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RESILIENT NEW YORK FLOOD MITIGATION INITIATIVE

FISH CREEK, NEW YORK

Prepared for:

NEW YORK STATE OF OPPORTUNITY. | Office of General Services

NEW YORK STATE OF OPPORTUNITY. | Department of Environmental Conservation

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HIGHLAND PLANNING

IN NOVEMBER 2018, NEW YORK STATE GOVERNOR ANDREW CUOMO COMMITTED FUNDING TO UNDERTAKE ADVANCED MODELING TECHNIQUES AND FIELD ASSESSMENTS OF 48 FLOOD-PRONE STREAMS TO IDENTIFY PRIORITY PROJECTS AND ACTIONS TO REDUCE COMMUNITY FLOOD AND ICE JAM RISKS, WHILE IMPROVING HABITAT. THE OVERALL GOAL OF THE PROGRAM IS TO MAKE NEW YORK STATE MORE RESILIENT TO FUTURE FLOODING.

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LIST OF ABBREVIATIONS

1-D	one-dimensional
2-D	two-dimensional
ACE	annual chance flood event
BCD	Barge Canal Datum
BFE	base flood elevation
BIN	Bridge Identification Number
BRIC	Building Resilient Infrastructure and Communities
CDBG	Community Development Block Grants
CFA	Consolidated Funding Applications
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIN	Culvert Identification Number
CMIP	Coupled Model Intercomparison Project
CRISSP	Comprehensive River Ice Simulation System Project
CRRA	Community Risk and Resiliency Act
CRREL	Cold Regions Research and Engineering Laboratory
CRS	Community Rating System
CSC	Climate Smart Communities
DEM	Digital Elevation Model
EWP	Emergency Watershed Protection
FDD	freezing degree-day
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
ft	feet
GIS	Geographic Information Systems
GLS	Generalized Least-Squares
GSE	Gomez and Sullivan Engineers, D.P.C.
H&H	Hydrologic and Hydraulic
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center's River Analysis System
Highland Planning	Highland Planning, LLC
HMGP	Hazard Mitigation Grant Program
IPaC	Information for Planning and Consultation
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
LP3	Log-Pearson III
mi^2	square miles
MSC	Map Service Center
NAVD88	North American Vertical Datum of 1988
NCEI	National Centers for Environmental Information
NFIP	National Flood Insurance Program
NLCD	National Land Cover Database
NRCS	Natural Resources Conservation Service

NWI	National Wetlands Inventory
NYSCC	New York State Canal Corporation
NYSDEC	New York State Department of Environmental Conservation
NYSDHSES	New York State Division of Homeland Security and Emergency Services
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
NYSGOSR	New York State Governors Office of Storm Recovery
NYSOEM	New York State Office of Emergency Management
NYSOGS	New York State Office of General Services
NYSOPRHP	New York State Office of Parks, Recreation, and Historic Places
PDM	Pre-Disaster Mitigation
RCP	Representative Concentration Pathways
Ramboll	Ramboll Americas Engineering Solutions, Inc.
R_c	Circularity Ratio
R_E	Elongation Ratio
R_F	Form Factor
RF	Radio Frequency
RICEN	River Ice Simulation Model
RL	Repetitive Loss
ROM	Rough Order of Magnitude
SFHA	Special Flood Hazard Area
SRL	Severe Repetitive Loss
USACE	United States Army Corps of Engineers
USDHS	United States Department of Homeland Security
USDOT	United States Department of Transportation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCRP	World Climate Research Programme
WGCM	Working Group Coupled Modelling
WQIP	Water Quality Improvement Project

Introduction

Historical Initiatives

Flood mitigation has historically been an initiative in central New York and in the Fish Creek watershed. Historically, the New York State Canal Corporation (NYSCC) has dredged sediment at the confluence Fish Creek and the New York Sate Barge Canal (Domack, 2004). Additionally, ordinances within the Town of Vienna restrict development within the designated flood hazard areas. Specific to the the Town of Vienna and the Village of Sylvan Beach there have been no major flood mitigation initiatives implemented along Fish Creek.

Floodplain Development

General recommendations for high risk floodplain development follow four basic strategies:

1. Remove the flood prone facilities from the floodplain.
2. Adapt the facilities to be flood resilient under repetitive inundation scenarios.
3. Develop nature-based mitigation measures (e.g., floodplain benches, constructed wetlands, etc.) to lower flood stages in effected areas.
4. Up-size bridges and culverts to be more resilient to ice jams, high flow events, and projected future flood flows due to climate change in effected areas.

In order to effectively mitigate flooding along substantial lengths of a watercourse corridor, floodplain management should restrict the encroachment on natural floodplain areas. Floodplains act to convey floodwaters downstream, mitigate damaging velocities, and provide areas for sediment to accumulate safely. The reduction in floodplain width of one reach of a stream, often leads to the increase in flooding upstream or downstream. During a flood event, a finite amount of water with an unchanging volume must be conveyed and, as certain conveyance areas are encroached upon, floodwaters will often expand into other sensitive areas.

A critical evaluation of existing floodplain law and policies should be undertaken to evaluate the effectiveness of current practices and requirements within this watershed. Local floodplain regulations should be consistent with the National Flood Insurance Program (NFIP) and Federal Emergency Management Agency (FEMA) regulations since the Town of Vienna and Village of Sylvan Beach are participating communities in the NFIP and should involve a floodplain coordinator and a site plan review process for all proposed developments. This review should be in accordance with local regulations and the NFIP requirements, which require the community to determine if any future proposed development could adversely impact the floodplain or floodway resulting in higher flood stages and sequentially greater economic losses to the community.

Resilient NY Initiative

In November of 2018, New York State Governor Andrew Cuomo announced the Resilient NY program in response to devastating flooding in communities across the State in the preceding years. A total of 48 high-priority flood prone watersheds across New York State are being addressed through the Resilient NY program. Flood mitigation studies were commissioned using advanced modeling techniques and field assessments to identify priority projects in these 48 flood-prone watersheds, develop state-of-the-art studies to reduce flooding and ice jams, and improve ecological habitats in the watersheds (NYSGPO, 2018). The Fish Creek watershed was chosen as a study site for this initiative.

The New York State Department of Environmental Conservation (NYSDEC) is responsible for implementing the Resilient NY program with contractual assistance from the New York State Office of General Services (NYSOGS). High-priority watersheds were selected based on several factors, such as frequency and severity of flooding and ice jams, extent of previous flood damage, and susceptibility to future flooding and ice-jam formations (NYSGPO, 2018).

The Resilient NY flood studies will identify the causes of flooding within each watershed and develop effective and ecologically sustainable flood and ice-jam hazard mitigation projects. Potential flood mitigation measures will be evaluated using hydrologic and hydraulic (H&H) modeling to quantitatively determine flood mitigation strategies that would result in the greatest flood reduction benefits. In addition, the flood mitigation studies incorporate the latest climate change forecasts and assess open water and ice-jam hazards where future flood risks have been identified.

This report is not intended to address detailed design considerations for individual flood mitigation alternatives. The mitigation alternatives discussed are conceptual projects that have been initially developed and evaluated to determine their flood mitigation benefits. A more in-depth engineering design study would still be required for any mitigation alternative chosen to further define the engineering project details. However, the information contained within this study can inform such in-depth engineering design studies and be used in the application for state and federal funding and/or grant programs.

The goals of the Resilient NY Program are to:

1. Perform comprehensive flood and ice jam studies to identify known and potential flood risks in flood-prone watersheds
2. Incorporate climate change predictions into future flood models
3. Develop and evaluate flood hazard mitigation alternatives for each flood-prone stream area, with a focus on ice-jam hazards

The overarching purpose of the initiative is to evaluate a suite of flood and ice-jam mitigation projects that local municipalities can undertake to make their community more resilient to future floods. The projects should be affordable, attainable through grant funding programs, able to be implemented either individually or in combination in phases over the course of several years, achieve measurable improvement at the completion of each phase, and fit with the community way of life. The information developed under this initiative is intended to provide the community with a basis for assessing and selecting flood mitigation strategies to pursue; no recommendations are made as to which strategies the community should pursue.

The flood mitigation and resiliency study for Fish Creek began in October of 2021 and a final flood study report was issued in May of 2022.

Data Collection

Initial Data Collection

Hydrological and meteorological data were obtained from readily available state and federal government databases, including ortho-imagery, flood zone maps, streamflow, precipitation, flooding and ice jam reports. Historical flood reports, newspaper articles, social media posts, community engagement meeting notes, and geographic information system (GIS) mapping were used to identify stakeholder concerns, produce watershed maps, and identify current high-risk areas. New York State Community Risk and Resiliency Act (NYSDEC, 2020) guidelines, New York State Department of Transportation (NYSDOT) bridge standards, and *StreamStats* v4.6.2 (USGS, 2021) software were used to develop current and future potential discharges and bankfull widths and depths at various points along the stream channel. H&H modeling was performed previously, as part of the 1999 FEMA Flood Insurance Studies (FIS) for the Town of Vienna and Village of Sylvan Beach.

Updated H&H modeling was performed in this study using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) v6.1 (USACE, 2021) software to compute water stage at current and potential future levels for high risk areas and to evaluate the effectiveness of potential flood mitigation strategies. These studies and data were obtained and used, all or in part, as part of this effort. Appendix A is a summary listing of data and reports collected for this study.

Public Outreach

An initial virtual project kickoff meeting was held on October 28, 2021, with representatives of the NYSDEC, NYSOGS, Ramboll Americas Engineering Solutions, Inc. (Ramboll), Gomez & Sullivan Engineers, D.P.C. (GSE), Highland Planning, USACE, Village of Sylvan Beach, and Oneida County Soil and Water Conservation District (Appendix B). At the project kickoff meeting, project specifics including background, purpose, funding, roles, and timelines were discussed. Discussions included a variety of topics, including:

- Firsthand accounts of past flooding events
- Identification of specific areas that flooded in each community, and the extent and severity of flood damage
- Information on post-flood mitigation efforts, such as temporary floodwalls

This outreach effort assisted in the identification of current high-risk areas to focus on during the future flood risk assessments.

Field Assessment

Following the initial data gathering and agency meetings, field staff from GSE undertook field data collection efforts with special attention given to high risk areas in the Town of Vienna and Village of Sylvan Beach, as identified in the initial data collection process. Initial field assessments of Fish Creek were conducted in December 2021. Information collected during field investigations included the following:

- Rapid "windshield" river corridor inspection
- Photo documentation of inspected areas
- Measurement and rapid hydraulic assessment of bridges, culverts, and dams
- Geomorphic classification and assessment, including measurement of bankfull channel widths and depths at key cross sections

- Field identification of potential flood storage areas
- Wolman pebble counts
- Characterization of key stream bank failures, head cuts, bed erosion, aggradation areas, and other unstable stream channel features
- Preliminary identification of potential flood hazard mitigation alternatives, including those requiring further analysis

Included in Appendix C is a copy of the Stream Channel Classification Form, Field Observation Form for the inspection of bridges and culverts, and Wolman Pebble Count Form. Appendix D is a photo log of select locations within the river corridor. The collected field data was categorized, summarized, indexed, and geographically located within a GIS database. This GIS database will be made available to the NYSDEC and NYSOGS upon completion of the project.

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.

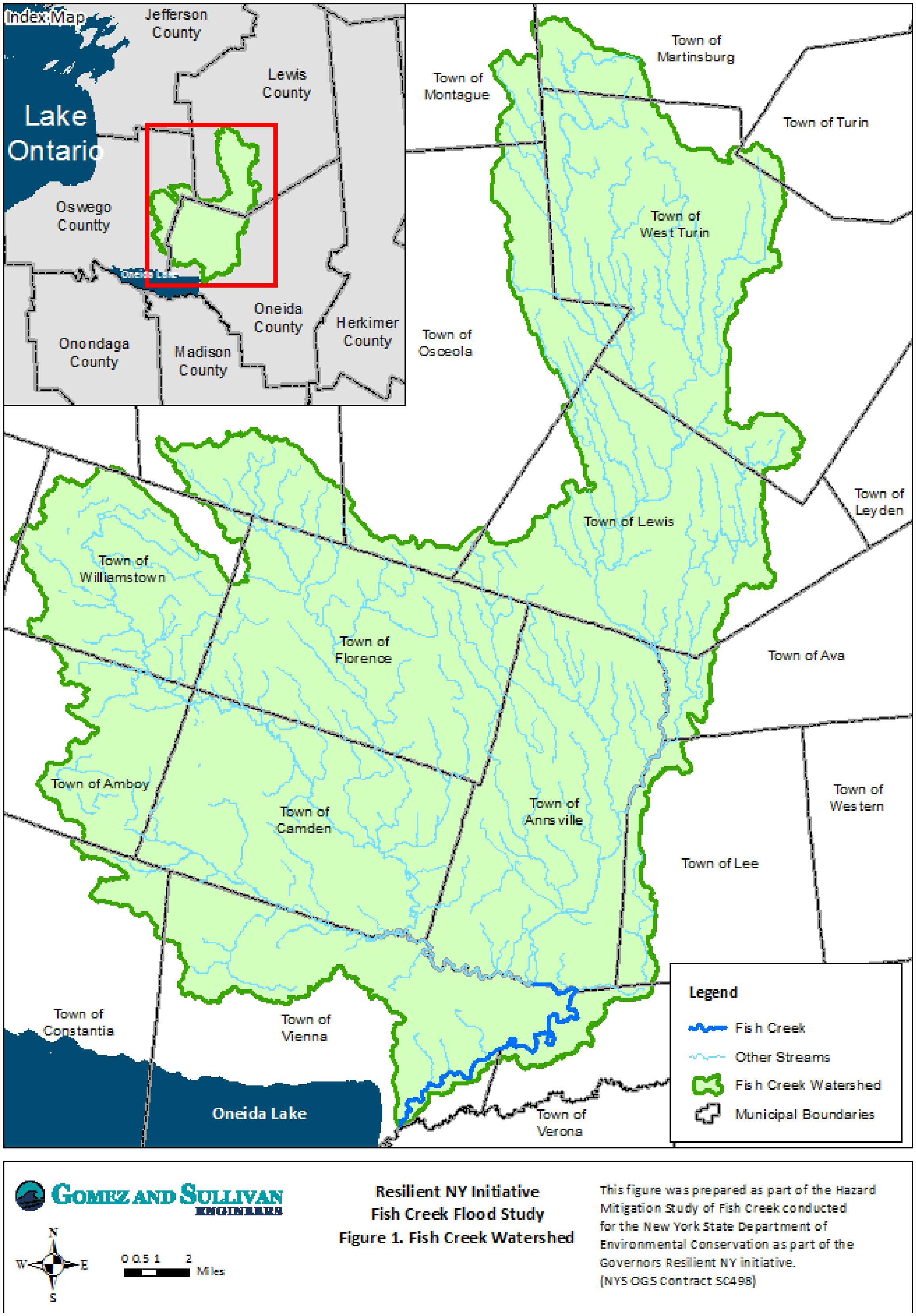
Watershed Characteristics

Study Area

The Fish Creek watershed lies to the west of Adirondack Park within the Counties of Oneida, Lewis, and Oswego, and includes all of the Towns of Camden and Annsville and the Village of Camden, as well as portions of the Towns of Martinsburg, Montague, Turin, West Turin, Osceola, Lewis, Redfield, Orwell, Williamstown, Florence, Amboy, Ava, Lee, Constantia, Rome, and Vienna, and the Village of Sylvan Beach. The creek has a total drainage area of 418 square miles at its confluence with the New York State Barge Canal. The headwaters lie within the Tug Hill region of New York, and are drained by the East Branch and West Branch of Fish Creek, which are approximately 48.8 miles and 42.4 miles long, respectively. The main stem of Fish Creek originates at the confluence of the East Branch and West Branch of Fish Creek, and flows in a south-westerly direction for 14.2 miles to the New York State Barge Canal, approximately one mile upstream of Oneida Lake.

Figure 1 depicts the location of the Fish Creek watershed. Within the watershed, the Town of Vienna and Village of Sylvan Beach were chosen as the target study area due to the history of flooding in and along the creek and the amount of development along the creek. Figure 2 identifies the study area. Figure 3 depicts the stationing along Fish Creek within the Town of Vienna and Village of Sylvan Beach, as well as the locations where field data was collected for this study.

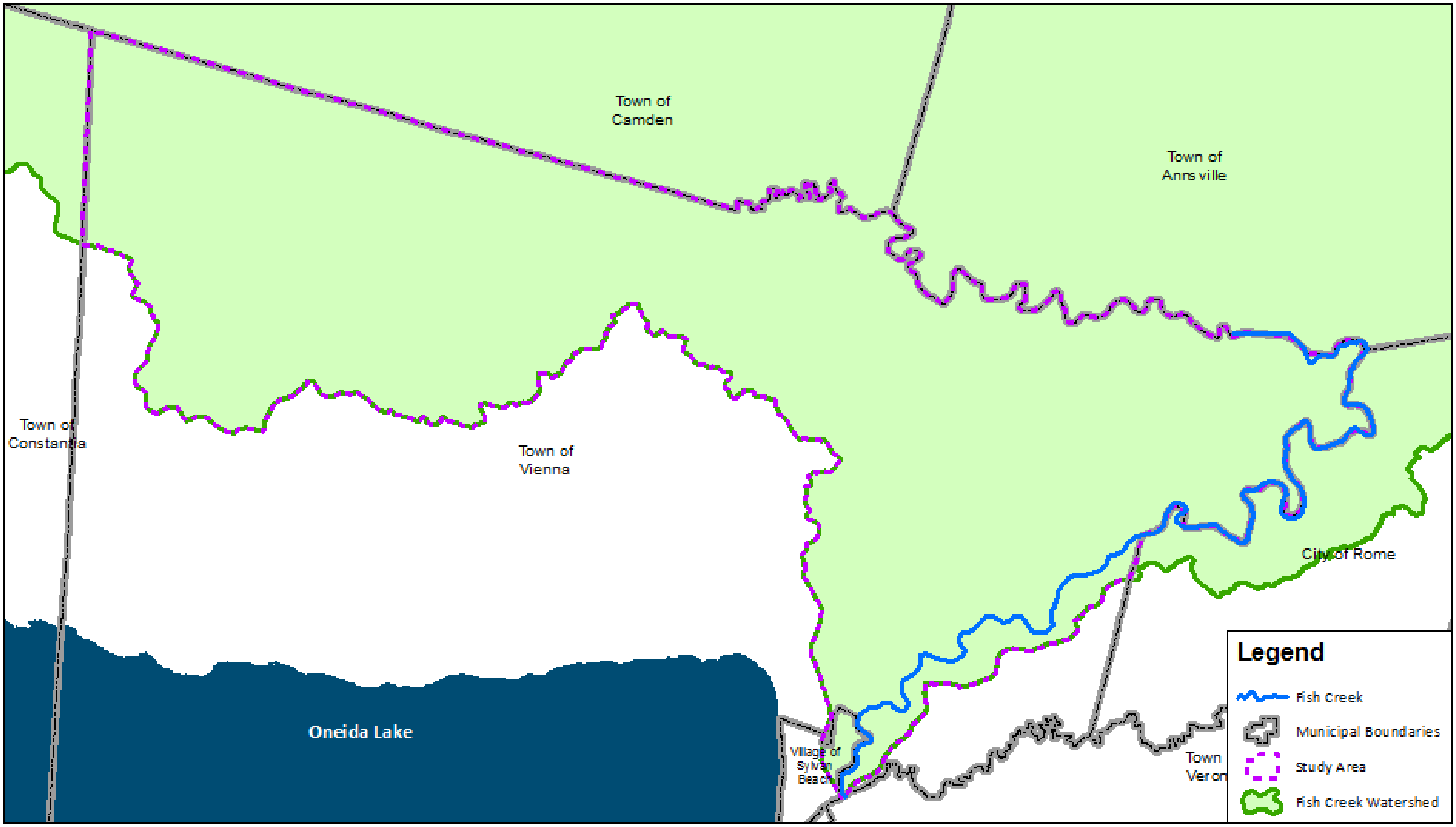
Figure 1. Fish Creek Watershed



Resilient NY Initiative
Fish Creek Flood Study
Figure 1. Fish Creek Watershed

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

Figure 2. Fish Creek Study Area, Oneida County, NY



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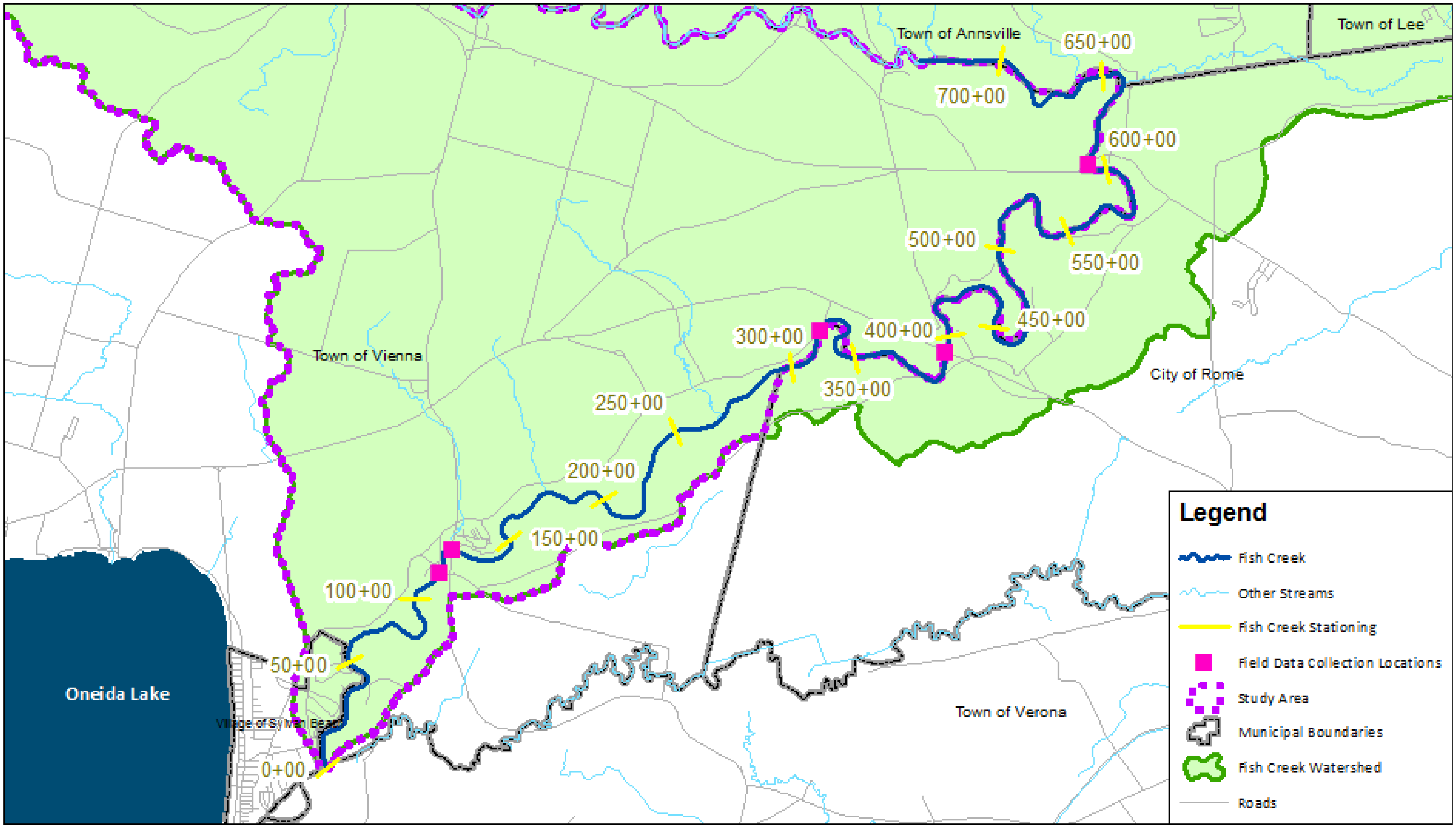
N W E S

0 0.75 1.5 3 Miles

Resilient NY Initiative
Fish Creek Flood Study
Figure 2. Fish Creek Study Area, Onieda County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

Figure 3. Fish Creek Stationing and Data Collection Locations, Oneida County, NY



Gomez and Sullivan Engineers

Resilient NY Initiative
Fish Creek Flood Study
Figure 3. Fish Creek Stationing and Data Collection Locations
Onieda County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

Environmental Conditions

An overview of the environmental and cultural resources within the Fish Creek study area was compiled using the following online tools:

- Environmental Resource Mapper (ERM): The Environmental Resource Mapper is a tool used to identify mapped federal and state wetlands, state designated significant natural communities, and plants and animals identified as endangered or threatened by the NYSDEC (NYSDEC, 2022) (https://gisservices.dec.ny.gov/gis/erm/)
- National Wetlands Inventory (NWI): The NWI is a digital map database available throught the U.S. Fish & Wildlife Service . It is also available on the NYSDEC Environmental Resource Mapper. Both maps provide information on the "status, extent, characteristics and functions of wetlands, riparian, and deep-water habitats" (NYSDEC, 2022) (https://www.fws.gov/wetlands/data/mapper.html)
- Information for Planning and Consultation (IPaC): The IPaC database provides information about endangered/threatened species and migratory birds regulated by the United States Fish and Wildlife Service (USFWS, 2021) (https://ecos.fws.gov/ipac/)
- National Register of Historic Places: The National Register of Historic Places lists historic places worthy of preservation, as authorized by the National Historic Preservation Act of 1966 (NPS, 2014) (https://www.nps.gov/maps/full.html?mapId=7ad17cc9-b808-4ff8-a2f9-a99909164466)

Wetlands

The State-Regulated Freshwater Wetlands database shows the approximate location of wetlands regulated by New York State. There are 88 mapped wetlands within and adjacent to the study area totalling approximately 8,250 acres (NYSDEC, 2022).

The NWI was reviewed to identify national wetlands and surface waters (Figure 4). The Fish Creek study area includes approximately 9,560 acres of national wetland inventory wetlands, mapped as 1,363 wetland features (NYSDEC, 2022).

Sensitive Natural Resources

The Environmental Resource Mapper (NYSDEC, 2022) identifies West Branch Fish Creek and the main stem of Fish Creek, just downstream from the confluence of the West Branch and East Branch, as mussel screening streams. The Enironmental Resource Mapper also shows a pitch pine-blueberry peat swamp beginning on the eastern edge of the study area (Figure 5).

Endangered or Threatened Species

The Environmental Resource Mapper shows that rare plants and animals including Lake Sturgeon, rare moths, and undisclosed species are in the study area (Figure 5). The NYSDEC Regional Office should be contacted to determine the potential presence of the species identified (NYSDEC, 2022).

Within the study area, the USFWS Information for Planning and Consultation (IPaC) results for the study area list the Monarch Butterfly (*Danaus plexippus*) as a Candidate species for listing under the Endangered Species Act. However, there is no critical habitat designated for the species (USFWS, 2021).

The migratory bird species listed in Table 1 are listed in the IPaC review of the study area.

Table 1. USFWS IPaC Listed Migratory Bird Species

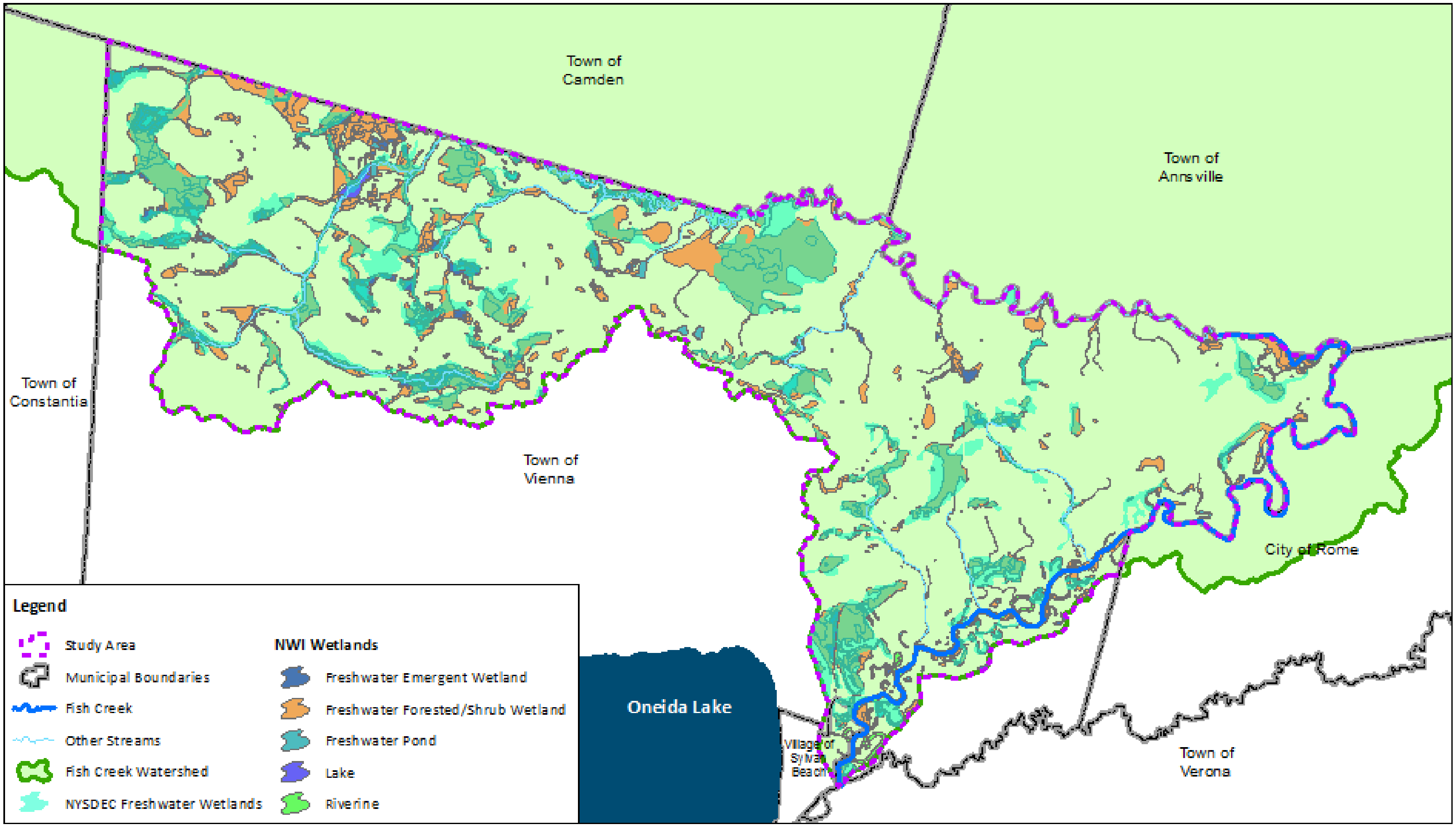
Common Name	Scientific Name	Level of Concern	Breeding Season
Bald Eagle	*Haliaeetus leucocephalus*	Non-BCC Vulnerable	Dec 1 to Aug 31
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BCC Rangewide (CON)	May 15 to Oct 10
Blue-winged Warbler	*Vermivora pinus*	BCC - BCR	May 1 to Jun 30
Bobolink	*Dolichonyx oryzivorus*	BCC Rangewide (CON)	May 20 to Jul 31
Canada Warbler	*Cardellina canadensis*	BCC Rangewide (CON)	May 20 to Aug 10
Cape May Warbler	*Setophaga tigrina*	BCC - BCR	Jun 1 to Jul 31
Cerulean Warbler	*Dendroica cerulea*	BCC Rangewide (CON)	Apr 20 to Jul 20
Eastern Whip-poor-will	*Antrostomus vociferus*	BCC Rangewide (CON)	May 1 to Aug 20
Evening Grosbeak	*Coccothraustes vespertinus*	BCC Rangewide (CON)	May 15 to Aug 10
Lesser Yellowlegs	*Tringa flavipes*	BCC Rangewide (CON)	Breeds elsewhere
Olive-sided Flycatcher	*Contopus cooperi*	BCC Rangewide (CON)	May 20 to Aug 31
Red-headed Woodpecker	*Melanerpes erythrocephalus*	BCC Rangewide (CON)	May 10 to Sep 10
Ruddy Turnstone	*Arenaria interpres morinella*	BCC - BCR	Breeds elsewhere
Short-billed Dowitcher	*Limnodromus griseus*	BCC Rangewide (CON)	Breeds elsewhere
Wood Thrush	*Hylocichla mustelina*	BCC Rangewide (CON)	May 10 to Aug 31

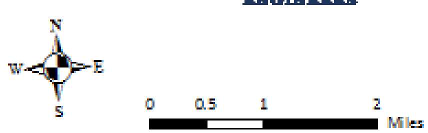
Source: (USFWS, 2021)

Cultural Resources

According to the National Register of Historic Places, there are zero (0) historic places located within the study area (NPS, 2014). Consultation with New York State Office of Parks, Recreation, and Historic Places (NYSOPRHP) should be performed to identify the potential presence of archeological resources and the subsequent need to perform a cultural resources investigation.

Figure 4. Fish Creek Study Area Wetlands and Hydrography, Oneida County, NY



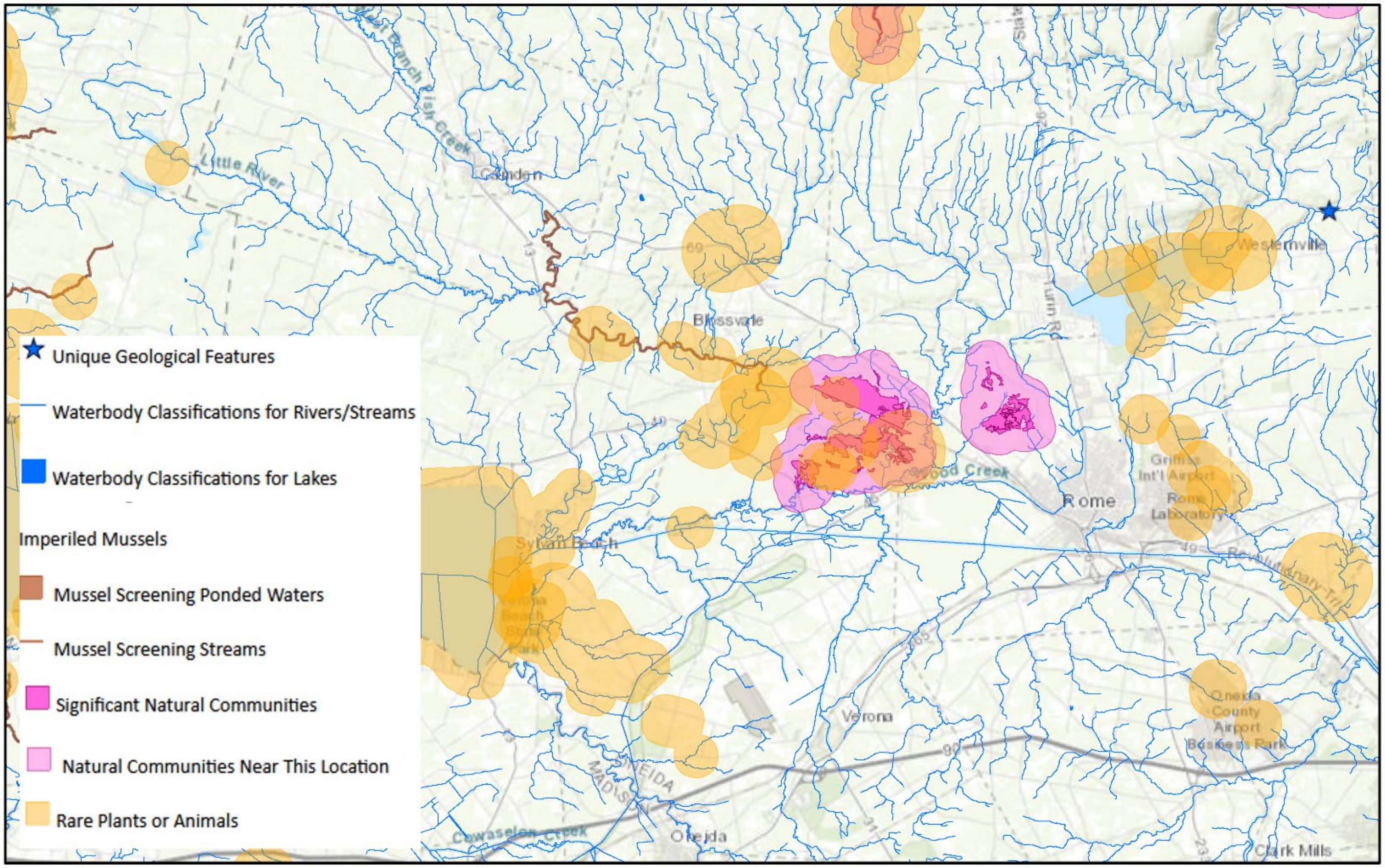


Resilient NY Initiative
Fish Creek Flood Study
Figure 4. Fish Creek Study Area Wetlands and Hydrography, Oneida County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative. (NYS OGS Contract SC498)

Figure 5. Significant Natural Communities and Rare Plants or Animals, Fish Creek Study Area, Oneida County, NY

Environmental Resource Mapper



January 21, 2022

Resilient NY Initiative
Fish Creek Flood Study
Figure 5. Significant Natural Communities and Rare Plants or Animals, Fish Creek Study Area, Oneida County, NY

1:288,895

0 1.75 3.5 7 mi

0 2.75 5.5 11 km

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri

NYS Department of Environmental Conservation
Not a legal document

Floodplain Location

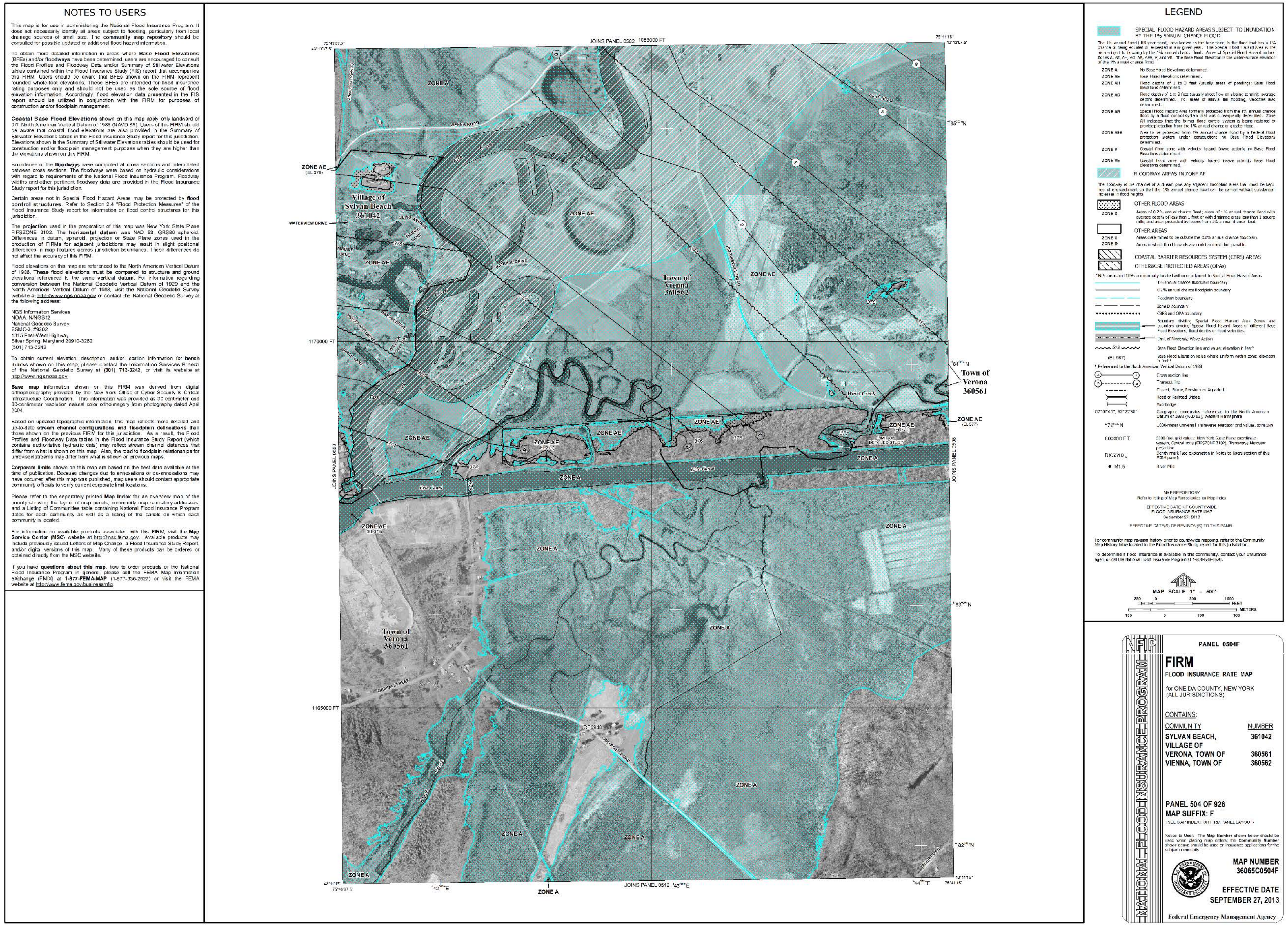
The FEMA Flood Map Service Center (MSC) (https://msc.fema.gov/portal/home) is a database that contains FEMA Flood Insurance Rate Maps (FIRMs) for areas that have had FEMA flood insurance studies completed throughout the United States. For the Town of Vienna and Village of Sylvan Beach, the current effective FEMA FIS was completed on September 27, 2013. According to the FIS, the hydrologic and hydraulic analyses completed, included re-delineation of the original FEMA H&H studies and updated new detailed studies from the original H&H studies. The FEMA FIS included Fish Creek as a re-delineation study (FEMA, 2013a).

Redelineation is the method of updating effective flood hazard boundaries to match current topographic data based on the computed water surface elevations from FEMA effective models. The results of a redelineation update are more accurate floodplain boundaries when compared to current ground conditions. Redelineation of floodplain boundaries can be applied to both riverine and coastal studies. No new engineering analyses are performed as part of the redelineation methodology; however, redelineation can be paired with new engineering studies as part of a larger update. For riverine studies, effective flood profiles and data tables from the Flood Insurance Study (FIS) report, Base Flood Elevations (BFEs) from the Flood Insurance Rate Maps (FIRMs), and supporting hydrologic and hydraulic analyses are used in conjunction with the updated topographic data to formulate new floodplain boundaries. The coastal redelineation method also typically involves no new analyses. This method combines effective information from the FIRM and FIS Report and the supporting analyses with new, more detailed, or more up to-date topographic data to redelineate coastal high hazard areas (FEMA, 2015a).

The FIRM for Fish Creek indicates Special Flood Hazard Areas (SFHAs), which are land areas covered by floodwaters during the 1% annual chance flood event (ACE), along the banks of the creek, for the entire length of the creek (FEMA, 2013b). Fish Creek is a Regulatory Floodway, which is defined as the watercourse channel and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than 1-foot over the 1% annual chance flood hazard water surface elevation, referred to as the Base Flood Elevation (BFE). In the regulatory floodway, communities must regulate encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway and demonstrate through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not increase flood levels within the community during the occurrence of the base flood. Development in the portions of the floodplain beyond the floodway, referred to as the floodway fringe, is allowed as long as it does not increase the BFE more than 1.0 foot (FEMA, 2000).

For watercourses where FEMA has provided BFEs, but no floodway has been designated, or where FEMA has not provided BFEs, the community must review floodplain development on a case-by-case basis to ensure that increases in water surface elevations do not occur or identify the need to adopt a floodway if adequate information is available. The flood zones indicated in the Fish Creek study area are Zones A, and AE, where mandatory flood insurance purchase requirements apply. A Zones are areas subject to inundation by the 1% ACE. Where detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. AE Zones are areas that have a 1% annual chance of flooding where BFEs are provided by FEMA. Figure 6 is a FIRM that includes a portion of Fish Creek in the Town of Vienna and Village of Sylvan Beach, NY (FEMA, 2013b).

Figure 6. FEMA FIRM, Fish Creek, Town of Vienna and Village of Sylvan Beach, Oneida County, NY



Study Area Land Use

The National Land Cover Database (MRLC, 2019) shows that, within the study area, the Woody Wetland land use cover type makes up 16.3% of the study area. All developed land cover types total 6.1% of the study area and all agriculture cover types total 11.4%. Further details of the distribution of land cover within the watershed are shown on Table 2. The Woody Wetland land use cover type is located generally throughout the south and western portion of the study area. Other than roads throughout the study area, the Developed land use cover types are primarily to the southwest within the Village of Sylvan Beach. Agriculture is present throughout the southeastern portions of the study area (Figure 4).

Table 2. Land Use Cover Types in the Fish Creek Study Area

Land Use Cover Type	Acres	Percentage
Barren Land (Rock/Sand/Clay)	3.06	0.0%
Cultivated Crops	1,073.02	4.5%
Deciduous Forest	6,911.61	29.2%
Developed High Intensity	3.97	0.0%
Developed, Low Intensity	223.78	0.9%
Developed, Medium Intensity	56.72	0.2%
Developed, Open Space	1,189.34	5.0%
Emergent Herbaceous Wetlands	191.48	0.8%
Evergreen Forest	6,211.33	26.2%
Grassland/Herbaceous	202.83	0.9%
Mixed Forest	1,344.36	5.7%
Open Water	404.48	1.7%
Pasture/Hay	1,638.43	6.9%
Shrub/Scrub	364.65	1.5%
Woody Wetlands	3,851.51	16.3%
Total	**23,670.57**	**100%**

Source: (MRLC, 2019)

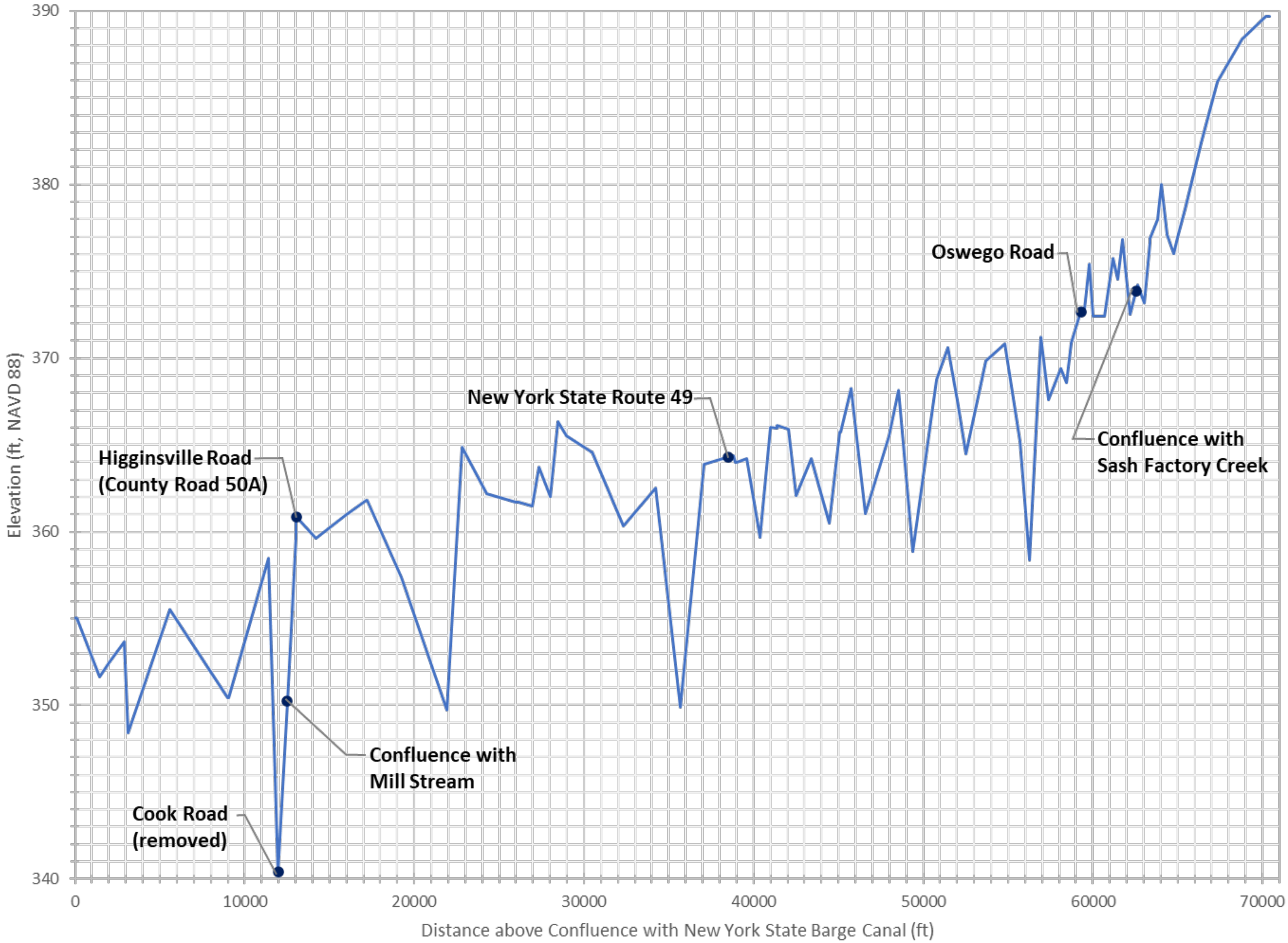
Geomorphology

While the headwaters are within the Tug Hill physiographic province and are characterized by steeply sloped stream profiles on the order of 40 feet per mile, the main Branch of Fish Creek is within the Erie-Ontario Lowland physiographic province with shallower stream profiles on the order of 2 feet per mile. The surficial geology consists glacial till and proglacial lacustrine soils with recent alluvium in proximity to the creek and lacustrine sands in the wider floodplains. The underlying bedrock transitions from siltstone to sandstone and shale.

Figure 7 is a profile of stream bed elevation and channel distance within the study area based on the hydraulic model used for this study. The figure includes the location of all stream crossings included within the hydraulic model.

Sediment depositional aggradation is occurring within the channel of Fish Creek. Aggradation is a natural fluvial process where sediment and other materials are deposited in a stream channel when the supply of sediment is greater than the amount of material that the system is able to transport. Over time, aggradation can lead to the development of sand and sediment bars within the stream channel. These sand and sediment bars may restrict flow by reducing the in-channel flow area and may act as catchpoints for ice pieces during ice breakup events, potentially increasing open water flood risks and ice jam formations (Mugade UR, Sapkale JB, 2015). Fish Creek was a significant natural sediment source which replenished the eastern shore of Oneida Lake. However, the development and operation of the New York State Barge Canal has altered the natural sediment transport processes from Fish Creek to Oneida Lake, resulting in excessive sedimentation at the confluence of Fish Creek and the New York State Barge Canal (Domack, 2004).

Figure 7. Fish Creek Study Area Profile of Stream Bed Elevation and Channel Distance



Hydrology

Fish Creek at the confluence with the New York State Barge Canal in the Town of Vienna and the Village of Sylvan Beach, NY has a watershed covering approximately 418 square miles (267,520 acres). Fish creek is approximately 14.2 miles long and is formed by the confluence of the East and West Branches of Fish Creek approximely one-third (1/3) of a mile downstream of Blossvale Road on the West Branch Fish Creek. The drainage area headwaters begin in the Tug Hill Plateau area of Lewis and Oswego Counties, generally flowing in a southerly direction where it joins the New York State Barge Canal approximately one (1) mile upstream of Oneida Lake.

Other notably significant tributaries along the main stem of Fish Creek are Sash Factory Creek and Mill Stream (upstream to downstream respectively). Sash Factory Creek joins Fish Creek approximately two-thirds (2/3) of a mile upstream of the Oswego Road Bridge over Fish Creek in the Town of Vienna. The Mill Stream confluence is located immediately downstream of the Higginsville Road (County Road 50A) Bridge over Fish Creek in the Town of Vienna.

Table 3 is a summary of the basin characteristic formulas and calculated values for the Fish Creek watershed, where A is the drainage area of the basin in square miles (mi^2), B_L is the basin length in miles, and B_P is the basin perimeter in miles (USGS, 1978). The basin length used for these computations is the longest flow length and extends up the East Branch of Fish Creek.

Table 3. Fish Creek Basin Characteristics Factors

Factor	Formula	Value
Drainage Area (A)	mi^2	418
Basin Length (B_L)	mi	63
Basin Perimeter (B_P)	mi	207
Form Factor (R_F)	A/B_L^2	0.11
Circularity Ratio (R_C)	$4\pi A/B_P^2$	0.12
Elongation Ratio (R_E)	$2(A/\pi)^{0.5}/B_L$	0.37

Form Factor (R_F) describes the shape of the basin (e.g., circular or elongated) and the intensity of peak discharges over a given duration of time. Circularity Ratio (R_C) gives an indication of topography where the higher the circularity ratio, the lower the relief and less disturbance to drainage systems by structures within the channel. Elongation Ratio (R_E) gives an indication of ground slope where values less than 0.7 correlate to steeper ground slopes and elongated basin shapes. Based on the basin characteristic factors, the Fish Creek basin would be categorized as more elongated with lower peak but longer duration high flows expected (Parveen, Kumar, & Singh, 2012). The drainage system within the basin would be expected to be steep with large impacts caused by structural disturbances in the drainage system (Waikar & Nilawar, 2014).

There are two (2) USGS stream gaging stations on Fish Creek within the watershed. The most upstream gage is located on the East Branch of Fish Creek in Taberg, NY (USGS Gage ID 04242500). This active gage has 84 years of recorded data ranging from 1924 to 2019. A gap in the data exists between 1995 and 2009. The highest recorded peak flow was 21,600 cubic feet per second on December 29, 1984. The second gage is located within the Town of Vienna at Becks Grove (USGS Gage ID 04242640). This active gage has 6 years of recorded date from 2015 to 2019. The highest recorded peak flow was 16,000 cubic feet per second on November 1, 2019.

An effective FEMA Flood Insurance Study (FIS) for Oneida County was issued on September 27, 2013, which included a redelineation study for Fish Creek and included drainage area and discharge information for the portions of Fish Creek included in this study. Table 4 summarizes the FEMA FIS drainage area and peak discharges, in cubic feet per second (cfs), for Fish Creek within the study area (FEMA, 2013a).

Table 4. Fish Creek FEMA FIS Peak Discharges

Flooding Location	Drainage Area (mi^2)	River Station (ft)	Peak Discharge (cfs)			
			10%	2%	1%	0.2%
FISH CREEK At the confluence with the New York State Barge Canal	412.5	0	18,390	23,520	26,080	31,511
FISH CREEK At confluence of Mill Stream	410.4	113+28	18,320	23,430	25,980	31,390
FISH CREEK At confluence of Sash Factory Creek	397.7	632+61	17,900	22,890	25,380	30,670

Source: (FEMA, 2013a)

According to the effective FEMA FIS, the hydrology estimates for the Town of Vienna and the Village of Sylvan Beach were determined through the log-Pearson Type III method for gage analysis of USGS gaging station No. 04242500 located on the East Branch Fish Creek at Taberg, New York. The estimates of peak discharges derived from this analysis were then transferred to various locations along Fish Creek using a general drainage area weighting equation (FEMA, 1999).

General limitations of the FEMA FIS methodology are the age of the effective FIS H&H analysis and the age of the methodology. The H&H analysis for Fish Creek was completed in 1997 using the methodology stated above.

The FIS studies were completed in 1999, with the peak flow estimates derived in 1997 by the methods stated above. The gaging analysis utilized 54 years of record between 1924 and 1977. It is unclear as to why additional records between 1977 and 1995 were not included in the analysis. Additionally, the current guidance within USGS SIR 2006-5112 recommends that transferring peak flow estimates between drainage areas are only considered valid if the project site drainage area is between 50 and 150 percent of the drainage area at the gage. The most upstream flow location at the confluence of Sash Factory Creek is calculated at 397.7 square miles per the FIS. The drainage area at the stream gage (USGS No. 04242500) is 188 square miles. This results in a project site drainage area that is 211% greater than the stream gage and is outside the parameters to use the area-transfer method for peak discharges, under current guidelines.

StreamStats v4.6.2 software (https://streamstats.usgs.gov/ss/) is a map-based web application that provides an assortment of analytical tools that are useful for water-resources planning and management, and engineering purposes. Developed by the USGS, the primary purpose of *StreamStats* is to provide estimates of streamflow statistics for user selected ungaged sites on streams and for USGS stream gages, which are locations where streamflow data are collected [(USGS, 2017); USGS 2017b)].

Methods for computing a peak discharge estimate for a selected recurrence interval at a specific site depend on whether the site is gaged or ungaged, and whether the drainage area lies within a single hydrologic region or crosses into an adjacent hydrologic region or State. Hydrologic regions refer to areas in which streamflow-gaging stations indicate a similarity of peak-discharge response that differs from the peak-discharge response in adjacent regions. These similarities and differences are defined by the regression residuals, which are the differences between the peak discharges calculated from station records and the values computed through the regression equation. There are currently six hydrologic regions in New York State [(USGS, 1991); (USGS, 2006)].

For ungaged sites, *StreamStats* relies on regional regression equations that were developed by statistically relating the streamflow statistics to the basin characteristics for a group of stream gages within a region. Estimates of streamflow statistics for an ungaged site can then be obtained by measuring its basin characteristics and inserting them into the regression equations (USGS, 2017). For example, the equation for estimating the 100-year flood for ungaged sites within the hydrologic region in New York for Fish Creek is:

$$Q_{100} = 10300*[(A)^{0.962}]*[(ST+1)^{-0.202}]*[(P)^{1.106}]*[(LAG+1)^{-0.520}]*[(FOR+80)^{-1.638}]$$

Where,

A is the drainage area, in square miles;

ST is the basin storage, in percent;

P is the mean annual precipitation, in inches

LAG is the basin lag factor, unitless

FOR is the basin forested area, in percent (USGS, 2006).

StreamStats delineates the drainage basin boundary for a selected site by use of an evenly spaced grid of land-surface elevations, known as a Digital Elevation Model (DEM), a digital representation of the stream network, and gridded land use and precipitation data. Using this data, the application calculates multiple basin characteristics, including drainage area, basin storage, mean annual precipitation, basin lag factor, and basin forested area. By using these characteristics in the calculation, the peak discharge values have increased accuracy and decreased standard errors by approximately 10% for a 1% annual chance interval (100-year recurrence) discharge when compared to the drainage-area only regression equation (USGS, 2017).

However, when one or more of the basin characteristics for an ungaged site are outside the given ranges, then the estimates are extrapolated. *StreamStats* provides warnings when extrapolation occurs. Although *StreamStats* does provide estimates of streamflow statistics in these circumstances, no error indicators are provided with them, as the errors associated with these estimates are unknown and may be very large (USGS, 2017).

In addition, estimates of streamflow statistics that are obtained from regression equations are based on the assumption of natural flow conditions at the ungaged site unless the reports that document the equations state otherwise. If human activities such as dam regulation and water withdrawals substantially affect the timing, magnitude, or duration of flows at a selected site, the regression-equation estimates provided by *StreamStats* should be adjusted by the user to account for those activities (USGS, 2017).

StreamStats was used to calculate the current peak discharges for Fish Creek and compared with the effective FIS peak discharges. Table 5 is the summary output of peak discharges calculated by the USGS *StreamStats* software for Fish Creek at the same locations as the FEMA FIS peak discharges.

Table 5. USGS *StreamStats* Peak Discharge for Fish Creek at the FEMA FIS Locations

Flooding Source and Location	Drainage Area (mi^2)	River Station (ft)	Peak Discharge (cfs)			
			10%	2%	1%	0.2%
FISH CREEK At the confluence with the New York State Barge Canal	418	0	9,100	11,600	12,900	15,600
FISH CREEK At confluence of Mill Stream	414	113+28	9,560	12,300	13,600	16,500
FISH CREEK At confluence of Sash Factory Creek	394	632+61	12,000	15,700	17,500	21,500

Source: (USGS, 2021)

As the table above shows, the results of the regional regression equation estimates of the peak flows at the flow locations identified in the FIS are highly irregular. As the locations move upstream and the drainage areas decrease, the regional regression equations calculate increased peak discharges for the same annual chance flood event. This is likely due to the combination of a very steep headwater reach and relatively flat downstream reach of Fish Creek resulting in an erroneous basin lag factor. This basin lag factor is the variable within the Hydrologic Region 1 regression equation that produces the most volatility within the estimated peak discharge value.

Using the standard error calculations from the regression equation analysis in *StreamStats*, an acceptable range at the 95% confidence interval for peak discharge values at the 10%, 2%, 1%, and 0.2% annual chance flood hazards was determined. Standard error gives an indication of how accurate the calculated peak discharges are when compared to the actual peak discharges since approximately two-thirds (68.3%) of the calculated peak discharges would be within one standard error of the actual peak discharge, 95.4% would be within two standard errors, and almost all (99.7%) would be within three standard errors (McDonald, 2014). Table 6 is a summary table of the USGS *StreamStats* standard errors at each percent annual chance flood hazard for Region 1 in New York State.

Table 6. USGS *StreamStats* Standard Errors for Full Regression Equations

Parameter	Annual Chance of Exceedance (%)			
	10%	2%	1%	0.2%
Standard Error of Peak Discharge (%)	27.2	29.4	30.8	35.1

Source: (USGS, 2006)

FEMA FIS peak discharges are greater than *StreamStats* peak discharges. As a result, the FEMA FIS peak discharge values were used in the hydraulic model simulations for this study to maintain consistency between the modeling outputs and the FEMA models.

In addition to peak discharges, the *StreamStats* software also calculates bankfull statistics by using stream survey data and discharge records from 281 cross-sections at 82 streamflow-gaging stations in a linear regression analysis to relate drainage area to bankfull discharge and bankfull-channel width, depth, and cross-sectional area for streams across New York State. These equations are intended to serve as a guide for streams in areas of the same hydrologic region, which contain similar hydrologic, climatic, and physiographic conditions (USGS, 2009).

Bankfull discharge is defined as the flow that reaches the transition between the channel and its flood plain. Bankfull discharge is considered to be the most effective flow for moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphological characteristics of channels (USGS, 2009). The bankfull width and depth of Fish Creek is important in understanding the distribution of available energy within the stream channel and the ability of various discharges occurring within the channel to erode, deposit, and move sediment (Rosgen & Silvey, 1996). Table 7 lists the estimated drainage area, bankfull discharge, width, and depth at select locations along Fish Creek as derived from the USGS *StreamStats* program.

Table 7. USGS *StreamStats* Estimated Drainage Area, Bankfull Discharge, Width, and Depth

Flooding Location	Drainage Area (mi^2)	River Station (ft)	Bankfull Depth (ft)	Bankfull Width (ft)	Bankfull Streamflow (cfs)
At the confluence with the New York State Barge Canal	418	0	7.72	194	8,330
At confluence of Mill Stream	414	113+28	7.70	190	8,270
At confluence of Sash Factory Creek	394	632+61	7.57	187	7,930

Source: (USGS, 2021)

Infrastructure

There are currently no dams located on Fish Creek within the study area. Table 8 summarizes pertinent information about the one (1) NYSDOT owned bridge crossing Fish Creek within the study area. In addition to the NYSDOT infrastructure, Fish Creek is crossed by two (2) structures within the study area, which are owned and maintained by Oneida County or the Town of Vienna, as summarized in Table 9. It is noted that there are no culvert crossings over Fish Creek within the study area. Hydraulic capacity is the measure of the amount of water that can pass through a structure or watercourse. Hydraulic design is an essential function of structures in watersheds. Exceeding the capacity can result in damages or flooding to surrounding areas and infrastructure (USDOT, 2012). In assessing hydraulic capacity of the culverts and bridges along Fish Creek, the FEMA FIS profile of Fish Creek was used to determine the lowest annual chance flood elevation to flow under the low chord of a bridge, without causing an appreciable backwater condition upstream (Table 8, Table 9). Figure 8 depicts the location of the infrastructure crossing Fish Creek within the study area.

Table 8. NYSDOT Bridges Crossing Fish Creek

Roadway Carried (NY/US Route)	NYSDOT BIN/CIN	River Station (ft)	Bridge Length (ft)	Surface Width[1] (ft)	Hydraulic Capacity (% Annual Chance)
NYS Route 49 (49 49 26021127)	1026210	392+50	256	33.9	0.2%

Notes:

1. Surface Width is measured parallel to creek flow and refers to the curb-to-curb width, which is the minimum distance between the curbs or the bridge railings (if there are no curbs), to the nearest 30 mm or tenth of a foot (NYSDOT, 2006).

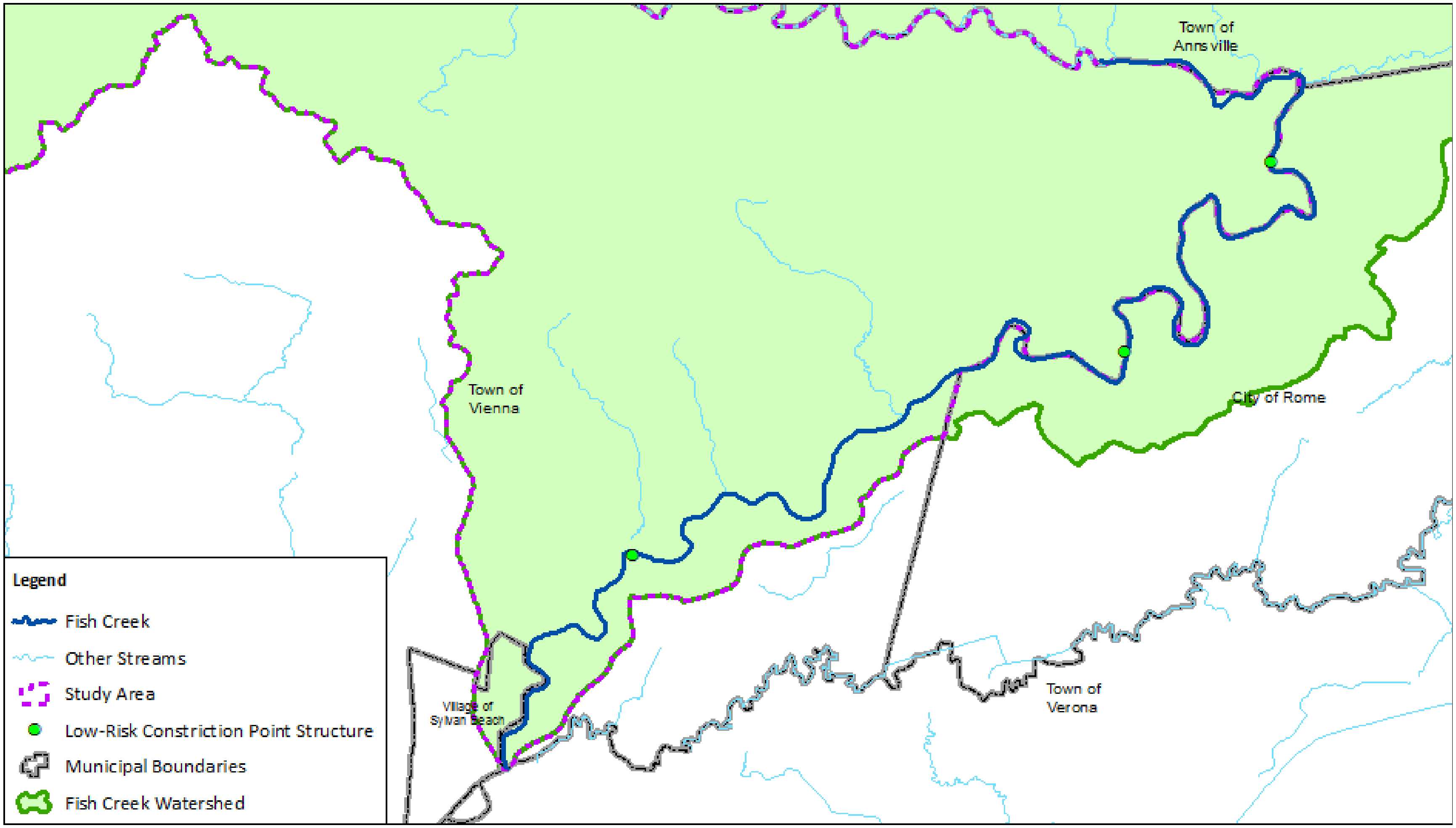
Source: (NYSDOT, 2019a); (FEMA, 2013a)

Table 9. Non-NYSDOT Bridges Crossing Fish Creek

Roadway Carried	BIN/CIN	River Station (ft)	Owner	Bridge Length (ft)	Surface Width (ft)	Hydraulic Capacity (% Annual Chance)
Higginsville Road (CR 50A)	3311290	123+00	Oneida County	404	30	0.2%
Oswego Road	2206390	605+74	Town of Vienna	305	34	0.2%

Source: (NYSDOT, 2019a); (FEMA, 2013a)

Figure 8. Fish Creek Study Area Infrastructure, Oneida County, NY



Resilient NY Initiative
Fish Creek Flood Study
Figure 8. Fish Creek Study Area Infrastructure
Oneida County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

In New York State, hydraulic and hydrologic regulations for bridges were developed by the NYSDOT. The NYSDOT guidelines require a factor of safety for bridges that cross waterways, known as freeboard. Freeboard is the additional capacity, usually expressed as a distance in feet, in a waterway above the calculated capacity required for a specified flood level, usually the base flood elevation. Freeboard compensates for the many unknown factors that could contribute to flood heights being greater than calculated, such as wave action, minor silt and debris deposits, the hydrological effect of urbanization of the watershed, etc. However, freeboard is not intended to compensate for higher floods expected under future climatic conditions, such as those due to sea-level rise or more extreme precipitation events (NYSDEC, 2020).

The term “bridge” shall apply to any structure whether single or multiple span construction with a clear span in excess of 20 feet when measurement is made horizontally along the center line of roadway from face to face of abutments or sidewalls immediately below the copings or fillets; or, if there are no copings or fillets, at 6 inches below the bridge seats or immediately under the top slab, in the case of frame structures. In the case of arches, the span shall be measured from spring line to spring line. All measurements shall include the widths of intervening piers or division walls, as well as the width of copings or fillets (NYSDOT, 2020).

According to the NYSDOT bridge manual (2019) for Region 2, which includes Hamilton, Herkimer, Fulton, Madison, Montgomery, and Oneida Counties, new and replacement bridges are required to meet certain standards, which include (NYSDOT, 2019b):

- The structure will not raise the water surface elevations anywhere when compared to the existing conditions for both the 2 and 1% annual chance flood event (ACE), which corresponds to the 50- and 100-year flood flows, respectively.
- The proposed low chord shall not be lower than the existing low chord.
- A minimum of 2’-0” of freeboard for the projected 2% ACE (50-year flood) is required for the proposed structure. The freeboard shall be measured at the lowest point of the superstructure between the two edges of the bottom angle for all structures.
- The current 1% ACE (100-year flood), based on peak streamflow from the USGS *StreamStats* plus a 20% increase in flow, shall pass below the proposed low chord without touching it.
- The maximum skew of the pier to the flow shall not exceed 10 degrees.

In addition, current peak flows shall be increased to account for future projected peak flows based on the USGS *StreamStats* tool where current 2% ACE peak flows shall be increased by 20% in Region 2. For critical bridges, the minimum hydraulic design criteria is 3-feet of freeboard over the 2% annual chance flood elevation. A critical bridge is considered to be vital infrastructure that the incapacity or destruction of such would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters [(NYSDOT, 2019b); (USDHS, 2010)].

In an effort to improve flood resiliency of infrastructure in light of future climate change, New York State passed the Community Risk and Resiliency Act (CRRA) in 2014. In accordance with the guidelines of the CRRA, the NYSDEC released the *New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act* (2020) report. In the report, the NYSDEC outlined infrastructure guidelines, most notably that the new freeboard recommendation for normal bridges is 2-feet of freeboard over the elevation of a flood with a 1% chance of being equaled or exceeded in a given year (i.e. base flood elevation) and 3-feet for a critical structure (NYSDEC, 2020). When compared to current guidelines, the new CRRA climate change recommended freeboard is based on the 1% ACE water surface elevation, while the previous guidelines were based on the 2% ACE. This is a higher standard for freeboard. Table 10 displays the 2% and 1% annual chance flood levels and their calculated difference at FEMA FIS infrastructure locations using the FIS profile for Fish Creek.

Table 10. FEMA FIS Profile 2 and 1% Annual Chance Flood Hazard Levels with Differences at Infrastructure Locations

Bridge Crossing	River Station (ft)	2% Water Surface Elevation (ft NAVD88)	1% Water Surface Elevation (ft NAVD88)	Difference in Water Surface Elevations (ft NAVD88)
Higginsville Road (CR 50A)	123+00	379.10	379.57	0.47
NYS Route 49	392+50	387.70	388.23	0.53
Oswego Road	605+74	399.37	400.43	1.06

Source: (FEMA, 2013a)

In assessing hydraulic capacity of the bridges located in the identified high-risk areas along Fish Creek, the FEMA FIS profile was used to determine the lowest annual chance flood elevation to flow under the low chord of a bridge, without causing a significant backwater condition upstream (Table 8, Table 9). According to the FEMA FIS profiles, two (2) of the structures within the identified high-risk areas do not meet the NYSDOT guidelines for 2-feet of freeboard for bridges: Higginsville Road (CR 50A) and NYS Route 49. In addition, these structures do not meet the new CRRA climate change infrastructure guidelines as described above. The low chord elevations are above the 0.2% ACE, but they do not provide the recommended freeboard (FEMA, 2013a). Even though these structures may have hydraulic capacity restraints, the NYSDOT has to balance both physical constraints along with cost versus benefit of replacing existing bridges to meet the new CRRA guidelines.

In addition to comparing the annual chance flood elevations and low chords for bridges that cross Fish Creek, the structure width and bankfull width were compared for each of these structures. The USGS *StreamStats* tool was used to calculate the bankfull widths and discharge for each structure along Fish Creek. The structures with bankfull widths that are wider than or close to the structures width indicate that water velocities have to slow and contract in order to pass through the structures, which can cause sediment depositional aggradation and the accumulation of sediment and debris. Aggradation can lead to the development of sediment and sand bars, which can cause upstream water surfaces to rise, increasing the potential for overtopping banks or backwater flooding. The bankfull widths estimated during field investigations at each bridge, suggested a wider bankfull width at the Higginsville Road Bridge and a smaller bankfull width at the Oswego Road Bridge than calculated by the StreamStats tool. All the bridges within the study area that cross Fish Creek have bridge openings that are wider than the bankfull widths, regardless of which bankfull width data source is utilized. As such, this study did not consider any of the existing bridged to be potential constriction points, and are mapped as low-risk constriction point structures in Figure 8.

Climate Change Implications

Future Projected Stream Flow in Fish Creek

In New York State, climate change is expected to exacerbate flooding due to projected increases of 1-8% in total annual precipitation coupled with increases in the frequency, intensity, and duration of extreme precipitation events (events with more than 1, 2, or 4 inches of rainfall) (NYSERDA, 2011). In response to these projected changes in climate, New York State passed the Community Risk and Resiliency Act (CRRA) in 2014. In accordance with the guidelines of the CRRA, the NYSDEC released the New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act (2020) report. In the report, two methods for estimating projected future discharges were discussed: an end of design life multiplier and the USGS *FutureFlow Explorer* map-based web application (NYSDEC, 2020).

USGS *FutureFlow Explorer* v1.5 (https://ny.water.usgs.gov/maps/floodfreq-climate/) is discussed as a potential tool to project peak flows under various climate scenarios into the future. *FutureFlow* Explorer was developed by the USGS in partnership with the NYSDOT. This application is an extension for the USGS *StreamStats* map-based web application and projects future stream flows in New York State. The USGS team examined 33 global climate models and selected five that best predicted past precipitation trends in the region. The results were then downscaled to apply to all six hydrologic regions of New York State. Three time periods can be examined: 2024-2049, 2050-2074 and 2075-2099, as well as two Intergovernmental Panel on Climate Change (IPCC) greenhouse gas emission scenarios: RCP 4.5 and RCP 8.5. RCP 4.5 is considered a midrange-emissions scenario, and RCP 8.5 is a high-emissions scenario [(Taylor, Stouffer, & Meehi, 2011); (NYSDEC, 2020)].

In general, climate models are better at forecasting temperature than precipitation and contain some level of uncertainty with their calculations and results. The USGS recommends using *FutureFlow* projections as qualitative guidance to see likely trends within any watershed and as an exploratory tool to inform selection of appropriate design flow. Current future flood projection models will not provide accurate results for basins that extend across more than one hydrologic region in New York (NYSDEC, 2020).

Based on the current future flood projection models, flood magnitudes are expected to increase in nearly all cases in New York State, but the magnitudes vary among regions. While the *FutureFlow* application is still being upgraded, it can be used with appropriate caution. Climate model forecasts are expected to improve and as they do, the existing regression approach will be tested and refined further (NYSDEC, 2020).

The NYSDEC recommends that future peak flow conditions should be adjusted by multiplying relevant peak flow parameters by a factor specific to the expected service life of the structure and geographic location of the project. For Eastern New York, the recommended design-flow multiplier is 20% increased flow for an end of design life of 2025-2100 (NYSDEC, 2020). Table 11 provides a summary of the projected future peak stream flows using the FEMA FIS peak discharges and 20% CRRA design multiplier.

Table 11. Fish Creek Projected Future Peak Discharges

Flooding Location	Drainage Area (mi^2)	River Station (ft)	Projected Future Peak Discharge (cfs)			
			10%	2%	1%	0.2%
At the confluence with the New York State Barge Canal	412.5	0	22,100	28,300	31,300	37,900
At confluence of Mill Stream	410.4	113+28	22,000	28,200	31,200	37,700
At confluence of Sash Factory Creek	397.7	632+61	21,500	27,500	30,500	36,900

Source: (NYSDEC, 2020)

Appendix E contains the HEC-RAS simulation summary sheets for the current and projected future flow simulations. The HEC-RAS model simulation results for the future condition model parameters using the future projected discharge values are similar to the based condition model output with the only difference being future projected water surface elevations are between 0.5 and 2.0 feet higher as a result of the increased discharges.

Table 12 provides a comparison of HEC-RAS base condition modeled water surface elevations at the FIS discharge locations, using the effective FEMA FIS flows, and future condition, using the 20% CRRA design multiplier flows.

Table 12. HEC-RAS Current and Projected Future Flow Water Surface Elevation Comparison

Flooding Location	Drainage Area (mi^2)	River Station (ft)	Water Surface Elevation Change (ft)[1]			
			10%	2%	1%	0.2%
At the confluence with the New York State Barge Canal	412.5	0	1.0	1.2	1.2	1.4
At confluence of Mill Stream	410.4	113+28	0.5	1.0	1.1	1.3
At confluence of Sash Factory Creek	397.7	632+61	1.8	1.9	1.8	2.0

Notes:
1. Positive changes in water surface elevation indicate the future conditions water surface elevation is higher than the base condition.

Source: : (FEMA, 2013a); (NYSDEC, 2020); (USACE, 2021)

Flooding Characteristics

Flooding History

Along Fish Creek, flooding tends to occur due to heavy spring rains or during the spring thaw. The flooding is exacerbated by the breakup and build-up of ice. The ice break up often gets stalled at the confluence of Fish Creek with the New York State Barge Canal, causing an ice jam which pushes upstream water surfaces artificially higher than if the waters were free flowing.

Fish Creek has experienced several large storm events. The most extreme event was the remnant hurricane in June 1972, Tropical Storm Agnes. Based on the USGS gage (Station No. 04242500) at Taberg on the East Branch Fish Creek, this storm equated to a 0.2% annual chance event. The storm increased the water levels on Oneida Lake to record highs (11.34 ft) and similar levels of flooding were observed along Fish Creek. Within the Village of Sylvan Beach, flooding mainly occurred within in the vicinity of Fish Creek oxbows and the marshy areas. Within the Town of Vienna, the shoreline of Fish Creek and Fish Creek Landing experienced the most severe damage from the flood.

FEMA FIRMs are available for Fish Creek, depicting the extent of the expected floodplain. Figure 9 and Figure 10 display the floodway and 1% and 0.2% ACE boundaries for Fish Creek as determined by FEMA for the Town of Vienna and Village of Sylvan Beach (FEMA, 2013b). It should be noted that due to the flat topography at the downstream end of Fish Creek, flooding from the creek, including the floodway, extends outside of the Fish Creek drainage area.

Figure 9. Fish Creek, FEMA Flood Zones, Town of Vienna, Oneida County, NY

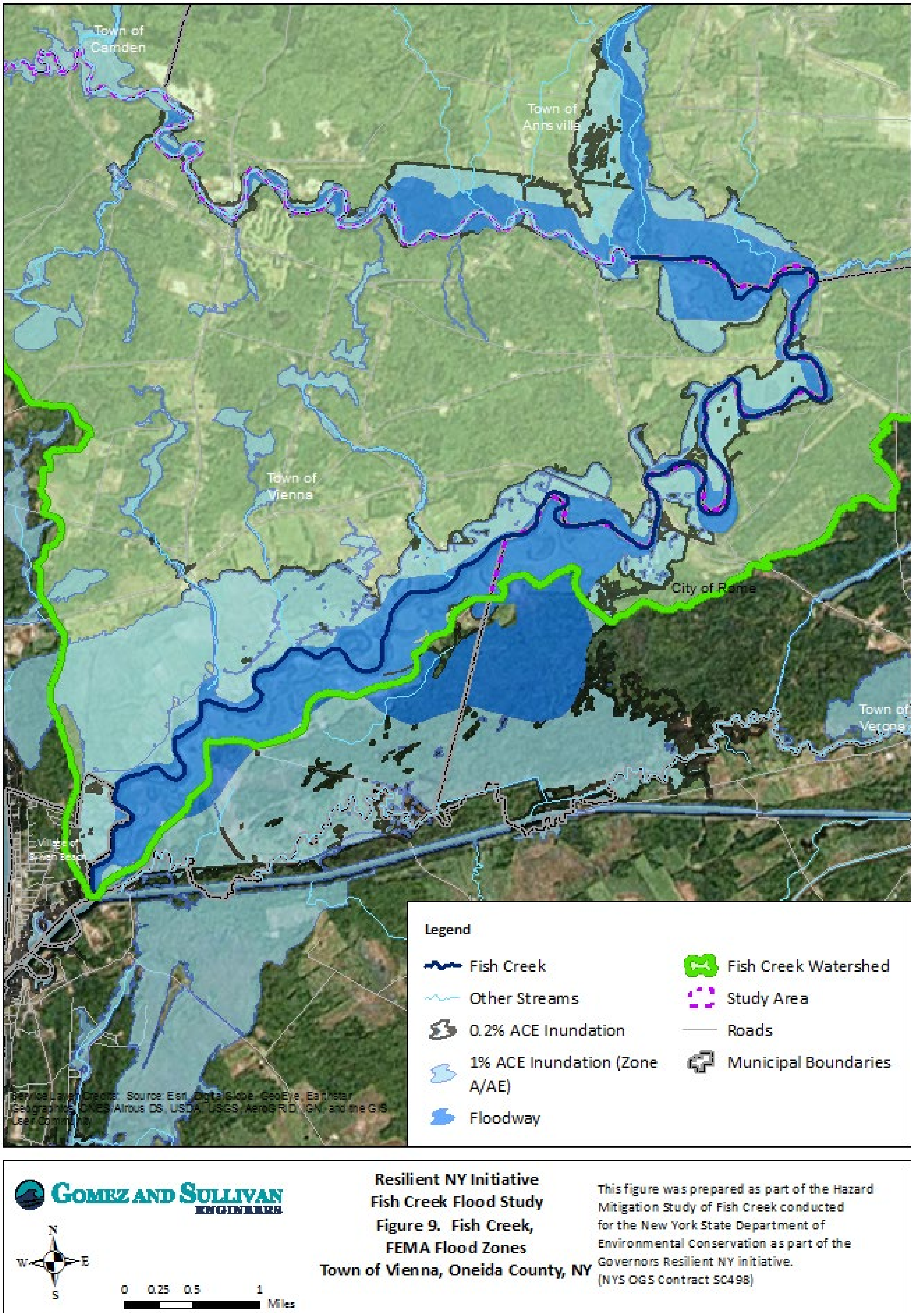


Figure 10. Fish Creek, FEMA Flood Zones, Village of Sylvan Beach, Oneida County, NY

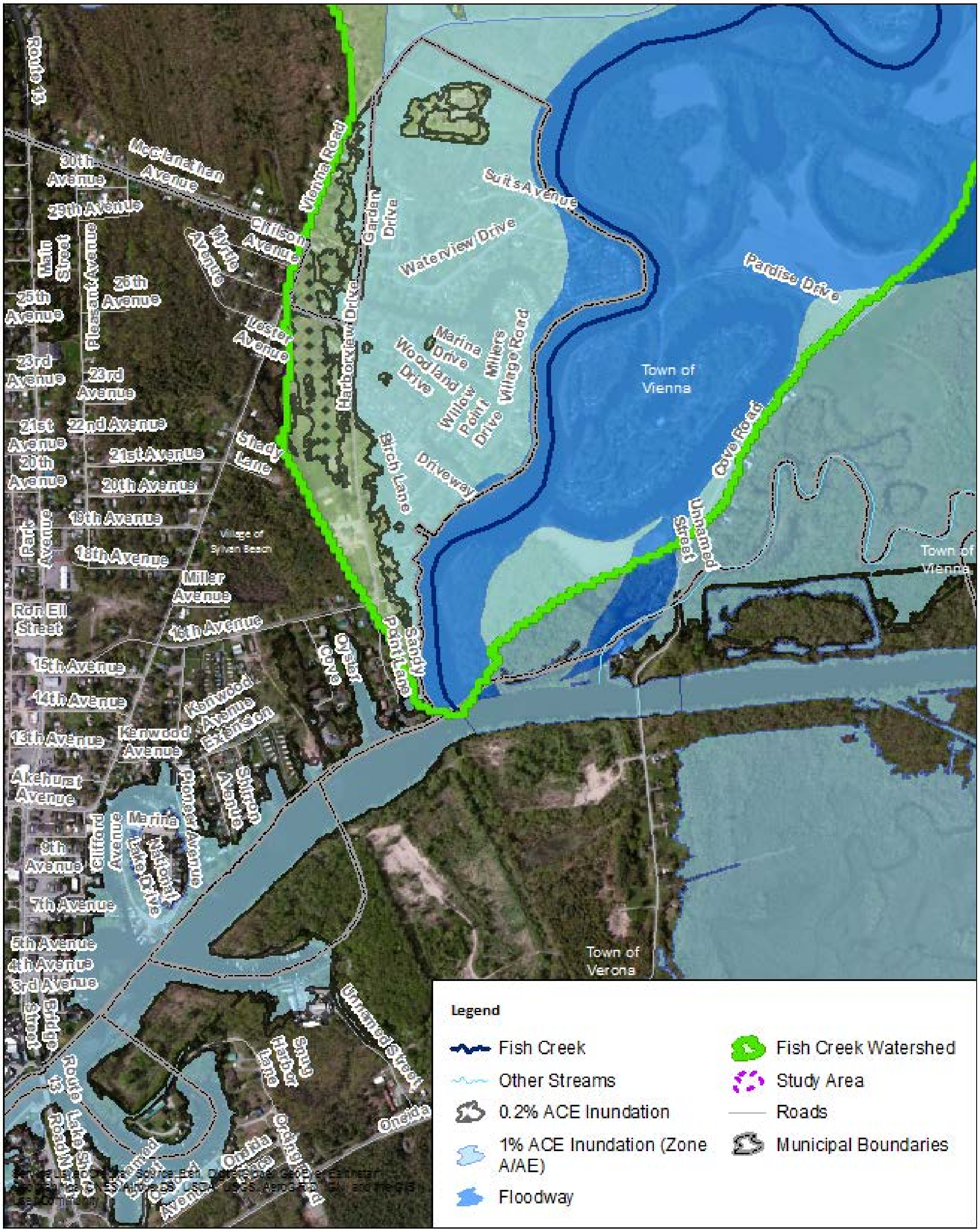


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Figure 10. Fish Creek,
FEMA Flood Zones
Village of Sylvan Beach,
Oneida County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC49B)

Flood Mitigation Analysis

For this study of Fish Creek, standard hydrologic and hydraulic study methods were used to determine and evaluate flood hazard data. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10%, 2%, 1%, and 0.2% chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of the effective FIS (FEMA, 2013a).

Hydraulic analysis of Fish Creek was conducted using the HEC-RAS v6.1 program (USACE, 2021). The HEC-RAS computer program was written by the USACE Hydrologic Engineering Center (HEC) and is considered to be the industry standard for riverine flood analysis. The model is used to compute water surface profiles for one- and two-Dimensional (2-D), steady-state, or time-varied (unsteady) flow. In one-dimensional (1-D) solutions, the water surface profiles are computed from one cross section to the next by solving the one-dimensional St. Venant equations with an iterative procedure (i.e. standard step backwater method). Energy losses are evaluated by friction (Manning's Equation) and the contraction / expansion of flow through the channel. The momentum equation is used in situations where the water surface profile is rapidly varied, such as hydraulic jumps, mixed-flow regime calculations, hydraulics of dams and bridges, and evaluating profiles at a river confluence (USACE, 2016a).

Hydraulic and Hydrologic modeling of Fish Creek in the Town of Vienna and Village of Sylvan Beach was completed by FEMA in 1997. Due to the age and format of the FIS study, an updated 1-D HEC-RAS model was developed using the following data and software:

- Oneida County, NY 1-meter LiDAR DEM data (NYSDEC, 2008)
- New York State Digital Ortho-imagery Program imagery for Oneida County (NYSOITS, 2017)
- National Land Cover Database (NLCD) data (MRLC, 2019)
- USGS *StreamStats* peak discharge data (USGS, 2021)
- RAS Mapper extension in HEC-RAS software
- ESRI ArcMap 10.7 with the HEC-GeoRAS extension GIS software (ESRI, 2019)

The hydraulic model was developed for Fish Creek beginning at the confluence with the NYS Barge Canal (river station 0+00) and extending upstream to the confluence of East Branch Fish Creek and West Branch Fish Creek (river station 722+37).

Methodology of HEC-RAS Model Development

Hydraulic modeling of Fish Creek for the effective FEMA FIS was completed in multiple sections using HEC-2 software. One of these models covering from the confluence with the NYS Barge Canal (river station 0+00) to just downstream of State Route 49 (river station 377+34) was available for this study. Information from this HEC-2 model was utilized as applicable during the development of the upated 1-D HEC-RAS model for this study.

The base condition hydraulic model was developed with the RAS Mapper extension in the HEC-RAS software using the following methodology:

- Main channel, bank lines, flow paths, and cross-sections, which were drawn along the main channel at stream meanders, contraction / expansion points, and at structures, were digitized in RAS Mapper using the LiDAR DEM data and orthoimagery.
- Cross section parameters including elevations, downstream reach lengths, and Manning's n values were assigned to each cross-section using LiDAR DEM data, NLCD land cover data, and orthoimagery.
- Elevations within the channel were adjusted based on the HEC-2 model, where available, and were otherwise adjusted based on the channel bottom elevations provided in the FEMA FIS profile.
- Ineffective areas were established based on the most recent LiDAR data (NYSDEC, 2008) (the ineffective areas from the HEC-2 model were not used)
- Bridge geometry was developed based on available drawings and field collected data

The base condition model water surface elevation results were then compared to the FEMA FIS water surface profiles and the effective FEMA FIS streambed elevation profiles to validate the model. The base condition water surface elevations differed by as much as 3.9 ft from the FIS water surface profiles, likely due to differences in ineffective areas, Manning's n values, cross section geometry, and/or downstream boundary conditions. These differences led to the base condition model suggesting that some bridges did not have adequate hydraulic capacity.

After the base condition model was verified, it was then used to develop alternative condition models to simulate potential flood mitigation strategies. Generic renderings of various potential flood mitigation strategies are provided in Appendix F. The simulation results of the alternative conditions were evaluated based on their reduction in water surface elevations. As the potential flood mitigation strategies are, at this point, preliminary, inundation mapping was not developed from the computed water surface profiles for each potential mitigation alternative. Inundation shown on figures within this report reflects that of the effective FEMA FIS for Town of Vienna and Village of Sylvan Beach. The effectiveness of each potential mitigation strategy was evaluated based on reduction in water surface elevations. In addition to reduced water surface elevations at the inundated structures, some structures may be removed from the inundation area for a given annual chance exceedance (ACE) event by implementing the mitigation strategies.

The flood mitigation strategies that were modeled were:

- Create Flood Benches Near Old State Route 49
- Create Flood Benches at Former Cook Road Bridge
- Create Flood Bench Near Confluence with NYS Barge Canal

Stationing references for the flood mitigation measures are based on the stream centerline digitized for for Fish Creek, which differs from the FEMA FIS stationing values.

Cost Estimate Analysis

Rough order of magnitude (ROM) cost estimates were prepared for each mitigation alternative. In order to reflect current construction market conditions, a semi-analogous cost estimating procedure was used by considering costs of a recently completed, similar scope construction project performed in Upstate

New York. Phase I of the Sauquoit Creek Channel and Floodplain Restoration Project in Whitestown, NY contained many elements similar to those found in the potential mitigation alternatives.

Where recent construction cost data was not readily available, RSMeans CostWorks 2019 was used to determine accurate and timely information (Gordian, Inc., 2019). Costs were adjusted for inflation and verified against current market conditions and trends.

Infrastructure and hydrologic modifications will require permits and applications to the New York State and / or FEMA, including construction and environmental permits from the State and accreditation, Letter of Map Revision (LOMR), etc. applications to FEMA. Application and permit costs were not incorporated in the ROM costs estimates.

Ice Jam Formation

An ice jam typically occurs in the late winter and/or early spring in ice-covered streams when ice accumulates at man-made (e.g. bridge piers, dams) or natural narrower or shallower sections or meanders of a river slowing down or blocking the incoming ice by bridging the ice across the width of the river.

As the air temperature drops, the water temperature reaches freezing temperatures and starts to form frazil ice crystals in the water column. These ice crystals travel in the water column (suspended ice) with the river currents, growing in concentration, and losing heat while traveling. They float on the surface (surface ice), and as the crystals grow in size, they form surface frazil ice. As the air temperature continues to drop, temperature losses from the water and frazil ice create more surface ice, and thicken the existing surface frazil ice, increasing the surface ice concentrations on the river as it approaches colder winter temperatures. The presence of surface and suspended frazil ice increases resistance to the flow, thus increasing the water levels of rivers in the wintertime. Increasing concentrations of surface and suspended frazil ice increase the potential for ice jam formation, which can inhibit the flow of water in the channel, affecting both upstream and downstream water levels.

An existing ice jam can break-up and travel downstream along with larger ice particles with the higher flows of a flash flood and accumulate at a constricted downstream location creating another break-up ice jam, or damage downstream riverbanks or downstream infrastructures severely. Ice-jam flooding presents a complex problem for scientists and engineers since the resulting flood stage can be significantly higher than the flood stage caused from streamflow alone. In other words, a relatively minor discharge of streamflow can result in a major flooding event during an ice jam (USACE, 1966).

Ice-Jam Flooding Mitigation Alternatives

There are several widely accepted and practiced standards for ice-jam controls to mitigate the ice-jam related flooding. These are referred to as ice-jam mitigation strategies, and each strategy is very much site dependent. A strategy that works for a certain reach of a river may not work for another reach in the same river due to river morphology and hydrodynamics. Therefore, each of these strategies need to be analyzed with numerical modeling and simulations to check if they work for a considered area or reach of a river before pursuing or implementing with the previous observational experience alone. The standard strategies that are widely accepted and practiced in cold-region engineering, such as in Eastern New York, are listed below with greater detail provided in Appendix G:

- Ice booms
- Ice breaking using explosives
- Ice breaking using ice-breaker ferries and cutters

- Installing inflatable dams (Obermeyer Spillways)
- Mixing heated effluent into the cold water
- Removal of bridge piers, heated bridge piers, or heated riverbank dikes
- Ice retention structures
- Ice forecasting systems and ice management

Gomez and Sullivan suggests performing a freeze-up or a break-up ice model simulation study prior to implementing any of the above discussed strategies. The basic data needs and steps involved in an ice simulation analysis are also outlined in Appendix G.

Ice-Jam Prone Areas

According to the USACE Cold Regions Research and Engineering Laboratory (CRREL) ice jam database and the effective FEMA FIS, there have been two (2) recorded events on Fish Creek [(USACE, 2020); (FEMA, 2013a)]. These occurred in January 2013 and January 2018 in the vicinity of the Village of Sylvan Beach, and the flooding each event caused damage to residential structures and required evacuations. These events were categorized as break-up ice jams, as opposed to freeze-up ice jams The CRREL ice jam database also includes 12 events along the East Branch of Fish Creek dating from the 1920's through the 1950's. The historic prescence of ice formation in the Fish Creek headwaters is an additional indicator for the potential to form break-up ice jams in the main stem. Based on information received during the stakeholder engagement meeting for Fish Creek, it was expressed that the break-up ice jams may also be caused by winds coming across Oneida Lake pushing ice up the New York State Barge Canal where the ice gets caught at the mouth of Fish Creek due to sediment deposits that used to be dredged. Another factor is the winter drawdown of Oneida Lake which affects water levels at the mouth of Fish Creek. The operating rule curves Oneida Lake suggests that water levels between April and December should be no lower than 369.1 ft NAVD88[1] (NYSCC, 2021a). However, observed water levels show that the winter drawdown was approximately 1.8 feet lower than this level in late February 2021 (NYSCC, 2021b). Lower Oneida Lake water levels during the latter part of the winter will expose more sediment bars and may increase the chances of ice-jams. Increased risk of ice-jams in other areas of Fish Creek could result from narrow channel widths or obstructions in the creek (e.g., sediment bars, bridge peirs, bridge abutments, debris). The location of the former Cook Road crossing represents such an area, as the abutments for this bridge remain in place causing a narrowing of the channel.

In order to determine the most appropriate mitigation measures to address ice jam flooding along Fish Creek, additional hydraulic and hydrologic modeling using ice simulation models and ice jam specific mitigation measures, as outlined in Appendix G, is recommended for each ice jam prone area.

High Risk Areas

Based on the FEMA FIS, historical flood reports, and stakeholder input from engagement meetings, three (3) areas along Fish Creek were identified as high-risk flood areas in the Town of Vienna and Village of Sylvan Beach.

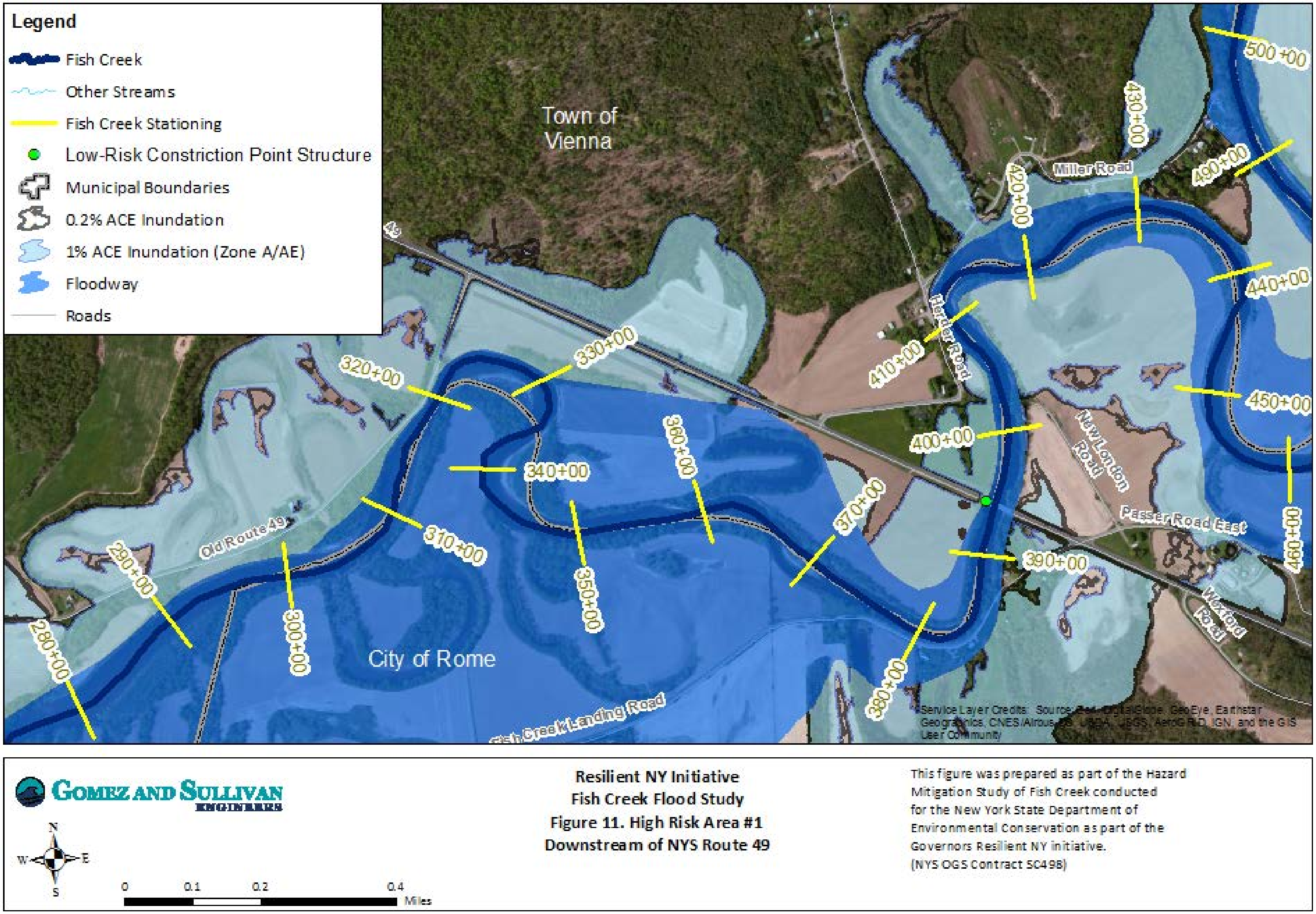
High Risk Area #1: Downsteam of NYS Route 49 (Station 300+00 to Station 392+00)

This risk area comprises approximately 1.5 miles of Fish Creek downstream of the NYS Route 49 Bridge (BIN: 1026210), and includes approximately 8 residences within the FEMA 1% and 0.2% annual chance

[1] The operating rule curve is provided in the Barge Canal Datum (BCD), which can be converted to the North American Vertical Datum of 1988 (NAVD88) by subtracting 1.2 feet.

flood hazard zones. Additionally, Fish Creek Landing Road and Old State Route 49 are in close proximity to the creek bank in this area. This area was selected due to bank failures threatening transportation infrastructure. A portion of Old State Route 49 was nearly washed out during the 2019 Halloween Storm, and was closed until bank stabilization activities were completed. The USGS Gage 04242640, located approximately 5.3 miles upstream of the bank stabilization project, reports a peak flow of 16,000 cfs for the 2019 Halloween Storm, which is less than the 10% ACE being analyzed for this study. A Wolman pebble count performed near Oswego Road Bridge indicated a fairly even distribution of substrate materials ranging in size from silt/clay to small cobbles, while a Wolman pebble count near Higginsville Road indicated that substrate materials are predominantly silt/clay. Therefore, alternatives which address bank stability in this area may also reduce the occurrence of sedimentation in lower portions of Fish Creek. Figure 11 depicts the extent of flooding within the risk area, while Figure 12 shows the water surface profiles within the risk area.

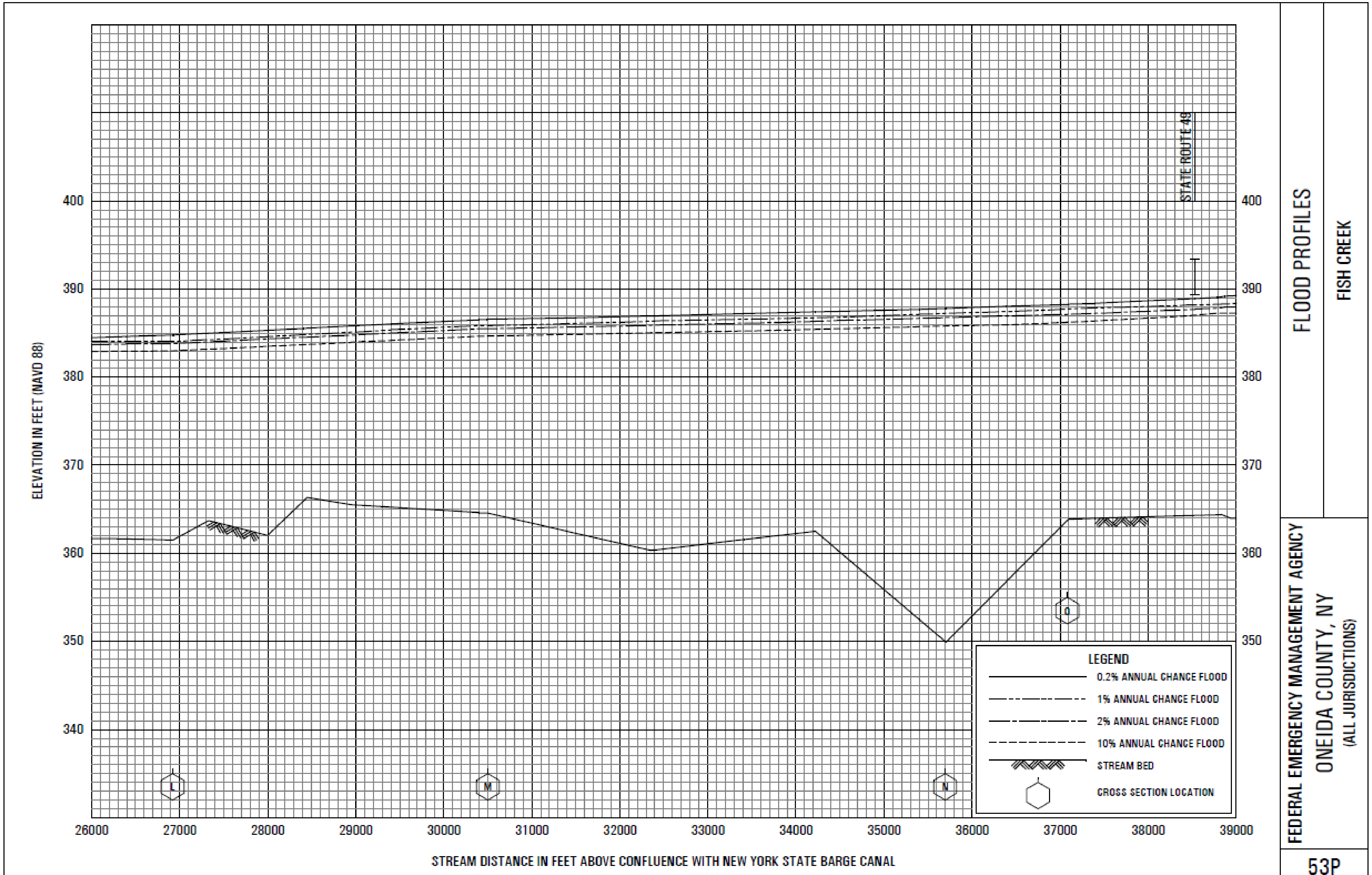
Figure 11. High Risk Area #1: Downstream of NYS Route 49



Resilient NY Initiative
Fish Creek Flood Study
Figure 11. High Risk Area #1
Downstream of NYS Route 49

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative. (NYS OGS Contract SC498)

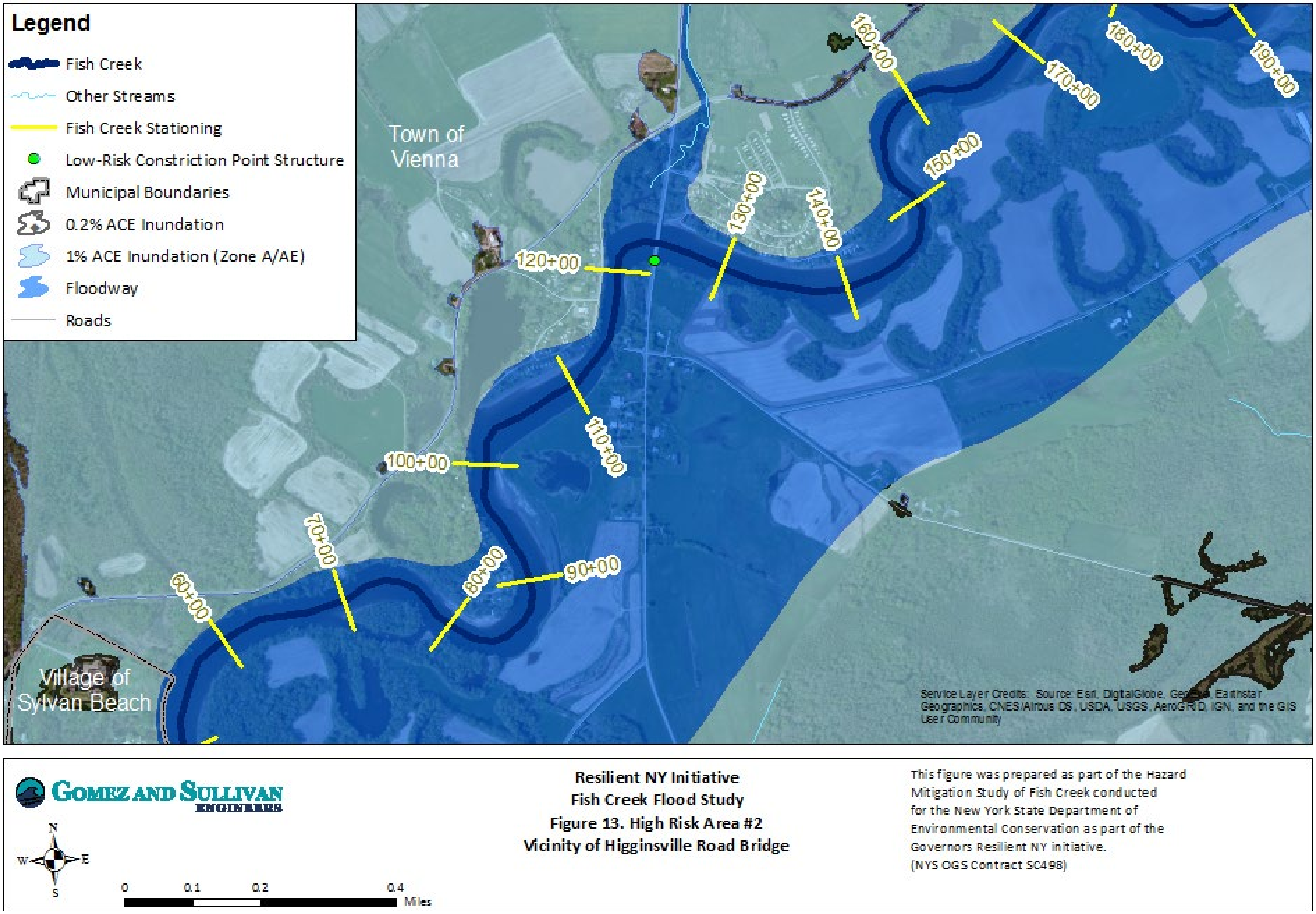
Figure 12. FEMA FIS Profile for Fish Creek in the Vicinity of High Risk Area #1



High Risk Area #2: Vicinity of Higginsville Road Bridge (Station 108+00 to Station 135+00)

This risk area comprises approximately 0.8 miles of Fish Creek centered about the Higginsville Road Bridge (County Road 50A, BIN: 3311290), and includes approximately 30 residences and two (2) campgrounds within the FEMA 1% and 0.2% annual chance flood hazard zones. The Higginsville Road Bridge is owned and maintained by Oneida County. In addition to open water flooding, this area is also susceptible to ice-jam formations and flooding as discussed in the previous section. While the 2018 flooding in Sylvan Beach was a result of an ice jam at the mouth of Fish Creek, news coverage suggests that another build-up was also located near the Higginsville Road Bridge (WKTV, 2018). This area was selected due to the presence of a potential choke point in the river, which could exacerbate open water flooding and increase ice-jam potential. The choke point is located approximately 0.2 miles downstream of the Higginsville Road Bridge, where the former Cook Road Bridge was located. The distance between the former bridge abutments is approximately 150 feet, compared to the estimated bankfull width for this area of 194 feet. A Wolman pebble count in this area indicated that substrate materials are predominantly silt/clay. Therefore, alternatives which address choke points and ice blockages in this area may also reduce the occurrence of sedimentation by reducing the backwater conditions and maintaining higher velocities. Figure 13 depicts the extent of flooding within the risk area, while Figure 14 shows the water surface profiles within the risk area.

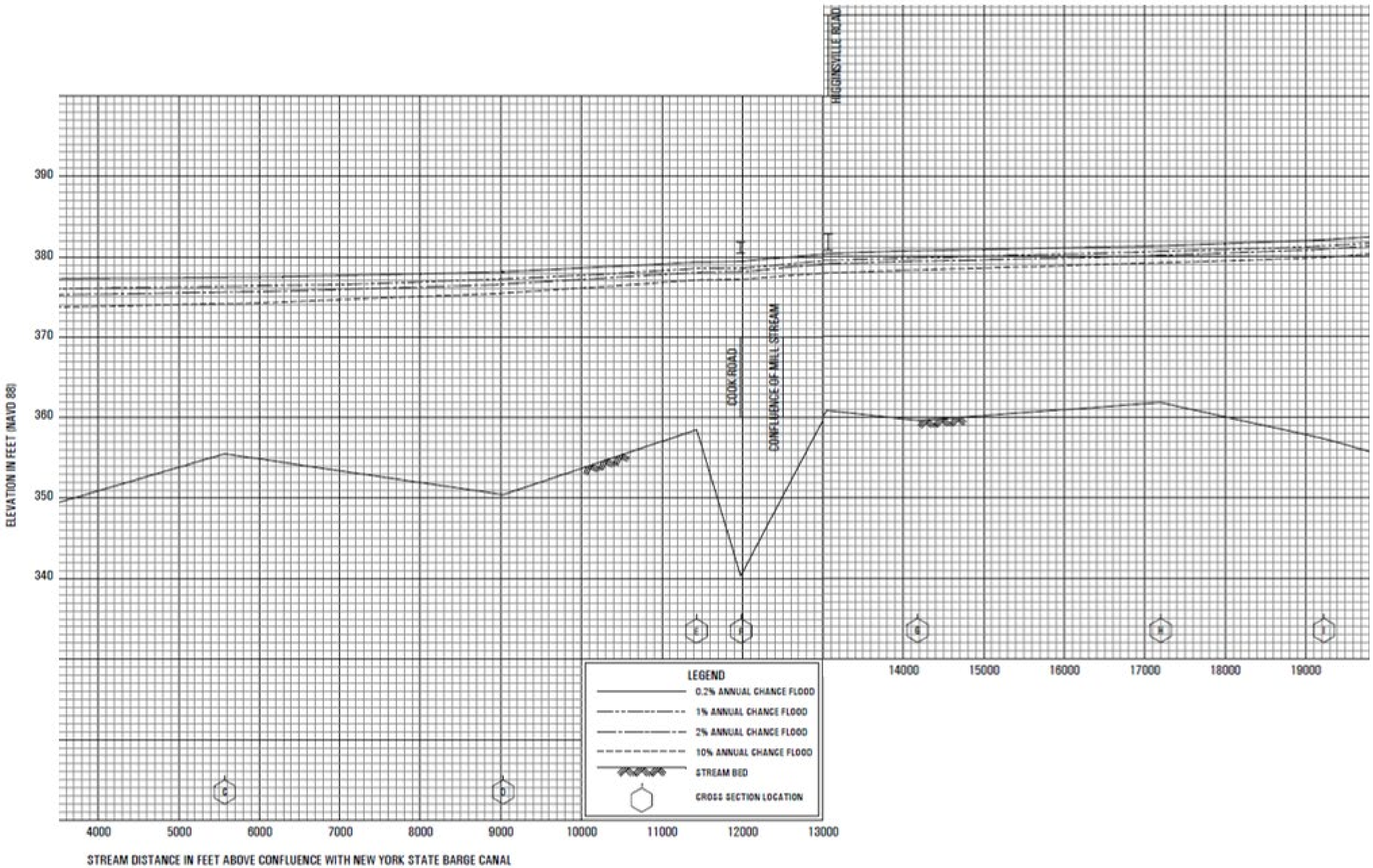
Figure 13. High Risk Area #2: Vicinity of Higginsville Road Bridge



Resilient NY Initiative
Fish Creek Flood Study
Figure 13. High Risk Area #2
Vicinity of Higginsville Road Bridge

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative. (NYS OGS Contract SC498)

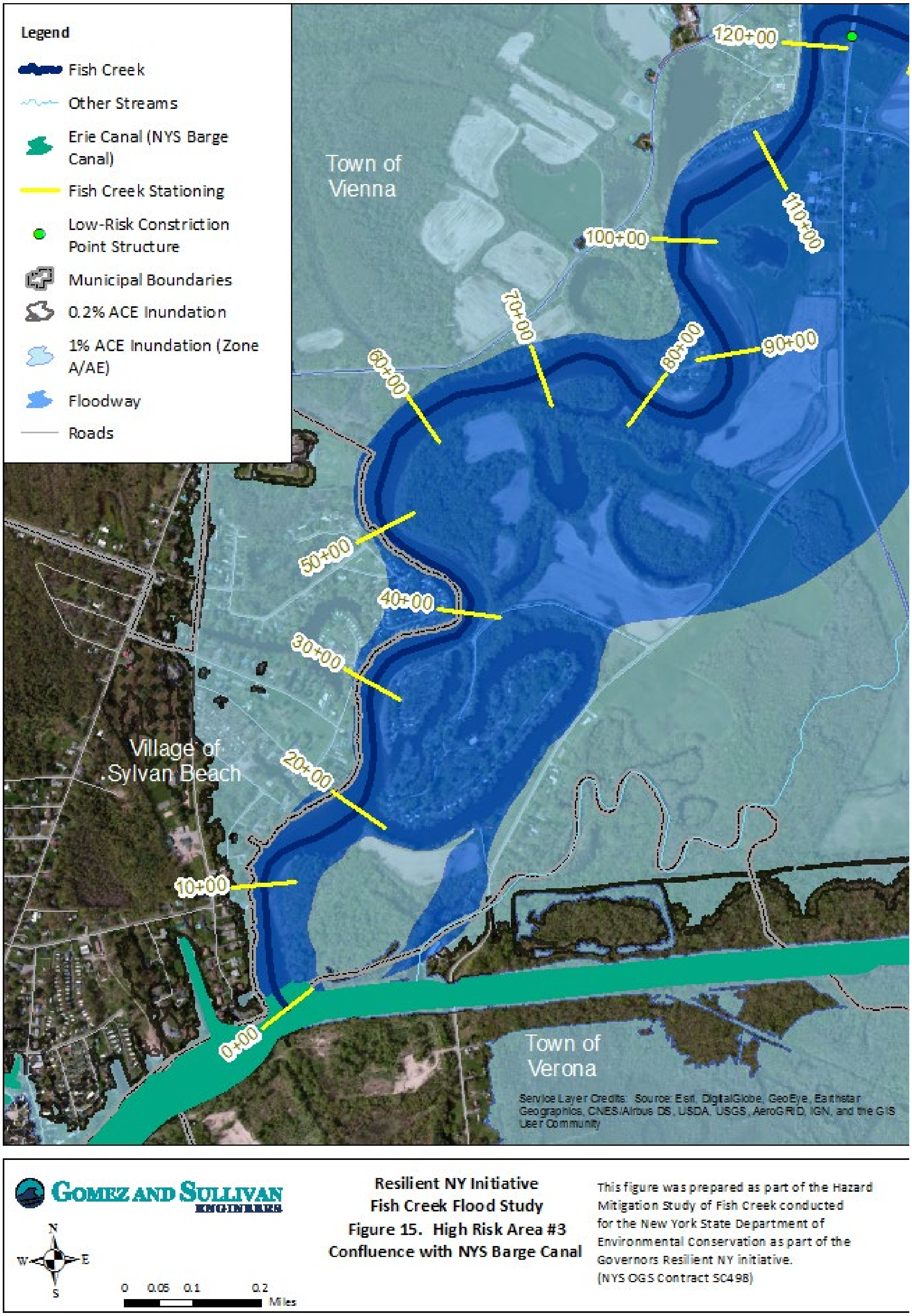
Figure 14. FEMA FIS Profile for Fish Creek in the Vicinity of High Risk Area #2



High Risk Area #3: Confluence with NYS Barge Canal (Station 0+00 to Station 53+00)

This risk area extends approximately 1 mile up Fish Creek from its confluence with the NYS Barge Canal, and includes approximately 113 residences and three (3) campgrounds within the FEMA 1% and 0.2% annual chance flood hazard zones. Three (3) of these residences are FEMA Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties. In addition to open water flooding, this area is also susceptible to ice-jam formations and flooding as discussed in the previous section. This area is known to have issues relative to excessive sedimentation (Domack, 2004), and has experienced multiple ice jams. Multiple factors have been proposed to increase the likelihood of ice-jams in this area, including Oneida Lake winter operating levels and decreased dredging activity. This area was selected due to its inefficient hydraulics, which could exacerbate open water flooding and increase ice-jam potential. A Wolman pebble count near Higginsville Road Bridge indicated that substrate materials are predominantly silt/clay, thus confirming the occurrence of excessive sedimentation. Therefore, alternatives which address choke points and ice blockages in this area may also reduce the occurrence of sedimentation by reducing the backwater conditions and maintaining higher velocities. Figure 15 depicts the extent of flooding within the risk area, while Figure 16 shows the water surface profiles within the risk area.

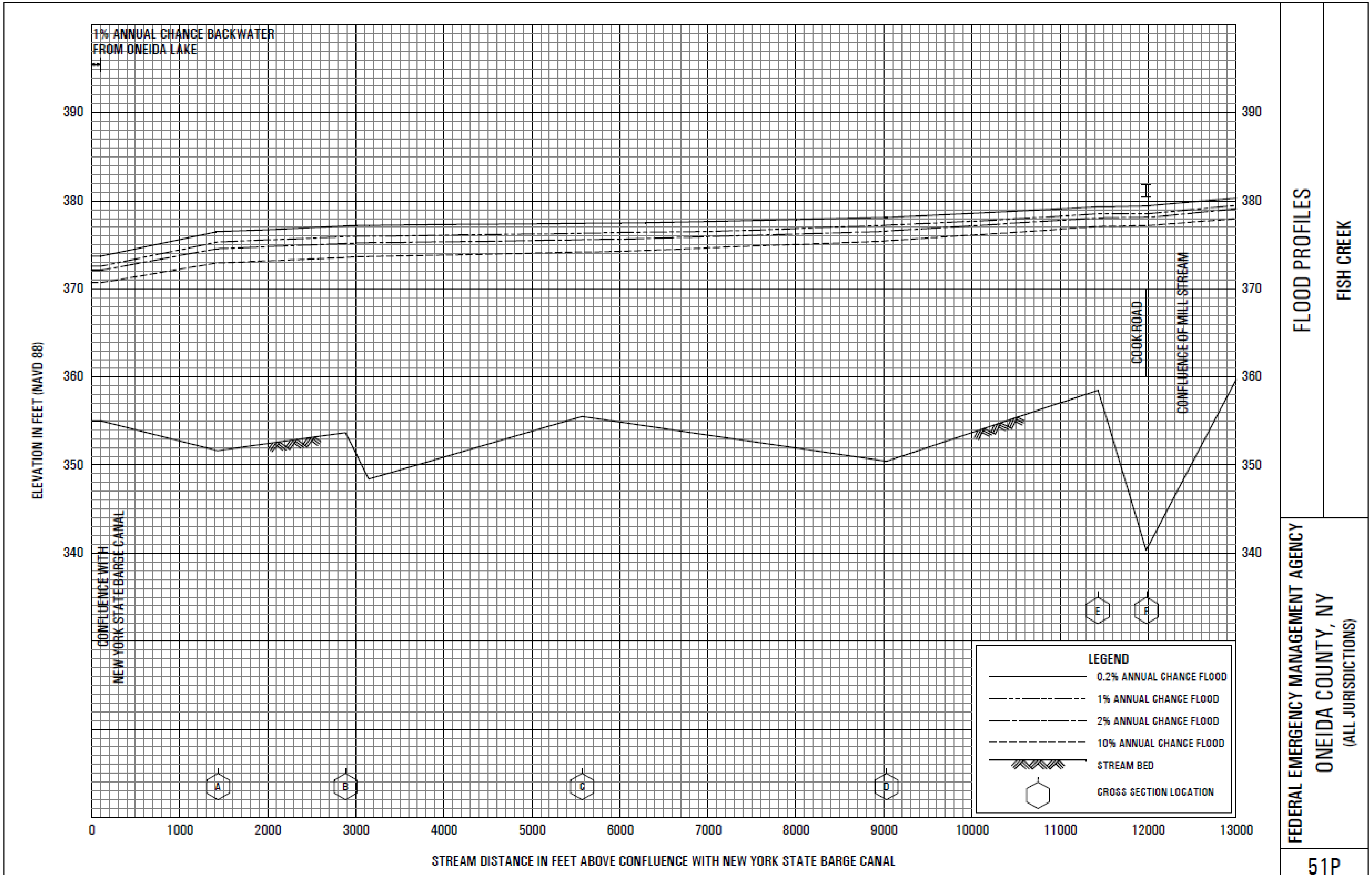
Figure 15. High Risk Area #3: Confluence with NYS Barge Canal



Resilient NY Initiative
Fish Creek Flood Study
Figure 15. High Risk Area #3
Confluence with NYS Barge Canal

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

Figure 16. FEMA FIS Profile for Fish Creek in the Vicinity of High Risk Area #3



Mitigation Alternatives

The following flood mitigation alternatives that have the potential to reduce water surface elevations were evaluated for the identified high-risk areas along Fish Creek. These alternatives could potentially reduce flood related damages in areas adjacent to the creek. The Town of Vienna and Village of Sylvan Beach should evaluate each alternative and consider the potential effects to the community and the level of community buy-in for each before pursuing them further.

High Risk Area #1: Downsteam of NYS Route 49 (Station 300+00 to Station 392+00)

Alternative #1-1: Create Flood Benches Near Old State Route 49 (Station 308+00 to Station 341+00)

The creek has experienced severe bank erosion in this area and is threatening infrastructure. A recent bank stabilization project (see Photo D-3) was completed due to Old State Route 49 nearly being washed out in 2019. Additionally, this bank erosion is likely contributing to sedimentation in lower parts of Fish Creek, which may be exacerbating ice jams. Bank erosion is a natural riverine process but is typically a response of the river to incision, straightening of the channel, and/or reduced sediment loading. The bankfull width adjacent to the bank failure location is approximately 130 feet, which is significantly less than the bankfull width according to StreamStats of 190 feet and the bankfull width upstream and downstream of the meander of around 200 feet or more. This potential flood mitigation alternative is intended to provide an alternative path during high flows to reduce velocities along the bank near the Old State Route 49. This would be accomplished through construction of multiple flood benches starting approximately 5,000 feet downstream of the NYS Route 49 bridge and extending downstream approximately 3,300 feet. A 330-foot wide lower bench would be constructed at elevation 375 ft NAVD88, approximately the bankfull water surface elevation. A 870-foot wide higher bench would be constructed at elevation 375 ft NAVD88, which is between the bankfull and 10-percent annual chance water surface elevations. This would result in the removal of approximately 56,000 cubic yards of material. Figure 17 depicts the conceptual extents of this alternative.

Figure 18 depicts the difference in modeled water surface elevations for existing flood conditions under the base condition and Alternative #1-1 conditions in the vicinity of this alternative. The hydraulic analysis shows that this alternative results in water surface elevation reductions extending for approximately 15,600 feet from the flood bench to approximately 8,700 feet upstream of State Route 49. Water surface elevation reductions under current discharges are computed to be as much as 0.3 ft for the 10%, 2%, 1%, and 0.2% ACE discharges. Similar results, relative to the extent and magnitude of water surface elevation reductions, were found under this alternative for the projected future discharges. Reductions under projected future discharges are computed to be as much as 0.3 ft for the 10%, 2%, and 1% ACE discharge, and 0.2 ft for the 0.2% ACE discharge.

In addition to reduced water surface elevations, this mitigation alternative results in reduced velocities in the channel where the flood bench is located. The hydraulic analysis shows that this alternative results in velocity reductions of as much as 0.7 ft/s for the 10%, 2%, and 0.2% ACE discharges, and 0.8 ft/s for the 1% ACE discharge. Similar results were found under this alternative for the projected future discharges. Reductions under projected future discharges are computed to be as much as 0.7 ft/s for the 10%, 2%, 1%, and 0.2% ACE discharges. This represents about a 15% to 20% reduction in velocities, which may help to alleviate bank erosion concerns in the vicinity of the flood bench in the vicinity of Old State Route 49. However, areas upstream of the flood bench indicated an increase in channel velocities of up to 0.3 ft/s due to the reduced water surface elevation. Therefore, any reduced bank erosion near Old State Route 49, may be offset by increased bank erosion elsewhere.

The Rough Order Magnitude cost is $5.7 million, which does not include land acquisition costs other than survey, appraisal, and engineering coordination. It should be noted that this floodbench is actually located within the City of Rome.

Figure 17. Location Map for Alternative #1-1

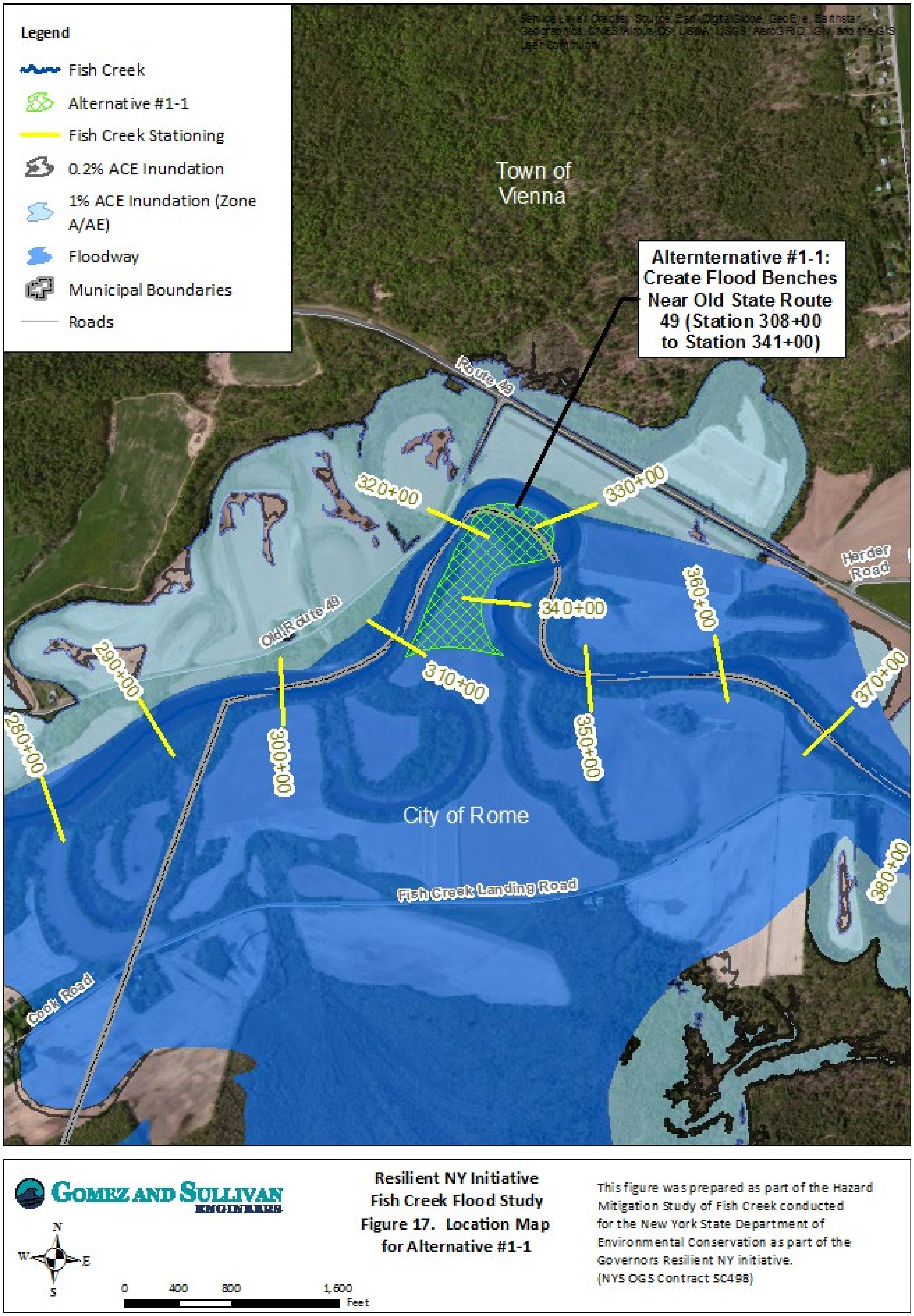
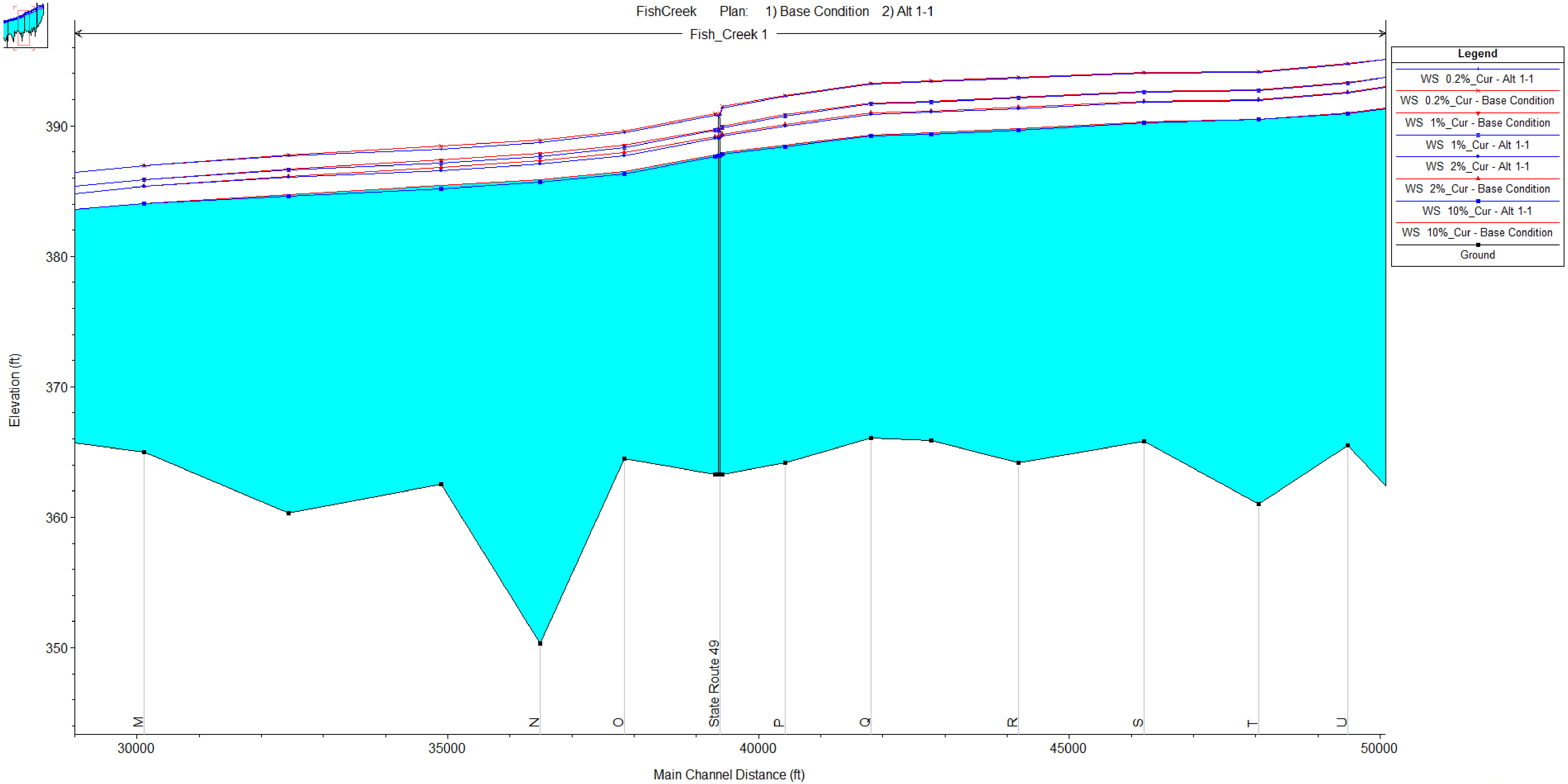


Figure 18. HEC-RAS Model Simulation Output Results for Alternative #1-1



High Risk Area #2: Vicinity of Higginsville Road Bridge (Station 108+00 to Station 135+00)

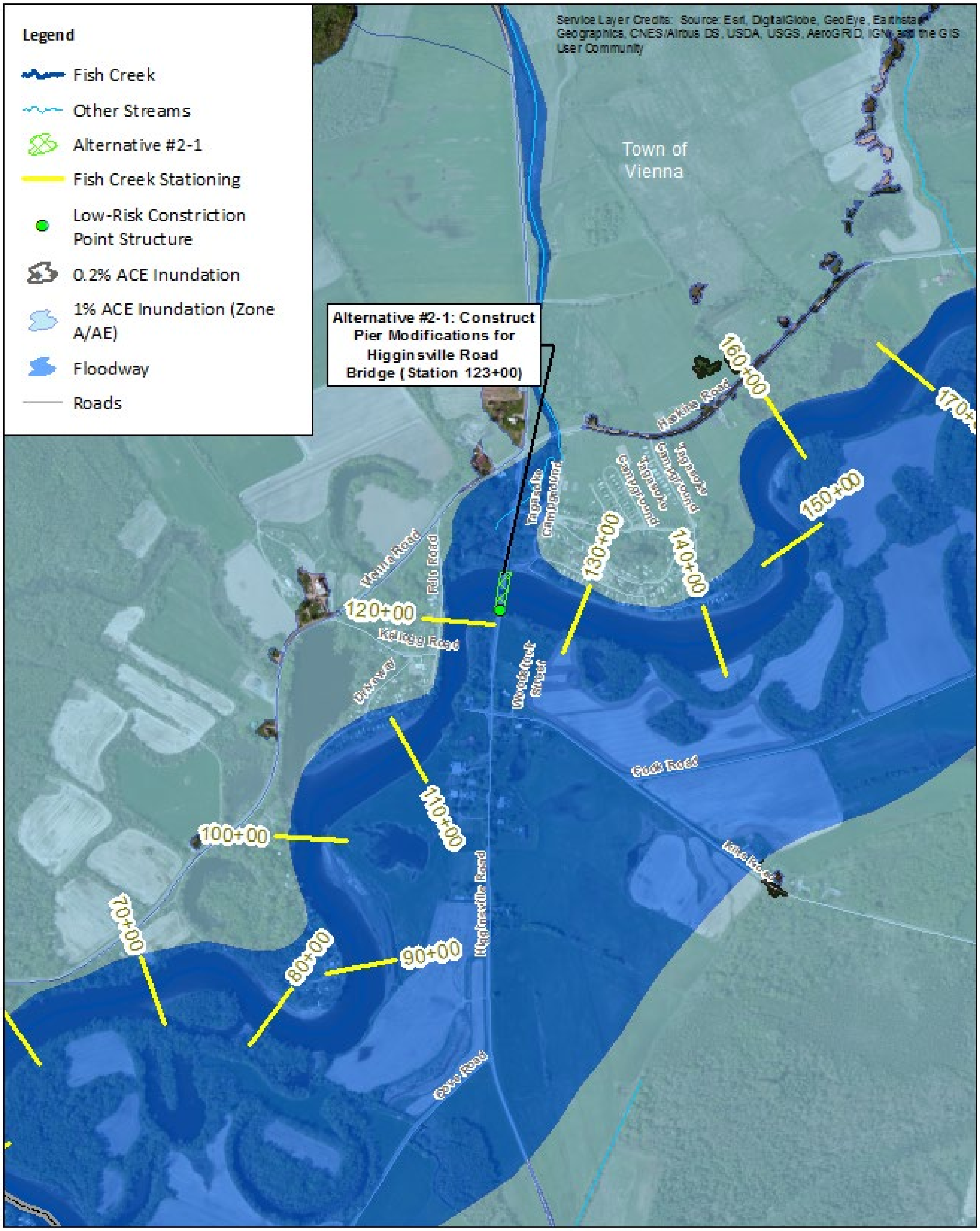
Alternative #2-1: Construct Pier Modifications for Higginsville Road Bridge (Station 123+00)

The lower portions of Fish Creek are susceptible to ice-jams, which cause flooding of residential areas. A choke point was identified just downstream of the Higginsville Road Bridge, where the former Cook Road Bridge was located, which may be exacerbating ice jam formation. The bankfull width at the former Cook Road Bridge is approximately 100 feet, compared to the StreamStats bankfull width of 190 feet and the bankfull width up and downstream of the constriction of approximately 250 to 300 feet, respectively. This potential flood mitigation alternative is intended to break up ice, thus reducing its size and potential for forming an ice jam at the location of the former Cook Road Bridge. This would be accomplished by modifying the existing piers under the Higginsville Road Bridge (see Photo D-1) to be heated during the winter.

Due to the complexity of ice jam modeling and the limited scope of this study, hydraulic modeling was not performed to assess the impact of this strategy. The frazil ice and surface ice flow are complicated due to the number of variables such water depths, surface area, air temperature, flow velocity, etc. Therefore, this alternative would need 2-D river ice simulation modeling to understand the ice transport and ice generation mechanism with and without the pier modifications to support the proposed design. Heated piers have been used to prevent ice from binding to the concrete structure. Without the 2-D river ice simulation modeling, it is unclear whether this alternative would address ice jams within Fish Creek.

The Rough Order Magnitude cost is $430,000, not including annual maintenance and operational costs or the detailed river ice simulation necessary for design of this alternative.

Figure 19. Location Map for Alternative #2-1



Resilient NY Initiative
Fish Creek Flood Study
Figure 19. Location Map for Alternative #2-1

This figure was prepFish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative. (NYS OGS Contract SC498)

GOMEZ AND SULLIVAN ENGINEERS

0 250 500 1,000 Feet

Alternative #2-2: Create Flood Benches at Former Cook Road Bridge (Station 112+00 to Station 119+00)

The lower portions of Fish Creek are susceptible to ice-jams, which cause flooding of residential areas. A choke point was identified just downstream of the Higginsville Road Bridge, where the former Cook Road Bridge was located, which may be exacerbating ice jam formation. The bankfull width at the former Cook Road Bridge is approximately 100 feet, compared to the StreamStats bankfull width of 190 feet and the bankfull width up and downstream of the constriction of approximately 250 to 300 feet, respectively. This potential flood mitigation alternative is intended to provide areas for ice shelving and/or alternative flow paths during high flow and ice jam situations. This would be accomplished by removing the former Cook Road Bridge abutment on the left bank and lowering the existing topography to create a 140-foot-wide upper flood bench and 70-foot wide lower flood bench. Each bench would extend approximately 700 feet from the Higginsville Road Bridge to just downstream of the former Cook Road Bridge abutment. The existing topography was lowered approximately three feet for the upper bench to an elevation of 374.5 ft NAVD88 between the bankfull and 10-percent annual chance water surface elevations, while the existing topography was lowered approximately eight feet for the lower bench to elevation 369.6 ft NAVD 88 the approximate bankfull water surface elevation. The creation of the flood benches for this flood mitigation alternative would result in the removal of approximately 19,500 cubic yards of material. Ice control structures could also be constructed to direct ice into the flood bench. However, these are constructed within the channel, and could pose a navigation hazard. Ice control structures have not been included in the costs for this alternative, since the lower portions of Fish Creek is used for recreational boating. Figure 19 depicts the conceptual extents of this alternative.

Figure 21 depicts the difference in modeled water surface elevations for existing flood conditions under the base condition and Alternative #2-2 conditions in the vicinity of this alternative. The hydraulic analysis shows that this alternative results in water surface elevation reductions extending approximately 3,600 feet from upstream of the former Cook Road Bridge. Water surface elevation reductions under current discharges are computed to be as much as 0.2 ft for the 10% ACE discharge, and 0.1 ft for the 2%, 1%, and 0.2% ACE discharge. Similar results, relative to the extent of water surface elevation reductions, were found under this alternative for the projected future discharges, with reductions under projected future discharges computed to be as much as 0.1 ft for the 10%, 2%, 1%, and 0.2% ACE discharges. It should be noted that modeling of this alternative suggests increased water levels at the flood bench, due to the increased flow area provided by the flood benches, and subsequent decrease in water velocity. However, these water level increases were approximately 0.1 feet for the current 10% ACE discharge, and less than 0.05 feet under all other current and all projected discharges. Adjustments to the flood benches during final design may be able to negate any potential water level increase due to flood bench creation. While the impacts on clear water flooding are minimal, greater benefits may be achieved for ice-jam flooding. This alternative would need 2-D river ice simulation modeling to understand the ice transport and ice generation mechanism with and without the flood bench to identify an appropriate design for ice-shelving and evaluate ice-jam flooding benefits.

The Rough Order Magnitude cost is $1.6 million, which does not include land acquisition costs other than survey, appraisal, and engineering coordination or the cost of detailed river ice simulation necessary for design of this alternative. It should be noted that the extents of the floodplain bench include three separate parcels owned by two separate individuals. Aerial imagery indicates that residential structures are located on two of the properties proposed for this mitigation alternative, for which demolition costs are not included in the cost estimate.

Figure 20. Location Map for Alternative #2-2

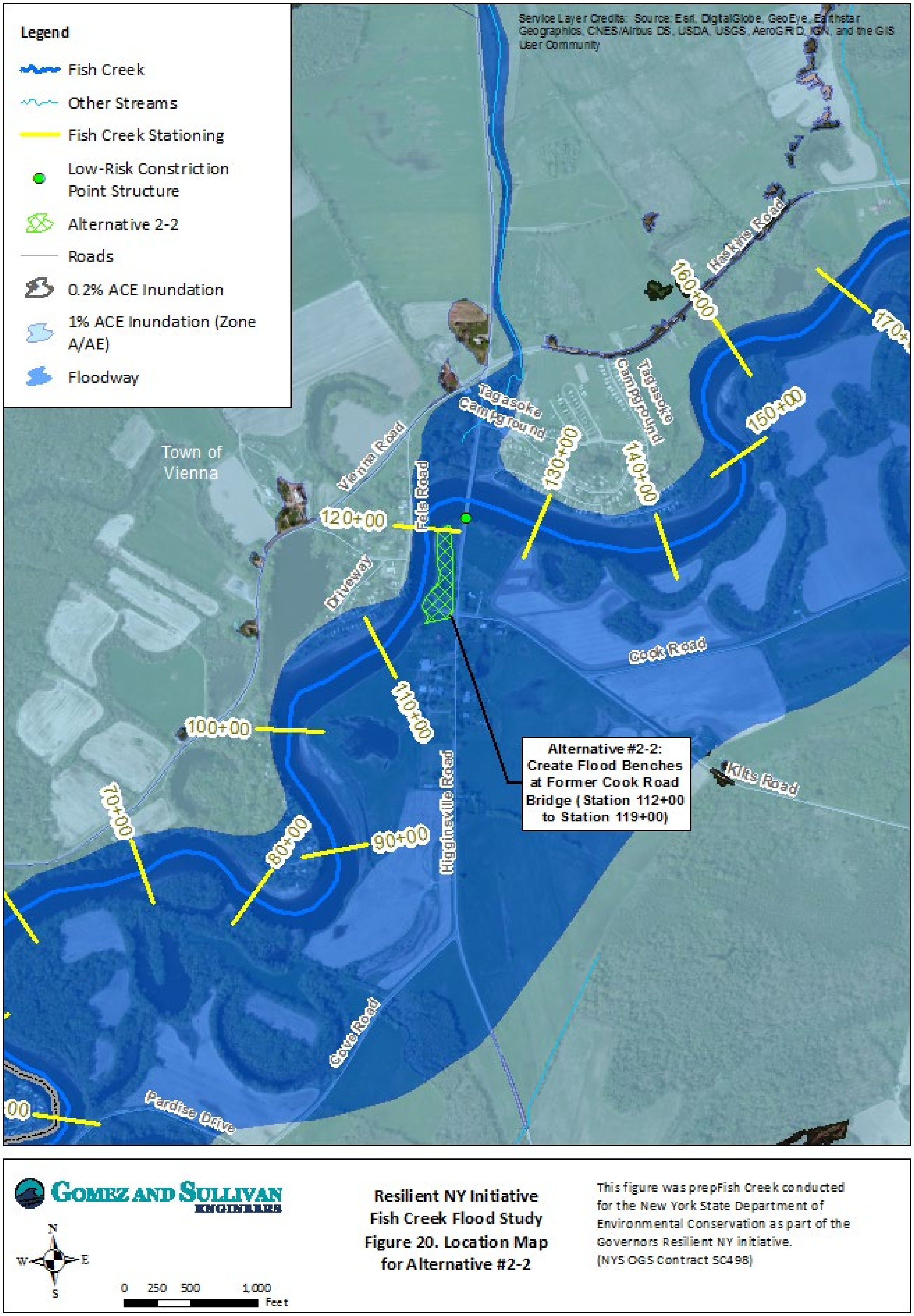
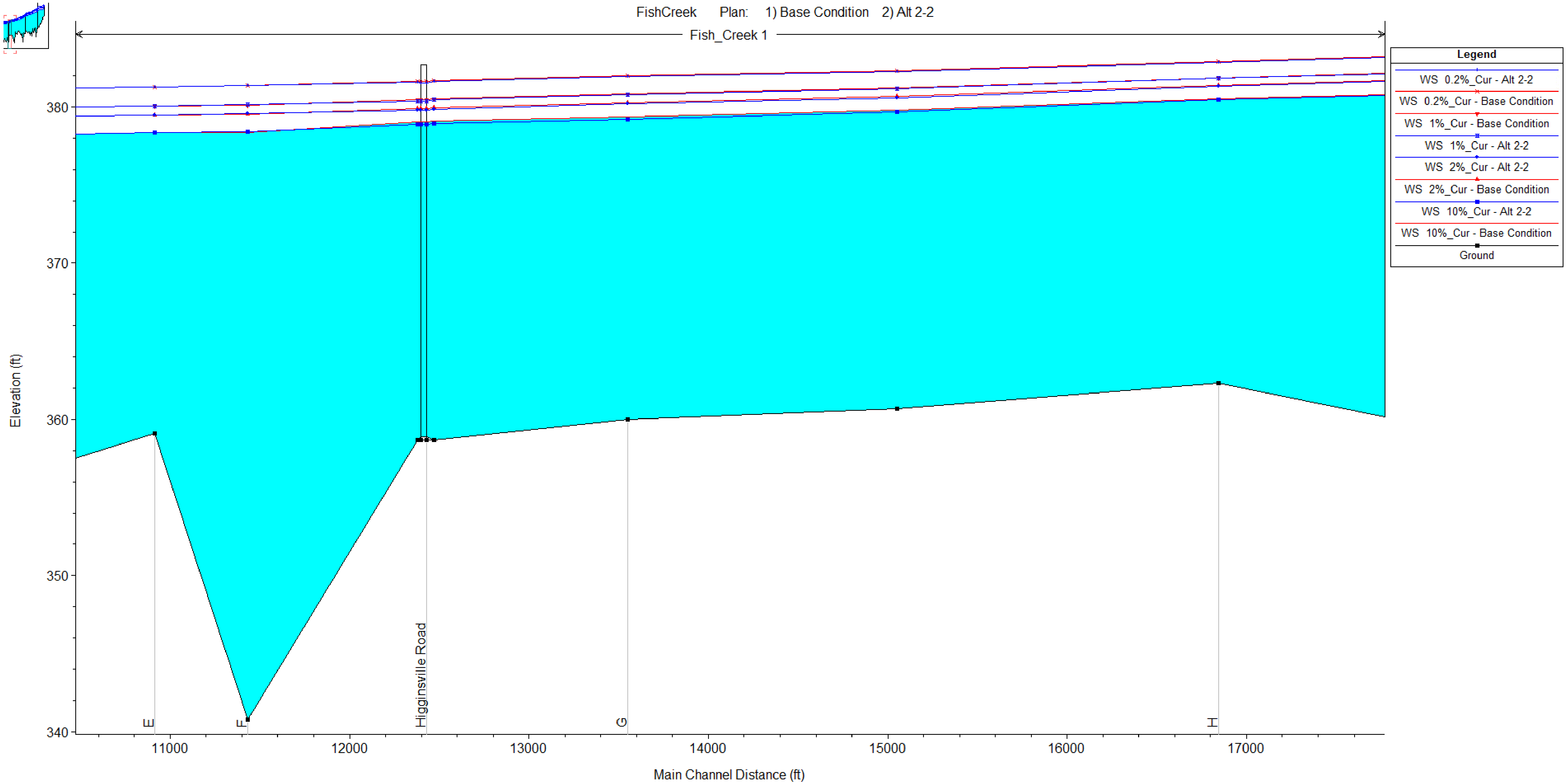


Figure 21. HEC-RAS Model Simulation Output Results for Alternative #2-2



High Risk Area #3: Confluence with NYS Barge Canal (Station 0+00 to Station 53+00)

Alternative #3-1: Create Flood Bench Near Confluence with NYS Barge Canal (Station 0+00 to Station 16+00)

This area experiences significant flooding due to ice jams. One approach to addressing ice-jams is to reduce the severity of ice jams. This potential flood mitigation alternative is intended to provide areas for ice shelving and alternative flow paths during high flows, through construction of a floodplain bench on the left overbank area extending from the confluence with the NYS Barge Canal to approximately 1,600 feet upstream of the confluence. The existing topography would be lowered by approximately 2.5 feet to elevation 369 ft NAVD88 just above the approximate bankfull water surface elevation. The bench would be approximately 850 feet wide, resulting in the removal of approximately 127,000 cubic yards of material. Ice control structures could also be constructed to direct ice into the flood bench. However, these are constructed within the channel, and could pose a navigation hazard. Ice control structures have not been included in the costs for this alternative, since the lower portions of Fish Creek is used for recreational boating. Figure 22 depicts the conceptual extents of this alternative.

Figure 23 depicts the difference in modeled water surface elevations for existing flood conditions under the base condition and Alternative #3-1 conditions in the vicinity of this alternative. The hydraulic analysis shows that this alternative results in water surface elevation reductions extending from the confluence with the NYS Barge Canal to approximately 30,000 feet upstream of the confluence. Water surface elevation reductions under current discharges are computed to be as much as 1.2 ft for the 10%, 2%, 1%, and 0.2% ACE discharges. Similar results, relative to the extent and magnitude of water surface elevation reductions, were found under this alternative for the projected future discharges. Reductions under projected future discharges are computed to be as much as 1.2 ft for the 10% and 2% ACE discharges, and 1.3 ft for the 1% and 0.2% ACE discharges. While the impacts on clear water flooding are significant, greater benefits may be achieved for ice-jam flooding. This alternative would need 2-D river ice simulation modeling to understand the ice transport and ice generation mechanism with and without the flood bench to identify an appropriate design for ice-shelving and evaluate ice-jam flooding benefits.

The Rough Order Magnitude cost is $7.5 million, which does not include land acquisition costs other than survey, appraisal, and engineering coordination or the cost of detailed river ice simulation necessary for design of this alternative. The entire proposed floodplain bench is located within the mapped extent of a state regulated wetland, which will require further wetland investigation, permitting, mitigation, post-construction monitoring. Additional costs, not accounted for in the estimate above, could be incurred as a result of the wetland disturbance.

Figure 22. Location Map for Alternative #3-1

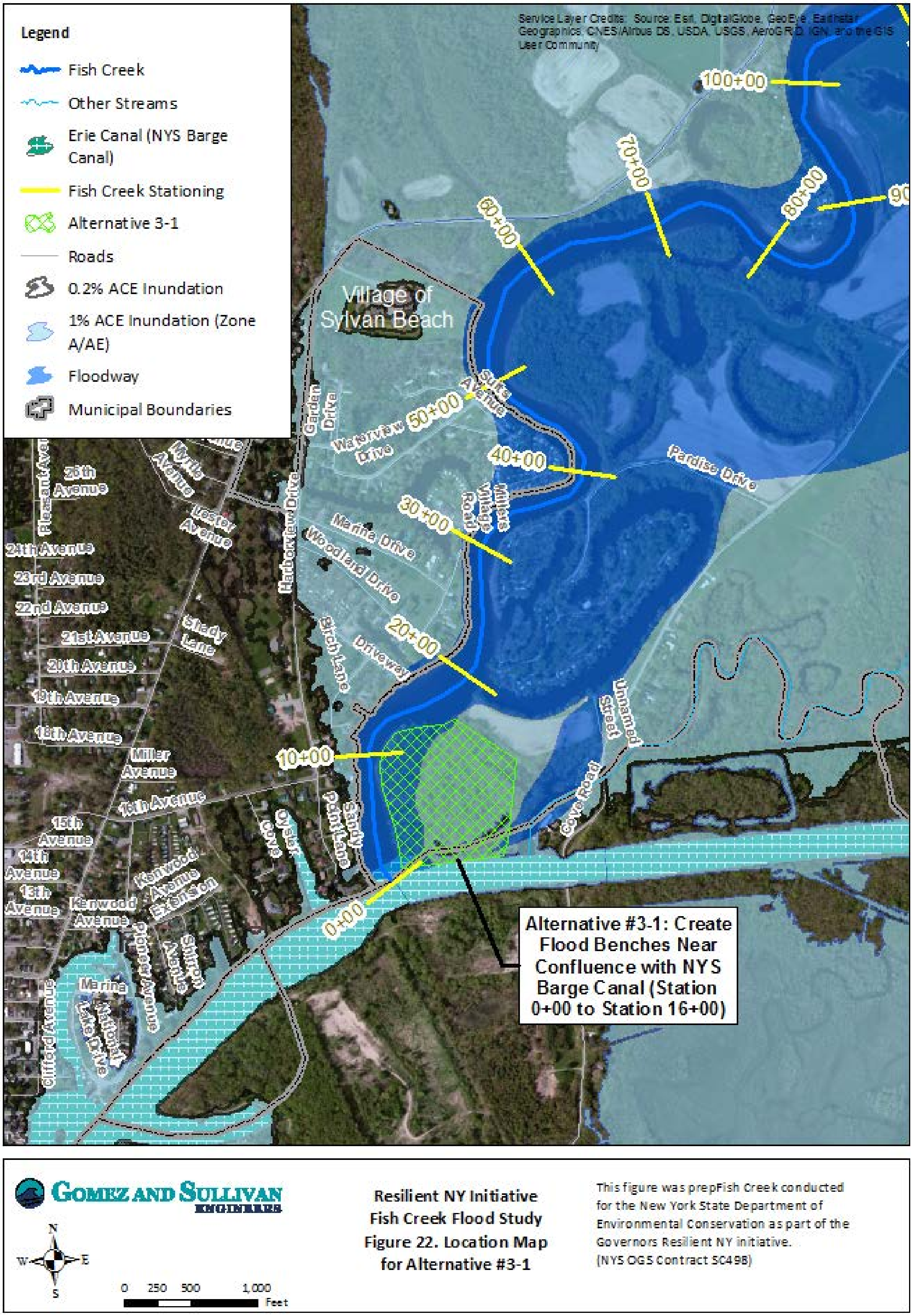
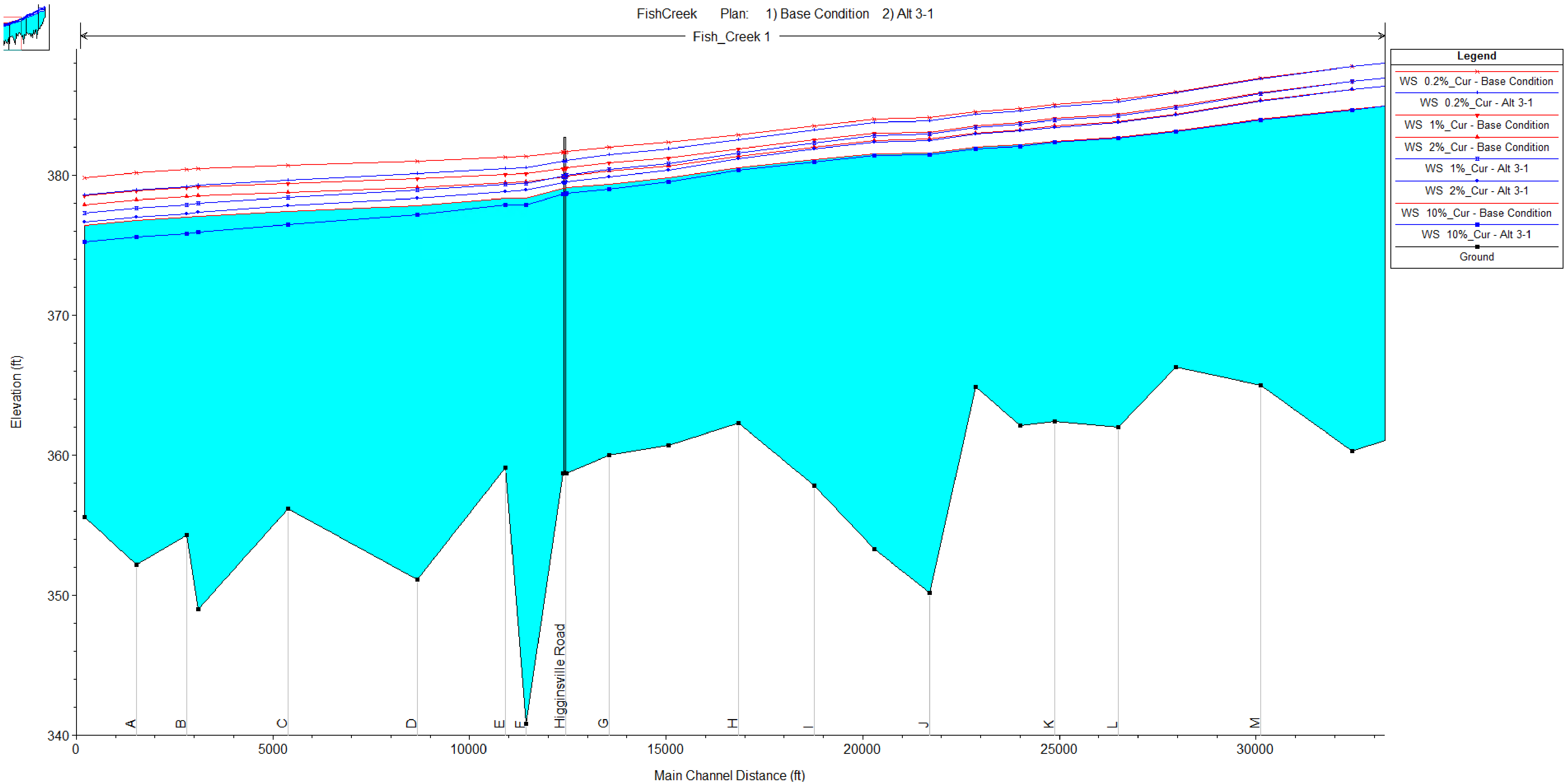


Figure 23. HEC-RAS Model Simulation Output Results for Alternative #3-1



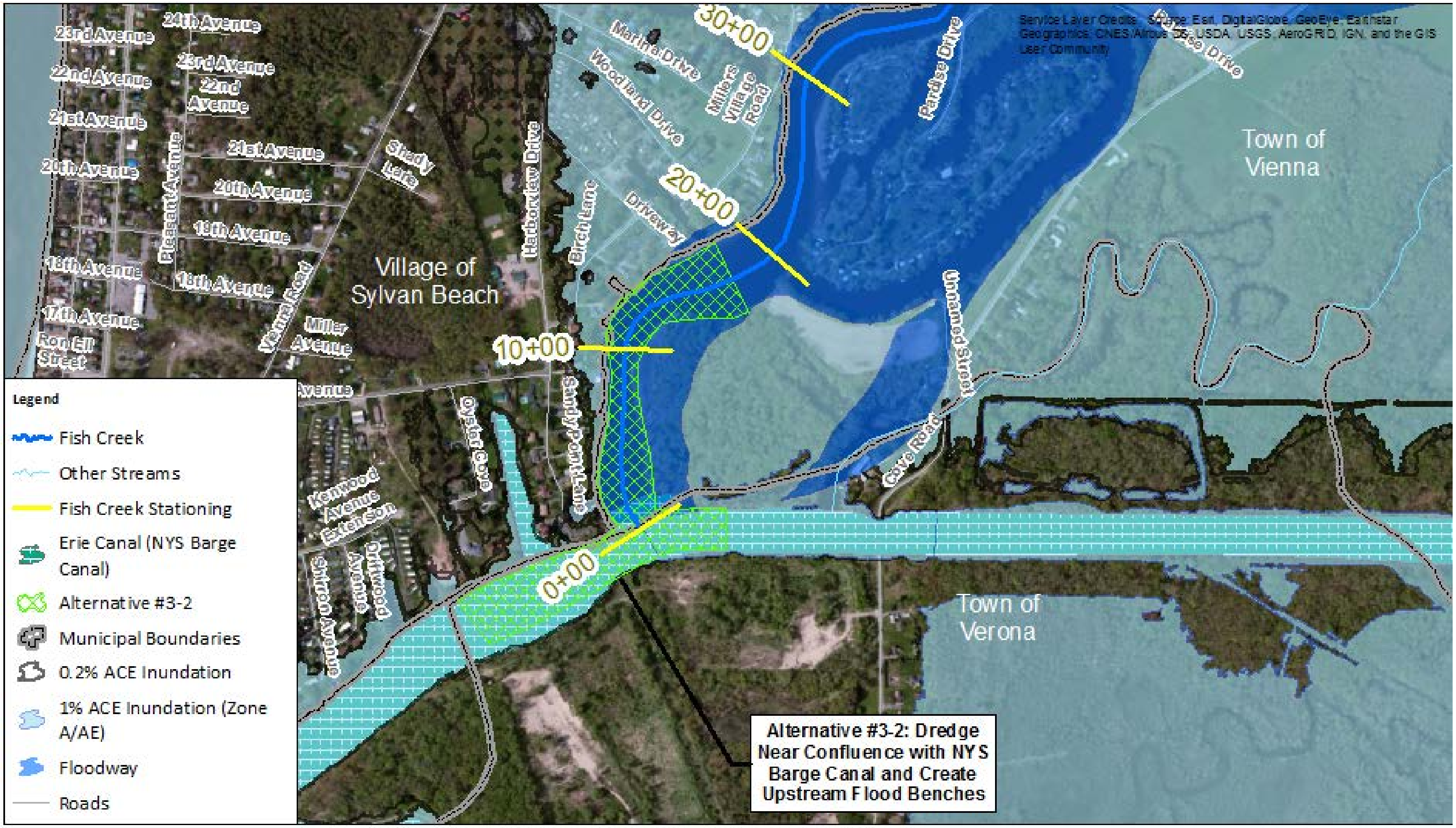
Alternative #3-2: Dredge Near Confluence with NYS Barge Canal and Create Upstream Flood Benches (Station 0+00 to Station 16+00)

As previously noted, this area experiences significant flooding due to ice-jams. Another approach to addressing the ice jam is to reduce the possibility of ice-jam formation. The natural sediment transport processes of Fish Creek were altered by the development and operation of the New York State Barge Canal. The NYSCC used to dredge sediment at the confluence Fish Creek, but has ceased such practices, which may be exacerbating ice-jam flooding. This potential flood mitigation alternative is intended to provide greater water depths to reduce potential locations for ice to snag. This would be accomplished by dredging in the vicinity of the the confluence with the NYS Barge Canal. Dredging was assumed to occur in the lower 1,600 feet of the channel for Fish Creek and in the NYS State Barge Canal for approximately 1,500 feet extending from 450 feet upstream of the confluence to approximately 1,050 feet downstream of the confluence. The scenario assumed that an average of 1 feet of sediment was removed throughout this area. However, the amount of dredging required to ensure that adequate flow depth remains in Fish Creek may be influenced by the late winter drawdowns on Oneida Lake. Figure 22 depicts the conceptual extents of the dredging for this alternative. Dredging could be accompanied by the creation of flood benches upstream which provide alternative areas for sedimentation to occur. Note that dredging operations would likely need to be coordinated with and approved by the NYS Barge Canal.

This alternative focuses on the reduction of ice jam formation and sedimentation in the lower reaches of Fish Creek. Due to the complexity of these natural processes, the potential influence of Oneida Lake operations, and the limited scope of this study, hydraulic modeling was not performed to assess the impact of this strategy. In addition to performing a 2-D river ice simulation modeling with and without the sediment to support any proposed dredging, a sediment transport model would be required to support the proposed design of upstream flood benches. Poorly designed flood benches may not provide an appropriate alternative area for future sedimentation to occur, and may result in the need for repeated dredging operations. The sediment transport model may also provide insights regarding improving the hydraulic efficiency of the lower portions of Fish Creek to reduce future sedimentation and dredging.

The Rough Order Magnitude cost is $7.4 million, does not include land acquisition costs other than survey, appraisal, and engineering coordination or the cost of detailed river ice simulation necessary for design of this alternative. The flood bench described for Alternative 1-1 was used for the purposes of costing this alternative. It should be noted that this alternative does not necessarily address the sources of sediment and that the effects may be shortlived, requiring maintenance of the flood bench and/or continual dredging to deal with future sedimentation. This cost estimate does not include sediment transport modeling.

Figure 24. Location Map for Alternative #3-2: Dredge Near Confluence with NYS Barge Canal and Create Upstream Flood Benches



GOMEZ AND SULLIVAN ENGINEERS

N W E S

0 400 800 1,600 Feet

Resilient NY Initiative
Fish Creek Flood Study
Figure 24. Location Map
for Alternative #3-2

This figure was prepared as part of the Hazard Mitigation Study of Eighteenmile Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative.
(NYS OGS Contract SC498)

Basin-wide Mitigation Alternatives

Non-structural measures attempt to avoid flood damages by modifying or removing properties currently located within flood-prone areas. These measures do not affect the frequency or level of flooding within the floodplain; rather, they affect floodplain activities. In considering the range of non-structural measures, the community needs to assess the type of flooding which occurs (depth of water, velocity, duration) prior to determining which measure best suits its needs (USACE, 2016b).

Alternative #4-1: Early Warning Flood Detection System

Early warning flood detection systems can be implemented, which can provide communities with more advanced warning of potential flood conditions. Early forecast and warning involve the identification of imminent flooding, implementation of a plan to warn the public, and assistance in evacuating persons and some personal property. A typical low-cost early warning flood detection system consists of commercially available off-the-shelf-components. The major components of an early warning flood detection system are a sensor connected to a data acquisition device with built-in power supply or backup, some type of notification or warning equipment, and a means of communication.

For ice-jam warning systems, conditions are generally monitored using a pressure transducer. The data acquisition system performs two functions: it collects and stores real-time flood stage data from the pressure transducer, and initiates the notification process once predetermined flood-stage conditions are met (USACE, 2016b).

This method can also be supplemented by an ice-jam prediction calculation procedure using the freezing degree-day (FDD) method to forecast the ice thickness at critical locations to inform early action to control ice (Shen & Yapa, A Unified Degree-Day Method for River Ice Cover Thickness Simulation, 2011). The method involves a small computer tool that goes through all the ice calculations and gives the output in a graphical format of the predicted ice thickness with time. This can be quickly implemented and can be a very good solution due to its low cost, and low labor and maintenance requirements. The method needs only the forecasted air temperature and current water level at the critical location. During severe winter conditions, the ice thickness prediction can be used to help prepare and coordinate resources needed for a potential ice jam event and consequential flooding. For regular winter conditions, the tool can be used as a quick ice-thickness monitoring mechanism.

The system can be powered from an alternating current source via landline or by batteries that are recharged by solar panels. The notification process can incorporate standard telephone or cellular telephone. Transfer of data from the system can be achieved using standard or cellular telephone, radio frequency (RF) telemetry, wireless internet, or satellite transceivers. Emergency management notification techniques can be implemented through the use of radio, siren, individual notification, or a reverse 911 system. More elaborate means include remote sensors that detect water levels and automatically warn residents. These measures normally serve to reduce flood hazards to life, and damage to portable personal property (USACE, 2016b).

The Rough Order Magnitude cost for this strategy is approximately $120,000, not including annual maintenance and operational costs.

Alternative #4-2: Flood Buyout Programs

Buyouts allow state and municipal agencies the ability to purchase developed properties within areas vulnerable to flooding from willing owners. Buyouts are effective management tools in response to natural disasters to reduce or eliminate future losses of vulnerable or repetitive loss properties. Buyout programs include the acquisition of private property, demolition of existing structures, and conversion of land into public space or natural buffers. The land is maintained in an undeveloped state for public use in perpetuity. Buyout programs not only assist individual homeowners, but are also intended to improve the resiliency of the entire community in the following ways (Siders, 2013):

- Reduce exposure by limiting the people and infrastructure located in vulnerable areas
- Reduce future disaster response costs and flood insurance payments
- Restore natural buffers such as wetlands in order to reduce future flooding levels
- Reduce or eliminate the need to maintain and repair flood control structures
- Reduce or eliminate the need for public expenditures on emergency response, garbage collection and other municipal services in the area
- Provide open space for the community

Resilience achieved through buyouts can have real economic consequences in addition to improved social resilience. According to FEMA, voluntary buyouts cost $1 for every $2 saved in future insurance claims, an estimate which does not include money saved on flood recovery and response actions, such as local flood fighting, evacuation, and rescue, and recovery expenses that will not be incurred in the future. In order to achieve these goals, buyouts need to acquire a continuous swath of land, rather than individual homes in isolated areas, or only some of the homes within flood-prone areas (Siders, 2013).

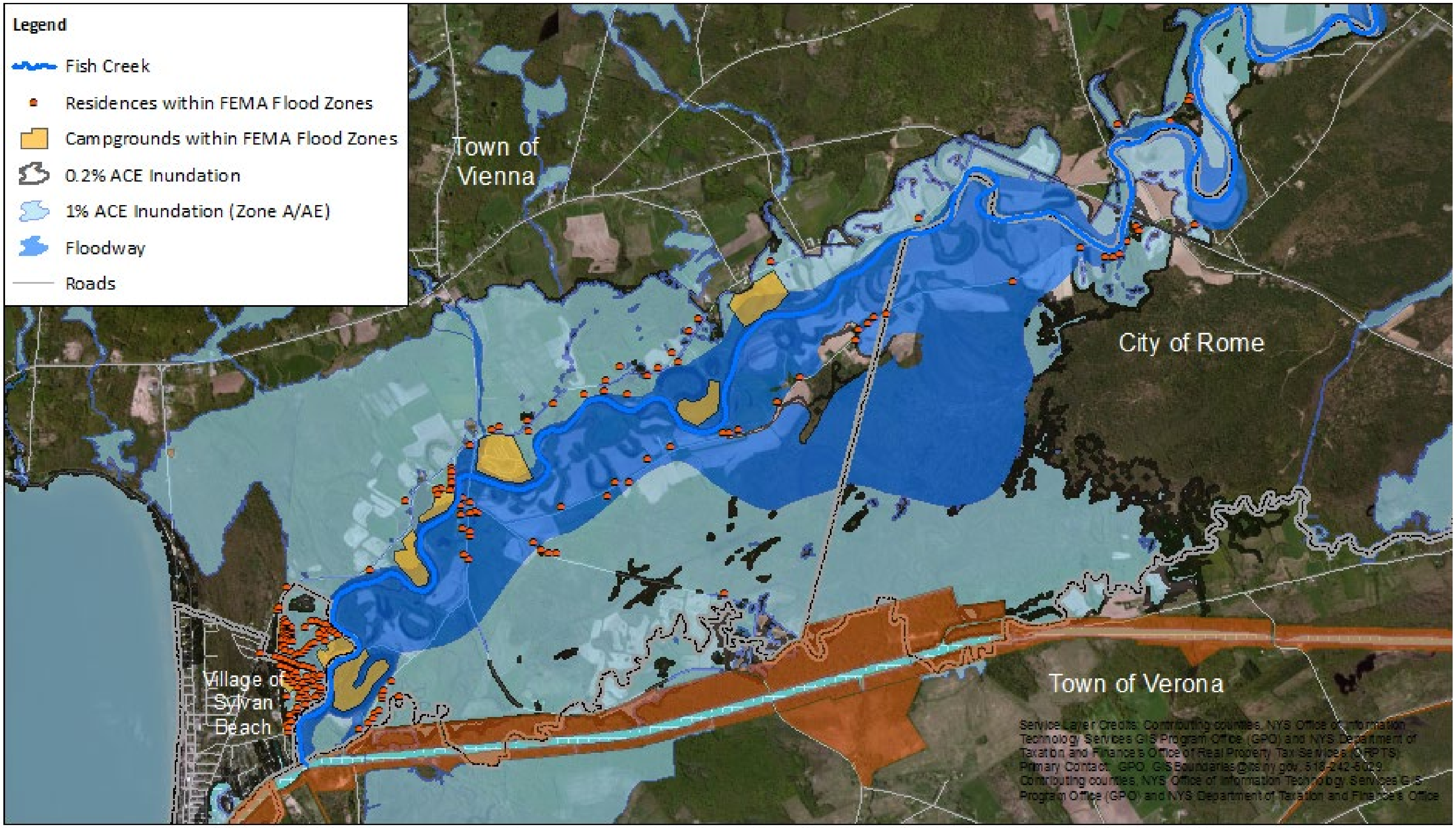
Buyout programs can be funded through a combination of federal, state or local funds, and are generally made available following a nationally recognized disaster. FEMA administers programs to help with buyouts under the Stafford Disaster Act, and the Department of Housing and Urban Development (HUD) administers another program through Community Development Block Grants (CDBG) [(FEMA, 2020), (NYSGOSR, 2019)]. These funding sources can reduce the economic burden on the local community. However, these funds also come with guidelines and regulations that may constrain policy makers' options on whether to pursue a buyout strategy and how to shape their programs. FEMA funds may be used to cover 75% of the expenses, but the remaining 25% must come from another non-federal source. In most cases, the buyout must be a cost-effective measure that will substantially reduce the risk of future flooding damage (Siders, 2013).

For homes in the special flood hazard area (SFHA), FEMA has developed precalculated benefits for property acquisition and structure elevation of buildings. Based on a national analysis that derived the average benefits for acquisition and elevation projects, FEMA has determined that acquisition projects that cost $276,000 or less, or elevation projects that costs $175,000 or less, and which are located in the 1% ACE (i.e. 100 year recurrence interval) floodplain are considered cost-effective and do not require a separate benefit-cost analysis. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criteria. If the cost to acquire or elevate a structure exceeds the amount of benefits listed above, then a traditional FEMA approved benefits-cost analysis must be completed (FEMA, 2015b).

There are approximately 190 residences and eight (8) campgrounds within the FEMA 1% and 0.2% annual chance flood hazard zones (Figure 25) along Fish Creek. In addition, there are three (3) FEMA RL and SRL properties located within the Fish Creek study area.

Due to the variable nature of buyout programs, no ROM cost estimate was produced for this study. It is recommended that any buyout program begin with a cost-benefit analysis for each property. After a substantial benefit has been established, a buyout strategy study should be developed that focuses on properties closest to Fish Creek in the highest-risk flood areas and progresses outwards from there to maximize flood damage reductions. In addition, structures located adjacent to flood prone infrastructure (i.e. bridges, culverts, etc.) should also be considered high-risk and prioritized in any buyout program strategy. A potential negative consequence of buyout programs is the permanent removal of properties from the floodplain, and resulting tax revenue, which would have long-term implications for local governments, and should be considered prior to implementing a buyout program.

Figure 25. Residences within FEMA Flood Zones, Fish Creek, Oneida County, NY



Resilient NY Initiative
Fish Creek Flood Study
Figure 25. Residences within FEMA Flood Zones, Fish Creek, Oneida County, NY

This figure was prepared as part of the Hazard Mitigation Study of Fish Creek conducted for the New York State Department of Environmental Conservation as part of the Governors Resilient NY initiative. (NYS OGS Contract SC498)

Alternative #4-3: Floodproofing

Floodproofing is defined as any combination of structural or nonstructural adjustments, changes, or actions that reduce or eliminate flood damage to a building, contents, and attendant utilities and equipment (FEMA, 2000). Floodproofing can prevent damage to existing buildings and can be used to meet compliance requirements for new construction of residential and non-residential buildings.

The most effective flood mitigation methods are relocation (i.e. moving a home to higher ground outside of a high-risk flood area) and elevation (i.e. raising the entire structure above BFE). The relationship between the BFE and a structure's elevation determines the flood insurance premium. Buildings that are situated at or above the level of the BFE have lower flood risk than buildings below BFE and tend to have lower insurance premiums than buildings situated below the BFE (FEMA, 2015c).

In some communities, where non-structural flood mitigation alternatives are not feasible, structural alternatives such as flood proofing may be a viable alternative. The NFIP has specific rules related to flood proofing for residential and non-residential structures. These can be found in the Code of Federal Regulations (CFR) 44 CFR 60.3 (FEMA, 2000).

For existing residential structures, structures should be raised above the BFE or above the freeboard required by local regulations. Floodproofing is allowed for non-residential structures, with design guidelines outlined in FEMA P-936 – Floodproofing Non-Residential Structures [(FEMA, 2000); (FEMA, 2013c)]. The local floodplain administrator should carefully review local ordinances, the CFR and available design guidelines before issuing a permit for structural flood proofing. Floodproofing strategies include:

Interior Modification/Retrofit Measures

Interior modification and retrofitting involve making changes to an existing building to protect it from flood damage. When the mitigation is properly completed in accordance with NFIP floodplain management requirements, interior modification / retrofit measures could achieve somewhat similar results as elevating a home above the BFE. Keep in mind, in areas where expected base flood depths are high, the flood protection techniques below may not provide protection on their own to the BFE or, where applicable, the locally required freeboard elevation (FEMA, 2015c).

Examples include:

- *Basement Infill*: This measure involves filling a basement located below the BFE to grade (ground level)
- *Abandon Lowest Floor*: This measure involves abandoning the lowest floor of a two or more story slab-on-grade residential building
- *Elevate Lowest Interior Floor*: This measure involves elevating the lowest interior floor within a residential building with high ceilings

Dry floodproofing

A combination of measures that results in a structure, including the attendant utilities and equipment, being watertight with all elements substantially impermeable to the entrance of floodwater and with structural components having the capacity to resist flood loads (FEMA, 2015c).

Although NFIP regulations require non-residential buildings to be watertight and protected only to the BFE for floodplain management purposes (to meet NFIP regulations), protection to a higher level is necessary for dry floodproofing measures to be considered for NFIP flood insurance rating purposes. Because of the additional risk associated with dry floodproofed buildings, to receive an insurance rating based on 1% annual chance (100-year) flood protection, a building must be dry floodproofed to an elevation at least 1-foot above the BFE (FEMA, 2013c).

In New York State, only non-residential buildings are allowed to be dry floodproofed and the building must be dry floodproofed to an elevation of at least 2 feet above the BFE. New York State has higher freeboard standards than federal regulations at 44 CFR Part 60.3. Care must be taken to check the New York State Building Code for more stringent guidelines.

Examples include:

- *Passive Dry Floodproofing System*: This measure involves installing a passive (works automatically without human assistance) dry floodproofing system around a home to protect the building from flood damage.
- *Elevation*: This measure involves raising an entire residential or non-residential building structure above the BFE or above the freeboard required by local regulations.

Wet floodproofing

The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a structure, which is intentionally allowed to flood (FEMA, 2015c).

Examples include:

- *Flood Openings*: This measure involves installing openings in foundation and enclosure walls located below the BFE that allow automatic entry and exit of floodwaters to prevent collapse from the pressures of standing water.
- *Elevate Building Utilities*: This measure involves elevating all building utility systems and associated equipment (e.g., furnaces, septic tanks, and electric and gas meters) to protect utilities from damage or loss of function from flooding.
- *Floodproof Building Utilities*: This measure involves floodproofing all building utility systems and associated equipment to protect it from damage or loss of function from flooding.
- *Flood Damage-Resistant Materials*: This measure involves the use of flood damage-resistant materials such as non-paper-faced gypsum board and terrazzo tile flooring for building materials and furnishings located below the BFE to reduce structural and nonstructural damage and post-flood event cleanup.

Barrier Measures

Barriers, such as floodwalls and levees, can be built around single or multiple residential and non-residential buildings to contain or control floodwaters (FEMA, 2015c). Although floodwalls or levees can be used to keep floodwaters away from buildings, implementing these measures will not affect a building's flood insurance rating unless the flood control structure is accredited in accordance with NFIP requirements (44 CFR §65.10) and provides protection from at least the 1% annual chance (100-year) flood. Furthermore, floodwalls or levees as a retrofit measure will not bring the building into compliance with NFIP requirements for Substantial Improvement/Damage (FEMA, 2013c). Barrier measures require ongoing maintenance (i.e. mowing, etc.) which should be factored into any cost analysis. In addition, barrier measures tend to create a false sense of security for the property owners and residents that are protected by them. If a barrier structure is not properly constructed or maintained and fails, catastrophic damages to surrounding areas can occur.

- *Floodwall with Gates and Floodwall without Gates*: These two measures involve installing a reinforced concrete floodwall, which works automatically without human assistance, constructed to a maximum of four feet above grade (ground level). The floodwall with gates is built with passive flood gates that are designed to open or close automatically due to the hydrostatic pressure caused by the floodwater. The floodwall without gates is built using vehicle ramps or pedestrian stairs to avoid the need for passive flood gates.
- *Levee with Gates and Levee without Gates*: These two measures involve installing an earthen levee around a home, which works automatically without human assistance, with a clay or concrete core constructed to a maximum of six feet above grade (ground level). The levee with gates is built with passive flood gates that are designed to open or close automatically due to hydrostatic pressure caused by the floodwater. The levee without gates is built using vehicle access ramps to avoid the need for passive flood gates.

Modifying a residential or non-residential building to protect it from flood damage requires extreme care, will require permits, and may also require complex engineered designs. Therefore, the following process is recommended to ensure proper and timely completion of any floodproofing project (FEMA, 2015c):

- Consult a registered design professional (i.e. architect or engineer) who is qualified to deal with the specifics of a flood mitigation project
- Check your community's floodplain management ordinances
- Contact your insurance agent to find out how your flood insurance premium may be affected
- Check what financial assistance might be available
- Hire a qualified contractor
- Contact the local building department to learn about development and permit requirements and to obtain a building permit
- Determine whether the mitigation project will trigger a Substantial Improvement declaration
- See the project through to completion
- Obtain an elevation certificate and an engineering certificate (if necessary)

No cost estimates were prepared for this alternative due to the variable and case-by-case nature of the flood mitigation strategy. Local municipal leaders should contact residential and non-residential building owners that are currently at a high flood risk to inform them about floodproofing measures, the recommended process to complete a floodproofing project, and the associated costs and benefits.

Alternative #4-4: Area Preservation / Floodplain Ordinances

This alternative proposes that municipalities within the Fish Creek watershed consider watershed and floodplain management practices such as preservation and/or conservation of areas along with land use ordinances that could minimize future development of sensitive areas such as wetlands, forests, riparian areas, and other open spaces. It could also include areas in the floodplain that are currently free from development and are providing floodplain storage.

A watershed approach to planning and management is an important part of water protection and restoration efforts. New York State's watersheds are the basis for management, monitoring, and assessment activities. The New York State Open Space Conservation Plan, NYSDEC's Smart Growth initiative and the Climate Smart Communities Program address land use within a watershed (NYSDEC, Date Unknown).

Natural floodplains provide flood risk reduction benefits by slowing runoff and storing flood water. They also provide other benefits of considerable economic, social, and environmental value that should be considered in local land-use decisions. Floodplains frequently contain wetlands and other important ecological areas which directly affect the quality of the local environment. Floodplain management is the operation of a community program of preventive and corrective measures to reduce the risk of current and future flooding, resulting in a more resilient community. These measures take a variety of forms, are carried out by multiple stakeholders with a vested interest in responsible floodplain management and generally include requirements for zoning, subdivision or building, building codes and special-purpose floodplain ordinances. While FEMA has minimum floodplain management standards for communities participating in the NFIP, best practices demonstrate that the adoption of higher standards will lead to safer, stronger, and more resilient communities (FEMA, 2006).

For floodplain ordinances, the NYSDEC has a sample of regulatory requirements for floodplain management that a community can adopt within their local flood damage prevention ordinance. If a community is interested in updating their local law to include regulatory language promoting floodplain management, it is recommended that they reach out to the NYSDEC through floodplain@dec.ny.gov or (518) 402-8185 for more information.

In addition, the Community Rating System (CRS) program through FEMA is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Participating communities are able to get discounted rates on the flood insurance premiums for residents in the community. Adopting these enhanced requirements and preserving open space for floodplain storage earns points in the CRS program, which can lead to discounted flood insurance premiums.

Further hydrology and hydraulic model scenarios could be performed to illustrate how future watershed and floodplain management techniques could benefit the communities within the Fish Creek watershed.

Alternative #4-5: Ice Management

This strategy is intended to control ice-jam formation by maintaining ice coverage in high-risk sections of Fish Creek. Ice management strategies include various methods of preventing ice jams by breaking ice using various ice cutting patterns and techniques, as well as various equipment and personnel. Suggested locations for ice cutting operations would be provided based on anticipated effectiveness, site accessibility, and historical occurrences of ice jams. Criteria and scheduling would be provided by county and / or state agencies and determined based on environmental conditions (e.g. temperature, ice thickness, weather forecast) (USACE, 2016b).

Possible ice management strategies would include:

- *Ice cutting*: cut ice free from banks or cross-cut ice to hasten the release of ice in order to prevent ice-jam formations
- *Trenchers and special design trenching equipment*: used to dig ditches customarily, but can be used to cut ice to hasten release downstream
- *Channeling plow*: plow mounted to a sledge drawn by a tractor that breaks and clears ice from channel

- *Water jet and thermal cutting*: supersonic water streams and thermal cutting tools to separate ice and move it downstream
- *Hole cutting*: drill large holes into the ice to reduce the integrity of the ice cover and curtail ice formation
- *Ice breakers*: ships, hovercrafts, amphibious hydraulic excavators, construction equipment, and blasting techniques designed to breakup ice and move ice downstream
- *Air bubbler and flow systems*: release air bubbles and warm water from the water bottom to suppress ice growth (USACE, 2002)

Generally, the FDD method, as previously discussed, is a good technique to first predict the ice thickness at critical locations, such as bridges or any flow constriction structures using the forecasted air temperature. This method will let the community officials know the severity of any possible ice jams based on future air temperature, allowing for time to get equipment and labor ready for the forthcoming ice jam. A small computer program could be used to do the iterative calculations faster, so that any non-technical user can use it to foresee the ice jam (Shen & Yapa, A Unified Degree-Day Method for River Ice Cover Thickness Simulation, 2011).

Another technique is maintaining a calibrated ice model to predict possible ice jam locations using forecasted air temperature and flow. This would include comprehensive 2-D river ice simulation model (RICEN) (Shen, Wang, & Wasantha, 1995) or Comprehensive River Ice Simulation System (CRISSP 2D) (CEATI, 2005) that predicts the fate of ice evolution from fall to spring.

The Rough Order Magnitude cost for this measure is $40,000, not including annual maintenance and operational costs.

Next Steps

Before selecting a flood mitigation strategy, securing funding or commencing an engineering design phase, Gomez and Sullivan recommends that additional modeling simulations and wetland investigations be performed.

Additional Data Modeling

Additional data collection and modeling would be necessary to more precisely model water surface elevations and the extent of potential flooding in overbank areas and the floodplain. 2-D unsteady flow modeling using the HEC-RAS program, would incorporate additional spatial information in model simulations producing more robust results with a higher degree of confidence than the currently modeled 1-D steady flow simulations. 2-D ice simulations are highly recommended to assess the wintery condition with the suggested alternatives to evaluate the water level rises due to presence of ice, ice-jam or break-up ice jam conditions.

State/Federal Wetlands Investigation

Any flood mitigation strategy that proposes using wetlands in any capacity, needs to be evaluated based on federal and state wetland criteria before that mitigation strategy can be pursued for consideration.

Ice Evaluation

Due to the complex interaction of ice formation and water flow through a river, it is difficult to draw conclusions regarding potential flood mitigation strategies and ice-jam formations based on observational data alone. The river bathymetry and channel meanders can complicate the ice dynamics and freeze-up jams. Spring runoff is affected by multiple environmental factors, including:

- Air temperature
- Water temperature
- Snow and ice melt intensity
- Upstream flow
- Upstream ice concentration
- Land cover
- Precipitation

Therefore, river reaches with potential ice jams should be analyzed using more comprehensive ice studies, possibly a 2-D ice dynamic study, to better understand the nature of the flooding, and the potential mitigation strategies. Ice-jam flooding is very different compared to regular flooding due to the presence of solid and frazil ice. The transportation of frazil ice and solid ice in a river constantly changes the hydrodynamics of the flow, and even at low flows can still raise water levels high enough to cause flooding. The growth of single-layer ice jams can create conditions that change low flood hazards, to high flood hazards, even at low flow conditions.

The impact of these factors will be amplified by climate change. Projected increases in precipitation across New York State indicates the potential for increases in spring runoff, which in turn would increase water levels and velocities in nearby streams and rivers (NYSERDA, 2011). In theory, the increased velocities would move solid ice and frazil ice down the river channel more quickly, possibly preventing ice jam formations. However, due to the limited available research in this area, additional data collection and modeling needs to be performed before a recommendation can be made regarding a flood mitigation strategy, and its specific influence on ice jam formations.

Example Funding Sources

There are numerous potential funding programs and grants for flood mitigation projects that may be used to offset municipal financing, including:

- New York State Division of Homeland Security and Emergency Services (NYSDHSES)
- Regional Economic Development Councils/Consolidated Funding Applications (CFA)
- Natural Resources Conservation Services (NRCS) Emergency Watershed Protection (EWP) Program
- FEMA Hazard Mitigation Grant Program (HMGP)

New York State Division of Homeland Security and Emergency Services (NYSDHSES)

The New York State Office of Emergency Management (NYSOEM), which is a part of the NYSDHSES, in conjunction with the United States Department of Homeland Security (USDHS) and FEMA, offers several funding opportunities through federal grant programs. Two primary programs are available through FEMA's Hazard Mitigation Grant Program (HMGP): Public Assistance, which includes post-disaster recovery grants enabled by Presidential declaration to reimburse for the emergency protective measures and the repair of eligible public facilities and infrastructure; and Hazard Mitigation, which includes pre-disaster project grants to eligible government sub-applicants to avoid or reduce the loss of life and property in future events. The NYSOEM would be the primary point of contact for all aspects of these programs.

Regional Economic Development Councils/Consolidated Funding Applications (CFA)

The CFA is a single application for state economic development resources from numerous state agencies. The ninth round of the CFA was offered in 2019.

Water Quality Improvement Project (WQIP) Program

The WQIP Program, administered through the NYSDEC, is a statewide reimbursement grant program to address documented water quality impairments. Eligible parties include local governments and not-for-profit corporations. Funding is available for construction/implementation projects; projects exclusively for planning are not eligible. Match for WQIP is a percentage of the award amount, not the total project cost. Deadlines are in accordance with the CFA application cycle.

Climate Smart Communities (CSC) Grant Program

The CSC Grant Program is a 50/50 matching grant program for municipalities under the New York State Environmental Protection Fund, offered through the CFA by the New York State Office of Climate Change. The purpose of the program is to fund climate change adaptation and mitigation projects and includes support for projects that are part of a strategy to become a Certified Climate Smart Community. The eligible project types that may be relevant include the following:

- The construction of natural resiliency measures, conservation or restoration of riparian areas and tidal marsh migration areas
- Nature-based solutions such as wetland protections to address physical climate risk due to water level rise, and/or storm surges and/or flooding

- Relocation or retrofit of facilities to address physical climate risk due to water level rise, and/or storm surges and/or flooding
- Flood risk reduction
- Climate change adaptation planning and supporting studies

Eligible projects include implementation and certification projects. Deadlines are in accordance with the CFA cycle.

NRCS Emergency Watershed Protection (EWP) Program

Through the EWP Program, the United States Department of Agriculture's (USDA) NRCS can assist communities in addressing watershed impairments that pose imminent threats to lives and property. Most EWP projects involve the protection of threatened infrastructure from continued stream erosion. Projects must have a project sponsor, defined as a legal subdivision of the State, such as a city, county, general improvement district, or conservation district, or an Indian Tribe or Tribal organization. Sponsors are responsible for providing land rights to do repair work, securing the necessary permits, furnishing the local cost share (25%), and performing any necessary operation and maintenance for a ten-year period. Through EWP, the NRCS may pay up to 75% of the construction costs of emergency measures, with up to 90% paid for projects in limited-resource areas. The remaining costs must come from local services. Eligible projects include, but are not limited to, debris-clogged stream channels, undermined and unstable streambanks, and jeopardized water control structures and public infrastructures.

FEMA Hazard Mitigation Grant Program (HMGP)

The HMGP, offered by FEMA and administered by the NYSDHSES, provides funding for creating/updating hazard mitigation plans and implementing hazard mitigation projects. The HMGP program consolidates the application process for FEMA's annual mitigation grant programs not tied to a State's Presidential disaster declaration. Funds are available under the Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance (FMA) Programs.

For flood mitigation measures that are being considered for funding through FEMA grant programs, a benefit-to-cost analysis will be required. In order to qualify for FEMA grants and/or funding, the benefit to cost ratio must be greater than one.

Building Resilient Infrastructure and Communities (BRIC) Program

Beginning in 2020, the BRIC grant program, which was created as part of Disaster Recovery Reform Act of 2018 (DRRA), replaced the existing Pre-Disaster Mitigation (PDM) program and is funded by a 6% set-aside from federal post-disaster grant expenditures. BRIC will support states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC aims to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. Through BRIC, FEMA will invest in a wide variety of mitigation activities, including community-wide public infrastructure projects. Moreover, FEMA anticipates BRIC will fund projects that demonstrate innovative approaches to partnerships, such as shared funding mechanisms and/or project design.

Flood Mitigation Assistance (FMA) Program

The FMA Program provides resources to reduce or eliminate long-term risk of flood damage to structures insured under the NFIP. The FMA project funding categories include Community Flood Mitigation – Advance Assistance (up to $200,000 total federal share funding) and Community Flood Mitigation Projects (up to $10 million total). Federal funding is available for up to 75% of the eligible activity costs. FEMA may contribute up to 100% federal cost share for severe repetitive loss properties, and up to 90% cost share for repetitive loss properties. Eligible project activities include the following:

- Infrastructure protective measures
- Floodwater storage and diversion
- Utility protective measures
- Stormwater management
- Wetland restoration/creation
- Aquifer storage and recovery
- Localized flood control to protect critical facility
- Floodplain and stream restoration
- Water and sanitary sewer system protective measures

Summary

The Town of Vienna and Village of Sylvan Beach have had a history of flooding events along Fish Creek. Flooding in the Town of Vienna and Village of Sylvan Beach primarily occurs during the summer and winter months due to heavy rains by convective systems and ice jams caused by above freezing temperatures allowing ice breakups in waterways. In response to persistent flooding, the State of New York in conjunction with the Town of Vienna and Village of Sylvan Beach, and Oneida County, are studying and evaluating potential flood mitigation projects for Fish Creek as part of the Resilient NY Initiative.

This study analyzed the historical and present day causes of flooding in the Fish Creek watershed. Hydraulic and hydrologic data was used to model potential flood mitigation measures. The model simulation results indicated that there are flood mitigation measures that have the potential to reduce water surface elevations along high-risk areas of Fish Creek, which could potentially reduce flood related damages in areas adjacent to the creek. Constructing multiple flood mitigation measures would increase the overall flood reduction potential along Fish Creek by combining the reduction potential of the mitigation measures being constructed.

Based on the flood mitigation analyses performed in this report, the mitigation measures that provided the greatest reductions in water surface elevations were:

- Alternative #1-1: Create Flood Benches Near Old State Route 49 (Station 308+00 to Station 341+00)
- Alternative #3-1: Create Flood Bench Near Confluence with NYS Barge Canal (Station 0+00 to Station 16+00)

The benefits of these measures should be balanced with the associated costs to determine if it would be feasible to move these alternatives forward. As such, benefits other than water surface elevation reduction should also be considered. The creation of flood benches may also reduce channel velocities, providing an area for sedimentation to occur, and provide an area for ice shelving to occur. The assessment of these additional benefits requires advanced 2-D sediment transport and 2-D river ice simulation modeling, which was beyond the scope of this study. Finally, while ice control structures create a potential boating hazard and were not considered in this study, future studies may evaluate whether these structures could be seasonally installed to enhance the ice-shelving potential of flood benches.

In addition to the creation of flood benches, the following mitigation measures would likely provide even greater reductions in water surface elevations during ice jam situations although these mitigation alternatives were not modeled:

- Alternative #2-1: Construct Pier Modifications for Higginsville Road Bridge (Station 123+00)
- Alternative #3-2: Dredge Near Confluence with NYS Barge Canal and Create Upstream Flood Benches (Station 14+34 to Station 0+00)

These mitigation alternatives require advanced 2-D river ice simulation modeling, which was beyond the scope of this study and should be considered in order to control ice build-up at critical points along Fish Creek and reduce the risk of flooding due to ice jams.

Some basin-wide alternatives which should be considered further include an ice-jam warning systems coupled with an ice management strategy that could include ice cutting and flood proofing. In

combination these can help to identify and control ice-jams to mitigate the worst effects of ice-jam flooding. The ice-jam warning system could enables municipalities to have the appropriate equipment available at the right time and place, while also alerting individual homeowners of the need to implement any flood proofing measures they may have.

There would be an overall greater effect in water surface elevations if multiple alternatives were implemented along Fish Creek in different phases, rather than a single mitigation project. For example, building multiple flood benches along a single reach would compound the flood mitigation benefits of each bench. Table 13 is a summary of the potential flood mitigation measures, including modeled water surface elevation reductions and estimated ROM costs.

Table 13. Summary of Flood Mitigation Measures

Alternative No.	Description	Change in Water Surface Elevation (ft)		ROM cost ($U.S. dollars)
		Current Flows	Projected Flows	
1-1	Create Flood Benches Near Old State Route 49	0.3	0.2 - 0.3	$5.7 million
2-1	Construct Pier Modifications for Higginsville Road Bridge	N/A	N/A	$430,000 (not including annual operational costs)
2-2	Create Flood Benches at Former Cook Road Bridge	0.1 - 0.2	0.1	$1.6 million
3-1	Create Flood Bench Near Confluence with NYS Barge Canal	1.2	1.2 - 1.3	$7.5 million
3-2	Dredge Near Confluence with NYS Barge Canal and Create Upstream Flood Benches	N/A	N/A	$7.4 million
4-1	Early Flood Warning Detection System	N/A	N/A	$120,000 (not including annual operational costs)
4-2	Flood Buyouts Program	N/A	N/A	Variable (case-by-case)
4-3	Floodproofing	N/A	N/A	Variable (case-by-case)
4-4	Area Preservation/Floodplain Ordinances	N/A	N/A	Variable (case-by-case)
4-5	Ice Management	N/A	N/A	$40,000 (not including annual operational costs)

Conclusion

Municipalities affected by flooding along Fish Creek can use this report to support flood mitigation initiatives within their communities. This report is intended to be a high-level overview of potential flood mitigation strategies, their impacts on water surface elevations, and the associated ROM cost for each mitigation strategy. The research and analysis that went into each potential strategy should be considered preliminary, and additional research, field observations, and modeling are recommended before final mitigation strategies are chosen.

In order to implement the flood mitigation strategies presented in this report, communities should engage in a process that follows the following steps:

4. Obtain stakeholder and public input to assess the feasibility and public support of each mitigation strategy presented in this report.
5. Complete additional data collection and modeling efforts to assess the effectiveness of the potential flood mitigation strategies.
6. Develop a list of final flood mitigation strategies based on the additional data collection and modeling results.
7. Select a final flood mitigation strategy or series of strategies to be completed for Fish Creek based on feasibility, permitting, effectiveness, and available funding.
8. Develop a preliminary engineering design report and cost estimate for each selected mitigation strategy.
9. Assess funding sources for the selected flood mitigation strategy.

Once funding has been secured and the engineering design has been completed for the final mitigation strategy, construction and / or implementation of the measure should begin.

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Appendix A. Summary of Data and Reports Collected

Year	Type	Document Title	Author	Publisher
1966	Report	Flood Plain Information: Buffalo Creek, New York in the Towns of Elma and West Seneca	Buffalo District	USACE
1978	Report	National Handbook of Recommended Methods for Water-Data Acquisition	Office of Water Data Coordination	USGS
1988	Report	Flood Insurance Study: Town of Annsville, New York		FEMA
1991	Report	Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island	Richard Lumia	USGS
1995	Article	Numerical Simulation of River Ice Processes	H. T. Shen, D. S. Wang, and L. A. Wasantha,	Journal of Cold Region Engineering
1996	Book	Applied River Morphology, 2nd Edition	D. L. Rosgen and H. L. Silvey	Wildland Hydrology Books
1998	Report	Flood Insurance Study: City of Rome, New York		FEMA
1999	Report	Flood Insurance Study: Town of Verona, New York		FEMA
1999	Report	Flood Insurance Study: Town of Vienna, New York		FEMA
1999	Report	Flood Insurance Study: Village of Sylvan Beach, New York		FEMA
2000	Code	Title 44: Emergency Management and Assistance, Chapter 1		FEMA

Year	Type	Document Title	Author	Publisher
2002	Standard	National Conservation Practice Standard No. 638: Water and Sediment Control Basin		NRCS
2002	Report	Engineering Manual 1110-2-1612: Engineering and Design – Ice Engineering		USACE
2004	Report	Sediment Dynamics of the Oneida Creek Delta, Oneida Lake, New York (Draft)	Eugene W. Domack, Scott Ingmire, and Katie Arnold	Hamilton College
2005	Software	Comprehensive River Ice Simulation System Project (CRISSP)		CEATI
2006	Report	Floodplain Management Requirements: A Study Guide and Desk Reference for Local Officials		FEMA
2006	Report	Bridge Inventory Manual		NYSDOT
2006	Report	Magnitude and Frequency of Floods in New York	Richard Lumia, Douglas A. Freehafer, and Martyn J. Smith	USGS
2007	Book	Elevation Data for Floodplain Mapping		NRC
2009	Report	Bankfull Discharge and Channel Characteristics of Streams in New York State	Christiane I. Mulvihill, Barry P. Baldigo, Sarah J. Miller, Douglas DeKoskie, and Joel DuBois	USGS
2010	Report	DHS Risk Lexicon		USDHS
2011	Report	Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State, Final Report		NYSERDA
2011	Article	A Unified Degree-Day Method for River Ice Cover Thickness Simulation	H. T. Shen and P. Yapa	Canadian Journal of Civil Engineering

Year	Type	Document Title	Author	Publisher
2011	Article	An Overview of CMIP5 and the Experiment Design	K. E. Taylor, R. J. Stouffer, and G. A. Meehi	Bulletin of the American Meteorological Society
2012	Report	Hydraulic Design of Safe Bridges	L. W. Zevenbergen, L. A. Arneson, J.H. Hunt, and A.C. Miller	USDOT
2012	Article	Geomorphic Characterization of Upper South Koel Basin, Jharkhand: A Remove Sensing and GIS Approach	R. Parveen, U. Kumar, and V. K. Singh	Journal of Water Resource and Protection, 1042-1050
2013	News	Water Begins to Recede in Sylvan Beach after Ice Flow Melts	The Dispatch Staff	New Haven Register
2013	News	Water Recedes as Fish Creek Ice Jam Breaks Up	Tom Eschen	CNY Central
2013	News	Flooding Results in Sylvan Beach Residential Evacuations		Utica Observer Dispatch
2013	Report	Flood Insurance Study: Oneida County, New York (All Jurisdictions)		FEMA
2013	Report	Flood Insurance Rate Map for Oneida County, New York (All Jurisdictions)		FEMA
2013	Report	Floodproofing Non-Residential Buildings		FEMA
2013	Report	Removal of Woody Debris and Trash from Rivers and Streams		NYSDEC
2013	Article	Anatomy of a Buyout Program – New York Post-Superstorm Sandy	A. R. Siders	Vermont Law School
2014	Book	Handbook of Biological Statistics, 3rd Edition	J. H. McDonald	Sparky House Publishing

Year	Type	Document Title	Author	Publisher
2014	Report	National Register of Historical Places and National Historic Landmarks Program Records for New York State		NPS
2014	Article	Morphometric Analysis of a Drainage Basin Using Geographical Information System: A Case Study	M. L. Waikar and A. P. Nilawar	International Journal of Multidisciplinary and Current Research
2015	Report	Guidance for Flood Risk Analysis and Mapping: Redelineation Guidance		FEMA
2015	Report	Hazard Mitigation Assistance Program Digest, September 2015		FEMA
2015	Report	Reducing Flood Risk to Residential Buildings That Cannot Be Elevated		FEMA
2015	Article	Influence of Aggradation and Degradation on River Channels: A Review	U. R. Mugade and J. B. Sapkale	International Journal of Engineering and Technical Research
2015	Report	Development of Flood Regressions and Climate Change Scenarios to Explore Estimates of Future Peak Flows	Douglas A. Burns, Martyn J. Smith, and Douglas A. Freehafer	USGS
2016	Report	Discoverty Report Appendix H: Discovery Meeting Summary Memorandum – Oneida Lake Watershed		FEMA
2016	Report	HEC-RAS: River Analysis System User's Manual, Version 5.0	HEC	USACE
2016	Report	Lexington Greene – Section 2015 of the 1948 Flood Control Act – Flood Risk Management	Buffalo District	USACE

Year	Type	Document Title	Author	Publisher
2016	Software	Application of Flood Regressions and Climate Change Scenarios to Explore Estimates of Future Peak Flows, Version 1.5 Web Application		USGS
2017	Data	New York State Digital Ortho-Imagery Program	GIS Program Office	NYSOITS
2017	Report	Fact Sheet 2017-3046: *StreamStats*, Version 4	Kernell G. Ries III, Jeremy K. Newsom, Martyn J. Smith, John D. Guthrie, Peter A. Steeves, Tiana L Haluska, Katharine R. Kolb, Ryan F. Thompson, Richard D. Santoro, and Hans W. Vraga	USGS
2018	News	"I've Never Seen This": Vienna Homes Flooded, People Seek Shelter in Churcy		CNY Central
2018	News	After Weekend Damage, Sylvan Beach Concerned about New Flooding Threats		CNY Central
2018	News	Officials Keeping a Close Eye on Fish Creek in Sylvan Beach		WKTV
2018	Report	DRAFT New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act		NYSDEC
2018	Report	Highway Design Manual	Engineering Division, Office of Design	NYSDOT
2018	Article	Governor Cuomo Announces $3 Million for Studies to Reduce Community Flood Risk		NYSGPO
2019	News	Sylvan Beach Flooding Worst in at Least 50 Years – and It's Not Over	Glenn Coin	Syracuse.com
2019	Software	ArcGIS for Desktop 10		ESRI

Year	Type	Document Title	Author	Publisher
2019	Data	2016 Land Cover: Conterminous United States	NLCD	MRLC
2019	Data	Bridge Point Locations and Select Attributes	Structures Division	NYSDOT
2019	Report	Bridge Manual	Structures Division	NYSDOT
2019	Data	CostsWorks 2019	RS Means Data Online	Gordian, Inc.
2019	Software	Hydrologic Engineering Center's River Analysis System, Version 5.0.7	HEC	USACE
2019	Report	Policy Manual: NY Rising Buyout and Acquisition Program, Version 7.0		NYSGOSR
2020	Report	New York State Flood Risk Management Guidance for Implementation of the Community Risk and Resiliency Act		NYSDEC
2020	Data	Storm Events Database	NCEI	NOAA
2020	Software	Environmental Resource Mapper Web Application		NYSDEC
2020	Data	Inventory of Dams – New York State		NYSDEC
2020	Standard	Standard Specifications (US Customary Units), Volume 1	Engineering Division	NYSDOT
2020	Data	Ice Jam Database	CRREL	USACE
2020	Software	Information for Planning and Consultation Web Application	ECOS	USFWS
2020	Software	*StreamStats*, Version 4.4.0 Web Application		USGS
2020	Website	Hazard Mitigation Grant Program (HMGP)		FEMA

Year	Type	Document Title	Author	Publisher
2021	Website	Oneida Lake Rule Curves		NYSCC
2021	Website	Oneida Lake Level - 2021		NYSCC
2021	Data	National Water Information System		USGS
Unk	Article	Watershed Management		NYSDEC

Appendix B. Agency and Stakeholder Meeting Attendees List

Initial Project Kickoff Meeting: October 28, 2021

Attendees	Affiliation
Richard Sullivan	Sylvan Beach, Village of
Michael Sayles	Sylvan Beach, Village of
Jessica McLaughlin	Oneida County Soil and Water Conservation District
Kevin Miller	Gomez & Sullivan
Nicholas DiGennaro	Gomez & Sullivan
Charvi Gupta	Highland Planning
Jen Topa	Highland Planning
Tom Snow	NYSDEC
Fred Munk	NYSDEC
Jana Lantry	NYSDEC
Geoffrey Golick	NYSDEC
David Erway	NYSDEC
Steve Case	NYSDEC
Eric Baurle	NYSOGS
Laura Ortiz	USACE
Shaun Gannon	Ramboll
Kadir Goz	Ramboll

Appendix C. Field Data Collection Forms

NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

Stream Channel Classification (Level II)

Wisconsin Job Sheet 811

Natural Resources Conservation Service (NRCS) **Wisconsin**

Project: ______________________ Date: ______________________

County: ______________________ Stream: ______________________

Reach No.: ______________________ Logged By: ______________________

Horizontal Datum: NAD ________ Projection: ☐ Transverse Mercator ☐ Lambert Conformal Conical

Coordinate System: ☐ __________ County Coordinates ☐ WTM ☐ State Plane Coordinates ☐ UTM

Units: ☐ Meters ☐ Feet Horizontal Control: N or Lat. ___________ E or Long. ___________

Elevation: ____________ ☐ Assumed ☐ DOT ☐ NAVD (29 / 88) Units: ☐ Meters ☐ Feet

Fluvial Geomorphology Features (3 Cross Sections) for Stream Classification

				Average
Bankfull Width (W_{bkf}):	________ ft.	________ ft.	________ ft.	0.00 ft.

Width of the stream channel, at bankfull stage elevation, in a riffle section.

Mean Depth (d_{bkf}):	________ ft.	________ ft.	________ ft.	0.00 ft.

Mean depth of the stream channel cross section, at bankfull stage elevation, in a riffle section. ($d_{bkf}=A_{bkf}/W_{bkf}$)

Bankfull X-Section Area (A_{bkf}):	________ sq. ft.	________ sq. ft.	________ sq. ft.	0.00 sq. ft.

Area of the stream channel cross section, at bankfull stage elevation, in a riffle section.

Width / Depth Ratio (W_{bkf}/d_{bkf}):	________ ft.	________ ft.	________ ft.	0.00 ft.

Bankfull width divided by bankfull mean depth, in a riffle section.

Maximum Depth (d_{mbkf}):	________ ft.	________ ft.	________ ft.	0.00 ft.

Maximum depth of the Bankfull channel cross section, or distance between the bankfull stage and thalweg elevations, in a riffle section.

Width of Flood-Prone Area (W_{fpa}):	________ ft.	________ ft.	________ ft.	0.00 ft.

Twice maximum depth, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area width is determined (riffle section).

Entrenchment Ratio (ER):	________ ft.	________ ft.	________ ft.	0.00 ft.

The ratio of flood-prone area width divided by bankfull channel width. (W_{fpa}/W_{bkf}) (riffle section)

Reach Characteristics

Channel Materials (Particle Size Index) D50: _________ mm

The D50 particle size index represents the median diameter of channel materials, as sampled from the channel surface, between the bankfull stage and thalweg elevations.

Water Surface Slope (S): ________________ ft./ft.

Channel slope = "rise" over "run" for a reach approximately 20-30 bankfull channel widths in length, with the "riffle to riffle" water surface slope representing the gradient at bankfull stage.

Channel Sinuosity (K): ________________.

Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL/VL); or estimated from a ratio of valley slope divided by channel slope (VS/S).

Distance to Up-Stream Structures: ______________________________.

Stream Type: _____________________ (For reference, note Stream Type Chart and Classification Key)

Dominant Channel Soils at an Eroding Bank Location

Bed Material: __________________________ Left Bank: ___________ Right Bank: ___________

Description of Soil Profiles (from base of bank to top):

Left: ____

____

Right: ____

____

Riparian Vegetation at an Eroding Bank Location

Left Bank: _____________________________ Right Bank: ____________________________

Percent Total Area (Mass): Left: __________________ Right: ___________________________

Percent Total Height with Roots: Left: __________________ Right: _____________________

Other Bank Features at an Eroding Bank Location

Actual Bank Height: _______________________ Bankfull Height: _________________________

Bank Slope (Horizontal to Vertical):

Left:
- ☐ 0-20° (flat)
- ☐ 21-60° (moderate)
- ☐ 61-80° (steep)
- ☐ 81-90° (vertical)
- ☐ 90°+ (undercut)

Right:
- ☐ 0-20° (flat)
- ☐ 21-60° (moderate)
- ☐ 61-80° (steep)
- ☐ 81-90° (vertical)
- ☐ 90°+ (undercut)

Visible Seepage in Bank? ☐ Yes ☐ No Where? _______________________________

Thalweg Location: ☐ Near 1/3 ☐ Mid 1/3 ☐ Far 1/3

NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

Pebble Count (Data Collection)

Wisconsin Job Sheet 810

Natural Resources Conservation Service (NRCS) **Wisconsin**

Project: ____________ Date: ____________

County: ____________ Stream: ____________

Reach No.: ____________ Logged By: ____________

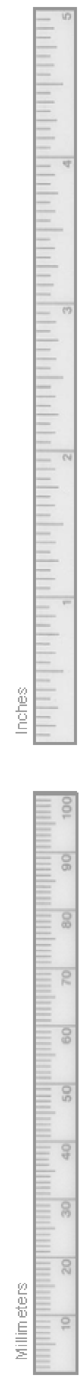
Horizontal Datum: NAD ________ Projection: ☐ Transverse Mercator ☐ Lambert Conformal Conical

Coordinate System: ☐ __________ County Coordinates ☐ WTM ☐ State Plane Coordinates ☐ UTM

Units: ☐ Meters ☐ Feet Horizontal Control: N or Lat. ____________ E or Long. ____________

Elevation: ____________ ☐ Assumed ☐ DOT ☐ NAVD (29 / 88) Units: ☐ Meters ☐ Feet

Inches	Millimeters	Particle	Particle Count			
			1	Total #	2	Total #
<.002	<.062	Silt/Clay				
.002 - .005	.062 - .125	Very Fine Sand				
.005 - .01	.125 - .25	Fine Sand				
.01 - .02	.25 - .50	Medium Sand				
.02 - .04	.50 - 1.0	Coarse Sand				
.04 - .08	1.0 - 2	Very Coarse Sand				
.08 - .16	2 - 4	Very Fine Gravel				
.16 - .22	4 - 5.7	Fine Gravel				
.22 - .31	5.7 - 8	Fine Gravel				
.31 - .44	8 - 11.3	Medium Gravel				
.44 - .63	11.3 - 16	Medium Gravel				
.63 - .89	16 - 22.6	Coarse Gravel				
.89 - 1.26	22.6 - 32	Coarse Gravel				
1.26 - 1.77	32 - 45	Very Coarse Gravel				
1.77 - 2.5	45 - 64	Very Coarse Gravel				
2.5 - 3.5	64 - 90	Small Cobbles				
3.5 - 5.0	90 - 128	Small Cobbles				
5.0 - 7.1	128 - 180	Large Cobbles				
7.1 - 10.1	180 - 256	Large Cobbles				
10.1 - 14.3	256 - 362	Small Boulders				
14.3 - 20	362 - 512	Small Boulders				
20 - 40	512 - 1024	Medium Boulders				
40 - 80	1024 - 2048	Large-Very Large Boulders				
		Bedrock				



Resilient New York

Date:

Field crew:

Stream:

Road crossing:

Structure data: ☐ Bridge

Height at edge[1]: _____ Width at top of opening: _____

Height at deepest point: _____ Bank slope: Rise: _____ Run: _____

Piers _____ Pier shape: round triangle square

Span between piers: _____ Width of piers: _____

☐ Culvert (see data below)

Length in direction of flow:

Manning value: Top: Bottom:

Deck thickness:

Height of rail:

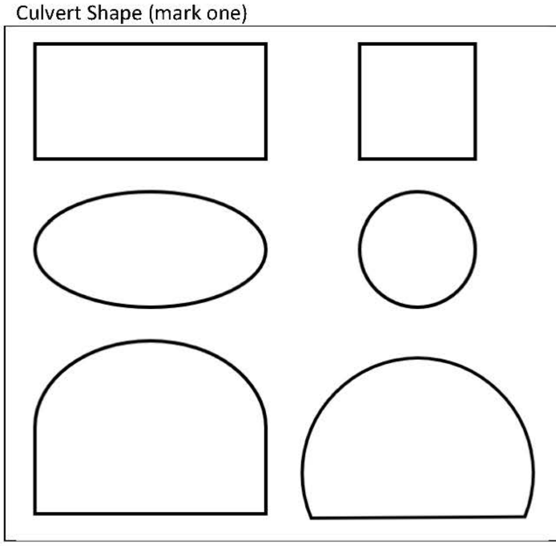
Type of rail:

Structure material:

Bottom substrate:

Description:

Culvert Shape (mark one)



Depth from top of opening to bottom of stream

at edge: _____

at deepest location: _____

Opening width: _____

[1] All measurements should be taken to 0.1 feet

P:\2065 - Resilient NY Initiative\Field Data Collections\Field_Template.docx

Appendix D. Photo Log

List of Additional Field Photos

Photo D-1. *Upstream Face of Higginsville Road Bridge*

Photo D-2. *Channel Downstream of Higginsville Road Bridge*

Photo D-3. *Bank Stabilization near Old State Route 49 Looking Upstream*

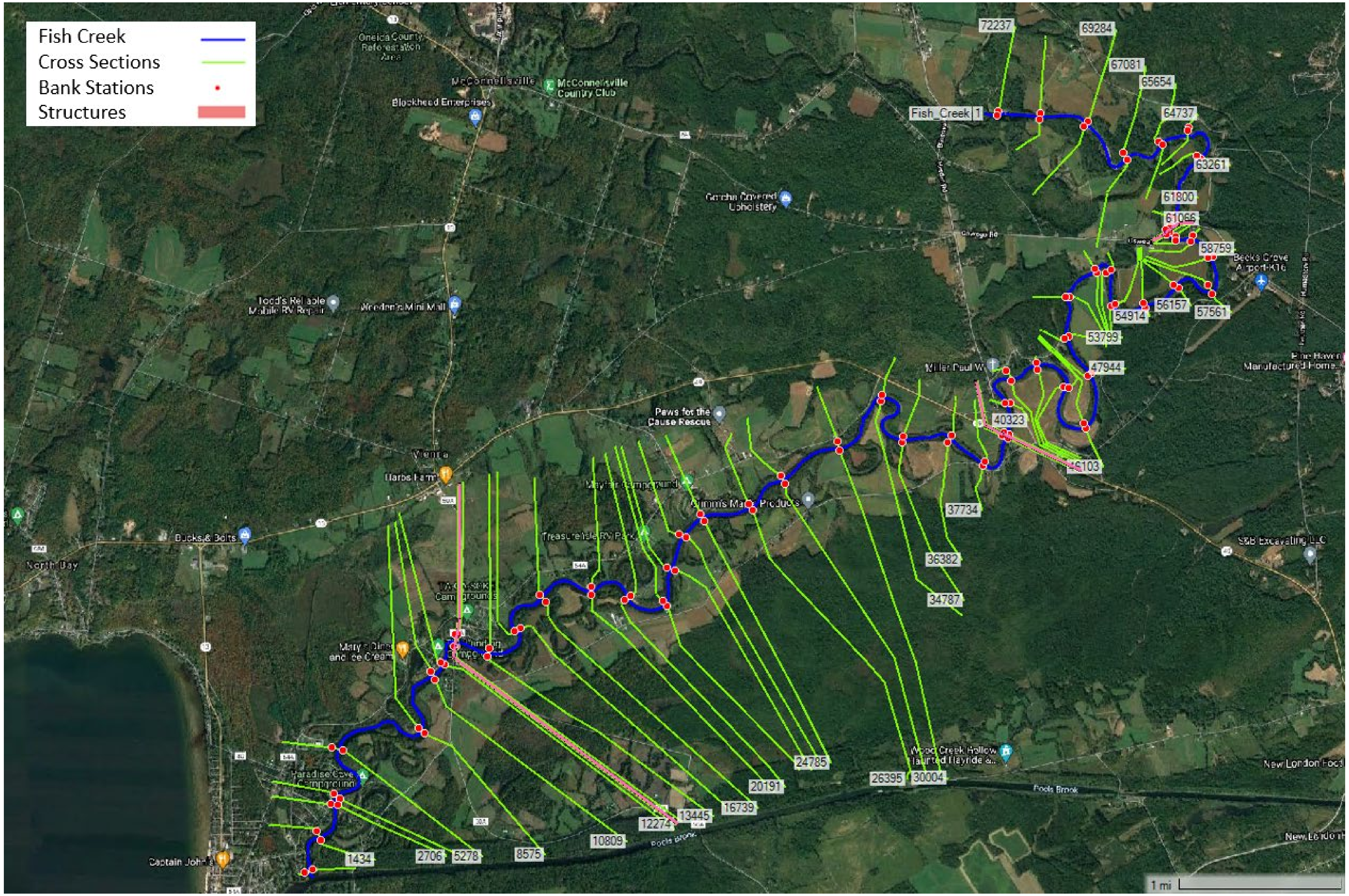
Photo D-4. *Downstream Face of State Route 49 Bridge*

Photo D-5. *Channel Downstream of State Route 49 Bridge*

Photo D-6. *Downstream Face of Oswego Road Bridge*

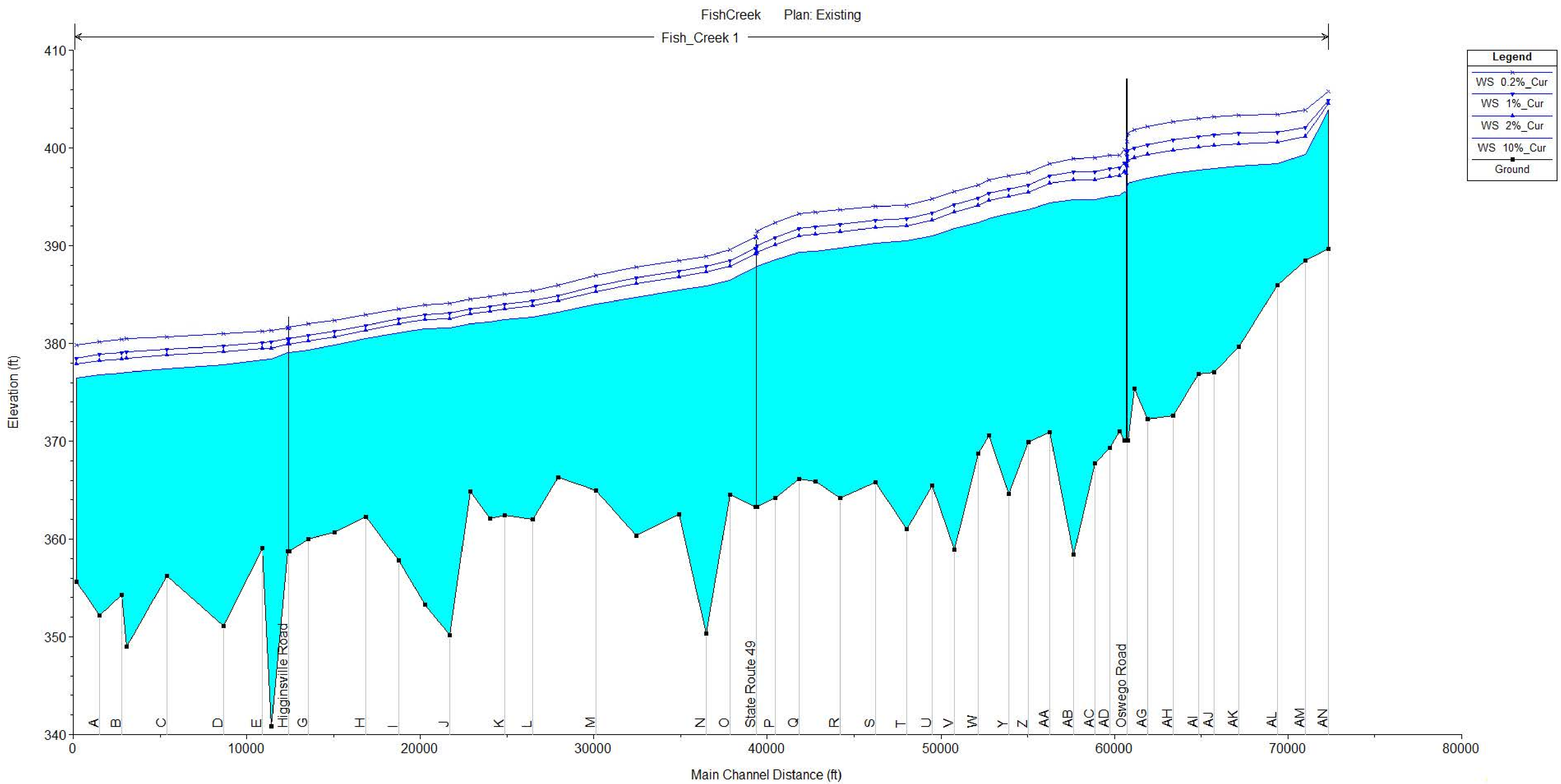
Photo D-7. *Channel Downstream of Oswego Road Bridge*

Appendix E. HEC-RAS Simulation Output



Plan: Base Condition

Flows: Current



Plan: Base Condition

Flows: Current

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	72237	10%_Cur	17900	389.7	403.86		404.22	0.001845	6.1	6445.72	1708.81	0.31
1	72237	2%_Cur	22890	389.7	404.55		405.01	0.002314	7.08	7491.02	1971.24	0.35
1	72237	1%_Cur	25380	389.7	404.91		405.39	0.002411	7.37	8083.87	2049.34	0.36
1	72237	0.2%_Cur	30670	389.7	405.82		406.28	0.002266	7.47	9604	2118.37	0.35
1	70873	10%_Cur	17900	388.5	399.36	396.77	400.22	0.00534	8.24	3897.15	2305.12	0.5
1	70873	2%_Cur	22890	388.5	401.17		401.62	0.002752	6.72	7393.62	3255.93	0.37
1	70873	1%_Cur	25380	388.5	402.1		402.43	0.001965	6.01	9387.02	3763.81	0.32
1	70873	0.2%_Cur	30670	388.5	403.84		404.05	0.001203	5.18	13118.44	3929.84	0.25
1	69284	10%_Cur	17900	386	398.38		398.42	0.000419	2.67	16140.68	4767.72	0.14
1	69284	2%_Cur	22890	386	400.62		400.65	0.000232	2.26	23044.05	5000.68	0.11
1	69284	1%_Cur	25380	386	401.63		401.66	0.000192	2.16	26170.68	5285.17	0.1
1	69284	0.2%_Cur	30670	386	403.47		403.5	0.000151	2.08	31837.74	5502.09	0.09
1	67081	10%_Cur	17900	379.7	398.14		398.16	0.000072	1.46	27739.21	4227.03	0.06
1	67081	2%_Cur	22890	379.7	400.45		400.46	0.000057	1.42	35269.04	4260.48	0.06
1	67081	1%_Cur	25380	379.7	401.49		401.5	0.000053	1.42	38636.74	4264.98	0.06
1	67081	0.2%_Cur	30670	379.7	403.34		403.36	0.000049	1.45	44694.95	4272.31	0.06
1	65654	10%_Cur	17900	377.1	397.92		397.98	0.000229	2.77	13826.85	1783.32	0.12
1	65654	2%_Cur	22890	377.1	400.27		400.32	0.000194	2.78	17280.21	1792.52	0.11
1	65654	1%_Cur	25380	377.1	401.31		401.36	0.000185	2.8	18816.87	1796.35	0.11
1	65654	0.2%_Cur	30670	377.1	403.17		403.23	0.000179	2.92	21579.55	1827.37	0.11
1	64737	10%_Cur	17900	376.9	397.73		397.79	0.000245	2.91	13190.46	1564.36	0.12
1	64737	2%_Cur	22890	376.9	400.1		400.16	0.000219	2.98	16067.66	1576.67	0.12
1	64737	1%_Cur	25380	376.9	401.15		401.2	0.000213	3.04	17344.27	1581.39	0.12
1	64737	0.2%_Cur	30670	376.9	403.01		403.07	0.000211	3.2	19622.1	1590.64	0.12
1	63261	10%_Cur	18320	372.6	397.37		397.5	0.000302	3.56	9743.86	1122.9	0.14
1	63261	2%_Cur	23430	372.6	399.77		399.9	0.000285	3.71	11975.05	1130.39	0.13
1	63261	1%_Cur	25980	372.6	400.83		400.96	0.000281	3.8	12958.09	1133.68	0.13
1	63261	0.2%_Cur	31390	372.6	402.69		402.83	0.000287	4.03	14696.55	1139.53	0.14
1	61800	10%_Cur	18320	372.3	396.91		397.06	0.000329	3.77	8157.72	731.05	0.14
1	61800	2%_Cur	23430	372.3	399.3		399.47	0.000339	4.1	9700.95	746.1	0.15
1	61800	1%_Cur	25980	372.3	400.35		400.52	0.000345	4.26	10383.25	751.53	0.15
1	61800	0.2%_Cur	31390	372.3	402.17		402.38	0.000371	4.63	11582.21	760.86	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	61066	10%_Cur	18320	375.4	396.58		396.77	0.000457	4.03	7111.43	876.77	0.16
1	61066	2%_Cur	23430	375.4	398.97		399.18	0.00045	4.33	8555.41	1077.68	0.17
1	61066	1%_Cur	25980	375.4	400.01		400.23	0.000452	4.48	9191.26	1100.27	0.17
1	61066	0.2%_Cur	31390	375.4	401.82		402.07	0.000477	4.84	10296.61	1122.64	0.17
1	60661	10%_Cur	18320	370.11	396.41	380.75	396.61	0.000312	3.74	5981.5	744.96	0.14
1	60661	2%_Cur	23430	370.11	398.75	381.94	399	0.00035	4.24	6816.06	898.25	0.15
1	60661	1%_Cur	25980	370.11	399.77	382.53	400.04	0.00037	4.48	7178.64	917.06	0.16
1	60661	0.2%_Cur	31390	370.11	401.51	383.61	401.85	0.000423	5.01	7800.03	950.67	0.17
1	60574		Bridge									
1	60485	10%_Cur	18320	370.11	395.51		395.91	0.000669	5.47	4477.38	736.82	0.2
1	60485	2%_Cur	23430	370.11	397.59		398.09	0.000766	6.21	5101.43	827.41	0.22
1	60485	1%_Cur	25980	370.11	398.47		399.03	0.000819	6.58	5364.31	876.91	0.23
1	60485	0.2%_Cur	31390	370.11	399.85		400.55	0.000968	7.41	5778.59	886.01	0.25
1	60172	10%_Cur	18320	371	395.11	382.64	395.64	0.000928	6.1	3829.7	729.75	0.23
1	60172	2%_Cur	23430	371	397.13	384.25	397.79	0.001052	6.9	4422.43	739.55	0.25
1	60172	1%_Cur	25980	371	397.97	385.01	398.7	0.001122	7.3	4672.59	913.31	0.26
1	60172	0.2%_Cur	31390	371	399.26	386.48	400.16	0.001326	8.22	5303.12	1112.73	0.29
1	59645	10%_Cur	18320	369.3	395.05	378.96	395.27	0.000333	3.85	5139.95	492.63	0.14
1	59645	2%_Cur	23430	369.3	397.06	380.16	397.36	0.000399	4.46	5755.97	823.93	0.16
1	59645	1%_Cur	25980	369.3	397.89	380.71	398.24	0.000435	4.77	6013.94	1204.4	0.17
1	59645	0.2%_Cur	31390	369.3	399.23	381.79	399.61	0.000478	5.17	8773.98	1375.12	0.18
1	58759	10%_Cur	18320	367.7	394.71	378.81	394.96	0.000393	4.21	6859.14	1333.62	0.16
1	58759	2%_Cur	23430	367.7	396.74	380.29	397	0.00041	4.55	8719.4	1929.68	0.16
1	58759	1%_Cur	25980	367.7	397.57	380.95	397.85	0.000422	4.72	9492.79	1983.62	0.16
1	58759	0.2%_Cur	31390	367.7	398.95	382.27	399.2	0.000408	4.81	13872.77	2098.45	0.16
1	57561	10%_Cur	18320	358.4	394.73	369.05	394.77	0.000052	1.79	15538.68	2094.73	0.06
1	57561	2%_Cur	23430	358.4	396.74	370.4	396.8	0.000061	2.03	18435.92	2446.72	0.07
1	57561	1%_Cur	25980	358.4	397.58	371.01	397.64	0.000065	2.14	19639.22	2495.32	0.07
1	57561	0.2%_Cur	31390	358.4	398.93	372.19	399	0.000075	2.36	24536.06	2622.97	0.07
1	56157	10%_Cur	18320	370.9	394.41	379.91	394.61	0.00036	3.95	6727.84	1166.08	0.15
1	56157	2%_Cur	23430	370.9	396.37	381.26	396.61	0.000408	4.45	7910.51	1512.76	0.16
1	56157	1%_Cur	25980	370.9	397.17	381.87	397.44	0.000433	4.69	8407.1	1584.96	0.17

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	56157	0.2%_Cur	31390	370.9	398.44	383.04	398.77	0.000507	5.25	9191.32	1721.1	0.18
1	54914	10%_Cur	18320	369.9	393.66	379.31	394.03	0.000581	5.01	4497.2	815.94	0.19
1	54914	2%_Cur	23430	369.9	395.47	380.65	395.94	0.000684	5.74	5599.34	1388.06	0.21
1	54914	1%_Cur	25980	369.9	396.21	381.28	396.73	0.000728	6.04	6174.34	1463.97	0.22
1	54914	0.2%_Cur	31390	369.9	397.5	382.55	398	0.000731	6.27	9349.72	1514	0.22
1	53799	10%_Cur	18320	364.6	393.27	376.49	393.51	0.000356	4.2	7520.76	1399.4	0.15
1	53799	2%_Cur	23430	364.6	395.08	377.96	395.35	0.000393	4.63	9950.51	2059.72	0.16
1	53799	1%_Cur	25980	364.6	395.84	378.62	396.11	0.000402	4.77	11247.14	2242.15	0.16
1	53799	0.2%_Cur	31390	364.6	397.17	379.99	397.41	0.000384	4.81	15816.42	2568.44	0.16
1	52665	10%_Cur	18320	370.6	392.81	379.36	393.06	0.000462	4.26	6775.59	1199.15	0.17
1	52665	2%_Cur	23430	370.6	394.6	380.6	394.87	0.000489	4.64	9415	2180.32	0.17
1	52665	1%_Cur	25980	370.6	395.36	381.16	395.63	0.000484	4.72	11135.11	2577.76	0.17
1	52665	0.2%_Cur	31390	370.6	396.69	382.36	396.96	0.000487	4.92	14491.16	2711.3	0.18
1	52024	10%_Cur	18320	368.7	392.39		392.73	0.000574	4.82	5005.14	841.7	0.19
1	52024	2%_Cur	23430	368.7	394.13		394.52	0.000632	5.34	7319.78	1819.42	0.2
1	52024	1%_Cur	25980	368.7	394.87		395.28	0.000658	5.57	8829.75	2125.06	0.2
1	52024	0.2%_Cur	31390	368.7	396.22		396.62	0.000659	5.78	11768.95	2213.81	0.21
1	50694	10%_Cur	18320	358.9	391.78		392.1	0.000399	4.67	5704.4	1002.16	0.16
1	50694	2%_Cur	23430	358.9	393.45		393.83	0.000468	5.27	7970.29	1799.9	0.18
1	50694	1%_Cur	25980	358.9	394.18		394.57	0.000484	5.45	9373.71	1977.73	0.18
1	50694	0.2%_Cur	31390	358.9	395.53		395.93	0.00051	5.77	12217.44	2249.58	0.19
1	49376	10%_Cur	18320	365.5	390.97		391.4	0.000719	5.6	4697.47	1062.53	0.21
1	49376	2%_Cur	23430	365.5	392.58		393.04	0.000773	6.09	6922.04	1658.46	0.22
1	49376	1%_Cur	25980	365.5	393.33		393.78	0.000766	6.19	8230.21	1808.95	0.22
1	49376	0.2%_Cur	31390	365.5	394.77		395.16	0.000696	6.13	10889.84	1875.34	0.21
1	47944	10%_Cur	18320	361	390.51		390.74	0.000309	4	6106.75	936.69	0.14
1	47944	2%_Cur	23430	361	392.03		392.31	0.000379	4.61	7722.54	1239.82	0.16
1	47944	1%_Cur	25980	361	392.74		393.05	0.000403	4.84	8685.42	1423.06	0.16
1	47944	0.2%_Cur	31390	361	394.15		394.48	0.000433	5.18	10965.93	1711.97	0.17
1	46103	10%_Cur	18320	365.8	390.27		390.35	0.00018	2.73	13961.28	2866.28	0.1
1	46103	2%_Cur	23430	365.8	391.86		391.92	0.000158	2.68	18794.38	3188.35	0.1
1	46103	1%_Cur	25980	365.8	392.6		392.66	0.00015	2.67	21201.44	3330.64	0.1
1	46103	0.2%_Cur	31390	365.8	394.06		394.11	0.000136	2.65	26210.64	3584.21	0.09

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	44085	10%_Cur	18320	364.2	389.76		389.94	0.000403	3.9	7807.57	1856.76	0.15
1	44085	2%_Cur	23430	364.2	391.41		391.59	0.000378	3.98	11058.41	2721.23	0.15
1	44085	1%_Cur	25980	364.2	392.18		392.34	0.000372	4.04	12740.44	3250.66	0.15
1	44085	0.2%_Cur	31390	364.2	393.7		393.84	0.000323	3.93	16302.08	4889.72	0.14
1	42674	10%_Cur	18320	365.9	389.45		389.54	0.000262	3	10133.06	1746.32	0.12
1	42674	2%_Cur	23430	365.9	391.13		391.23	0.000251	3.11	12472.12	1955.51	0.12
1	42674	1%_Cur	25980	365.9	391.91		392	0.000247	3.16	13543.54	2837.49	0.12
1	42674	0.2%_Cur	31390	365.9	393.45		393.55	0.000238	3.26	15692.88	4027.73	0.12
1	41705	10%_Cur	18320	366.1	389.29	374.37	389.35	0.000147	2.16	11847.29	1479.03	0.09
1	41705	2%_Cur	23430	366.1	390.97	375.22	391.04	0.000152	2.34	14379.64	2067.75	0.1
1	41705	1%_Cur	25980	366.1	391.74	375.62	391.81	0.000153	2.42	15612.87	2807.04	0.1
1	41705	0.2%_Cur	31390	366.1	393.29	376.41	393.36	0.000153	2.54	18128.21	4355.97	0.1
1	40323	10%_Cur	18320	364.2	388.54	376.69	388.96	0.000682	5.33	4213.81	813.94	0.22
1	40323	2%_Cur	23430	364.2	390.12	378.08	390.63	0.00077	5.99	5090.11	904.15	0.24
1	40323	1%_Cur	25980	364.2	390.85	378.74	391.39	0.000803	6.26	5494.07	927.34	0.24
1	40323	0.2%_Cur	31390	364.2	392.33	380.14	392.94	0.000853	6.76	6314.22	1141.13	0.25
1	39316	10%_Cur	18320	363.3	387.93	374.57	388.31	0.000579	5.04	3978.78	1349.59	0.2
1	39316	2%_Cur	23430	363.3	389.34	375.97	389.87	0.00073	5.93	4419.14	1568.96	0.23
1	39316	1%_Cur	25980	363.3	389.98	376.64	390.57	0.000801	6.34	4622.48	1726.41	0.24
1	39316	0.2%_Cur	31390	363.3	391.49	377.96	392.1	0.000808	6.66	6420.96	3118.14	0.24
1	39250		Bridge									
1	39190	10%_Cur	18320	363.3	387.78	374.45	388.11	0.000588	4.58	4079.53	1453.69	0.2
1	39190	2%_Cur	23430	363.3	389.16	375.79	389.6	0.00073	5.39	4478.81	2154.75	0.22
1	39190	1%_Cur	25980	363.3	389.74	376.39	390.25	0.000803	5.77	4659.65	2254.03	0.24
1	39190	0.2%_Cur	31390	363.3	390.91	377.64	391.44	0.000829	6.11	6539.56	2604.37	0.24
1	37734	10%_Cur	18320	364.5	386.51	374.15	387.05	0.000819	5.94	3579.42	1785.69	0.24
1	37734	2%_Cur	23430	364.5	387.93	375.63	388.46	0.000826	6.25	5994.36	2144.75	0.24
1	37734	1%_Cur	25980	364.5	388.5	376.31	389.05	0.00086	6.5	6684.15	2206.32	0.25
1	37734	0.2%_Cur	31390	364.5	389.61	377.7	390.19	0.000906	6.9	8131.02	2445.98	0.26
1	36382	10%_Cur	18320	350.3	385.89	370.81	386.11	0.000486	3.98	5957.93	1745.13	0.18
1	36382	2%_Cur	23430	350.3	387.32	372.31	387.54	0.000479	4.19	8737.07	3080.58	0.18
1	36382	1%_Cur	25980	350.3	387.87	373.02	388.1	0.000491	4.33	9662.04	3753.57	0.18

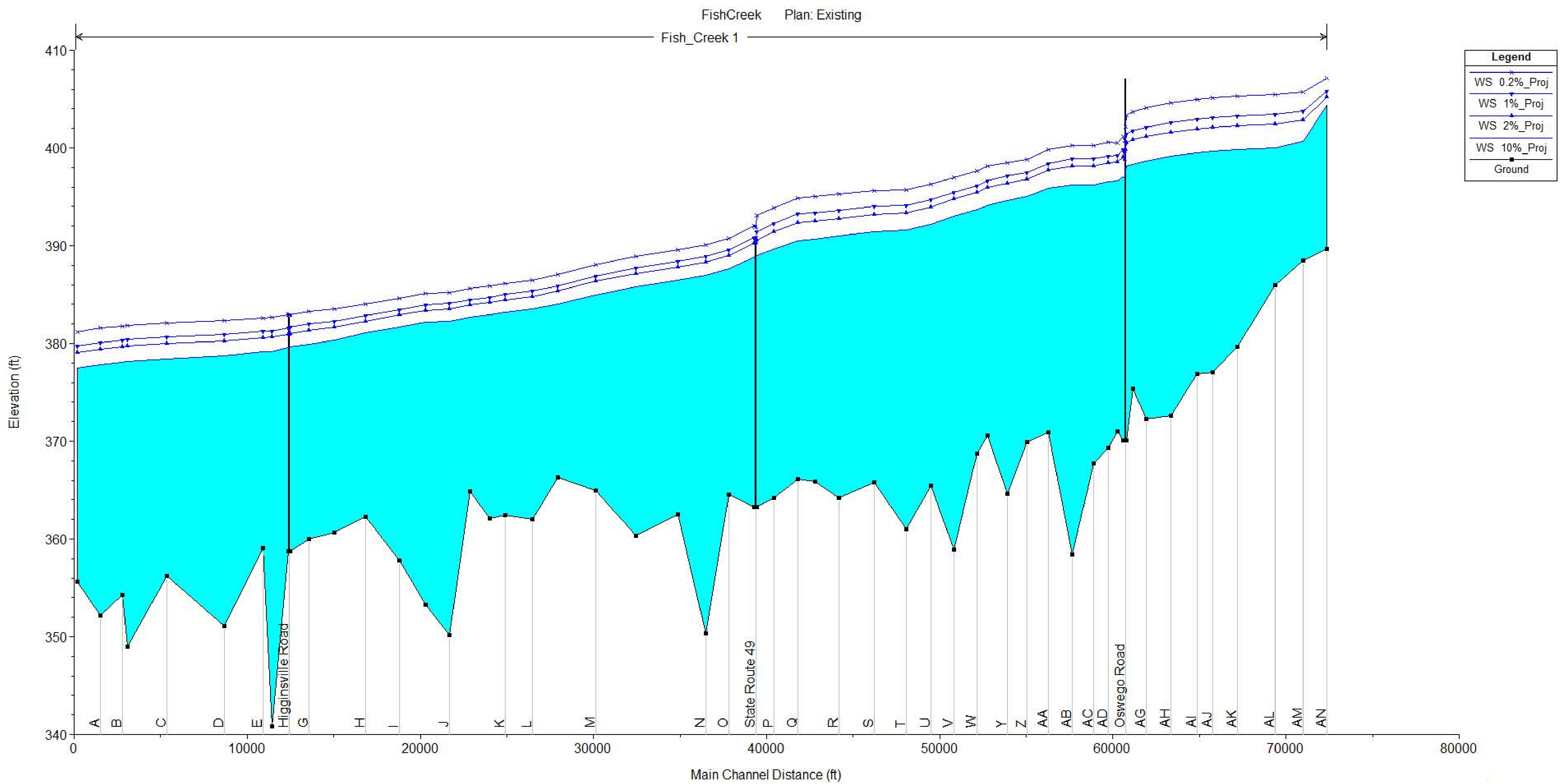
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	36382	0.2%_Cur	31390	350.3	388.92	374.43	389.18	0.000533	4.69	11833.08	4641.36	0.19
1	34787	10%_Cur	18320	362.5	385.42		385.53	0.000263	3.28	11060.51	2577.78	0.14
1	34787	2%_Cur	23430	362.5	386.83		386.95	0.000275	3.52	14224.54	4370.59	0.14
1	34787	1%_Cur	25980	362.5	387.39		387.5	0.000271	3.56	15586.04	4962.19	0.14
1	34787	0.2%_Cur	31390	362.5	388.45		388.56	0.000267	3.66	18215.02	6218.6	0.14
1	32336	10%_Cur	18320	360.3	384.71		384.91	0.000317	3.88	8127.51	2104.78	0.15
1	32336	2%_Cur	23430	360.3	386.13		386.33	0.000323	4.1	11072.94	3908.01	0.16
1	32336	1%_Cur	25980	360.3	386.71		386.9	0.000326	4.19	12299.08	4715.28	0.16
1	32336	0.2%_Cur	31390	360.3	387.78		387.98	0.000331	4.36	14630.57	5738.77	0.16
1	30004	10%_Cur	18320	365	384.01		384.15	0.00035	3.38	7374.94	3954.14	0.15
1	30004	2%_Cur	23430	365	385.33		385.52	0.000425	3.93	9334.49	9748.82	0.17
1	30004	1%_Cur	25980	365	385.89		386.09	0.000436	4.07	10354.54	11015.19	0.17
1	30004	0.2%_Cur	31390	365	386.94		387.15	0.000453	4.32	12387.67	12281.89	0.18
1	27852	10%_Cur	18320	366.3	383.16		383.33	0.00041	3.56	7342.74	2993.33	0.16
1	27852	2%_Cur	23430	366.3	384.35		384.55	0.000469	4.02	9483.22	7176.97	0.18
1	27852	1%_Cur	25980	366.3	384.91		385.11	0.000466	4.1	10617.47	9375.77	0.18
1	27852	0.2%_Cur	31390	366.3	385.95		386.15	0.000463	4.26	12750.83	11318.82	0.18
1	26395	10%_Cur	18320	362	382.69		382.8	0.000328	3.19	9430.54	3628.33	0.15
1	26395	2%_Cur	23430	362	383.82		383.95	0.000367	3.55	11258.82	7912.36	0.16
1	26395	1%_Cur	25980	362	384.35		384.5	0.000398	3.78	12341.96	9877.79	0.16
1	26395	0.2%_Cur	31390	362	385.38		385.54	0.00042	4.04	14662.19	11439.19	0.17
1	24785	10%_Cur	18320	362.4	382.41		382.45	0.000145	2.17	15582.28	6839.48	0.1
1	24785	2%_Cur	23430	362.4	383.51		383.56	0.000166	2.43	18248.43	8762.86	0.11
1	24785	1%_Cur	25980	362.4	384.03		384.08	0.000168	2.5	19557.82	9054.4	0.11
1	24785	0.2%_Cur	31390	362.4	385.05		385.1	0.000174	2.64	22126.04	9339.82	0.11
1	23901	10%_Cur	18320	362.1	382.18		382.29	0.000261	3.14	10202.59	6035.66	0.14
1	23901	2%_Cur	23430	362.1	383.24		383.37	0.000303	3.52	12257.64	7706.45	0.15
1	23901	1%_Cur	25980	362.1	383.75		383.89	0.00031	3.63	13290.55	8048.75	0.15
1	23901	0.2%_Cur	31390	362.1	384.76		384.91	0.00032	3.83	15330.55	9280.89	0.15
1	22770	10%_Cur	18320	364.9	382		382.05	0.000177	2.3	12933.87	7187.63	0.11
1	22770	2%_Cur	23430	364.9	383.01		383.08	0.00022	2.68	14942.67	9431.8	0.12
1	22770	1%_Cur	25980	364.9	383.52		383.59	0.000231	2.81	16066.3	10097.78	0.13
1	22770	0.2%_Cur	31390	364.9	384.53		384.6	0.000238	2.97	18320.3	10611.04	0.13

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	21592	10%_Cur	18320	350.2	381.58		381.8	0.000424	4.27	8846.09	7797.44	0.19
1	21592	2%_Cur	23430	350.2	382.56		382.8	0.000473	4.69	11118.11	9746.12	0.2
1	21592	1%_Cur	25980	350.2	383.08		383.32	0.000469	4.77	12431.34	10353.94	0.2
1	21592	0.2%_Cur	31390	350.2	384.11		384.34	0.000453	4.86	15052.55	10957.91	0.2
1	20191	10%_Cur	18320	353.3	381.5		381.55	0.000088	2.27	18064.66	10508.2	0.09
1	20191	2%_Cur	23430	353.3	382.46		382.51	0.000105	2.55	20638.83	11177.26	0.1
1	20191	1%_Cur	25980	353.3	382.97		383.03	0.00011	2.65	22012.93	11265.67	0.1
1	20191	0.2%_Cur	31390	353.3	383.99		384.05	0.000118	2.84	24749.02	11627.26	0.11
1	18663	10%_Cur	18320	357.8	381.1		381.29	0.000431	3.99	8670.55	10290.38	0.19
1	18663	2%_Cur	23430	357.8	381.99		382.22	0.000493	4.45	10406.63	11000.81	0.2
1	18663	1%_Cur	25980	357.8	382.5		382.72	0.000498	4.57	11402.29	11234.88	0.2
1	18663	0.2%_Cur	31390	357.8	383.51		383.74	0.000499	4.77	13401.53	11799.96	0.21
1	16739	10%_Cur	18320	362.3	380.53		380.64	0.000277	3.12	11368.08	11480.08	0.15
1	16739	2%_Cur	23430	362.3	381.36		381.48	0.000312	3.45	13535.39	12176.86	0.16
1	16739	1%_Cur	25980	362.3	381.87		381.99	0.000309	3.51	14869.99	12314.74	0.16
1	16739	0.2%_Cur	31390	362.3	382.9		383.02	0.000301	3.62	17556.06	12550.61	0.16
1	14949	10%_Cur	18320	360.7	379.79	371.77	380.04	0.000441	4.56	7666.99	13489.41	0.21
1	14949	2%_Cur	23430	360.7	380.66	372.92	380.88	0.000422	4.64	11870.83	13934.12	0.21
1	14949	1%_Cur	25980	360.7	381.22	373.44	381.42	0.000396	4.6	13517.93	13998.1	0.21
1	14949	0.2%_Cur	31390	360.7	382.34	374.62	382.51	0.000347	4.51	16813.53	14094.22	0.19
1	13445	10%_Cur	18320	360	379.35	371.7	379.48	0.000299	3.51	9953.98	12927.24	0.17
1	13445	2%_Cur	23430	360	380.29	373.19	380.4	0.00027	3.5	14619.56	13817.2	0.17
1	13445	1%_Cur	25980	360	380.87	373.59	380.97	0.000257	3.5	16215	13997.31	0.16
1	13445	0.2%_Cur	31390	360	382.02	374.34	382.12	0.000234	3.52	19396.34	14137.68	0.16
1	12366	10%_Cur	18320	358.7	379.1	368.19	379.23	0.000189	3.01	9288.8	11969.13	0.14
1	12366	2%_Cur	23430	358.7	379.96	369.08	380.11	0.000225	3.42	11510.97	12723.87	0.15
1	12366	1%_Cur	25980	358.7	380.54	369.47	380.7	0.000224	3.49	13034.02	13063.85	0.15
1	12366	0.2%_Cur	31390	358.7	381.7	370.24	381.86	0.000218	3.61	16095.2	13525.33	0.15
1	12300		Bridge									
1	12274	10%_Cur	18320	358.7	379.05	368.06	379.17	0.000183	2.93	9586.69	12087.86	0.14
1	12274	2%_Cur	23430	358.7	379.9	369.25	380.04	0.000219	3.33	11736.38	12527.23	0.15
1	12274	1%_Cur	25980	358.7	380.47	369.66	380.62	0.000218	3.4	13249.95	12730.07	0.15

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	12274	0.2%_Cur	31390	358.7	381.64	370.46	381.78	0.00021	3.5	16662.36	12935.82	0.15
1	11328	10%_Cur	18390	340.8	378.36	361.18	378.83	0.000411	5.54	4533.34	12498.5	0.21
1	11328	2%_Cur	23520	340.8	379.52	363.09	379.78	0.000295	4.85	11909.4	12980.96	0.18
1	11328	1%_Cur	26080	340.8	380.13	363.96	380.37	0.000285	4.85	13730.62	13019.81	0.17
1	11328	0.2%_Cur	31511	340.8	381.35	365.65	381.55	0.000262	4.81	17384.59	13163.88	0.17
1	10809	10%_Cur	18390	359.1	378.36	370.46	378.48	0.000269	3.31	10314.57	12286.57	0.16
1	10809	2%_Cur	23520	359.1	379.47	371.71	379.56	0.000213	3.12	15073.49	12605.64	0.15
1	10809	1%_Cur	26080	359.1	380.07	372.12	380.16	0.000205	3.14	16587.13	12695.67	0.15
1	10809	0.2%_Cur	31511	359.1	381.28	373.19	381.37	0.000188	3.18	19640.76	12807.24	0.14
1	8575	10%_Cur	18390	351.1	377.83	368.65	377.95	0.000241	3.33	10982.47	11878.24	0.16
1	8575	2%_Cur	23520	351.1	379.14	369.83	379.2	0.00015	2.79	19635.08	11962.14	0.12
1	8575	1%_Cur	26080	351.1	379.76	370.3	379.82	0.000141	2.77	21741.44	11976.68	0.12
1	8575	0.2%_Cur	31511	351.1	381.01	371.21	381.07	0.000126	2.76	25947.26	12033.73	0.12
1	5278	10%_Cur	18390	356.2	377.38		377.43	0.000128	2.23	17149.79	6648.57	0.11
1	5278	2%_Cur	23520	356.2	378.78		378.83	0.000113	2.25	21488.79	7154.98	0.11
1	5278	1%_Cur	26080	356.2	379.43		379.47	0.000108	2.27	23482.8	7284.51	0.11
1	5278	0.2%_Cur	31511	356.2	380.71		380.75	0.000101	2.32	27437.28	7485.34	0.1
1	2988	10%_Cur	18390	349	377.08		377.15	0.000176	2.89	13605.94	6179.64	0.13
1	2988	2%_Cur	23520	349	378.52		378.59	0.000164	2.96	16806.61	6658.51	0.13
1	2988	1%_Cur	26080	349	379.17		379.24	0.00016	3.01	18267.04	6731.49	0.13
1	2988	0.2%_Cur	31511	349	380.47		380.54	0.000153	3.09	21151.22	6765.77	0.13
1	2706	10%_Cur	18390	354.3	377		377.1	0.000181	3.22	12180.46	5710.47	0.14
1	2706	2%_Cur	23520	354.3	378.44		378.54	0.000175	3.34	15113.76	5908.8	0.14
1	2706	1%_Cur	26080	354.3	379.1		379.2	0.000173	3.4	16452.01	5995.97	0.14
1	2706	0.2%_Cur	31511	354.3	380.4		380.5	0.00017	3.52	19094.45	6045.9	0.14
1	1434	10%_Cur	18390	352.2	376.78	364.31	376.87	0.000175	2.82	12455.46	3323.02	0.13
1	1434	2%_Cur	23520	352.2	378.22	365.78	378.31	0.000175	3.01	15092.11	3744.2	0.13
1	1434	1%_Cur	26080	352.2	378.88	366.5	378.97	0.000176	3.1	16294.74	3823.51	0.14
1	1434	0.2%_Cur	31511	352.2	380.17	367.98	380.27	0.000176	3.27	18669.33	3855.1	0.14
1	105	10%_Cur	18390	355.6	376.43	366.66	376.59	0.0003	3.6	8798.26	1810.22	0.17
1	105	2%_Cur	23520	355.6	377.86	367.76	378.03	0.0003	3.85	10883.51	1820.89	0.17
1	105	1%_Cur	26080	355.6	378.52	368.3	378.69	0.0003	3.96	11834.1	1825.48	0.18
1	105	0.2%_Cur	31511	355.6	379.81	369.25	380	0.0003	4.17	13710.29	1829.58	0.18

Plan: Base Condition

Flows: Projected



Plan: Base Condition

Flows: Projected

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	72237	10%_Proj	21500	389.7	404.38		404.82	0.002209	6.86	7231.94	1920.13	0.34
1	72237	2%_Proj	27500	389.7	405.24		405.72	0.002392	7.46	8644.95	2066.58	0.36
1	72237	1%_Proj	30500	389.7	405.79		406.25	0.002277	7.47	9546.51	2115.82	0.35
1	72237	0.2%_Proj	36900	389.7	407.14		407.53	0.001879	7.22	11789.07	2389.87	0.32
1	70873	10%_Proj	21500	388.5	400.64		401.19	0.003358	7.17	6287.63	2877.99	0.4
1	70873	2%_Proj	27500	388.5	402.85		403.11	0.001554	5.58	10981.9	3912.17	0.28
1	70873	1%_Proj	30500	388.5	403.78		404	0.001221	5.2	12992.4	3928.98	0.25
1	70873	0.2%_Proj	36900	388.5	405.72		405.88	0.000816	4.66	17141.85	3948.99	0.21
1	69284	10%_Proj	21500	386	400.03		400.06	0.000265	2.34	21211.2	4961.93	0.12
1	69284	2%_Proj	27500	386	402.43		402.45	0.00017	2.11	28617.57	5417.72	0.1
1	69284	1%_Proj	30500	386	403.41		403.44	0.000152	2.08	31646.88	5499.66	0.09
1	69284	0.2%_Proj	36900	386	405.42		405.44	0.000125	2.05	37838.37	5731.11	0.09
1	67081	10%_Proj	21500	379.7	399.84		399.86	0.00006	1.42	33285.25	4255.27	0.06
1	67081	2%_Proj	27500	379.7	402.29		402.3	0.000051	1.43	41259.52	4268.24	0.06
1	67081	1%_Proj	30500	379.7	403.28		403.29	0.000049	1.45	44490.74	4272.1	0.06
1	67081	0.2%_Proj	36900	379.7	405.3		405.32	0.000046	1.5	51085.98	4278.77	0.05
1	65654	10%_Proj	21500	377.1	399.65		399.71	0.000201	2.77	16373.18	1790.25	0.11
1	65654	2%_Proj	27500	377.1	402.12		402.17	0.00018	2.83	20010.48	1799.33	0.11
1	65654	1%_Proj	30500	377.1	403.11		403.17	0.00018	2.91	21485.1	1826.53	0.11
1	65654	0.2%_Proj	36900	377.1	405.13		405.19	0.000176	3.05	24561.66	1867.98	0.11
1	64737	10%_Proj	21500	376.9	399.48		399.54	0.000224	2.96	15313.25	1573.92	0.12
1	64737	2%_Proj	27500	376.9	401.96		402.02	0.00021	3.09	18334.14	1585.34	0.12
1	64737	1%_Proj	30500	376.9	402.95		403.01	0.000212	3.19	19544.84	1590.32	0.12
1	64737	0.2%_Proj	36900	376.9	404.97		405.04	0.000213	3.38	22025.86	1599.99	0.12
1	63261	10%_Proj	22000	372.6	399.15		399.27	0.000288	3.67	11392.52	1128.43	0.13
1	63261	2%_Proj	28200	372.6	401.64		401.78	0.000282	3.89	13715.67	1136.27	0.14
1	63261	1%_Proj	31200	372.6	402.63		402.77	0.000287	4.02	14637.53	1139.34	0.14
1	63261	0.2%_Proj	37700	372.6	404.64		404.8	0.000295	4.28	16526.96	1146.5	0.14
1	61800	10%_Proj	22000	372.3	398.68		398.84	0.000335	4.01	9297.35	742.56	0.15
1	61800	2%_Proj	28200	372.3	401.15		401.33	0.000355	4.41	10906.68	755.61	0.15
1	61800	1%_Proj	31200	372.3	402.11		402.31	0.00037	4.62	11541.32	760.53	0.16
1	61800	0.2%_Proj	37700	372.3	404.09		404.32	0.000398	5.02	12850.27	769.43	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	61066	10%_Proj	22000	375.4	398.35		398.55	0.00045	4.24	8178.72	953.47	0.16
1	61066	2%_Proj	28200	375.4	400.8		401.03	0.00046	4.62	9675.51	1109.64	0.17
1	61066	1%_Proj	31200	375.4	401.75		402	0.000476	4.83	10258.95	1121.84	0.17
1	61066	0.2%_Proj	37700	375.4	403.7		403.99	0.000503	5.23	11461.76	1160.22	0.18
1	60661	10%_Proj	22000	370.11	398.15	381.61	398.38	0.000339	4.11	6600.02	882.81	0.15
1	60661	2%_Proj	28200	370.11	400.53	382.97	400.83	0.000391	4.7	7452.21	930.99	0.16
1	60661	1%_Proj	31200	370.11	401.45	383.57	401.79	0.000421	4.99	7778.93	949.68	0.17
1	60661	0.2%_Proj	37700	370.11	403.32	384.78	403.74	0.000481	5.57	8448.42	989.15	0.18
1	60574		Bridge									
1	60485	10%_Proj	22000	370.11	397.06		397.53	0.000737	6.01	4942.57	801.09	0.22
1	60485	2%_Proj	28200	370.11	399.1		399.71	0.000875	6.91	5552.77	880.89	0.24
1	60485	1%_Proj	31200	370.11	399.8		400.5	0.000963	7.38	5764.76	885.64	0.25
1	60485	0.2%_Proj	37700	370.11	401.2		402.09	0.001149	8.34	6184.04	908.01	0.28
1	60172	10%_Proj	22000	371	396.62	383.83	397.24	0.001015	6.68	4271.43	735.86	0.25
1	60172	2%_Proj	28200	371	398.56	385.63	399.36	0.0012	7.67	4959.97	999.21	0.27
1	60172	1%_Proj	31200	371	399.21	386.45	400.11	0.00132	8.19	5280.63	1111.96	0.29
1	60172	0.2%_Proj	37700	371	400.54	388.32	401.64	0.001532	9.13	5958.7	1148.15	0.31
1	59645	10%_Proj	22000	369.3	396.55	379.82	396.83	0.00038	4.29	5599.71	774.83	0.16
1	59645	2%_Proj	28200	369.3	398.48	381.17	398.86	0.000472	5.04	6194.34	1295.94	0.18
1	59645	1%_Proj	31200	369.3	399.18	381.75	399.56	0.000476	5.16	8728.55	1367.83	0.18
1	59645	0.2%_Proj	37700	369.3	400.55	382.95	400.99	0.000542	5.69	10102.59	1475.6	0.19
1	58759	10%_Proj	22000	367.7	396.23	379.89	396.48	0.000404	4.46	8250.44	1856.93	0.16
1	58759	2%_Proj	28200	367.7	398.15	381.51	398.44	0.000442	4.91	10026.36	2021.84	0.17
1	58759	1%_Proj	31200	367.7	398.91	382.23	399.16	0.000408	4.8	13796.71	2095.29	0.16
1	58759	0.2%_Proj	37700	367.7	400.27	383.67	400.54	0.000438	5.14	16126.85	2153.28	0.17
1	57561	10%_Proj	22000	358.4	396.24	370.04	396.29	0.000058	1.96	17705.97	2416	0.06
1	57561	2%_Proj	28200	358.4	398.16	371.49	398.22	0.00007	2.25	20469.26	2532.74	0.07
1	57561	1%_Proj	31200	358.4	398.88	372.15	398.95	0.000075	2.35	24438.01	2622.46	0.07
1	57561	0.2%_Proj	37700	358.4	400.24	373.42	400.31	0.000086	2.6	27384.57	2636.03	0.08
1	56157	10%_Proj	22000	370.9	395.87	380.92	396.11	0.000394	4.31	7608.88	1465.57	0.16
1	56157	2%_Proj	28200	370.9	397.71	382.36	398.01	0.000464	4.93	8742.5	1678.66	0.17
1	56157	1%_Proj	31200	370.9	398.4	382.99	398.72	0.000505	5.23	9165.19	1720.76	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	56157	0.2%_Proj	37700	370.9	399.81	384.55	400.09	0.000458	5.17	14404.43	1733.01	0.18
1	54914	10%_Proj	22000	369.9	395.02	380.28	395.47	0.00065	5.52	5283.22	1314.17	0.2
1	54914	2%_Proj	28200	369.9	396.81	381.82	397.29	0.000697	6.01	8375.53	1509.04	0.21
1	54914	1%_Proj	31200	369.9	397.46	382.49	397.96	0.000729	6.25	9292.49	1513.71	0.22
1	54914	0.2%_Proj	37700	369.9	398.81	383.93	399.34	0.000771	6.65	11204.87	1520.79	0.23
1	53799	10%_Proj	22000	364.6	394.64	377.59	394.89	0.000384	4.52	9270.76	1778.22	0.16
1	53799	2%_Proj	28200	364.6	396.42	379.19	396.69	0.000408	4.88	12398.4	2490.99	0.16
1	53799	1%_Proj	31200	364.6	397.13	379.96	397.37	0.000384	4.81	15712.82	2566.86	0.16
1	53799	0.2%_Proj	37700	364.6	398.51	381.41	398.74	0.000383	4.96	19219.99	2610.24	0.16
1	52665	10%_Proj	22000	370.6	394.15	380.27	394.42	0.000488	4.57	8541.7	2009.82	0.17
1	52665	2%_Proj	28200	370.6	395.94	381.51	396.21	0.000497	4.87	12573.34	2705.61	0.18
1	52665	1%_Proj	31200	370.6	396.65	382.34	396.92	0.000488	4.92	14384.03	2710.98	0.18
1	52665	0.2%_Proj	37700	370.6	398.12	383.69	398.33	0.000418	4.74	19257.77	2741.15	0.17
1	52024	10%_Proj	22000	368.7	393.69		394.07	0.000621	5.22	6565.87	1631.58	0.2
1	52024	2%_Proj	28200	368.7	395.46		395.87	0.000655	5.65	10097.4	2177.74	0.2
1	52024	1%_Proj	31200	368.7	396.18		396.58	0.000659	5.78	11673.22	2213.41	0.21
1	52024	0.2%_Proj	37700	368.7	397.67		398.04	0.000622	5.84	14998.59	2225.28	0.2
1	50694	10%_Proj	22000	358.9	393.03		393.39	0.000449	5.11	7271.53	1525	0.17
1	50694	2%_Proj	28200	358.9	394.77		395.17	0.000495	5.59	10570.79	2091.83	0.18
1	50694	1%_Proj	31200	358.9	395.48		395.89	0.000509	5.76	12119.8	2243.96	0.19
1	50694	0.2%_Proj	37700	358.9	397.01		397.4	0.00051	5.96	15626.64	2311.94	0.19
1	49376	10%_Proj	22000	365.5	392.16		392.62	0.000771	6.01	6256.09	1513.8	0.22
1	49376	2%_Proj	28200	365.5	393.96		394.39	0.000738	6.18	9377.42	1856.27	0.22
1	49376	1%_Proj	31200	365.5	394.72		395.12	0.000698	6.13	10804.77	1873.92	0.21
1	49376	0.2%_Proj	37700	365.5	396.31		396.66	0.000643	6.13	13884.12	2064.93	0.21
1	47944	10%_Proj	22000	361	391.63		391.9	0.000363	4.46	7249.68	1115.84	0.15
1	47944	2%_Proj	28200	361	393.32		393.66	0.000434	5.09	9572.72	1664.87	0.17
1	47944	1%_Proj	31200	361	394.1		394.43	0.000433	5.17	10886.94	1709.23	0.17
1	47944	0.2%_Proj	37700	361	395.68		396.02	0.00045	5.46	13981.79	2319.21	0.17
1	46103	10%_Proj	22000	365.8	391.44		391.5	0.000163	2.69	17469.63	3123.13	0.1
1	46103	2%_Proj	28200	365.8	393.2		393.26	0.000148	2.7	23226.91	3427.26	0.1
1	46103	1%_Proj	31200	365.8	394.01		394.06	0.000137	2.65	26040.13	3561.71	0.09
1	46103	0.2%_Proj	37700	365.8	395.62		395.67	0.000126	2.65	32362.46	4184.6	0.09

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	44085	10%_Proj	22000	364.2	390.98		391.15	0.000387	3.97	10136.33	2543.48	0.15
1	44085	2%_Proj	28200	364.2	392.8		392.95	0.000356	4.02	14149.58	4228.53	0.15
1	44085	1%_Proj	31200	364.2	393.65		393.79	0.000324	3.94	16179.81	4864.48	0.14
1	44085	0.2%_Proj	37700	364.2	395.29		395.43	0.000308	4.01	20659.67	5637.15	0.14
1	42674	10%_Proj	22000	365.9	390.69		390.79	0.000253	3.08	11854.11	1881.47	0.12
1	42674	2%_Proj	28200	365.9	392.53		392.63	0.000245	3.21	14413.98	3515.79	0.12
1	42674	1%_Proj	31200	365.9	393.4		393.5	0.000239	3.25	15622.3	4024.47	0.12
1	42674	0.2%_Proj	37700	365.9	395.05		395.16	0.000234	3.38	17920.25	4081.79	0.12
1	41705	10%_Proj	22000	366.1	390.53	374.99	390.59	0.000151	2.3	13679.91	1922.05	0.09
1	41705	2%_Proj	28200	366.1	392.37	375.94	392.44	0.000154	2.48	16629.3	3353.54	0.1
1	41705	1%_Proj	31200	366.1	393.24	376.37	393.31	0.000153	2.54	18045.62	4342.59	0.1
1	41705	0.2%_Proj	37700	366.1	394.89	377.28	394.97	0.000154	2.68	20735.94	4495.65	0.1
1	40323	10%_Proj	22000	364.2	389.7	377.7	390.18	0.000747	5.82	4858.25	893.59	0.23
1	40323	2%_Proj	28200	364.2	391.44	379.28	392.01	0.000831	6.49	5821.48	944.97	0.25
1	40323	1%_Proj	31200	364.2	392.28	380.08	392.89	0.000851	6.74	6287.49	1132.24	0.25
1	40323	0.2%_Proj	37700	364.2	393.85	381.48	394.53	0.000905	7.28	7157.36	1518.22	0.26
1	39316	10%_Proj	22000	363.3	388.98	375.59	389.46	0.000689	5.69	4301.95	1512.63	0.22
1	39316	2%_Proj	28200	363.3	390.63	377.19	391.2	0.00078	6.38	5796.69	2077.27	0.24
1	39316	1%_Proj	31200	363.3	391.44	377.92	392.05	0.000806	6.64	6385.8	3074.59	0.24
1	39316	0.2%_Proj	37700	363.3	393.09	379.36	393.64	0.000737	6.65	8773.66	4426.68	0.24
1	39250		Bridge									
1	39190	10%_Proj	22000	363.3	388.81	375.42	389.22	0.000689	5.17	4374.86	2018.98	0.22
1	39190	2%_Proj	28200	363.3	390.22	376.91	390.79	0.000866	6.1	4807.1	2283.74	0.25
1	39190	1%_Proj	31200	363.3	390.87	377.6	391.4	0.000826	6.09	6510.9	2586.45	0.24
1	39190	0.2%_Proj	37700	363.3	392.02	379.01	392.6	0.000879	6.53	8121.31	3757.53	0.25
1	37734	10%_Proj	22000	364.5	387.63	375.22	388.13	0.000788	6.05	5642.85	2056.74	0.23
1	37734	2%_Proj	28200	364.5	388.96	376.88	389.53	0.000886	6.69	7271.98	2294.54	0.25
1	37734	1%_Proj	31200	364.5	389.58	377.64	390.15	0.000904	6.88	8084.86	2436.63	0.26
1	37734	0.2%_Proj	37700	364.5	390.72	379.19	391.3	0.000934	7.23	9631.75	2926.46	0.26
1	36382	10%_Proj	22000	350.3	386.95	371.91	387.2	0.000519	4.3	6809.57	2670.09	0.18
1	36382	2%_Proj	28200	350.3	388.32	373.6	388.56	0.000498	4.44	10526.47	4218.32	0.18
1	36382	1%_Proj	31200	350.3	388.89	374.37	389.14	0.000533	4.68	11754.9	4638.87	0.19

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1	36382	0.2%_Proj	37700	350.3	390.05	375.92	390.3	0.000516	4.8	14363.67	4790.94	0.19
1	34787	10%_Proj	22000	362.5	386.48		386.59	0.000265	3.42	13385.11	4050.83	0.14
1	34787	2%_Proj	28200	362.5	387.85		387.96	0.000268	3.6	16704.26	5609.83	0.14
1	34787	1%_Proj	31200	362.5	388.42		388.52	0.000267	3.66	18126.7	6185.82	0.14
1	34787	0.2%_Proj	37700	362.5	389.59		389.69	0.000262	3.75	21398.88	7259.44	0.14
1	32336	10%_Proj	22000	360.3	385.78		385.98	0.000323	4.06	10321.21	3417.84	0.16
1	32336	2%_Proj	28200	360.3	387.17		387.37	0.000327	4.26	13304.6	5224.33	0.16
1	32336	1%_Proj	31200	360.3	387.75		387.94	0.000331	4.36	14552.66	5702.79	0.16
1	32336	0.2%_Proj	37700	360.3	388.91		389.12	0.000353	4.65	17759.15	7735.97	0.17
1	30004	10%_Proj	22000	365	384.98		385.17	0.000421	3.86	8746.56	7981.39	0.17
1	30004	2%_Proj	28200	365	386.35		386.55	0.000443	4.17	11225.34	11779.41	0.18
1	30004	1%_Proj	31200	365	386.91		387.12	0.000453	4.31	12319.02	12264.99	0.18
1	30004	0.2%_Proj	37700	365	388.04		388.26	0.000467	4.56	14552.1	12627.04	0.18
1	27852	10%_Proj	22000	366.3	384.02		384.21	0.000459	3.92	8845.51	5429.39	0.18
1	27852	2%_Proj	28200	366.3	385.36		385.57	0.000462	4.16	11549.78	10457.07	0.18
1	27852	1%_Proj	31200	366.3	385.92		386.12	0.000463	4.25	12678.85	11275.81	0.18
1	27852	0.2%_Proj	37700	366.3	387.03		387.24	0.000465	4.44	15019.23	11937.89	0.18
1	26395	10%_Proj	22000	362	383.5		383.63	0.000363	3.48	10695.84	6457.65	0.16
1	26395	2%_Proj	28200	362	384.78		384.94	0.000425	3.98	13309.89	10825.91	0.17
1	26395	1%_Proj	31200	362	385.34		385.5	0.00042	4.04	14581.27	11412.19	0.17
1	26395	0.2%_Proj	37700	362	386.48		386.63	0.000405	4.14	17165.81	11961.21	0.17
1	24785	10%_Proj	22000	362.4	383.19		383.23	0.000166	2.4	17439.23	8364.58	0.11
1	24785	2%_Proj	28200	362.4	384.46		384.51	0.00017	2.56	20629.88	9196.36	0.11
1	24785	1%_Proj	31200	362.4	385.01		385.07	0.000174	2.64	22035.68	9332	0.11
1	24785	0.2%_Proj	37700	362.4	386.14		386.2	0.000179	2.79	24973.53	9493.64	0.11
1	23901	10%_Proj	22000	362.1	382.91		383.04	0.0003	3.47	11619.42	7446.53	0.15
1	23901	2%_Proj	28200	362.1	384.18		384.32	0.000315	3.72	14143.41	8553.76	0.15
1	23901	1%_Proj	31200	362.1	384.73		384.87	0.00032	3.82	15258.91	9256.94	0.15
1	23901	0.2%_Proj	37700	362.1	385.86		386	0.000327	4.01	17569.99	10422.9	0.16
1	22770	10%_Proj	22000	364.9	382.71		382.77	0.000203	2.54	14277.81	9077.21	0.12
1	22770	2%_Proj	28200	364.9	383.94		384.02	0.000234	2.88	17006.96	10344.52	0.13
1	22770	1%_Proj	31200	364.9	384.49		384.57	0.000238	2.97	18240.68	10598.44	0.13
1	22770	0.2%_Proj	37700	364.9	385.62		385.7	0.000243	3.13	20788.21	10930.68	0.13

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	21592	10%_Proj	22000	350.2	382.26		382.5	0.000467	4.61	10400.54	9424.96	0.2
1	21592	2%_Proj	28200	350.2	383.51		383.74	0.000463	4.81	13527.87	10553.76	0.2
1	21592	1%_Proj	31200	350.2	384.08		384.3	0.000453	4.86	14959.92	10933.62	0.2
1	21592	0.2%_Proj	37700	350.2	385.23		385.45	0.000432	4.94	17888.21	11215.19	0.19
1	20191	10%_Proj	22000	353.3	382.16		382.22	0.000102	2.49	19842.01	11111.57	0.1
1	20191	2%_Proj	28200	353.3	383.39		383.46	0.000113	2.73	23155.96	11336.75	0.1
1	20191	1%_Proj	31200	353.3	383.95		384.02	0.000118	2.83	24651.91	11606.02	0.11
1	20191	0.2%_Proj	37700	353.3	385.09		385.17	0.000125	3.02	27721.26	12163.27	0.11
1	18663	10%_Proj	22000	357.8	381.7		381.92	0.000489	4.38	9833.35	10843.54	0.2
1	18663	2%_Proj	28200	357.8	382.92		383.15	0.0005	4.66	12235.13	11612.04	0.2
1	18663	1%_Proj	31200	357.8	383.47		383.7	0.000499	4.76	13329.72	11794.81	0.21
1	18663	0.2%_Proj	37700	357.8	384.61		384.84	0.000494	4.95	15584.29	12012.49	0.21
1	16739	10%_Proj	22000	362.3	381.06		381.19	0.000313	3.4	12769.14	12077	0.16
1	16739	2%_Proj	28200	362.3	382.3		382.42	0.000306	3.56	15987.11	12425.61	0.16
1	16739	1%_Proj	31200	362.3	382.86		382.98	0.000301	3.62	17458.07	12542.32	0.16
1	16739	0.2%_Proj	37700	362.3	384.03		384.15	0.00029	3.72	20493.75	12813.16	0.16
1	14949	10%_Proj	22000	360.7	380.34	372.61	380.57	0.000438	4.66	10925.91	13881.76	0.21
1	14949	2%_Proj	28200	360.7	381.69	373.91	381.88	0.000375	4.57	14895.47	14027.52	0.2
1	14949	1%_Proj	31200	360.7	382.3	374.59	382.47	0.000349	4.52	16692.9	14090.03	0.19
1	14949	0.2%_Proj	37700	360.7	383.54	375.85	383.69	0.000308	4.45	20344.8	14266.97	0.19
1	13445	10%_Proj	22000	360	379.95	372.7	380.06	0.000279	3.49	13694.55	13611.63	0.17
1	13445	2%_Proj	28200	360	381.35	373.9	381.45	0.000247	3.51	17547.18	14053.74	0.16
1	13445	1%_Proj	31200	360	381.98	374.32	382.08	0.000235	3.52	19279.35	14127.41	0.16
1	13445	0.2%_Proj	37700	360	383.25	375.1	383.34	0.000216	3.56	22776.25	14212	0.15
1	12366	10%_Proj	22000	358.7	379.62	368.84	379.78	0.000224	3.36	10639.11	12563.74	0.15
1	12366	2%_Proj	28200	358.7	381.02	369.8	381.18	0.000222	3.54	14310.13	13287.53	0.15
1	12366	1%_Proj	31200	358.7	381.66	370.22	381.81	0.000218	3.6	15980.6	13523.15	0.15
1	12366	0.2%_Proj	37700	358.7	382.98	371.05	383.11	0.000186	3.5	21196.46	13738.51	0.14
1	12300		Bridge									
1	12274	10%_Proj	22000	358.7	379.56	369.01	379.71	0.000219	3.27	10874.43	12409.5	0.15
1	12274	2%_Proj	28200	358.7	380.96	370.01	381.1	0.000214	3.44	14774.97	12840.34	0.15
1	12274	1%_Proj	31200	358.7	381.59	370.44	381.74	0.000211	3.5	16539.95	12920.51	0.15

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	12274	0.2%_Proj	37700	358.7	382.92	371.3	383.06	0.000197	3.56	20243.14	13486.46	0.15
1	11328	10%_Proj	22100	340.8	379.17	362.59	379.44	0.000298	4.83	10870.65	12952.31	0.18
1	11328	2%_Proj	28300	340.8	380.64	364.68	380.86	0.000276	4.84	15256.35	13029.7	0.17
1	11328	1%_Proj	31300	340.8	381.3	365.6	381.51	0.000263	4.81	17247.46	13159.4	0.17
1	11328	0.2%_Proj	37900	340.8	382.68	367.49	382.86	0.000238	4.74	21383.53	13282.98	0.16
1	10809	10%_Proj	22100	359.1	379.13	371.45	379.21	0.000218	3.1	14212.24	12554.78	0.15
1	10809	2%_Proj	28300	359.1	380.58	372.65	380.66	0.000198	3.16	17860.81	12767.93	0.14
1	10809	1%_Proj	31300	359.1	381.24	373.16	381.32	0.000189	3.18	19525.99	12804.7	0.14
1	10809	0.2%_Proj	37900	359.1	382.61	374.14	382.69	0.000173	3.22	22989.73	12954.83	0.14
1	8575	10%_Proj	22100	351.1	378.78	369.54	378.85	0.000156	2.8	18426.35	11946.34	0.13
1	8575	2%_Proj	28300	351.1	380.29	370.68	380.34	0.000134	2.76	23500.08	12000.55	0.12
1	8575	1%_Proj	31300	351.1	380.96	371.18	381.02	0.000126	2.76	25789.81	12031.59	0.12
1	8575	0.2%_Proj	37900	351.1	382.37	372.33	382.42	0.000114	2.76	30524.87	12360.29	0.11
1	5278	10%_Proj	22100	356.2	378.41		378.45	0.000117	2.25	20339.17	7042.44	0.11
1	5278	2%_Proj	28300	356.2	379.97		380.01	0.000105	2.29	25140.23	7374.89	0.1
1	5278	1%_Proj	31300	356.2	380.66		380.7	0.000101	2.31	27289.72	7480.91	0.1
1	5278	0.2%_Proj	37900	356.2	382.09		382.13	0.000094	2.37	31712.49	7601.69	0.1
1	2988	10%_Proj	22100	349	378.14		378.21	0.000166	2.94	15962.13	6587.5	0.13
1	2988	2%_Proj	28300	349	379.72		379.79	0.000157	3.04	19477.53	6737.61	0.13
1	2988	1%_Proj	31300	349	380.42		380.49	0.000153	3.09	21043.78	6765.11	0.13
1	2988	0.2%_Proj	37900	349	381.86		381.94	0.000148	3.19	24256.47	6784.99	0.13
1	2706	10%_Proj	22100	354.3	378.06		378.16	0.000177	3.31	14339.88	5866.06	0.14
1	2706	2%_Proj	28300	354.3	379.64		379.74	0.000172	3.45	17561.11	6035.11	0.14
1	2706	1%_Proj	31300	354.3	380.35		380.45	0.00017	3.51	18996.07	6045.9	0.14
1	2706	0.2%_Proj	37900	354.3	381.79		381.89	0.000167	3.64	21938.5	6045.9	0.14
1	1434	10%_Proj	22100	352.2	377.84	365.39	377.93	0.000175	2.96	14396.69	3650.2	0.13
1	1434	2%_Proj	28300	352.2	379.42	367.1	379.52	0.000176	3.17	17291.47	3852.86	0.14
1	1434	1%_Proj	31300	352.2	380.13	367.92	380.23	0.000176	3.26	18580.96	3855.1	0.14
1	1434	0.2%_Proj	37900	352.2	381.57	371.32	381.67	0.000177	3.45	21220.74	3855.1	0.14
1	105	10%_Proj	22100	355.6	377.49	367.47	377.65	0.0003	3.78	10333.85	1819.15	0.17
1	105	2%_Proj	28300	355.6	379.06	368.69	379.24	0.0003	4.05	12621.82	1827.12	0.18
1	105	1%_Proj	31300	355.6	379.76	369.3	379.95	0.0003	4.16	13640.5	1829.42	0.18
1	105	0.2%_Proj	37900	355.6	381.2	371.64	381.4	0.0003	4.4	15724.54	1833.98	0.18

Plan: Alt 1-1 Flows: Current and Projected

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	72237	10%_Cur	17900	389.7	403.87		404.22	0.001844	6.1	6447.15	1709.05	0.31
1	72237	2%_Cur	22890	389.7	404.55		405.01	0.00231	7.08	7495.83	1972.6	0.35
1	72237	1%_Cur	25380	389.7	404.91		405.39	0.002411	7.37	8083.87	2049.34	0.36
1	72237	0.2%_Cur	30670	389.7	405.82		406.28	0.002267	7.47	9601.88	2118.27	0.35
1	72237	10%_Proj	21500	389.7	404.39		404.83	0.002206	6.86	7236.3	1920.44	0.34
1	72237	2%_Proj	27500	389.7	405.24		405.72	0.002393	7.46	8644.09	2066.5	0.36
1	72237	1%_Proj	30500	389.7	405.79		406.24	0.002278	7.47	9543.93	2115.7	0.35
1	72237	0.2%_Proj	36900	389.7	407.14		407.52	0.001881	7.22	11785.73	2389.3	0.32
1	70873	10%_Cur	17900	388.5	399.36	396.77	400.22	0.005352	8.25	3891.68	2303.97	0.5
1	70873	2%_Cur	22890	388.5	401.16		401.62	0.002764	6.73	7377.78	3251.56	0.37
1	70873	1%_Cur	25380	388.5	402.09		402.42	0.001971	6.02	9375.01	3761.16	0.32
1	70873	0.2%_Cur	30670	388.5	403.84		404.05	0.001205	5.18	13109.43	3929.78	0.25
1	70873	10%_Proj	21500	388.5	400.63		401.18	0.003381	7.19	6265.74	2871.64	0.4
1	70873	2%_Proj	27500	388.5	402.84		403.11	0.001558	5.59	10973.15	3912.1	0.28
1	70873	1%_Proj	30500	388.5	403.78		403.99	0.001224	5.21	12980.9	3928.9	0.25
1	70873	0.2%_Proj	36900	388.5	405.72		405.88	0.000817	4.67	17133.94	3948.96	0.21
1	69284	10%_Cur	17900	386	398.37		398.41	0.000422	2.68	16111.44	4759.02	0.14
1	69284	2%_Cur	22890	386	400.61		400.64	0.000233	2.26	23014.63	4998.93	0.11
1	69284	1%_Cur	25380	386	401.63		401.65	0.000192	2.16	26149.91	5284.34	0.1
1	69284	0.2%_Cur	30670	386	403.47		403.49	0.000151	2.08	31823.16	5501.9	0.09
1	69284	10%_Proj	21500	386	400.01		400.04	0.000267	2.34	21165.41	4959.5	0.12
1	69284	2%_Proj	27500	386	402.42		402.45	0.00017	2.11	28602.9	5416.51	0.1
1	69284	1%_Proj	30500	386	403.41		403.43	0.000152	2.08	31628.09	5499.43	0.09
1	69284	0.2%_Proj	36900	386	405.42		405.44	0.000126	2.05	37826.05	5730.38	0.09
1	67081	10%_Cur	17900	379.7	398.13		398.15	0.000072	1.46	27705.09	4226.91	0.06
1	67081	2%_Cur	22890	379.7	400.44		400.45	0.000057	1.42	35236.13	4260.39	0.06
1	67081	1%_Cur	25380	379.7	401.48		401.49	0.000053	1.42	38613.77	4264.95	0.06
1	67081	0.2%_Cur	30670	379.7	403.34		403.35	0.000049	1.45	44678.93	4272.29	0.06
1	67081	10%_Proj	21500	379.7	399.83		399.84	0.00006	1.43	33233.53	4255.17	0.06
1	67081	2%_Proj	27500	379.7	402.29		402.3	0.000051	1.43	41243.3	4268.22	0.06
1	67081	1%_Proj	30500	379.7	403.28		403.29	0.000049	1.45	44470.15	4272.08	0.06
1	67081	0.2%_Proj	36900	379.7	405.3		405.31	0.000047	1.5	51072.55	4278.75	0.05
1	65654	10%_Cur	17900	377.1	397.91		397.97	0.000229	2.78	13810.31	1783.27	0.12
1	65654	2%_Cur	22890	377.1	400.26		400.31	0.000195	2.78	17264.6	1792.48	0.11
1	65654	1%_Cur	25380	377.1	401.3		401.36	0.000185	2.8	18806.06	1796.33	0.11

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	65654	0.2%_Cur	30670	377.1	403.17		403.22	0.00018	2.92	21571.99	1827.3	0.11
1	65654	10%_Proj	21500	377.1	399.63		399.69	0.000202	2.77	16348.57	1790.19	0.11
1	65654	2%_Proj	27500	377.1	402.11		402.17	0.00018	2.84	20002.83	1799.31	0.11
1	65654	1%_Proj	30500	377.1	403.1		403.16	0.00018	2.92	21475.3	1826.44	0.11
1	65654	0.2%_Proj	36900	377.1	405.13		405.19	0.000176	3.05	24555.07	1867.91	0.11
1	64737	10%_Cur	17900	376.9	397.72		397.78	0.000246	2.91	13176.05	1564.29	0.12
1	64737	2%_Cur	22890	376.9	400.09		400.14	0.00022	2.99	16054.21	1576.62	0.12
1	64737	1%_Cur	25380	376.9	401.14		401.2	0.000213	3.04	17335	1581.36	0.12
1	64737	0.2%_Cur	30670	376.9	403.01		403.07	0.000212	3.2	19615.71	1590.61	0.12
1	64737	10%_Proj	21500	376.9	399.46		399.52	0.000225	2.96	15292.05	1573.84	0.12
1	64737	2%_Proj	27500	376.9	401.95		402.01	0.00021	3.09	18327.62	1585.32	0.12
1	64737	1%_Proj	30500	376.9	402.94		403	0.000212	3.2	19536.59	1590.29	0.12
1	64737	0.2%_Proj	36900	376.9	404.97		405.03	0.000213	3.39	22020.42	1599.97	0.12
1	63261	10%_Cur	18320	372.6	397.36	383.81	397.49	0.000303	3.57	9731.69	1122.86	0.14
1	63261	2%_Cur	23430	372.6	399.76	385.35	399.89	0.000285	3.72	11963.91	1130.35	0.13
1	63261	1%_Cur	25980	372.6	400.82	386.06	400.95	0.000282	3.8	12950.47	1133.65	0.13
1	63261	0.2%_Cur	31390	372.6	402.68	387.56	402.83	0.000287	4.03	14691.33	1139.52	0.14
1	63261	10%_Proj	22000	372.6	399.13	384.94	399.26	0.000289	3.67	11374.96	1128.37	0.13
1	63261	2%_Proj	28200	372.6	401.63	386.68	401.77	0.000283	3.89	13710.34	1136.25	0.14
1	63261	1%_Proj	31200	372.6	402.62	387.5	402.76	0.000287	4.02	14630.83	1139.32	0.14
1	63261	0.2%_Proj	37700	372.6	404.64	391.22	404.8	0.000295	4.28	16522.54	1146.47	0.14
1	61800	10%_Cur	18320	372.3	396.89	383.92	397.04	0.00033	3.78	8148.45	730.94	0.14
1	61800	2%_Cur	23430	372.3	399.29	385.57	399.45	0.000339	4.11	9692.47	746.03	0.15
1	61800	1%_Cur	25980	372.3	400.34	386.32	400.52	0.000346	4.26	10377.44	751.48	0.15
1	61800	0.2%_Cur	31390	372.3	402.17	387.23	402.37	0.000371	4.63	11578.16	760.83	0.16
1	61800	10%_Proj	22000	372.3	398.66	385.27	398.82	0.000336	4.02	9283.92	742.43	0.15
1	61800	2%_Proj	28200	372.3	401.14	386.69	401.33	0.000355	4.41	10902.59	755.58	0.15
1	61800	1%_Proj	31200	372.3	402.1	387.22	402.31	0.000371	4.62	11536.19	760.49	0.16
1	61800	0.2%_Proj	37700	372.3	404.08	388.2	404.32	0.000398	5.02	12846.86	769.41	0.16
1	61066	10%_Cur	18320	375.4	396.57	384.09	396.75	0.000458	4.03	7102.08	870.53	0.16
1	61066	2%_Cur	23430	375.4	398.96	385.95	399.16	0.000451	4.33	8546.96	1072.85	0.17
1	61066	1%_Cur	25980	375.4	400	386.55	400.22	0.000453	4.48	9185.45	1100.16	0.17
1	61066	0.2%_Cur	31390	375.4	401.81	387.69	402.06	0.000477	4.84	10292.6	1122.55	0.17
1	61066	10%_Proj	22000	375.4	398.33	385.23	398.53	0.000452	4.25	8165.29	953.33	0.16
1	61066	2%_Proj	28200	375.4	400.8	387.06	401.03	0.000461	4.63	9671.45	1109.55	0.17
1	61066	1%_Proj	31200	375.4	401.75	387.65	401.99	0.000477	4.83	10253.84	1121.73	0.17
1	61066	0.2%_Proj	37700	375.4	403.7	388.95	403.99	0.000504	5.23	11458.38	1160.13	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	60661	10%_Cur	18320	370.11	396.4	380.77	396.59	0.000313	3.75	5975.84	744.37	0.14
1	60661	2%_Cur	23430	370.11	398.74	381.97	398.99	0.000351	4.25	6810.98	897.92	0.15
1	60661	1%_Cur	25980	370.11	399.76	382.54	400.03	0.000371	4.48	7175.19	916.88	0.16
1	60661	0.2%_Cur	31390	370.11	401.5	383.64	401.84	0.000424	5.01	7797.63	950.56	0.17
1	60661	10%_Proj	22000	370.11	398.12	381.66	398.36	0.00034	4.11	6591.96	882.21	0.15
1	60661	2%_Proj	28200	370.11	400.53	383	400.83	0.000391	4.7	7449.78	930.86	0.16
1	60661	1%_Proj	31200	370.11	401.44	383.6	401.78	0.000422	4.99	7775.88	949.54	0.17
1	60661	0.2%_Proj	37700	370.11	403.32	384.83	403.74	0.000481	5.57	8446.41	989.05	0.18
1	60574		Bridge									
1	60485	10%_Cur	18320	370.11	395.49	381.87	395.89	0.000672	5.48	4471.96	736.09	0.2
1	60485	2%_Cur	23430	370.11	397.57	383.6	398.08	0.000768	6.22	5096.46	826.55	0.22
1	60485	1%_Cur	25980	370.11	398.46	384.39	399.02	0.00082	6.58	5360.89	876.84	0.23
1	60485	0.2%_Cur	31390	370.11	399.84	385.87	400.55	0.000969	7.41	5776.14	885.95	0.25
1	60485	10%_Proj	22000	370.11	397.03	383.16	397.51	0.000741	6.02	4934.73	799.98	0.22
1	60485	2%_Proj	28200	370.11	399.09	385.07	399.7	0.000876	6.91	5550.33	880.84	0.24
1	60485	1%_Proj	31200	370.11	399.79	385.82	400.49	0.000964	7.39	5761.62	885.55	0.25
1	60485	0.2%_Proj	37700	370.11	401.2	387.59	402.08	0.00115	8.35	6181.86	907.87	0.28
1	60172	10%_Cur	18320	371	395.09	382.64	395.62	0.000932	6.1	3824.01	729.68	0.24
1	60172	2%_Cur	23430	371	397.11	384.25	397.77	0.001056	6.91	4417.08	737.85	0.25
1	60172	1%_Cur	25980	371	397.96	385.01	398.69	0.001124	7.3	4668.88	912.36	0.26
1	60172	0.2%_Cur	31390	371	399.25	386.48	400.15	0.001328	8.22	5298.32	1112.57	0.29
1	60172	10%_Proj	22000	371	396.59	383.83	397.21	0.00102	6.69	4263.06	735.74	0.25
1	60172	2%_Proj	28200	371	398.55	385.63	399.35	0.001202	7.68	4956.15	996.92	0.27
1	60172	1%_Proj	31200	371	399.2	386.45	400.1	0.001323	8.2	5274.51	1111.75	0.29
1	60172	0.2%_Proj	37700	371	400.53	388.32	401.63	0.001535	9.14	5954.3	1147.97	0.31
1	59645	10%_Cur	18320	369.3	395.03	378.96	395.25	0.000334	3.85	5133.91	485.89	0.14
1	59645	2%_Cur	23430	369.3	397.04	380.16	397.34	0.000401	4.47	5750.33	818.83	0.16
1	59645	1%_Cur	25980	369.3	397.88	380.71	398.22	0.000436	4.77	6010.04	1201.96	0.17
1	59645	0.2%_Cur	31390	369.3	399.22	381.79	399.6	0.000478	5.17	8764.17	1373.62	0.18
1	59645	10%_Proj	22000	369.3	396.52	379.82	396.8	0.000382	4.3	5590.87	771.8	0.16
1	59645	2%_Proj	28200	369.3	398.47	381.17	398.85	0.000472	5.04	6191.53	1294.76	0.18
1	59645	1%_Proj	31200	369.3	399.17	381.75	399.55	0.000477	5.16	8716.1	1366.63	0.18
1	59645	0.2%_Proj	37700	369.3	400.54	382.95	400.98	0.000543	5.69	10093.6	1475.33	0.19
1	58759	10%_Cur	18320	367.7	394.69	378.81	394.94	0.000395	4.22	6839.09	1329.72	0.16
1	58759	2%_Cur	23430	367.7	396.72	380.29	396.98	0.000412	4.56	8701.06	1928.24	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	58759	1%_Cur	25980	367.7	397.56	380.95	397.84	0.000424	4.73	9480.08	1982.91	0.17
1	58759	0.2%_Cur	31390	367.7	398.94	382.27	399.19	0.000409	4.81	13854.92	2097.75	0.16
1	58759	10%_Proj	22000	367.7	396.2	379.89	396.45	0.000407	4.47	8221.6	1846.7	0.16
1	58759	2%_Proj	28200	367.7	398.14	381.51	398.43	0.000443	4.91	10017.22	2020.67	0.17
1	58759	1%_Proj	31200	367.7	398.89	382.23	399.15	0.000409	4.81	13774.23	2094.22	0.16
1	58759	0.2%_Proj	37700	367.7	400.26	383.67	400.53	0.000439	5.15	16110.02	2153.2	0.17
1	57561	10%_Cur	18320	358.4	394.71	369.05	394.75	0.000052	1.79	15507.5	2083.14	0.06
1	57561	2%_Cur	23430	358.4	396.72	370.4	396.78	0.000061	2.03	18407.44	2445.63	0.07
1	57561	1%_Cur	25980	358.4	397.57	371.01	397.62	0.000066	2.14	19619.5	2494.44	0.07
1	57561	0.2%_Cur	31390	358.4	398.92	372.19	398.99	0.000075	2.36	24512.86	2622.85	0.07
1	57561	10%_Proj	22000	358.4	396.2	370.04	396.26	0.000059	1.96	17661.19	2413.97	0.06
1	57561	2%_Proj	28200	358.4	398.15	371.49	398.21	0.00007	2.25	20455.11	2532.16	0.07
1	57561	1%_Proj	31200	358.4	398.87	372.15	398.94	0.000075	2.35	24408.75	2622.3	0.07
1	57561	0.2%_Proj	37700	358.4	400.23	373.42	400.3	0.000087	2.6	27363.35	2635.93	0.08
1	56157	10%_Cur	18320	370.9	394.39	379.91	394.59	0.000362	3.95	6714.86	1161.59	0.15
1	56157	2%_Cur	23430	370.9	396.34	381.26	396.59	0.00041	4.46	7897.53	1511.17	0.16
1	56157	1%_Cur	25980	370.9	397.16	381.87	397.43	0.000435	4.7	8398.05	1583.34	0.17
1	56157	0.2%_Cur	31390	370.9	398.43	383.04	398.76	0.000508	5.25	9184.21	1721.01	0.18
1	56157	10%_Proj	22000	370.9	395.84	380.92	396.08	0.000397	4.32	7588.55	1462.79	0.16
1	56157	2%_Proj	28200	370.9	397.7	382.36	398	0.000465	4.93	8735.99	1677.63	0.17
1	56157	1%_Proj	31200	370.9	398.38	382.99	398.71	0.000506	5.24	9156.21	1720.65	0.18
1	56157	0.2%_Proj	37700	370.9	399.8	384.55	400.08	0.000459	5.17	14389.29	1732.94	0.18
1	54914	10%_Cur	18320	369.9	393.63	379.31	394	0.000583	5.02	4483.01	800.63	0.19
1	54914	2%_Cur	23430	369.9	395.44	380.65	395.92	0.000687	5.75	5580.85	1385.11	0.21
1	54914	1%_Cur	25980	369.9	396.19	381.28	396.71	0.000731	6.05	6159.93	1462.27	0.22
1	54914	0.2%_Cur	31390	369.9	397.48	382.55	397.99	0.000733	6.27	9328.46	1513.89	0.22
1	54914	10%_Proj	22000	369.9	394.99	380.28	395.43	0.000654	5.53	5257.05	1303.52	0.2
1	54914	2%_Proj	28200	369.9	396.8	381.82	397.28	0.0007	6.02	8356.31	1508.97	0.21
1	54914	1%_Proj	31200	369.9	397.44	382.49	397.94	0.000732	6.26	9265.75	1513.57	0.22
1	54914	0.2%_Proj	37700	369.9	398.8	383.93	399.33	0.000774	6.66	11185.09	1520.73	0.23
1	53799	10%_Cur	18320	364.6	393.24	376.49	393.48	0.000359	4.21	7488.19	1394.6	0.15
1	53799	2%_Cur	23430	364.6	395.06	377.96	395.32	0.000393	4.62	9910.09	2046.93	0.16
1	53799	1%_Cur	25980	364.6	395.82	378.62	396.09	0.000404	4.78	11210.69	2234.96	0.16
1	53799	0.2%_Cur	31390	364.6	397.15	379.99	397.4	0.000386	4.82	15773.59	2567.8	0.16
1	53799	10%_Proj	22000	364.6	394.59	377.59	394.85	0.000388	4.54	9209.09	1768.71	0.16
1	53799	2%_Proj	28200	364.6	396.41	379.19	396.68	0.00041	4.88	12366.95	2488.03	0.16
1	53799	1%_Proj	31200	364.6	397.11	379.96	397.35	0.000386	4.82	15659.13	2565.87	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	53799	0.2%_Proj	37700	364.6	398.49	381.41	398.73	0.000385	4.97	19180.24	2610.02	0.16
1	52665	10%_Cur	18320	370.6	392.78	379.36	393.03	0.000466	4.28	6740.42	1198.32	0.17
1	52665	2%_Cur	23430	370.6	394.57	380.6	394.84	0.000493	4.66	9354.99	2171.51	0.18
1	52665	1%_Cur	25980	370.6	395.34	381.16	395.61	0.000487	4.73	11077.83	2560.81	0.18
1	52665	0.2%_Cur	31390	370.6	396.67	382.36	396.94	0.00049	4.93	14439.38	2711.15	0.18
1	52665	10%_Proj	22000	370.6	394.12	380.27	394.38	0.000479	4.53	8489.99	2000.98	0.17
1	52665	2%_Proj	28200	370.6	395.92	381.51	396.2	0.0005	4.88	12526.13	2705.47	0.18
1	52665	1%_Proj	31200	370.6	396.62	382.34	396.89	0.000491	4.93	14319.03	2710.79	0.18
1	52665	0.2%_Proj	37700	370.6	398.1	383.69	398.31	0.00042	4.75	19210.56	2740.82	0.17
1	52024	10%_Cur	18320	368.7	392.35		392.69	0.000578	4.83	4975	821.1	0.19
1	52024	2%_Cur	23430	368.7	394.1		394.49	0.000637	5.35	7258.4	1795.6	0.2
1	52024	1%_Cur	25980	368.7	394.84		395.26	0.000663	5.58	8769.59	2123.25	0.2
1	52024	0.2%_Cur	31390	368.7	396.19		396.6	0.000664	5.8	11715.1	2213.59	0.21
1	52024	10%_Proj	22000	368.7	393.66		394.04	0.000625	5.24	6514.66	1617.76	0.2
1	52024	2%_Proj	28200	368.7	395.44		395.85	0.000659	5.66	10049.64	2175.5	0.2
1	52024	1%_Proj	31200	368.7	396.15		396.55	0.000665	5.8	11605.61	2213.13	0.21
1	52024	0.2%_Proj	37700	368.7	397.65		398.03	0.000625	5.85	14952.55	2225.11	0.2
1	50694	10%_Cur	18320	358.9	391.74		392.06	0.000402	4.68	5663.06	989.57	0.16
1	50694	2%_Cur	23430	358.9	393.41		393.79	0.000472	5.29	7896.9	1773.31	0.18
1	50694	1%_Cur	25980	358.9	394.15		394.54	0.000488	5.47	9304.85	1973.35	0.18
1	50694	0.2%_Cur	31390	358.9	395.5		395.9	0.000514	5.79	12149.53	2245.67	0.19
1	50694	10%_Proj	22000	358.9	392.99		393.36	0.000452	5.13	7216.08	1506.63	0.17
1	50694	2%_Proj	28200	358.9	394.74		395.14	0.000498	5.61	10514.39	2084.66	0.18
1	50694	1%_Proj	31200	358.9	395.45		395.85	0.000514	5.78	12034.84	2239.21	0.19
1	50694	0.2%_Proj	37700	358.9	396.98		397.38	0.000514	5.98	15566.53	2311.63	0.19
1	49376	10%_Cur	18320	365.5	390.92		391.35	0.000728	5.63	4644.04	1025.91	0.21
1	49376	2%_Cur	23430	365.5	392.53		393	0.000785	6.13	6831.94	1628.45	0.22
1	49376	1%_Cur	25980	365.5	393.28		393.74	0.000779	6.23	8139.13	1806.39	0.22
1	49376	0.2%_Cur	31390	365.5	394.73		395.13	0.000705	6.17	10815.29	1874.08	0.21
1	49376	10%_Proj	22000	365.5	392.11		392.58	0.000781	6.04	6182.56	1496.15	0.22
1	49376	2%_Proj	28200	365.5	393.93		394.36	0.000737	6.17	9333.81	1852.7	0.22
1	49376	1%_Proj	31200	365.5	394.67		395.07	0.00071	6.18	10710.79	1872.48	0.22
1	49376	0.2%_Proj	37700	365.5	396.27		396.63	0.000651	6.16	13814.74	2064.67	0.21
1	47944	10%_Cur	18320	361	390.46		390.68	0.000312	4.01	6053.97	928.1	0.14
1	47944	2%_Cur	23430	361	391.97		392.25	0.000384	4.63	7645.56	1219.68	0.16
1	47944	1%_Cur	25980	361	392.68		392.99	0.000409	4.86	8602.81	1412.69	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	47944	0.2%_Cur	31390	361	394.1		394.44	0.000438	5.21	10882.88	1709.09	0.17
1	47944	10%_Proj	22000	361	391.57		391.85	0.000368	4.48	7187.9	1107.93	0.15
1	47944	2%_Proj	28200	361	393.29		393.63	0.000437	5.1	9521.93	1663.78	0.17
1	47944	1%_Proj	31200	361	394.04		394.38	0.00044	5.21	10782.27	1705.26	0.17
1	47944	0.2%_Proj	37700	361	395.64		395.98	0.000455	5.49	13884.98	2313.36	0.18
1	46103	10%_Cur	18320	365.8	390.21		390.28	0.000185	2.76	13777.21	2849.67	0.11
1	46103	2%_Cur	23430	365.8	391.79		391.85	0.000162	2.71	18574.52	3178.85	0.1
1	46103	1%_Cur	25980	365.8	392.54		392.6	0.000151	2.67	21006.3	3286.53	0.1
1	46103	0.2%_Cur	31390	365.8	394.01		394.06	0.000138	2.67	26026.55	3558.6	0.09
1	46103	10%_Proj	22000	365.8	391.38		391.44	0.000167	2.72	17276.91	3111.12	0.1
1	46103	2%_Proj	28200	365.8	393.17		393.22	0.00015	2.71	23114.11	3423.98	0.1
1	46103	1%_Proj	31200	365.8	393.95		394	0.00014	2.67	25809.72	3527.34	0.09
1	46103	0.2%_Proj	37700	365.8	395.58		395.63	0.000128	2.67	32180.24	4183.44	0.09
1	44085	10%_Cur	18320	364.2	389.68		389.87	0.000414	3.94	7679.87	1817.96	0.16
1	44085	2%_Cur	23430	364.2	391.33		391.51	0.000389	4.03	10881.54	2697.5	0.15
1	44085	1%_Cur	25980	364.2	392.11		392.28	0.000382	4.08	12587.65	3143.65	0.15
1	44085	0.2%_Cur	31390	364.2	393.64		393.79	0.000329	3.97	16157.22	4859.56	0.14
1	44085	10%_Proj	22000	364.2	390.9		391.08	0.000397	4.02	9982.16	2489.78	0.15
1	44085	2%_Proj	28200	364.2	392.76		392.92	0.00036	4.05	14058.99	4187.1	0.15
1	44085	1%_Proj	31200	364.2	393.58		393.72	0.000333	3.98	15997.08	4837.62	0.14
1	44085	0.2%_Proj	37700	364.2	395.24		395.38	0.000313	4.04	20503.22	5633.53	0.14
1	42674	10%_Cur	18320	365.9	389.36		389.46	0.00027	3.03	10008.53	1734.79	0.13
1	42674	2%_Cur	23430	365.9	391.04		391.14	0.000258	3.14	12345.7	1939.33	0.12
1	42674	1%_Cur	25980	365.9	391.83		391.93	0.000252	3.19	13440.05	2761.9	0.12
1	42674	0.2%_Cur	31390	365.9	393.39		393.49	0.000242	3.28	15603.97	4023.62	0.12
1	42674	10%_Proj	22000	365.9	390.61		390.7	0.00026	3.11	11738.58	1873.13	0.12
1	42674	2%_Proj	28200	365.9	392.49		392.59	0.000247	3.22	14355.14	3479.58	0.12
1	42674	1%_Proj	31200	365.9	393.32		393.42	0.000243	3.28	15509.72	4019.27	0.12
1	42674	0.2%_Proj	37700	365.9	395		395.11	0.000237	3.4	17846.15	4081.46	0.12
1	41705	10%_Cur	18320	366.1	389.19		389.25	0.00015	2.18	11719.15	1456.82	0.09
1	41705	2%_Cur	23430	366.1	390.88		390.94	0.000156	2.36	14229.01	2025.49	0.1
1	41705	1%_Cur	25980	366.1	391.66		391.73	0.000156	2.43	15487.49	2744.61	0.1
1	41705	0.2%_Cur	31390	366.1	393.22		393.3	0.000156	2.56	18019.95	4338.21	0.1
1	41705	10%_Proj	22000	366.1	390.44		390.5	0.000154	2.32	13543.74	1892.51	0.1
1	41705	2%_Proj	28200	366.1	392.32		392.39	0.000156	2.49	16557.47	3293.07	0.1
1	41705	1%_Proj	31200	366.1	393.15		393.23	0.000156	2.56	17908.47	4309.09	0.1
1	41705	0.2%_Proj	37700	366.1	394.83		394.91	0.000156	2.69	20645.98	4495.12	0.1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	40323	10%_Cur	18320	364.2	388.43		388.86	0.000701	5.38	4151.08	800.48	0.22
1	40323	2%_Cur	23430	364.2	390		390.52	0.000791	6.05	5025.62	900.91	0.24
1	40323	1%_Cur	25980	364.2	390.75		391.31	0.00082	6.31	5441.98	924.78	0.25
1	40323	0.2%_Cur	31390	364.2	392.24		392.86	0.000867	6.8	6269.19	1118.96	0.26
1	40323	10%_Proj	22000	364.2	389.59		390.09	0.000766	5.87	4799.5	891.08	0.24
1	40323	2%_Proj	28200	364.2	391.38		391.97	0.000841	6.52	5791.49	943.21	0.25
1	40323	1%_Proj	31200	364.2	392.17		392.79	0.000869	6.8	6230.4	1104.43	0.26
1	40323	0.2%_Proj	37700	364.2	393.78		394.47	0.000917	7.32	7120.11	1495.58	0.27
1	39316	10%_Cur	18320	363.3	387.8	374.57	388.19	0.000594	5.08	3941.97	1334.56	0.2
1	39316	2%_Cur	23430	363.3	389.21	375.97	389.74	0.000748	5.98	4376.48	1552.21	0.23
1	39316	1%_Cur	25980	363.3	389.87	376.64	390.47	0.000816	6.38	4587.56	1683.57	0.24
1	39316	0.2%_Cur	31390	363.3	391.39	377.96	392.01	0.000826	6.71	6344.55	2995.6	0.25
1	39316	10%_Proj	22000	363.3	388.86	375.59	389.35	0.000705	5.74	4262.71	1501.81	0.22
1	39316	2%_Proj	28200	363.3	390.42	377.19	391.08	0.000872	6.7	4764.3	1902.61	0.25
1	39316	1%_Proj	31200	363.3	391.31	377.92	391.94	0.000829	6.71	6288.87	2843.5	0.25
1	39316	0.2%_Proj	37700	363.3	393.01	379.36	393.57	0.000751	6.7	8696.44	4413.3	0.24
1	39250		Bridge									
1	39190	10%_Cur	18320	363.3	387.65	374.45	387.98	0.000604	4.62	4042.23	1431.25	0.2
1	39190	2%_Cur	23430	363.3	389.02	375.79	389.47	0.00075	5.43	4437.85	2107.39	0.23
1	39190	1%_Cur	25980	363.3	389.64	376.39	390.16	0.000819	5.81	4627.05	2244.92	0.24
1	39190	0.2%_Cur	31390	363.3	390.81	377.64	391.36	0.000848	6.16	6464.35	2553.24	0.25
1	39190	10%_Proj	22000	363.3	388.68	375.42	389.1	0.000707	5.21	4338.07	1955.51	0.22
1	39190	2%_Proj	28200	363.3	390.11	376.91	390.69	0.000882	6.13	4775.07	2278.01	0.25
1	39190	1%_Proj	31200	363.3	390.75	377.6	391.3	0.00085	6.15	6415.66	2505.22	0.25
1	39190	0.2%_Proj	37700	363.3	391.94	379.01	392.53	0.000898	6.58	8030.97	3654.51	0.26
1	37734	10%_Cur	18320	364.5	386.33	374.15	386.88	0.000853	6.03	3472.49	1741.83	0.24
1	37734	2%_Cur	23430	364.5	387.73	375.63	388.28	0.000869	6.37	5756.9	2088.26	0.25
1	37734	1%_Cur	25980	364.5	388.32	376.3	388.9	0.000907	6.63	6461.83	2185.56	0.25
1	37734	0.2%_Cur	31390	364.5	389.45	377.7	390.05	0.00095	7.03	7912.2	2408.39	0.26
1	37734	10%_Proj	22000	364.5	387.43	375.23	387.96	0.000832	6.18	5428.65	2030.99	0.24
1	37734	2%_Proj	28200	364.5	388.79	376.89	389.38	0.000934	6.83	7043.65	2252.28	0.26
1	37734	1%_Proj	31200	364.5	389.37	377.63	389.98	0.00096	7.05	7807.76	2387.99	0.26
1	37734	0.2%_Proj	37700	364.5	390.57	379.19	391.18	0.000977	7.36	9429.07	2786.73	0.27
1	36382	10%_Cur	18320	350.3	385.67	370.81	385.9	0.000519	4.07	5778.13	1592.03	0.18
1	36382	2%_Cur	23430	350.3	387.06	372.31	387.3	0.000524	4.34	8314.61	2762.7	0.19

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	36382	1%_Cur	25980	350.3	387.64	373.02	387.89	0.000529	4.46	9265.25	3552.88	0.19
1	36382	0.2%_Cur	31390	350.3	388.7	374.43	388.98	0.000578	4.84	11333.81	4625.17	0.2
1	36382	10%_Proj	22000	350.3	386.71	371.91	386.98	0.000555	4.4	6615.36	2476.49	0.19
1	36382	2%_Proj	28200	350.3	388.1	373.6	388.35	0.000537	4.57	10074.78	4049.79	0.19
1	36382	1%_Proj	31200	350.3	388.66	374.37	388.92	0.000548	4.71	11254.44	4607.9	0.19
1	36382	0.2%_Proj	37700	350.3	389.85	375.92	390.12	0.000552	4.93	13922.57	4766.7	0.2
1	34787	10%_Cur	18320	362.5	385.15		385.26	0.000292	3.42	10498.17	2427.85	0.14
1	34787	2%_Cur	23430	362.5	386.54		386.65	0.000295	3.61	13504.15	4135.48	0.15
1	34787	1%_Cur	25980	362.5	387.11		387.23	0.000302	3.73	14895.41	4535.89	0.15
1	34787	0.2%_Cur	31390	362.5	388.18		388.3	0.000294	3.81	17536.54	5959.6	0.15
1	34787	10%_Proj	22000	362.5	386.19		386.31	0.000297	3.58	12712.99	3716.25	0.15
1	34787	2%_Proj	28200	362.5	387.57		387.69	0.000298	3.76	16024.54	5231.78	0.15
1	34787	1%_Proj	31200	362.5	388.15		388.27	0.000294	3.81	17446.48	5927.22	0.15
1	34787	0.2%_Proj	37700	362.5	389.36		389.47	0.000282	3.87	20705.63	7086.47	0.15
1	32336	10%_Cur	18320	360.3	384.63		384.75	0.00022	3.23	11052.08	2261.21	0.13
1	32336	2%_Cur	23430	360.3	386.05		386.16	0.000218	3.36	14050.38	3807.4	0.13
1	32336	1%_Cur	25980	360.3	386.62		386.74	0.000221	3.44	15280.49	4539.99	0.13
1	32336	0.2%_Cur	31390	360.3	387.7		387.82	0.00023	3.62	17611.23	5640.77	0.13
1	32336	10%_Proj	22000	360.3	385.7		385.81	0.000217	3.32	13295.73	3258.65	0.13
1	32336	2%_Proj	28200	360.3	387.09		387.21	0.000224	3.52	16286.19	5136.71	0.13
1	32336	1%_Proj	31200	360.3	387.67		387.78	0.000229	3.62	17533.85	5602.01	0.13
1	32336	0.2%_Proj	37700	360.3	388.84		388.98	0.000259	3.97	20706.06	7671.42	0.14
1	30004	10%_Cur	18320	365	384.01	373.53	384.15	0.00035	3.38	7374.94	3954.14	0.15
1	30004	2%_Cur	23430	365	385.33	374.83	385.52	0.000425	3.93	9334.49	9748.82	0.17
1	30004	1%_Cur	25980	365	385.89	375.35	386.09	0.000436	4.07	10354.54	11015.19	0.17
1	30004	0.2%_Cur	31390	365	386.94	376.21	387.15	0.000453	4.32	12387.67	12281.89	0.18
1	30004	10%_Proj	22000	365	384.98	374.45	385.17	0.000421	3.86	8746.56	7981.39	0.17
1	30004	2%_Proj	28200	365	386.35	375.7	386.55	0.000443	4.17	11225.34	11779.41	0.18
1	30004	1%_Proj	31200	365	386.91	376.18	387.12	0.000453	4.31	12319.02	12264.99	0.18
1	30004	0.2%_Proj	37700	365	388.04	377.08	388.26	0.000467	4.56	14552.1	12627.04	0.18
1	27852	10%_Cur	18320	366.3	383.16		383.33	0.00041	3.56	7342.74	2993.33	0.16
1	27852	2%_Cur	23430	366.3	384.35		384.55	0.000469	4.02	9483.22	7176.97	0.18
1	27852	1%_Cur	25980	366.3	384.91		385.11	0.000466	4.1	10617.47	9375.77	0.18
1	27852	0.2%_Cur	31390	366.3	385.95		386.15	0.000463	4.26	12750.83	11318.82	0.18
1	27852	10%_Proj	22000	366.3	384.02		384.21	0.000459	3.92	8845.51	5429.39	0.18
1	27852	2%_Proj	28200	366.3	385.36		385.57	0.000462	4.16	11549.78	10457.07	0.18
1	27852	1%_Proj	31200	366.3	385.92		386.12	0.000463	4.25	12678.85	11275.81	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	27852	0.2%_Proj	37700	366.3	387.03		387.24	0.000465	4.44	15019.23	11937.89	0.18
1	26395	10%_Cur	18320	362	382.69		382.8	0.000328	3.19	9430.54	3628.33	0.15
1	26395	2%_Cur	23430	362	383.82		383.95	0.000367	3.55	11258.82	7912.36	0.16
1	26395	1%_Cur	25980	362	384.35		384.5	0.000398	3.78	12341.96	9877.79	0.16
1	26395	0.2%_Cur	31390	362	385.38		385.54	0.00042	4.04	14662.19	11439.19	0.17
1	26395	10%_Proj	22000	362	383.5		383.63	0.000363	3.48	10695.84	6457.65	0.16
1	26395	2%_Proj	28200	362	384.78		384.94	0.000425	3.98	13309.89	10825.91	0.17
1	26395	1%_Proj	31200	362	385.34		385.5	0.00042	4.04	14581.27	11412.19	0.17
1	26395	0.2%_Proj	37700	362	386.48		386.63	0.000405	4.14	17165.81	11961.21	0.17
1	24785	10%_Cur	18320	362.4	382.41		382.45	0.000145	2.17	15582.28	6839.48	0.1
1	24785	2%_Cur	23430	362.4	383.51		383.56	0.000166	2.43	18248.43	8762.86	0.11
1	24785	1%_Cur	25980	362.4	384.03		384.08	0.000168	2.5	19557.82	9054.4	0.11
1	24785	0.2%_Cur	31390	362.4	385.05		385.1	0.000174	2.64	22126.04	9339.82	0.11
1	24785	10%_Proj	22000	362.4	383.19		383.23	0.000166	2.4	17439.23	8364.58	0.11
1	24785	2%_Proj	28200	362.4	384.46		384.51	0.00017	2.56	20629.88	9196.36	0.11
1	24785	1%_Proj	31200	362.4	385.01		385.07	0.000174	2.64	22035.68	9332	0.11
1	24785	0.2%_Proj	37700	362.4	386.14		386.2	0.000179	2.79	24973.53	9493.64	0.11
1	23901	10%_Cur	18320	362.1	382.18		382.29	0.000261	3.14	10202.59	6035.66	0.14
1	23901	2%_Cur	23430	362.1	383.24		383.37	0.000303	3.52	12257.64	7706.45	0.15
1	23901	1%_Cur	25980	362.1	383.75		383.89	0.00031	3.63	13290.55	8048.75	0.15
1	23901	0.2%_Cur	31390	362.1	384.76		384.91	0.00032	3.83	15330.55	9280.89	0.15
1	23901	10%_Proj	22000	362.1	382.91		383.04	0.0003	3.47	11619.42	7446.53	0.15
1	23901	2%_Proj	28200	362.1	384.18		384.32	0.000315	3.72	14143.41	8553.76	0.15
1	23901	1%_Proj	31200	362.1	384.73		384.87	0.00032	3.82	15258.91	9256.94	0.15
1	23901	0.2%_Proj	37700	362.1	385.86		386	0.000327	4.01	17569.99	10422.9	0.16
1	22770	10%_Cur	18320	364.9	382		382.05	0.000177	2.3	12933.87	7187.63	0.11
1	22770	2%_Cur	23430	364.9	383.01		383.08	0.00022	2.68	14942.67	9431.8	0.12
1	22770	1%_Cur	25980	364.9	383.52		383.59	0.000231	2.81	16066.3	10097.78	0.13
1	22770	0.2%_Cur	31390	364.9	384.53		384.6	0.000238	2.97	18320.3	10611.04	0.13
1	22770	10%_Proj	22000	364.9	382.71		382.77	0.000203	2.54	14277.81	9077.21	0.12
1	22770	2%_Proj	28200	364.9	383.94		384.02	0.000234	2.88	17006.96	10344.52	0.13
1	22770	1%_Proj	31200	364.9	384.49		384.57	0.000238	2.97	18240.68	10598.44	0.13
1	22770	0.2%_Proj	37700	364.9	385.62		385.7	0.000243	3.13	20788.21	10930.68	0.13
1	21592	10%_Cur	18320	350.2	381.58		381.8	0.000424	4.27	8846.09	7797.44	0.19
1	21592	2%_Cur	23430	350.2	382.56		382.8	0.000473	4.69	11118.11	9746.12	0.2
1	21592	1%_Cur	25980	350.2	383.08		383.32	0.000469	4.77	12431.34	10353.94	0.2

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	21592	0.2%_Cur	31390	350.2	384.11		384.34	0.000453	4.86	15052.55	10957.91	0.2
1	21592	10%_Proj	22000	350.2	382.26		382.5	0.000467	4.61	10400.54	9424.96	0.2
1	21592	2%_Proj	28200	350.2	383.51		383.74	0.000463	4.81	13527.87	10553.76	0.2
1	21592	1%_Proj	31200	350.2	384.08		384.3	0.000453	4.86	14959.92	10933.62	0.2
1	21592	0.2%_Proj	37700	350.2	385.23		385.45	0.000432	4.94	17888.21	11215.19	0.19
1	20191	10%_Cur	18320	353.3	381.5		381.55	0.000088	2.27	18064.66	10508.2	0.09
1	20191	2%_Cur	23430	353.3	382.46		382.51	0.000105	2.55	20638.83	11177.26	0.1
1	20191	1%_Cur	25980	353.3	382.97		383.03	0.00011	2.65	22012.93	11265.67	0.1
1	20191	0.2%_Cur	31390	353.3	383.99		384.05	0.000118	2.84	24749.02	11627.26	0.11
1	20191	10%_Proj	22000	353.3	382.16		382.22	0.000102	2.49	19842.01	11111.57	0.1
1	20191	2%_Proj	28200	353.3	383.39		383.46	0.000113	2.73	23155.96	11336.75	0.1
1	20191	1%_Proj	31200	353.3	383.95		384.02	0.000118	2.83	24651.91	11606.02	0.11
1	20191	0.2%_Proj	37700	353.3	385.09		385.17	0.000125	3.02	27721.26	12163.27	0.11
1	18663	10%_Cur	18320	357.8	381.1		381.29	0.000431	3.99	8670.55	10290.38	0.19
1	18663	2%_Cur	23430	357.8	381.99		382.22	0.000493	4.45	10406.63	11000.81	0.2
1	18663	1%_Cur	25980	357.8	382.5		382.72	0.000498	4.57	11402.29	11234.88	0.2
1	18663	0.2%_Cur	31390	357.8	383.51		383.74	0.000499	4.77	13401.59	11799.96	0.21
1	18663	10%_Proj	22000	357.8	381.7		381.92	0.000489	4.38	9833.35	10843.54	0.2
1	18663	2%_Proj	28200	357.8	382.92		383.15	0.0005	4.66	12235.07	11612.02	0.2
1	18663	1%_Proj	31200	357.8	383.47		383.7	0.000499	4.76	13329.72	11794.81	0.21
1	18663	0.2%_Proj	37700	357.8	384.61		384.84	0.000494	4.95	15584.29	12012.49	0.21
1	16739	10%_Cur	18320	362.3	380.53		380.64	0.000277	3.12	11368.08	11480.08	0.15
1	16739	2%_Cur	23430	362.3	381.36		381.48	0.000312	3.45	13535.39	12176.86	0.16
1	16739	1%_Cur	25980	362.3	381.87		381.99	0.000309	3.51	14869.99	12314.74	0.16
1	16739	0.2%_Cur	31390	362.3	382.9		383.02	0.000301	3.62	17556.14	12550.62	0.16
1	16739	10%_Proj	22000	362.3	381.06		381.19	0.000313	3.4	12769.14	12077	0.16
1	16739	2%_Proj	28200	362.3	382.3		382.42	0.000306	3.56	15987.04	12425.6	0.16
1	16739	1%_Proj	31200	362.3	382.86		382.98	0.000301	3.62	17458.07	12542.32	0.16
1	16739	0.2%_Proj	37700	362.3	384.03		384.15	0.00029	3.72	20493.75	12813.16	0.16
1	14949	10%_Cur	18320	360.7	379.79	371.77	380.04	0.000441	4.56	7666.99	13489.41	0.21
1	14949	2%_Cur	23430	360.7	380.66	372.92	380.88	0.000422	4.64	11870.83	13934.12	0.21
1	14949	1%_Cur	25980	360.7	381.22	373.44	381.42	0.000396	4.6	13517.93	13998.1	0.21
1	14949	0.2%_Cur	31390	360.7	382.34	374.62	382.51	0.000347	4.51	16813.62	14094.23	0.19
1	14949	10%_Proj	22000	360.7	380.34	372.61	380.57	0.000438	4.66	10925.91	13881.76	0.21
1	14949	2%_Proj	28200	360.7	381.69	373.91	381.88	0.000375	4.57	14895.38	14027.52	0.2
1	14949	1%_Proj	31200	360.7	382.3	374.59	382.47	0.000349	4.52	16692.72	14090.02	0.19
1	14949	0.2%_Proj	37700	360.7	383.54	375.85	383.69	0.000308	4.45	20344.8	14266.97	0.19

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	13445	10%_Cur	18320	360	379.35	371.7	379.48	0.000299	3.51	9953.98	12927.24	0.17
1	13445	2%_Cur	23430	360	380.29	373.19	380.4	0.00027	3.5	14619.56	13817.2	0.17
1	13445	1%_Cur	25980	360	380.87	373.59	380.97	0.000257	3.5	16215	13997.31	0.16
1	13445	0.2%_Cur	31390	360	382.02	374.34	382.12	0.000234	3.52	19396.51	14137.69	0.16
1	13445	10%_Proj	22000	360	379.95	372.7	380.06	0.000279	3.49	13694.55	13611.63	0.17
1	13445	2%_Proj	28200	360	381.35	373.9	381.45	0.000247	3.51	17547.09	14053.74	0.16
1	13445	1%_Proj	31200	360	381.98	374.32	382.08	0.000235	3.52	19279.18	14127.4	0.16
1	13445	0.2%_Proj	37700	360	383.25	375.1	383.34	0.000216	3.56	22776.25	14212	0.15
1	12366	10%_Cur	18320	358.7	379.1	368.19	379.23	0.000189	3.01	9288.8	11969.13	0.14
1	12366	2%_Cur	23430	358.7	379.96	369.08	380.11	0.000225	3.42	11510.97	12723.87	0.15
1	12366	1%_Cur	25980	358.7	380.54	369.47	380.7	0.000224	3.49	13034.02	13063.85	0.15
1	12366	0.2%_Cur	31390	358.7	381.7	370.24	381.86	0.000218	3.61	16095.37	13525.33	0.15
1	12366	10%_Proj	22000	358.7	379.62	368.84	379.78	0.000224	3.36	10639.11	12563.74	0.15
1	12366	2%_Proj	28200	358.7	381.02	369.8	381.18	0.000222	3.54	14310.05	13287.51	0.15
1	12366	1%_Proj	31200	358.7	381.66	370.22	381.81	0.000218	3.6	15980.44	13523.15	0.15
1	12366	0.2%_Proj	37700	358.7	382.98	371.05	383.11	0.000186	3.5	21196.46	13738.51	0.14
1	12300		Bridge									
1	12274	10%_Cur	18320	358.7	379.05	368.06	379.17	0.000183	2.93	9586.69	12087.86	0.14
1	12274	2%_Cur	23430	358.7	379.9	369.25	380.04	0.000219	3.33	11736.38	12527.23	0.15
1	12274	1%_Cur	25980	358.7	380.47	369.66	380.62	0.000218	3.4	13249.95	12730.07	0.15
1	12274	0.2%_Cur	31390	358.7	381.64	370.46	381.78	0.00021	3.5	16662.44	12935.83	0.15
1	12274	10%_Proj	22000	358.7	379.56	369.01	379.71	0.000219	3.27	10874.43	12409.5	0.15
1	12274	2%_Proj	28200	358.7	380.96	370.01	381.1	0.000214	3.44	14774.89	12840.34	0.15
1	12274	1%_Proj	31200	358.7	381.59	370.44	381.74	0.000211	3.5	16539.78	12920.49	0.15
1	12274	0.2%_Proj	37700	358.7	382.92	371.3	383.06	0.000197	3.56	20243.14	13486.46	0.15
1	11328	10%_Cur	18390	340.8	378.36	361.18	378.83	0.000411	5.54	4533.34	12498.5	0.21
1	11328	2%_Cur	23520	340.8	379.52	363.09	379.78	0.000295	4.85	11909.4	12980.96	0.18
1	11328	1%_Cur	26080	340.8	380.13	363.96	380.37	0.000285	4.85	13730.62	13019.81	0.17
1	11328	0.2%_Cur	31511	340.8	381.35	365.65	381.55	0.000262	4.81	17384.68	13163.88	0.17
1	11328	10%_Proj	22100	340.8	379.17	362.59	379.44	0.000298	4.83	10870.65	12952.31	0.18
1	11328	2%_Proj	28300	340.8	380.64	364.68	380.86	0.000276	4.84	15256.26	13029.7	0.17
1	11328	1%_Proj	31300	340.8	381.3	365.6	381.51	0.000263	4.81	17247.18	13159.39	0.17
1	11328	0.2%_Proj	37900	340.8	382.68	367.49	382.86	0.000238	4.74	21383.53	13282.98	0.16
1	10809	10%_Cur	18390	359.1	378.36	370.46	378.48	0.000269	3.31	10314.57	12286.57	0.16
1	10809	2%_Cur	23520	359.1	379.47	371.71	379.56	0.000213	3.12	15073.49	12605.64	0.15

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	10809	1%_Cur	26080	359.1	380.07	372.12	380.16	0.000205	3.14	16587.13	12695.67	0.15
1	10809	0.2%_Cur	31511	359.1	381.28	373.19	381.37	0.000188	3.18	19640.83	12807.24	0.14
1	10809	10%_Proj	22100	359.1	379.13	371.45	379.21	0.000218	3.1	14212.24	12554.78	0.15
1	10809	2%_Proj	28300	359.1	380.58	372.65	380.66	0.000198	3.16	17860.73	12767.92	0.14
1	10809	1%_Proj	31300	359.1	381.24	373.16	381.32	0.000189	3.18	19525.84	12804.7	0.14
1	10809	0.2%_Proj	37900	359.1	382.61	374.14	382.69	0.000173	3.22	22989.73	12954.83	0.14
1	8575	10%_Cur	18390	351.1	377.83	368.65	377.95	0.000241	3.33	10982.47	11878.24	0.16
1	8575	2%_Cur	23520	351.1	379.14	369.83	379.2	0.00015	2.79	19635.08	11962.14	0.12
1	8575	1%_Cur	26080	351.1	379.76	370.3	379.82	0.000141	2.77	21741.44	11976.68	0.12
1	8575	0.2%_Cur	31511	351.1	381.01	371.21	381.07	0.000126	2.76	25947.37	12033.73	0.12
1	8575	10%_Proj	22100	351.1	378.78	369.54	378.85	0.000156	2.8	18426.35	11946.34	0.13
1	8575	2%_Proj	28300	351.1	380.29	370.68	380.34	0.000134	2.76	23499.97	12000.55	0.12
1	8575	1%_Proj	31300	351.1	380.96	371.18	381.02	0.000126	2.76	25789.6	12031.59	0.12
1	8575	0.2%_Proj	37900	351.1	382.37	372.33	382.42	0.000114	2.76	30524.87	12360.29	0.11
1	5278	10%_Cur	18390	356.2	377.38		377.43	0.000128	2.23	17149.79	6648.57	0.11
1	5278	2%_Cur	23520	356.2	378.78		378.83	0.000113	2.25	21488.79	7154.98	0.11
1	5278	1%_Cur	26080	356.2	379.43		379.47	0.000108	2.27	23482.8	7284.51	0.11
1	5278	0.2%_Cur	31511	356.2	380.71		380.75	0.000101	2.32	27437.37	7485.34	0.1
1	5278	10%_Proj	22100	356.2	378.41		378.45	0.000117	2.25	20339.17	7042.44	0.11
1	5278	2%_Proj	28300	356.2	379.97		380.01	0.000105	2.29	25140.14	7374.89	0.1
1	5278	1%_Proj	31300	356.2	380.66		380.7	0.000101	2.31	27289.54	7480.91	0.1
1	5278	0.2%_Proj	37900	356.2	382.09		382.13	0.000094	2.37	31712.49	7601.69	0.1
1	2988	10%_Cur	18390	349	377.08		377.15	0.000176	2.89	13605.94	6179.64	0.13
1	2988	2%_Cur	23520	349	378.52		378.59	0.000164	2.96	16806.61	6658.51	0.13
1	2988	1%_Cur	26080	349	379.17		379.24	0.00016	3.01	18267.04	6731.49	0.13
1	2988	0.2%_Cur	31511	349	380.47		380.54	0.000153	3.09	21151.29	6765.77	0.13
1	2988	10%_Proj	22100	349	378.14		378.21	0.000166	2.94	15962.13	6587.5	0.13
1	2988	2%_Proj	28300	349	379.72		379.79	0.000157	3.04	19477.46	6737.61	0.13
1	2988	1%_Proj	31300	349	380.42		380.49	0.000153	3.09	21043.64	6765.11	0.13
1	2988	0.2%_Proj	37900	349	381.86		381.94	0.000148	3.19	24256.47	6784.99	0.13
1	2706	10%_Cur	18390	354.3	377		377.1	0.000181	3.22	12180.46	5710.47	0.14
1	2706	2%_Cur	23520	354.3	378.44		378.54	0.000175	3.34	15113.76	5908.8	0.14
1	2706	1%_Cur	26080	354.3	379.1		379.2	0.000173	3.4	16452.01	5995.97	0.14
1	2706	0.2%_Cur	31511	354.3	380.4		380.5	0.00017	3.52	19094.51	6045.9	0.14
1	2706	10%_Proj	22100	354.3	378.06		378.16	0.000177	3.31	14339.88	5866.06	0.14
1	2706	2%_Proj	28300	354.3	379.64		379.74	0.000172	3.45	17561.05	6035.11	0.14
1	2706	1%_Proj	31300	354.3	380.35		380.45	0.00017	3.51	18995.95	6045.9	0.14

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	2706	0.2%_Proj	37900	354.3	381.79		381.89	0.000167	3.64	21938.5	6045.9	0.14
1	1434	10%_Cur	18390	352.2	376.78	364.31	376.87	0.000175	2.82	12455.46	3323.02	0.13
1	1434	2%_Cur	23520	352.2	378.22	365.78	378.31	0.000175	3.01	15092.11	3744.2	0.13
1	1434	1%_Cur	26080	352.2	378.88	366.5	378.97	0.000176	3.1	16294.74	3823.51	0.14
1	1434	0.2%_Cur	31511	352.2	380.17	367.98	380.27	0.000176	3.27	18669.39	3855.1	0.14
1	1434	10%_Proj	22100	352.2	377.84	365.39	377.93	0.000175	2.96	14396.69	3650.2	0.13
1	1434	2%_Proj	28300	352.2	379.42	367.1	379.52	0.000176	3.17	17291.41	3852.86	0.14
1	1434	1%_Proj	31300	352.2	380.13	367.92	380.23	0.000176	3.26	18580.85	3855.1	0.14
1	1434	0.2%_Proj	37900	352.2	381.57	371.32	381.67	0.000177	3.45	21220.74	3855.1	0.14
1	105	10%_Cur	18390	355.6	376.43	366.66	376.59	0.0003	3.6	8798.26	1810.22	0.17
1	105	2%_Cur	23520	355.6	377.86	367.76	378.03	0.0003	3.85	10883.51	1820.89	0.17
1	105	1%_Cur	26080	355.6	378.52	368.3	378.69	0.0003	3.96	11834.1	1825.48	0.18
1	105	0.2%_Cur	31511	355.6	379.81	369.33	380	0.0003	4.17	13710.33	1829.58	0.18
1	105	10%_Proj	22100	355.6	377.49	367.47	377.65	0.0003	3.78	10333.85	1819.15	0.17
1	105	2%_Proj	28300	355.6	379.06	368.65	379.24	0.0003	4.05	12621.73	1827.12	0.18
1	105	1%_Proj	31300	355.6	379.76	369.21	379.95	0.0003	4.16	13640.42	1829.42	0.18
1	105	0.2%_Proj	37900	355.6	381.2	371.64	381.4	0.0003	4.4	15724.54	1833.98	0.18

Plan: Alt 2-2

Flows: Current and Projected

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	72237	10%_Cur	17900	389.7	403.86		404.22	0.001845	6.1	6445.76	1708.81	0.31
1	72237	2%_Cur	22890	389.7	404.55		405.01	0.002314	7.08	7491.07	1971.26	0.35
1	72237	1%_Cur	25380	389.7	404.91		405.39	0.002411	7.37	8083.92	2049.34	0.36
1	72237	0.2%_Cur	30670	389.7	405.82		406.28	0.002266	7.47	9604	2118.37	0.35
1	72237	10%_Proj	21500	389.7	404.38		404.82	0.002209	6.86	7231.94	1920.13	0.34
1	72237	2%_Proj	27500	389.7	405.24		405.72	0.002392	7.46	8644.9	2066.58	0.36
1	72237	1%_Proj	30500	389.7	405.79		406.25	0.002277	7.47	9546.46	2115.81	0.35
1	72237	0.2%_Proj	36900	389.7	407.14		407.53	0.001879	7.22	11789.07	2389.87	0.32
1	70873	10%_Cur	17900	388.5	399.36	396.77	400.22	0.00534	8.24	3896.89	2305.07	0.5
1	70873	2%_Cur	22890	388.5	401.17		401.62	0.002752	6.72	7393.56	3255.91	0.37
1	70873	1%_Cur	25380	388.5	402.1		402.43	0.001965	6.01	9386.83	3763.77	0.32
1	70873	0.2%_Cur	30670	388.5	403.84		404.05	0.001203	5.18	13118.44	3929.84	0.25
1	70873	10%_Proj	21500	388.5	400.64		401.19	0.003358	7.17	6287.57	2877.97	0.4
1	70873	2%_Proj	27500	388.5	402.85		403.11	0.001554	5.58	10981.71	3912.17	0.28
1	70873	1%_Proj	30500	388.5	403.78		404	0.001222	5.2	12992.2	3928.98	0.25
1	70873	0.2%_Proj	36900	388.5	405.72		405.88	0.000816	4.66	17141.85	3948.99	0.21
1	69284	10%_Cur	17900	386	398.38		398.42	0.00042	2.67	16139.17	4767.26	0.14
1	69284	2%_Cur	22890	386	400.62		400.65	0.000232	2.26	23043.87	5000.67	0.11
1	69284	1%_Cur	25380	386	401.63		401.66	0.000192	2.16	26170.21	5285.15	0.1
1	69284	0.2%_Cur	30670	386	403.47		403.5	0.000151	2.08	31837.74	5502.09	0.09
1	69284	10%_Proj	21500	386	400.02		400.06	0.000265	2.34	21211.01	4961.92	0.12
1	69284	2%_Proj	27500	386	402.43		402.45	0.00017	2.11	28617.28	5417.69	0.1
1	69284	1%_Proj	30500	386	403.41		403.44	0.000152	2.08	31646.6	5499.66	0.09
1	69284	0.2%_Proj	36900	386	405.42		405.44	0.000125	2.05	37838.37	5731.11	0.09
1	67081	10%_Cur	17900	379.7	398.14		398.16	0.000072	1.46	27737.62	4227.03	0.06
1	67081	2%_Cur	22890	379.7	400.45		400.46	0.000057	1.42	35268.85	4260.48	0.06
1	67081	1%_Cur	25380	379.7	401.49		401.5	0.000053	1.42	38636.25	4264.98	0.06
1	67081	0.2%_Cur	30670	379.7	403.34		403.36	0.000049	1.45	44694.95	4272.31	0.06
1	67081	10%_Proj	21500	379.7	399.84		399.86	0.00006	1.42	33285.06	4255.27	0.06
1	67081	2%_Proj	27500	379.7	402.29		402.3	0.000051	1.43	41259.22	4268.24	0.06
1	67081	1%_Proj	30500	379.7	403.28		403.29	0.000049	1.45	44490.44	4272.1	0.06
1	67081	0.2%_Proj	36900	379.7	405.3		405.32	0.000046	1.5	51085.98	4278.77	0.05
1	65654	10%_Cur	17900	377.1	397.92		397.98	0.000229	2.77	13826.04	1783.32	0.12
1	65654	2%_Cur	22890	377.1	400.27		400.32	0.000194	2.78	17280.12	1792.52	0.11
1	65654	1%_Cur	25380	377.1	401.31		401.36	0.000185	2.8	18816.6	1796.35	0.11

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	65654	0.2%_Cur	30670	377.1	403.17		403.23	0.000179	2.92	21579.55	1827.37	0.11
1	65654	10%_Proj	21500	377.1	399.65		399.71	0.000201	2.77	16373.09	1790.25	0.11
1	65654	2%_Proj	27500	377.1	402.12		402.17	0.00018	2.83	20010.35	1799.33	0.11
1	65654	1%_Proj	30500	377.1	403.11		403.17	0.00018	2.91	21484.91	1826.53	0.11
1	65654	0.2%_Proj	36900	377.1	405.13		405.19	0.000176	3.05	24561.59	1867.98	0.11
1	64737	10%_Cur	17900	376.9	397.73		397.79	0.000246	2.91	13189.79	1564.35	0.12
1	64737	2%_Cur	22890	376.9	400.1		400.16	0.000219	2.98	16067.55	1576.67	0.12
1	64737	1%_Cur	25380	376.9	401.15		401.2	0.000213	3.04	17344.05	1581.39	0.12
1	64737	0.2%_Cur	30670	376.9	403.01		403.07	0.000211	3.2	19622.1	1590.64	0.12
1	64737	10%_Proj	21500	376.9	399.48		399.53	0.000224	2.96	15313.18	1573.92	0.12
1	64737	2%_Proj	27500	376.9	401.96		402.02	0.00021	3.09	18334.03	1585.34	0.12
1	64737	1%_Proj	30500	376.9	402.95		403.01	0.000212	3.19	19544.69	1590.32	0.12
1	64737	0.2%_Proj	36900	376.9	404.97		405.04	0.000213	3.38	22025.82	1599.99	0.12
1	63261	10%_Cur	18320	372.6	397.37	383.81	397.5	0.000302	3.56	9743.32	1122.89	0.14
1	63261	2%_Cur	23430	372.6	399.77	385.35	399.9	0.000285	3.71	11974.96	1130.38	0.13
1	63261	1%_Cur	25980	372.6	400.83	386.06	400.96	0.000281	3.8	12957.86	1133.67	0.13
1	63261	0.2%_Cur	31390	372.6	402.69	387.56	402.83	0.000287	4.03	14696.55	1139.53	0.14
1	63261	10%_Proj	22000	372.6	399.15	384.94	399.27	0.000288	3.67	11392.46	1128.43	0.13
1	63261	2%_Proj	28200	372.6	401.64	386.68	401.78	0.000282	3.89	13715.58	1136.27	0.14
1	63261	1%_Proj	31200	372.6	402.63	387.5	402.77	0.000287	4.02	14637.39	1139.34	0.14
1	63261	0.2%_Proj	37700	372.6	404.64	391.22	404.8	0.000295	4.28	16526.89	1146.5	0.14
1	61800	10%_Cur	18320	372.3	396.91	383.92	397.05	0.00033	3.78	8157.31	731.04	0.14
1	61800	2%_Cur	23430	372.3	399.3	385.57	399.47	0.000339	4.1	9700.89	746.1	0.15
1	61800	1%_Cur	25980	372.3	400.35	386.32	400.52	0.000345	4.26	10383.11	751.53	0.15
1	61800	0.2%_Cur	31390	372.3	402.17	387.23	402.38	0.000371	4.63	11582.17	760.86	0.16
1	61800	10%_Proj	22000	372.3	398.68	385.27	398.84	0.000335	4.01	9297.29	742.56	0.15
1	61800	2%_Proj	28200	372.3	401.15	386.69	401.33	0.000355	4.41	10906.62	755.61	0.15
1	61800	1%_Proj	31200	372.3	402.11	387.22	402.31	0.00037	4.62	11541.22	760.53	0.16
1	61800	0.2%_Proj	37700	372.3	404.09	388.2	404.32	0.000398	5.02	12850.23	769.43	0.16
1	61066	10%_Cur	18320	375.4	396.58	384.09	396.77	0.000457	4.03	7111.01	876.49	0.16
1	61066	2%_Cur	23430	375.4	398.97	385.95	399.18	0.00045	4.33	8555.36	1077.6	0.17
1	61066	1%_Cur	25980	375.4	400.01	386.55	400.23	0.000452	4.48	9191.12	1100.27	0.17
1	61066	0.2%_Cur	31390	375.4	401.82	387.69	402.07	0.000477	4.84	10296.58	1122.64	0.17
1	61066	10%_Proj	22000	375.4	398.35	385.23	398.55	0.00045	4.24	8178.68	953.47	0.16
1	61066	2%_Proj	28200	375.4	400.8	387.06	401.03	0.00046	4.62	9675.44	1109.63	0.17
1	61066	1%_Proj	31200	375.4	401.75	387.65	402	0.000476	4.83	10258.85	1121.84	0.17
1	61066	0.2%_Proj	37700	375.4	403.7	388.95	403.99	0.000503	5.23	11461.72	1160.21	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	60661	10%_Cur	18320	370.11	396.41	380.77	396.61	0.000312	3.74	5981.24	744.93	0.14
1	60661	2%_Cur	23430	370.11	398.75	381.97	399	0.00035	4.24	6816.02	898.25	0.15
1	60661	1%_Cur	25980	370.11	399.77	382.54	400.04	0.00037	4.48	7178.56	917.06	0.16
1	60661	0.2%_Cur	31390	370.11	401.51	383.64	401.85	0.000423	5.01	7800	950.67	0.17
1	60661	10%_Proj	22000	370.11	398.15	381.66	398.38	0.000339	4.11	6600	882.81	0.15
1	60661	2%_Proj	28200	370.11	400.53	383	400.83	0.000391	4.7	7452.17	930.99	0.16
1	60661	1%_Proj	31200	370.11	401.45	383.6	401.79	0.000421	4.99	7778.87	949.68	0.17
1	60661	0.2%_Proj	37700	370.11	403.32	384.83	403.74	0.000481	5.57	8448.4	989.15	0.18
1	60574		Bridge									
1	60485	10%_Cur	18320	370.11	395.51	381.87	395.91	0.000669	5.47	4477.13	736.78	0.2
1	60485	2%_Cur	23430	370.11	397.59	383.6	398.09	0.000766	6.22	5101.39	827.4	0.22
1	60485	1%_Cur	25980	370.11	398.47	384.39	399.03	0.000819	6.58	5364.25	876.91	0.23
1	60485	0.2%_Cur	31390	370.11	399.85	385.87	400.55	0.000968	7.41	5778.58	886.01	0.25
1	60485	10%_Proj	22000	370.11	397.06	383.16	397.53	0.000737	6.01	4942.53	801.08	0.22
1	60485	2%_Proj	28200	370.11	399.1	385.07	399.71	0.000875	6.91	5552.75	880.89	0.24
1	60485	1%_Proj	31200	370.11	399.8	385.82	400.5	0.000963	7.38	5764.7	885.64	0.25
1	60485	0.2%_Proj	37700	370.11	401.2	387.59	402.09	0.001149	8.34	6184.02	908.01	0.28
1	60172	10%_Cur	18320	371	395.11	382.64	395.64	0.000928	6.1	3829.44	729.75	0.23
1	60172	2%_Cur	23430	371	397.13	384.25	397.79	0.001052	6.9	4422.38	739.52	0.25
1	60172	1%_Cur	25980	371	397.97	385.01	398.7	0.001122	7.3	4672.51	913.29	0.26
1	60172	0.2%_Cur	31390	371	399.26	386.48	400.16	0.001326	8.22	5303.09	1112.73	0.29
1	60172	10%_Proj	22000	371	396.62	383.83	397.24	0.001015	6.68	4271.38	735.86	0.25
1	60172	2%_Proj	28200	371	398.56	385.63	399.36	0.0012	7.67	4959.91	999.19	0.27
1	60172	1%_Proj	31200	371	399.21	386.45	400.11	0.00132	8.19	5280.54	1111.95	0.29
1	60172	0.2%_Proj	37700	371	400.54	388.32	401.64	0.001532	9.13	5958.65	1148.15	0.31
1	59645	10%_Cur	18320	369.3	395.05	378.96	395.27	0.000333	3.85	5139.68	492.3	0.14
1	59645	2%_Cur	23430	369.3	397.06	380.16	397.36	0.000399	4.46	5755.91	823.83	0.16
1	59645	1%_Cur	25980	369.3	397.89	380.71	398.23	0.000435	4.77	6013.85	1204.35	0.17
1	59645	0.2%_Cur	31390	369.3	399.23	381.79	399.61	0.000478	5.17	8773.89	1375.11	0.18
1	59645	10%_Proj	22000	369.3	396.55	379.82	396.83	0.00038	4.29	5599.65	774.81	0.16
1	59645	2%_Proj	28200	369.3	398.48	381.17	398.86	0.000472	5.04	6194.29	1295.92	0.18
1	59645	1%_Proj	31200	369.3	399.18	381.75	399.56	0.000476	5.16	8728.37	1367.82	0.18
1	59645	0.2%_Proj	37700	369.3	400.55	382.95	400.99	0.000542	5.69	10102.44	1475.6	0.19
1	58759	10%_Cur	18320	367.7	394.71	378.81	394.96	0.000393	4.21	6858.24	1333.5	0.16
1	58759	2%_Cur	23430	367.7	396.74	380.29	397	0.00041	4.55	8719.23	1929.67	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	58759	1%_Cur	25980	367.7	397.57	380.95	397.85	0.000422	4.72	9492.48	1983.6	0.16
1	58759	0.2%_Cur	31390	367.7	398.95	382.27	399.2	0.000408	4.81	13872.51	2098.43	0.16
1	58759	10%_Proj	22000	367.7	396.23	379.89	396.48	0.000404	4.46	8250.22	1856.81	0.16
1	58759	2%_Proj	28200	367.7	398.15	381.51	398.44	0.000442	4.91	10026.19	2021.82	0.17
1	58759	1%_Proj	31200	367.7	398.91	382.23	399.16	0.000408	4.8	13796.35	2095.27	0.16
1	58759	0.2%_Proj	37700	367.7	400.27	383.67	400.54	0.000438	5.15	16126.54	2153.28	0.17
1	57561	10%_Cur	18320	358.4	394.73	369.05	394.77	0.000052	1.79	15537.28	2094.29	0.06
1	57561	2%_Cur	23430	358.4	396.74	370.4	396.8	0.000061	2.03	18435.66	2446.71	0.07
1	57561	1%_Cur	25980	358.4	397.58	371.01	397.64	0.000065	2.14	19638.74	2495.29	0.07
1	57561	0.2%_Cur	31390	358.4	398.93	372.19	399	0.000075	2.36	24535.66	2622.97	0.07
1	57561	10%_Proj	22000	358.4	396.24	370.04	396.29	0.000058	1.96	17705.58	2415.98	0.06
1	57561	2%_Proj	28200	358.4	398.16	371.49	398.22	0.00007	2.25	20469	2532.73	0.07
1	57561	1%_Proj	31200	358.4	398.88	372.15	398.95	0.000075	2.35	24437.54	2622.45	0.07
1	57561	0.2%_Proj	37700	358.4	400.24	373.42	400.31	0.000086	2.6	27384.18	2636.02	0.08
1	56157	10%_Cur	18320	370.9	394.41	379.91	394.61	0.00036	3.95	6727.25	1165.88	0.15
1	56157	2%_Cur	23430	370.9	396.37	381.26	396.61	0.000408	4.45	7910.38	1512.75	0.16
1	56157	1%_Cur	25980	370.9	397.17	381.87	397.44	0.000434	4.69	8406.87	1584.92	0.17
1	56157	0.2%_Cur	31390	370.9	398.44	383.04	398.77	0.000507	5.25	9191.19	1721.1	0.18
1	56157	10%_Proj	22000	370.9	395.87	380.92	396.11	0.000394	4.31	7608.69	1465.55	0.16
1	56157	2%_Proj	28200	370.9	397.71	382.36	398.01	0.000464	4.93	8742.38	1678.65	0.17
1	56157	1%_Proj	31200	370.9	398.4	382.99	398.72	0.000505	5.23	9165.02	1720.76	0.18
1	56157	0.2%_Proj	37700	370.9	399.81	384.55	400.09	0.000458	5.17	14404.08	1733.01	0.18
1	54914	10%_Cur	18320	369.9	393.66	379.31	394.03	0.000581	5.01	4496.56	815.62	0.19
1	54914	2%_Cur	23430	369.9	395.47	380.65	395.94	0.000684	5.74	5599.16	1388.04	0.21
1	54914	1%_Cur	25980	369.9	396.21	381.28	396.73	0.000728	6.04	6174	1463.94	0.22
1	54914	0.2%_Cur	31390	369.9	397.5	382.55	398	0.000731	6.27	9349.3	1514	0.22
1	54914	10%_Proj	22000	369.9	395.02	380.28	395.47	0.00065	5.52	5282.99	1314.08	0.2
1	54914	2%_Proj	28200	369.9	396.81	381.82	397.29	0.000697	6.01	8375.1	1509.04	0.21
1	54914	1%_Proj	31200	369.9	397.46	382.49	397.96	0.000729	6.25	9292.02	1513.71	0.22
1	54914	0.2%_Proj	37700	369.9	398.81	383.93	399.34	0.000771	6.65	11204.4	1520.79	0.23
1	53799	10%_Cur	18320	364.6	393.27	376.49	393.51	0.000357	4.2	7519.26	1399.18	0.15
1	53799	2%_Cur	23430	364.6	395.08	377.96	395.34	0.000393	4.63	9950.01	2059.61	0.16
1	53799	1%_Cur	25980	364.6	395.84	378.62	396.1	0.000402	4.77	11246.26	2241.97	0.16
1	53799	0.2%_Cur	31390	364.6	397.17	379.99	397.41	0.000384	4.81	15815.57	2568.43	0.16
1	53799	10%_Proj	22000	364.6	394.64	377.59	394.89	0.000384	4.52	9270.29	1778.15	0.16
1	53799	2%_Proj	28200	364.6	396.42	379.19	396.69	0.000408	4.88	12397.71	2490.92	0.16
1	53799	1%_Proj	31200	364.6	397.13	379.96	397.37	0.000384	4.81	15711.98	2566.84	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	53799	0.2%_Proj	37700	364.6	398.51	381.41	398.74	0.000383	4.96	19219.06	2610.23	0.16
1	52665	10%_Cur	18320	370.6	392.81	379.36	393.06	0.000462	4.26	6773.98	1199.12	0.17
1	52665	2%_Cur	23430	370.6	394.6	380.6	394.87	0.000489	4.64	9414.26	2180.09	0.17
1	52665	1%_Cur	25980	370.6	395.36	381.16	395.63	0.000484	4.72	11133.85	2577.34	0.17
1	52665	0.2%_Cur	31390	370.6	396.69	382.36	396.96	0.000487	4.92	14490.08	2711.3	0.18
1	52665	10%_Proj	22000	370.6	394.15	380.27	394.42	0.000488	4.57	8540.97	2009.7	0.17
1	52665	2%_Proj	28200	370.6	395.94	381.51	396.21	0.000497	4.87	12572.33	2705.61	0.18
1	52665	1%_Proj	31200	370.6	396.65	382.34	396.92	0.000488	4.92	14382.94	2710.98	0.18
1	52665	0.2%_Proj	37700	370.6	398.12	383.69	398.33	0.000418	4.74	19256.63	2741.14	0.17
1	52024	10%_Cur	18320	368.7	392.39		392.72	0.000574	4.82	5003.73	840.67	0.19
1	52024	2%_Cur	23430	368.7	394.13		394.52	0.000632	5.34	7319.01	1819.09	0.2
1	52024	1%_Cur	25980	368.7	394.87		395.28	0.000658	5.57	8828.45	2125.02	0.2
1	52024	0.2%_Cur	31390	368.7	396.22		396.62	0.000659	5.78	11767.8	2213.81	0.21
1	52024	10%_Proj	22000	368.7	393.69		394.07	0.000621	5.22	6565.08	1631.37	0.2
1	52024	2%_Proj	28200	368.7	395.46		395.87	0.000655	5.65	10096.33	2177.69	0.2
1	52024	1%_Proj	31200	368.7	396.18		396.58	0.00066	5.78	11672.14	2213.41	0.21
1	52024	0.2%_Proj	37700	368.7	397.67		398.04	0.000622	5.84	14997.44	2225.27	0.2
1	50694	10%_Cur	18320	358.9	391.78		392.1	0.000399	4.67	5702.48	1001.66	0.16
1	50694	2%_Cur	23430	358.9	393.45		393.83	0.000468	5.27	7969.41	1799.73	0.18
1	50694	1%_Cur	25980	358.9	394.18		394.57	0.000484	5.46	9372.26	1977.64	0.18
1	50694	0.2%_Cur	31390	358.9	395.53		395.93	0.00051	5.77	12216	2249.5	0.19
1	50694	10%_Proj	22000	358.9	393.03		393.39	0.000449	5.11	7270.64	1524.7	0.17
1	50694	2%_Proj	28200	358.9	394.77		395.17	0.000495	5.59	10569.64	2091.68	0.18
1	50694	1%_Proj	31200	358.9	395.48		395.89	0.000509	5.76	12118.5	2243.89	0.19
1	50694	0.2%_Proj	37700	358.9	397.01		397.4	0.00051	5.96	15625.22	2311.93	0.19
1	49376	10%_Cur	18320	365.5	390.97		391.4	0.00072	5.6	4694.91	1061.24	0.21
1	49376	2%_Cur	23430	365.5	392.58		393.04	0.000773	6.09	6920.88	1658.17	0.22
1	49376	1%_Cur	25980	365.5	393.33		393.78	0.000766	6.19	8228.28	1808.9	0.22
1	49376	0.2%_Cur	31390	365.5	394.77		395.16	0.000696	6.13	10888.29	1875.31	0.21
1	49376	10%_Proj	22000	365.5	392.16		392.62	0.000771	6.01	6254.94	1513.58	0.22
1	49376	2%_Proj	28200	365.5	393.96		394.39	0.000738	6.18	9375.89	1856.25	0.22
1	49376	1%_Proj	31200	365.5	394.72		395.12	0.000698	6.13	10803.34	1873.9	0.21
1	49376	0.2%_Proj	37700	365.5	396.3		396.66	0.000643	6.13	13882.54	2064.92	0.21
1	47944	10%_Cur	18320	361	390.51		390.73	0.000309	4	6104.27	936.29	0.14
1	47944	2%_Cur	23430	361	392.03		392.31	0.000379	4.61	7721.51	1239.55	0.16
1	47944	1%_Cur	25980	361	392.74		393.05	0.000404	4.84	8683.68	1422.84	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	47944	0.2%_Cur	31390	361	394.15		394.48	0.000433	5.18	10964.21	1711.91	0.17
1	47944	10%_Proj	22000	361	391.63		391.9	0.000363	4.47	7248.66	1115.71	0.15
1	47944	2%_Proj	28200	361	393.32		393.66	0.000434	5.09	9570.99	1664.83	0.17
1	47944	1%_Proj	31200	361	394.1		394.43	0.000433	5.17	10885.33	1709.17	0.17
1	47944	0.2%_Proj	37700	361	395.68		396.02	0.00045	5.46	13979.67	2319.02	0.17
1	46103	10%_Cur	18320	365.8	390.27		390.34	0.00018	2.73	13952.62	2865.64	0.1
1	46103	2%_Cur	23430	365.8	391.86		391.92	0.000158	2.68	18791.56	3188.23	0.1
1	46103	1%_Cur	25980	365.8	392.6		392.66	0.00015	2.67	21197.18	3330.28	0.1
1	46103	0.2%_Cur	31390	365.8	394.06		394.11	0.000136	2.65	26206.7	3583.79	0.09
1	46103	10%_Proj	22000	365.8	391.44		391.5	0.000163	2.69	17466.39	3122.92	0.1
1	46103	2%_Proj	28200	365.8	393.2		393.26	0.000148	2.7	23223.04	3427.14	0.1
1	46103	1%_Proj	31200	365.8	394.01		394.06	0.000137	2.65	26036.55	3560.89	0.09
1	46103	0.2%_Proj	37700	365.8	395.62		395.67	0.000126	2.65	32358.61	4184.57	0.09
1	44085	10%_Cur	18320	364.2	389.75		389.94	0.000404	3.9	7801.51	1854.89	0.15
1	44085	2%_Cur	23430	364.2	391.41		391.58	0.000378	3.98	11056.18	2720.82	0.15
1	44085	1%_Cur	25980	364.2	392.17		392.34	0.000372	4.04	12737.02	3247.88	0.15
1	44085	0.2%_Cur	31390	364.2	393.7		393.84	0.000323	3.94	16298.96	4889.55	0.14
1	44085	10%_Proj	22000	364.2	390.97		391.15	0.000387	3.97	10133.69	2542.58	0.15
1	44085	2%_Proj	28200	364.2	392.79		392.95	0.000356	4.02	14146.46	4227.36	0.15
1	44085	1%_Proj	31200	364.2	393.65		393.79	0.000325	3.94	16176.91	4861.88	0.14
1	44085	0.2%_Proj	37700	364.2	395.29		395.42	0.000308	4.01	20656.42	5637.08	0.14
1	42674	10%_Cur	18320	365.9	389.44		389.54	0.000263	3	10127.18	1745.81	0.12
1	42674	2%_Cur	23430	365.9	391.13		391.23	0.000251	3.11	12470.55	1955.36	0.12
1	42674	1%_Cur	25980	365.9	391.91		392	0.000247	3.16	13541.25	2836.16	0.12
1	42674	0.2%_Cur	31390	365.9	393.45		393.55	0.000238	3.26	15690.97	4027.64	0.12
1	42674	10%_Proj	22000	365.9	390.69		390.78	0.000253	3.08	11852.07	1881.21	0.12
1	42674	2%_Proj	28200	365.9	392.53		392.63	0.000245	3.21	14411.94	3514.83	0.12
1	42674	1%_Proj	31200	365.9	393.4		393.5	0.000239	3.26	15620.52	4024.39	0.12
1	42674	0.2%_Proj	37700	365.9	395.05		395.16	0.000234	3.38	17918.68	4081.78	0.12
1	41705	10%_Cur	18320	366.1	389.28		389.34	0.000147	2.16	11841.25	1477.76	0.09
1	41705	2%_Cur	23430	366.1	390.97		391.03	0.000152	2.34	14377.71	2067.13	0.1
1	41705	1%_Cur	25980	366.1	391.74		391.81	0.000154	2.42	15610.1	2805.93	0.1
1	41705	0.2%_Cur	31390	366.1	393.29		393.36	0.000153	2.54	18125.88	4355.68	0.1
1	41705	10%_Proj	22000	366.1	390.53		390.59	0.000151	2.3	13677.62	1921.53	0.09
1	41705	2%_Proj	28200	366.1	392.37		392.44	0.000154	2.48	16626.78	3351.36	0.1
1	41705	1%_Proj	31200	366.1	393.24		393.31	0.000153	2.54	18043.49	4342.23	0.1
1	41705	0.2%_Proj	37700	366.1	394.89		394.97	0.000154	2.68	20734.1	4495.64	0.1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	40323	10%_Cur	18320	364.2	388.53		388.95	0.000683	5.34	4210.88	812.24	0.22
1	40323	2%_Cur	23430	364.2	390.12		390.62	0.00077	5.99	5089.28	904.11	0.24
1	40323	1%_Cur	25980	364.2	390.85		391.39	0.000803	6.27	5493.21	927.3	0.24
1	40323	0.2%_Cur	31390	364.2	392.32		392.94	0.000853	6.76	6313.27	1140.77	0.25
1	40323	10%_Proj	22000	364.2	389.7		390.18	0.000748	5.82	4857.25	893.55	0.23
1	40323	2%_Proj	28200	364.2	391.44		392.01	0.000832	6.5	5820.41	944.9	0.25
1	40323	1%_Proj	31200	364.2	392.28		392.89	0.000851	6.74	6286.59	1131.02	0.25
1	40323	0.2%_Proj	37700	364.2	393.84		394.53	0.000906	7.28	7156.58	1518.07	0.26
1	39316	10%_Cur	18320	363.3	387.92	374.57	388.3	0.00058	5.04	3977.06	1348.92	0.2
1	39316	2%_Cur	23430	363.3	389.34	375.97	389.87	0.00073	5.93	4418.59	1568.74	0.23
1	39316	1%_Cur	25980	363.3	389.98	376.64	390.57	0.000801	6.34	4621.9	1725.75	0.24
1	39316	0.2%_Cur	31390	363.3	391.49	377.96	392.1	0.000808	6.66	6419.38	3116.12	0.24
1	39316	10%_Proj	22000	363.3	388.98	375.59	389.46	0.000689	5.69	4301.29	1512.45	0.22
1	39316	2%_Proj	28200	363.3	390.62	377.19	391.2	0.00078	6.38	5795.08	2074.35	0.24
1	39316	1%_Proj	31200	363.3	391.44	377.92	392.05	0.000807	6.64	6384.29	3072.69	0.24
1	39316	0.2%_Proj	37700	363.3	393.09	379.36	393.64	0.000738	6.65	8772.07	4426.4	0.24
1	39250		Bridge									
1	39190	10%_Cur	18320	363.3	387.78	374.45	388.1	0.000589	4.59	4077.79	1451.68	0.2
1	39190	2%_Cur	23430	363.3	389.16	375.79	389.6	0.00073	5.39	4478.28	2154.01	0.22
1	39190	1%_Cur	25980	363.3	389.74	376.39	390.25	0.000803	5.77	4659.11	2253.88	0.24
1	39190	0.2%_Cur	31390	363.3	390.9	377.64	391.44	0.00083	6.11	6538.02	2603.4	0.24
1	39190	10%_Proj	22000	363.3	388.8	375.42	389.22	0.00069	5.17	4374.26	2017.55	0.22
1	39190	2%_Proj	28200	363.3	390.21	376.91	390.78	0.000866	6.1	4806.44	2283.62	0.25
1	39190	1%_Proj	31200	363.3	390.87	377.6	391.4	0.000827	6.09	6509.43	2585.4	0.24
1	39190	0.2%_Proj	37700	363.3	392.02	379.01	392.6	0.00088	6.53	8119.41	3756.04	0.25
1	37734	10%_Cur	18320	364.5	386.5	374.15	387.04	0.000821	5.95	3574.43	1783.96	0.24
1	37734	2%_Cur	23430	364.5	387.93	375.63	388.46	0.000827	6.26	5990.97	2144.55	0.24
1	37734	1%_Cur	25980	364.5	388.5	376.31	389.05	0.000861	6.5	6680.39	2206.11	0.25
1	37734	0.2%_Cur	31390	364.5	389.61	377.7	390.19	0.000907	6.9	8126.78	2445.03	0.26
1	37734	10%_Proj	22000	364.5	387.63	375.22	388.13	0.000788	6.05	5639.39	2056.2	0.23
1	37734	2%_Proj	28200	364.5	388.96	376.88	389.52	0.000887	6.69	7267.82	2293.74	0.25
1	37734	1%_Proj	31200	364.5	389.58	377.64	390.15	0.000905	6.88	8080.63	2435.95	0.26
1	37734	0.2%_Proj	37700	364.5	390.71	379.19	391.3	0.000935	7.23	9627.65	2924.97	0.26
1	36382	10%_Cur	18320	350.3	385.88	370.81	386.1	0.000487	3.99	5949.65	1737.04	0.18
1	36382	2%_Cur	23430	350.3	387.32	372.31	387.54	0.00048	4.19	8731.31	3069.69	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	36382	1%_Cur	25980	350.3	387.87	373.02	388.1	0.000491	4.33	9655.36	3750.69	0.18
1	36382	0.2%_Cur	31390	350.3	388.92	374.43	389.18	0.000534	4.69	11823.62	4641.06	0.19
1	36382	10%_Proj	22000	350.3	386.95	371.91	387.2	0.00052	4.3	6806.51	2666.67	0.18
1	36382	2%_Proj	28200	350.3	388.32	373.6	388.55	0.000499	4.44	10518.25	4216.03	0.18
1	36382	1%_Proj	31200	350.3	388.88	374.37	389.14	0.000534	4.69	11745.45	4638.57	0.19
1	36382	0.2%_Proj	37700	350.3	390.05	375.92	390.29	0.000517	4.8	14354.83	4790.41	0.19
1	34787	10%_Cur	18320	362.5	385.41		385.52	0.000264	3.28	11034.59	2571.03	0.14
1	34787	2%_Cur	23430	362.5	386.83		386.94	0.000275	3.52	14213.76	4366.7	0.14
1	34787	1%_Cur	25980	362.5	387.39		387.5	0.000271	3.56	15574.72	4952.36	0.14
1	34787	0.2%_Cur	31390	362.5	388.45		388.55	0.000268	3.66	18202.29	6214.45	0.14
1	34787	10%_Proj	22000	362.5	386.48		386.59	0.000265	3.42	13374.45	4043.89	0.14
1	34787	2%_Proj	28200	362.5	387.84		387.95	0.000269	3.6	16692.25	5603.48	0.14
1	34787	1%_Proj	31200	362.5	388.41		388.52	0.000268	3.66	18113.97	6179.83	0.14
1	34787	0.2%_Proj	37700	362.5	389.58		389.69	0.000262	3.76	21384.93	7256.28	0.14
1	32336	10%_Cur	18320	360.3	384.69		384.89	0.000319	3.89	8095.47	2098.15	0.15
1	32336	2%_Cur	23430	360.3	386.13		386.33	0.000324	4.11	11060.04	3900.65	0.16
1	32336	1%_Cur	25980	360.3	386.7		386.9	0.000326	4.19	12285.77	4700.84	0.16
1	32336	0.2%_Cur	31390	360.3	387.78		387.97	0.000332	4.37	14616.24	5732.81	0.16
1	32336	10%_Proj	22000	360.3	385.78		385.98	0.000324	4.06	10308.03	3407.76	0.16
1	32336	2%_Proj	28200	360.3	387.17		387.36	0.000328	4.26	13290.88	5219.51	0.16
1	32336	1%_Proj	31200	360.3	387.74		387.94	0.000332	4.36	14538.39	5694.85	0.16
1	32336	0.2%_Proj	37700	360.3	388.9		389.11	0.000353	4.65	17739.94	7730.48	0.17
1	30004	10%_Cur	18320	365	383.99	373.53	384.13	0.000352	3.38	7348.15	3868.42	0.15
1	30004	2%_Cur	23430	365	385.32	374.83	385.51	0.000426	3.94	9320.01	9727.8	0.17
1	30004	1%_Cur	25980	365	385.88	375.35	386.08	0.000437	4.08	10338.92	11000.74	0.17
1	30004	0.2%_Cur	31390	365	386.93	376.21	387.14	0.000454	4.32	12370.44	12277.66	0.18
1	30004	10%_Proj	22000	365	384.97	374.45	385.16	0.000422	3.86	8733.44	7923.59	0.17
1	30004	2%_Proj	28200	365	386.34	375.7	386.54	0.000444	4.18	11208.8	11765.26	0.18
1	30004	1%_Proj	31200	365	386.9	376.18	387.11	0.000454	4.31	12301.81	12260.75	0.18
1	30004	0.2%_Proj	37700	365	388.03	377.08	388.25	0.000469	4.56	14535.75	12625.4	0.18
1	27852	10%_Cur	18320	366.3	383.14		383.3	0.000413	3.57	7303.1	2919.26	0.16
1	27852	2%_Cur	23430	366.3	384.33		384.54	0.000472	4.02	9458.5	7116.29	0.18
1	27852	1%_Cur	25980	366.3	384.89		385.1	0.000468	4.1	10592.18	9342.27	0.18
1	27852	0.2%_Cur	31390	366.3	385.94		386.14	0.000465	4.26	12724.66	11303.19	0.18
1	27852	10%_Proj	22000	366.3	384.01		384.2	0.000461	3.92	8822.81	5376.79	0.18
1	27852	2%_Proj	28200	366.3	385.35		385.55	0.000465	4.16	11524.55	10433.25	0.18
1	27852	1%_Proj	31200	366.3	385.9		386.11	0.000466	4.26	12652.63	11260.14	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	27852	0.2%_Proj	37700	366.3	387.02		387.23	0.000467	4.44	14994.23	11935.37	0.18
1	26395	10%_Cur	18320	362	382.66		382.77	0.000331	3.21	9383.53	3543.16	0.15
1	26395	2%_Cur	23430	362	383.81		383.94	0.000369	3.56	11230.9	7846.75	0.16
1	26395	1%_Cur	25980	362	384.34		384.48	0.0004	3.79	12308.56	9822.36	0.17
1	26395	0.2%_Cur	31390	362	385.36		385.52	0.000422	4.05	14625.92	11427	0.17
1	26395	10%_Proj	22000	362	383.48		383.61	0.000365	3.49	10671.82	6404.94	0.16
1	26395	2%_Proj	28200	362	384.77		384.93	0.000428	3.99	13274.11	10805.6	0.17
1	26395	1%_Proj	31200	362	385.33		385.49	0.000423	4.05	14544.8	11400.06	0.17
1	26395	0.2%_Proj	37700	362	386.47		386.62	0.000407	4.14	17132.95	11958.47	0.17
1	24785	10%_Cur	18320	362.4	382.38		382.42	0.000147	2.18	15500.84	6747.85	0.1
1	24785	2%_Cur	23430	362.4	383.49		383.54	0.000167	2.44	18205.98	8747.53	0.11
1	24785	1%_Cur	25980	362.4	384.01		384.06	0.000169	2.5	19513.83	9046.17	0.11
1	24785	0.2%_Cur	31390	362.4	385.03		385.08	0.000175	2.65	22080.42	9335.87	0.11
1	24785	10%_Proj	22000	362.4	383.17		383.22	0.000167	2.4	17397.54	8335.28	0.11
1	24785	2%_Proj	28200	362.4	384.44		384.49	0.000171	2.56	20584.9	9193.19	0.11
1	24785	1%_Proj	31200	362.4	384.99		385.05	0.000175	2.64	21989.88	9328.04	0.11
1	24785	0.2%_Proj	37700	362.4	386.13		386.19	0.00018	2.79	24931.37	9493.1	0.11
1	23901	10%_Cur	18320	362.1	382.14		382.25	0.000264	3.16	10130.67	5855.75	0.14
1	23901	2%_Cur	23430	362.1	383.22		383.35	0.000305	3.53	12220.2	7694.93	0.15
1	23901	1%_Cur	25980	362.1	383.73		383.87	0.000312	3.64	13251.61	8030.71	0.15
1	23901	0.2%_Cur	31390	362.1	384.74		384.89	0.000322	3.84	15290.52	9267.51	0.15
1	23901	10%_Proj	22000	362.1	382.89		383.03	0.000302	3.48	11582.67	7422.15	0.15
1	23901	2%_Proj	28200	362.1	384.16		384.3	0.000317	3.73	14103.35	8516.15	0.15
1	23901	1%_Proj	31200	362.1	384.71		384.85	0.000322	3.83	15218.64	9243.47	0.15
1	23901	0.2%_Proj	37700	362.1	385.84		385.99	0.000328	4.02	17533.44	10399.32	0.16
1	22770	10%_Cur	18320	364.9	381.95		382	0.000178	2.3	12863.47	7036.44	0.11
1	22770	2%_Cur	23430	364.9	382.99		383.06	0.000222	2.69	14897.96	9410.41	0.12
1	22770	1%_Cur	25980	364.9	383.5		383.57	0.000232	2.82	16019.04	10068.4	0.13
1	22770	0.2%_Cur	31390	364.9	384.51		384.58	0.00024	2.98	18271.92	10604.03	0.13
1	22770	10%_Proj	22000	364.9	382.69		382.75	0.000205	2.55	14235.44	9044.63	0.12
1	22770	2%_Proj	28200	364.9	383.92		384	0.000236	2.89	16958.5	10333.25	0.13
1	22770	1%_Proj	31200	364.9	384.47		384.55	0.00024	2.98	18192.04	10589.73	0.13
1	22770	0.2%_Proj	37700	364.9	385.6		385.68	0.000244	3.14	20744.84	10928.83	0.13
1	21592	10%_Cur	18320	350.2	381.54		381.76	0.000427	4.28	8751.91	7637.64	0.19
1	21592	2%_Cur	23430	350.2	382.53		382.78	0.000478	4.71	11055.79	9725.7	0.2
1	21592	1%_Cur	25980	350.2	383.05		383.29	0.000475	4.79	12364.75	10339.29	0.2

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	21592	0.2%_Cur	31390	350.2	384.09		384.32	0.000457	4.88	14987.19	10942.77	0.2
1	21592	10%_Proj	22000	350.2	382.23		382.48	0.000472	4.63	10342.06	9386.87	0.2
1	21592	2%_Proj	28200	350.2	383.49		383.72	0.000468	4.83	13460.67	10545.45	0.2
1	21592	1%_Proj	31200	350.2	384.05		384.28	0.000458	4.88	14893.95	10909.8	0.2
1	21592	0.2%_Proj	37700	350.2	385.21		385.43	0.000436	4.95	17832.05	11214.33	0.2
1	20191	10%_Cur	18320	353.3	381.45		381.5	0.00009	2.28	17941.83	10483.6	0.09
1	20191	2%_Cur	23430	353.3	382.43		382.49	0.000106	2.56	20567.21	11172.02	0.1
1	20191	1%_Cur	25980	353.3	382.94		383	0.000111	2.66	21940.41	11260.69	0.1
1	20191	0.2%_Cur	31390	353.3	383.96		384.03	0.000119	2.85	24677.31	11610.95	0.11
1	20191	10%_Proj	22000	353.3	382.13		382.19	0.000103	2.5	19773.67	10974.41	0.1
1	20191	2%_Proj	28200	353.3	383.37		383.43	0.000114	2.74	23082.46	11333.94	0.1
1	20191	1%_Proj	31200	353.3	383.92		383.99	0.000119	2.84	24579.55	11591.95	0.11
1	20191	0.2%_Proj	37700	353.3	385.07		385.14	0.000126	3.03	27659.56	12160.55	0.11
1	18663	10%_Cur	18320	357.8	381.04		381.24	0.000441	4.03	8567.66	10223.24	0.19
1	18663	2%_Cur	23430	357.8	381.96		382.19	0.0005	4.47	10343.15	10980.02	0.2
1	18663	1%_Cur	25980	357.8	382.46		382.69	0.000504	4.59	11338.03	11220.11	0.2
1	18663	0.2%_Cur	31390	357.8	383.47		383.71	0.000505	4.79	13338.73	11795.46	0.21
1	18663	10%_Proj	22000	357.8	381.67		381.9	0.000496	4.4	9772.7	10820.72	0.2
1	18663	2%_Proj	28200	357.8	382.88		383.12	0.000506	4.68	12170.22	11584.55	0.21
1	18663	1%_Proj	31200	357.8	383.44		383.67	0.000505	4.78	13266.37	11790.35	0.21
1	18663	0.2%_Proj	37700	357.8	384.58		384.81	0.000498	4.96	15530.99	12009.63	0.21
1	16739	10%_Cur	18320	362.3	380.45		380.57	0.000287	3.16	11177.59	11286.9	0.15
1	16739	2%_Cur	23430	362.3	381.31		381.44	0.000318	3.47	13421.32	12167.7	0.16
1	16739	1%_Cur	25980	362.3	381.83		381.95	0.000315	3.53	14757.12	12306.58	0.16
1	16739	0.2%_Cur	31390	362.3	382.86		382.98	0.000305	3.64	17449.87	12541.62	0.16
1	16739	10%_Proj	22000	362.3	381.02		381.15	0.000319	3.43	12658.9	12052.92	0.16
1	16739	2%_Proj	28200	362.3	382.26		382.38	0.000312	3.58	15875.04	12414.87	0.16
1	16739	1%_Proj	31200	362.3	382.82		382.94	0.000306	3.64	17350.77	12533.23	0.16
1	16739	0.2%_Proj	37700	362.3	383.99		384.11	0.000293	3.73	20406.83	12794.96	0.16
1	14949	10%_Cur	18320	360.7	379.69	371.77	379.95	0.000462	4.64	7441.52	13305.15	0.22
1	14949	2%_Cur	23430	360.7	380.59	372.92	380.82	0.000436	4.7	11677.41	13921.66	0.21
1	14949	1%_Cur	25980	360.7	381.16	373.44	381.37	0.000408	4.66	13333.26	13994.37	0.21
1	14949	0.2%_Cur	31390	360.7	382.28	374.62	382.46	0.000356	4.56	16654.94	14088.71	0.2
1	14949	10%_Proj	22000	360.7	380.27	372.61	380.51	0.000453	4.72	10732.15	13873.36	0.22
1	14949	2%_Proj	28200	360.7	381.63	373.91	381.82	0.000385	4.62	14719.61	14022.36	0.2
1	14949	1%_Proj	31200	360.7	382.24	374.59	382.42	0.000358	4.56	16532.07	14084.44	0.2
1	14949	0.2%_Proj	37700	360.7	383.5	375.85	383.65	0.000313	4.48	20223.46	14260.33	0.19

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	13445	10%_Cur	18320	360	379.22	371.7	379.36	0.000317	3.59	9708.2	12586.94	0.18
1	13445	2%_Cur	23430	360	380.21	373.19	380.32	0.00028	3.55	14399.1	13771.54	0.17
1	13445	1%_Cur	25980	360	380.79	373.59	380.9	0.000265	3.55	16010.44	13979.04	0.16
1	13445	0.2%_Cur	31390	360	381.96	374.34	382.06	0.000239	3.55	19226.62	14122.79	0.16
1	13445	10%_Proj	22000	360	379.87	372.7	379.99	0.00029	3.55	13469.69	13569.49	0.17
1	13445	2%_Proj	28200	360	381.28	373.9	381.39	0.000254	3.55	17355.17	14050.44	0.16
1	13445	1%_Proj	31200	360	381.92	374.32	382.02	0.000241	3.55	19107.03	14116.91	0.16
1	13445	0.2%_Proj	37700	360	383.2	375.1	383.3	0.000219	3.58	22649.92	14209.87	0.15
1	12366	10%_Cur	18320	358.7	378.92	368.19	379.07	0.000216	3.19	7612.31	11652.11	0.15
1	12366	2%_Cur	23430	358.7	379.87	369.08	380.03	0.000233	3.46	11272.71	12699.78	0.16
1	12366	1%_Cur	25980	358.7	380.45	369.47	380.62	0.000231	3.53	12812.64	13027	0.16
1	12366	0.2%_Cur	31390	358.7	381.63	370.24	381.79	0.000223	3.64	15912.4	13521.61	0.15
1	12366	10%_Proj	22000	358.7	379.53	368.84	379.69	0.000232	3.41	10398.37	12509.1	0.15
1	12366	2%_Proj	28200	358.7	380.95	369.8	381.11	0.000228	3.58	14103.05	13237.53	0.16
1	12366	1%_Proj	31200	358.7	381.59	370.22	381.75	0.000223	3.64	15795.06	13518.04	0.15
1	12366	0.2%_Proj	37700	358.7	382.93	371.05	383.06	0.000189	3.52	21052.46	13714.62	0.14
1	12300		Bridge									
1	12274	10%_Cur	18320	358.7	378.89	368.06	379.03	0.000211	3.11	7900.77	11945.46	0.15
1	12274	2%_Cur	23430	358.7	379.8	369.25	379.95	0.000227	3.37	11494.78	12497.59	0.15
1	12274	1%_Cur	25980	358.7	380.39	369.66	380.54	0.000225	3.44	13022.88	12710.07	0.15
1	12274	0.2%_Cur	31390	358.7	381.56	370.46	381.71	0.000215	3.53	16462.79	12915.77	0.15
1	12274	10%_Proj	22000	358.7	379.47	369.01	379.62	0.000226	3.31	10631.79	12359.85	0.15
1	12274	2%_Proj	28200	358.7	380.88	370.01	381.03	0.000221	3.48	14551.15	12829.69	0.15
1	12274	1%_Proj	31200	358.7	381.52	370.44	381.67	0.000216	3.53	16338.17	12909.27	0.15
1	12274	0.2%_Proj	37700	358.7	382.87	371.3	383.01	0.0002	3.58	20100.74	13476.72	0.15
1	11328	10%_Cur	18390	340.8	378.43	361.18	378.73	0.000357	4.47	5657.31	12539.83	0.19
1	11328	2%_Cur	23520	340.8	379.55	363.09	379.73	0.000257	3.96	13021.61	12982.55	0.16
1	11328	1%_Cur	26080	340.8	380.16	363.96	380.32	0.000248	3.97	14829.93	13020.34	0.16
1	11328	0.2%_Cur	31511	340.8	381.37	365.65	381.52	0.000227	3.96	18460.2	13166.07	0.15
1	11328	10%_Proj	22100	340.8	379.21	362.59	379.39	0.000262	3.94	11988.14	12964.12	0.16
1	11328	2%_Proj	28300	340.8	380.66	364.68	380.82	0.000239	3.97	16344.59	13030.27	0.16
1	11328	1%_Proj	31300	340.8	381.32	365.6	381.47	0.000228	3.96	18323.52	13161.61	0.15
1	11328	0.2%_Proj	37900	340.8	382.7	367.49	382.83	0.000207	3.94	22439.65	13284.3	0.15
1	10809	10%_Cur	18390	359.1	378.36	370.46	378.48	0.000269	3.31	10314.57	12286.57	0.16
1	10809	2%_Cur	23520	359.1	379.47	371.71	379.56	0.000213	3.12	15073.49	12605.64	0.15

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	10809	1%_Cur	26080	359.1	380.07	372.12	380.16	0.000205	3.14	16587.13	12695.67	0.15
1	10809	0.2%_Cur	31511	359.1	381.28	373.19	381.37	0.000188	3.18	19640.83	12807.24	0.14
1	10809	10%_Proj	22100	359.1	379.13	371.45	379.21	0.000218	3.1	14212.24	12554.78	0.15
1	10809	2%_Proj	28300	359.1	380.58	372.65	380.66	0.000198	3.16	17860.73	12767.92	0.14
1	10809	1%_Proj	31300	359.1	381.24	373.16	381.32	0.000189	3.18	19525.84	12804.7	0.14
1	10809	0.2%_Proj	37900	359.1	382.61	374.14	382.69	0.000173	3.22	22989.73	12954.83	0.14
1	8575	10%_Cur	18390	351.1	377.83	368.65	377.95	0.000241	3.33	10982.47	11878.24	0.16
1	8575	2%_Cur	23520	351.1	379.14	369.83	379.2	0.00015	2.79	19635.08	11962.14	0.12
1	8575	1%_Cur	26080	351.1	379.76	370.3	379.82	0.000141	2.77	21741.44	11976.68	0.12
1	8575	0.2%_Cur	31511	351.1	381.01	371.21	381.07	0.000126	2.76	25947.37	12033.73	0.12
1	8575	10%_Proj	22100	351.1	378.78	369.54	378.85	0.000156	2.8	18426.35	11946.34	0.13
1	8575	2%_Proj	28300	351.1	380.29	370.68	380.34	0.000134	2.76	23499.97	12000.55	0.12
1	8575	1%_Proj	31300	351.1	380.96	371.18	381.02	0.000126	2.76	25789.6	12031.59	0.12
1	8575	0.2%_Proj	37900	351.1	382.37	372.33	382.42	0.000114	2.76	30524.87	12360.29	0.11
1	5278	10%_Cur	18390	356.2	377.38		377.43	0.000128	2.23	17149.79	6648.57	0.11
1	5278	2%_Cur	23520	356.2	378.78		378.83	0.000113	2.25	21488.79	7154.98	0.11
1	5278	1%_Cur	26080	356.2	379.43		379.47	0.000108	2.27	23482.8	7284.51	0.11
1	5278	0.2%_Cur	31511	356.2	380.71		380.75	0.000101	2.32	27437.37	7485.34	0.1
1	5278	10%_Proj	22100	356.2	378.41		378.45	0.000117	2.25	20339.17	7042.44	0.11
1	5278	2%_Proj	28300	356.2	379.97		380.01	0.000105	2.29	25140.14	7374.89	0.1
1	5278	1%_Proj	31300	356.2	380.66		380.7	0.000101	2.31	27289.54	7480.91	0.1
1	5278	0.2%_Proj	37900	356.2	382.09		382.13	0.000094	2.37	31712.49	7601.69	0.1
1	2988	10%_Cur	18390	349	377.08		377.15	0.000176	2.89	13605.94	6179.64	0.13
1	2988	2%_Cur	23520	349	378.52		378.59	0.000164	2.96	16806.61	6658.51	0.13
1	2988	1%_Cur	26080	349	379.17		379.24	0.00016	3.01	18267.04	6731.49	0.13
1	2988	0.2%_Cur	31511	349	380.47		380.54	0.000153	3.09	21151.29	6765.77	0.13
1	2988	10%_Proj	22100	349	378.14		378.21	0.000166	2.94	15962.13	6587.5	0.13
1	2988	2%_Proj	28300	349	379.72		379.79	0.000157	3.04	19477.46	6737.61	0.13
1	2988	1%_Proj	31300	349	380.42		380.49	0.000153	3.09	21043.64	6765.11	0.13
1	2988	0.2%_Proj	37900	349	381.86		381.94	0.000148	3.19	24256.47	6784.99	0.13
1	2706	10%_Cur	18390	354.3	377		377.1	0.000181	3.22	12180.46	5710.47	0.14
1	2706	2%_Cur	23520	354.3	378.44		378.54	0.000175	3.34	15113.76	5908.8	0.14
1	2706	1%_Cur	26080	354.3	379.1		379.2	0.000173	3.4	16452.01	5995.97	0.14
1	2706	0.2%_Cur	31511	354.3	380.4		380.5	0.00017	3.52	19094.51	6045.9	0.14
1	2706	10%_Proj	22100	354.3	378.06		378.16	0.000177	3.31	14339.88	5866.06	0.14
1	2706	2%_Proj	28300	354.3	379.64		379.74	0.000172	3.45	17561.05	6035.11	0.14
1	2706	1%_Proj	31300	354.3	380.35		380.45	0.00017	3.51	18995.95	6045.9	0.14

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	2706	0.2%_Proj	37900	354.3	381.79		381.89	0.000167	3.64	21938.5	6045.9	0.14
1	1434	10%_Cur	18390	352.2	376.78	364.31	376.87	0.000175	2.82	12455.46	3323.02	0.13
1	1434	2%_Cur	23520	352.2	378.22	365.78	378.31	0.000175	3.01	15092.11	3744.2	0.13
1	1434	1%_Cur	26080	352.2	378.88	366.5	378.97	0.000176	3.1	16294.74	3823.51	0.14
1	1434	0.2%_Cur	31511	352.2	380.17	367.98	380.27	0.000176	3.27	18669.39	3855.1	0.14
1	1434	10%_Proj	22100	352.2	377.84	365.39	377.93	0.000175	2.96	14396.69	3650.2	0.13
1	1434	2%_Proj	28300	352.2	379.42	367.1	379.52	0.000176	3.17	17291.41	3852.86	0.14
1	1434	1%_Proj	31300	352.2	380.13	367.92	380.23	0.000176	3.26	18580.85	3855.1	0.14
1	1434	0.2%_Proj	37900	352.2	381.57	371.32	381.67	0.000177	3.45	21220.74	3855.1	0.14
1	105	10%_Cur	18390	355.6	376.43	366.66	376.59	0.0003	3.6	8798.26	1810.22	0.17
1	105	2%_Cur	23520	355.6	377.86	367.76	378.03	0.0003	3.85	10883.51	1820.89	0.17
1	105	1%_Cur	26080	355.6	378.52	368.3	378.69	0.0003	3.96	11834.1	1825.48	0.18
1	105	0.2%_Cur	31511	355.6	379.81	369.33	380	0.0003	4.17	13710.33	1829.58	0.18
1	105	10%_Proj	22100	355.6	377.49	367.47	377.65	0.0003	3.78	10333.85	1819.15	0.17
1	105	2%_Proj	28300	355.6	379.06	368.65	379.24	0.0003	4.05	12621.73	1827.12	0.18
1	105	1%_Proj	31300	355.6	379.76	369.21	379.95	0.0003	4.16	13640.42	1829.42	0.18
1	105	0.2%_Proj	37900	355.6	381.2	371.64	381.4	0.0003	4.4	15724.54	1833.98	0.18

Plan: Alt 3-1 Flows: Current and Projected

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	72237	10%_Cur	17900	389.7	403.86		404.22	0.001845	6.1	6445.89	1708.84	0.31
1	72237	2%_Cur	22890	389.7	404.55		405.01	0.002313	7.08	7491.22	1971.3	0.35
1	72237	1%_Cur	25380	389.7	404.91		405.39	0.002411	7.37	8083.87	2049.34	0.36
1	72237	0.2%_Cur	30670	389.7	405.82		406.28	0.002266	7.47	9603.7	2118.36	0.35
1	72237	10%_Proj	21500	389.7	404.38		404.82	0.002209	6.86	7232.04	1920.14	0.34
1	72237	2%_Proj	27500	389.7	405.24		405.72	0.002392	7.46	8644.85	2066.57	0.36
1	72237	1%_Proj	30500	389.7	405.79		406.24	0.002277	7.47	9546.21	2115.8	0.35
1	72237	0.2%_Proj	36900	389.7	407.14		407.53	0.00188	7.22	11788.21	2389.73	0.32
1	70873	10%_Cur	17900	388.5	399.36	396.77	400.22	0.005341	8.24	3896.49	2304.98	0.5
1	70873	2%_Cur	22890	388.5	401.17		401.62	0.002753	6.72	7392.26	3255.55	0.37
1	70873	1%_Cur	25380	388.5	402.1		402.43	0.001966	6.01	9385.85	3763.55	0.32
1	70873	0.2%_Cur	30670	388.5	403.84		404.05	0.001203	5.18	13117.07	3929.83	0.25
1	70873	10%_Proj	21500	388.5	400.64		401.19	0.003358	7.17	6287.08	2877.82	0.4
1	70873	2%_Proj	27500	388.5	402.84		403.11	0.001555	5.58	10980.47	3912.16	0.28
1	70873	1%_Proj	30500	388.5	403.78		404	0.001222	5.2	12991.03	3928.97	0.25
1	70873	0.2%_Proj	36900	388.5	405.72		405.88	0.000816	4.66	17139.82	3948.99	0.21
1	69284	10%_Cur	17900	386	398.38		398.42	0.00042	2.67	16137.01	4766.6	0.14
1	69284	2%_Cur	22890	386	400.62		400.65	0.000232	2.26	23041.52	5000.53	0.11
1	69284	1%_Cur	25380	386	401.63		401.66	0.000192	2.16	26168.62	5285.09	0.1
1	69284	0.2%_Cur	30670	386	403.47		403.5	0.000151	2.08	31835.58	5502.06	0.09
1	69284	10%_Proj	21500	386	400.02		400.05	0.000265	2.34	21210.07	4961.87	0.12
1	69284	2%_Proj	27500	386	402.43		402.45	0.00017	2.11	28615.12	5417.52	0.1
1	69284	1%_Proj	30500	386	403.41		403.43	0.000152	2.08	31644.63	5499.64	0.09
1	69284	0.2%_Proj	36900	386	405.42		405.44	0.000126	2.05	37835.27	5730.93	0.09
1	67081	10%_Cur	17900	379.7	398.14		398.15	0.000072	1.46	27735.04	4227.02	0.06
1	67081	2%_Cur	22890	379.7	400.45		400.46	0.000057	1.42	35266.16	4260.47	0.06
1	67081	1%_Cur	25380	379.7	401.48		401.5	0.000053	1.42	38634.46	4264.98	0.06
1	67081	0.2%_Cur	30670	379.7	403.34		403.36	0.000049	1.45	44692.55	4272.31	0.06
1	67081	10%_Proj	21500	379.7	399.84		399.86	0.00006	1.42	33283.96	4255.26	0.06
1	67081	2%_Proj	27500	379.7	402.29		402.3	0.000051	1.43	41256.83	4268.23	0.06
1	67081	1%_Proj	30500	379.7	403.28		403.29	0.000049	1.45	44488.36	4272.1	0.06
1	67081	0.2%_Proj	36900	379.7	405.3		405.32	0.000046	1.5	51082.5	4278.76	0.05
1	65654	10%_Cur	17900	377.1	397.92		397.98	0.000229	2.77	13824.82	1783.31	0.12
1	65654	2%_Cur	22890	377.1	400.27		400.32	0.000194	2.78	17278.86	1792.51	0.11
1	65654	1%_Cur	25380	377.1	401.31		401.36	0.000185	2.8	18815.79	1796.35	0.11

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	65654	0.2%_Cur	30670	377.1	403.17		403.23	0.000179	2.92	21578.41	1827.36	0.11
1	65654	10%_Proj	21500	377.1	399.65		399.71	0.000201	2.77	16372.64	1790.25	0.11
1	65654	2%_Proj	27500	377.1	402.12		402.17	0.00018	2.83	20009.18	1799.33	0.11
1	65654	1%_Proj	30500	377.1	403.11		403.16	0.00018	2.91	21483.96	1826.52	0.11
1	65654	0.2%_Proj	36900	377.1	405.13		405.19	0.000176	3.05	24559.96	1867.97	0.11
1	64737	10%_Cur	17900	376.9	397.73		397.79	0.000246	2.91	13188.68	1564.35	0.12
1	64737	2%_Cur	22890	376.9	400.1		400.15	0.000219	2.98	16066.48	1576.66	0.12
1	64737	1%_Cur	25380	376.9	401.15		401.2	0.000213	3.04	17343.34	1581.39	0.12
1	64737	0.2%_Cur	30670	376.9	403.01		403.07	0.000211	3.2	19621.17	1590.64	0.12
1	64737	10%_Proj	21500	376.9	399.48		399.53	0.000224	2.96	15312.73	1573.92	0.12
1	64737	2%_Proj	27500	376.9	401.96		402.02	0.00021	3.09	18333.06	1585.34	0.12
1	64737	1%_Proj	30500	376.9	402.95		403.01	0.000212	3.19	19543.87	1590.32	0.12
1	64737	0.2%_Proj	36900	376.9	404.97		405.04	0.000213	3.39	22024.44	1599.98	0.12
1	63261	10%_Cur	18320	372.6	397.37	383.81	397.5	0.000302	3.56	9742.39	1122.89	0.14
1	63261	2%_Cur	23430	372.6	399.77	385.35	399.9	0.000285	3.71	11974.05	1130.38	0.13
1	63261	1%_Cur	25980	372.6	400.83	386.06	400.96	0.000281	3.8	12957.3	1133.67	0.13
1	63261	0.2%_Cur	31390	372.6	402.69	387.56	402.83	0.000287	4.03	14695.75	1139.53	0.14
1	63261	10%_Proj	22000	372.6	399.14	384.94	399.27	0.000288	3.67	11392.1	1128.43	0.13
1	63261	2%_Proj	28200	372.6	401.64	386.68	401.77	0.000282	3.89	13714.82	1136.26	0.14
1	63261	1%_Proj	31200	372.6	402.62	387.5	402.77	0.000287	4.02	14636.74	1139.34	0.14
1	63261	0.2%_Proj	37700	372.6	404.64	391.22	404.8	0.000295	4.28	16525.78	1146.49	0.14
1	61800	10%_Cur	18320	372.3	396.91	383.92	397.05	0.00033	3.78	8156.59	731.03	0.14
1	61800	2%_Cur	23430	372.3	399.3	385.57	399.47	0.000339	4.1	9700.19	746.1	0.15
1	61800	1%_Cur	25980	372.3	400.35	386.32	400.52	0.000345	4.26	10382.67	751.52	0.15
1	61800	0.2%_Cur	31390	372.3	402.17	387.23	402.38	0.000371	4.63	11581.59	760.86	0.16
1	61800	10%_Proj	22000	372.3	398.68	385.27	398.84	0.000335	4.01	9297.01	742.56	0.15
1	61800	2%_Proj	28200	372.3	401.14	386.69	401.33	0.000355	4.41	10906.04	755.61	0.15
1	61800	1%_Proj	31200	372.3	402.11	387.22	402.31	0.00037	4.62	11540.7	760.53	0.16
1	61800	0.2%_Proj	37700	372.3	404.08	388.2	404.32	0.000398	5.02	12849.36	769.43	0.16
1	61066	10%_Cur	18320	375.4	396.58	384.09	396.77	0.000457	4.03	7110.3	876.01	0.16
1	61066	2%_Cur	23430	375.4	398.97	385.95	399.18	0.00045	4.33	8554.67	1076.61	0.17
1	61066	1%_Cur	25980	375.4	400.01	386.55	400.23	0.000452	4.48	9190.68	1100.26	0.17
1	61066	0.2%_Cur	31390	375.4	401.81	387.69	402.06	0.000477	4.84	10295.99	1122.62	0.17
1	61066	10%_Proj	22000	375.4	398.35	385.23	398.55	0.00045	4.24	8178.39	953.46	0.16
1	61066	2%_Proj	28200	375.4	400.8	387.06	401.03	0.00046	4.62	9674.89	1109.62	0.17
1	61066	1%_Proj	31200	375.4	401.75	387.65	402	0.000476	4.83	10258.31	1121.82	0.17
1	61066	0.2%_Proj	37700	375.4	403.7	388.95	403.99	0.000503	5.23	11460.85	1160.19	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	60661	10%_Cur	18320	370.11	396.41	380.77	396.61	0.000312	3.74	5980.8	744.89	0.14
1	60661	2%_Cur	23430	370.11	398.75	381.97	399	0.000351	4.24	6815.61	898.22	0.15
1	60661	1%_Cur	25980	370.11	399.77	382.54	400.04	0.00037	4.48	7178.3	917.05	0.16
1	60661	0.2%_Cur	31390	370.11	401.51	383.64	401.85	0.000423	5.01	7799.66	950.66	0.17
1	60661	10%_Proj	22000	370.11	398.14	381.66	398.38	0.000339	4.11	6599.84	882.79	0.15
1	60661	2%_Proj	28200	370.11	400.53	383	400.83	0.000391	4.7	7451.84	930.97	0.16
1	60661	1%_Proj	31200	370.11	401.45	383.6	401.79	0.000422	4.99	7778.55	949.67	0.17
1	60661	0.2%_Proj	37700	370.11	403.32	384.83	403.74	0.000481	5.57	8447.89	989.12	0.18
1	60574		Bridge									
1	60485	10%_Cur	18320	370.11	395.5	381.87	395.9	0.00067	5.47	4476.71	736.73	0.2
1	60485	2%_Cur	23430	370.11	397.59	383.6	398.09	0.000766	6.22	5100.98	827.33	0.22
1	60485	1%_Cur	25980	370.11	398.47	384.39	399.03	0.000819	6.58	5363.96	876.9	0.23
1	60485	0.2%_Cur	31390	370.11	399.85	385.87	400.55	0.000968	7.41	5778.2	886	0.25
1	60485	10%_Proj	22000	370.11	397.06	383.16	397.53	0.000737	6.01	4942.37	801.06	0.22
1	60485	2%_Proj	28200	370.11	399.1	385.07	399.71	0.000875	6.91	5552.4	880.88	0.24
1	60485	1%_Proj	31200	370.11	399.8	385.82	400.5	0.000963	7.38	5764.37	885.63	0.25
1	60485	0.2%_Proj	37700	370.11	401.2	387.59	402.08	0.001149	8.34	6183.46	907.97	0.28
1	60172	10%_Cur	18320	371	395.11	382.64	395.63	0.000929	6.1	3829.01	729.75	0.23
1	60172	2%_Cur	23430	371	397.13	384.25	397.78	0.001053	6.9	4421.94	739.31	0.25
1	60172	1%_Cur	25980	371	397.97	385.01	398.7	0.001122	7.3	4672.2	913.21	0.26
1	60172	0.2%_Cur	31390	371	399.25	386.48	400.16	0.001326	8.22	5302.35	1112.71	0.29
1	60172	10%_Proj	22000	371	396.62	383.83	397.24	0.001015	6.68	4271.21	735.85	0.25
1	60172	2%_Proj	28200	371	398.56	385.63	399.36	0.0012	7.67	4959.38	999	0.27
1	60172	1%_Proj	31200	371	399.21	386.45	400.11	0.001321	8.19	5279.89	1111.93	0.29
1	60172	0.2%_Proj	37700	371	400.54	388.32	401.63	0.001533	9.14	5957.53	1148.1	0.31
1	59645	10%_Cur	18320	369.3	395.04	378.96	395.27	0.000333	3.85	5139.21	491.74	0.14
1	59645	2%_Cur	23430	369.3	397.05	380.16	397.36	0.0004	4.47	5755.45	823.03	0.16
1	59645	1%_Cur	25980	369.3	397.89	380.71	398.23	0.000435	4.77	6013.53	1204.15	0.17
1	59645	0.2%_Cur	31390	369.3	399.23	381.79	399.61	0.000478	5.17	8772.38	1374.88	0.18
1	59645	10%_Proj	22000	369.3	396.55	379.82	396.83	0.00038	4.29	5599.49	774.75	0.16
1	59645	2%_Proj	28200	369.3	398.48	381.17	398.86	0.000472	5.04	6193.91	1295.74	0.18
1	59645	1%_Proj	31200	369.3	399.18	381.75	399.56	0.000476	5.16	8727.05	1367.73	0.18
1	59645	0.2%_Proj	37700	369.3	400.54	382.95	400.99	0.000542	5.69	10100.19	1475.53	0.19
1	58759	10%_Cur	18320	367.7	394.71	378.81	394.95	0.000394	4.21	6856.73	1333.28	0.16
1	58759	2%_Cur	23430	367.7	396.73	380.29	397	0.00041	4.55	8717.69	1929.54	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	58759	1%_Cur	25980	367.7	397.57	380.95	397.85	0.000423	4.73	9491.44	1983.54	0.16
1	58759	0.2%_Cur	31390	367.7	398.95	382.27	399.2	0.000408	4.81	13869.79	2098.32	0.16
1	58759	10%_Proj	22000	367.7	396.23	379.89	396.48	0.000404	4.46	8249.74	1856.57	0.16
1	58759	2%_Proj	28200	367.7	398.15	381.51	398.44	0.000442	4.91	10024.95	2021.66	0.17
1	58759	1%_Proj	31200	367.7	398.9	382.23	399.16	0.000408	4.8	13793.94	2095.16	0.16
1	58759	0.2%_Proj	37700	367.7	400.26	383.67	400.54	0.000439	5.15	16122.34	2153.26	0.17
1	57561	10%_Cur	18320	358.4	394.72	369.05	394.77	0.000052	1.79	15534.91	2093.55	0.06
1	57561	2%_Cur	23430	358.4	396.74	370.4	396.79	0.000061	2.03	18433.29	2446.62	0.07
1	57561	1%_Cur	25980	358.4	397.58	371.01	397.64	0.000065	2.14	19637.11	2495.22	0.07
1	57561	0.2%_Cur	31390	358.4	398.93	372.19	398.99	0.000075	2.36	24532.13	2622.95	0.07
1	57561	10%_Proj	22000	358.4	396.24	370.04	396.29	0.000058	1.96	17704.88	2415.95	0.06
1	57561	2%_Proj	28200	358.4	398.16	371.49	398.22	0.00007	2.25	20467.11	2532.66	0.07
1	57561	1%_Proj	31200	358.4	398.88	372.15	398.95	0.000075	2.35	24434.34	2622.44	0.07
1	57561	0.2%_Proj	37700	358.4	400.23	373.42	400.31	0.000086	2.6	27378.85	2636	0.08
1	56157	10%_Cur	18320	370.9	394.41	379.91	394.61	0.000361	3.95	6726.3	1165.55	0.15
1	56157	2%_Cur	23430	370.9	396.36	381.26	396.61	0.000408	4.45	7909.31	1512.62	0.16
1	56157	1%_Cur	25980	370.9	397.17	381.87	397.44	0.000434	4.69	8406.12	1584.79	0.17
1	56157	0.2%_Cur	31390	370.9	398.44	383.04	398.77	0.000507	5.25	9190.13	1721.08	0.18
1	56157	10%_Proj	22000	370.9	395.87	380.92	396.11	0.000394	4.31	7608.37	1465.5	0.16
1	56157	2%_Proj	28200	370.9	397.71	382.36	398.01	0.000464	4.93	8741.52	1678.51	0.17
1	56157	1%_Proj	31200	370.9	398.39	382.99	398.72	0.000505	5.23	9164.06	1720.75	0.18
1	56157	0.2%_Proj	37700	370.9	399.81	384.55	400.09	0.000458	5.17	14400.32	1732.99	0.18
1	54914	10%_Cur	18320	369.9	393.65	379.31	394.03	0.000581	5.01	4495.52	815.09	0.19
1	54914	2%_Cur	23430	369.9	395.46	380.65	395.94	0.000684	5.74	5597.63	1387.79	0.21
1	54914	1%_Cur	25980	369.9	396.21	381.28	396.73	0.000729	6.04	6172.81	1463.8	0.22
1	54914	0.2%_Cur	31390	369.9	397.5	382.55	398	0.000731	6.27	9346.15	1513.98	0.22
1	54914	10%_Proj	22000	369.9	395.02	380.28	395.47	0.00065	5.52	5282.55	1313.9	0.2
1	54914	2%_Proj	28200	369.9	396.81	381.82	397.29	0.000698	6.01	8372.6	1509.03	0.21
1	54914	1%_Proj	31200	369.9	397.46	382.49	397.96	0.000729	6.25	9289.17	1513.69	0.22
1	54914	0.2%_Proj	37700	369.9	398.81	383.93	399.34	0.000772	6.66	11199.47	1520.77	0.23
1	53799	10%_Cur	18320	364.6	393.27	376.49	393.5	0.000357	4.2	7516.89	1398.83	0.15
1	53799	2%_Cur	23430	364.6	395.08	377.96	395.34	0.000393	4.63	9946.2	2058.68	0.16
1	53799	1%_Cur	25980	364.6	395.84	378.62	396.1	0.000402	4.77	11243.34	2241.38	0.16
1	53799	0.2%_Cur	31390	364.6	397.17	379.99	397.41	0.000384	4.81	15809.28	2568.33	0.16
1	53799	10%_Proj	22000	364.6	394.64	377.59	394.89	0.000384	4.52	9269.21	1777.98	0.16
1	53799	2%_Proj	28200	364.6	396.42	379.19	396.69	0.000408	4.88	12393.58	2490.46	0.16
1	53799	1%_Proj	31200	364.6	397.13	379.96	397.37	0.000384	4.81	15706.22	2566.74	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	53799	0.2%_Proj	37700	364.6	398.51	381.41	398.74	0.000384	4.96	19209.16	2610.18	0.16
1	52665	10%_Cur	18320	370.6	392.81	379.36	393.06	0.000462	4.26	6771.44	1199.06	0.17
1	52665	2%_Cur	23430	370.6	394.59	380.6	394.87	0.00049	4.64	9408.77	2178.44	0.17
1	52665	1%_Cur	25980	370.6	395.36	381.16	395.63	0.000484	4.72	11129.06	2575.74	0.17
1	52665	0.2%_Cur	31390	370.6	396.69	382.36	396.95	0.000488	4.92	14482.61	2711.28	0.18
1	52665	10%_Proj	22000	370.6	394.15	380.27	394.42	0.000489	4.58	8539.32	2009.42	0.17
1	52665	2%_Proj	28200	370.6	395.93	381.51	396.21	0.000497	4.87	12566.19	2705.59	0.18
1	52665	1%_Proj	31200	370.6	396.64	382.34	396.91	0.000488	4.92	14376.02	2710.96	0.18
1	52665	0.2%_Proj	37700	370.6	398.11	383.69	398.33	0.000419	4.74	19244.91	2741.06	0.17
1	52024	10%_Cur	18320	368.7	392.38		392.72	0.000574	4.82	5001.53	839.06	0.19
1	52024	2%_Cur	23430	368.7	394.13		394.51	0.000632	5.34	7313.29	1816.7	0.2
1	52024	1%_Cur	25980	368.7	394.87		395.28	0.000658	5.57	8823.52	2124.88	0.2
1	52024	0.2%_Cur	31390	368.7	396.22		396.62	0.00066	5.79	11760.03	2213.78	0.21
1	52024	10%_Proj	22000	368.7	393.69		394.07	0.000621	5.22	6563.48	1630.94	0.2
1	52024	2%_Proj	28200	368.7	395.46		395.86	0.000656	5.65	10090.22	2177.4	0.2
1	52024	1%_Proj	31200	368.7	396.17		396.58	0.00066	5.78	11664.92	2213.38	0.21
1	52024	0.2%_Proj	37700	368.7	397.67		398.04	0.000623	5.84	14985.96	2225.23	0.2
1	50694	10%_Cur	18320	358.9	391.78		392.1	0.000399	4.67	5699.45	1000.86	0.16
1	50694	2%_Cur	23430	358.9	393.44		393.82	0.000468	5.27	7962.49	1798.38	0.18
1	50694	1%_Cur	25980	358.9	394.18		394.57	0.000485	5.46	9366.58	1977.3	0.18
1	50694	0.2%_Cur	31390	358.9	395.52		395.93	0.00051	5.77	12206.25	2248.94	0.19
1	50694	10%_Proj	22000	358.9	393.02		393.39	0.000449	5.11	7268.97	1524.12	0.17
1	50694	2%_Proj	28200	358.9	394.77		395.16	0.000495	5.59	10562.3	2090.75	0.18
1	50694	1%_Proj	31200	358.9	395.48		395.88	0.00051	5.76	12109.39	2243.36	0.19
1	50694	0.2%_Proj	37700	358.9	397		397.39	0.000511	5.97	15610.13	2311.85	0.19
1	49376	10%_Cur	18320	365.5	390.97		391.4	0.00072	5.6	4690.99	1059.02	0.21
1	49376	2%_Cur	23430	365.5	392.57		393.04	0.000774	6.09	6912.28	1656.07	0.22
1	49376	1%_Cur	25980	365.5	393.32		393.78	0.000767	6.19	8220.82	1808.69	0.22
1	49376	0.2%_Cur	31390	365.5	394.76		395.16	0.000698	6.14	10877.65	1875.13	0.21
1	49376	10%_Proj	22000	365.5	392.16		392.62	0.000771	6.01	6252.67	1513.15	0.22
1	49376	2%_Proj	28200	365.5	393.95		394.38	0.000739	6.19	9366.6	1856.16	0.22
1	49376	1%_Proj	31200	365.5	394.72		395.11	0.000699	6.14	10793.28	1873.74	0.21
1	49376	0.2%_Proj	37700	365.5	396.3		396.65	0.000645	6.14	13865.15	2064.86	0.21
1	47944	10%_Cur	18320	361	390.51		390.73	0.000309	4	6100.44	935.68	0.14
1	47944	2%_Cur	23430	361	392.02		392.31	0.00038	4.61	7714.22	1237.64	0.16
1	47944	1%_Cur	25980	361	392.74		393.04	0.000404	4.84	8676.82	1421.99	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	47944	0.2%_Cur	31390	361	394.14		394.47	0.000434	5.18	10952.35	1711.5	0.17
1	47944	10%_Proj	22000	361	391.62		391.9	0.000364	4.47	7246.82	1115.47	0.15
1	47944	2%_Proj	28200	361	393.32		393.65	0.000435	5.09	9560.73	1664.61	0.17
1	47944	1%_Proj	31200	361	394.1		394.43	0.000433	5.18	10874.11	1708.78	0.17
1	47944	0.2%_Proj	37700	361	395.67		396.01	0.000451	5.47	13955.69	2316.89	0.18
1	46103	10%_Cur	18320	365.8	390.27		390.34	0.000181	2.73	13939.33	2864.65	0.1
1	46103	2%_Cur	23430	365.8	391.85		391.91	0.000158	2.68	18770.65	3187.32	0.1
1	46103	1%_Cur	25980	365.8	392.6		392.65	0.00015	2.67	21179.8	3328.8	0.1
1	46103	0.2%_Cur	31390	365.8	394.05		394.1	0.000136	2.65	26180.46	3580.98	0.09
1	46103	10%_Proj	22000	365.8	391.44		391.5	0.000163	2.69	17460.77	3122.56	0.1
1	46103	2%_Proj	28200	365.8	393.19		393.25	0.000148	2.7	23200.24	3426.48	0.1
1	46103	1%_Proj	31200	365.8	394		394.05	0.000137	2.65	26011.79	3555.22	0.09
1	46103	0.2%_Proj	37700	365.8	395.61		395.66	0.000126	2.65	32313.42	4184.29	0.09
1	44085	10%_Cur	18320	364.2	389.75		389.94	0.000405	3.9	7792.29	1852.03	0.15
1	44085	2%_Cur	23430	364.2	391.41		391.58	0.000379	3.99	11039.43	2717.84	0.15
1	44085	1%_Cur	25980	364.2	392.17		392.34	0.000373	4.05	12723.12	3237.3	0.15
1	44085	0.2%_Cur	31390	364.2	393.69		393.83	0.000324	3.94	16278.49	4888.44	0.14
1	44085	10%_Proj	22000	364.2	390.97		391.15	0.000388	3.98	10129.16	2541.03	0.15
1	44085	2%_Proj	28200	364.2	392.79		392.94	0.000357	4.03	14128.23	4221.5	0.15
1	44085	1%_Proj	31200	364.2	393.64		393.78	0.000325	3.94	16157.45	4859.58	0.14
1	44085	0.2%_Proj	37700	364.2	395.28		395.41	0.000309	4.02	20617.7	5636.18	0.14
1	42674	10%_Cur	18320	365.9	389.44		389.53	0.000263	3	10118.31	1745.04	0.12
1	42674	2%_Cur	23430	365.9	391.12		391.22	0.000252	3.11	12458.62	1954.21	0.12
1	42674	1%_Cur	25980	365.9	391.9		392	0.000247	3.16	13531.81	2830.67	0.12
1	42674	0.2%_Cur	31390	365.9	393.44		393.54	0.000239	3.26	15678.45	4027.06	0.12
1	42674	10%_Proj	22000	365.9	390.69		390.78	0.000254	3.08	11848.73	1880.78	0.12
1	42674	2%_Proj	28200	365.9	392.52		392.62	0.000245	3.21	14400.07	3507.1	0.12
1	42674	1%_Proj	31200	365.9	393.39		393.49	0.000239	3.26	15608.6	4023.84	0.12
1	42674	0.2%_Proj	37700	365.9	395.04		395.14	0.000235	3.39	17900.35	4081.7	0.12
1	41705	10%_Cur	18320	366.1	389.28		389.33	0.000147	2.16	11832.08	1475.82	0.09
1	41705	2%_Cur	23430	366.1	390.96		391.03	0.000152	2.34	14363.47	2063.43	0.1
1	41705	1%_Cur	25980	366.1	391.73		391.8	0.000153	2.42	15599.4	2801.52	0.1
1	41705	0.2%_Cur	31390	366.1	393.28		393.35	0.000153	2.54	18110.63	4353.68	0.1
1	41705	10%_Proj	22000	366.1	390.52		390.59	0.000151	2.3	13673.61	1920.62	0.09
1	41705	2%_Proj	28200	366.1	392.36		392.43	0.000155	2.48	16612.35	3338.88	0.1
1	41705	1%_Proj	31200	366.1	393.23		393.3	0.000153	2.54	18028.98	4339.75	0.1
1	41705	0.2%_Proj	37700	366.1	394.88		394.95	0.000155	2.68	20711.88	4495.51	0.1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	40323	10%_Cur	18320	364.2	388.53		388.95	0.000684	5.34	4206.41	809.46	0.22
1	40323	2%_Cur	23430	364.2	390.11		390.61	0.000772	5.99	5083.22	903.79	0.24
1	40323	1%_Cur	25980	364.2	390.84		391.38	0.000805	6.27	5488.76	927.08	0.24
1	40323	0.2%_Cur	31390	364.2	392.31		392.93	0.000855	6.77	6306.92	1138.38	0.25
1	40323	10%_Proj	22000	364.2	389.7		390.18	0.000748	5.82	4855.52	893.47	0.23
1	40323	2%_Proj	28200	364.2	391.42		392	0.000833	6.5	5814.42	944.55	0.25
1	40323	1%_Proj	31200	364.2	392.27		392.88	0.000853	6.75	6280.58	1124.48	0.25
1	40323	0.2%_Proj	37700	364.2	393.83		394.52	0.000908	7.29	7147.41	1514.18	0.26
1	39316	10%_Cur	18320	363.3	387.91	374.57	388.29	0.000581	5.05	3974.45	1347.9	0.2
1	39316	2%_Cur	23430	363.3	389.33	375.97	389.85	0.000732	5.94	4414.59	1567.17	0.23
1	39316	1%_Cur	25980	363.3	389.97	376.64	390.56	0.000802	6.34	4618.92	1721.91	0.24
1	39316	0.2%_Cur	31390	363.3	391.47	377.96	392.09	0.000811	6.67	6408.6	3102.28	0.24
1	39316	10%_Proj	22000	363.3	388.97	375.59	389.46	0.000689	5.69	4300.14	1512.13	0.22
1	39316	2%_Proj	28200	363.3	390.61	377.19	391.19	0.000782	6.38	5786.02	2056.02	0.24
1	39316	1%_Proj	31200	363.3	391.42	377.92	392.04	0.000809	6.65	6374.15	3058.95	0.24
1	39316	0.2%_Proj	37700	363.3	393.07	379.36	393.62	0.000741	6.67	8753.07	4423.09	0.24
1	39250		Bridge									
1	39190	10%_Cur	18320	363.3	387.77	374.45	388.09	0.00059	4.59	4075.14	1448.63	0.2
1	39190	2%_Cur	23430	363.3	389.14	375.79	389.59	0.000732	5.39	4474.4	2148.32	0.22
1	39190	1%_Cur	25980	363.3	389.73	376.39	390.24	0.000804	5.78	4656.34	2253.1	0.24
1	39190	0.2%_Cur	31390	363.3	390.89	377.64	391.43	0.000832	6.12	6527.39	2596.77	0.24
1	39190	10%_Proj	22000	363.3	388.8	375.42	389.21	0.00069	5.17	4373.18	2014.97	0.22
1	39190	2%_Proj	28200	363.3	390.2	376.91	390.77	0.000868	6.1	4802.8	2282.97	0.25
1	39190	1%_Proj	31200	363.3	390.86	377.6	391.39	0.000829	6.1	6499.43	2578.27	0.24
1	39190	0.2%_Proj	37700	363.3	392	379.01	392.58	0.000884	6.54	8097.16	3738.68	0.25
1	37734	10%_Cur	18320	364.5	386.49	374.15	387.03	0.000823	5.95	3566.91	1780.01	0.24
1	37734	2%_Cur	23430	364.5	387.92	375.63	388.45	0.000825	6.25	5979.38	2137.06	0.24
1	37734	1%_Cur	25980	364.5	388.48	376.31	389.03	0.000865	6.51	6661.21	2205.06	0.25
1	37734	0.2%_Cur	31390	364.5	389.59	377.7	390.17	0.000913	6.91	8097.13	2438.6	0.26
1	37734	10%_Proj	22000	364.5	387.62	375.22	388.12	0.00079	6.05	5633.19	2055.24	0.23
1	37734	2%_Proj	28200	364.5	388.94	376.88	389.51	0.000892	6.7	7245.12	2289.38	0.25
1	37734	1%_Proj	31200	364.5	389.55	377.64	390.13	0.000911	6.9	8051.52	2431.26	0.26
1	37734	0.2%_Proj	37700	364.5	390.68	379.19	391.27	0.000945	7.26	9578.4	2908.12	0.26
1	36382	10%_Cur	18320	350.3	385.87	370.81	386.09	0.000489	3.99	5937.04	1725.65	0.18
1	36382	2%_Cur	23430	350.3	387.3	372.31	387.53	0.000482	4.2	8709.94	3035.47	0.18

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	36382	1%_Cur	25980	350.3	387.85	373.02	388.08	0.000495	4.34	9621	3735.87	0.18
1	36382	0.2%_Cur	31390	350.3	388.89	374.43	389.15	0.00054	4.71	11756.96	4638.94	0.19
1	36382	10%_Proj	22000	350.3	386.94	371.91	387.19	0.000521	4.3	6801	2661.2	0.18
1	36382	2%_Proj	28200	350.3	388.3	373.6	388.53	0.000503	4.45	10473.25	4203.59	0.18
1	36382	1%_Proj	31200	350.3	388.85	374.37	389.11	0.00054	4.71	11680.08	4636.43	0.19
1	36382	0.2%_Proj	37700	350.3	390	375.92	390.25	0.000525	4.83	14248.56	4781.45	0.19
1	34787	10%_Cur	18320	362.5	385.39		385.5	0.000266	3.29	10995.03	2561.66	0.14
1	34787	2%_Cur	23430	362.5	386.81		386.93	0.000277	3.53	14174.05	4354.98	0.14
1	34787	1%_Cur	25980	362.5	387.36		387.48	0.000274	3.58	15516.72	4897.57	0.14
1	34787	0.2%_Cur	31390	362.5	388.41		388.52	0.000271	3.68	18112.51	6179.15	0.14
1	34787	10%_Proj	22000	362.5	386.47		386.58	0.000266	3.42	13355.43	4031.46	0.14
1	34787	2%_Proj	28200	362.5	387.82		387.93	0.000271	3.62	16625.68	5567.73	0.14
1	34787	1%_Proj	31200	362.5	388.38		388.49	0.000271	3.68	18025.95	6141.76	0.14
1	34787	0.2%_Proj	37700	362.5	389.53		389.64	0.000267	3.78	21217.28	7214.72	0.14
1	32336	10%_Cur	18320	360.3	384.67		384.87	0.000321	3.9	8046.58	2088.62	0.15
1	32336	2%_Cur	23430	360.3	386.11		386.31	0.000327	4.12	11012.8	3873.03	0.16
1	32336	1%_Cur	25980	360.3	386.67		386.87	0.00033	4.21	12217.71	4624.06	0.16
1	32336	0.2%_Cur	31390	360.3	387.73		387.93	0.000337	4.39	14514.98	5681.8	0.16
1	32336	10%_Proj	22000	360.3	385.76		385.97	0.000325	4.07	10284.28	3387.99	0.16
1	32336	2%_Proj	28200	360.3	387.13		387.33	0.000332	4.28	13214.23	5187.12	0.16
1	32336	1%_Proj	31200	360.3	387.7		387.9	0.000337	4.39	14439.4	5632.69	0.16
1	32336	0.2%_Proj	37700	360.3	388.83		389.04	0.000362	4.7	17508.58	7659.28	0.17
1	30004	10%_Cur	18320	365	383.96	373.53	384.1	0.000355	3.39	7307.24	3738.95	0.15
1	30004	2%_Cur	23430	365	385.29	374.83	385.48	0.00043	3.95	9266.99	9637.67	0.17
1	30004	1%_Cur	25980	365	385.84	375.35	386.04	0.000444	4.1	10259.27	10910.24	0.17
1	30004	0.2%_Cur	31390	365	386.87	376.21	387.09	0.000464	4.36	12247.92	12247.46	0.18
1	30004	10%_Proj	22000	365	384.96	374.45	385.14	0.000424	3.87	8709.88	7818.96	0.17
1	30004	2%_Proj	28200	365	386.29	375.7	386.5	0.000451	4.2	11116.86	11686.4	0.18
1	30004	1%_Proj	31200	365	386.84	376.18	387.05	0.000463	4.35	12181.49	12231.17	0.18
1	30004	0.2%_Proj	37700	365	387.93	377.08	388.16	0.000484	4.62	14337.43	12605.53	0.19
1	27852	10%_Cur	18320	366.3	383.09		383.26	0.000418	3.59	7242.49	2784.24	0.17
1	27852	2%_Cur	23430	366.3	384.29		384.5	0.00048	4.05	9367.56	6883.03	0.18
1	27852	1%_Cur	25980	366.3	384.83		385.04	0.000479	4.14	10462.08	9157.47	0.18
1	27852	0.2%_Cur	31390	366.3	385.85		386.06	0.000481	4.32	12534.63	11183.41	0.18
1	27852	10%_Proj	22000	366.3	383.98		384.18	0.000464	3.93	8781.56	5299.61	0.18
1	27852	2%_Proj	28200	366.3	385.28		385.49	0.000477	4.21	11381.36	10298.27	0.18
1	27852	1%_Proj	31200	366.3	385.81		386.02	0.000481	4.31	12466.29	11138.99	0.18

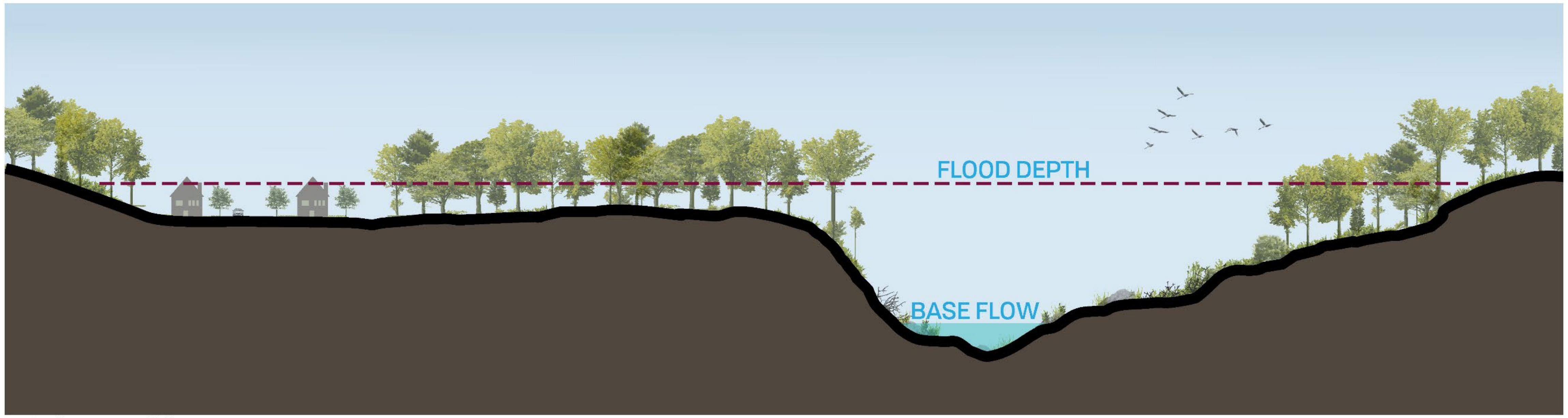
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	27852	0.2%_Proj	37700	366.3	386.88		387.1	0.000486	4.51	14701.29	11903.03	0.19
1	26395	10%_Cur	18320	362	382.61		382.72	0.000337	3.23	9311.37	3424.06	0.15
1	26395	2%_Cur	23430	362	383.75		383.89	0.000376	3.59	11129.73	7603.09	0.16
1	26395	1%_Cur	25980	362	384.26		384.41	0.000412	3.83	12136.91	9600.68	0.17
1	26395	0.2%_Cur	31390	362	385.24		385.41	0.000442	4.13	14359.67	11332.97	0.18
1	26395	10%_Proj	22000	362	383.46		383.59	0.000368	3.5	10628.44	6302.57	0.16
1	26395	2%_Proj	28200	362	384.68		384.84	0.000444	4.04	13069.73	10643.38	0.17
1	26395	1%_Proj	31200	362	385.21		385.38	0.000442	4.12	14282.91	11300.57	0.18
1	26395	0.2%_Proj	37700	362	386.29		386.46	0.000432	4.24	16746.18	11924.29	0.18
1	24785	10%_Cur	18320	362.4	382.32		382.36	0.00015	2.2	15374.38	6595.72	0.1
1	24785	2%_Cur	23430	362.4	383.43		383.48	0.000171	2.46	18049.14	8691.02	0.11
1	24785	1%_Cur	25980	362.4	383.92		383.98	0.000175	2.54	19285.84	9003.83	0.11
1	24785	0.2%_Cur	31390	362.4	384.9		384.96	0.000182	2.69	21745.26	9306.96	0.11
1	24785	10%_Proj	22000	362.4	383.14		383.19	0.000169	2.41	17321.96	8282.51	0.11
1	24785	2%_Proj	28200	362.4	384.34		384.39	0.000178	2.6	20327.17	9172.65	0.11
1	24785	1%_Proj	31200	362.4	384.87		384.92	0.000182	2.69	21660.32	9295.64	0.11
1	24785	0.2%_Proj	37700	362.4	385.94		386	0.000191	2.86	24433.13	9477.03	0.12
1	23901	10%_Cur	18320	362.1	382.08		382.19	0.00027	3.19	10019.1	5580.31	0.14
1	23901	2%_Cur	23430	362.1	383.15		383.28	0.000312	3.57	12081.65	7644.46	0.15
1	23901	1%_Cur	25980	362.1	383.63		383.78	0.000323	3.69	13049.4	7915.27	0.15
1	23901	0.2%_Cur	31390	362.1	384.6		384.75	0.000338	3.91	14994.95	9159.79	0.16
1	23901	10%_Proj	22000	362.1	382.86		382.99	0.000306	3.5	11516	7375.8	0.15
1	23901	2%_Proj	28200	362.1	384.04		384.19	0.00033	3.79	13873.52	8336.13	0.15
1	23901	1%_Proj	31200	362.1	384.56		384.71	0.000338	3.91	14927.83	9133.27	0.16
1	23901	0.2%_Proj	37700	362.1	385.63		385.79	0.00035	4.12	17097.46	10100.16	0.16
1	22770	10%_Cur	18320	364.9	381.89		381.94	0.000181	2.31	12755.11	6764.97	0.11
1	22770	2%_Cur	23430	364.9	382.92		382.99	0.000228	2.72	14732.44	9334.03	0.12
1	22770	1%_Cur	25980	364.9	383.4		383.47	0.000236	2.83	15785.06	9937.92	0.13
1	22770	0.2%_Cur	31390	364.9	384.35		384.43	0.000253	3.04	17913.72	10527.74	0.13
1	22770	10%_Proj	22000	364.9	382.65		382.71	0.000207	2.56	14158.95	8987.08	0.12
1	22770	2%_Proj	28200	364.9	383.8		383.87	0.000246	2.94	16679.59	10268.32	0.13
1	22770	1%_Proj	31200	364.9	384.31		384.39	0.000252	3.04	17839.59	10515.25	0.13
1	22770	0.2%_Proj	37700	364.9	385.37		385.46	0.000262	3.23	20224.99	10906.63	0.14
1	21592	10%_Cur	18320	350.2	381.47		381.69	0.000438	4.32	8594.08	7360.12	0.19
1	21592	2%_Cur	23430	350.2	382.44		382.69	0.000492	4.76	10839.23	9641.47	0.2
1	21592	1%_Cur	25980	350.2	382.92		383.18	0.000501	4.9	12031.78	10216.87	0.21

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	21592	0.2%_Cur	31390	350.2	383.89		384.14	0.000493	5.03	14497.1	10815.6	0.21
1	21592	10%_Proj	22000	350.2	382.19		382.44	0.000481	4.66	10235.48	9313.26	0.2
1	21592	2%_Proj	28200	350.2	383.33		383.58	0.000498	4.96	13069.69	10489.24	0.21
1	21592	1%_Proj	31200	350.2	383.86		384.11	0.000493	5.03	14411.12	10797.52	0.21
1	21592	0.2%_Proj	37700	350.2	384.94		385.18	0.00048	5.15	17149.6	11182.3	0.2
1	20191	10%_Cur	18320	353.3	381.38		381.43	0.000092	2.31	17736.64	10431.9	0.09
1	20191	2%_Cur	23430	353.3	382.34		382.4	0.000109	2.59	20314.66	11153.52	0.1
1	20191	1%_Cur	25980	353.3	382.81		382.87	0.000115	2.71	21577.24	11236.44	0.1
1	20191	0.2%_Cur	31390	353.3	383.76		383.83	0.000126	2.91	24139.93	11394.46	0.11
1	20191	10%_Proj	22000	353.3	382.09		382.15	0.000104	2.52	19648.62	10871.73	0.1
1	20191	2%_Proj	28200	353.3	383.21		383.27	0.00012	2.8	22655.12	11309.7	0.11
1	20191	1%_Proj	31200	353.3	383.73		383.8	0.000126	2.91	24050.2	11381.41	0.11
1	20191	0.2%_Proj	37700	353.3	384.79		384.87	0.000136	3.12	26908.3	12082.11	0.11
1	18663	10%_Cur	18320	357.8	380.95		381.16	0.000458	4.09	8395.03	10054.4	0.19
1	18663	2%_Cur	23430	357.8	381.85		382.08	0.000523	4.55	10117.98	10916.57	0.21
1	18663	1%_Cur	25980	357.8	382.3		382.55	0.000537	4.7	11014.06	11153.63	0.21
1	18663	0.2%_Cur	31390	357.8	383.23		383.49	0.00055	4.95	12862.89	11761.93	0.21
1	18663	10%_Proj	22000	357.8	381.62		381.85	0.000507	4.44	9661.53	10786.8	0.2
1	18663	2%_Proj	28200	357.8	382.69		382.94	0.000544	4.81	11789.12	11394.51	0.21
1	18663	1%_Proj	31200	357.8	383.2		383.45	0.00055	4.94	12797.37	11756.7	0.21
1	18663	0.2%_Proj	37700	357.8	384.25		384.51	0.000556	5.18	14874.85	11974.57	0.22
1	16739	10%_Cur	18320	362.3	380.33		380.45	0.000303	3.23	10856.63	11001.07	0.16
1	16739	2%_Cur	23430	362.3	381.16		381.29	0.000341	3.57	13009.38	12130.81	0.17
1	16739	1%_Cur	25980	362.3	381.6		381.74	0.000346	3.67	14175.23	12258.72	0.17
1	16739	0.2%_Cur	31390	362.3	382.54		382.68	0.000345	3.81	16624.8	12472.46	0.17
1	16739	10%_Proj	22000	362.3	380.94		381.07	0.000331	3.48	12454.32	11999.69	0.16
1	16739	2%_Proj	28200	362.3	382		382.13	0.000346	3.73	15199.46	12338.82	0.17
1	16739	1%_Proj	31200	362.3	382.51		382.65	0.000345	3.81	16536.45	12465.17	0.17
1	16739	0.2%_Proj	37700	362.3	383.57		383.71	0.000339	3.95	19311.75	12676.27	0.17
1	14949	10%_Cur	18320	360.7	379.51	371.77	379.79	0.000492	4.75	7088.83	12811.72	0.22
1	14949	2%_Cur	23430	360.7	380.34	372.92	380.61	0.000495	4.95	10945.73	13882.62	0.23
1	14949	1%_Cur	25980	360.7	380.82	373.44	381.07	0.000479	4.97	12347.54	13962.81	0.22
1	14949	0.2%_Cur	31390	360.7	381.85	374.62	382.07	0.000431	4.93	15369.79	14044.02	0.22
1	14949	10%_Proj	22000	360.7	380.14	372.61	380.4	0.000484	4.85	10361.9	13818.6	0.22
1	14949	2%_Proj	28200	360.7	381.25	373.91	381.49	0.00046	4.97	13608.87	13999.93	0.22
1	14949	1%_Proj	31200	360.7	381.81	374.59	382.03	0.000433	4.94	15259.33	14040.17	0.22
1	14949	0.2%_Proj	37700	360.7	382.96	375.85	383.15	0.000387	4.88	18641.55	14220.68	0.21

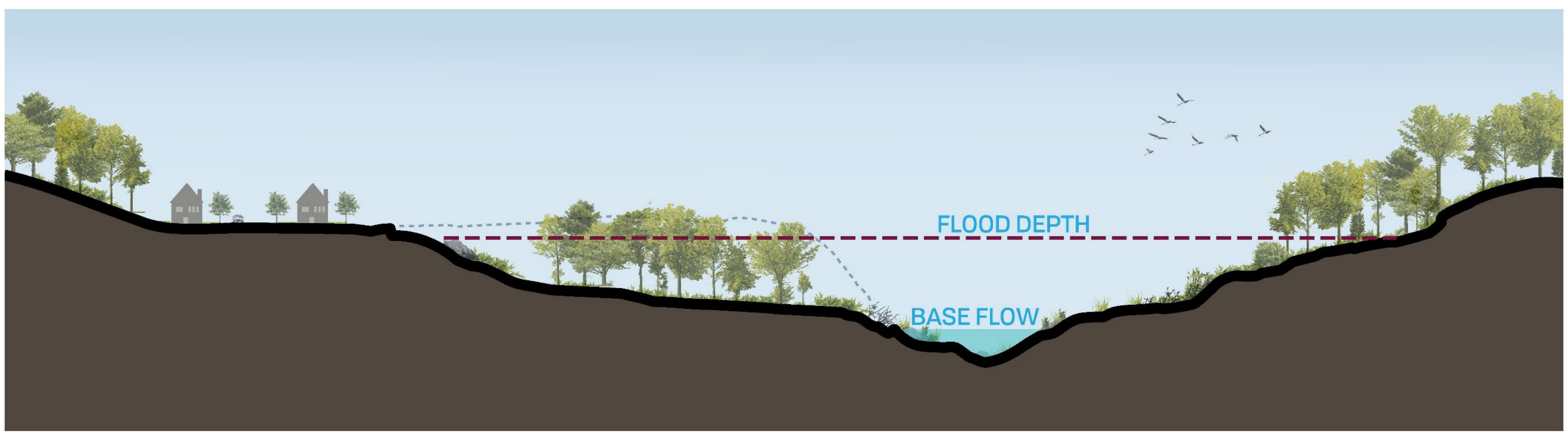
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	13445	10%_Cur	18320	360	379	371.7	379.16	0.000346	3.71	9316.03	11966.05	0.18
1	13445	2%_Cur	23430	360	379.89	373.19	380.03	0.000325	3.76	13541.68	13582.98	0.18
1	13445	1%_Cur	25980	360	380.38	373.59	380.52	0.000317	3.81	14891.63	13859.46	0.18
1	13445	0.2%_Cur	31390	360	381.45	374.34	381.57	0.000293	3.84	17820.18	14058.42	0.17
1	13445	10%_Proj	22000	360	379.71	372.7	379.83	0.000313	3.66	13032.69	13484.4	0.18
1	13445	2%_Proj	28200	360	380.83	373.9	380.96	0.000307	3.83	16112.05	13986.06	0.18
1	13445	1%_Proj	31200	360	381.41	374.32	381.53	0.000294	3.84	17712.02	14056.57	0.17
1	13445	0.2%_Proj	37700	360	382.59	375.1	382.71	0.000272	3.89	20973.09	14181.69	0.17
1	12366	10%_Cur	18320	358.7	378.68	368.19	378.84	0.000233	3.28	7135.45	11345.89	0.15
1	12366	2%_Cur	23430	358.7	379.51	369.08	379.69	0.000266	3.64	10340.57	12496.55	0.17
1	12366	1%_Cur	25980	358.7	379.98	369.47	380.17	0.000274	3.77	11582.22	12730.27	0.17
1	12366	0.2%_Cur	31390	358.7	381.05	370.24	381.24	0.000272	3.93	14375.15	13303.59	0.17
1	12366	10%_Proj	22000	358.7	379.35	368.84	379.52	0.000248	3.49	9928.86	12340.83	0.16
1	12366	2%_Proj	28200	358.7	380.43	369.8	380.62	0.000275	3.85	12740.78	13011.32	0.17
1	12366	1%_Proj	31200	358.7	381.01	370.22	381.2	0.000273	3.93	14269.84	13277.58	0.17
1	12366	0.2%_Proj	37700	358.7	382.26	371.05	382.42	0.000237	3.84	19110.42	13547.36	0.16
1	12300		Bridge									
1	12274	10%_Cur	18320	358.7	378.65	368.06	378.8	0.000228	3.2	7429.12	11716.14	0.15
1	12274	2%_Cur	23430	358.7	379.44	369.25	379.61	0.00026	3.55	10551.31	12337.35	0.16
1	12274	1%_Cur	25980	358.7	379.91	369.66	380.09	0.000269	3.68	11767.41	12531.4	0.17
1	12274	0.2%_Cur	31390	358.7	380.97	370.46	381.15	0.000265	3.82	14795.39	12841.29	0.17
1	12274	10%_Proj	22000	358.7	379.29	369.01	379.45	0.000243	3.4	10165.99	12235.34	0.16
1	12274	2%_Proj	28200	358.7	380.35	370.01	380.53	0.000269	3.76	12913.1	12700.39	0.17
1	12274	1%_Proj	31200	358.7	380.93	370.44	381.11	0.000266	3.82	14684.08	12836.1	0.17
1	12274	0.2%_Proj	37700	358.7	382.15	371.3	382.32	0.000254	3.93	18089.6	13047.1	0.17
1	11328	10%_Cur	18390	340.8	377.9	361.18	378.4	0.000447	5.75	3862.53	12000	0.21
1	11328	2%_Cur	23520	340.8	378.95	363.09	379.28	0.000368	5.33	10198.99	12856.78	0.2
1	11328	1%_Cur	26080	340.8	379.42	363.96	379.75	0.000377	5.47	11611.72	12976.39	0.2
1	11328	0.2%_Cur	31511	340.8	380.55	365.65	380.84	0.000354	5.47	14989.96	13027.77	0.19
1	11328	10%_Proj	22100	340.8	378.83	362.59	379.14	0.00034	5.11	9856.52	12801.08	0.19
1	11328	2%_Proj	28300	340.8	379.89	364.68	380.2	0.000369	5.48	13007.18	13015.6	0.2
1	11328	1%_Proj	31300	340.8	380.51	365.6	380.8	0.000355	5.47	14862.16	13026.84	0.19
1	11328	0.2%_Proj	37900	340.8	381.8	367.49	382.05	0.000322	5.39	18748.4	13208.41	0.19
1	10809	10%_Cur	18390	359.1	377.87	370.46	378.02	0.000339	3.63	9277.78	11974.53	0.18
1	10809	2%_Cur	23520	359.1	378.84	371.71	379	0.000356	3.91	11349.95	12469.53	0.19

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	10809	1%_Cur	26080	359.1	379.36	372.14	379.47	0.000275	3.52	14790.94	12589.26	0.17
1	10809	0.2%_Cur	31511	359.1	380.47	373.19	380.58	0.000255	3.57	17596.82	12762.1	0.16
1	10809	10%_Proj	22100	359.1	378.73	371.44	378.88	0.00033	3.74	11113.83	12448.31	0.18
1	10809	2%_Proj	28300	359.1	379.82	372.64	379.93	0.000267	3.55	15946.25	12659.18	0.17
1	10809	1%_Proj	31300	359.1	380.43	372.96	380.54	0.000256	3.57	17490.21	12759.74	0.16
1	10809	0.2%_Proj	37900	359.1	381.72	374.14	381.82	0.000233	3.6	20736.72	12842.46	0.16
1	8575	10%_Cur	18390	351.1	377.15	368.65	377.32	0.00033	3.78	9458.96	11760.33	0.18
1	8575	2%_Cur	23520	351.1	378.33	369.83	378.43	0.000218	3.25	16918.65	11925.18	0.15
1	8575	1%_Cur	26080	351.1	378.91	370.3	379	0.000204	3.22	18868.79	11952.55	0.14
1	8575	0.2%_Cur	31511	351.1	380.08	371.22	380.16	0.00018	3.18	22819.04	11984.12	0.14
1	8575	10%_Proj	22100	351.1	378.06	369.56	378.22	0.000315	3.85	11492.69	11904.88	0.18
1	8575	2%_Proj	28300	351.1	379.4	370.68	379.48	0.000193	3.2	20503.19	11968.13	0.14
1	8575	1%_Proj	31300	351.1	380.04	371.18	380.12	0.000181	3.18	22670.02	11983.09	0.14
1	8575	0.2%_Proj	37900	351.1	381.38	372.35	381.45	0.00016	3.15	27180.79	12079.67	0.13
1	5278	10%_Cur	18390	356.2	376.46		376.53	0.000205	2.68	14294.46	6150.88	0.14
1	5278	2%_Cur	23520	356.2	377.8		377.86	0.000173	2.65	18430.53	6849.25	0.13
1	5278	1%_Cur	26080	356.2	378.41		378.47	0.000163	2.65	20334.27	7042	0.13
1	5278	0.2%_Cur	31511	356.2	379.64		379.7	0.000146	2.66	24141.47	7299.25	0.12
1	5278	10%_Proj	22100	356.2	377.44		377.5	0.00018	2.65	17334.32	6693.52	0.13
1	5278	2%_Proj	28300	356.2	378.92		378.98	0.000155	2.66	21915.1	7177.68	0.13
1	5278	1%_Proj	31300	356.2	379.6		379.65	0.000147	2.66	23998.74	7294.97	0.12
1	5278	0.2%_Proj	37900	356.2	380.98		381.04	0.000133	2.69	28289.62	7525.53	0.12
1	2988	10%_Cur	18390	349	375.95		376.07	0.000293	3.53	11084.57	5632.85	0.17
1	2988	2%_Cur	23520	349	377.37		377.48	0.000255	3.52	14258.69	6312.69	0.16
1	2988	1%_Cur	26080	349	378.02		378.12	0.000243	3.54	15690.46	6565.48	0.16
1	2988	0.2%_Cur	31511	349	379.29		379.39	0.000224	3.58	18523.7	6733.05	0.15
1	2988	10%_Proj	22100	349	377		377.11	0.000263	3.52	13427.52	6120.02	0.16
1	2988	2%_Proj	28300	349	378.55		378.65	0.000235	3.55	16870.05	6665.59	0.16
1	2988	1%_Proj	31300	349	379.24		379.34	0.000225	3.57	18418.02	6732.4	0.15
1	2988	0.2%_Proj	37900	349	380.66		380.76	0.000209	3.64	21579.58	6769.38	0.15
1	2706	10%_Cur	18390	354.3	375.82		375.99	0.000292	3.9	9774.24	5113.37	0.17
1	2706	2%_Cur	23520	354.3	377.25		377.41	0.000269	3.96	12697.16	5772.62	0.17
1	2706	1%_Cur	26080	354.3	377.9		378.05	0.000261	4	14014.72	5848.02	0.17
1	2706	0.2%_Cur	31511	354.3	379.18		379.32	0.000246	4.07	16620.62	6000.02	0.16
1	2706	10%_Proj	22100	354.3	376.88		377.03	0.000274	3.94	11931.93	5678.57	0.17
1	2706	2%_Proj	28300	354.3	378.43		378.58	0.000255	4.03	15099.65	5908.42	0.17
1	2706	1%_Proj	31300	354.3	379.13		379.28	0.000247	4.07	16523.48	5997.82	0.16

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1	2706	0.2%_Proj	37900	354.3	380.56		380.7	0.000234	4.15	19428.25	6045.9	0.16
1	1434	10%_Cur	18390	352.2	375.57	364.3	375.65	0.000202	2.86	12259.92	2875.09	0.14
1	1434	2%_Cur	23520	352.2	377	365.78	377.09	0.000198	3.04	14894.94	3387.21	0.14
1	1434	1%_Cur	26080	352.2	377.65	366.48	377.74	0.000197	3.12	16080.79	3619.61	0.14
1	1434	0.2%_Cur	31511	352.2	378.93	367.96	379.03	0.000195	3.29	18426.64	3827.44	0.14
1	1434	10%_Proj	22100	352.2	376.63	365.38	376.71	0.000198	2.99	14205.79	3222.28	0.14
1	1434	2%_Proj	28300	352.2	378.18	367.1	378.28	0.000196	3.19	17056.88	3737.91	0.14
1	1434	1%_Proj	31300	352.2	378.88	367.9	378.98	0.000195	3.28	18339.16	3823.85	0.14
1	1434	0.2%_Proj	37900	352.2	380.31	371.26	380.41	0.000195	3.46	20953.65	3855.1	0.15
1	105	10%_Cur	18390	355.6	375.23	366.65	375.36	0.0003	3.41	9387.01	1623	0.17
1	105	2%_Cur	23520	355.6	376.67	367.79	376.8	0.0003	3.66	11430.87	1813.67	0.17
1	105	1%_Cur	26080	355.6	377.31	368.31	377.46	0.0003	3.78	12368.25	1818.01	0.17
1	105	0.2%_Cur	31511	355.6	378.59	370.73	378.74	0.0003	3.99	14221.62	1825.8	0.18
1	105	10%_Proj	22100	355.6	376.29	367.5	376.43	0.0003	3.6	10886.58	1783.83	0.17
1	105	2%_Proj	28300	355.6	377.84	370.35	377.99	0.0003	3.87	13138.83	1820.78	0.18
1	105	1%_Proj	31300	355.6	378.54	370.68	378.7	0.0003	3.98	14152.5	1825.58	0.18
1	105	0.2%_Proj	37900	355.6	379.96	371.32	380.13	0.0003	4.22	16216.59	1830.11	0.18

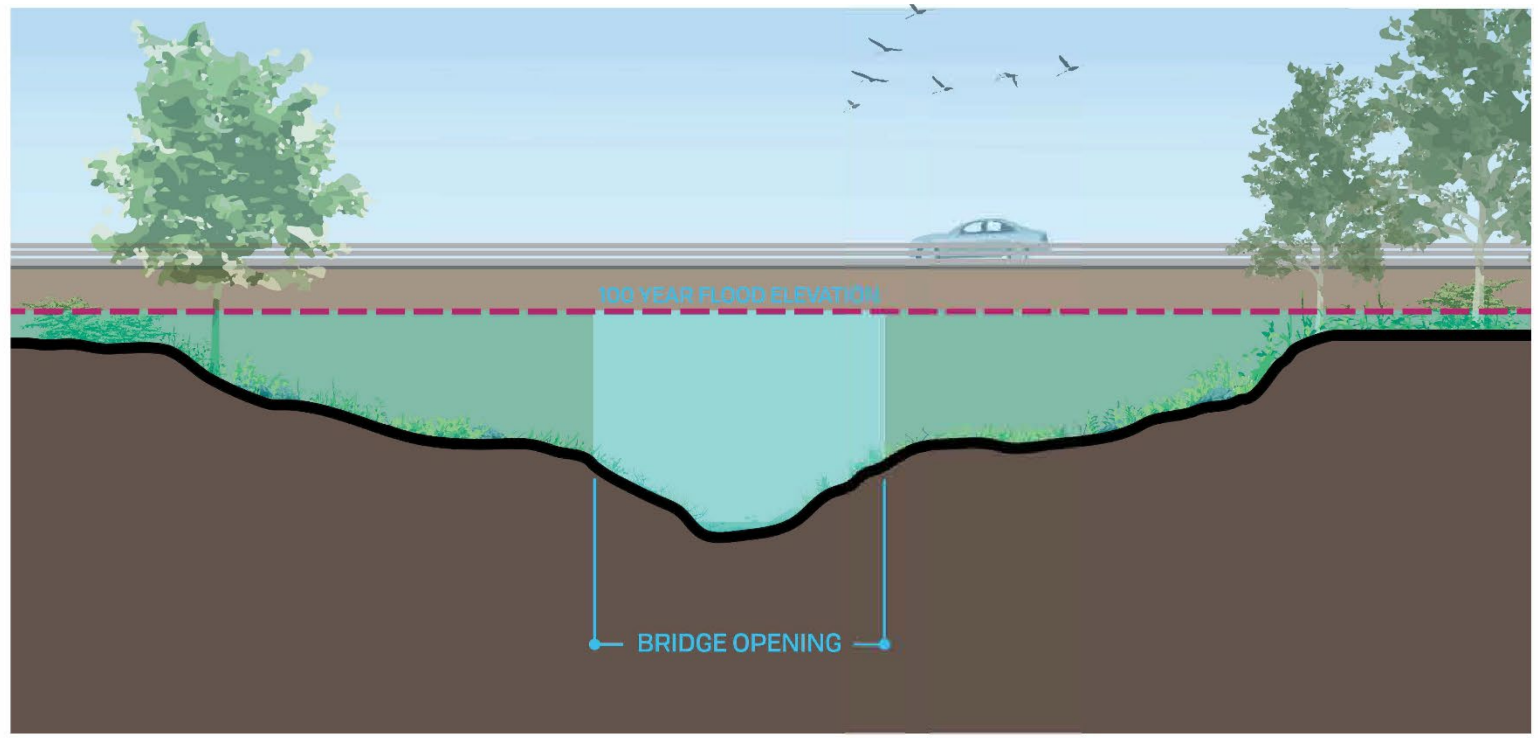


Existing Condition



Future Condition

FLOODPLAIN BENCH



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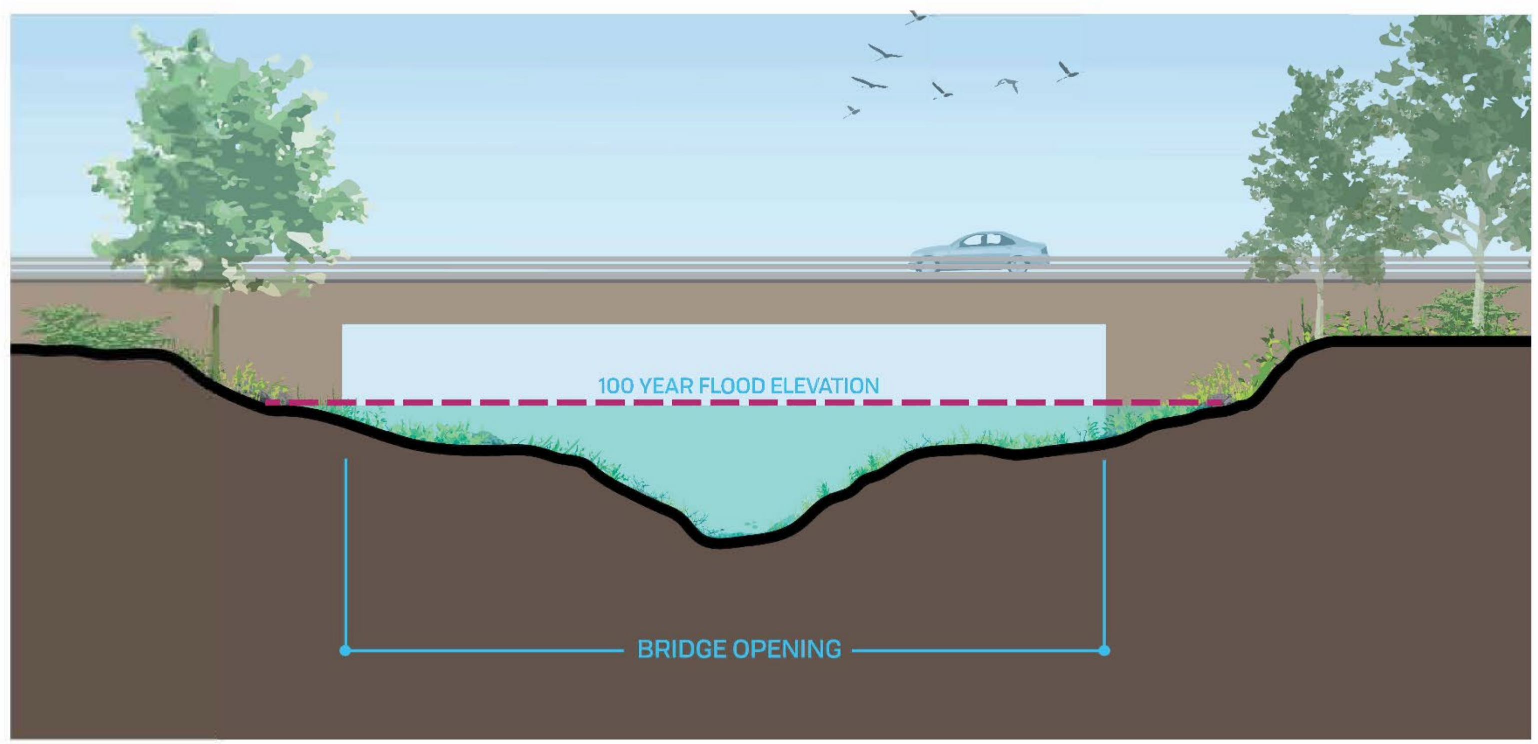
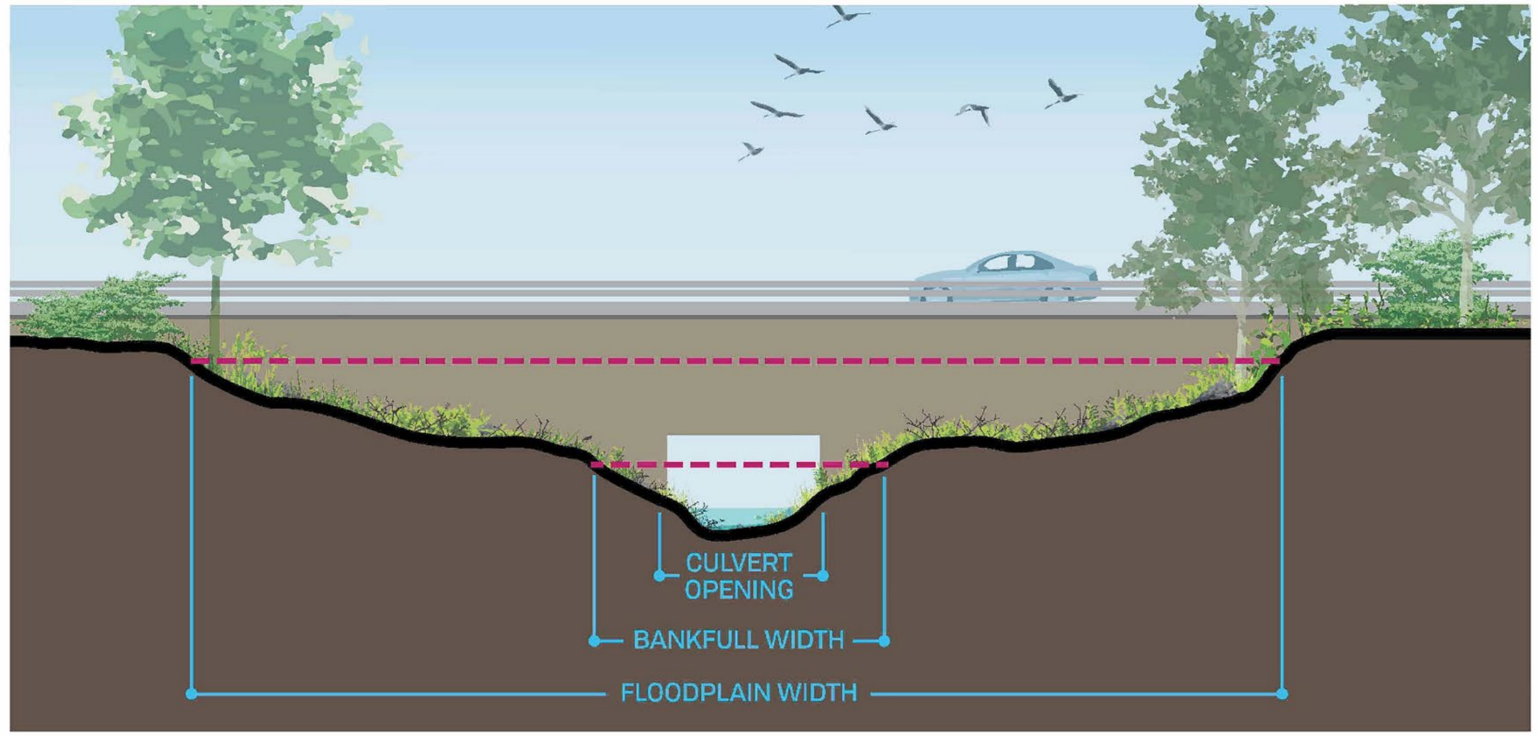


Future Condition

EXPANDED BRIDGE OPENING



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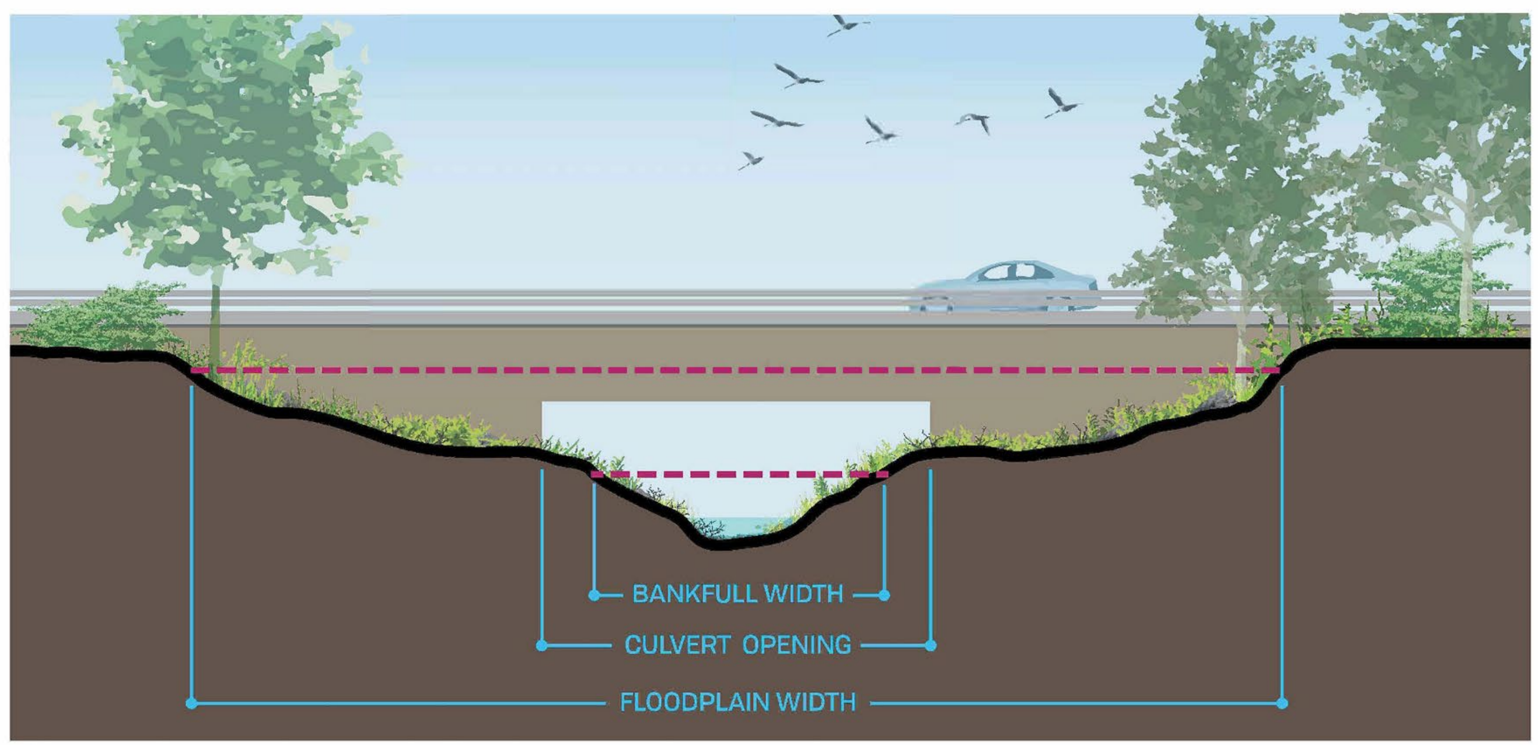
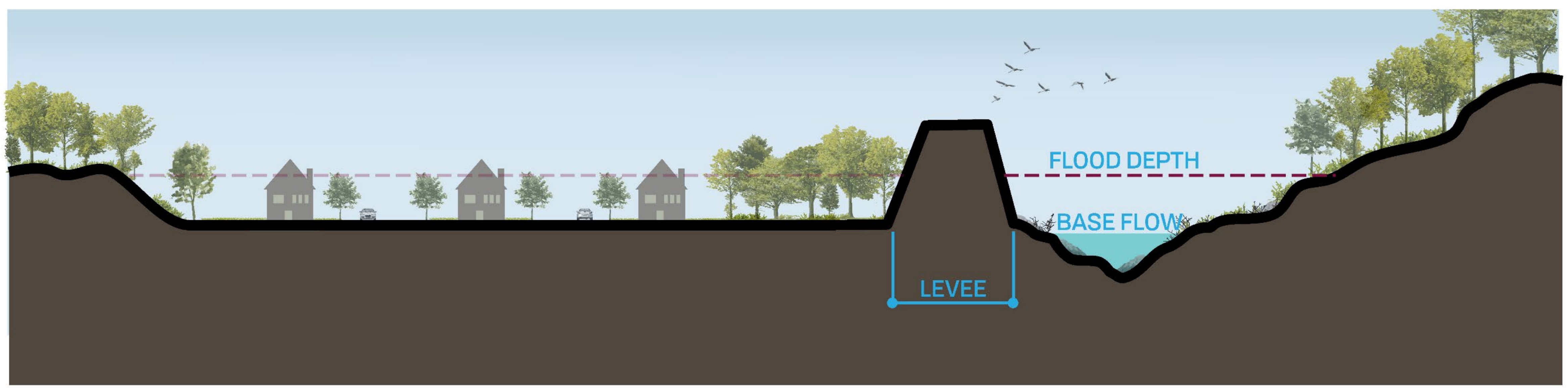


Future Condition

EXPANDED CULVERT OPENING

Existing Condition



Future Condition

PROTECTIVE LEVEE

Appendix G. Ice-Jam Mitigation Strategies

Ice Jam Flooding Mitigation Strategies

There are several widely accepted and practiced standards for ice jam controls to mitigate the ice jam related flooding. These are referred to as ice jam mitigation strategies and each strategy is very much site dependent. A strategy that works for a certain reach of a river wouldn't work for another reach in the same river due to river morphology and hydrodynamics. Therefore, each of these strategies need to be analyzed with numerical modeling and simulations to check if they work for a considered area/reach of a river before implementing or recommending with the previous observational experience alone. The standard strategies that are widely accepted and practiced in cold region engineering are:

- Ice booms
- Ice breaking using explosives
- Ice breaking using ice-breaker ferries and cutters
- Installing inflatable dams (Obermeyer spillways)
- Mixing heated effluent to the cold water
- Removal of bridge piers or heated bridge piers or heated riverbank dikes
- Ice retention structures
- Ice forecasting systems and ice management

Ice Booms

Ice booms are the most widely used ice jam control strategy to control ice movement and minimizes surface ice transport. They can be both permanent and temporary structures depending on the emergency measure in high-risk situations. They mainly consist of a series of timber beams or pontoons connected and strung across a river. Once the ice disappears, the booms can be removed if needed and transported elsewhere for storage during the summer months. Ice booms are flexible and can be designed to release ice gradually when overloaded. They can be a relatively cost-effective intervention and can be placed seasonally to reduce potential negative environmental impacts. Ice booms can also be deployed relatively rapidly, rendering them effective as an emergency response measure.

However, the removal of ice booms can be costly since the components of each boom must be disconnected, cleaned, transported and stored until their next deployment. Ice booms can also be ineffective given that ice jams have the potential to circumvent the booms by moving underneath them. Ice booms do not suit all river environments and require low river flow velocity and adequate upstream ice storage capacity.

Ice Breaking Using Explosives

Thermally grown ice is relatively easy to break up by blasting, while frazil ice is more difficult because it absorbs much of the blast energy. Ice blasting using dynamite is being widely used in rivers where very thick ice jams are formed. It is a very efficient method that can be performed within minutes. It is easily transported to remote locations and does not require any maintenance. Holes are drilled in the ice and dynamite is inserted to blow the ice apart. The most effective results can be achieved by placing the charges underneath the ice surface.

Using dynamite to clear ice can, however, be harmful to the environment. It is also a dangerous method to employ with potentially fatal consequences. Dynamite is not a sustainable solution and can require multiple treatments during extreme cold. It also requires the containment of large areas, which might have to be repeated several times.

Ice Breaking using Ice-Breaker Ferries and Cutters

Ice breakers are specialized vessels designed to break ice jams in wide rivers. They represent a non-structural ice jam mitigation method that is used internationally, in lakes, wide rivers, and oceans. Ice breakers are generally operated when temperatures start to rise, before it reaches the peak cold. They are most suitable for ice sheet breaking (juxtaposed type ice jams), as there are limitations for the ice thickness that they are capable of breaking.

Cutting thick ice covers can also mechanically weaken the ice jams and help relive the internal pressure of an ice-covered channel due to the thick ice cover. A thick ice cover increases the resistance to flow and slowdown the discharge under the ice covers and increase the backwater effects upstream. By cutting the ice cover this pressure can be relieved and the backwater effects can be minimized to reduce upstream flooding potentials. This can also help to control the ice jam breakup and control large ice pieces release from the break-up.

Ice breakers can typically break thick ice covers of up to three to ten feet. Ice breakers have proven to be effective tools for breaking up ice cover on rivers. There are multiple types of ice breakers and, being a mobile solution, they can be flexibly targeted at areas with the most need. Operating ice breakers requires a highly skilled command and crew and are not suitable in all environments. Transporting ice breakers is also relatively difficult, making it a time-consuming and potentially cost-intensive solution.

Installing Inflatable Dams (Obermeyer Spillways)

Removing permanent run-of-river low head dams that are prone to ice jams and replacing them with floatable dams can be a good solution for flow control for all seasons. Since the crest elevation can altered, they allow for a control release of incoming ice, allowing it to spillover without jamming. Also, in case of a sudden freeze-up jam that lead to an overnight thick jam can also be broken by frequent or oscillatory movement of lowering and raising the crest to break or weaken the ice jam. Obermeyer Spillway gates are recommended in areas where it is more prone to ice accumulation and flow control is still essential during all seasons.

Obermeyer Spillway Gates consist of a row of steel gate panels installed either at the top of dams or as free-standing structures. The system utilizes a combination of metal flap-gate panels supported by multiple small inflatable “bladders” that adjust the panels’ angle and elevation. By controlling the pressure in the bladders, the water flow can be infinitely adjusted within the system control range. Panels can also be designed to include heated abutment plates to prevent ice formation.

Mixing Heated Effluent to the Cold Water

The release of warm water waves into a river from a nearby treatment plants or additions of heated water mixing can help mitigate ice jam formations where the above mentioned alternatives won’t work. Provided that the effluent is added to the river prior to ice jam formation, the additional water volume can increase the river flow velocities and prevent ice jam creation in the first place. The wastewater can also be used for the thermal control of ice, as the released warm water can melt or thin ice jams.

Removal of Bridge Piers or Heated Bridge Piers or Heated Riverbank Dikes

Bridge piers are a hotspot for capturing surface and suspended frazil ice. When surface ice floes are adhered to the bridge piers and abutments the lateral growth of ice rapidly increase thus snagging more ice on the surface creating an ice bridge across the river. When there are more piers across the river the potential of ice bridging between piers increase due to a series of small ice bridging between two piers can be rapidly form than between longer between the longer pier spans.

Removing bridge piers can lead to high cost construction projects with inconvenience to the daily traffic through the bridge and the structural integrity. Therefore, heated bridge piers can be a good alternative to the existing piers that are prone to more ice cohesion and that can lead to high cost of removing the piers. This will limit the ice adhesion to the bridge and pass through the surface and suspended ice without encouraging snagging, capturing and flocculation of surface ice at bridge piers avoiding the possible ice jams.

Also, the heating of piers can heat the surrounding water and mix with the ambient cold water that will lead to the melt existing surface and suspended ice in the water. This reduces any extra ice generation in the water column.

However, heating bridge piers involves carful installation of the wiring and maintenance of the heating elements and energy costs. More frequent inspections of the bridge piers are also needed since the temperature can affect the concrete composition or special treatment for the concrete is needed.

Ice Retention Structures

Ice retention structures are used to control ice jams by actively initiating jams in more suitable locations where they are less damaging. Ice is captured and retained upstream of residential areas.

Ice retention structures are cost-effective, installation methods are simple, however the design is highly customizable according to the site. A retention structure can be associated with a flood bench so that increased water levels due to ice accumulation can be compromised be allowing more storage in the flood bench. The retention structures don’t increase the water level during normal flows.

However, the structures do require ongoing maintenance to remove debris. Channel bed scour is a concern for these structures, therefore, a scour analysis needed to perform in the vicinity of the structure to make sure the ice mitigation strategy will not adversely affect the normal river flow.

Ice Forecasting Systems and Ice Management

Visual monitoring of the ice formation, and ice cover progressions and water levels are good elements of monitoring the ice conditions of a river during the wintertime, but not sufficient to accurately predict the upstream back water effects or ice jam formations or ice jam break-ups. Ice condition and ice jam monitoring system is a useful tool for emergency ice management but limited in ice forecasting ability.

Ice long-term forecasting and short-term freeze-up and ice jam breakup predictions is a complicated process and challenging due to several reasons. Ice forecasting needs geomorphological, meteorological, coupled thermodynamics and hydrodynamics to identify the factors effecting an ice jam condition.

Therefore, an ice forecasting simulation will not be able to be carried out in a timely manner to help making emergency decisions. Therefore, a good forecasting system that will recommend an ice management plan would and customized ice monitoring strategy would be the most appropriate alternative to follow. An annual ice jam simulation with that accounts for forecasted meteorological and hydrological conditions and simulated ice control strategy that is suitable for the upcoming winter can identify the flood prone areas and enable to calculate the associate risk beforehand. These annual studies can also suggest the type of monitoring that is needed in different reaches or areas. For example, if an area needed to visually monitor the ice formation and ice transport through webcams or need to perform a calculation procedure such as “Freezing-Degree-Day” (FDD) method to predict the thickness of an ice jam to break to make decision when to start breaking. This will help officials to manager the resources and order the equipment and staff available before an emergency occur.

Gomez and Sullivan suggests performing a freeze-up or a break-up ice simulation study before implementing or recommending any of the above discussed strategies. The basic data needs and steps involved in an ice simulation analysis is also outlined below.

Ice Forecasting Model Simulations

Freeze-up ice simulation is a complex simulation carried out to predict ice generation, movement and coagulation with the change of air temperature, water temperature and water flow over a period of time. Usually these simulations and carried out for a two to three-month time period. A calibration and validation is also needed to ensure accuracy. A freeze-up or ice jam simulation needs the following input data:

- Accurate river bathymetry created from LiDAR survey or hydro-corrected bathymetric data from the state agencies.
- Weather data such as air temperature, wind condition, cloud cover, snowfall and precipitation data.
- Flow conditions, from gauge data or measured data. (e.g. upstream discharge and downstream water level data).
- Ice conditions data, such as water temperature data, incoming ice concentration, and initial ice cover thickness or initial ice floe concertation’s and ice floe thickness.
- Visual observation data that are useful to calibrate the model, such as ice cover leading edge propagation locations, water temperature and ice thickness measurements.

The results of such a simulation, when the results are in agreement with observational data, can lead to a better understanding of ice behavior and associated ice jam flooding in the simulated areas that will aid officials and emergency responders in developing better ice management plans.