CERTIFICATION EVALUATION AND SCOPING STUDY REPORT

Montour Falls Flood Damage Reduction Project
Location: Montour Falls, Schuyler County, New York
NYS DEC Region 8, and USACE Buffalo District

Schnabel Reference 21C25005.00
August 17, 2021 (Rev. September 10, 2021)

Prepared For: Village of Montour Falls

Schnabel ENGINEERING
T 518.348.8575
28 Corporate Drive, Suite 204 / Clifton Park, NY 12065
schnabel-eng.com

August 17, 2021 (Rev. September 10, 2021)

Mr. Michael O'Connell, PE
Larson Design Group
1 West Market Street
Corning, NY 14830

Subject: **Montour Falls Flood Damage Reduction Project**
Certification Evaluation and Scoping Study
Montour Falls, Schuyler County, New York (Schnabel Reference 21C25009.00)

Dear Mr. O'Connell:

Schnabel-Lachel Engineering, P.C. (Schnabel) is pleased to submit our Certification Evaluation and Scoping Study Report for the Montour Falls Flood Damage Reduction Project (MFFDRP). This report includes the findings and discussion of our evaluation of the Catharine Creek Left and Right Bank, the Shequaga Creek levee systems. The scope of this study is defined in our project proposal dated, authorized on April 22, 2021. This work has been completed with the support of the NYS DEC Region 8 (levee sponsor) and the USACE Buffalo District.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL-LACHEL ENGINEERING, P.C.

Michael S. Quinn, PE
Senior Associate

Kevin J. Ruswick, PE. CFM
Senior Associate

MSQ:KJR:scc

CERTIFICATION EVALUATION AND SCOPING STUDY REPORT
MONTOUR FALLS FLOOD DAMAGE REDUCTION PROJECT
VILLAGE OF MONTOUR FALLS, NEW YORK

TABLE OF CONTENTS

LIST OF TABLES

LIST OF REPORT FIGURES

LIST OF ATTACHED FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Schnabel-Lachel Engineering, P.C. (Schnabel) was retained by the Larson Design Group as a subconsultant for the Village of Montour Falls to perform a Phase 1 Certification Evaluation and Scoping Study for obtaining Federal Emergency Management Administration (FEMA) accreditation of the Montour Falls Flood Damage Reduction Project (MFFDRP).

Phase 1 Study - The Phase 1 study has been directed at evaluating whether the existing levee systems meet the National Flood Insurance Program (NFIP) definition of levee system. Title 44, Chapter 1,Section 59.1 of the Code of Federal Regulations (44 CFR 59.1) defines a levee as a flood risk reduction system that consists of a levees, and associated structures, such as closure and drainage devices. Community and/or other party seeking recognition or continued recognition of a levee system on a Flood Insurance Rate Map (FIRM) must provide FEMA with data and documentation, certified by a registered professional engineer, showing that the levee system is expected to provide 1-percent-annual-chance (base) flood risk reduction. This Phase 1 study provides information regarding how FEMA maps levee systems, a checklist of the types of data and documentation that must be submitted for levee systems to be accredited on FIRMs, and a preliminary assessment of what geotechnical investigations, hydrologic and hydraulic modeling and structural evaluations are needed for accreditation of the Catharine Creek an Shequaga Creek levee systems.

Levee System Features - The Catharine Creek Levee System is comprised of the earthen levees of the Northern Left Bank, Southern Left Bank, and Right Bank Ring Dike. The Northern Left Bank is approximately 0.9 miles long, while the southern section is just under 0.4 miles, and the right bank measures about 0.2 miles in length. There are six (6) numbered culverts closures along the Catharine Creek Right and Left Bank levee systems starting at the northern limit of the left bank north reach. The Shequaga Creek flood protection system consists of an upstream concrete stilling basin at the base of the falls, a twin-cell concrete box culvert, downstream stilling basin, and an earthen levee. The Shequaga Creek levee is approximately 0.2 miles in length and contains five (5) culverts and an abandoned railroad crossing (currently a pedestrian bridge). The crossing is located approximately 770 feet downstream from the end of the culvert floodwall.

Hydrologic Flow Evaluation – Schnabel evaluated the discharges presented in the USACE Local Flood Protection Project Operation and Maintenance Manual for comparison with flows used in the FEMA regulatory hydraulic model for Catharine Creek, the Diversion Channel, and Shequaga Creek. Based on the evaluation of flow data from various sources at the upstream and downstream end of the project, the flow rates used in the FEMA regulatory hydraulic models are consistently lower than those presented in the Corps As-built drawings as well as lower than estimates from the USGS StreamStats application. Should the Village decide to pursue levee accreditation, it is recommended that more detailed hydrologic modeling be performed to develop flows for use in assessing freeboard compliance during the 100-year base flood storm event.

Initial Freeboard Assessment - The current regulatory hydraulic models for the Catharine Creek Diversion Channel and Shequaga Creek were developed as part of the October 1, 1980 Flood Insurance Study (FIS) for the Village of Montour Falls. Review of available survey, digital elevation models, and revised FEMA modeling found that overall, the revised FEMA model generally predicted higher water surface elevations for the 100-Year Base Flood Event of approximately 0.5 to 1.5 ft. This is presumably due to the utilization of unsteady flow data in the revised model geometry for inflows at Catharine Creek, Havana Glen, Catlin Creek, and Shequaga Creek. Importantly however is even if the higher elevations are reasonable, the excess freeboard identified in Figures 1.3 – 1.6 would indicate that the existing levee system likely meets minimum freeboard requirements. On the basis of our comparative evaluation of freeboard it appears that original design parameters are conservative compared to FEMA's evaluation requirements.

Levee Inspection - Schnabel representatives performed a visual inspection of the Catharine Creek and Shequaga Falls levee systems' embankment crest, protected (landside) slope, flood slope, and culvert structures on May 25 and 26, 2021. On July 20, 2021 the USACE's performed their routine annual inspection with the NYSDEC, and Schnabel as well as the Village representative Dean Hillyard attended. The levee inspection observations are documented in Section 2.0 and a photo log is included as Appendix A. The USACE indicated at the conclusion of the July 20th inspection that levee system components for the Catharine Creek and Shequaga Falls levees systems, with the exception of the culvert closures, would be rated as "acceptable" to "minimally acceptable". USACE stated that without the completion of the video inspection by the Sponsor (NYS DEC) of the culvert closures that these structures would as in 2020 be rated "unacceptable". Completion of the video inspection by the NYS DEC is scheduled for this late summer and fall 2021.

General Levee Accreditation Process - Accreditation of a levee system involves the gathering of data and documentation that will demonstrate that the existing system meets or can meet and be in compliance with the NFIP 44 CFR 65.10 requirements. Compliance with NFIP 44 CFR 65.10 allows FEMA to recognize a levee system provides a 1 percent-annual-chance flood reduction for the community, and areas on the landside (protected side) of the levee system maybe mapped as Zone X on the FIRM's. FEMA has developed checklists for community owners, sponsors and their engineering representatives to follow as means of preparing a comprehensive accreditation submittal, and as a means of streamlining review of the submittal. Schnabel plans to follow the checklists, data organization, and submittal format recommended in the document titled **FEMA Suggested Tabbed Submission for 44 CFR 65.10 Accreditation Material**. Based on this FEMA document and checklists a comprehensive accreditation submittal will be prepared that includes the data and documentation for four general categories of an accreditation submittal including Design Criteria, Operational Plan, Interior Drainage Plan, and Maintenance Plan.

Accreditation of MFFDRP - It is Schnabel's opinion that the MFFDRP is certifiable with the completion of updated hydrologic and hydraulic modeling and with the completion of a supplemental geotechnical exploration program. This opinion is based on our review of the checklists presented in Section 3, the review of available MFFDRP documentation and data, and our site inspections on May 25th and July 20th. The accreditation scope for MFFDRP has been broken into four categories consistent with the checklists outlined in Section 3 that includes Design Criteria (i.e., six components), Operations Plan, Interior Drainage Plan and Maintenance Plan. The detailed scope for each of the four categories is presented in Section 4.0.

MFFDRP Accreditation Cost Estimate – Schnabel has developed an engineer's opinion of probable accreditation costs (EOPAC) based on the anticipated levee accreditation activities required for FEMA review and approval of the MFFDRP. The EOPAC is a "Class 4" estimate, according to the categories of cost estimates defined by the Association for the Advancement of Cost Engineering (AACE) International and presented in Table 5.1. The EOPAC for MFFDRP accreditation which includes thirteen (13) engineering, geotechnical investigation and hydrologic & hydraulic modeling tasks is $280,000. In addition to the accreditation cost, Schnabel prepared a preliminary estimate for the relining of eleven (11) culvert closures within the Catharine Creek and Shequaga Creek levee systems assuming relining the culvert in necessary. This additional design and construction cost is estimated to range from $330,000 to $460,000 for the wet-out felt or fiberglass CIPP methods respectively. Re-lining of the culvert pipes maybe a recommendation at the completion of the video inspection of the culverts closures being completed by the NYS DEC late this summer and fall.

1.0 INTRODUCTION

1.1 General

Schnabel-Lachel Engineering, P.C. (Schnabel) was retained by the Larson Design Group as a subconsultant for the Village of Montour Falls to perform a Phase 1 Certification Evaluation and Scoping Study for obtaining Federal Emergency Management Administration (FEMA) accreditation of the Montour Falls Flood Damage Reduction Project (MFFDRP). The visual observations and discussions presented in this report represent our understanding of the current site conditions. As part of our scope of services Schnabel has completed a site visit and inspection that included walking both the Catharine Creek and Shequaga Creek levee systems and inspecting the existing closure structures.

The Phase 1 study has been directed at evaluating whether the existing levee systems meet the National Flood Insurance Program (NFIP) definition of levee system. Title 44, Chapter 1,Section 59.1 of the Code of Federal Regulations (44 CFR 59.1) defines a levee as a flood risk reduction system that consists of a levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices to protect a hydraulically distinct area. The NFIP considers a levee a manmade typically earthen embankment structure, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

As part of the flood mapping process, the FEMA, and its State and local mapping partners, review and evaluate levee system data and documentation. Community and/or other party seeking recognition or continued recognition of a levee system on a Flood Insurance Rate Map (FIRM) must provide FEMA with data and documentation, certified by a registered professional engineer, showing that the levee system is expected to provide 1-percent-annual-chance (base) flood risk reduction. FEMA does not evaluate the performance of a levee system this is the responsibility of the levee owner. FEMA is responsible for establishing levee system evaluation and mapping standards, determining flood insurance risk zones, and reflecting these determinations on the Flood Insurance Rate Maps (FIRMs).

To be mapped on a FIRM as providing base flood risk reduction, levee systems must meet and continue to meet the NFIP minimum design, operation, and maintenance requirements described in Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10). This Phase 1 study provides information regarding how FEMA maps levee systems, a checklist of the types of data and documentation that must be submitted for levee systems to be accredited on FIRMs, and a preliminary assessment of what geotechnical investigations, hydrologic and hydraulic modeling and structural evaluations are needed for accreditation of the Catharine Creek an Shequaga Creek levee systems.

Accredited Levee System

An accredited levee system is a system that FEMA has determined to meet the design, data, and documentation requirements of 44 CFR 65.10; it therefore can be shown on a FIRM as reducing the base flood hazard. Consistent with all systems, the determination for Catharine Creek an Shequaga Creek levee systems is based on a submittal, on behalf of the Village, which includes 44 CFR 65.10—compliant data and documentation, certified by a registered professional engineer. The area landward of an accredited levee system will ultimately be shown on the FIRM as a moderate-hazard area, labeled Zone X, except for areas of interior drainage flooding such as ponding areas, which will be shown as high-hazard areas, called Special Flood Hazard Areas (SFHAs). Flood insurance is not mandatory in Zone X (shaded) areas, but it is mandatory in SFHAs.

1.2 Study Objective

As stated in Schnabel's March 16, 2021 proposal the objective of the Phase 1 study is to define the geotechnical, structural, and Hydrology/Hydraulic (H&H) engineering services required for a levee certification evaluation, and develope a scope for geotechnical investigation, hydrologic and hydraulic model and structural assessment of the levee systems. The Phase 1 effort is directed at making an informed initial characterization of the MFFDRP with respect to the certification requirements outlined in 44CFR 65.10, and whether the levee systems:

1. Appears likely to be certifiable
2. Appears unlikely to be certifiable
3. Has potential to meet Levee Analysis and Mapping Procedures (LAMP) eligibility for non-accredited systems
4. Has insufficient information (data or other knowledge gaps, including more detailed information and engineering assessment) to evaluate the likelihood of certification

Should the system appear likely to be certifiable (1), the study will develop the Scope required to complete a "Phase 2" Levee Certification Report and advance the certification process. If the system appears likely to not be certifiable (2), the study will identify the deficiencies and outline potential improvements likely necessary to meet certification requirements and also determine if the system has the potential to meet LAMP eligibility (3). Finally, if there is insufficient information available to evaluate the likelihood of certification (4), we will develop a recommended scope of work to close data or knowledge gaps in order to make an informed evaluation to the likelihood of certification.

1.3 Elevation Datum, and Site Terminology

Elevations in this report are in feet (ft) and referenced to the North American Vertical Datum of 1988 (NAVD88) unless noted otherwise. The abbreviation "EL" represents Elevation. Descriptive nomenclature for levees is based upon one looking in the downstream direction. The terms "right" and "left" are referenced in this manner. The impoundment side is known as "flood side" with the opposite side of the levee referred to as "landside". Note that the original design drawings reference a Bench Mark M-102 with an elevation of EL 457.43. Record drawings for the Shequaga Creek Improvement Project note that elevations are referenced to the Plane of Mean Sea Level at Sandy Hook, New Jersey. Record drawings of the Catharine Creek Levee Extension note that elevations are referenced to the mean tide at New York City. The National Geodetic Survey (NGS) has a datasheet for a Bench Mark L 102 in Montour Falls that is noted to be stamped United States Army Corps of Engineers (USACE) BM L 102 reset 1952. This bench mark has an Elevation of EL 455.4 in NAVD 1988 vertical datum. A review of the record drawing top of levee elevations from the 1953 drawings compared with elevations from the National Levee Database and LiDAR based Digital Elevation Model (DEM) data generally showed that the record drawing elevations are approximately 2 ft higher than the NAVD 1988 data; this is generally consistent with the elevation difference between Bench Mark M-102 from the design drawings and BM L-102 Bench Mark from the NGS. Future H&H modeling and engineering evaluation will use NGS and the LiDAR based DEM based elevations and where necessary the proper corrections/conversions will be made to the elevations referenced on the record drawings.

1.4 Review of Existing Data, Drawings, and Documentation

Our review of the existing documentation and data for MFFDRP included the following:

- *Inspection of Completed Works inspection report for the Flood Risk Management Project at Catharine and She-Qua-Ga Creeks*, prepared by USACE. Inspection July 21, 2020, Report September 18, 2020
- *Periodic Inspection of Completed Works, Flood Risk Management Project, Catharine and Shequaga Creeks, Montour Falls, New York,* prepared by USACE. Inspection June 26, 2017, Report June 15, 2018
- *Levee Analysis and Mapping Plan - Montour Falls Flood Damage Reduction Project*, prepared by FEMA. June 2019
- *Montour Falls Flood Protection Project Operation and Maintenance Manual*, May 1953
- *Montour Falls Flood Damage Reduction Project*, prepared by NYS DEC.
- *Emergence Action Plan (revised 2011)*
- *National Levee Database (NLD) survey data*
- *USGS Seneca NY Watershed LiDAR DEM (2014)*

1.5 Levee System Features

The Catharine Creek Levee System is comprised of the earthen levees of the Northern Left Bank, Southern Left Bank, and Right Bank Ring Dike. The Northern Left Bank is approximately 0.9 miles long, while the southern section is just under 0.4 miles, and the right bank measures about 0.2 miles in length.

The crest and slope along the entire Catharine Creek Levee System are vegetated with grass. Seasonal mowing operations were underway during our initial inspection of May 25th and 26th with a portion of the southern reach completed. The landside and floodside earthen embankment slopes of the Southern section are generally inclined at 2.5H:1V.

There are six (6) numbered culverts closures along the Catharine Creek Right and Left Bank levee systems starting at the northern limit of the left bank north reach.

Table 1.1: Catharine Creek Left and Right Bank – Headwall Schedule

Closure Gate No.	Pipe Invert (ft)	Pipe Length (ft)	Pipe Diameter (inches)	Top EL. (ft)	Base EL. (ft)	Length (ft)	Depth (ft)	Base (ft)
1	447.77	62.66	36	451.77	444.77	10.0	7.0	4.25
2	447.36	62.66	36	451.36	444.36	14.0	7.0	4.25
3	450.26	75.36	24	453.26	447.26	8.0	6.0	3.91
4	450.03	75.36	24	453.03	446.53	10.0	6.5	4.08
5	451.84	66.46	24	454.84	448.84	8.0	6.0	3.91
6	451.60	67.08	24	454.60	448.10	10.0	6.5	4.08

Culvert 1 is located on the northern section, approximately half a mile downstream from the Clawson Blvd Bridge. Culvert 2 is also located on the northern section approximately 0.2 miles downstream from Clawson Blvd. Bridge. Culverts 3 and 4 are on the northern section as well, but are approximately 200

and 700 ft upstream of Clawson Blvd, respectively. Culvert 5 is located on the southern section, approximately 600 ft upstream from New York State Route 14. Culvert 5 is the only culvert without a flap gate on the outlet side, and is instead flow through the culvert is controlled by a sluice gate actuated from the crest of the levee through a manhole riser. Culvert 6 is located on the Right Bank Ring Levee, approximately 150 ft downstream of Clawson Blvd. Other than Culvert 5 all of the culverts utilize some combination of corrugated metal pipe (CMP), concrete headwalls and flap gates.
On the Right Bank Ring Levee of Catharine Creek, there is a sewage pump station located about 40 ft from the toe on the protected side. This pump station also has a vent located on the protected slope of the levee. The sewer line is an 8-inch diameter sanitary forcemain installed in 1961 using open trench excavation across the Catharine Creek diversion flood plane and stream channel. The alignment of the sanitary line is a straight line between the two (2) 4-inch diameter PVC vent pipe risers that extend approximately 10 ft above the crest of the levees.

The Shequaga Creek flood protection system consists of an upstream concrete stilling basin at the base of the falls, a twin-cell concrete box culvert, downstream stilling basin, and an earthen levee. The upstream stilling basin contains several 8-inch diameter flap gates that provide drainage and inflow from the landside of the right stilling basin wall. On the left side of upstream stilling basin there is a V-notch weir in the crest of the wall. Flows from a smaller stream channel enter the upstream stilling basin over the V-notch weir through a short length of 30-inch diameter culvert pipe buried within the access road embankment and left wall backfill. Flow from the upstream stilling basin discharges to the left side into the approximately 560 ft long twin-cell box culvert. Each of the culverts is a square section with an inside height and width dimension of 14 inch-6-inch. Two (2) drains penetrate (i.e., one catch basin and one lawn drain) the roof of the culvert permitting some surface water above the culverts to enter and combine with the Shequaga Creek flows. The twin-cell box culvert empties into a 75 ft long downstream stilling basin with an end sill before entering the Shequaga Creek channel, which is bound by an earthen levee on the right side and on the left by the creek channel bank.

The Shequaga Creek levee is approximately 0.2 miles in length and contains five (5) culverts and an abandoned railroad crossing (currently a pedestrian bridge). The crossing is located approximately 770 feet downstream from the end of the culvert floodwall. Two (2) of the culverts an 8-inch and 24-inch diameter are upstream of the pedestrian bridge and three (3) culverts an 18-inch, 24-inch, and 12-inch in diameter and are located at 100, 180, and 450 ft, respectively, downstream of the pedestrian bridge. All five (5) culverts are comprised of a CMP or concrete pipe, concrete headwall, and a flap gate. The earthen levee is covered in grass and weeds, most of it is constructed with a mid-slope bench of approximately 20 ft in width. The Shequaga Creek levee system ends at the confluence with the Catharine Creek adjacent to Henry Street which dead ends at this location. Catharine Creek which provides interior drainage for the Village and it is not clear whether backwater flooding occurs during the 100-yr flood event.

1.6 Physical Properties of the MFFDRP

Tables 1.2 through 1.5 detail the important physical properties of each of the four reaches of the MFFDRP.

Table 1.2: Catharine Creek Left Bank Southern Reach

Construction	Earthen embankment 0.4 mi
Number of Conduit Crossings	1, (Gate No. 5)
Number of Highway Crossings	1, (State Hwy. Route 14)
Crest Elevations	477.5 ft at start and 473 ft at end
Protection	Connects southern high ground end of reach to high ground at Fire Academy

Table 1.3: Catharine Creek Left Bank Northern Reach

Construction	Earthen embankment 0.9 mi
Number of Conduit Crossings	4, (Flap Gates No. 1 through 4)
Number of Highway Crossings	1, (Clawson Avenue)
Crest Elevations	467.2 ft at start and 455 ft at end
Protection	Extends from the north side of high ground at the Fire Academy to the end of the left bank levee segment.

Table 1.4: Catharine Creek Right Bank Ring Levee

Construction	Earthen embankment 0.2 mi
Number of Conduit Crossings	1, (Flap Gate No. 6)
Number of Highway Crossings	0, (east side Clawson Avenue Bridge approach is part of levee system)
Crest Elevations	470.7 ft at start and 463.3 ft at end
Protection	Levee is U-shaped earthen embankment connecting the intersection of L'hommedieu Street and Clawson Blvd. to the other end of the levee 320 ft to the north. Levee protects six (6) properties.

Table 1.5: Shequaga Creek Reach

Construction	Concrete stilling basins, a twin-cell concrete box culvert, and an earthen embankment 0.2 mi
Number of Conduit Crossings	5, (Flap Gates No. CS1 through CS5 through earthen embankment section)
Number of Highway Crossings	2, (Steuben Street and N. Genesee Street)
Crest Elevations	458.6 ft at start and 454.9 ft at end
Protection	Concrete stilling basins and conveyance tunnels contain and covey Shequaga Creek flows north to the Shequaga Creek channel that is bound on the right back by an earthen levee segment protecting the Village.

1.7 Hydrologic Data

Based on the USACE Local Flood Protection Project Operation and Maintenance Manual for Catharine and Shequaga Creeks (O&M Manual), the design discharge for the Catharine Creek Diversion channel varied from 25,000 cfs above Havana Glen to 35,000 cfs at the downstream end of the project. The design discharge for the improved Shequaga Creek Channel was 8,000 cfs. Note that the O&M Manual did not provide a recurrence interval for the design discharges, but the as-built drawings did include flow frequency curves for Catharine Creek and the Diversion Channel at the upstream and downstream ends of the project reach. Schnabel evaluated these discharges for comparison with flows used in the FEMA regulatory hydraulic model for Catharine Creek, the Diversion Channel, and Shequaga Creek. The FEMA FIS notes that flows for Catharine Creek, the Diversion Channel, the Barge Canal, and Shequaga Creek were estimated with exceedance interval/discharge curves developed in accordance with a United States Geological Survey (USGS) Report, *Floods in New York – Magnitude and Frequency* (1961). Where possible, Schnabel also evaluated drainage areas and peak flow estimates with the web-based USGS StreamStats application.

1.7.1 <u>Catharine Creek Above Havana Glen</u>

Based on the Regulatory FIS for Montour Falls (October 1, 1980), Catharine Creek upstream of Havana Glen and the southern end of the project reach has a watershed area of approximately 43 square miles. This is generally consistent with the USACE Local Flood Protection Project Operation and Maintenance Manual for Catharine and Shequaga Creeks, which lists a drainage area of 44 square miles upstream of Havana Glen. The USGS StreamStats application was also used to delineate the drainage area of Catharine Creek upstream of Havana Glen and to provide comparative peak flow estimates. StreamStats provided a drainage area of 44 square miles. Table 1.6 summarizes peak flows for Catharine Creek from the various sources reviewed.

Table 1.6: Catharine Creek Above Havana Glen

Study Source	Drainage Area (sq. mi.)	Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year
FEMA	43	2,930	4,080	4,600	5,800
Corps Manual	44	3,600	5,700	7,000	11,000
USGS StreamStats	44	3,600	5,920	7,010	9,910

Note that the regulatory 100-year flow values, which are used by FEMA for delineation of the regulatory base flood elevations and evaluation of levee freeboard criteria, are approximately 35 percent lower than the flows from the Corps flow-frequency curve and USGS StreamStats estimates. USGS Stream Gage 04232200 is located on Catharine Creek approximately 3,300 ft above the confluence of Havana Glen. At this location, the drainage area is estimated to be approximately 41.1 square miles and the gage has recorded annual peak flows from 1972 – 2019. The largest peak flow was recorded on November 8th, 1996, with a peak flow of approximately 4,700 cfs. The USACE statistical application HEC-SSP was used to perform a Bulletin 17B flow frequency analysis for the stream gage data. A plot of the computed curve along with 5% and 95% confidence limits is provided below.

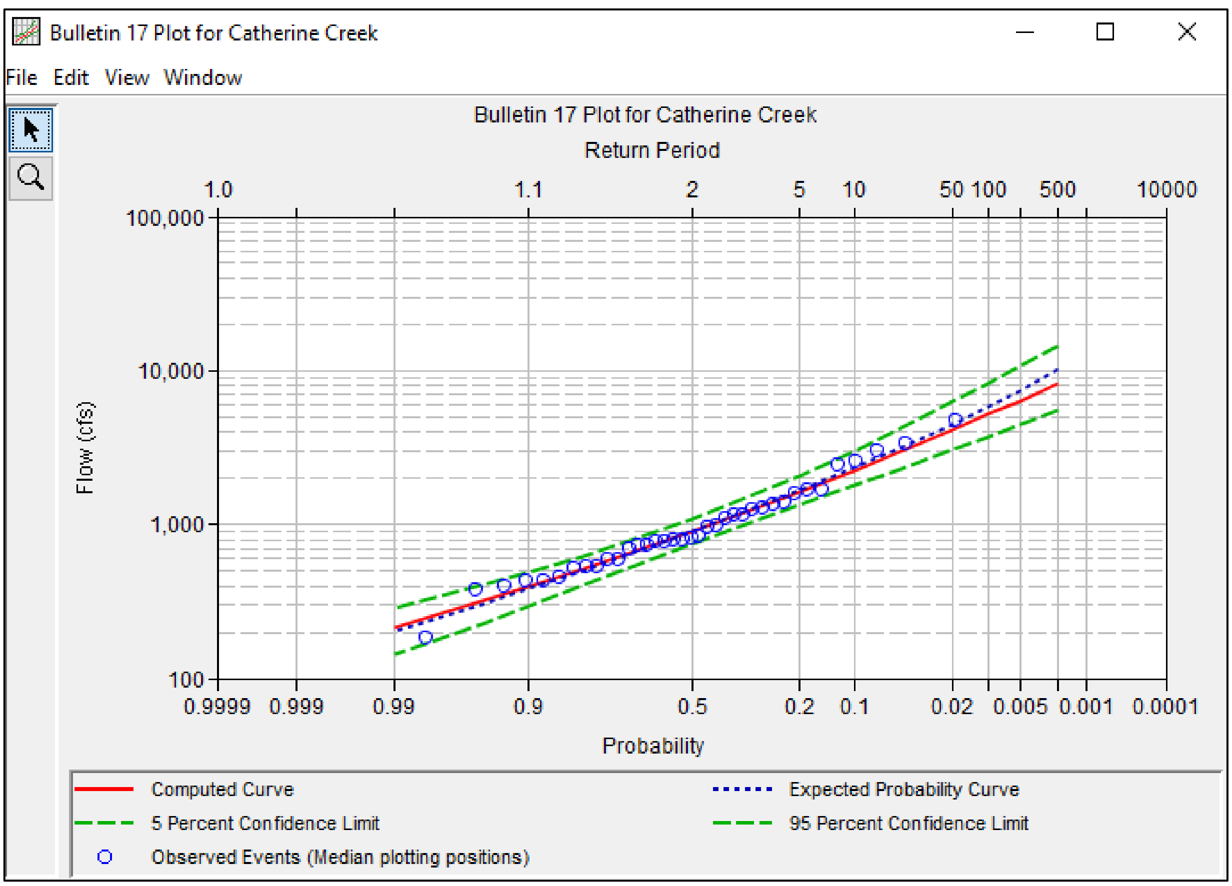


Figure 1.1: HEC-SSP Flow Frequency Curve for Catharine Creek above Montour Falls (USGS 04232200)

The computed 100-year recurrence interval flow at the stream gage is approximately 5,190 cfs and the 95% and 5% confidence limit flows are approximately 3,740 cfs and 8,250 cfs, respectively. Overall, the statistical analyses of the stream gage data predicts a higher 100-year flow than used in the current FEMA regulatory model, but is less than the flows predicted by the Corps and StreamStats. Though it is important to note that all of the flows from the various sources are enveloped within the 95% and 5% confidence limits.

1.7.2 Catharine Creek Diversion Channel

Based on the Regulatory FIS for Montour Falls (October 1, 1980), the Catharine Creek Diversion Channel at the northern end of the project reach has a watershed area of approximately 66 square miles. This is similar to the Corps of Engineer's Local Flood Protection Project Operation and Maintenance Manual for Catharine and Shequaga Creeks, which lists a drainage area of 68 square miles at the northern end of the project reach.

Table 1.7 summarizes the peak flows at the downstream end of the Catharine Creek Diversion Channel. Note that the flow frequency estimates from the USACE are approximately 58 percent higher than those used in the FEMA regulatory hydraulic model.

Table 1.7: Catharine Creek Diversion Channel Downstream End of Project

Study Source	Drainage Area (sq. mi.)	Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year
FEMA	66	4,030	5,460	6,000	7,600
Corps Manual	68	4,800	7,900	9,500	12,000

1.7.3 Shequaga Creek

Based on the Regulatory FIS for Montour Falls (October 1, 1980), Shequaga Creek at the mouth has a watershed area of approximately 16 square miles. This is larger than the USACE Local Flood Protection Project Operatation and Maintenance Manual for Catharine and Shequaga Creeks, which lists a drainage area of 13 square miles at the mouth of Shequaga Creek. The USGS StreamStats application was also used to delineate the drainage area at the mouth of Shequaga Creek and to provide comparative peak flow estimates. StreamStats provided a drainage area of 14.6 square miles. Table 1.8 summarizes peak flows for Catharine Creek from the various sources reviewed.

Table 1.8: Shequaga Creek

Study Source	Drainage Area (sq. mi.)	Peak Flow (cfs)			
		10-Year	50-Year	100-Year	500-Year
FEMA	16	1,310	1,820	2,030	2,580
Corps Manual	13	1,500	2,500	3,200	4,000
USGS StreamStats	14.6	1,410	2,350	2,790	3,980

1.7.4 Overall Flow Evaluation

Based on the evaluation of flow data from various sources at the upstream and downstream end of the project, the flow rates used in the FEMA regulatory hydraulic models are consistently lower than those presented in the Corps As-built drawings as well as lower than estimates from the USGS StreamStats application. Should the Village decide to pursue levee accreditation, it is recommended that more detailed hydrologic modeling be performed to develop flows for use in assessing freeboard compliance during the 100-year base flood storm event. This would include calibration of the model for Catharine Creek for the historic storm events at USGS Gage 04232200.

1.8 Hydraulic Model Evaluation and Initial Freeboard Assessment

1.8.1 FEMA Regulatory Hydraulic Model

The current regulatory hydraulic models for the Catharine Creek Diversion Channel and Shequaga Creek were developed as part of the October 1, 1980 Flood Insurance Study (FIS) for the Village of Montour Falls. The models were developed with the Corps of Engineers HEC-2 hydraulic model. The FIS notes that the model cross sections were developed from topographic mapping at a scale of 1:2,400 and 5 ft contour intervals and were supplemented with in channel field measurements. All bridges and culverts were field surveyed to develop the elevation and structural geometry. Manning's n-values for Catharine Creek and the Diversion Channel ranged from 0.030-0.035 for the channel and from 0.045-0.06 for the overbanks. Manning's n-values for Shequaga Creek were 0.03 for the channel and 0.05 for the overbank areas. The model results for the 100-year base flood were used to develop the regulatory Flood Insurance Rate Map (FIRM) for Montour Falls replicated below. Note that the model and base flood elevations are referenced to the NGVD 1929 vertical datum. Also note that the MFFDRP was considered accredited for development of the 1980 FIRM.

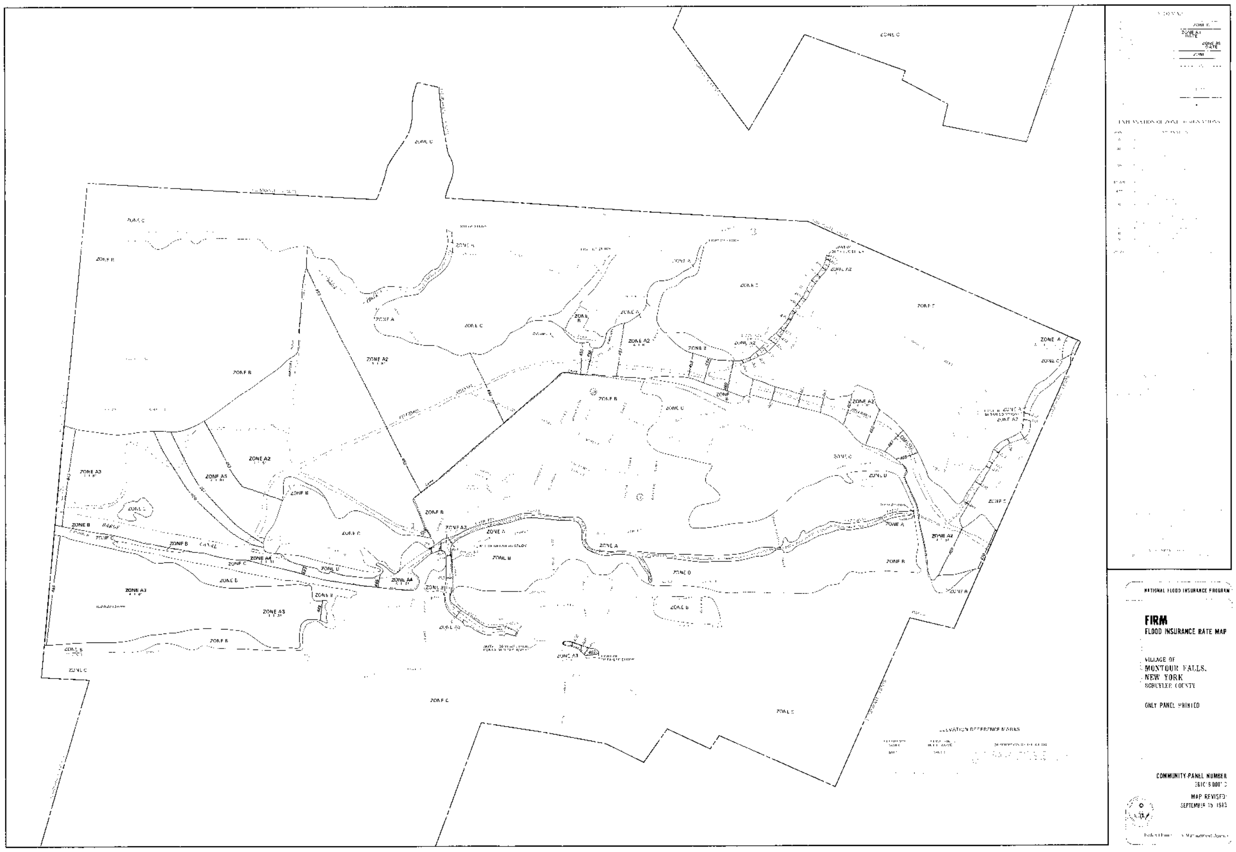


Figure 1.2: Regulatory Flood Insurance Rate Map for Montour Falls

Per current 44 CFR 65.10 levee accreditation requirements, the current minimum freeboard is 3 ft above the Base Flood Elevation (BFE) along the length of the levee. This minimum is increased by an additional 1 foot within 100 ft of structures (such as bridges) or wherever the flow is restricted, and an additional 0.5 foot at the upstream end of a levee. As part of this Phase 1 Certification Evaluation and Scoping Study, Schnabel performed an initial assessment of levee freeboard provided by the existing levee system. Schnabel obtained levee survey point data from the National Levee Database (NLD) as well as LiDAR derived 2-meter resolution digital elevation model (DEM) data encompassing the project reach. Profiles were developed from the NLD alignment for each levee segment which compare the NLD elevation data, LiDAR DEM data, along with FEMA regulatory Base Flood Elevations and the minimum required freeboard. Note that the regulatory BFE's were adjusted from NGVD 1929 vertical datum to the NAVD 1988 vertical datum which is the datum that the NLD data and DEM data are referenced to. The profile plots are presented as Figures 1.3 – 1.6.

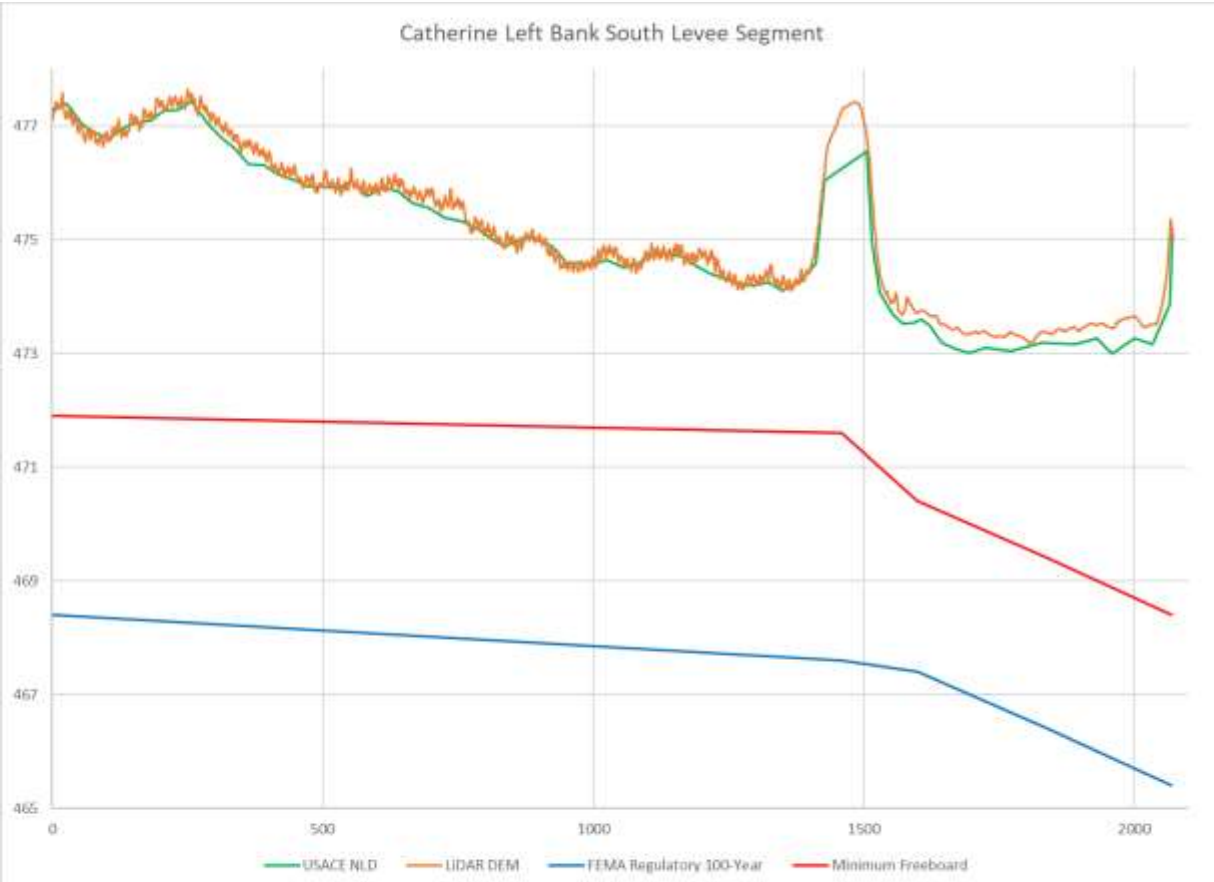


Figure 1.3: Levee Profile for Catharine Left Bank South Levee Segment

The NLD and DEM data indicate that the existing Catharine Left Bank South Levee Segment has crest elevations that generally exceed the minimum freeboard requirements by approximately two (2) to five (5) ft.

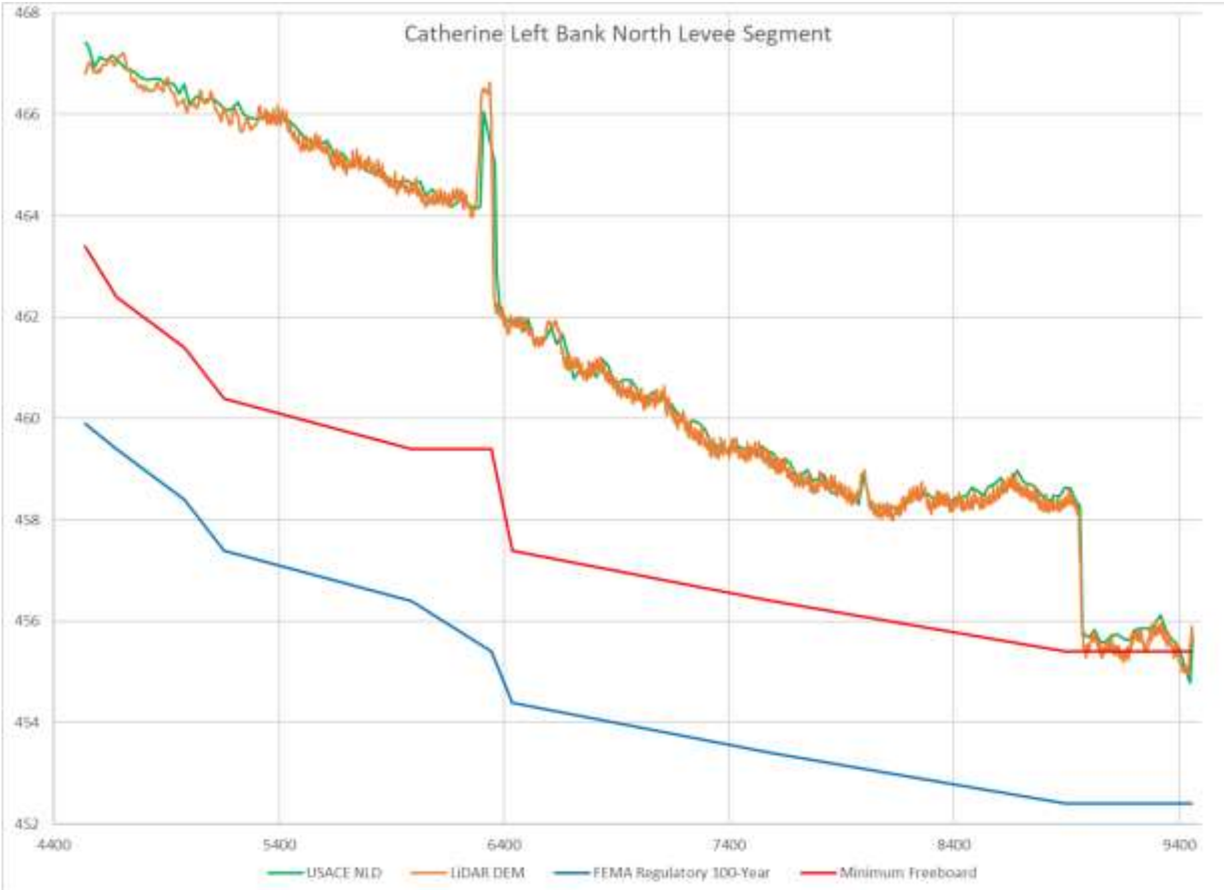


Figure 1.4: Levee Profile for Catharine Left Bank North Levee Segment

The NLD and DEM data indicate that the existing Catharine Left Bank North Levee Segment has crest elevations that generally exceed the minimum freeboard requirements by approximately two (2) to five (5) ft. However, the most downstream portion which was constructed as a levee extension in 1953 may have some minor areas that are below the minimum freeboard requirement.

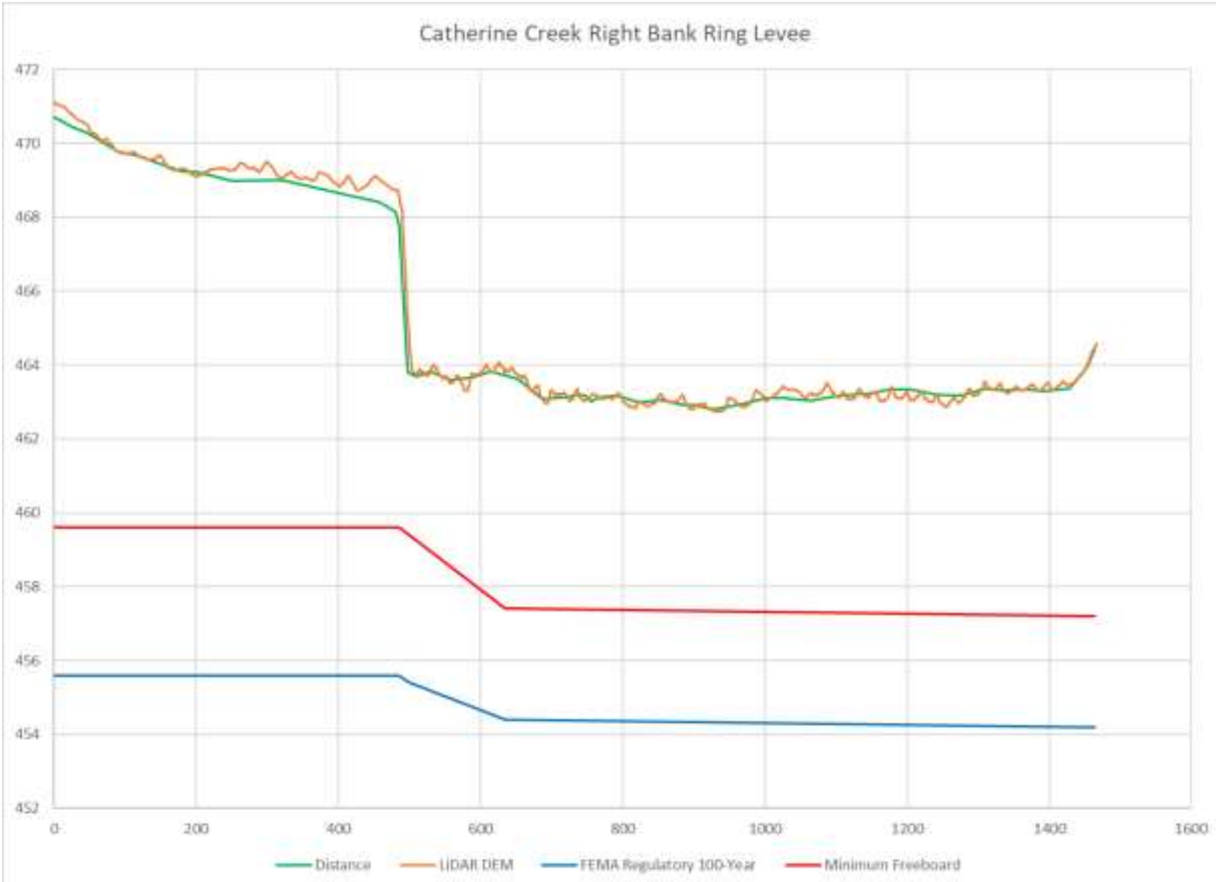


Figure 1.5: Levee Profile for Catharine Right Bank Ring Levee

The NLD and DEM data indicate that the existing Catharine Right Bank Ring Levee has crest elevations that generally exceed the minimum freeboard requirements by approximately four (4) to ten (10) ft.

Figure 1.6: Levee Profile for Shequaga Creek Levee

The NLD and DEM data indicate that the existing Shequaga Levee has crest elevations that generally exceed the minimum freeboard requirements by approximately two (2) to three (3) ft.

1.8.2 FEMA Levee Analysis and Mapping Plan (June 2019)

In September 2018, FEMA Region II partnered with stakeholders in the Village of Montour Falls to form a collaborative Local Levee Partnership Team (LLPT) and worked to determine potential mapping procedures applicable to the Catharine Creek Left Bank and Right Bank Levee Systems. FEMA and its Production and Technical Services provider Strategic Alliance for Risk Reduction II (STARR II) performed some initial hydraulic analyses to help characterize various floodplain mapping options for the Catharine Creek Left Bank and Right Bank Levee Systems. This work included the Natural Valley Procedure, Structural-Based Inundation Procedure, as well as the Sound Reach Procedure. As part of this work, the regulatory HEC-2 model was imported into HEC-RAS 5.06 and converted to an unsteady flow coupled 1-Dimensional (1D) and 2-Dimensional (2D) simulation with geometry based on the NAVD 1988 vertical datum. Unsteady flow hydrographs were developed using the NRCS Unit Hydrograph methodology and scaled to provide peak flows consistent with the current regulatory flow rates for the 100-year base flood. A schematic of the HEC-RAS model geometry is presented in Figure 1.7.

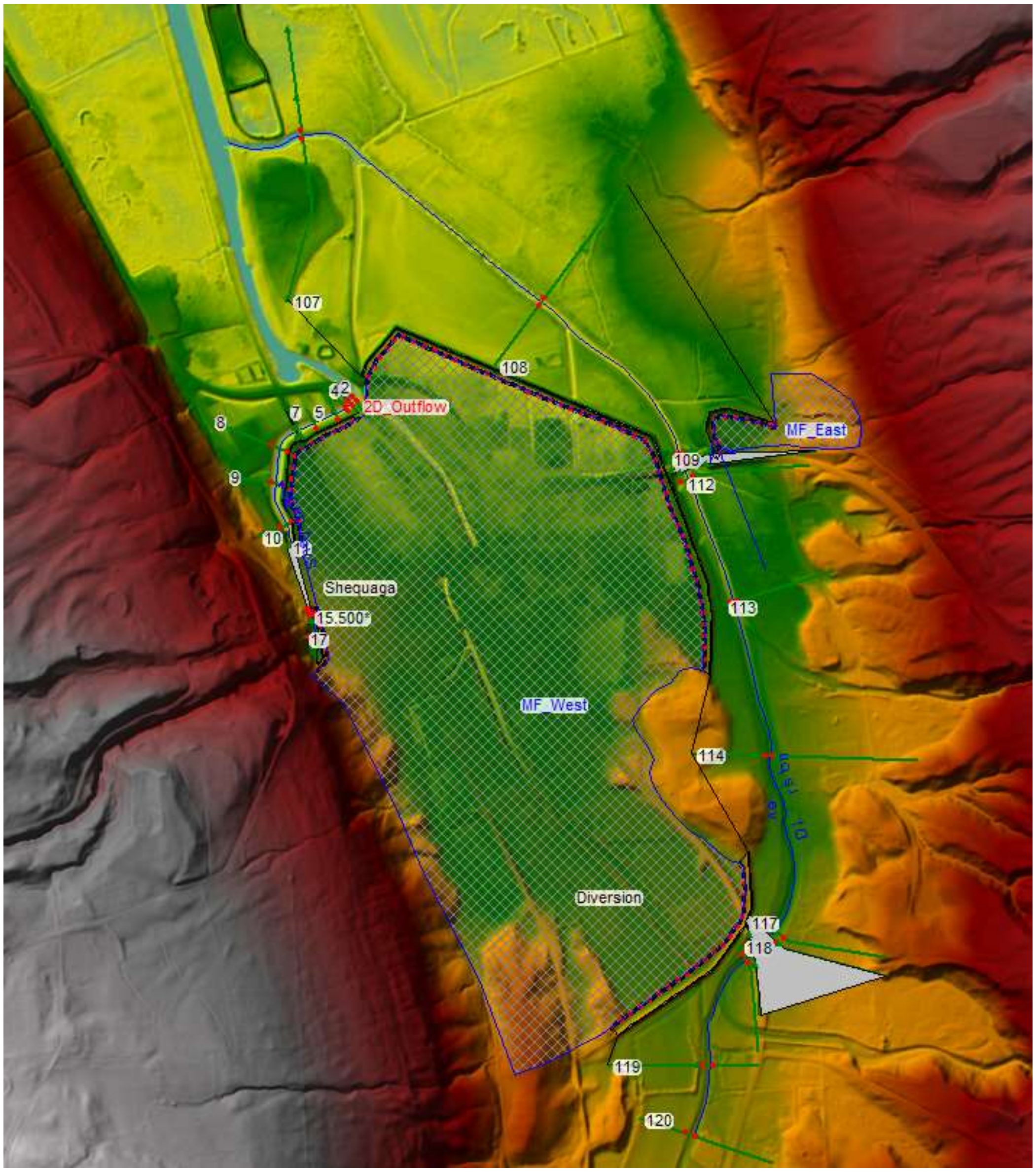


Figure 1.7: HEC-RAS Coupled 1D & 2D Model Geometry for Montour Falls Flood Damage Reduction Project

Schnabel received the HEC-RAS model files from FEMA and reviewed them for applicability for the accreditation process. Based on this review, it looks like the model was developed by utilizing the regulatory 1D model converted to NAVD 1988 vertical datum and then represented the area protected by the levee system as 2D flow areas connected to the 1D model through lateral structures representing the various levee segments. One item of concern is that while the 2D flow areas utilized the 2014 LiDAR DEM data, it appears that the 1D cross sections for Catharine Creek, the Diversion Channel and Shequaga Creek retained cross section data from the FEMA regulatory hydraulic model. In some locations, the cross-section data correlated well with the DEM data, but at a majority of the cross-sections, there were significant differences. An example is at Cross Section 113 of the Diversion Channel presented below.

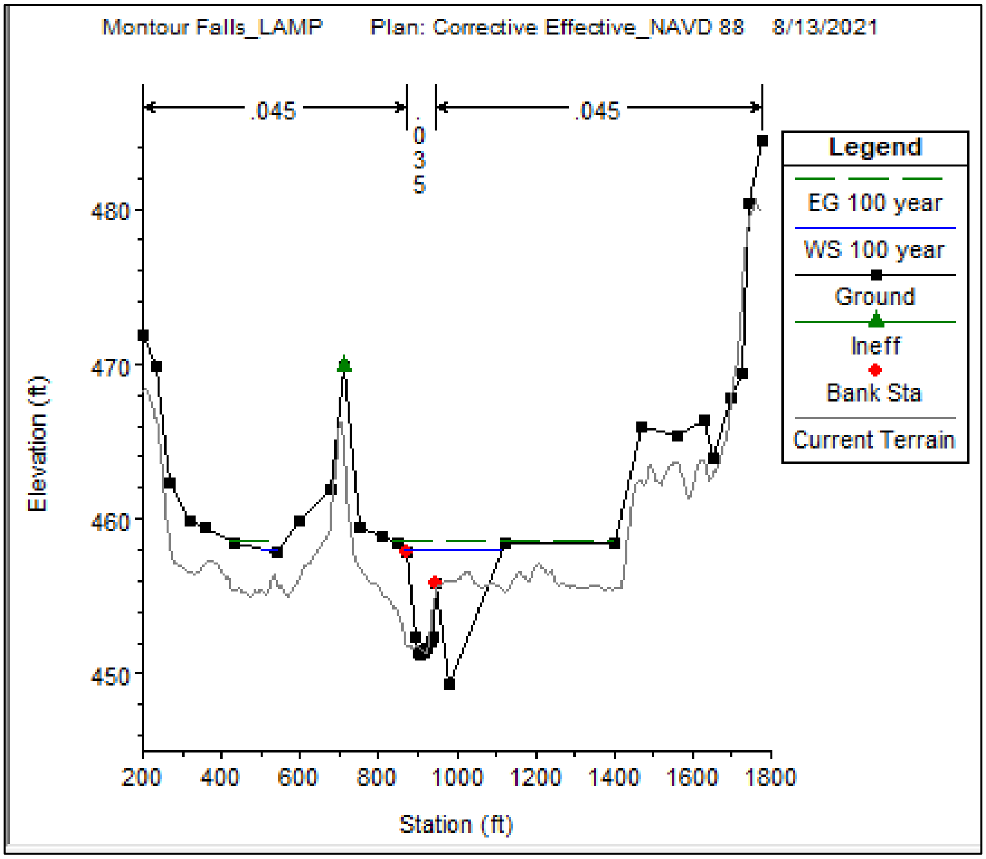


Figure 1.8: HEC-RAS Cross Section 113 and DEM Terrain Data

Schnabel also reviewed peak water surface elevation data between the regulatory 1D model (converted to NAVD 1988) and the coupled 1D-2D model. A comparison plot of peak water surface elevations at Cross Section 113 is presented in Figure 1.9.

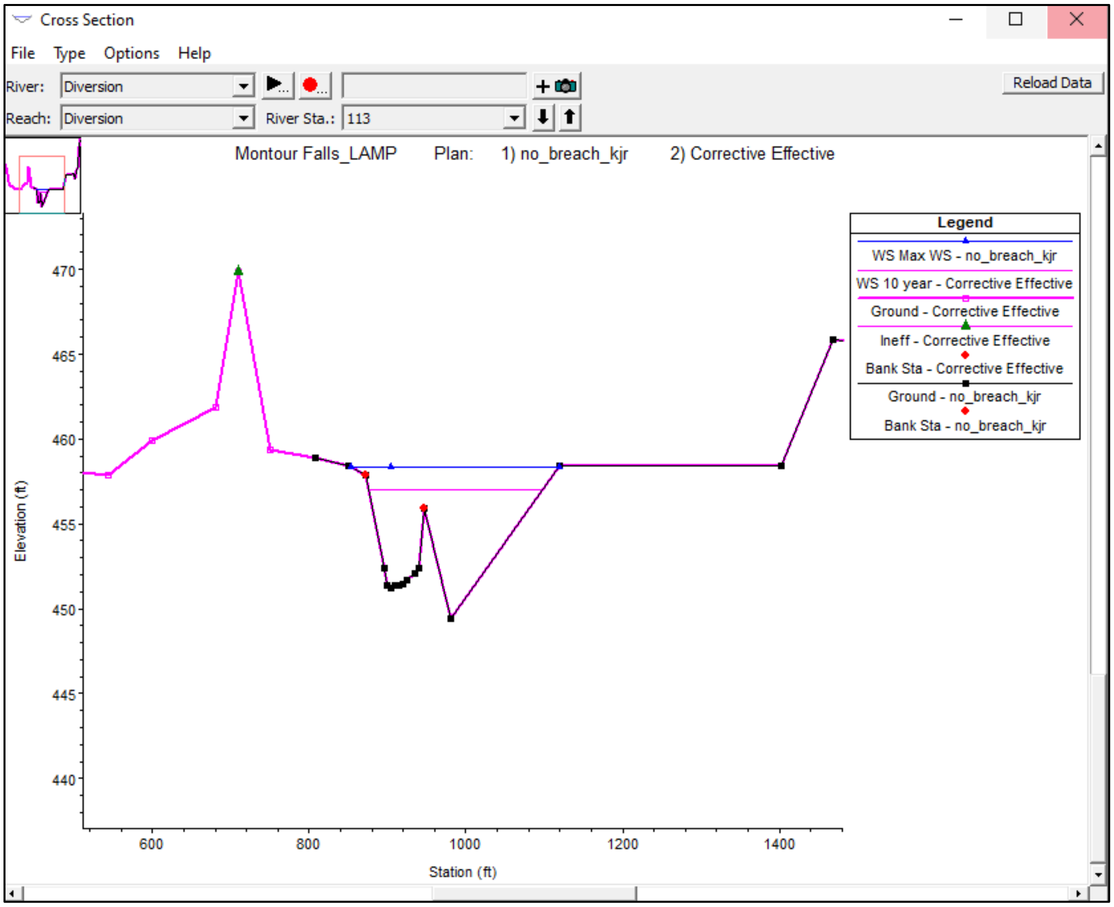


Figure 1.9: 100-Year WSEL Comparison at Cross Section 113

Overall, the revised model generally predicted higher water surface elevations for the 100-Year Base Flood Event of approximately 0.5 to 1.5 ft. This is presumably due to the utilization of unsteady flow data in the revised model geometry for inflows at Catharine Creek, Havana Glen, Catlin Creek, and Shequaga Creek. Even if the higher elevations are reasonable, the excess freeboard identified in Figures 1.3 – 1.6 would indicate that the existing levee system likely meets minimum freeboard requirements. The revised FEMA modeling was also used to assess potential velocities that the levees may be subjected to. Peak velocities for the Sound Reach with No Breaches are presented in Figure 1.10. The Left Bank South segment is predicted to have velocities less than 2 ft/s, which would generally be non-erosive. The Left Bank North segment would likely experience higher velocities of approximately 5 ft/s upstream of Clawson Blvd. The Shequaga Levee segment is predicted to experience the highest velocities of around 6 ft/s.

If the Village decides to move forward with Phase 2 of the accreditation process, we believe that refined hydraulic modeling will need to be performed to better ascertain levee freeboard and erosion stability. We would recommend a full 2-Dimensional model that better utilizes the high resolution DEM data that is available. The model should also utilize refined flow data from the recommended hydrologic modeling of the watershed.

Figure 1.10: 100-Year Peak Velocities

2.0 LEVEE INSPECTION

2.1 General

Schnabel representatives performed a visual inspection of the Catharine Creek and Shequaga Falls levee systems' embankment crest, protected (landside) slope, flood slope, and culvert structures on May 25 and 26, 2021. Schnabel informed the NYS DEC (Sponsor) and the USACE Buffalo District of the inspection and were invited to the USACE's routine annual inspection. On July 20, 2021 the USACE's performed their routine annual inspection with the NYSDEC, and Schnabel as well as the Village representative Dean Hillyard attended. For this report Schnabel has prepared a photo log of the key features of the Catharine Creek Right and Left Bank levee reaches and the Shequaga Stilling Basins, Twin-cell Culverts, and earthen levee using photos taken during these two inspections. The photo log is included as Appendix A.

2.2 Summary of Previous Deficiencies and Recommendations

The 2020 Joint Routine Inspection Report prepared by the USACE details the deficiencies and recommendations, provides photographs, aerial mapping, and provides rating designations of specific levee system components and features as "Acceptable", "Minimally Acceptable" or "Unacceptable". The USACE assigned the MFFDRP with an overall rating of "Minimally Acceptable" and stated the levee system is currently "Active" in the USACE Rehabilitation Program. The report provides a summary of required maintenance and recommendations and these include:

1. Sponsor (NYS DEC) needs to conduct pipe videotape inspections and provide an assessment report to USACE as soon as possible, but by no later than the FY22 inspection. During the July 20, 2021 Joint Annual Inspection representatives of the NYS DEC said they would complete the video inspections late this summer. Due to the lack of video inspections the USACE's has rated the culvert crossings as "Unacceptable". Importantly, no other levee components received an "Unacceptable" rating.

2. Levee deficiencies and recommendations noted in the 2020 Report are limited to stream channel shoaling, erosion and meandering. Future maintenance activity may require shoal excavation and removal especially where vegetation begins to grow within the shoal sediment deposits. Additionally it may be necessary to place rip rap to armor sections of eroding stream channel banks. Shoal deposition and bank erosion was also observed during the recent July 20, 2021 inspection as a maintenance item, however the USACE stated that these dynamic stream channel maintenance items are not something that will interfere with the function of the flood protection levee system.

3. While maintenance of Old Catharine Creek is not required by the project O&M Manual, it is recommended that NYS DEC discuss the possibility of having Village maintain the creek since it serves to facilitate interior drainage through the village.

4. If available the Village should provide documentation regarding the depth of the 8-inch diameter sewer force main immediately downstream of the Clawson Street Bridge. It is understood that this sewer line was installed in 1961 along an alignment marked by the 4-inch diameter vent risers on the ring levee and north segment of the Catharine Creek Left bank. The force main pipe is reported by the Village to be a ductile iron pipe.

At the conclusion of the July 20, 2021 inspection the Robert Remmers of USACE gave a verbal summary of the levee systems stating that conditions are generally unchanged from July 2020 and the levees are in good condition being well maintained and mowed. Also the Shequaga concrete conveyance structures appear in good condition.

2.3 Embankment Crest

During the May 25th and 26th inspection the Catharine Creek Left Bank embankment crest was covered in tall grass, with the exception of the southern levee section where mowing was underway and the crest was freshly mowed. At the July 20th USACE's routine inspection all the levee reaches were mowed (Photos 2 & 9). Some minor ruts and tracks from vehicle access were noted on both the northern and southern sections of the Left Bank. No wet spots, cracking, or rodent holes were observed on the on the Catharine Creek Left and Right Banks or Shequaga Creek levee section crests.

The Shequaga Creek channel begins at the base of the Shequaga Falls and is composed of a series of concrete structures including stilling basins and a twin-cell box culvert that extends beneath North Genesee Street (Photos 21 & 26). Beyond the concrete structures the Shequaga Creek is bound on the right side by an earthen levee and the crest of the levee is grass covered (Photos 28 & 33). A few rodent holes were observed along the crest (Photo 29). No wet spots, depressions, or cracks were observed.

2.4 Protected Slope

The protected slope of both the Catharine Creek Left and Right Bank levees are in good condition with good grass vegetation, and no indications of slope instability or erosion. Access to the protected side, as well as, the flood side slopes can be made via multiple Village Streets, the Clawson Avenue bridge and State Route 14 bridge crossings. On the Southern Left Bank, encroachments are limited to utility pole and power line crossings (Photo 7, 9, and 13). Interior drainage from the protected area of the Left Bank is provided by culvert crossings and flap gates No.1 through 4, and sluice gate No. 5 (Photo 10 and 11). The Right Bank has a sewer force main encroachment marked by 4-inch diameter PVC riser vents. A sewer pumping station is protected within the Right Bank levee enclosure. Interior drainage from the protected area is provided by culvert crossing and flap gate No. 6 (Photo 16 and 17). No sloughs, cracking, wet spots, or depressions were observed.

The protected side of the Shequaga Creek Levee had a relatively gentle slope. The slope is vegetated with grass. No sloughs, cracking, wet spots, or depressions were observed.

2.5 Flood Slope

The flood slope of both Catharine Creek Left and Right Bank levees sections appeared were in good condition. On the Left Bank southern section, there were three utility poles on the flood side with power lines running above and across the levee (Photo 9). The location of the poles are greater than 15 ft from the toe of the levee the power lines however cross over the levee thereby are an encroachment. The flap gates for culverts No. 1, 2, 3, 4, and 6 were found to be in good working order. Flow control through culvert No. 5 at the southern of the levee is managed with actuation of a sluice gate. The sluice gate is partially open as runoff ponded in ditches on the flood side from recent heavy rains has drained through the culvert to the old Catharine Creek channel.

Similar to Catharine Creek the flood slope of the Shequaga Creek levee is in good condition with only a utility pole and power line encroachment. Some rodent activity was observed on the flood slope where the earthen embankment meets the culvert outlet structure. The abandoned railroad bridge is the only creek crossing point between the twin-cell box culvert upstream and the end of the levee downstream (Photo 33) at Henry Street.

2.6 Interior Drainage Culvert Structures

A total of six (6) numbered culverts provide interior drainage on the Catharine Creek Levee System. Culverts No's. 1, 2, 3, and 4 are located within the Left Bank Northern section, culvert No. 5 is located within the Left Bank Southern section, and culvert No. 6 is on the Right Bank Ring levee. All of the numbered culverts except for No. 5 are flap gates; culverts No's. 3, 4, and 6 measure 24-inch in diameter (Photos 1, 5, 6, & 17), and culvert No. 1 and 2 measure 36-inch in diameter (Photo 3). Culvert No. 5 also measures 24-inch in diameter it is controlled by a sluice gate manually actuated from the crest of the levee (Photos 10, 11, & 12). The inlet for culvert No. 6 is a shallow catch basin structure that is covered by a grate located near a sewage pump station (Photos 15 & 16). All flap gates were in working order and seemed to be regularly maintained.

The concrete stilling basin at the base of Shequaga Falls directs the water towards the twin-cell concrete culvert. Each culvert cell of the concrete box culvert measures approximately 14 x 14 ft. Within the upstream stilling basin and culvert, there are several flap gates and inlets that allow water to drain into the channel (Photos 22, 23, & 25). Some slight cracking was observed at the base of the northern cell near the inlet (Photo 24). There was little to no debris observed inside the culvert or inlet and outlet stilling basins. There is however sediment shoals that should be excavated and removed to mitigate meandering and erosion by stream flows.

On the Shequaga Creek earthen levee interior drainage is provide by five culverts each having a flap gate on the flood side discharge end. The USACE has numbered these culverts CS-1 through CS-5 starting with the culvert farthest upstream near the outflow stilling basin of the twin-cell culvert. The measured diameter of culverts CS-1 through CS-5 are 8-inch, 24-inch, 12-inch, 24-inch, and 12-inch respectively (Photos 31 and 32).

At the end of the Shequaga Creek levee (i.e., Henry Street) the confluence of old Catharine Creek channel is provides interior drainage. During the July 20, 2021 inspection discussion of the level of protection at the confluence concluded with further modeling of flood events is needed to better understand the backwater impacts north of the confluence. The levee crest elevation upstream of Henry Street is believed to be overbuilt due to the former box culvert creek crossing that constricted Shequaga Creek flows. With the removal of the box culvert the level height may be lowered to the existing berm height. Modeling should investigate the terminus of the Shequaga Creek system.

3.0 LEVEE ACCREDITATION

Accreditation of a levee system involves the gathering of data and documentation that will demonstrate that the existing system meets or can meet and be in compliance with the NFIP 44 CFR 65.10 requirements. Compliance with NFIP 44 CFR 65.10 allows FEMA to recognize a levee system provides a 1 percent-annual-chance flood reduction for the community and areas on the landside (protected side) of the levee system maybe mapped as Zone X on the FIRM's.

3.1 Checklist

FEMA has developed checklists for community owners, sponsors and their engineering representatives to follow as means of preparing a comprehensive accreditation submittal, and as a means of streamlining review of the submittal. Schnabel plans to follow the checklists, data organization, and submittal format recommended in the document titled **FEMA Suggested Tabbed Submission for 44 CFR 65.10 Accreditation Material**. Based on this FEMA document and checklists a comprehensive accreditation submittal will be prepared that includes the data and documentation for four general categories of an accreditation submittal including Design Criteria, Operational Plan, Interior Drainage Plan, and Maintenance Plan.

Design Criteria (Section of the NFIP Regulations: 65.10(b)): includes six (6) general levee system features that require analysis to ensure continued base flood risk reduction capability. Each of the levee system design features are described below:

- **Freeboard.** Through hydrologic and hydraulic modeling of the levee systems Schnabel will verify that the required minimum freeboard is 3 ft above the Base Flood Elevation (BFE) along the length of the levee. This minimum is increased by an additional 1 foot within 100 ft of structures (such as bridges) or wherever the flow is restricted, and an additional 0.5 foot at the upstream end of a levee (i.e., the South Segment of the Catharine Creek Left Bank levee system).

- **Closures.** The existing conduits within the MFFDRP include five (5) openings on the Catharine Creek Left Bank, one opening on the Catharine Creek Right Bank (Ring Levee) and five (5) openings on the Shequaga Creek levee systems respectively. Each of these openings through the earthen levee include closure devices (i.e., flap gates and sluice gates) that are structural parts of the system during operation. These structures will be thoroughly inspected to ensure they are properly designed and operational.

- **Embankment Protection.** Schnabel will complete engineering analyses that evaluate the potential for erosion of the levee embankment during the base flood, as a result of flow velocity during the BFE. Where erosion resistance analysis show armoring is necessary conceptual design recommendation will be prepared, or the analysis will be used to support the conclusion that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability.

- **Embankment and Foundation Stability Analyses.** Critical to accreditation is an engineering analyses of levee embankment to evaluate stability. Schnabel will provide analyses that evaluate expected seepage during loading conditions associated with the base flood and demonstrate that seepage into or through the levee foundation and embankment will not destabilize embankment or foundation soils. Schnabel will complete an analysis that meets the Case IV levee embankment loading conditions as defined in the USACE Engineer Manual 1110–2–1913, Design and Construction of Levees, (Chapter 6, Section II). This analysis is aimed at demonstrating that the levee is designed and constructed for stability against loading conditions developed during the base flood event.

- **Settlement Analyses.** Although settlement is not expected to be significant given the age of the MFFDRP, Schnabel will collect the samples, and perform the necessary laboratory testing to support an engineering analyses that assesses the potential and magnitude of future losses of freeboard as a result of levee settlement. This analysis will address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in USACE Engineer Manual 1110–1–1904, Soil Mechanics Design—Settlement Analysis, will be submitted.

- **Interior Drainage.** Levee accreditation requires an interior drainage analysis that identifies the source(s) of interior flooding, the extent of the interior flooded area, and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters, as described in USACE Engineer Manual 1110-2-1914, Hydrologic Analysis of Interior Areas.

Operation Plan (Paragraph 65.10(c)(1) of the NFIP Regulations): For a levee system to be accredited, the operational criteria described below must be provided. Closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought. Checklist for Operation Plan:

- **Flood Warning System.** Documentation of the flood warning system that will be used to trigger emergency operation activities is required. The warning system must demonstrated that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.

- **Plan of Operation.** An accredited levee system must have a formal plan documenting the operation including specific actions and assignments of responsibility by individual name or title.

- **Periodic Operation of Closures.** The operations plan must include provisions for periodic operation, at not less than 1-year intervals, of the closure structure for testing and training purposes.

Interior Drainage Plan (Paragraph 65.10(c)(2) of the NFIP Regulations): Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood risk reduction purposes only if the following minimum criteria are included in the operation plan. Checklist for Interior Drainage Plan:

- **Flood Warning System.** Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities; and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.

- **Plan of Operation.** A formal plan of operation including specific actions and assignments of responsibility by individual name or title.

- **Manual Backup.** Provision for manual backup for the activation of automatic systems.

- **Periodic Inspection.** Provisions for periodic inspection of interior drainage systems and periodic operation of mechanized portions for testing and training purposes. The plan must define the frequency of these inspections to be 1 year or less.

Maintenance Plan (Paragraph 65.10(d) of the NFIP Regulation): Accredited levees require the maintenance criteria described below. Checklist for Maintenance Plan:

- Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system as a condition for accreditation.

- All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP which must assume ultimate responsibility for maintenance.

- This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, the plan shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

3.2 Certification

Paragraph 65.10(e) of the NFIP Regulations require a Professional Engineer certifies data submitted to support that a given levee system complies with the structural requirements set forth in “Design Criteria” (Paragraphs 65.10(b)(1) through (7) of the regulations). Certifications are subject to the definition given in Section 65.2 of the NFIP regulations which have been promulgated to ensure the levee system has been adequately designed and constructed to provide protection from the base flood.

Certified as-built levee plans are included in the submittal. For MFFDRP the existing May 1953 record drawings will be reviewed and revised as necessary for submission as record drawings.

4.0 MFFDRP SCOPE FOR ACCREDITATION

As stated in our proposal the scope of work for levee accreditation is predicated on the likelihood that the MFFDRP is certifiable. It is Schnabel's opinion that the MFFDRP is certifiable with the completion of updated hydrologic and hydraulic modeling and with the completion of a supplemental geotechnical exploration program. This opinion is based on our review of the checklists presented in Section 3, the review of available MFFDRP documentation and data, and our site inspections on May 25th and July 20th.

The accreditation scope has been broken into four general categories consistent with the checklists outlined in Section 3.

4.1 Scope for Accreditation Design Criteria

Design criteria accreditation includes six components as outlined in Section 3. Schnabel has grouped each design criteria based on the lead engineering discipline hydrologic and hydraulic, geotechnical and geostructural.

4.1.1 Hydrologic and Hydraulic Design Criteria

Based on review of the FEMA regulatory and interim refined hydraulic modeling, we believe that more detailed hydrologic and hydraulic analyses will be required to support accreditation of the MFFDRP. Three (3) critical design criteria including freeboard, embankment protection and interior drainage will be addressed with the refined H&H assessment and modeling of the MFFDRP.

Revised Hydrologic Modeling

As summarized in Section 1.7, various flow estimates have been made for Catharine Creek, the Diversion Channel, and Shequaga Creek to support the design of the levee system as well as for preparation of FEMA Flood Insurance Rate Maps. Based on review of the various studies, the flow estimates are based on dated regression-based methodologies from the 1950's and 1960's. While the flows used in the Corps design of the levee system appear conservative, we believe that a more refined hydrologic model of the Catharine Creek, Diversion Channel, and Shequaga Creek watersheds is warranted.

The refined hydrologic model would be developed using the Corps of Engineer's HEC-HMS hydrologic model. Sub-basins would be developed for Catharine Creek at the USGS stream gage, Havana Creek, Catlin Mill Creek, Diversion Channel, and Shequaga Creek as well as for interior areas within the levee protected region. Hydrologic parameters would be initially estimated using available topographic mapping, soils mapping, and landuse mapping. The parameters would then be refined or validated through evaluation of historic storm events at the USGS stream gage on Catharine Creek. The hydrologic model would then be evaluated for design storm events including the 10-year, 50-year, 100-year, and 500-year recurrence interval events utilizing rainfall depths and distributions from NOAA Atlas 14.

Revised Hydraulic Modeling

Schnabel will develop a full 2D hydraulic model of the MFFDRS using HEC-RAS Version 6.0. Model geometry will utilize the high-resolution DEM data Supplemented with channel and bridge survey data from the FEMA regulatory model. Unsteady inflow hydrographs will be utilized from the refined HEC-HMS model. Manning's roughness coefficients will be based on the 2016 National Land Classification Database and refined for channel areas consistent with the FEMA regulatory model. The model will extend from upstream of Havana Glen, downstream to the Barge Canal and will use FEMA stillwater elevations in Seneca Lake as the downstream boundary condition. The HEC-RAS 2S model will be evaluated for the 10-year, 50-year, 100-year, and 500-year storm events. This will allow for evaluation of the levee system freeboard requirements as well as to quantify localized velocities at the levee segments to assess the potential for erosion that could compromise the stability and integrity of the embankments during design storm events. The HEC-RAS 2D model will also be used to evaluate the interior drainage system behind the levee system. This will help map any potential special flood hazard areas within the levee protected area.

4.1.2 Geotechnical Design Criteria

Two (2) design criteria including, embankment and foundation stability analysis, and embankment settlement will be addressed with geotechnical investigation, testing and analysis. Schnabel proposes that the accreditation submission include geotechnical assessment to evaluate the geotechnical aspects of levee system. Based on our site visits and review to the levee system record drawings Schnabel recommends the performing a geotechnical investigation at each of the levee system segments including the Catharine Creek Left Bank North Section, the Left Bank South Section, the Right Bank Ring Section and the Shequaga Creek levee.

Geotechnical Drilling Investigation

The objective of the investigation and testing is to support the development of stratigraphic sections through the earthen levee embankments, define soil strengths and settlement characteristics of the embankment and foundation soils for geotechnical engineering analyses (e.g., seepage and slope stability, and stability). To accomplish this objective, the geotechnical investigation would include:

1. Drilling test borings and collecting samples of encountered fill soils, foundation soils, and bedrock (if encountered).
2. Performing Standard Penetration Tests (SPTs) and collecting split-spoon samples of encountered soil materials for laboratory testing.
3. Collecting thin-wall “Shelby” tube samples of encountered applicable soil materials for laboratory testing.

Four (4) subsurface exploration locations have been selected for completion of a geotechnical drilling and testing investigation. At three (3) of the locations including: the North Segment of the Left Bank, the South Segment of the Left Bank, and the Right Bank Ring levee we propose advancing three (3) borings (e.g., a flood side toe, levee crest and landside toe boring). The fourth location would be a single boring on the crest of the Shequaga Creek Levee embankment.

The borings will provide geotechnical data and samples for laboratory testing of the embankment fill and foundation soils and be used to develop cross sections of the levee structure and ground water levels. The four (4) drilling locations listed below are referenced to the May 1953 Record Drawings by Plate No. and Station location.

1. North Segment Left Bank, Station No. 517+50 Plate 4, Landside toe boring 25 ft, Levee crest boring 40 ft, and Flood side toe boring 25 ft.

2. South Segment Left Bank, Station No. 610+00 Plate 10, Landside toe boring 25 ft, Levee crest boring 40 ft, and Flood side toe boring 25 ft.

3. Ring Levee Right Bank, Station No. 725+50 Plate 5, Landside toe boring 25 ft, Levee crest boring 40 ft, and Flood side toe boring 25 ft.

4. Shequaga Creek Levee Embankment, Station No. 453+00 Plate 26, Levee crest boring 40 ft.

During the drilling operation Schnabel would observe the field operations, select sample collection depths, log the borings, and classify soil samples in accordance with ASTM D2488 (Visual Manual Method). Test borings will be advanced using 4.25-inch inside-diameter (I.D.) hollow stem augers (HSA) to the desired termination depth or until refusal, which will be interpreted as the top of bedrock.

Soil will be sampled in test borings either using a 2-inch outside-diameter (O.D.), 24-inch length split-spoon sampler (to collect a disturbed sample) or using a 3-inch diameter, 30-inch tube length thin-walled (Shelby) tube sampler (to collect a relatively undisturbed sample). Split-spoon samples will be obtained by performing SPTs, which will be performed in accordance with ASTM D1586, “Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.” Continuous sampling utilizing split-spoon samplers will be performed until directed otherwise by the Engineer’s on-site representative. Variance from continuous SPT sampling may include sampling with Shelby tube samplers or changing the SPT sequence from continuous to 5 ft interval sampling within the foundation material at the direction of the Engineer. Shelby tube sampling will be performed in embankment and foundation materials if encountered soils are likely to lead to acceptable Shelby tube recoveries. Shelby tube samples will be obtained in general accordance with ASTM D1587, “Standard Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purpose.”

Pocket penetrometer readings will be collected on applicable fine-grained SPT and Shelby tube samples. Pocket torvane readings will be collected on Shelby tube samples.

Borings will be backfilled from the bottom up with a cement-bentonite grout via tremie pipe. Grouting will be performed in stages. Water levels will be measured before commencing grouting operations. A stake will be placed at the test boring location after backfilling is complete. Upon completion of the geotechnical investigation, the site will be restored to pre-investigation conditions to the extent practical. We assume that site restoration may include repair of vehicle ruts, spreading of spoil piles, seeding and mulching of disturbed areas.

Geotechnical Engineering Analyses

Schnabel will perform seepage, stability and settlement analyses for the four drilling locations discussed above based on the best available geometry developed from prior surveys, publically available GIS LiDAR data of the MFFDRP, and the available record drawings. Soil strength, permeability and settlement parameters derived from the drilling data, the geotechnical testing laboratory results and engineering judgement will be used in the analyses. A computer-aided limit-equilibrium embankment slope stability analysis will include computing factors of safety (FOS) for the levee embankment to determine if they meets generally accepted standard safety levels as outlined by the USACE in EM 1110-2-1902 Table 3-1 for the five different loading conditions described below:

- Normal Pool, Steady State Seepage – Lake at the maximum, normal pool elevation, upstream and downstream embankment slopes modeled;
- Rapid Drawdown – Condition in which the phreatic surface mirrors the upstream slope to model elevated pore pressures in soils that may not drain as rapidly in the event the reservoir is drained, upstream embankment slope modeled;
- Maximum Surcharge Pool – Maximum water level during the PMF, downstream embankment slope modeled;
- Seismic Loading – Water at normal pool elevation with a peak seismic ground acceleration as determined using USGS method for the dam site, upstream and downstream embankment slopes modeled.

The piezometric conditions encountered at the site during the exploration program (and preferably multiple readings over time with varying reservoir pool levels) will be used to update the piezometric conditions in the slope stability models.

Where compressible embankment or foundation soils are encountered at the drilling location a settlement analysis will be performed using geotechnical laboratory soil compressibility test results of undisturbed samples obtained with Shelby tube sampling. Based on the age of the levees, no plans for additional loading and the observed crest uniformity during our site visit, Schnabel does not expect settlement to be a levee accreditation issue. Data and analysis will be used to confirm the observed condition and performance of the levees.

Calculations, results, and a summary of the analyses will be provided as part of the accreditation application package.

4.1.3 Geostructural Design Criteria

A final design criteria, closures, will be addressed with geostructural inspection and assessment. Schnabel anticipates that the accreditation submission will include a thorough inspection of the six (6) closure gates permitting interior drainage through culverts crossing the Catharine Creek Left and Right Bank levee segments, and the five closure gates permitting interior drainage through culverts crossing the Shequaga Creek levee. The inspections will be coordinated with the NYS DEC (Sponsor) for assistance in clearing ditch and intake structures of debris and sediment. In addition to the closure gate inspections, the geostructural assessment will review the culvert inspection video and documentation, that is scheduled for completion by the Sponsor late this summer and early fall 2021 using a remotely operated vehicle (ROV).

Based on our May 25th and July 20th levee inspection Schnabel observed the closure gates to be in good condition and this assessment was shared by the USACE's personnel during their July 20th inspection. The culvert piping passing through the base of the levee, however, is primarily metal pipe (CMP) that has been in service for nearly 60 years exceeding its design life. It is likely that ROV video will show the need for relining some or all the culvert pipes as part of accreditation of the levee systems. It is important at this point in time to address the aging CMP culverts before the piping weakens due to corrosion and collapses. Relining the CMP with fold-and-form or insitu-form PVC or fiberglass liner is a common culvert pipe rehabilitation technique of earthen embankment levees.

For the Catharine Creek Left and Right Bank levees the estimated length of CMP includes: two 36-inch diameter culverts totaling 130 ft and four 24-inch diameter culverts totaling 280 ft. For the Shequaga Creek levee the culvert crossing include: one 8-inch diameter culvert at an estimated length of 80 ft, two (2) 12-inch diameter culverts totaling and estimated 145 ft, and two (2) 24-inch diameter culverts totaling an estimated 155 ft. The slip-lining process provides a structural repair of the culvert pipes and improved flow efficiency that compensates for the minor reduction in inside pipe diameter.

4.2 Scope for Accreditation Operations Plan

The Catharine Creek Left and Right Bank, Shequaga Creek levee systems have an existing Operations Plan titled the Local Flood Protection Project Operation and Maintenance Manual (1953). This document is the officially adopted operations manual. As part of the accreditation this manual will be updated and be provided to FEMA. The updated manual will be formatted to in accordance with FEMA recommended checklist format as outlined below.

- **Flood Warning System –** The total drainage area of the Catharine Creek and Shequaga Creek watersheds are comparatively small in both length and width therefore the establishment of a flood warning system is not practical and has never been included the Operations Manual. Furthermore only the hand operated sluice gate in the control manhole at Catharine Creek requires closure during high water events. Given the MFFDRP levee flood control system relies largely on passive flow control through ditches, culverts and flap gates the emphasis of the updated Operations Manual will be to insure these systems are well maintained. No flood warning system is anticipated to be required for accreditation of the MFFDRP.

- **Plan of Operation -** Operation Manual lists six levee system components and features these include: Channels and Floodway, Earthen Levees, Drainage Ditches and Culverts, Concrete Retaining Walls, the Concrete Flood Control Structures at Shequaga Creek, and Highway and Foot Bridges. None of these components or features, with the exception of hand operated sluice gate in the control manhole at Catharine Creek, requires operation. The Operation Manual will detail the required patrolling and inspections during periods of high water.

- **Periodic Operation of Closures -** The updated Operation Manual will identify that periodic operation and closures is limited to the hand operated sluice gate in the control manhole at Catharine Creek (i.e., culvert closure No. 5 Catharine Creek Left Bank). The plan will insure that periodic operation of the Sluice gate is performed at a frequency of 1-year or less. The flap gate culvert closures will be inspected to insure not obstructions inhibit the opening and closure of these passive control gates.

4.3 Scope for Interior Drainage Plan

Interior drainage systems for the MFFDRP flood control includes storage areas, and gravity outlets (i.e., the old Catharine Creek Channel). There are no pumping stations for flood control. Updated H&H modeling of these drainage systems will be completed as part of the design criteria discussed in Section 4.1. The modeling will more accurately define the performance of the storage areas and Catharine Creek drainage during the BFE to identify where interior high-hazard areas (i.e., Special Flood Hazard Areas) may be present. For accreditation the existing Operation Manual will be updated to present a passive interior drainage plan and the limits of flood impacts. The updated manual will be formatted to in accordance with FEMA recommended checklist format as outlined below.

- **Flood Warning System.** The existing Operation Manual does not include a flood warning system for interior drainage since performance of the MFFDRP flood controls had demonstrated that existing interior low lying areas and gravity drainage provide sufficient storage and drainage during high water events.

- **Plan of Operation.** At this time we anticipate that the plan of operation for the Interior Drainage Plan will be to patrol designated low storage areas and the Catharine Creek channel to insure drainage is not obstructed and predictive model limits of flooding are not exceeded. Updated plan will establish the inspection routine and critical points of observation.

- **Manual Backup.** Given the MFFDRP flood controls are either manual or passive this requirement will not be applicable in the updated interior drainage plan.

- **Periodic Inspection.** The updated interior drainage plan will include periodic inspection of interior drainage systems. The plan will insure that periodic operation of the Sluice gate is performed at a frequency of 1-year or less.

4.4 Scope for Maintenance Plan

Accredited levees require the maintenance criteria described in Section 3.1. The existing plan identifies seven general levee system components and features requiring routine maintenance. These include:

1. Catharine Creek channel and floodway, embankments, drainage ditches and culverts, and spoils areas
2. Owego Street Highway Bridge (NYS Route 14)
3. Foot Bridge (demolished and removed)
4. Clawson Blvd. Highway Bridge
5. Shequaga Creek stilling basin, channel upstream and downstream of conduit, Concrete retaining wall, concrete twin-cell conduit, embankments, local drainage facilities, and spoils area
6. Pennsylvania Railroad Bridge
7. Project Signs

The updated Maintenance Plan would retain these levee system components and features with the exception of No. 3 as the foot bridge has been removed. For the six (6) remaining levee system components and features the update plan will specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

5.0 MFFDRP ACCREDITATION COST ESTIMATE

We have developed an engineer's opinion of probable accreditation costs (EOPAC) based on the anticipated levee accreditation activities required for FEMA review and approval of the MFFDRP. The EOPAC contained herein should be considered a "Class 4" estimate, according to the categories of cost estimates defined by the Association for the Advancement of Cost Engineering (AACE) International, which are summarized in Table 5.1.

Table 5.1: AACE Accuracy Matrix for Estimating Classes

Estimate Class	Primary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	**END USE Typical purpose of estimate**	**METHODOLOGY Typical estimating method**	**EXPECTED ACCURACY RANGE Typical variation in low and high ranges**
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment or Analogy	Low: -20% to -50% High: +30% to +100%
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	Low: -15% to -30% High: +20% to +50%
Class 3	10% to 40%	Budget Authorization or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	Low: -10% to -20% High: +10% to +30%
Class 2	30% to 75%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	Low: -5% to -15% High: +5% to +20%
Class 1	65% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	Low: -3% to -10% High: +3% to +15%

Tables 5.2 presents our EOPAC's based on the accreditation process and our recommendation that the existing culverts six (6) within the Catharine Creek System and five (5) within the Shequaga Creek system be rehabilitated by insitu form slip-lining. The opinion of cost is intended for evaluation and budget planning by the Village. More formal estimates for drilling subcontractor and insitu slip-lining subcontractors as well as engineering services will be provided with the Village's request to proceed with accreditation and certification (i.e., Phase 2).

Table 5.2: EOPAC's MFFDRP Accreditation Class 4 Cost Estimate

Acceditation Task	Engineering Labor	Expenses	Subcontractor Fee	Total
1 - Hydrologic and Hydraulic Design Criteria – Freeboard Assessment	$20,000	$2,000		$22,000
2 - Hydrologic and Hydraulic Design Criteria – Interior Drainage	$12,000			$12,000
3 - Hydrologic and Hydraulic Design Criteria – Embankment Protection	$10,000			$10,000
4 - Levee Geotechnical Exploration of Catharine Creek and Shequaga Creek Levees - Drilling and Analysis	$30,000	$4,000	$44,000	$78,000
5 - Geotechnical Laboratory Testing of Embankment and Foundation Soils	$8,000		$9,000	$17,000
6 - Design Criteria: Levee Stability, Seepage and Settlement Analysis	$24,000			$24,000
7 -Geotechnical Report and Accreditation Application	$17,000	$3,000		$20,000
8 - Geostructural Assessment Design	$20,000	$3,000		$23,000
9 - Accreditation Operations Plan	$9,000	$1,000		$10,000
10 - Interior Drainage Plan	$11,000	$1,000		$12,000
11- Maintenance Plan	$8,000	$1,000		$9,000
12 - Flood Mapping, FEMA Coordination, Engineer's Certification	$28,000			$28,000
13 - Meetings	$15,000			$15,000
Accreditation Estimate Total	**$212,000**	**$15,000**	**$53,000**	**$280,000**

In addition to the thrirteen (13) engineering, modeling and investigation costs presented in Table 5.2 there will likely be costs associated with the findings from the culvert closure pipe video inspections scheduled for completion this fall. Schnabel has assumed that the eleven (11) existing culverts will require relining. Based on using cure-in-place pipe (CIPP) lining technology the estimated cost for a CIPP repair for the MFFDRP would be approximately $330,000 and $460,000 for wet-out felt or fiberglass methods respectively. This preliminary estimate is based on the culvert pipe lengths and diameters presented in the Table 5.3 and recent unit budget costs provided by a specialty contractor that routinely performs CIPP repairs.

Other future costs will include excavation and removal of shoals, and construction of rip rap armoring of eroded creek banks. These costs are routine construction costs and not conditional for accreditation.

Table 5.3: Preliminary Cost Estimate for MFFDRP Culvert relining with CIPP

Culverts	Diameter (in.)	Length (ft)	Felt Unit Cost/ft.	Cost to reline Wet-out Felt	Fiberglass Unit Cost/ft.	Cost to reline Fiberglass
Catharine Creek Left and Right Bank Closures						
Gate No. 1	36	63	$505	$31,600	$690	$43,200
Gate No. 2	36	63	$505	$31,600	$690	$43,200
Gate No. 3	24	75	$385	$29,000	$540	$40,700
Gate No. 4	24	75	$385	$29,000	$540	$40,700
Gate No. 5	24	66	$385	$25,600	$540	$35,900
Gate No. 6	24	67	$385	$25,800	$540	$36,200
	Total length Catharine Creek	410				
Shequaga Creek Closures						
CS-1	8	80	$215	$17,200	$285	$22,800
CS-2	24	75	$385	$28,900	$540	$40,500
CS-3	18	65	$270	$17,600	$355	$23,100
CS-4	24	80	$385	$30,800	$540	$43,200
CS-5	12	80	$215	$17,200	$285	$22,800
	Total length Shequaga Creek	380				
Total length for MFFDRP		**790**				
			Est. Total CIPP Cost	**$284,300**		**$392,300**
			Engineering and Construction Oversight	**$48,300**		**$66,700**
			Total CIPP Project Cost	**$333,000**		**$459,000**

6.0 LIMITATIONS

The analyses and recommendations submitted in this report are based on the information obtained by our review of the available documentation, our visual observations of the site and facilities, and our experience from other projects similar in nature. We have attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may exist at the site that influence the results of our evaluations and/or affect recommended remedial activities.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report or any other instrument of service.

FIGURES

Source: Esri, HERE, Garmin, (c) OpenStreetMap contributors
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Projection: NAD 1983 2011 StatePlane New York Central FIPS 3102 Ft US

2,500 1,250 0 2,500 Feet
Scale: 1 inch equals 2,500 feet

8/16/2021 G:\2021-Jobs\Albany\21C25005_00_Montour Falls Levee System\03-SEProducts\07-GIS\03-Maps\Site_Location.mxd swise

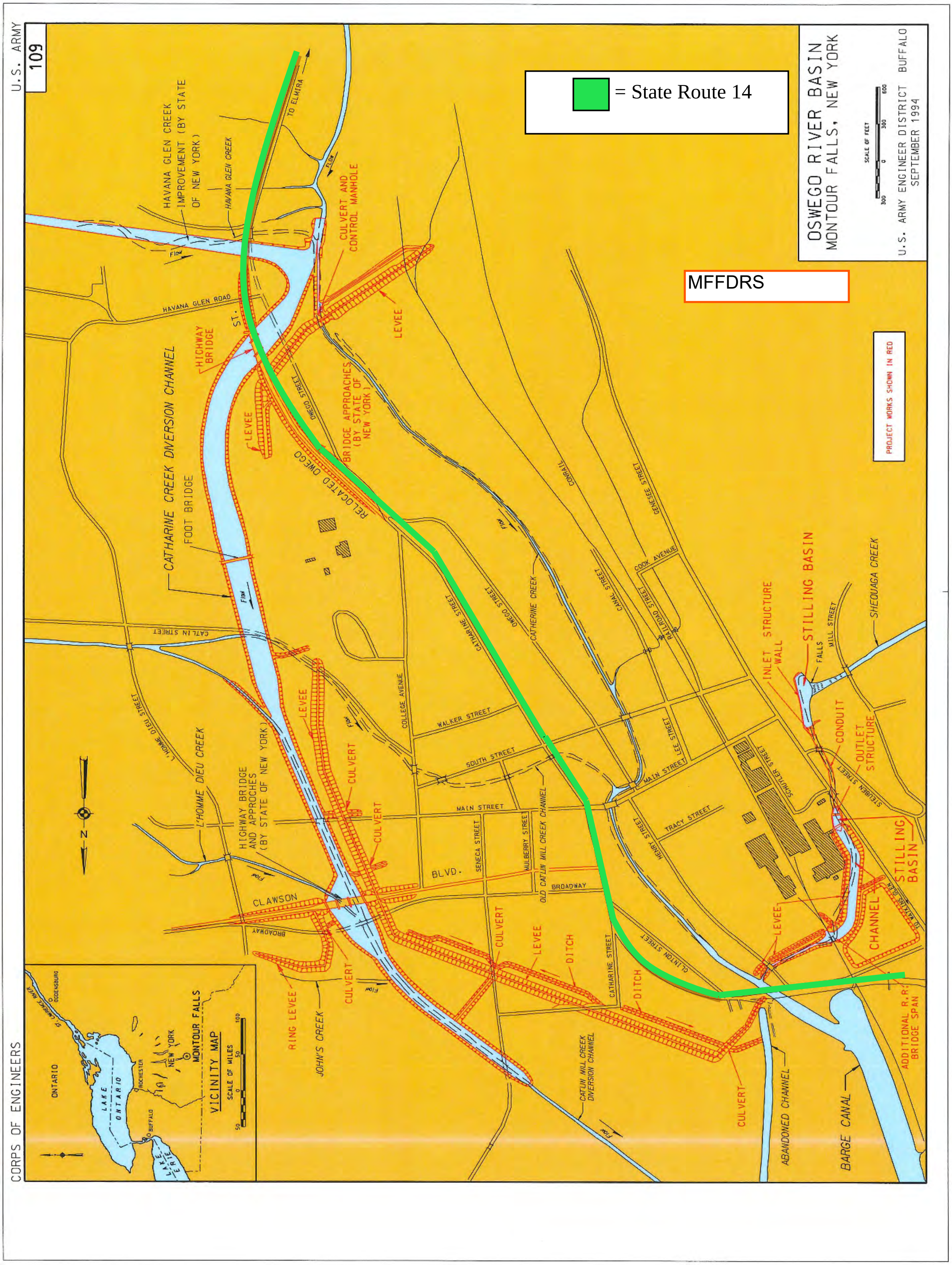
Schnabel ENGINEERING

MONTOUR FALLS LEVEE SYSTEM
TOWN OF MONTOUR FALLS
SCHUYLER COUNTY, NEW YORK
PROJECT NO. 21C25005.00

SITE LOCATION MAP

FIGURE 1

Figure 2: Project Map - Montour Falls Flood Damage Reduction System (MFFDRS) Catharine and She-Qua-Ga Creeks, Montour Falls, New York (Source USACE Routine Inspection Rpt. 07/2020)



APPENDIX A

Levee Inspection Photo Log

PHOTO 1

DATE TAKEN: 07/202021

LOCATION:

Flood slope of Catharine Creek Left Bank Northern section.

Approx. Station: 81+00 L

COMMENTS:

PHOTO 2

DATE TAKEN: 05/25/2021

LOCATION:

Catharine Creek Left Bank North Section looking upstream.

Approx. Station: 65+00 L

COMMENTS:

Schnabel ENGINEERING

LEVEE INSPECTION
VILLAGE OF MONTOUR FALLS
MONTOUR FALLS, SCHUYLER COUNTY, NY
PROJECT NO. 21C25005.00

CATHARINE CREEK AND SHEQUAGA FALLS LEVEE SYSTEMS

PHOTO 3

DATE TAKEN: 07/20/2021

LOCATION:

Flood slope of Catharine Creek Left Bank Northern section at culvert #2.

Approx. Station: 65+00 L

COMMENTS:

PHOTO 4

DATE TAKEN: 05/26/2021

LOCATION:

Protected landside slope of Catharine Creek Left Bank Northern section.

Approx. Station: 50+00 L

COMMENTS:

Note dead tree measured 18 from toe of slope and therefore not classified as an encroachment .

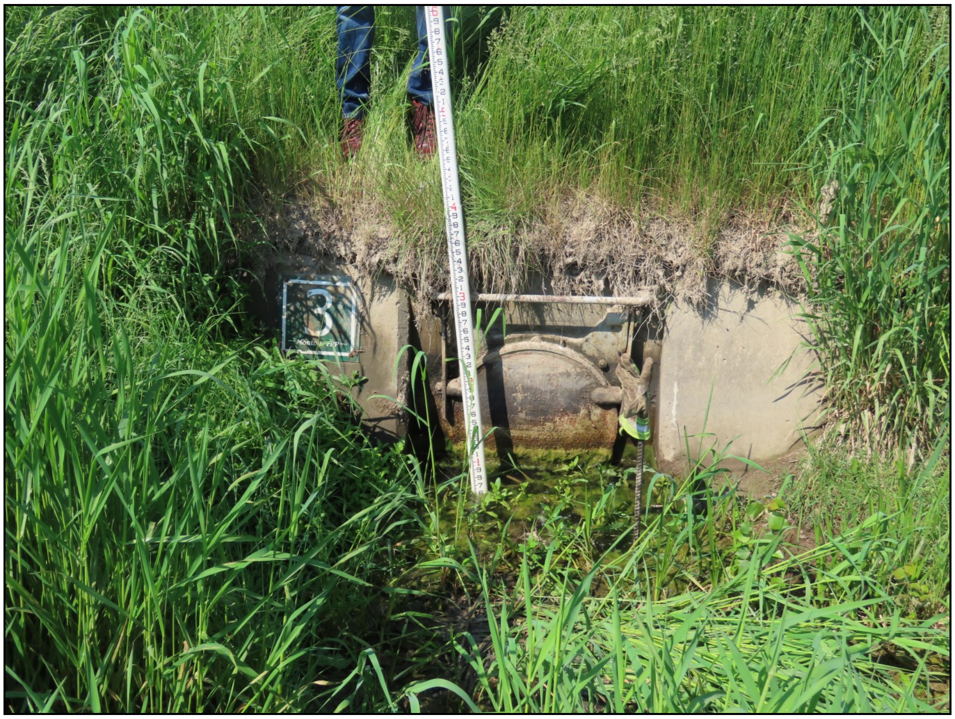


PHOTO 5

DATE TAKEN: 05/26/2021

LOCATION:

Flood slope of Catharine Creek Left Bank Northern section at culvert #3.

Approx. Station: 52+00 L

COMMENTS:

PHOTO 6

DATE TAKEN: 07/20/2021

LOCATION:

Flood slope of Catharine Creek Left Bank Northern section at culvert #4.

Approx. Station: 48+00 L

COMMENTS:

PHOTO 7

DATE TAKEN: 07/20/2021

LOCATION:

Levee Encroachment, Catharine Creek Left Bank North Section at culvert #4 upstream.

Approx. Station: 45+00 L

COMMENTS:

Note encroachment of utility lines running across the levee.

PHOTO 8

DATE TAKEN: 07/20/2021

LOCATION:

Flood side of Catharine Creek Left Bank Northern section.

Approx. Station: 40+00 L

COMMENTS:

Confluence of Caitlin Mill Creek and Catharine Creek Diversion channel. Large rip rap riffle approved alteration.

PHOTO 9

DATE TAKEN: 05/25/2021

LOCATION:

Catharine Creek Left Bank South looking upstream.

Approx. Station: 11+00 L

COMMENTS:

Note utility lines running across the levee and utility pole in the channel. Utility lines are a minor encroachment. Poles are spaced sufficiently far apart from toe of embankment.

PHOTO 10

DATE TAKEN: 05/25/2021

LOCATION:

Catharine Creek Left Bank Southern section looking downstream.

Approx. Station: 8+50 L

COMMENTS:

Culvert #5 manhole station. Conduit flow control is via 24" sluice gate.

PHOTO 11

DATE TAKEN: 05/25/2021

LOCATION:

Flood side of Catharine Creek Left Bank South at culvert #5.

Approx. Station: 8+50 L

COMMENTS:

PHOTO 12

DATE TAKEN: 05/25/2021

LOCATION:

Protected side of Catharine Creek Left Bank South at culvert #5.

Approx. Station: 8+50 L

COMMENTS:

PHOTO 13

DATE TAKEN: 07/20/2021

LOCATION:

Flood side of Catharine Creek Left Bank South looking towards end of southern extent of levee system .

Approx. Station: 4+00 L

COMMENTS:

Note: Utility line encroachment. Silt on grass is from temporary impoundment of runoff at flood gate #5.

PHOTO 14

DATE TAKEN: 05/25/2021

LOCATION:

Southern end of Catharine Creek Left Bank Levee looking downstream.

Approx. Station: 0+00 L

COMMENTS:

Bridge in background is NYS Rte. 14.

PHOTO 15

DATE TAKEN: 05/26/2021

LOCATION:

Grated headwall/catch basin structure for intake of culvert #6 at protected side of Catharine Creek Right Bank Ring Levee.

Approx. Station: 6+00 R

COMMENTS:

PHOTO 16

DATE TAKEN: 05/26/2021

LOCATION:

Protected side of Catharine Creek Right Bank Ring Levee.

Approx. Station: 6+00 R

COMMENTS:

Note: Small utility building is a sewage pump station. On crest of dam is a 4" dia. sewage vent riser, and grated culvert inlet is located at the toe of the levee embankment

PHOTO 17

DATE TAKEN: 05/26/2021

LOCATION:

Flood side of Catharine Creek Right Bank Ring Levee at culvert #6.

Approx. Station: 6+00 R

COMMENTS:

PHOTO 18

DATE TAKEN: 05/26/2021

LOCATION:

Catharine Creek Right Bank Ring Levee looking east.

Approx. Station: 10+00 R

COMMENTS:

PHOTO 19

DATE TAKEN: 05/26/2021

LOCATION:

Catharine Creek Right Bank Ring Levee looking west from Village street access.

Approx. Station: 14+50 R

COMMENTS:

PHOTO 20

DATE TAKEN: 05/26/2021

LOCATION:

Upstream stilling basin and floodwall at base of Shequaga Falls.

Approx. Station: 113+00 L

COMMENTS:

PHOTO 21

DATE TAKEN: 05/26/2021

LOCATION:

Stilling Basin, floodwall, twin-cell culvert and V-notch weir spillage at base of Shequaga Falls looking downstream.

Approx. Station: 114+00 L

COMMENTS:

PHOTO 22

DATE TAKEN: 05/26/2021

LOCATION:

Stilling basin at base of Shequaga Falls.

Approx. Station: 110+00 L

COMMENTS:

One of several flap gates on the stilling basin providing drainage from behind the landside of the wall.

Schnabel ENGINEERING	LEVEE INSPECTION VILLAGE OF MONTOUR FALLS MONTOUR FALLS, SCHUYLER COUNTY, NY PROJECT NO. 21C25005.00	CATHARINE CREEK AND SHEQUAGA FALLS LEVEE SYSTEMS

PHOTO 23

DATE TAKEN: 05/26/2021

LOCATION:

V-notxh weir at base of Shequaga Falls looking downstream.

Approx. Station: 112+00 L

COMMENTS:

PHOTO 24

DATE TAKEN: 05/26/2021

LOCATION:

Shequaga Falls twin-cell culvert inlet right cell some concrete deterioration requiring patching.

Approx. Station: 109+00 L

COMMENTS:

Schnabel ENGINEERING

LEVEE INSPECTION
VILLAGE OF MONTOUR FALLS
MONTOUR FALLS, SCHUYLER COUNTY, NY
PROJECT NO. 21C25005.00

CATHARINE CREEK AND SHEQUAGA FALLS LEVEE SYSTEMS

PHOTO 25

DATE TAKEN: 05/26/2021

LOCATION:

Inside Shequaga Falls twin-cell culvert.

Approx. Station: 106+00 L

COMMENTS:

PHOTO 26

DATE TAKEN: 05/26/2021

LOCATION:

Shequaga Falls culvert outlet stilling basin looking upstream.

Approx. Station: 100+00 L

COMMENTS:

PHOTO 27

DATE TAKEN: 07/20/2021

LOCATION:

Shequaga Creek Levee looking North at remains of the Pennsylvania Railroad bridge crossing.

Approx. Station: 93+00 L

COMMENTS:

Abandoned railroad bridge spanning Shequaga Creek.

PHOTO 28

DATE TAKEN: 07/20/2021

LOCATION:

Shequaga Creek Levee looking downstream from twin-cell culvert outlet stilling basin.

Approx. Station: 98+00 L

COMMENTS:

Note shoaling at terminus of stilling basin. Shoal should be removed as it is creating toe scour on right levee embankment.

PHOTO 29

DATE TAKEN: 05/26/2021

LOCATION:

Rodent borrow at end of Shequaga Falls culvert and beginning of Shequaga Creek Levee.

Approx. Station: 101+00 L

COMMENTS:

PHOTO 30

DATE TAKEN: 07/20/2021

LOCATION:

Shequaga Creek levee CS-1 culvert.

Approx. Station: 92+00 L

COMMENTS:

CS-1 one of five flap gates on the Shequaga Creek levee.

PHOTO 31

DATE TAKEN: 05/26/2021

LOCATION:

Shequaga Creek levee culvert outlet.

Approx. Station: 91+00 L

COMMENTS:

CS-2 one of five flap gates on the Shequaga Creek levee.

PHOTO 32

DATE TAKEN: 05/26/2021

LOCATION:

Shequaga Creek levee northernmost culvert.

Approx. Station: 88+00 L

COMMENTS:

CS-3 one of five flap gates on the Shequaga Creek levee.

PHOTO 33

DATE TAKEN: 07/20/2021

LOCATION:

End of Shequaga Creek levee looking upstream from the end of Henry Street.

Approx. Station: 88+00 L

COMMENTS:

Note this section of levee is benched.

PHOTO 32

DATE TAKEN: 05/26/2021

LOCATION:

Shequaga Creek levee northernmost culvert.

Approx. Station: 88+00 L

COMMENTS:

CS-5 one of five flap gates on the Shequaga Creek levee.

PHOTO 33

DATE TAKEN: 07/20/2021

LOCATION:

End of Shequaga Creek levee at the confluence of Shequaga Creek and the old Catharine Creek channel (interior drainage).

Approx. Station: 88+00 L

COMMENTS:

Note bridge in background is Catharine Street Bridge.

PHOTO 32

DATE TAKEN: 07/20/2021

LOCATION:

Shequaga Creek levee looking at end of levee at Henry street.

Approx. Station: 88+00 L

COMMENTS:

.