



## APPENDIX H. LEVEE INFORMATION

Tetra Tech reviewed levee data available to integrate components of the levee accreditation process and identify ways the hazard mitigation process can help to establish a path forward for the levee accreditation process. To that end, we gathered basic information on the nine NYS DEC levee and floodwall systems in Broome County.

### H.1 LEVEE NEEDS ASSESSMENT

Tetra Tech gathered information from a combination of the National Levee Database (NLD), Federal Emergency Management Agency (FEMA) Flood Mapping Products website, New York State Department of Environmental Conservation (NYS DEC) Region 7 project details and maps website and the United States Geological Survey (USGS) StreamStats website.

The following tables present summaries of the levee system features, their risk, and current FEMA Accreditation status.

**Table H-1. Levee System Feature Information from the National Levee Database**

System	Year Complete	Levee (miles)	Floodwall (miles)	Pump Stations (#)	Gravity Drains (#)	Closures (#)
Deposit	1985	0.82	0.30	0	0	0
Endicott	1961	2.10	0.42	3	30	1
Johnson City	1961	1.89	0.09	2	21	3
Lisle	1948	0.73	0.21	0	9	3
Northeast Binghamton	1942	1.70	1.90	6	34	7
Northwest Binghamton	1940	0.25	0.30	2	4	0
South Binghamton	1941	1.67	0.41	2	19	4
Vestal	1961	2.95	0.04	4	26	2
Whitney Point Village	1948	1.36	0.00	0	14	1

**Table H-2. Levee System Risk Information from the National Levee Database**

System	LSAC*	Overtopping ACE**	People at Risk	Structures at Risk	Property Value
Deposit	N	N	562	266	\$89.1M
Endicott	Low	0.005	7,470	2,355	\$398M
Johnson City	N	N	1,884	454	\$306M
Lisle	Low	0.002	202	88	\$7.1M
Northeast Binghamton	Moderate	N	14,743	3,550	\$2.2B
Northwest Binghamton	Moderate	0.005	2,034	815	\$227M
South Binghamton	Moderate	0.005	4,195	1,599	\$569M
Vestal	Low	0.005	2,191	879	\$199M
Whitney Point Village	Low	0.002	351	204	\$51.6M

\*LSAC - Levee Safety Action Classification Rating by the U.S. Army Corps of Engineers

\*\*ACE - Annual Chance Exceedance

N - No Data Entered or LSAC In Progress





Table H-3. Levee System FEMA Accreditation

Levee System Name	Effective FIS ID	Total Length (miles)	Leveed Area (sq. miles)	Levee System Summary in NLD	Levee System Accreditation Status*
Deposit	360043V000	0.85	0.230	NO	Non Accredited
Endicott	360045V000	2.52	1.590	YES	Non-Accredited
Johnson City	2305130002	1.98	0.490	NO	Non-Accredited
Lisle	2305190001	0.92	0.093	YES	Pending**
Northeast Binghamton	2305060001	3.53	2.200	YES	Non-Accredited
Northwest Binghamton	2305060003	0.55	0.370	YES	Non-Accredited
South Binghamton	2305060002	2.08	0.790	YES	Non-Accredited
Vestal	2305130003	2.99	1.080	YES	Non-Accredited
Port Dickinson***		0.72			Pending**
Whitney Point Village	2305310001	1.36	0.210	YES	Pending**

\*Based on LAMP DFIRM status as reported in the Broome County Floodplain Mapping Fact Sheet (FEMA 2018)

\*\*Could possibly be accredited even though they are shown as SFHAs on the DFIRM

\*\*\*Information from Levee Analysis and Mapping Plan Village of Deposit Levees (FEMA TBD 2018)

### H.1.1 Meeting the Criteria for Accrediting Levee Systems on NFIP Flood Maps

Even though FEMA established the levee system accreditation status in Table 3, it is the community’s responsibility to provide data and documentation to demonstrate that a levee system meets National Flood Insurance Program (NFIP) requirements as described in Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR Section 65.10).

To be recognized as providing a 1-percent-annual-chance level of flood protection on the modernized NFIP maps, called Digital Flood Insurance Rate Maps (DFIRMs), levee systems must meet *and continue to meet* the minimum design, operation, and maintenance standards (44 CFR Section 65.10).

The minimum design, operation, and maintenance standards (44 CFR Section 65.10) are detailed below. These elements were used to develop the checklist for data needs and inventory questionnaire for the flood protection systems in Broome County.

#### Design Criteria Section of the NFIP Regulations: 65.10(b)

**Description:** For levee systems to be recognized (i.e., accredited) by FEMA, evidence that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists must be provided. The following requirements must be met:

**Freeboard.** Minimum freeboard required 3 feet above the Base Flood Elevation (BFE) all along length, and an additional 1 foot within 100 feet of structures (such as bridges) or wherever the flow is restricted. Additional 0.5 foot at the upstream end of a levee. Coastal levees have special freeboard requirements (see Paragraphs 65.10(b)(1)(iii) and (iv)).

**Closures.** All openings must be provided with closure devices that are structural parts of the system during operation and designed according to sound engineering practice.

**Embankment Protection.** Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and 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.** Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided must evaluate expected seepage during loading conditions associated with the base flood and must demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (USACE) Engineer Manual 1110–2–1913, Design and Construction of Levees, (Chapter 6, Section II), may be used.

**Settlement Analyses.** Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained. This analysis must 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, must be submitted.

**Interior Drainage.** An analysis must be submitted that identifies the source(s) of such flooding, the extent of the 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.

### Operation Plan - Paragraph 65.10(c)(1) of the NFIP Regulations

For a levee system to be recognized (i.e., accredited), the operational criteria must be as described below. All 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 or when the manual for a previously recognized system is revised in any manner. All operations 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. The following is a checklist for the Operation 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 for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.

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

**Periodic Operation of Closures.** Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes.

**Interior Drainage Plan.** See below.

### 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 protection purposes only if the following minimum criteria are included in the operation plan. The following items are required for the 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 any mechanized portions for testing and training purposes. No more than 1 year shall elapse between either the inspections or the operations.

### Maintenance Plan - Paragraph 65.10(d) of the NFIP Regulations

For levee systems to be recognized as providing protection from the base flood (i.e., accredited by FEMA), the maintenance criteria must be as described as follows.

- 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 when recognition is being sought or when the plan for a previously recognized system is revised in any manner.
- 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 that 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.

### Certification - Paragraph 65.10(e) of the NFIP Regulations

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) must be certified by a Registered Professional Engineer. Also, certified “as-built” plans of the levee must be submitted. Certifications are subject to the definition given in Section 65.2 of the NFIP regulations. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection from the base flood.

## H.2 PHASED APPROACH TO CERTIFICATION AND INITIAL FUNDING

Tetra Tech uses a phased approach to levee certification that allows communities to understand data gaps and what improvements may be needed to meet FEMA Levee Certification criteria. Phase 1 is a data needs and engineering assessment phase that is collection of data required to perform engineering analyses to determine if the levee meets design criteria. Typical Phase 1 tasks are described in detail. Preliminary estimates for Phase 1 studies of the levee systems in Broome County are presented in the tables following the detailed descriptions.

### H.2.1 Task 1 - Data Collection and Information Management

This task includes correspondence and cataloging of available data sources. It includes organizing and reviewing data sources from sources such as; the U.S. Army Corps of Engineers (USACE), Baltimore District,



New York State Department of Environmental Conservation (NYS DEC), New York State Department of Transportation (NYS DOT), Federal Emergency Management Agency (FEMA) Region II, the local communities as needed during the project duration.

- As-Built Drawings and/or Plans and Specifications for Original Construction. We assume that these are available from the community, NYS DEC or USACE Baltimore District.
- Geotechnical Information – data developed by/for the USACE in support of the design of the flood protection system. This includes the soil boring information in the USACE Detailed Design Report (DDR) and on the final USACE construction plans.
- NYS DEC information – May include original USACE design and construction information as well as local sponsor information on the maintenance and operation of the system.
- 2008 USACE Baltimore District Continuing Eligibility and other system inspections by NYS DEC.
- Hydrologic and Hydraulic Models – Any computer models developed by FEMA and the USACE
- FEMA FIS and DFIRM maps and supporting documentation
- NYS DOT Plans, County Plans, and Community Plans – Design plans and geotechnical information for any roadway crossings of the levee or in the leveed reach of the river
- Other – Operation and Maintenance manuals, as-built plans for the flood control system and any additional inspection reports.

### **H.2.2 Task 2 - Levee Inspection and Memorandum**

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Tetra Tech would inspect the levee system using USACE inspection criteria and other criteria developed for FEMA Certification. The memorandum will reference levee system elements from existing Continuing Eligibility Inspection reports and note any observations that may impact FEMA Certification.

### **H.2.3 Task 3 - Permitting**

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A Section 408 Permit for the USACE Baltimore District would be prepared to allow field exploration and drilling on the levee system. We assume that a number of borings will be required to verify DDR contents and subsurface conditions.

### **H.2.4 Task 4 - Survey and Mapping**

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Survey and mapping would be prepared using North American Datum of 1983 (NAD 83) State Plan Coordinate System for all horizontal coordinates. All elevations will be provided on the North American Vertical Datum of 1988 (NAVD 88). The following survey and mapping will be delivered:

- Levee Centerline – the survey will include a 3D line (Poly-line) produced from topographic locations made at the top center of the levee alignment. This will be used to verify data currently in the National Levee Database and freeboard computations.
- Cross Sections - Survey of levee cross sections used in the geotechnical analysis.
- Drainage Structures - Locations and elevations of rims and inverts on drainage structures with verification of dimensions of each.
- Soil Borings – Survey the Locations and elevations of Soil Borings.

### **H.2.5 Task 5 - Engineering Analyses and Assessment**

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Engineering analyses and will be performed to address the design criteria and operations and maintenance criteria required to comply with 44 CFR 65.10 for FEMA Levee Accreditation. The following sub-tasks



identify specific sections that are anticipated in the Engineering Analyses and Assessment and the associated FEMA regulation. Engineering analyses and assessments may include:

- Additional hydraulic modeling and freeboard analysis (risk and uncertainty analysis could reduce required freeboard in some locations)
- Interior Drainage Modeling and Evaluation
- Subsurface Exploration / Laboratory Testing / Logs and Test Reports
- Geotechnical Engineering Evaluations
- Review Operations and Maintenance Manual
- Review Warning System and Evacuation Plan

### H.2.6 Task 6 - Prepare FEMA Levee Certification Data Needs Report

There are two types of reports:

1. If, after Phase 1, the levee appears to meet FEMA Certification criteria, Tetra Tech would prepare a scope and fee to prepare a FEMA Levee Certification Report package. This package would include the levee forms (the MT-2 FEMA Form 1 – “Overview & Concurrence”, Form 2 – “Riverine Hydrology & Hydraulic”, and Form 3 – “Riverine Structures”) and other supporting information. The format would follow the requirements established by FEMA (digital format, separate form for each levee, etc.).
2. If, after Phase 1, the levee is found deficient, Tetra Tech would prepare a report of preliminary findings and prepare alternatives to meet FEMA Certification criteria (levee raise, floodwall raise, toe drains, etc.). This report would prepare a scope and that would address any additional engineering analyses, design or construction required for the levee system to meet FEMA Certification Requirements.

### H.2.7 Phase 1 Initial Planning Level Estimates

The following tables present a planning level estimate the fee breakdown by Task number, as described in the Scope of Work above for each levee system. This is based on the FEMA LAMP findings and our general experience. The availability of data can greatly impact the levee of effort, these are estimates that Tetra Tech has used for previous studies.

**Table H-4. Deposit Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$17,000
Task 3	Permitting – 408 Process	\$34,000
Task 4	Survey and Mapping	\$50,000
Task 5	Engineering Analyses and Assessment	\$212,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$22,000
<b>Total</b>		<b>\$350,000</b>

**Table H-5. Endicott Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000



Task	Scope of Work	Cost
Task 2	Levee Inspection and Memorandum	\$25,000
Task 3	Permitting – 408 Process	\$50,000
Task 4	Survey and Mapping	\$140,000
Task 5	Engineering Analyses and Assessment	\$350,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$40,000
<b>Total</b>		<b>\$620,000</b>

**Table H-6. Johnson City Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$20,000
Task 3	Permitting – 408 Process	\$45,000
Task 4	Survey and Mapping	\$110,000
Task 5	Engineering Analyses and Assessment	\$300,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$30,000
<b>Total</b>		<b>\$520,000</b>

**Table H-7. Lisle Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$18,000
Task 3	Permitting – 408 Process	\$36,000
Task 4	Survey and Mapping	\$51,000
Task 5	Engineering Analyses and Assessment	\$222,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$23,000
<b>Total</b>		<b>\$365,000</b>

**Table H-8. Binghamton Levee System (Northeast, Northwest and South) Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$25,000
Task 2	Levee Inspection and Memorandum	\$35,000
Task 3	Permitting – 408 Process	\$55,000
Task 4	Survey and Mapping	\$330,000
Task 5	Engineering Analyses and Assessment	\$400,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$20,000
<b>Total</b>		<b>\$765,000</b>

**Table H-9. Vestal Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$25,000



Task	Scope of Work	Cost
Task 3	Permitting – 408 Process	\$50,000
Task 4	Survey and Mapping	\$155,000
Task 5	Engineering Analyses and Assessment	\$375,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$40,000
<b>Total</b>		<b>\$660,000</b>

**Table H-10. Port Dickinson Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$15,000
Task 3	Permitting – 408 Process	\$30,000
Task 4	Survey and Mapping	\$40,000
Task 5	Engineering Analyses and Assessment	\$180,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$20,000
<b>Total</b>		<b>\$300,000</b>

**Table H-11. Whitney Point Levee System Phase 1 Study Estimate**

Task	Scope of Work	Cost
Task 1	Data Collection and Information Management	\$15,000
Task 2	Levee Inspection and Memorandum	\$20,000
Task 3	Permitting – 408 Process	\$39,000
Task 4	Survey and Mapping	\$68,000
Task 5	Engineering Analyses and Assessment	\$250,000
Task 6	Prepare FEMA Levee Certification Data Needs Report	\$28,000
<b>Total</b>		<b>\$420,000</b>