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

BIG CREEK
ONEIDA 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

BCA	Benefit-Cost Analysis
BCR	Benefit Cost Ratio
CFS	Cubic Feet per Second
CME	Creighton Manning Engineering
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FTP	File Transfer Protocol
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
MMI	Milone & MacBroom, Inc.
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
PDM	Pre-Disaster Mitigation
SFHA	Special Flood Hazard Area
STA	River Station
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 & 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 Big 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.

The Big Creek drainage basin is located in the town of Marshall and village of Waterville in Oneida County, in east central New York. Figure 1 is a basin location map. The creek drains a total land area of 19.1 square miles and flows into Oriskany Creek. The drainage basin is approximately 40 percent forested, with primarily rural residential and agricultural uses throughout. The village of Waterville is the only highly developed area within the watershed.

Big Creek has an average slope of 1.75 percent over its entire length of 10.8 miles. The steeper reaches of Big Creek generate greater stream power during high flows, especially along the steep reach located just downstream of the village of Waterville, where the creek parallels Route 315.

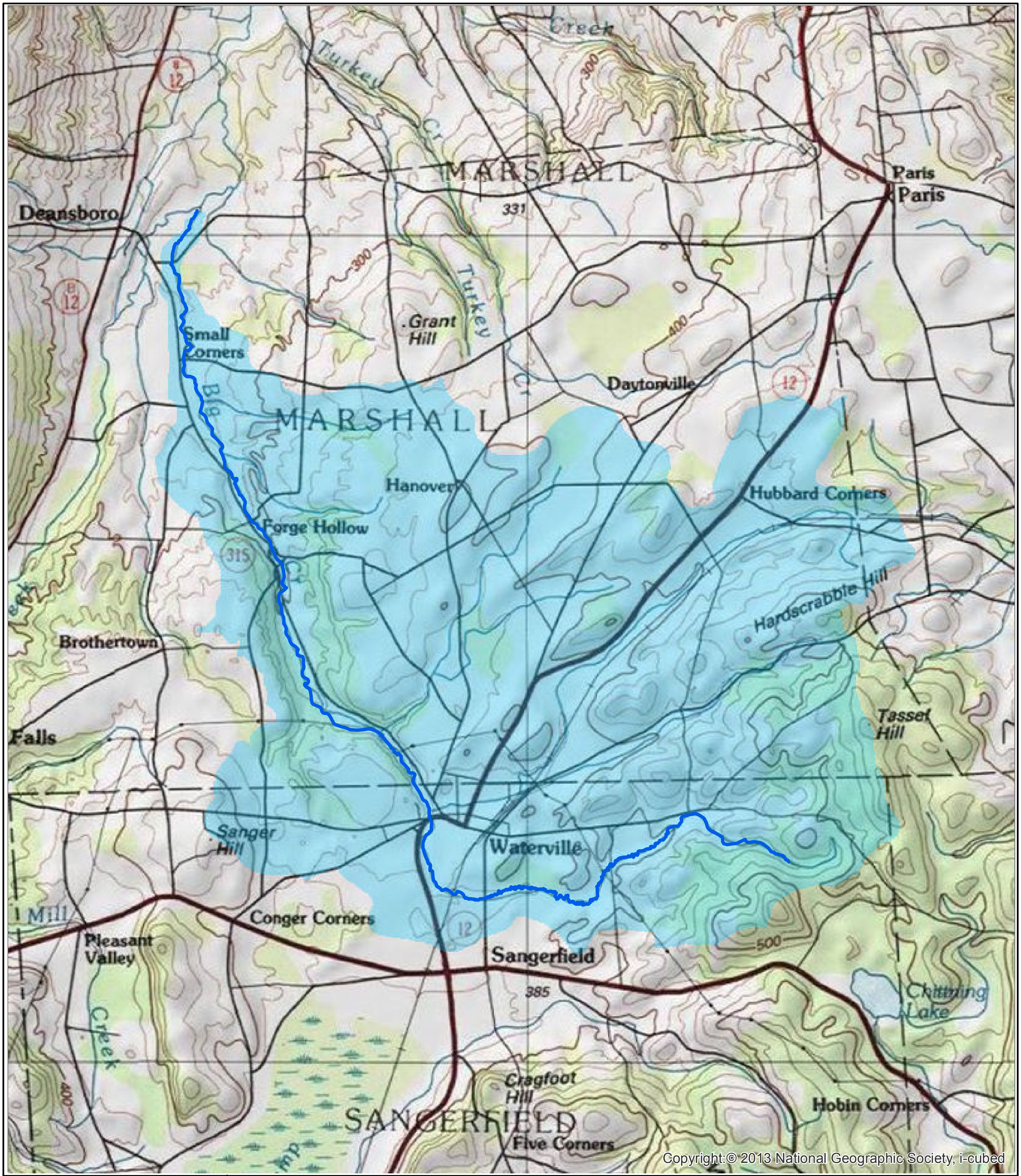
Many road crossings are not wide enough to span the creek's bankfull width, and act to restrict flows during storm events. Areas of bank and bed instability contribute a substantial sediment load to the creek during high flow events, restricting channel and bridge capacity. Residential development occurs in the floodplain, in some cases to within several feet of the edge of the stream. These properties are at greatest risk of flooding.

The goals of the subject water basin assessment were to:

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

2. Identify critical areas subject to flood risk

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



SOURCE(S):	Figure 1: Big Creek Drainage Basin Location	LOCATION: Oneida County, New York
	NYDOT: Emergency Transportation Infrastructure Recovery MXD: Y:\5231-01\GIS\Maps\Figure 1 Maps\Figure 1 Big Creek.mxd	**Map By:** CMP **MMI#:** 5231-01 **Original:** 01/06/2014 **Revision:** 4/10/2014 **Scale:** 1 inch = 5,000 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 Big Creek at STA 0+00 and continues upstream to STA 548+00 at its headwaters. 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 Big 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

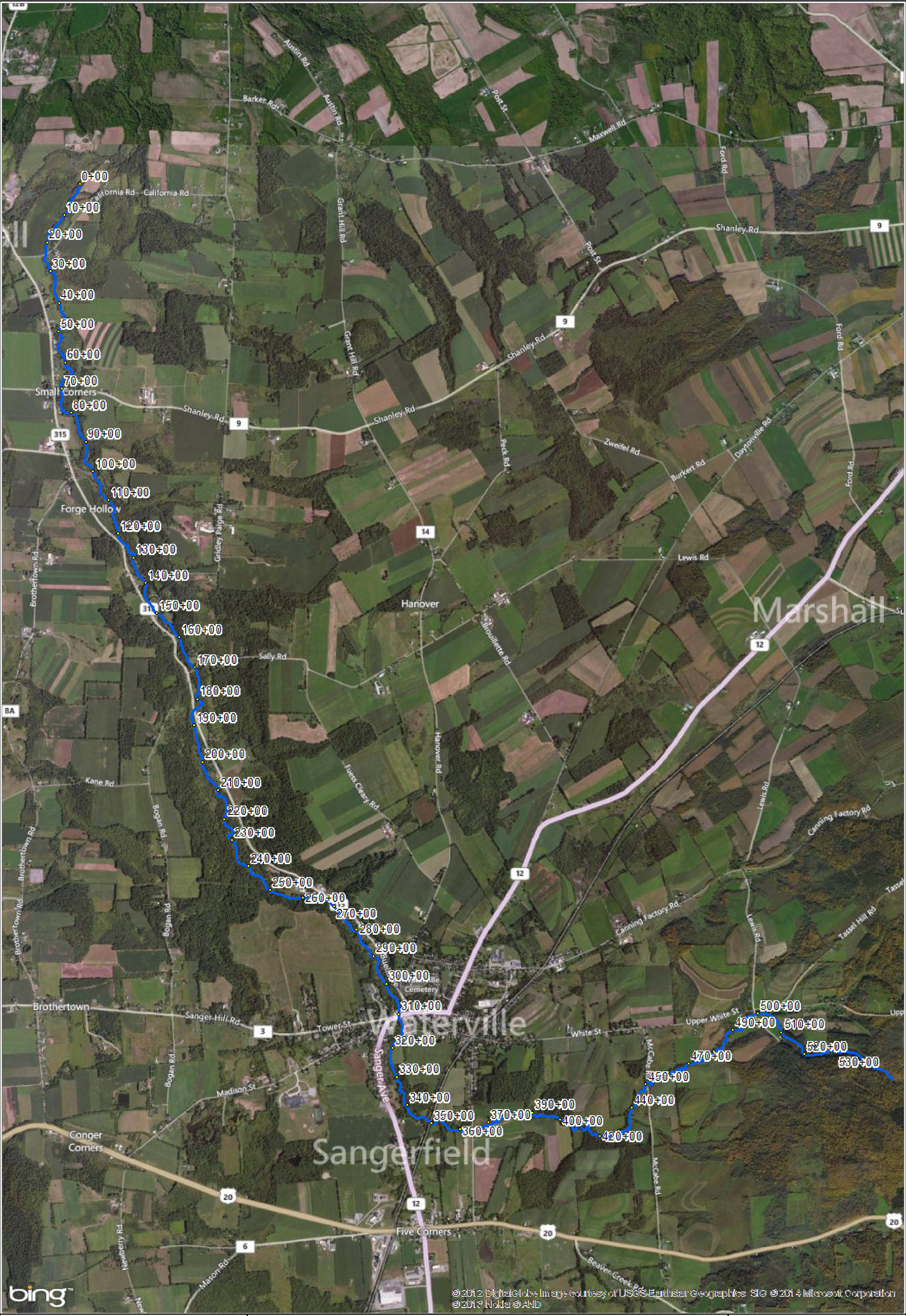
Public information pertaining to Big Creek was collected from previously published documents as well as through meetings with municipal, county, and state officials. Data collected includes reports, flood photographs, newspaper articles, Federal Emergency Management Agency (FEMA) Flood Insurance Studies (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 at Oneida Community Hall to discuss Oriskany and Big Creeks. 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 removal of sediments from the channel. 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: Big Creek Watercourse Stationing

Location:
Oneida County, New York

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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

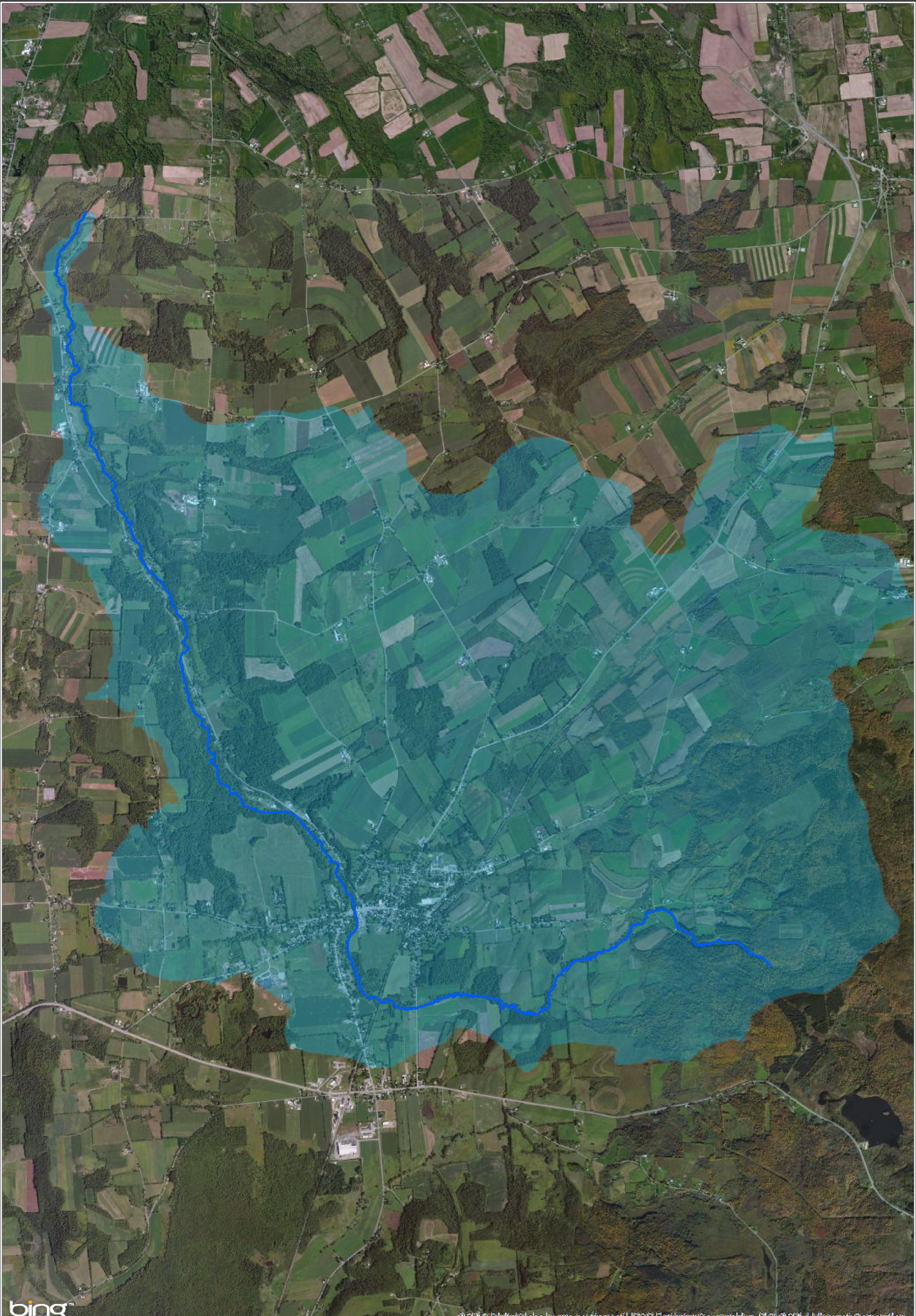
Included in Appendix B is a copy of the River Assessment Reach Data Form, River Condition Assessment Form, Bridge Waterway Inspection Form, and Wolman Pebble Count Form. Appendix C is a photo log of select locations within the river corridor. Field Data Collection Index Summary Mapping has been developed 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. The data and mapping were also provided electronically to NYSDEC.

2.4 Watershed Land Use

Figure 3 is a watershed map of Big Creek. The drainage basin is approximately 40 percent forested, with primarily rural residential and agricultural uses. The village of Waterville is the only highly developed area within the watershed.

Big Creek originates above a series of small impoundments located in a wooded area to the south of Upper White Street, approximately three miles east of Waterville at STA 548+00. The creek flows west through a mix of forest and agricultural land uses before turning south and paralleling Sanger Avenue (Route 12) as it flows toward Waterville. Big Creek passes under Main Street East (Route 12) in Waterville at STA 310+00.

Downstream of Waterville, the creek parallels Route 315 and drops quickly in elevation through a steep ravine before flowing alongside the wastewater treatment plant at STA 260+00 and crossing under Route 315 at STA 185+25. Big Creek continues through a mix of forested, agricultural, and rural residential land uses and passes under several more road crossings before outletting to Oriskany Creek at STA 0+00.



SOURCE(S):

Figure 3: Big Creek Drainage Basin Aerial

Location:
Oneida County, New York

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NYDOT: Emergency Transportation Infrastructure Recovery

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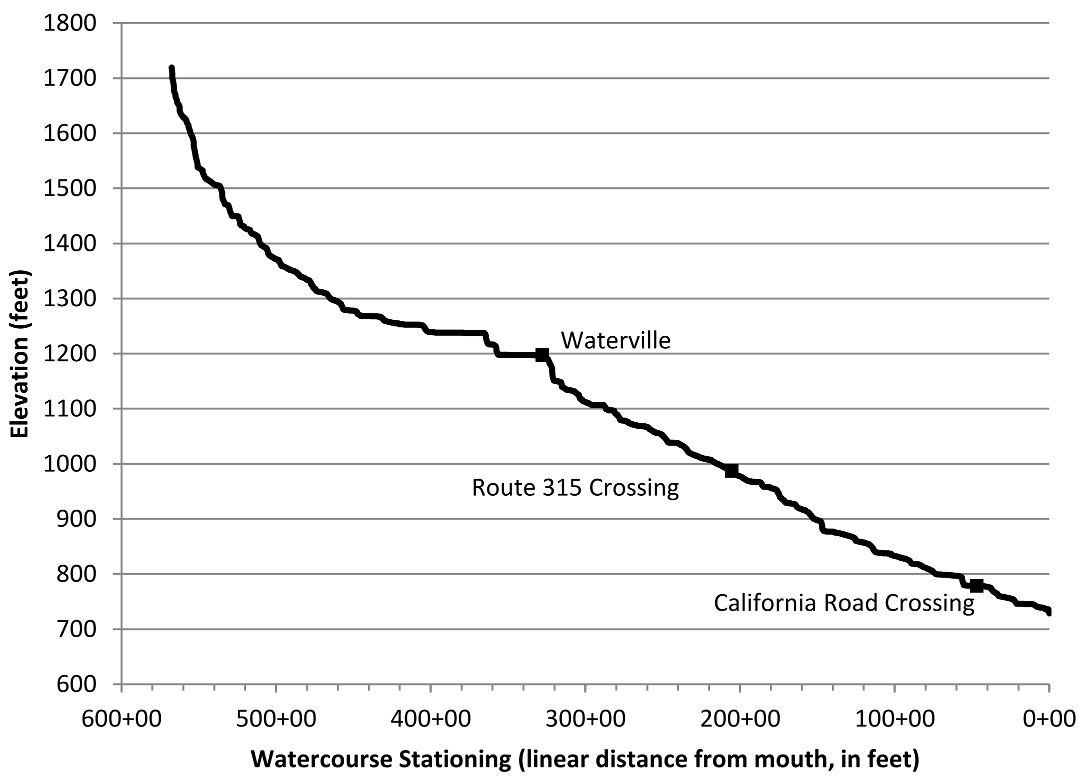
2.5 Geomorphology

Big Creek flows for a length of 10.8 miles in a north and northwesterly direction, from its headwaters in Sangerville at the village of Waterville, downstream to the hamlet of Deansboro, where it flows into Oriskany Creek. Big Creek has several small unnamed tributaries that flow into it along its length, the largest entering from the east in Waterville.

While the average slope of Big Creek is relatively modest at 1.75 percent, portions of the stream are quite steep, with evidence of high sediment load in the main channel, some of which originates in the upstream tributaries. In the upstream portion of the watershed, Big Creek begins at a series of reservoirs located east of Waterville. The creek flows north under Route 12 in Waterville, then parallels Route 315 for approximately six stream miles before flowing into Oriskany Creek.

Figure 4 is a profile of Big Creek, showing its elevation versus linear distance from its headwaters.

FIGURE 4
Profile of Big Creek



The creek drops a total of 991 vertical feet, from elevation 1,719 feet above sea level at its headwaters to an elevation of 728 feet at its outlet at Oriskany Creek. The upper portion of Big Creek, upstream of Waterville, has an average slope of 2.2 percent. Downstream of Waterville, the creek is not as steep, with an average slope of 1.4 percent. The reach of Big Creek just downstream of Waterville becomes steeper, including a quarter-mile section (from STA 310+00 downstream to STA 296+00) that drops 50 feet, with a slope of 3.7 percent. Eroding banks and bank failures are evident in this reach and contribute to high sediment loads and a high volume of woody debris in the channel.

Much of Big Creek's channel and banks are quite natural in appearance; however, at various points along the channel, there is evidence of efforts to control bank erosion. For example, just upstream of the Route 315 crossing, between STA 187+00 and STA 185+00, the creek banks have been lined with stacked rock walls.

2.6 Hydrology

Alluvial river channels adjust their width and depth around a long-term dynamic equilibrium condition that corresponds to "bankfull" conditions. Extensive data sets indicate that the channel-forming or bankfull discharge in specific regions is primarily a function of watershed area. The bankfull width and depth of alluvial channels represent long-term equilibrium conditions and are important design criteria. Table 1 below lists estimated bankfull discharge, width, and depth at several points along Big 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 Steele Creek	Station	Watershed Area (sq. mi.)	Discharge (cfs)	Bankfull Width (ft)	Bankfull Depth (ft)
Along Route 315 d/s of Waterville	302+00	9.62	315	37.3	1.91
At Route 315 crossing	185+25	15.1	463	45.7	2.26
At Shanley Road	71+00	18.7	556	50.3	2.44
Upstream California Road	26+00	19.0	563	50.6	2.46

Actual bankfull widths measured on Big Creek were compared to the regional bankfull channel dimensions reported above. The measured bankfull width along Route 315 downstream of Waterville (at STA 302+00) was 39 feet, compared to the regional bankfull channel width of 37.3 feet at this location. The bankfull width in the vicinity of the Route 315 bridge crossing (STA 185+25) ranged from 30 to 35 feet compared to the regional bankfull channel width of 45.7 feet. The measured bankfull width in the vicinity of Shanley Road (at STA 71+00) was 30 feet, versus the regional bankfull channel width of 50.3 feet. Upstream of California Road (at STA 26+00), the bankfull width was 26.5 feet compared to the regional bankfull channel width of 50.6 feet.

These comparisons indicate that the Big Creek stream channel, while adequately sized through some of its reaches, is undersized through others, especially in the vicinity of road crossings where the channel is confined between abutments or retaining walls. The channel appears to be increasingly undersized moving in the downstream direction.

There are no USGS stream gauging stations on Big Creek; however, hydrologic data on peak flood flow rates are available from the FEMA FIS and from *StreamStats* regional data. The most current FEMA FIS that applies to Big Creek is for Oneida County, with an effective date of September 27, 2013. According to this FIS, the most recent hydraulic modeling for Big Creek was completed in July 1980.

The hydrologic analysis methods employed in the FEMA study used a regional analysis of streamflow gauges in the area. A linear correlation was made for the gauges to relate the logarithm of the peak flows and the logarithm of the drainage area at the gauges. The analysis was supplied by the USGS and followed the standard log-Pearson Type III method as presented by the Water Resources Council (Water Resources Council, 1976). Discharges developed by FEMA were applied in a backwater analysis on Big 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 Oneida County.

Estimated peak discharges for the 10-, 50-, 100-, and 500-year frequency events were calculated by MMI using *StreamStats* and compared to peak discharges reported in the FEMA FIS. Table 2 lists estimated peak flows on Big Creek reported in the FEMA FIS as well as those derived from the *StreamStats* program.

TABLE 2
Big Creek FEMA and StreamStats Peak Discharges

Location	Drainage Area (sq. mi.)	10-Yr	50-Yr	100-Yr	500-Yr
		FEMA Peak Discharges			
Limit of Town of Marshall/Village of Waterville	10.00	1,010	1,400	1,575	1,990
Approx. 100 feet D/S Access to Sewage Plant	12.63	1,200	1,665	1,885	2,385
Approx. 64 feet D/S Bogan Rd	15.44	1,380	1,915	2,150	2,725
Confluence with Oriskany Creek	18.59	1,595	2,215	2,500	3,150
		StreamStats Peak Discharges			
Limit of Town of Marshall/Village of Waterville	9.83	1,000	1,490	1,730	2,290
Access to Sewage Plant	12.9	1,270	1,870	2,170	2,870
Bogan Rd Crossing	15.5	1,490	2,190	2,540	3,370
Confluence with Oriskany Creek	19.1	1,820	2,680	3,110	4,120

Peak discharges derived from *StreamStats* are higher than those reported by FEMA. For the 100-year frequency event, the *StreamStats* discharges range from 10 percent higher near the village of Waterville, to 24 percent higher at the confluence of Big Creek and Oriskany Creek.

2.7 Infrastructure

Big Creek passes under several bridges including Route 12 (STA 310+00), Route 315 (STA 185+25), Gridley Paige Road (STA 148+50), Shanley Road (STA 71+00), and California Road (STA 24+00). Culverts make up the crossings upstream of Route 12, as well as a single culvert crossing at Bogan Road (STA 170+00). In the vicinity of STA 187+00, sediments have been removed from the stream channel and banks have been graded and stabilized, including a two- to four-foot-high stacked stone wall along the outside bend, accompanied by a weir structure.

Bridge and culvert spans and heights were measured as part of field inspections. Table 3 summarizes the bridge measurements collected. For purposes 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)
Main Street (Route 12)	310+00	---	14.0	15.0	25.5
Route 315	185+25	000000001045630	30.0	5.0	45.7
Bogan Road	170+00	---	20.0 (dia.)	N/A	46.0
Sally Road	162+00	000000002205870	Removed	N/A	N/A
Gridley Paige Road	148+50	000000002205850	21.3	10.8	46.5
Shanley Road	71+00	000000003310830	17.5	7.8	50.3
California Road	24+00	000000003310850	61.5	7.9	50.6

Comparing the measurements in Table 3, all of the bridges and culverts, with the exception of California Road, fail to span the estimated bankfull width of Big Creek, indicating that these crossings are undersized. Adequately sized stream crossings not only have the potential to reduce flooding, but they also provide a range of environmental benefits by allowing aquatic organisms, sediment, and debris to be conveyed through the stream corridor.

Flood profiles published in the FEMA FIS were evaluated to determine which bridges on Big Creek may be acting as hydraulic constrictions during large flood events and which bridges overtop during these events based on FEMA modeling for the 10-, 50-, 100-, and 500-year frequency flood events. According to the profiles, all of the bridges listed in

Table 3 above create hydraulic constrictions, with the most severe constrictions occurring at Bogan Road, Sally Road, and Gridley Paige Road. Based on aerial photos, it appears that the Sally Road bridge has been removed or was washed out.

3.0 FLOODING CHARACTERISTICS

3.1 Flooding History Along Big Creek

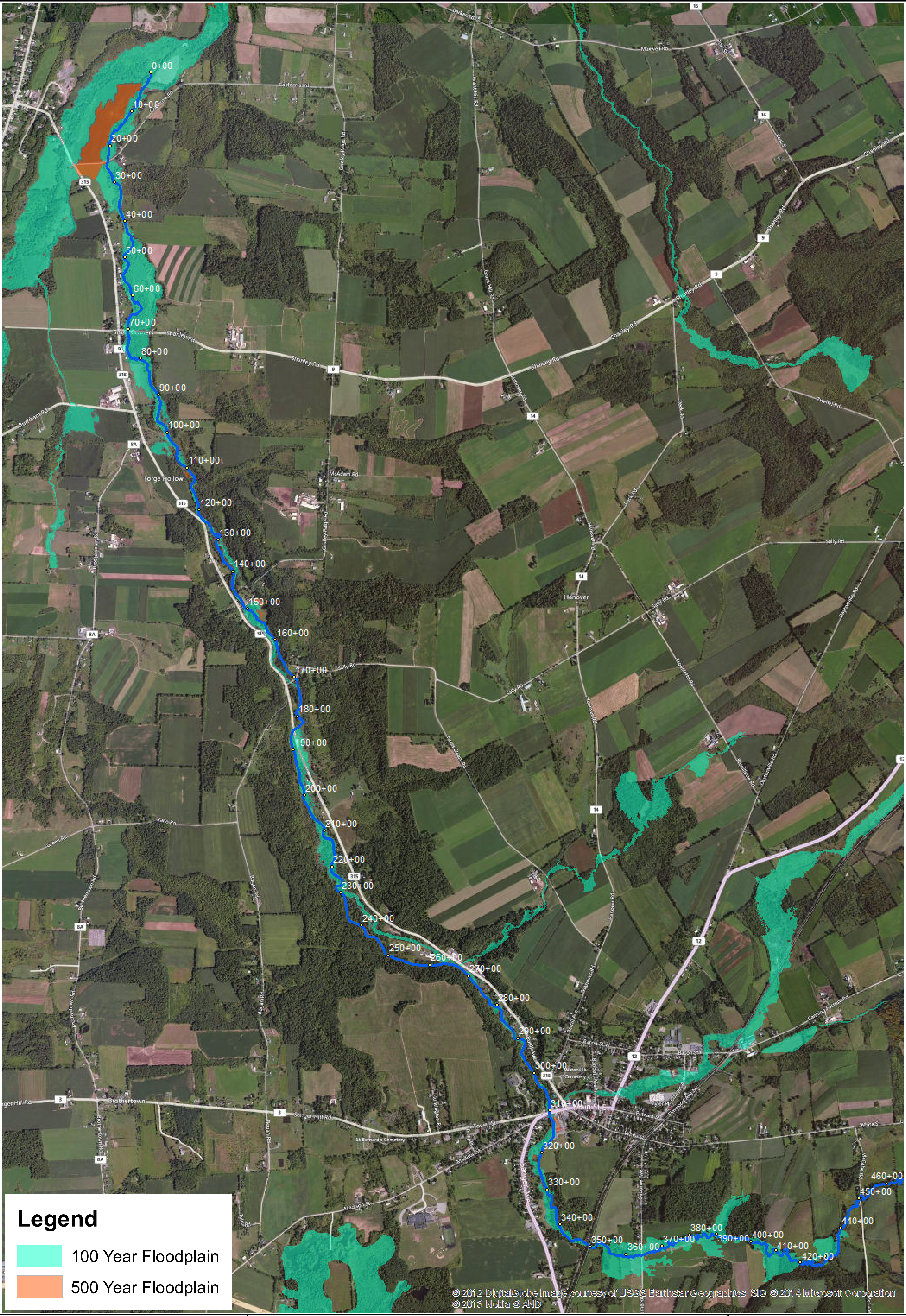
The FEMA FIS for Oneida County provides an overview of major flood events and flood-related damage for Oriskany Creek but not for Big Creek. FEMA flood insurance inundation mapping and stream profiles are available for Big Creek. These are presented in Figures 5 through 10.

The maps highlight the areas of flooding that occur along Big Creek during a 100-year frequency flood event. The maps indicate that Route 315 is flooded in the vicinity of where it crosses Big Creek and that flooding occurs at the Gridley Paige Road bridge and the Shanley Road bridge. According to the FEMA maps, an extensive area in the vicinity of the California Road bridge is also flooded although some amount of this flooding can be attributed to Oriskany Creek.

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

Community officials report that the most severe flood-related damages on Big Creek occurred along Route 315 downstream of Waterville, and at the Route 315 bridge crossing. Several homes with back yards along Big Creek along Route 315 (STA 306+00 downstream to STA 272+00) experienced flooded basements and flood-related structural damage. In the vicinity of STA 264+50, utility lines associated with the wastewater treatment plant were threatened by erosion. In the vicinity of the Route 315 bridge crossing (STA 185+25), damages to the bridge, the road, and the channel upstream of the crossing were repaired after the June flood event.



SOURCE(S):

Figure 5: Big Creek FEMA Flood Zones

Location: **Oneida County, New York**

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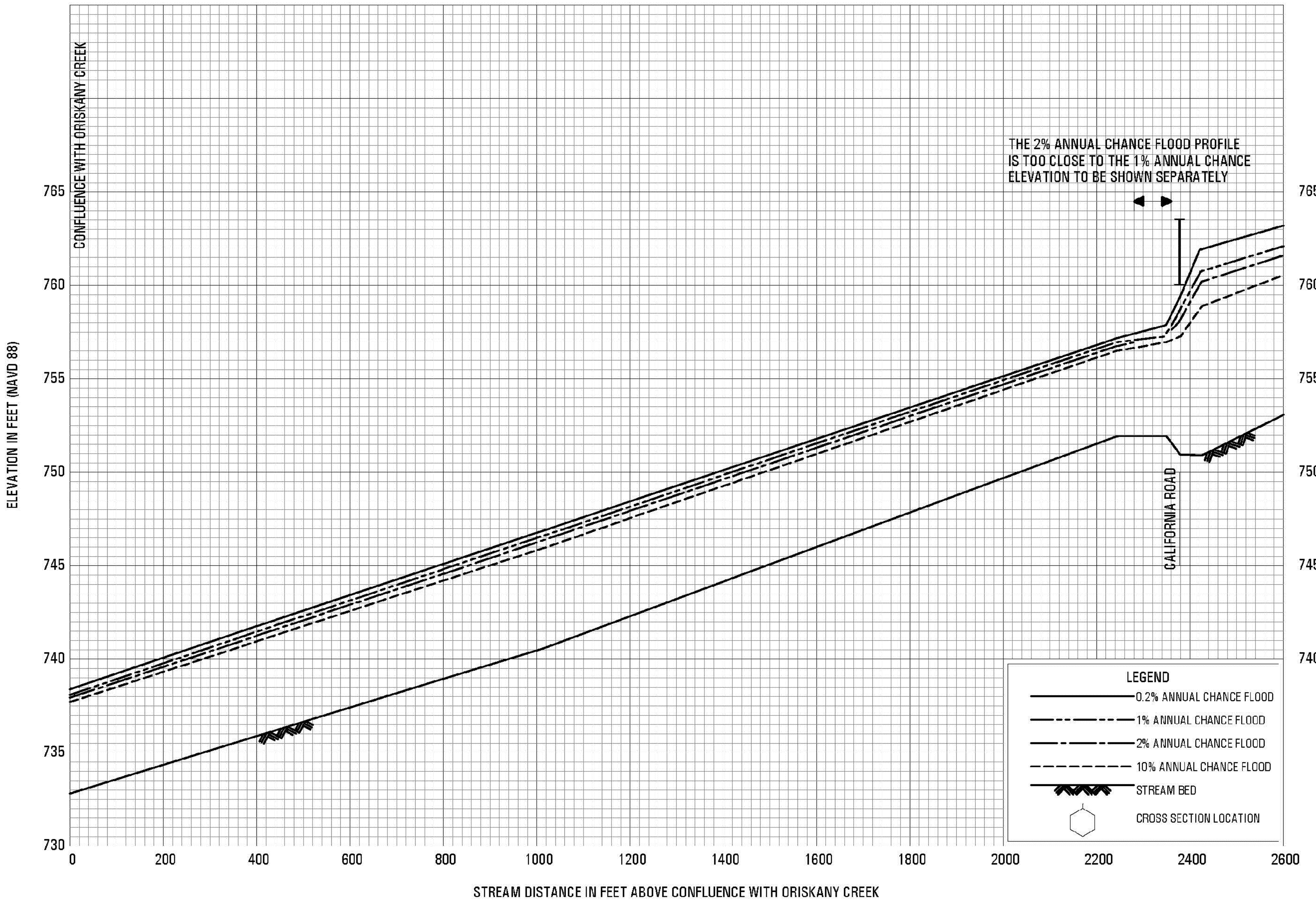

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Big Creek FEMA FIS Profile

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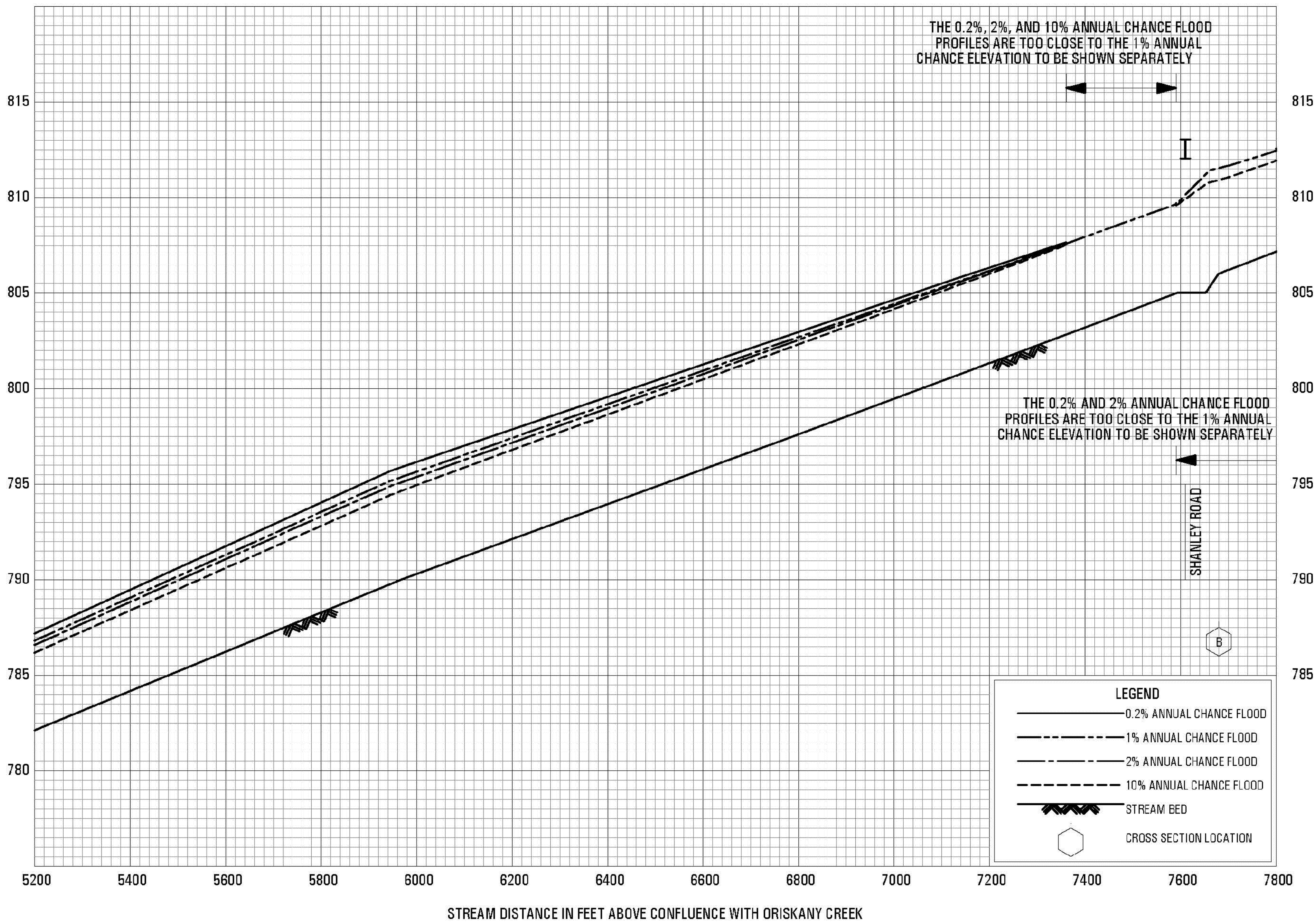
FIG. 6



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Big Creek FEMA FIS Profile

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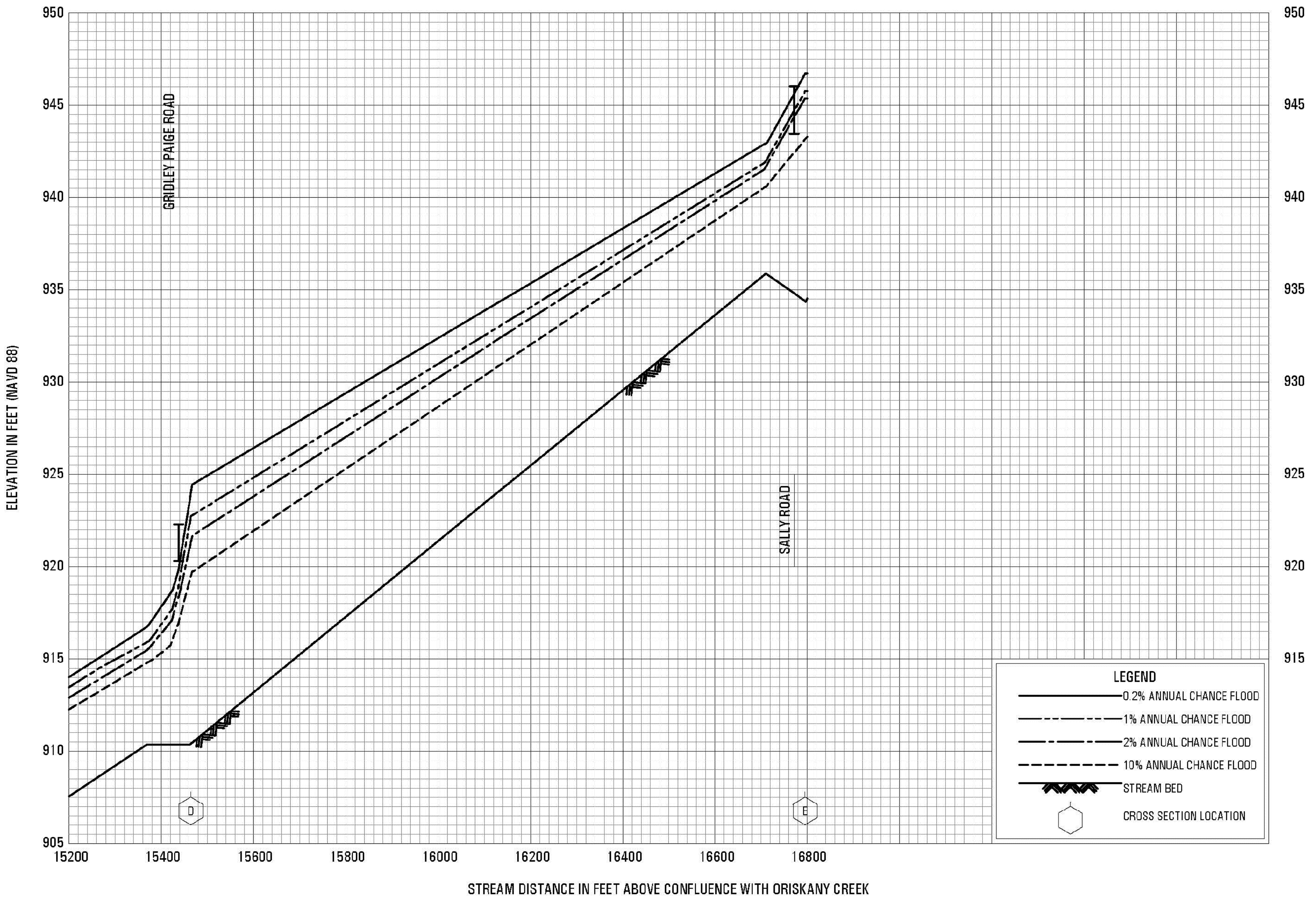
FIG. 7



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Big Creek FEMA FIS Profile

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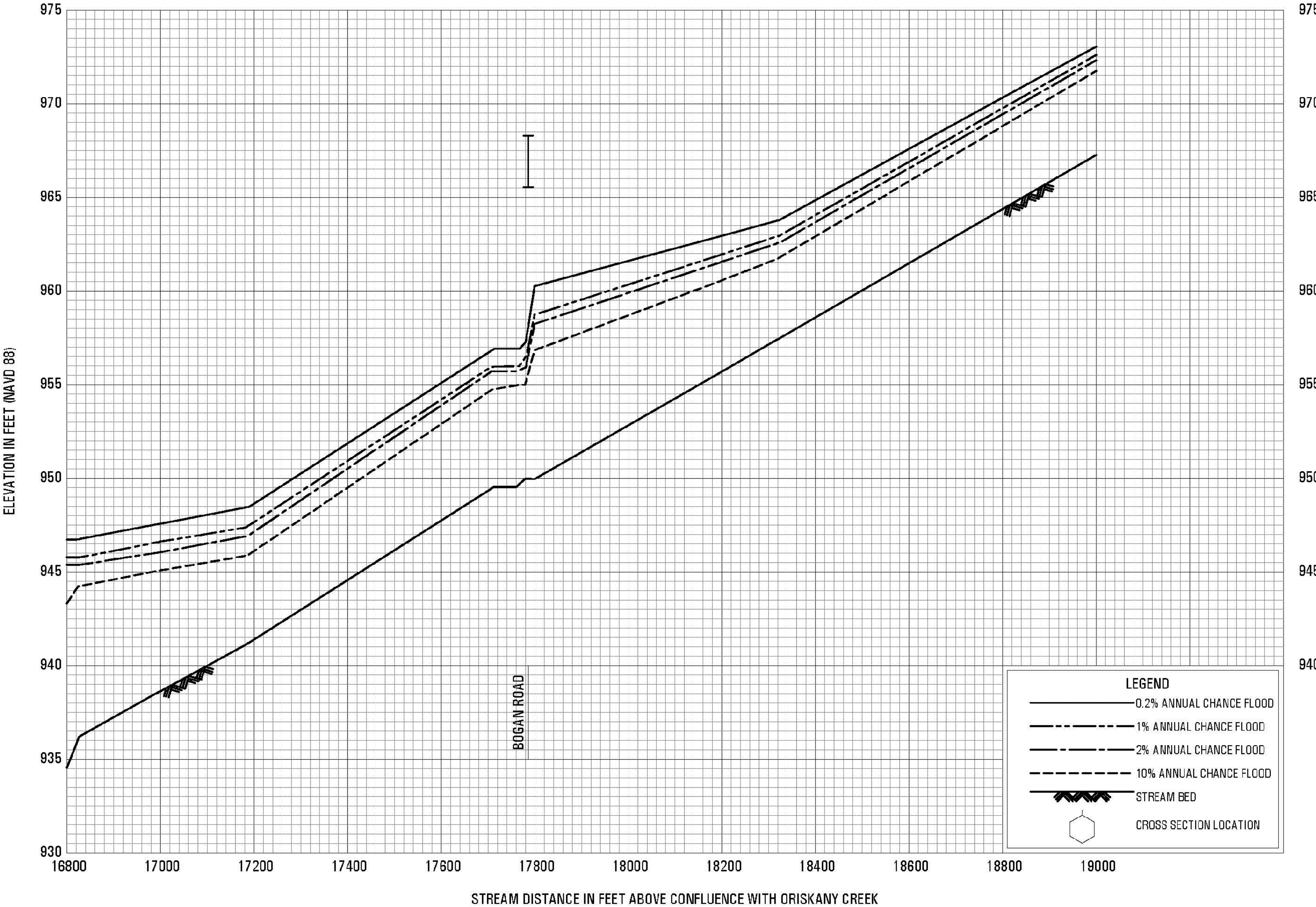
FIG. 8



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Big Creek FEMA FIS Profile

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FIG. 9

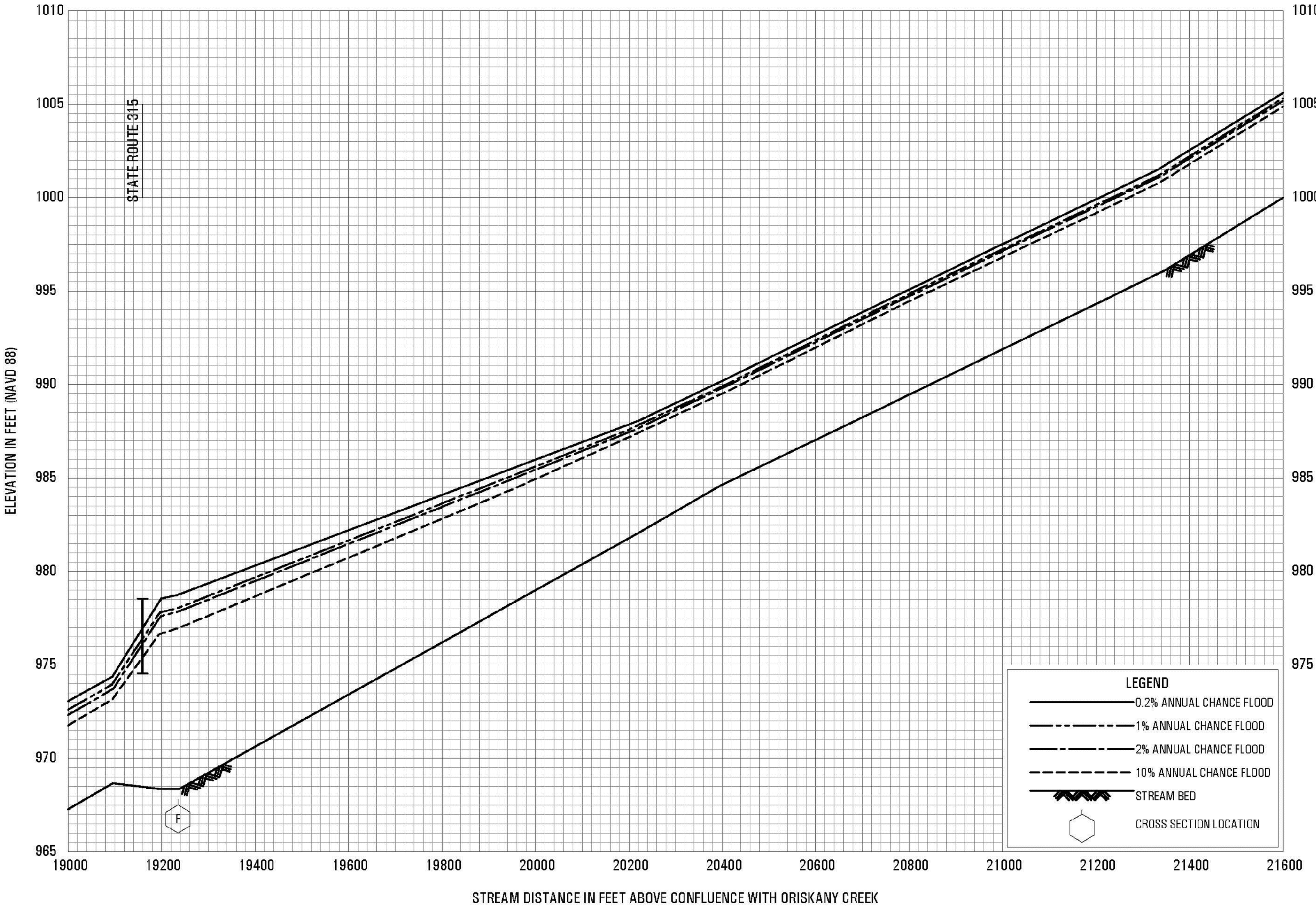

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FIG. 10

3.2 Post-Flood Community Response

Following the heavy flooding in June 2013, the NYSDOT, the Town of Marshall and the Village of Waterville implemented a number of repairs in the Big Creek basin. The NYSDOT conducted work at the Route 315 bridge crossing, including repairs to the bridge and roadway as well as construction of stacked rock walls as a repair measure for creek bank erosion upstream of the bridge. Damage to the bridge at California Road was also repaired. Private property owners in the town and village attempted repairs to individual sections of stream bank as well.

3.3 High-Risk Area #1 – Route 315 Downstream of Waterville (STA 274+00 to STA 310+00)

Figure 11 is a location plan of High Risk Area #1. This area includes Big Creek downstream of Waterville as it flows along Route 315 from Waterville (STA 310+00) to the wastewater treatment plant (STA 260+00). Within this section, floodwaters have overtopped the banks and caused bank erosion and failures. This reach of Big Creek becomes steeper, including a quarter-mile section that drops 50 feet, with a slope of 3.7 percent. The eroding banks and bank failures contribute to sediment loads in the stream and have caused trees to become uprooted and fall into the creek, resulting in a high volume of woody debris in the channel.

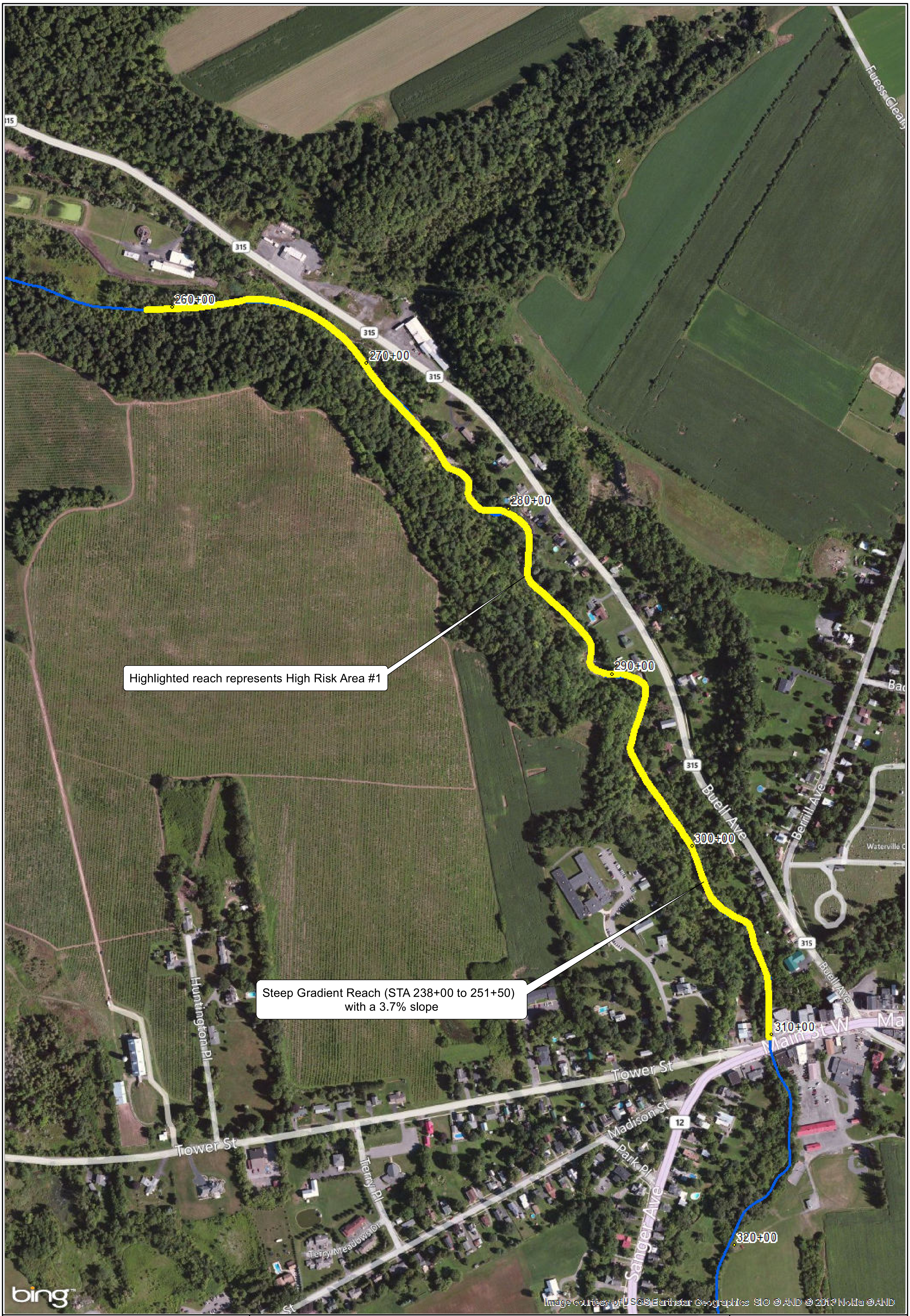
From STA 307+00 downstream to STA 274+00, the right creek bank is lined with houses, several of them located very close to the creek. During recent flood events, several of these homes experienced flooded basements as well as flood-related structural damage. On the left, the creek is confined by a high slope, which is eroding at several locations and contributing sediments to the creek. Near STA 264+50, utility lines associated with the wastewater treatment plant are being threatened by erosion.

Based on observations and measurements made in the field, the stream channel does not appear to be fundamentally undersized. FEMA mapping indicates that Big Creek's floodplain is narrow through this area, not extending out very far from the creek's normal channel. Water velocities are high due to the steepness of the channel.

The fundamental issue within the middle segment of Big Creek is many small bank failures. While no single one of these failures is the major cause of sediment transport, collectively they contribute a significant amount of sediment loading in Big Creek. Once mobilized, this sediment restricts channel and bridge capacity and exacerbates flooding.

Alternative 1-1: Stream Repair and Management Program

A stream repair and management program for this reach of Big Creek could be developed and implemented to address the multiple bank failures and areas of erosion on a site-by-site basis using a combination of conventional and bioengineering techniques. Such a program



SOURCE(S):	Figure 11: Big Creek High Risk Area #1	Location: Oneida County, New York
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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

Access to the stream channel is limited due to the steep slopes along the left bank and houses along the right bank. Use of heavy equipment will be difficult and could cause more environmental harm than benefit. The in-stream work would need to be accomplished by crews working with hand tools, using materials that could be carried in or gathered on site.

Alternative 1-2: Strategic Acquisition of High Risk Properties

In areas along this reach of Big Creek where dwellings have suffered repeated losses due to flooding, property acquisition is a potentially viable mitigation alternative, either through a FEMA buyout program or governmental buyout. Such properties can be converted to passive, nonintensive land uses such as streamside parks, picnic areas, fishing access sites, or wildlife observation areas.

Property acquisitions may be funded by FEMA under three grant programs: the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA). The PDM Program was authorized by Part 203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act) and provides funds for hazard mitigation planning and mitigation projects. The HMGP is authorized under Section 404 of the Stafford Act and provides grants to implement hazard mitigation measures after a major disaster declaration. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect

life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.
The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist states and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP. The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

The NFIP provides the funding for the FMA program. The PDM and FMA programs are subject to the availability of appropriation funding, as well as any program-specific directive or restriction made with respect to such funds. FEMA is the entity that dispenses funds for all three programs.

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

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

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

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

Alternative 1-3: Floodproofing and Flood Protection of Individual Properties

Potential measures for property protection include the following:

Elevation of the structure. Home elevation involves the removal of the building structure from the basement and elevating it on piers to a height such that the first floor is located above the 1 percent annual chance flood level. The basement area is abandoned and filled to be no higher than the existing grade. All utilities and appliances located within the basement must be relocated to the first-floor level.

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

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

Wet floodproofing of the structure to allow floodwaters to pass through the lower area of the structure unimpeded. Wet floodproofing refers to intentionally letting floodwater into a building to equalize interior and exterior water pressures. Wet floodproofing should only be used as a last resort. If considered, furniture and electrical appliances should be moved away or elevated above the 1 percent annual chance flood elevation.

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

- Relocate valuable belongings above the 1 percent annual chance flood elevation to reduce the amount of damage caused during a flood event.
- Relocate or elevate water heaters, heating systems, washers, and dryers to a higher floor or to at least 12 inches above the high water mark (if the ceiling permits). A wooden platform of pressure-treated wood can serve as the base.
- Anchor the fuel tank to the wall or floor with noncorrosive metal strapping and lag bolts.
- Install a backflow valve to prevent sewer backup into the home.
- Install a floating floor drain plug at the lowest point of the lowest finished floor.
- Elevate the electrical box or relocate it to a higher floor and elevate electric outlets to at least 12 inches above the high water mark.

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

Recommendations

Alternatives 1-1, 1-2, and 1-3 are recommended concurrently as site conditions, property owner participation, and funding allow.

3.4 High-Risk Area #2 – Undersized Bridges

Figure 12 is a location plan of High Risk Area #2. A number of bridges and one culvert along Big Creek are undersized and should be evaluated for replacement as funding allows. The most severe constrictions are occurring at the Bogan Road culvert (STA 170+00) and Gridley Paige Road bridge (STA 148+50). The bridges at Route 315 (STA 185+25), Shanley Road (STA 71+00), and California Road (STA 24+00) are also undersized. All of these crossings, with the exception of California Road, fail to span the estimated bankfull width of Big Creek, indicating that they are undersized. According to FEMA profiles, all of these crossings create hydraulic constrictions.

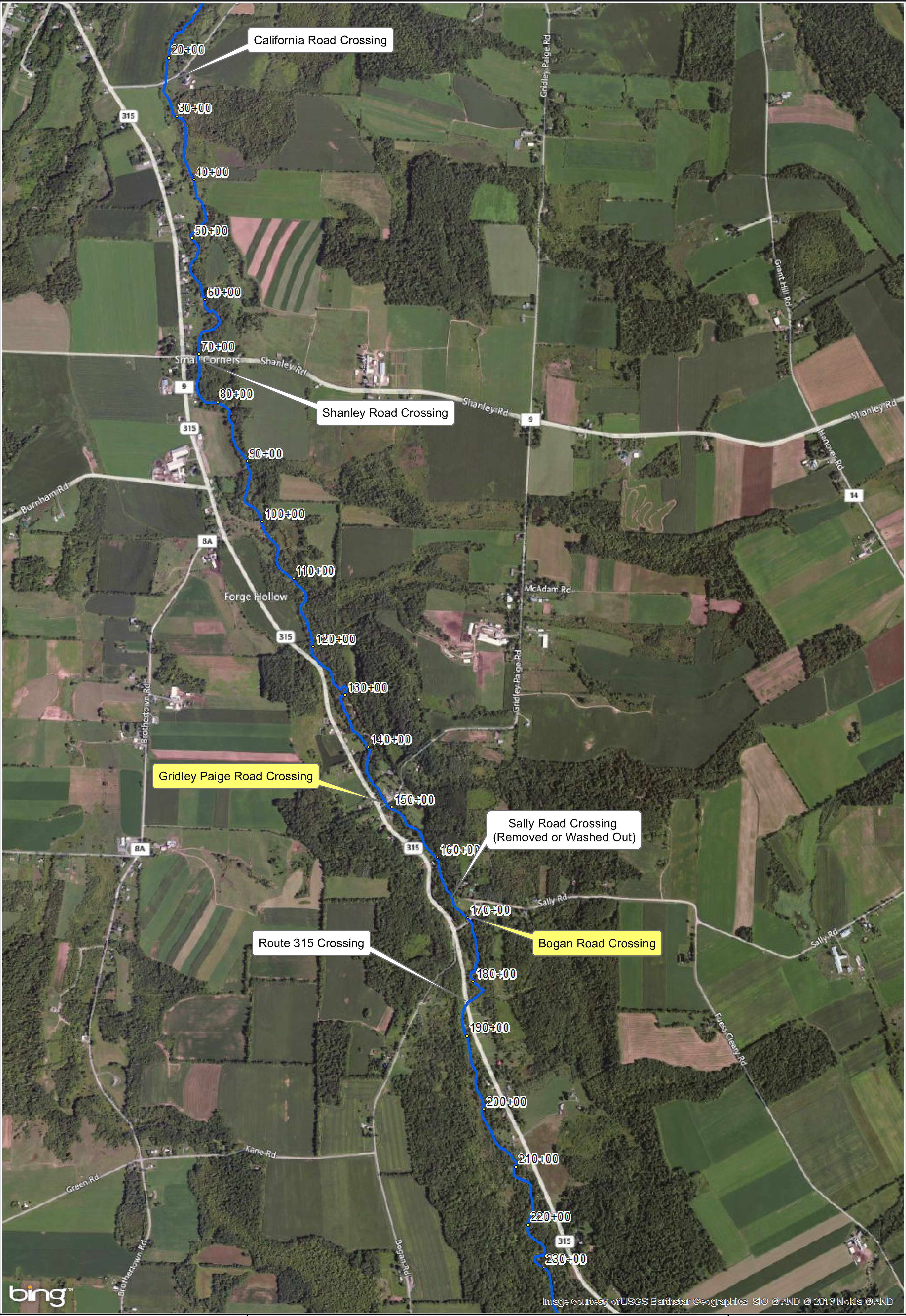
Community officials report that the bridge at Route 315 (STA 185+25) has flooded, with resulting damage to the bridge and road. This bridge is undersized and is also poorly aligned with the creek.

It appears that at one time there were crossings at both Bogan Road and Sally Road. Based on aerial photos, it appears that the Sally Road bridge has been removed or was washed out. These crossings are in very close proximity to one another. To reduce the number of crossings over Big Creek, either the Bogan Road crossing or the Sally Road crossing should be replaced, but not both.

The Gridley Paige Road, Shanley Road, and California Road bridges are all undersized. Community officials report that the California Road bridge has flooded, with resulting damage to the bridge and road.

Alternative 2-1: Replacement of Crossings at Route 315, Bogan Road, and Gridley Paige Road

Bridge replacement is expensive and often approaches or exceeds the million dollar mark. The floodplain along Big Creek is fairly narrow along much of its length and, with the exception of the lower reach near its outlet into Oriskany Creek, large land areas are not affected by flooding. As such, justification of bridge replacement to protect a relatively few number of developed parcels may be difficult. However, as these structures are scheduled for repair or replacement, modifications should be undertaken to increase their hydraulic capacity.



SOURCE(S):

Figure 12: Big Creek High Risk Area #2

Location: **Oneida County, New York**

N

NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\High Risk Areas\Big High Risk #2.mxd
1st Version: 01/06/2014
Revision: 2/20/2014
Scale: 1 in = 1,235 ft

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Specifically, when the crossings at Route 315 (STA 185+25), Bogan Road (STA 170+00), Sally Road (STA 162+00), and Gridley Paige Road (STA 148+50) are considered for replacement, they should be designed to span the creek's bankfull width and convey flood flows without causing hydraulic constriction. Due to their close proximity to one another, either the Bogan Road or the Sally Road crossing should be replaced, not both.

According to NYSDOT Bridge Inspection Reports, a number of the above bridges have been identified as being structurally deficient or in need of repairs. The Route 315 bridge was one of the bridges identified for replacement in Governor Cuomo's Scour Critical Bridge Replacement Program. According to the Governor's website, this bridge carries NY Route 315 over Big Creek in the town of Marshall, Oneida County. The highway at this location carries an average of 1,640 vehicles a day. This 36-foot span steel jack arch bridge on high concrete abutments founded on rock was constructed in 1930 and connects Waterville with Deansboro. The bridge connects residential and business districts to I-90. In this case, it is recommended to replace the bridge with one that is adequately sized rather than to repair the existing structure.

Alternative 2-2: Replacement of Crossings at Shanley Road and California Road

Similar to Alternative 2-1, when the crossings at Shanley Road (STA 71+00) and California Road (STA 24+00) are considered for repair or replacement, they should be designed to span the creek's bankfull width and convey flood flows without causing hydraulic constriction. Both of these bridges are reported to be in satisfactory to excellent condition according to 2010 NYSDOT Bridge Inspection Reports, and neither bridge causes extensive flooding of structures.

Recommendations

Alternatives 2-1 and 2-2 are recommended concurrently as bridge replacement funding allows, with the bridges identified in Alternative 2-1 being of higher priority.

4.0 RECOMMENDATIONS

The following recommendations are offered relative to flood mitigation in Big Creek:

1. *Develop and Implement a Stream Repair and Management Program* – The fundamental issue within the middle segment of Big Creek (STA 260+00 to STA 310+00) is many small bank failures. While no single one of these failures is the major cause of sediment transport, collectively they contribute a significant amount of sediment loading in Big Creek. Once mobilized, this sediment restricts channel and bridge capacity and exacerbates flooding. Arresting local bank failures and erosion is recommended through a combination of conventional and bioengineering techniques. These include planting of native vegetation to stabilize failing slopes, construction of stone weirs or drop structures to stabilize the channel and dissipate the energy of the

flowing water, and other measures to improve the condition and stability of the stream channel.

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

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

4. *Replace Undersized Bridges* – Numerous undersized bridges are located within High Risk Area #2, including the bridges at Route 315 (STA 185+25), Bogan Road (STA 170+00), Sally Road (STA 162+00, which has been washed out or removed), and Gridley Paige Road (STA 148+50). As these structures are scheduled for repair or replacement, modifications should be undertaken to increase their hydraulic capacity. They should be designed to span the creek's bankfull width and convey flood flows without causing hydraulic constrictions. Either the Bogan Road bridge or the Sally Road bridge should be replaced, not both bridges.

5. *Future Replacement of Undersized Bridges* – Numerous additional crossings within High Risk Area #2, including bridges at Shanley Road (STA 71+00) and California Road (STA 24+00), are also undersized but create less of a hydraulic constriction and do not cause extensive flooding of structures. When these bridges are scheduled for replacement, they should be designed to span the creek's bankfull width and convey flood flows without causing hydraulic constrictions.

6. *Evaluate Floodplain Regulations* – A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements. Identification of a floodplain coordinator and development of a detailed site plan review process for all proposed development within the floodplain would provide a mechanism to quantify floodplain impacts and ascertain appropriate mitigation measures.

7. *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				
Big Creek Recommendations	< $100k	$100k-$500k	$500k-$1M	$1M-$5M	>$5M
Stream Repair and Management Program	X				
Replacement of Undersized Bridges					X
Future Replacement of Undersized Bridges					X

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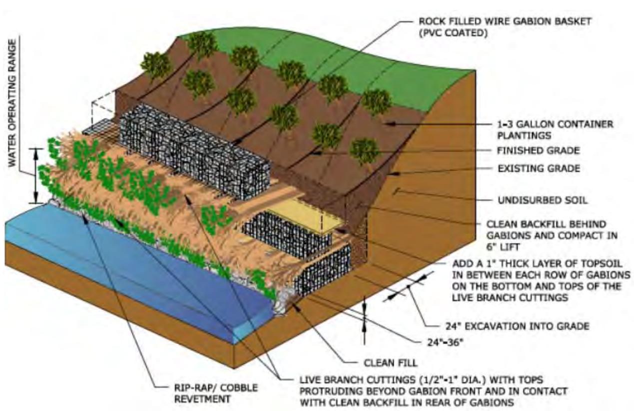
BIG CREEK, ONEIDA COUNTY, NEW YORK

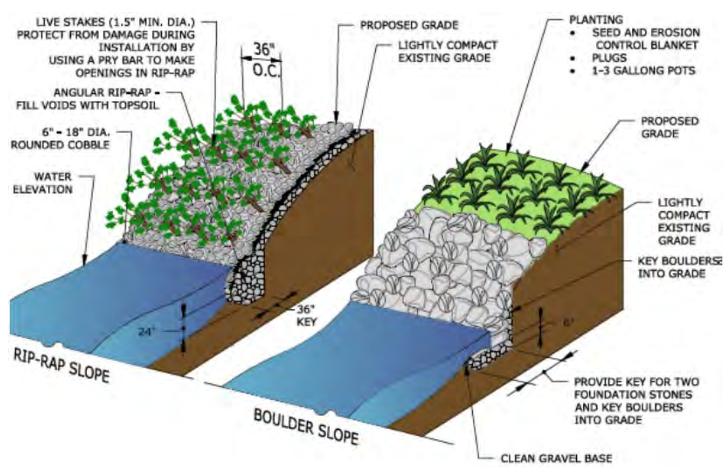
High-Risk Area #1 – Route 315 Downstream of Waterville

Site Description: High Risk Area #1 involves the area downstream of Waterville (STA 238+00 to STA 310+00) where floodwaters have overtopped the banks and caused bank erosion and failures. The multiple bank failures through this reach collectively contribute to the sediment load that is carried downstream as well as flooding damage to downstream dwellings.

Recommendations:

- Develop and implement a program for stream maintenance and repair including stabilization and restoration of bank failures and erosional sites.
- Incorporate a combination of conventional and bioengineering techniques to prevent bank erosion.





	BENEFITS
✓	Stabilized Banks
✓	Reduction of Mobile Sediments
✓	Improved Ecological Habitat

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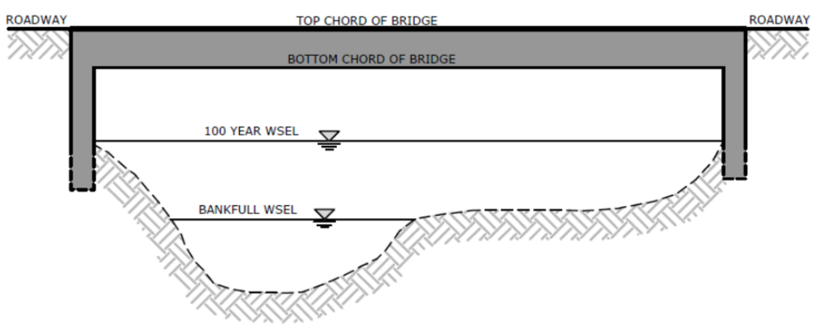
BIG CREEK, ONEIDA COUNTY, NEW YORK

High-Risk Area #2 – High Priority Undersized Bridges

Site Description: Numerous undersized bridges are located within High Risk Area #2 including Route 315 (STA 185+25, shown in the photograph below), Bogan Road (STA 170+00), Sally Road (STA 162+00, has been washed out or removed), and Gridley Paige Road (STA 148+50).

Recommendation:

- As these structures are scheduled for repair or replacement, modifications should be undertaken to increase their hydraulic capacity.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
✓	Improved Hydraulic Capacity
✓	Reduced Flood Hazard
✓	Reduction in Debris Jams
✓	Improved Ecological Connectivity
✓	Improved Safety

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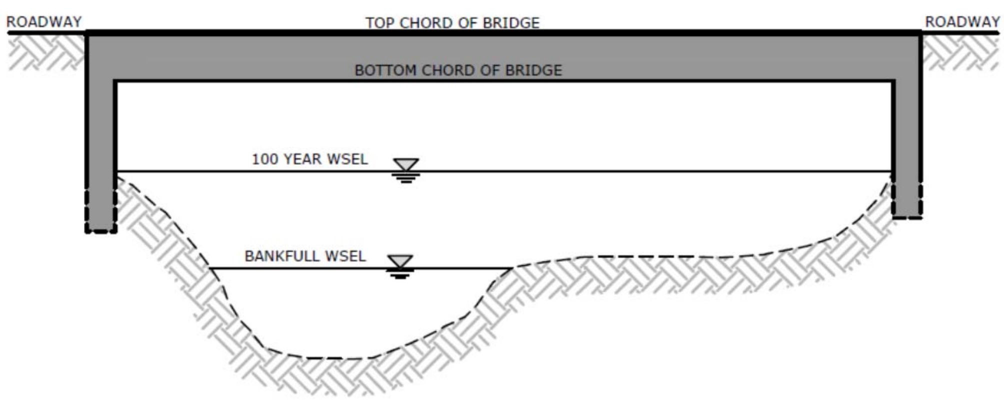
High-Risk Area #2 – Low Priority Undersized Bridges

Site Description: Numerous additional crossings within High Risk Area #2 including Shanley Road (STA 71+00) and California Road (STA 24+00), are also undersized but create less of a hydraulic constriction and do not cause extensive flooding of structures.

Recommendation:

- When these bridges are scheduled for replacement, they should be designed to span the creek's bankfull width and convey flood flows without causing hydraulic constrictions.



TYPICAL UNCONSTRAINED BRIDGE CROSSING

	BENEFITS
✓	Improved Hydraulic Capacity
✓	Reduced Flood Hazard
✓	Reduction in Debris Jams
✓	Improved Ecological Connectivity

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APPENDIX A

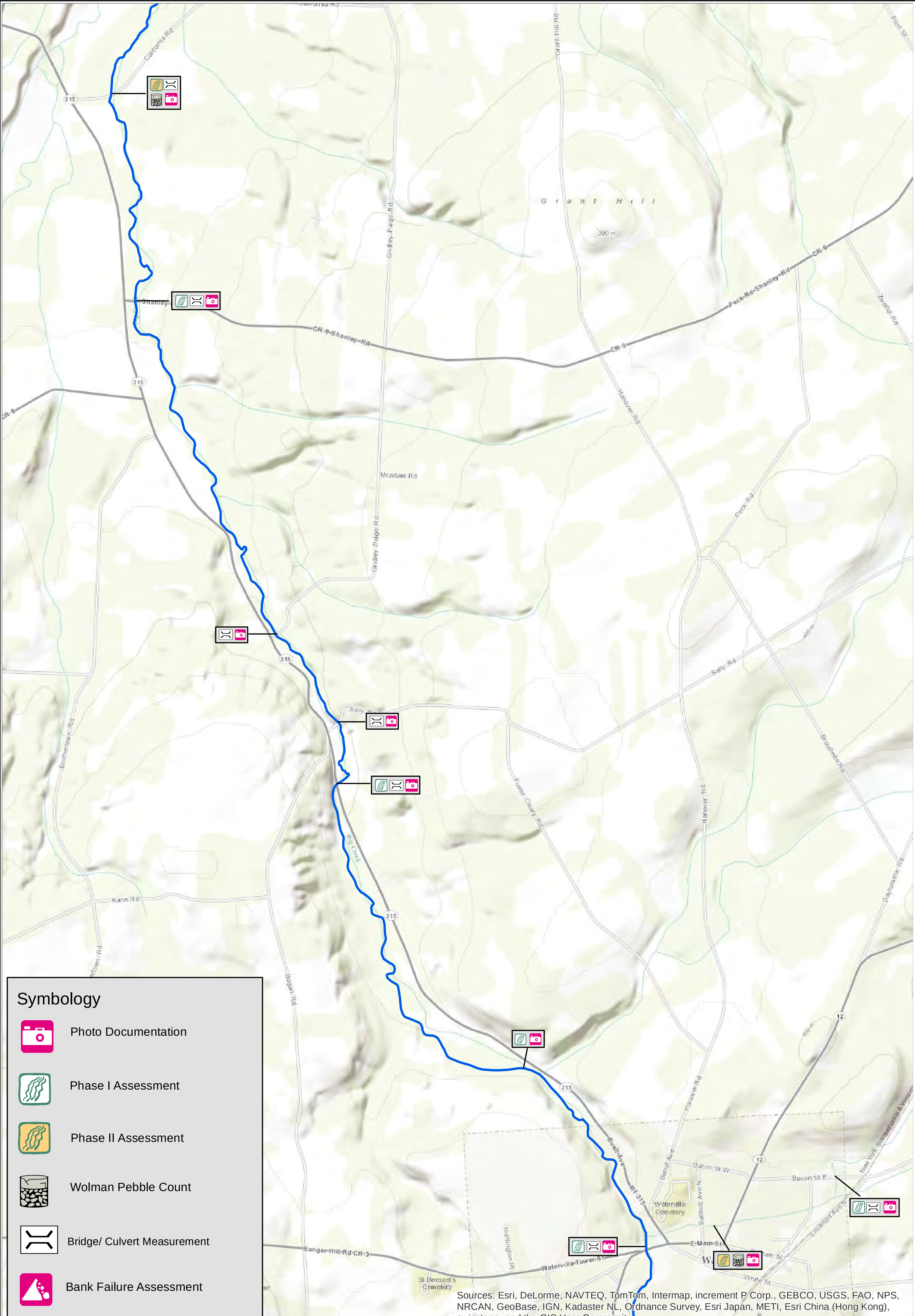
Summary of Data and Reports Collected

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):

Figure 10-1: Big Creek Data Collection Points

Location: Oneida County, New York

N

NYDOT: Emergency Transportation Infrastructure Recovery

Map By: CMP
MMI#: 5231-01
MXD: Y:\5231-01\GIS\Maps\Phase II Icon Maps\Big Creek10-1.mxd
1st Version: 12/12/2013
Revision: 12/12/2013
Scale: 1 in = 1,667 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 (Circle one)	Confined >80% L	Semiconfined 20-80%	Unconfined <20%
Valley Relief	<20'	20-100'	>100
Floodplain Width	<2 W_b	2-10 W_b	>10 W_b

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

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

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

Cascades	__________	Alluvial	__________	Channel Transport
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:

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

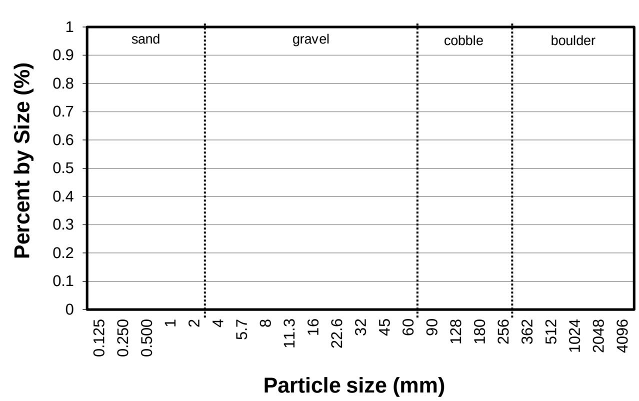
Mean	

Riffle Stability Index (%)

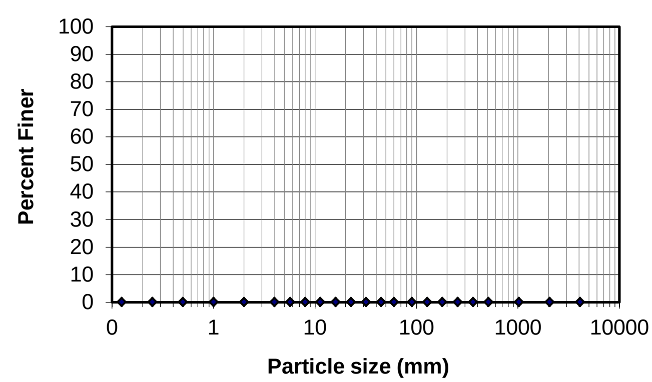
(Kappesser, 2002)

Notes

Particle Size Histogram



Gradation Curve



APPENDIX C

Big Creek Photo Log

Engineering,
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(203 271-1773

PROJECT PHOTOS

PHOTO NO.: **1** DESCRIPTION: Looking downstream from approximate location STA 295+00, this reach of Big Creek is confined to the left and overtops its banks, flooding houses along the right bank.	
PHOTO NO.: **2** DESCRIPTION: Upstream of the Route 315 crossing at STA 187+00, the bank has been stabilized with a low rock reventment wall with a weir structure installed in the channel.	

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PHOTO NO.: **3** DESCRIPTION: Depicting the Route 315 crossing at STA 184+00, this bridge is included in High Risk Area #2 due to its undersized crossing width and poor alignment to the creek.	
PHOTO NO.: **4** DESCRIPTION: In the lower reach of Big Creek at STA 26+00, this image shows a naturalistic section of channel upstream of the California Road crossing.