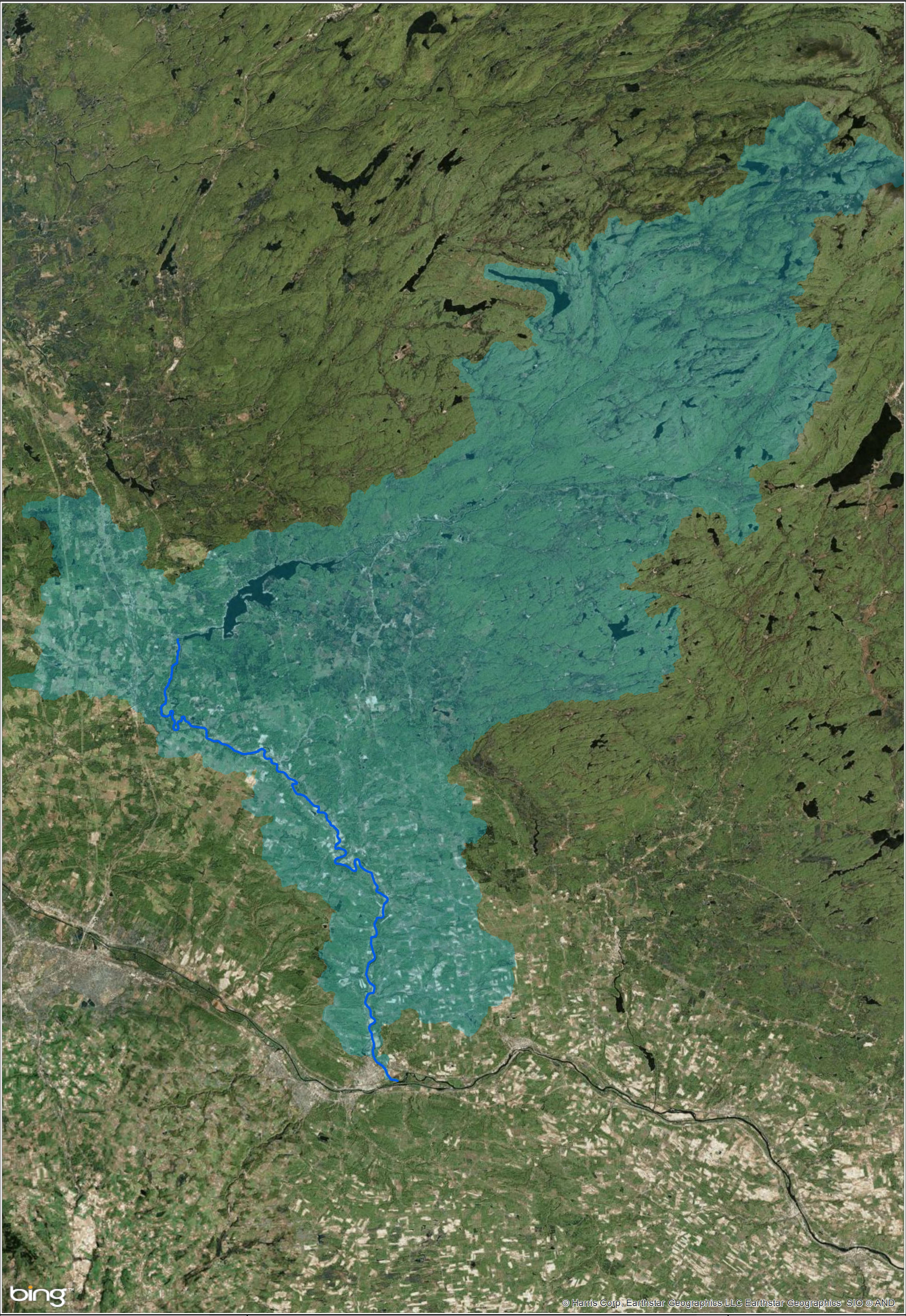
- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas
- Measurement and rapid hydraulic assessment of bridges, culverts, and dams
- Geomorphic classification and assessment, including measurement of bankfull channel widths and depths at key cross sections
- Field identification 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 West Canada Creek. The creek drains portions of Hamilton, Herkimer, and Oneida Counties, in east central New York State. Its headwaters are in the Adirondack Mountains. The creek drains an area of 559 square miles and flows into the Mohawk River just east of the village of Herkimer. The overall drainage basin is approximately 77 percent forested. The upper portions of the basin are primarily forested, with sparse rural residential uses. The lower portions of the basin have a higher mix of agricultural uses. Residential and commercial land uses occur in towns and villages along the creek.

The village of Middleville is situated on both sides of West Canada Creek, on the boundary of the towns of Newport and Fairfield. Route 28 (Bridge Street) spans the creek and connects the two sides of the village. As West Canada Creek approaches Middleville, it is paralleled on its right bank by Fishing Rock Road. The left creek bank contains floodplain forest and is largely undeveloped upstream of the Route 28 bridge. Maltanner Creek enters West Canada Creek from the east, just upstream of the Route 28 bridge, and carries a considerable sediment load into West Canada Creek. Several commercial buildings line Route 28 on both sides of the bridge. Downstream of the Route 28 bridge, West Canada Creek makes a bend to the right and is lined on the right bank by a residential neighborhood on Kanata Street and on the left by homes lining Route 169 (South Main Street).



SOURCE(S):

Figure 3: West Canada Creek Drainage Basin Aerial

Location: **Herkimer County, New York**

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NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
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MXD: Y:\5231-01\GIS\Maps\Figure 3 Maps\Figure 3 West Canada Creek.mxd
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2.5 Geomorphology

The stream corridor along West Canada Creek is primarily forested, especially in the upper basin above Hinckley Reservoir, and appears to be quite natural and unaltered by human use. At several points along its length, the geomorphic characteristics of West Canada Creek are influenced by the operation of hydroelectric dams and reservoirs, rather than by natural river processes. Sediment transport and deposition through these reaches are influenced by dam operation. The largest reservoir on the creek is Hinckley Reservoir, and there are smaller impoundments along the main stem and on several tributaries. According to FEMA, three large dams in the town of Newport serve the purposes of hydroelectric generation and water supply impoundment. Hinckley Reservoir is capable of providing significant flood control capability if the reservoir is at its lowest regulated level.

Downstream of Hinckley Reservoir, uses along the creek banks become increasingly agricultural. West Canada Creek flows through several communities, including Hinckley, Prospect, Poland, Newport, and Middleville, where the creek banks have been hardened by stacked rock walls or riprap. Near its outlet at the Mohawk River, West Canada Creek passes between Herkimer and East Herkimer.

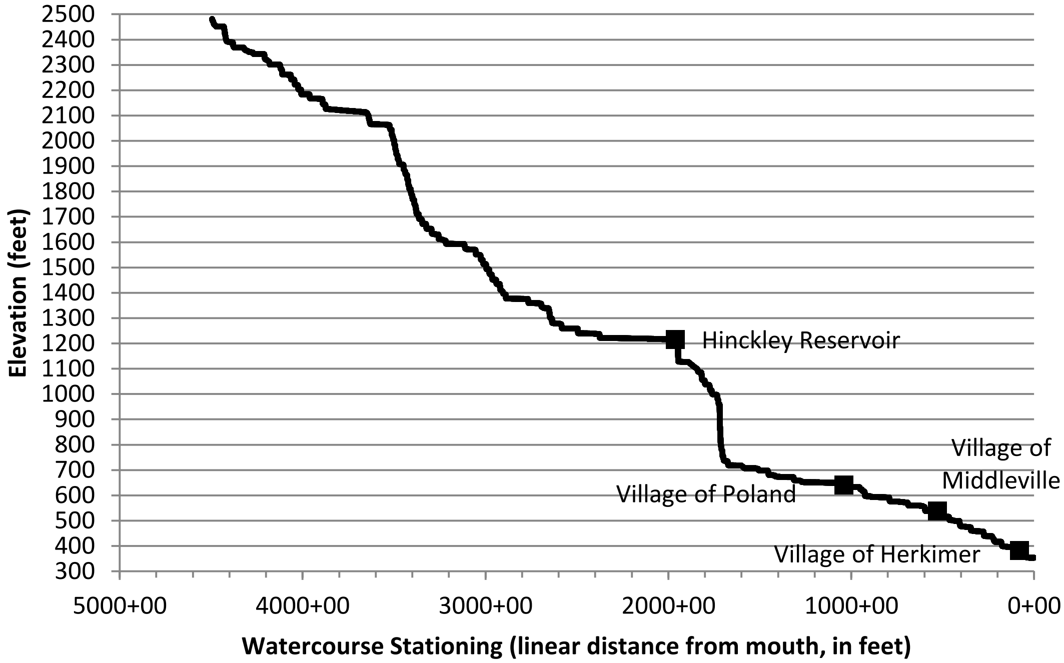
Figure 4 is a profile of West Canada Creek, showing the watercourse elevation versus the linear distance from the mouth of the watercourse. The creek has an average slope of 0.47 percent over its entire stream length of 85.1 miles. It drops a total of 2,128 vertical feet over its length, from an elevation of 2,481 feet above sea level at its headwaters in the Adirondacks to 354 feet at its mouth at the Mohawk River east of the village of Herkimer.

At various points along West Canada Creek between Middleville and Herkimer, signs of bank failures, slumping hillslopes, and low bank erosion were observed. Many of these areas have revegetated and stabilized, indicating that they are in the process of recovering from damage that occurred during high flow events. These areas were judged to be within the normal range of disturbance and recovery for a watershed of West Canada Creek's size, are not contributing large amounts of sediment to the creek, and are not considered to be contributing to flooding problems.

A large cobble sediment bar was observed under the Route 28 bridge in Middleville (STA 527+00). The sediment is almost entirely blocking the left (eastern) span of the bridge. The source of the sediment is Maltanner Creek, which enters West Canada Creek just upstream of the Route 28 bridge on the left (east) bank.

During field investigations, an accumulation of coarse-grained sediment was observed in the channel near the outlet of West Canada Creek, downstream of the East State Street (Route 5) bridge, from STA 46+00 downstream to STA 10+00. This aggradation is occurring as flow velocities decrease as the creek flattens and widens and enters the backwater effect of the Mohawk River. The FEMA study reports that ice jams occur in this area.

FIGURE 4
West Canada Creek 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 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 two points along West Canada 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)
At Middleville	527+00	516	9,970	206	8.27
At Mohawk River	0+00	559	10,700	212	8.5

Measurements of bankfull width taken in the field at various points between Middleville and Herkimer indicate that West Canada Creek varies in width but is within the expected range when compared to the regional bankfull width derived using *StreamStats*.

There is a USGS stream gauging station on West Canada Creek (USGS Gauge No. 01346000, at Kast Bridge, NY) at STA 131+00. Hydrologic data on peak flood flow rates are also available from the FEMA FIS and from *StreamStats,* which uses nearby regulated stream gauge information to estimate flows.

The most current FEMA FIS that applies to West Canada Creek is for all of Herkimer County. The study is effective as of September 27, 2013. The FIS includes analysis of West Canada Creek Reach 1 (the town and village of Herkimer), Reach 2 (the town and village of Newport), and Reach 3 (the towns of Newport and Russia, and the village of Poland). It does not include analysis of West Canada Creek where it flows through the village of Middleville.

As part of the FIS, FEMA conducted statistical analysis of the USGS stream gauge data in the Mohawk River Basin to determine peak flow discharges. For establishing peak discharges at ungauged locations, a USGS transfer equation method was applied from the gauge at Kast Bridge to other reaches of the West Canada Creek. The 10-, 50-, 100-, and 500-year frequency discharges were estimated for the gauging stations by employing Bulletin 17B, *Guidelines for Determining Flood Flow Frequency* (Interagency Advisory Committee on Water Data, 1982). The gauge analysis was performed using the USGS *PeakFQ* software, which performs flood flow frequency analyses in accordance with Bulletin 17B (USGS, 2006). The analysis approach described in Bulletin 17B assumes the logarithms of annual peak flows fit a Pearson Type III distribution.

FEMA conducted a backwater analysis on West Canada Creek, and the resulting water-surface elevations were compared 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 Herkimer County.

Table 2 lists estimated peak flows on West Canada Creek at each of the cross sections reported in the FEMA FIS and at similar drainage points delineated with the *StreamStats* program.

The FEMA FIS does not contain peak discharge information for the 10-, 50-, and 500-year events at two of the three cross sections. The report does not include discharge values for West Canada Creek at Middleville. For the 100-year event, the FEMA discharge is higher at the cross section located upstream of Old State Road than at the Kast Bridge cross section despite the fact that Kast Bridge is located further downstream and should show a higher discharge.

Comparing the 100-year discharges reported by FEMA to the discharges derived from *StreamStats*, the FEMA discharges are in the range of 9.5 to 26.5 percent higher than the discharge estimated using *StreamStats*.

TABLE 2
West Canada Creek FEMA and *StreamStats* Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr	50-Yr	100-Yr	500-Yr
	FEMA Discharge Values for Storm Reoccurrence				
Kast Bridge	561	16,200	20,600	22,000	26,200
0.8 mi U/S Old State Road	426.2	---	---	22,900	---
Above confluence of Cincinnati Creek	374	---	---	20,100	---
	StreamStats Discharge Values for Storm Reoccurrence				
West End Road (Kast Bridge)	560	15,400	18,800	20,100	22,700
Route 28 in Middleville	516	14,400	18,000	19,400	22,500
0.8 mi U/S Old State Road	451	12,800	16,600	18,100	21,600
Confluence of Cincinnati Creek	381	11,100	14,800	16,300	21,100

2.7 Infrastructure

Bridge spans and heights were measured as part of the field inspection. Table 3 summarizes the bridge measurements collected. For safety reasons, field measurements were not taken at the abandoned railroad bridge (STA 44+00) or at the active railroad bridge (STA 23+50). For the purpose of comparison, estimated bankfull widths at each structure are also included.

TABLE 3
Summary of Stream Crossing Data

Roadway Crossing	Station	BIN	Width (ft)	Height (ft)	Bankfull Width (ft)
Route 28 (Bridge Street)	527+00	000000001020110	96.0 x 2	3.5-22.5	206
West End Road	224+50	000000003307700	148.0	---	211
Shells Bush Road	131+00	000000002204620	137.8	---	212
East State Street (Route 5)	47+00	000000001002440	154.9	---	212

The nearest bridge crossings over West Canada Creek, aside from the Route 28 bridge in Middleville, is the Route 200 (Bridge Street) bridge located approximately four miles upstream in Newport and the Route 7 (West End Road) bridge located approximately five miles downstream.

Table 3 indicates that none of the bridges spanning West Canada Creek downstream of Route 28 in Middleville are wide enough to span the bankfull width. The Route 28 bridge is wide enough to span the bankfull width, but the hydraulic capacity has been substantially reduced by the sediment bar that has formed under the left (east) span. Reports from community officials indicate that the Route 28 bridge does act as a hydraulic constriction.

Flood profiles published in the FEMA FIS were evaluated to determine which bridges on West Canada Creek are acting as hydraulic constrictions. The FEMA profiles do not include the Bridge Street (Route 28) bridge or the West End Road bridge. The bridges at Shells Bush Road and downstream, including the two railroad bridges, are not shown to constrict floodwaters at any reoccurrence interval. However, FEMA reports that ice jams occur in the vicinity of the Route 5 bridge.

3.0 FLOODING HAZARDS AND MITIGATION ALTERNATIVES

3.1 Flooding History in West Canada Creek

According to the FEMA FIS, flooding on West Canada Creek can occur during all seasons, but the most severe floods have occurred in the spring when snowmelt adds to heavy rainfall to produce increased runoff. Flooding may also be caused by thunderstorms, tropical storms, and hurricanes. FEMA reports that damaging floods occurred in 1936, 1945, 1955, 1964, 1972, and 1984. The greatest flood of record on West Canada Creek occurred in October 1945.

The FEMA study does not provide specific information on flooding history and flood damages along West Canada Creek through the village of Middleville. It does report that ice jams occur in the vicinity of the Route 5 bridge near the village of Herkimer, where West Canada Creek becomes quite flat and wide as it approaches its outlet to the Mohawk River. The change in the hydraulic characteristics of the channel in this area results in slower velocities, resulting in ice jams.

According to community officials and residents, the most severe flood-related damages on West Canada Creek in Middleville have occurred to homes along Fishing Rock Road, which parallels the creek along its right bank, north of Route 28, between STA 552+00 and STA 527+00. Homes line the road between STA 538+00 and STA 527+00. During a severe flood in 2006, flooding reportedly occurred along Fishing Rock Road, extended south to Route 28, and damaged trailers, which were subsequently replaced by FEMA. Flood damage has also occurred to homes and businesses along Kanata Street, which parallels the right bank of the creek south of Route 28, between STA 526+00 and STA 516+00. On the left bank, combined floodwaters from West Canada Creek and Maltanner Brook have flooded the firehouse, in the vicinity of STA 538+00.

3.2 Post-Flood Community Response

According to the FEMA study, a levee was constructed along the west bank of West Canada Creek by the State of New York in cooperation with local authorities following a flood in 1910. This levee extends for approximately two miles, upstream of Route 5. In 1936, embankment construction, consisting primarily of dressing the existing levee, was completed with Federal Emergency Relief Funds. In 1958, a series of levees on West Canada Creek and the Mohawk River was designed to protect the village of Herkimer from flooding. FEMA reports that Hinckley Reservoir, in the upper watershed, is seasonally regulated and has significant flood control capability if the reservoir is at its lowest regulated level, with a usable storage of approximately 76,000 acre-feet.

According to community officials, a deflector was constructed in the late 1990s along the right bank of West Canada Creek, upstream of Route 28 in the vicinity of STA 531+00. The intention was to increase flow velocities passing under the bridge in order to reduce the accumulation of sediments in this area.

3.3 High-Risk Area #1 – Sediment Accumulation Zones

Substantial accumulations of sediment have formed in two specific areas of West Canada Creek. A large lateral sediment bar has formed between STA 532+00 and STA 523+00, upstream of and under the bridge over West Canada Creek at Bridge Street (Route 28) in Middleville. The sediment is composed primarily of cobble and is almost entirely blocking the left (eastern) span of the bridge, substantially reducing the hydraulic capacity of the channel as it passes under the bridge. This reduction in channel capacity has resulted in an increase in water surface elevations upstream of the Route 28 bridge and has contributed to flooding of homes along Fishing Rock Road. The source of the sediment is primarily Maltanner Brook, which enters West Canada Creek at STA 532+00, just upstream of the Route 28 bridge on the left side.

The assessment of Maltanner Brook (presented in a separate report), the major tributary to West Canada Creek, includes recommendations for controlling sediments in that basin. Once those control methods have been implemented, sediment deposition in this area of West Canada Creek will be reduced. However, some amount of sediment will likely continue to accumulate in this area regardless of what actions are taken to control sediments in the upper reaches or on Maltanner Brook.

A substantial accumulation of coarse-grained sediment has also formed in the channel near the outlet of West Canada Creek, downstream of the East State Street (Route 5) bridge, from STA 46+00 downstream to STA 10+00. Aggradation is occurring at this location as flow velocities decrease where the creek flattens and widens and enters the backwater effect of the Mohawk River. Ice jams occur in this area and contribute to flooding. Due to the physical characteristics of this reach of West Canada Creek, it will continue to act as a dynamic section of channel where sediment bars form and the channel shifts its location.

Alternative 1-1: Implement Sediment Control Mechanisms Recommended in Maltanner Brook Basin

A concurrent study and report with recommendations for controlling sediments on Maltanner Brook have been completed as part of the Emergency Transportation Infrastructure Recovery Water Basin Assessment program. These recommendations, when implemented, will reduce the volume of sediment being transported into West Canada Creek and depositing in the vicinity of the Route 28 bridge in Middleville.

Alternative 1-2: Remove Excess Sediment from Channel in Middleville (STA 523+00 to STA532+00)

Removing the lateral sediment bar from the West Canada Creek channel in Middleville will improve the hydraulic capacity at the Route 28 bridge and reduce flooding associated with this reach of the channel. Access to the channel can be gained from the left bank, upstream of the bridge. The existing sediment bar will need to be removed. When Alternative 1-1 has been implemented, sediment accumulation in this area will be reduced, as will the need for dredging. However, the channel will need to be monitored to determine whether additional dredging is necessary after the existing bar has been removed.

Alternative 1-3: Remove Excess Sediment on Lower West Canada Creek (STA 0+00 to STA 46+00)

Excess sediments will continue to collect within the reach of West Canada Creek from the East State Street (Route 5) bridge downstream to near the outlet at the Mohawk River. These sediments will need to be removed as necessary to prevent the formation of ice jams in this area. This area of channel will need to be monitored to determine whether additional dredging is necessary after the existing bars have been removed.

Alternative 1-4: Sediment Management

Periodic channel inspection and maintenance should be conducted, and excess sediments should be removed from the channel, where appropriate.

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. Improperly conducted dredging action 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 maintenance 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 sediment excavation in the stream channel is necessary, a methodology should be developed that would allow for proper channel sizing and slope. The following guidelines are suggested:

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 West Canada Creek are provided in Table 1 of this report and range from 206 feet at Middleville to 212 feet at the creek's outlet at the Mohawk River.

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.

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.

3.4 High-Risk Area #2 – Minor Bank Failures and Erosion

Several areas of eroding banks, minor bank failures, and slumping hill slopes were observed along West Canada 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. While no single failure is a major cause of sediment transport issues in West Canada Creek, once mobilized, this sediment can restrict channel capacity and exacerbate flooding.

Alternative 2-1: Monitor Bank Failures and Erosion

A stream repair and maintenance program for West Canada Creek can be developed and implemented to address bank failures and areas of erosion on a site-by-site basis using a combination of conventional and bioengineering techniques. Such a program could include periodic inspection to identify future areas subject to erosion, periodic removal of woody debris from the channel, and monitoring of restored areas.

Bioengineering approaches could include the following:

- Construction of rock vortex vanes to deflect or redirect flows away from eroding banks
- Use of stone weirs or drop structures to stabilize the channel and dissipate the energy of the flowing water
- Use of coir logs filled with soil to provide interplanting areas in lower-flow velocity zones along the banks
- Use of vegetated natural boulder slopes in higher-flow velocity zones along the bank
- Use of brush mattresses, live fascines, live stakes, tubelings, and/or blueberry/fern sod where bare soils have been exposed [Available plant species for live stakes, fascines, mattresses, and tubelings typically include willow (*Salix* spp.), speckled alder (*Alnus rugosa*), silky dogwood (*Cornus amomum*), red twig dogwood (*Cornus sericia*), nannyberry (*Viburnum lentago*), and northern arrowwood (*Viburnum dentatum*).]
- Transplanting native plantings, such as willow (*Salix* spp.), from nearby sites, combined with seeding to reestablish vegetation on creek banks where bare soils have been exposed
- Erosion control matting to stabilize banks combined with seeding to reestablish vegetation on creek banks where bare soils have been exposed

4.0 RECOMMENDATIONS

1. *Control Sediment at its Source in the Maltanner Brook Basin* – The actions recommended in the concurrent Maltanner Brook basin report should be implemented in order to reduce the volume of sediment entering West Canada Creek.

2. *Remove Cobble Bar from the Channel at Bridge Street (Route 28) in Middleville (STA 523+00 to STA 532+00)* – This will improve the hydraulic capacity at the Route 28 bridge and reduce flooding associated with this reach of the channel.

3. *Periodically Remove Sediment on Lower West Canada Creek (STA 0+00 to STA 46+00)* – Removal of these sediments will prevent the formation of ice jams and reduce flooding in this area.

4. *Adopt Sediment Management Standards* – Coarse-grained sediments will continue to be transported into West Canada 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.

5. *Monitor Minor Bank Failures and Erosion* – Several areas of eroding banks, minor bank failures, and slumping hill slopes were observed along West Canada 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.

6. *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 4 provides an estimated cost range for key recommendations.

TABLE 4
Cost Range of Recommended Actions

	Approximate Cost Range				
West Canada Creek Recommendations	< $100k	$100k-$500k	$500k-$1M	$1M-$5M	>$5M
Remove Cobble Bar from the Channel at Bridge Street in Middleville	X				
Periodically Remove Sediment from the Channel Downstream of East State Street	X				

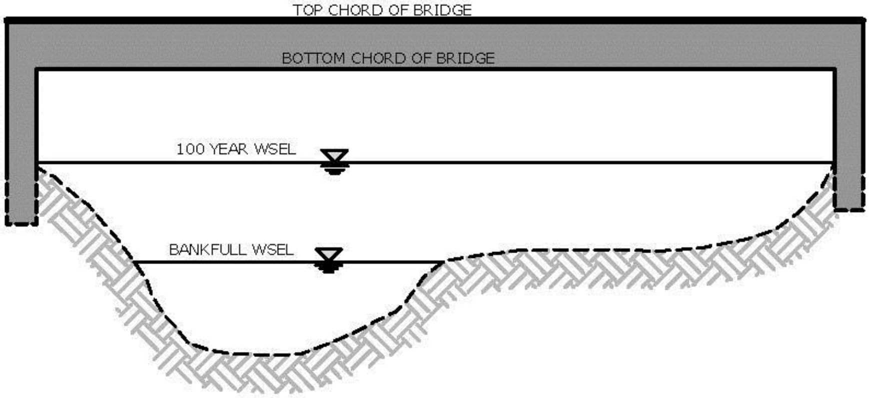
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES WEST CANADA CREEK, ONEIDA COUNTY, NEW YORK

High-Risk Area #1: High Volume Aggradation Zone (STA 523+00 to 532+00)

Site Description: Located under the left (northeast) span of the Route 29 Bridge over West Canada Creek in Middleville, just downstream of Maltanner Creek, a lateral cobble sediment bar has formed. Under high velocity flows, these materials are carried from Maltanner Creek and deposited in the channel , effectively decreasing channel capacity and exacerbating flood conditions.

Recommendation:

- Remove aggregated sediment from the channel bar and relocate outside of floodplain.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

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

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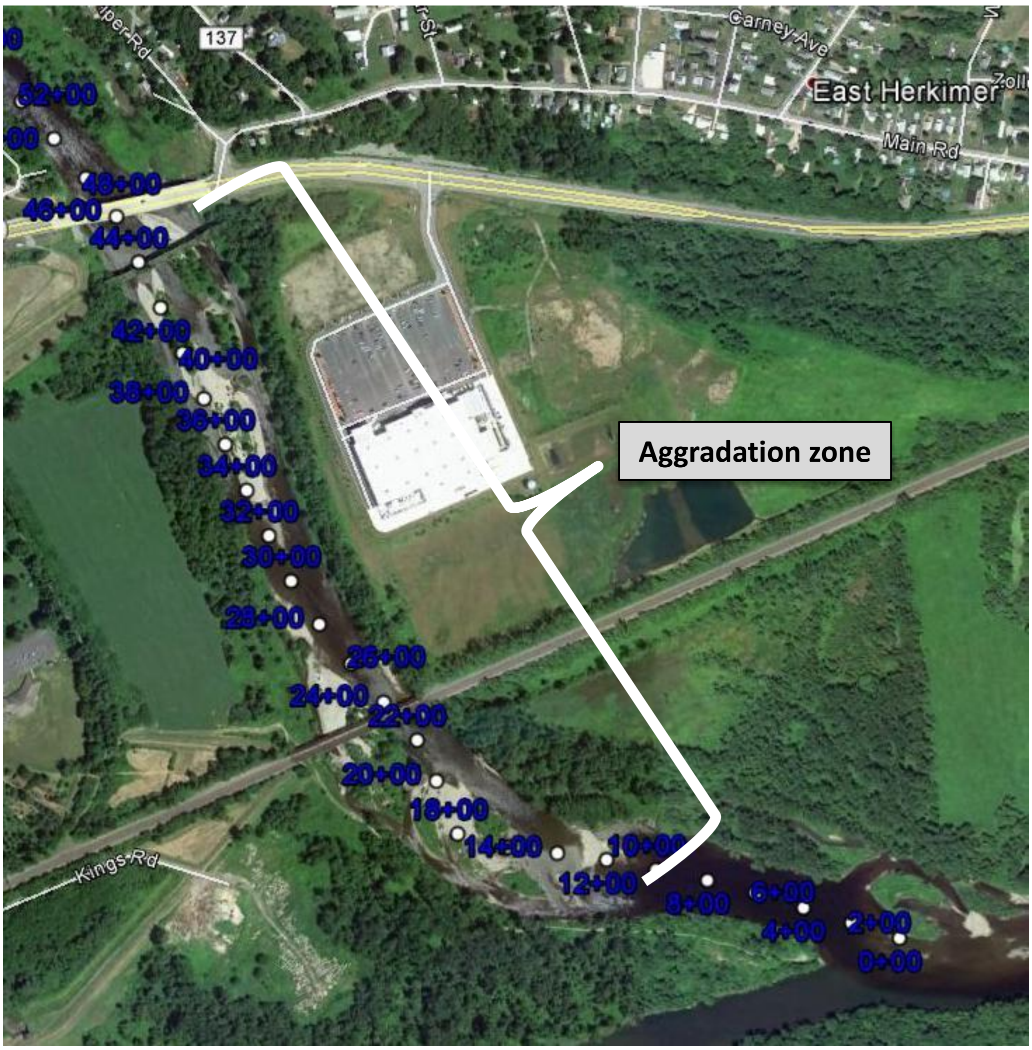
WATER BASIN ASSESSMENT AND FLOOD HAZARD MITIGATION ALTERNATIVES
WEST CANADA CREEK, ONEIDA COUNTY, NEW YORK

High-Risk Area #2: Aggradation Zone (STA 0+00 to STA 46+00)

Site Description: A substantial accumulation of coarse grained sediment has formed in the channel near the outlet of West Canada Creek, downstream of the East State Street (Route 5) Bridge, from STA 46+00 downstream to STA 10+00. Aggradation is occurring at this location as flow velocities decrease where the creek flattens and widens and enters the backwater effect of the Mohawk River. Ice jams occur in this area, and contribute to flooding.



Recommendation:

- Remove aggregated sediment from the channel and relocate outside of floodplain.

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

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APPENDIX A

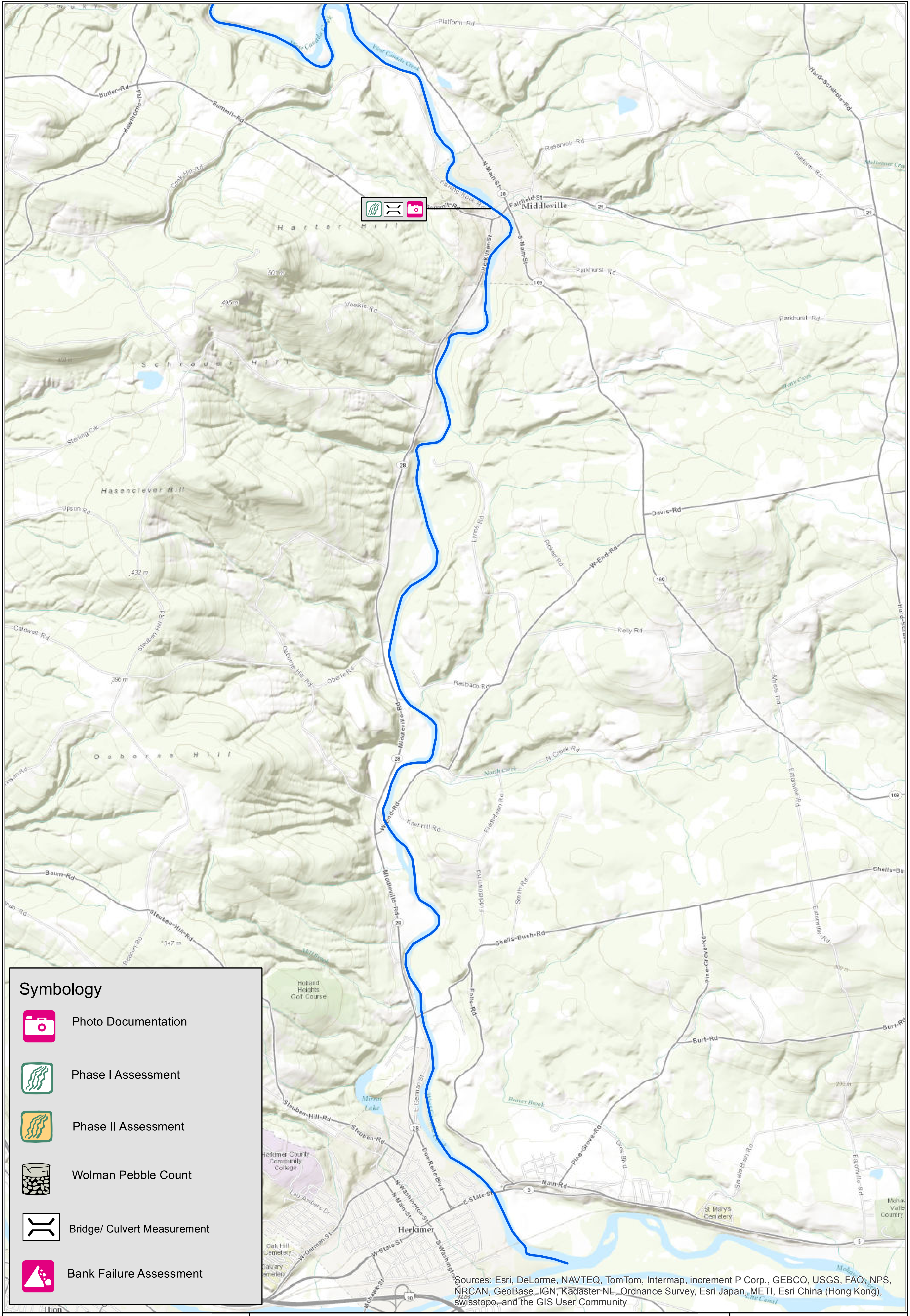
Summary of Data and Reports Collected

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



SOURCE(S):

Appendix B: West Canada 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\West Canada 13-1.mxd
1st Version: 12/12/2013
Revision: 3/17/2014
Scale: 1 in = 3,500 ft

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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	Confined	Semiconfined	Unconfined
(Circle one)	>80% L	20-80%	<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	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)

				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)

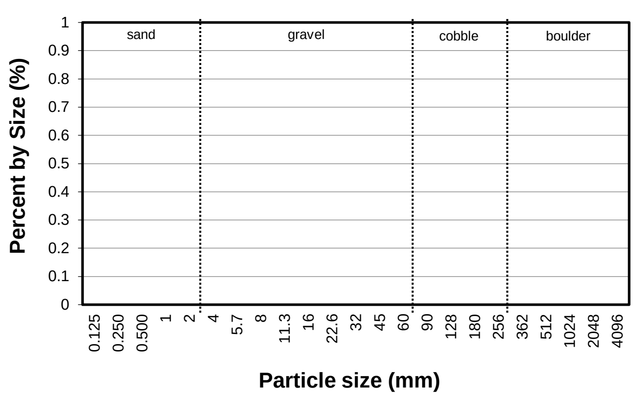
D (mm) of the largest mobile particles on bar	
Mean	

Riffle Stability Index (%)

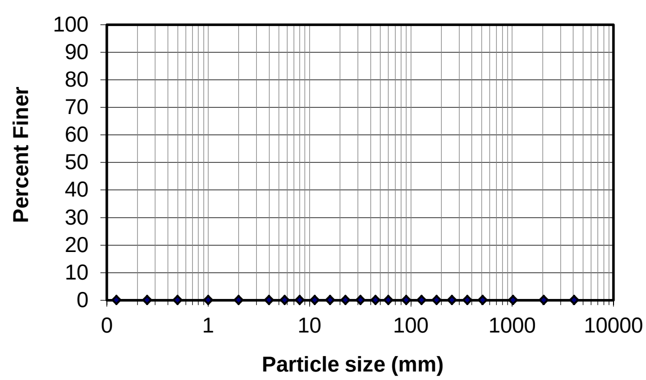
(Kappesser, 2002)

Notes

Particle Size Histogram



Gradation Curve



APPENDIX C

West Canada Creek Photo Log

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Cheshire, Connecticut 06410
(203 271-1773

West Canada Creek
Project Photos

MMI# 5231-01
NYDOT
March 2014

PHOTO NO.:

1

DESCRIPTION:
Aerial photograph from Google Earth showing Route 28 bridge. Maltanner Creek enters West Canada Creek just upstream of the bridge, bringing sediment with it. A sediment bar has formed which extends through the bridge and has begun extending downstream of the bridge as well.

PHOTO NO.:

2

DESCRIPTION:
A representative photograph of the sediment bar. The sediment seems uniform in size, ranging from coarse sand to small cobbles.

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(203 271-1773

West Canada Creek
Project Photos

MMI# 5231-01
NYDOT
March 2014

PHOTO NO.: **3** DESCRIPTION: The sediment bar extends to the bridge, and limits the capacity of the bridge to carry flows. The bar extends to the central pier, affecting the hydraulic capacity of the entire eastern span, and limiting the bridge opening by almost half.