

EXISTING CONDITIONS HYDRAULIC MODEL VERIFICATION  
FLINT RIVERFRONT RESTORATION PROJECT  
FLINT, MICHIGAN

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Hydraulic Study for Instream Improvements  
of the Flint River from Hamilton Ave Bridge to Fabri Dam

Prepared for:  
Genesee County Parks and Recreation Commission

Prepared by:  
RiverRestoration  
P.O. Box 248  
Carbondale, CO 81623

July 27, 2018



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## 1.0 Introduction

In-channel modifications to the Flint River at Flint, Michigan have been proposed to revitalize the urban river corridor, improve access, provide fish passage, diversify flow and aquatic habitat, promote instream recreation opportunities, enhance the natural river aesthetic, and augment public safety. This technical memo details the development of the Existing Conditions HEC-RAS Model (ECM) which will be used for the evaluation of the Proposed Improvements associated with the Flint Riverfront Restoration Project.

Analyses were conducted using the United States Army Corps of Engineering Hydrologic Engineering Center River Analysis System (HEC-RAS) v5.0.3 (Brunner, 2016a) publically available hydraulic software. HEC-RAS analyses presented herein include the existing water-surface elevations (WSE) and energy grade line (EGL) for the 2- through 500-year flood frequency discharges. Once approved by the Michigan Department of Environmental Quality (MDEQ), the ECM will be the baseline for evaluating impacts from the proposed improvement for flooding of existing structures in and adjacent to the floodplain an associated potential harmful interference.

This report follows guidelines established by the Michigan Department of Environmental Quality (MDEQ) Hydraulic Report Guidelines (MDEQ, 2013). The intended reviewer of this report is MDEQ and the report structure follows recommended guidelines; Section 1 describes the project and the location, Section 2 describes methods of analysis, and Section 3 provides results.

### 1.1 Project description

The project reach upstream extent is Hamilton Ave Bridge and the downstream extent is Fabri Dam. The majority of proposed in-channel improvements are between Fabri Dam and Hamilton Dam, which is referred to as Reach A. Improvements in Reach A include six naturalized channel features within the downtown corridor of Flint, MI, including partial deconstruction and repurposing of Fabri Dam. In-channel improvements are also being made adjacent to Veteran’s Park, immediately downstream of the Hamilton Ave Bridge, and Hamilton Dam will be structurally modified as a part of Reach C. These improvements include two grade control structures to maintain low flow pool elevations at the Gillkey Creek confluence (RS 163+97.00) and the City of Flint’s emergency water intake (RS 262+79.65). Upstream and downstream limits of the hydraulic model study are taken from the limits of the Corrected Effective HEC-RAS model (CEM) used within this study.

### 1.2 Watercourse and location

Reach A of the Flint River is an engineered and stabilized system confined within concrete floodwalls and stabilized with riprap proximal to bridge infrastructure. In its current configuration, the channel is approximately 135-ft wide with a typical gradient of approximately 0.02%. Bridges with hydraulic influence in the project reach include crossings at Harrison Street, Saginaw Street, and Beach/Garland Street. There are upstream and downstream bridges near the Reach A boundaries at a pedestrian crossing and Grand Traverse Street, respectively. One pedestrian bridge downstream of Beech/Garland Street has no hydraulic influence and is not included in the CEM.

Above Hamilton Dam, the Flint River is lined by trees and brush on both sides. A road follows the river on both sides behind the treeline, James P Cole Blvd on the right bank and E Boulevard Dr on the left bank. The river channel width is similar to the lower reach and the average gradient is slightly steeper at 0.04%. A series of bridges cross the river through this reach, in order from downstream to upstream: University of Michigan Pedestrian Bridge, Robert T Longway Blvd, E 5<sup>th</sup> Ave Bridge, and Hamilton Bridge.

### *1.3 Scope of analysis*

Upon approval of the ECM, the model will be modified and utilized to evaluate potential of proposed actions to increase WSE and EGL during the 2-, 5-, 10-, 25-, 50-, 100- and 500-year flood frequency events. Proposed model results will be compared with ECM WSE and EGL within the river and on the adjacent floodplain to assess harmful interference. The potential impact threshold is defined by MDEQ as an increase in EGL of 0.005 ft or greater (MDEQ, 2013). Exceedance of the threshold requires assessment of harmful interference, defined by MDEQ (2013) as “*causing an increase stage or change in the direction of flow that causes, or is likely to cause: damage to property; a threat to life; pollution, impairment, or destruction of water or other natural resources*”.

### *1.4 Existing studies*

The following studies are relevant to the current project:

- 1) Current Federal Emergency Management Agency (FEMA) flood insurance study (FIS) (FEMA, 2009);
- 2) Flint River Hydraulics (Stantec, 2010);
- 3) Hydraulic report – Flint east boulevard former manufactured gas plant site sediment response action (Barr, 2016);
- 4) Stantec hydraulics report: Phase 1 – Flint Riverfront Restoration Project (Stantec, 2017).

### *Current FEMA FIS*

The current FEMA FIS was prepared using the United States Geological Survey (USGS) one-dimensional program E431 (FEMA, 2009). That study provides the information used to develop the current Flood Insurance Rate Maps (FIRMs). The FEMA FIS model was not obtained or analyzed in this study. Selected Firmettes (FEMA, 2009) are provided in Appendix A.

### *Hydraulic report (Stantec, 2010)*

Stantec (2010) obtained the FEMA (2009) FIS model and created a Duplicate Effective Model using HEC-RAS. Additional survey and information was included to create a CEM extending from Mott Dam to University Avenue Bridge. Michigan Department of Natural Resources (MDNR) reviewed and accepted the Stantec (2010) CEM to be used in a Letter of Map Revision (LOMR) process as detailed in MDNR (2010).

Hydraulic report (Barr, 2016)

Barr Engineering Company (Barr) evaluated project actions upstream of the Hamilton Dam as part of a sedimentation remediation effort referred to as the Consumers Energy Project. Barr (2016) modified the Stantec (2010) CEM to create proposed conditions representing dredging and capping.

Hydraulic report (Stantec, 2017)

This study evaluated the partial deconstruction of Hamilton Dam and Fabri Dam using the accepted Stantec (2010) CEM as a baseline. The Fabri Dam from Stantec (2010) was modified to update the gate inverts from the top of the concrete sill to the top of the gates in the closed position. Findings at the 100-year return interval were insignificant to flood impacts.

## 2.0 Method of Analysis

### 2.1 Numerical Hydraulic Model

Analyses conducted in this study used HEC-RAS v.5.0.3 software (Brunner, 2016a). HEC-RAS is the preferred hydraulic analysis software of the MDEQ (MDEQ, 2013).

### 2.2 Datum

The vertical datum used in performed analyses is the North American Vertical Datum of 1988 (NAVD88). Data from Barr (2016) incorporated into the hydraulic analyses were converted from the native National Geodetic Vertical Datum 1929 (NGVD 29) following the conversion from National Geodetic Survey (2017):

$$\text{NGVD} - 0.502 \text{ ft} = \text{NAVD88}$$

### 2.3 Hydrologic Data

Hydraulic analyses were performed using steady-state simulations at the 2- through 500-year flood frequency flow rates as provided in Table 1. These flow rates were dictated through correspondence with MDEQ as detailed in Appendix B.

**Table 1.** MDEQ flood frequency flow rates

Return Period	MDEQ Flowrates
<i>years</i>	Cfs
2	4,000
10	5,800
25	9,000
50	10,300
100	11800
500	14,400

## 2.4 Geometry Data

The HEC-RAS models used in this analysis were based on the MDNR accepted Stantec (2010) CEM which is further described as the ECM in Stantec (2017). Section geometries were updated with surveyed topography and bathymetry as supplied by Wade Trim (2017).

### 2.4.1 Extent of Model and Cross-section Spacing

The Stantec (2010) CEM extends from the Mott Dam (RS 391+51.40) downstream to the University Avenue Bridge (RS 0+0) which was maintained for the current ECM. The ECM used the cross-section spacing of the CEM with the exception of:

- a) Removing sections which were added by Stantec (2010) to represent work not proposed in this project; and
- b) Adding sections which represent the locations of work proposed in this project. At a minimum cross sections were placed at the toes and crest of each proposed in-channel grade control structure.

Table 2 and Table 3 provide a list of the cross sections which were removed from the Stantec (2010) CEM and those added to the ECM, respectively. Cross-section spacing was adjusted to account for the removal or addition of sections. A series of figures showing cross section locations is included as Appendix C.

**Table 2.** Cross-section removed from Stantec (2010) CEM in Project Existing Conditions Model

Cross-section Station ft	Stantec CEM Description
9016.6	-
9077.8	Structure 5
9087	
9100.3	
9329.4	Structure 4
9329.4	
9387.9	
9396.6	
9413.3	Deflector 2
9741.8	
9756.1	Structure 3
9797.5	
9844.2	
9860.2	Deflector 1
10135.7	
10149.6	
10163.9	Structure 2
10668.3	
10680.7	
10694.3	Structure 1
10848.1	

**Table 3.** Cross-section added to Project Existing Conditions Model from Stantec (2010) CEM

Cross Section Station ft	Reason for added Cross Section
8671.75	Proposed Fabri Dam Improvements
8756.7	
8969.76	Proposed In-channel features in Reach A
9079.9	
9765.99	
10681.63	
10752	
13550	Evaluation of Consumers Reach
14650	
15450	
15726.53	Proposed In-channel features in Reach C
15933.91	
16138.96	
16209.7	
16256.41	
16287.46	
16348.42	
16397.01	
16924.74	

### 2.4.2 Conditions Modeled

The follow condition was modeled for the existing conditions of the project reach:

- 1) Existing conditions using the modified Stantec (2010) CEM;

#### 2.4.2.1 Existing Conditions

The ECM revised the Stantec (2010) CEM to more accurately represent project actions and updated information. Cross-sections representative of Stantec (2010) project actions, yet never constructed in the river, were removed. Sections where channel modifications are proposed were added. The Fabri Dam invert elevation was set at the top of the concrete sill to 692.52 ft, representing the modification performed at Fabri Dam in the winter of 2017/2018. Likewise, the Hamilton Dam weir crest was modified in the model to represent the concrete weir constructed in winter and spring 2017/2018. The weir elevation is based on the as-built survey and varies in elevation from 701.79 ft to 702.10 ft. A graphic of the as-built survey shots on the newly built weir crest is included as Appendix D.

Additional survey data have become available since 2010 as provided by Wade Trim (2017). The cross-section geometries of the Stantec (2010) CEM were updated with these data, which refined the original geometry with further detail. The Consumers Energy Project associated with Barr (2016) has been constructed and as described in that hydraulic report. Sectional geometries from Barr (2016) were incorporated to the ECM for seven cross sections extending from Hamilton Dam to Robert T. Longway Blvd.

### 2.4.3 Roughness Coefficients

Manning’s roughness coefficients used in the ECM were taken from the values of the Stantec (2010) CEM. Values used are consistent with the recommendations of the HEC-RAS Hydraulic Reference Manual (Brunner, 2016b). Further, values conform to guidelines from USDA (2007) which factor in flow depth and substrate sizes. Roughness values used in the models are described in Table 4.

**Table 4.** Manning’s roughness coefficients

Area land cover	Manning's roughness coefficients
River bottom and river banks	0.035 - 0.060
Overbanks and floodplain	0.035 - 0.100
Feature invert (proposed)	0.042
Smoothed concrete	0.020

### 2.4.4 Contraction and Expansion Coefficients

Contraction and expansion coefficients are identical to those in the Stantec (2010) CEM and align with those recommended by Brunner (2016b). These values are provided in Table 5.

**Table 5.** Contraction and expansion coefficients

Hydraulic condition	Contraction coefficient	Expansion coefficient
Gradual transitions	0.1	0.3
Bridge and inline structure transitions	0.3	0.5

### 2.4.5 Bridge and Inline Structure Considerations

With the exception of the Robert T Longway Bridge, Fabri Dam, and Hamilton Dams, all infrastructure (bridges listed in section 1.2) were left unaltered from the Stantec (2010) CEM.

Fabri and Hamilton Dams were modified as described in Section 2.4.2.1.

The Robert T. Longway Bridge is located at RS 127+89.67. The downstream cross section was altered to reflect dredging as part of the Consumers Energy Project in the ECM and Proposed Conditions Model (Barr, 2016).

### 2.4.6 Ineffective Flow

Several cross sections from the Stantec (2010) CEM contain ineffective flows at low-lying overbank areas which do not contribute to river conveyance. These ineffective flows remained unchanged.

### 2.4.7 Digital Terrain Model

A digital terrain model was provided by Wade Trim (2017). This surface was used unmodified for the ECM.

### 2.5 Boundary Conditions

Downstream boundary conditions for the 2- through 500-year return flood intervals were known WSE as provided in the CEM. Upstream boundary conditions were the MDEQ provided flow rates associated with the flood intervals. As flow events were run using the sub-critical flow regime.

### 2.6 Existing Conditions Model Verification

The ECM was compared the 100-year WSE with the FIS 100-year WSE (FEMA, 2009). Table 6 provides values for this comparison. The inclusion of Fabri Dam and updated cross-section geometry results in differences of greater than one foot. Stantec (2017) found similar results comparing the modified CEM to the FIS. The project team and the City of Flint are aware of this discrepancy and plan on updating the FIS through Flint, Michigan through the CLOMR/LOMR process.

**Table 6.** 100-year WSE comparison between Existing Conditions and FIS (NAVD88)

FEMA XS Label	FIS	Existing Conditions Model		$\Delta$ WSE (ft)
	WSE (ft)	HEC-RAS XS	WSE (ft)	
ES	707.75	10817.09	709.17	1.42
ER	707.47	10643.36	709.08	1.61
Harrison Street				
EQ	707.25	10411.87	708.82	1.57
Saginaw Street				
EP	707.13	9828.58	708.35	1.22
Beech/Garland Street				
EO	707.05	9472.50	707.84	0.79
EN	707.00	9240.00	707.79	0.79
EM	706.85	8904.53	707.72	0.87
Fabri Dam				
EL	706.50	8627.22	706.87	0.37

## 3.0 Results

Modeling results for the WSE and EGL of the ECM are provided in Appendix E. HEC-RAS profile plots of the WSE and EGL are provided in Appendix F.

## 4.0 References

- Barr (2016). “Hydraulic Report – Flint East Boulevard former manufactured gas plant site sediment response action.” Barr Engineering Company, Ann Arbor, Michigan.
- Brunner, G. (2016a). “HEC-RAS River Analysis System – User’s Manual Version 5.0.” US Army Corps of Engineers Hydrologic Engineering Center. CPD-68.
- Brunner, G. (2016a). “HEC-RAS River Analysis System – Hydraulic Reference Manual Version 5.0.” US Army Corps of Engineers Hydrologic Engineering Center. CPD-69.
- FEMA, 2009. “Flood Insurance Study, Genesee County, Michigan.” Federal Emergency Management Agency. *Flood Insurance Study Numbre 26049CV001A*. Effective September 25, 2009.
- Jarrett, R.D. 1985. Determination of roughness coefficients for streams in Colorado, US Geological Survey Water Resources Investigation Report 85-4004.
- Leopold, L.B. Wolman, M.G. and Miller, J.P., 1964, *Fluvial process in geomorphology*: New York, Dover Books on Earth Sciences.
- Limerinos, J.T., 1970. Determination of Manning’s coefficient from measured bed roughness in natural channels: US Geological Survey Water-Supply Paper 1898-B.
- MDEQ (2013). “Michigan Department of Environmental Quality, Hydraulic Report Guidelines.” Revised 02-14-2013.
- MDNR (2010). “Email from Bruce Menerey to Burt Steinman RE: Flint River – Corrective Effective HEC-RAS model.” Provided in Stantec (2017).
- National Geodetic Survey, 2017. National Geodetic Survey, VERTCON website: [http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert\\_con.prl](http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl)
- Phillips, J.V., and Ingersoll, T.L., 1998, Verification of roughness coefficients for selected and natural channels in Arizona: U.S. Geological Survey Professional Paper 1584.
- Stantec (2010). “Flint River Hydarulics: Hamilton Dam Project, Flint River, Flint, Michigan.” Stantec Consulting Michigan, Inc. Ann Arbor Michigan, July 2010.
- Stantec (2017). “Hydraulics Report (revision 2): Phase 1 Flint River Restoration Project, Flint, Michigan.” Stantec Consulting Michigan, Inc. Ann Arbor, Michigan, December, 2017.
- USDA (2007). “Part 654 National Engineering Handbook, Stream Restoration Design.” United States Department of Agriculture. Natural Resources Conservation Service. Report 210-VI-NEH.
- Wade Trim (2017). “Flint River topographic and bathymetric survey data and surfaces.” Provided to RiverRestoration.
- Wade Trim (2018). “City of Flint structure elevations and harmful interference targets.” Provided to RiverRestoration.

# APPENDIX A: FEMA FIRMETTES OF THE PROJECT REACH

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**NFIP**

**PANEL 0191D**

**NATIONAL FLOOD INSURANCE PROGRAM**

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**GENESEE COUNTY,**  
**MICHIGAN**  
**(ALL JURISDICTIONS)**

**PANEL 191 OF 475**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

<u>COMMUNITY</u>	<u>NUMBER</u>	<u>PANEL</u>	<u>SUFFIX</u>
FLINT, CITY OF	260076	0191	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
**26049C0191D**

**EFFECTIVE DATE**  
**September 25, 2009**

**Federal Emergency Management Agency**

# LEGEND



## SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100 year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard may include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.



## FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.



## OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.



## OTHER AREAS

**ZONE X** Areas determined to be outside of the 0.2% annual chance floodplain.

**ZONE D** Areas in which flood hazards are undetermined, but possible.



## COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS



## OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet\*
- Base Flood Elevation value where uniform within zone; elevation in feet\*

\*Referenced to the North American Vertical Datum of 1988



Cross section line



Transect line

85° 03' 45.0", 41° 24' 22.5"

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

487000 M

1000-meter Universal Transverse Mercator grid values, zone 17

2250000 FT

5000-foot grid ticks: Michigan State Plane South Coordinate System, 6401 zone (FIPZONE 2113), Lambert Conformal Conic projection

KA0015 X

Bench mark (see explanation in Notes to Users section of this FIRM panel)

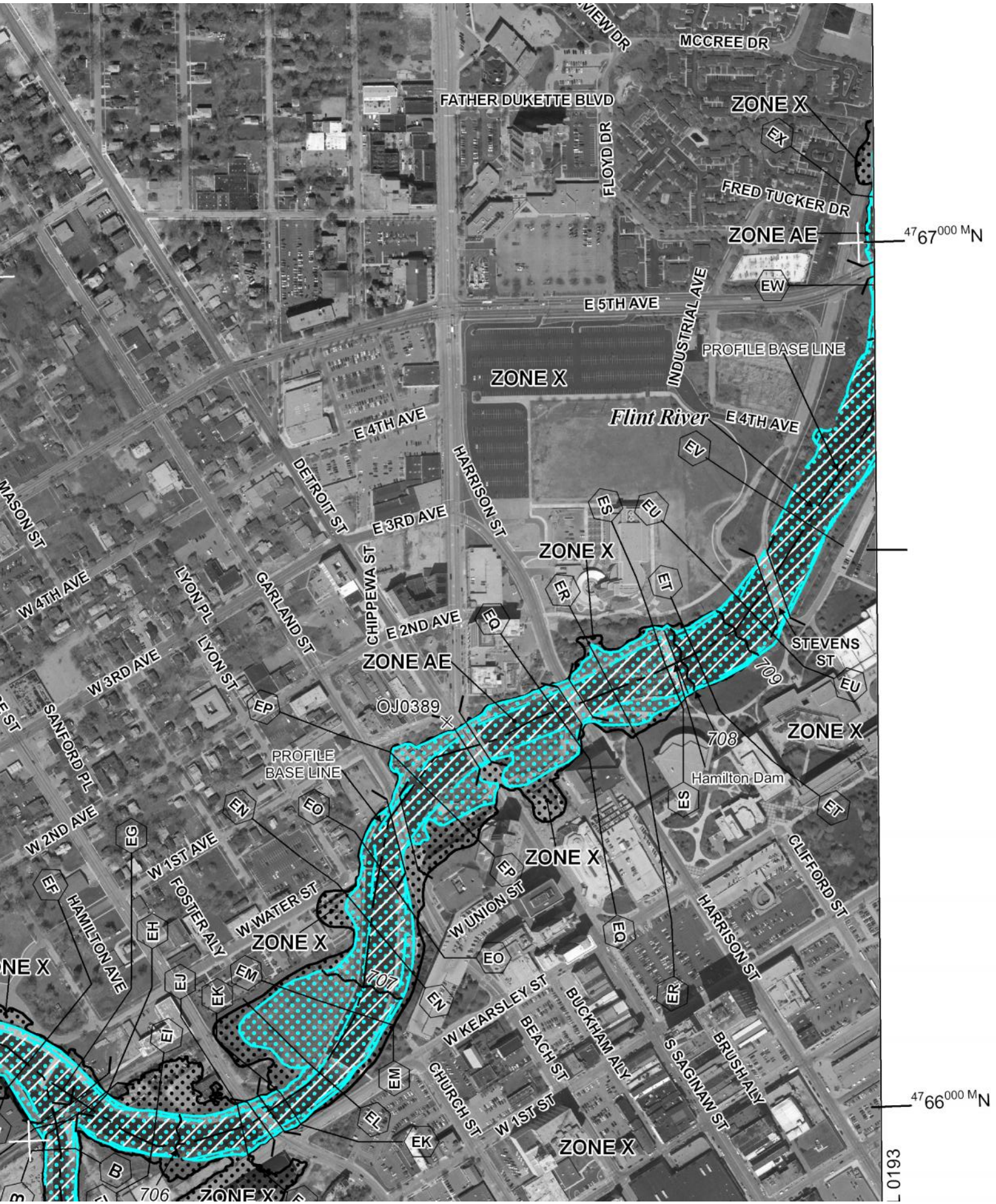
● M1.5

River Mile

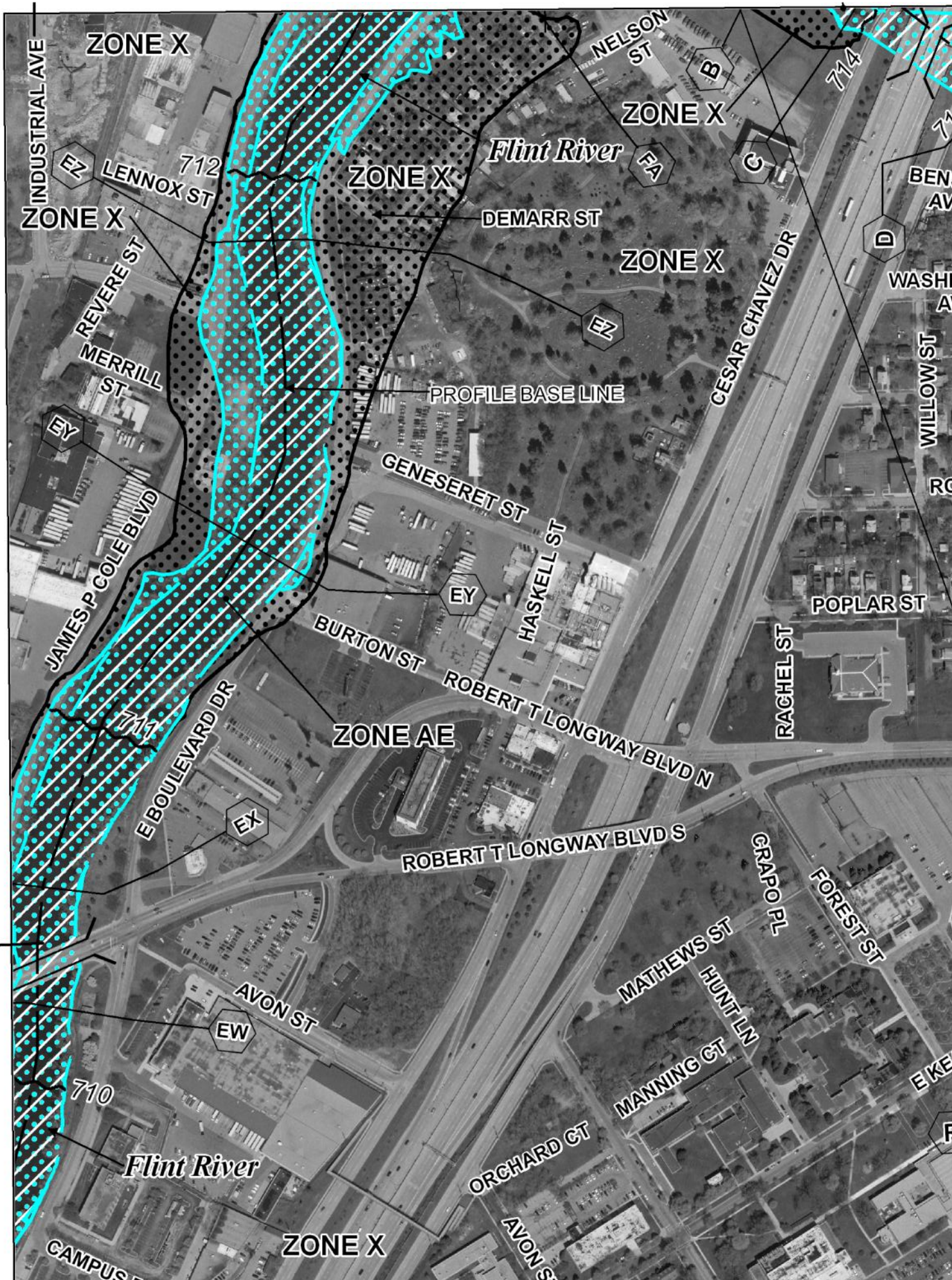
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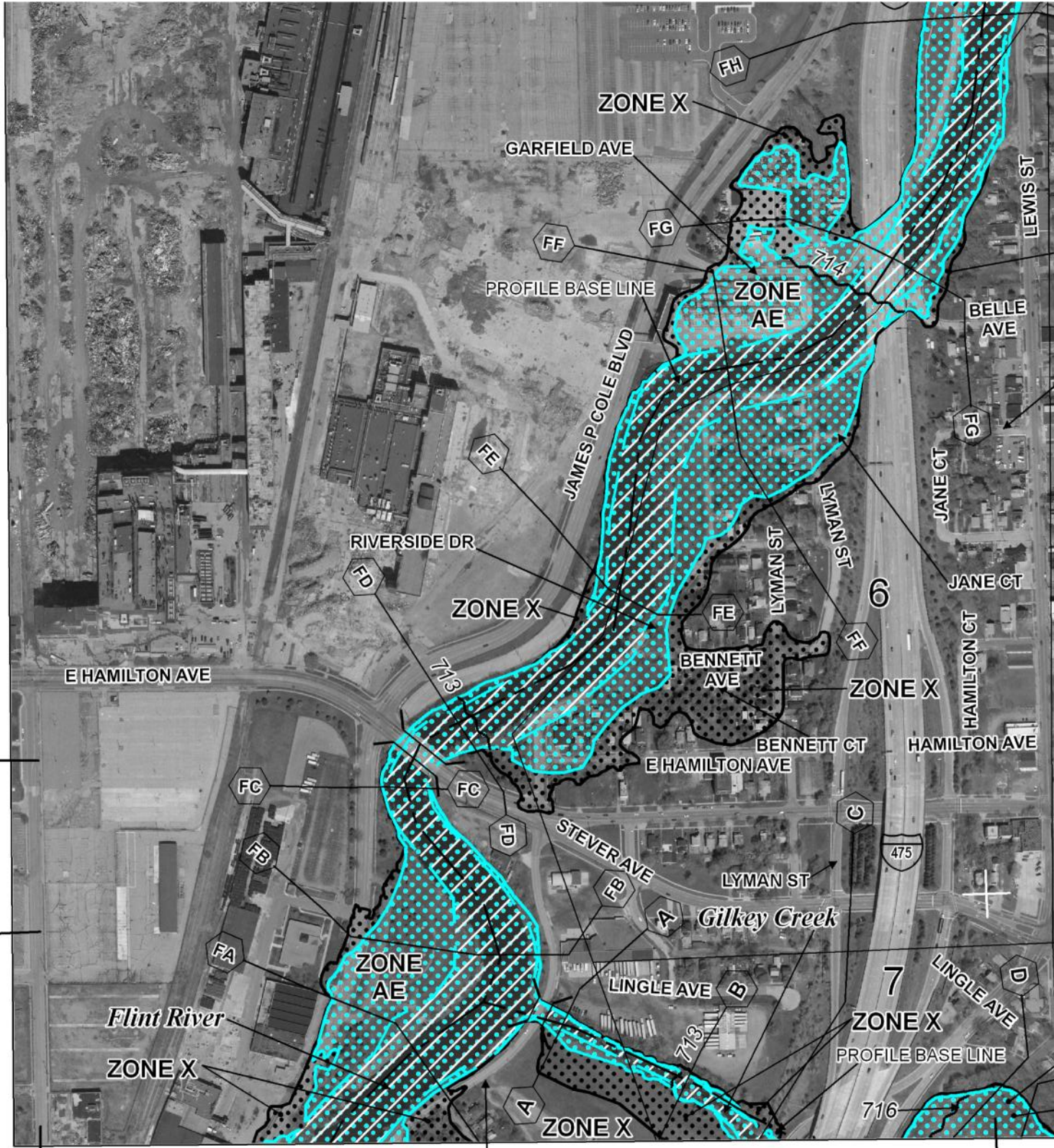
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE  
FLOOD INSURANCE RATE MAP  
September 25, 2009



52.5"





560000 FT

1' 52.5"

83° 41' 15.0"

E BOULEVARD DR

282000 M E

# APPENDIX B: MDEQ HYDROLOGIC DATA REQUEST AND RESPONSE

---

**Subject:** RE: flood or low flow discharge request (ContentID - 168812)

**From:** deq-wrd-qreq <deq-wrd-qreq@michigan.gov>

**Date:** 9/19/2017, 9:55 AM

**To:** "michael.scurlock@riverrestoration.org" <michael.scurlock@riverrestoration.org>

We have estimated the flood frequency discharges requested in your email of August 24, 2017 (Process No. 20170439), as follows:

Flint River at Hamilton Dam, Section 7, T7N, R7E, City of Flint, Genesee County, has a total drainage area of 751 square miles and a contributing drainage area of 742 square miles. The 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% chance peak flows are estimated to be 4000 cubic feet per second (cfs), 5800 cfs, 7200 cfs, 9000 cfs, 10300 cfs, 11800 cfs, 13000 cfs, and 14400 cfs, respectively. (Watershed Basin No. 32B Flint).

Please include a copy of this letter with your application for permit. These estimates should be confirmed by our office if an application is not submitted within one year. If you have any questions concerning the discharge estimates, please contact Ms. Susan Greiner, Hydrologic Studies and Dam Safety Unit, at 517-284-5579 or by email to GreinerS@michigan.gov. Any questions concerning the hydraulics or the proper procedure for filing for a permit should be directed to Ms. Donna Cervelli, Water Resources Division, Lansing District Office, at 517-243-6951 or email to CervelliD@michigan.gov.

Low flows will be provided in a separate email.

**From:** michael.scurlock@riverrestoration.org [mailto:michael.scurlock@riverrestoration.org]

**Sent:** Thursday, August 24, 2017 12:23 PM

**To:** deq-wrd-qreq <deq-wrd-qreq@michigan.gov>

**Subject:** flood or low flow discharge request (ContentID - 168812)

Requestor: Michael Scurlock

Company: riverrestoration.org

Address: PO Box 248

City: Carbondale/Colorado

Zip: 81601

Phone: 970-947-9568

Date: 08-24-2017

F50percent: Yes

F20percent: Yes

F10percent: Yes

F4percent: Yes

F2percent: Yes

F1percent: Yes

F0.5percent: Yes

F0.2percent: Yes

Monthly95: Yes

MonthlyMean: Yes

90DayQ10: Yes

Lowest95: Yes

Lowest50: Yes

HarmonicMean: Yes

FlowExceedanceCurve: Yes

ContactAgency: Other

ContactPerson:

Watercourse: Flint River

LocalName:

CountyLocation: Genesee

CityorTownship: Flint

Section: 24

Town: 7N

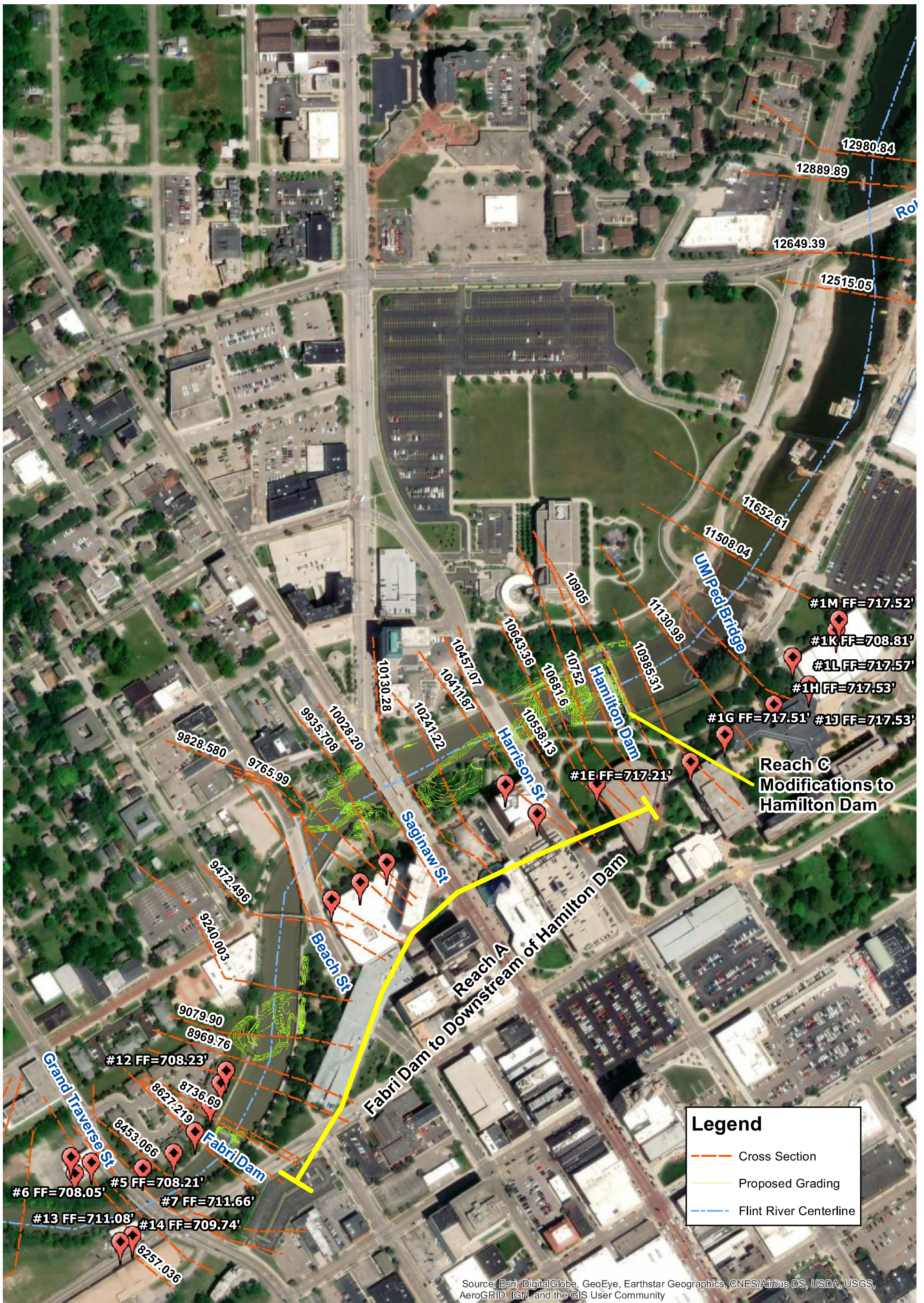
Range: 6E

Location: N. Grand Traverse St. Hamilton Dam Fabri Dam

FFR1: Floodplain

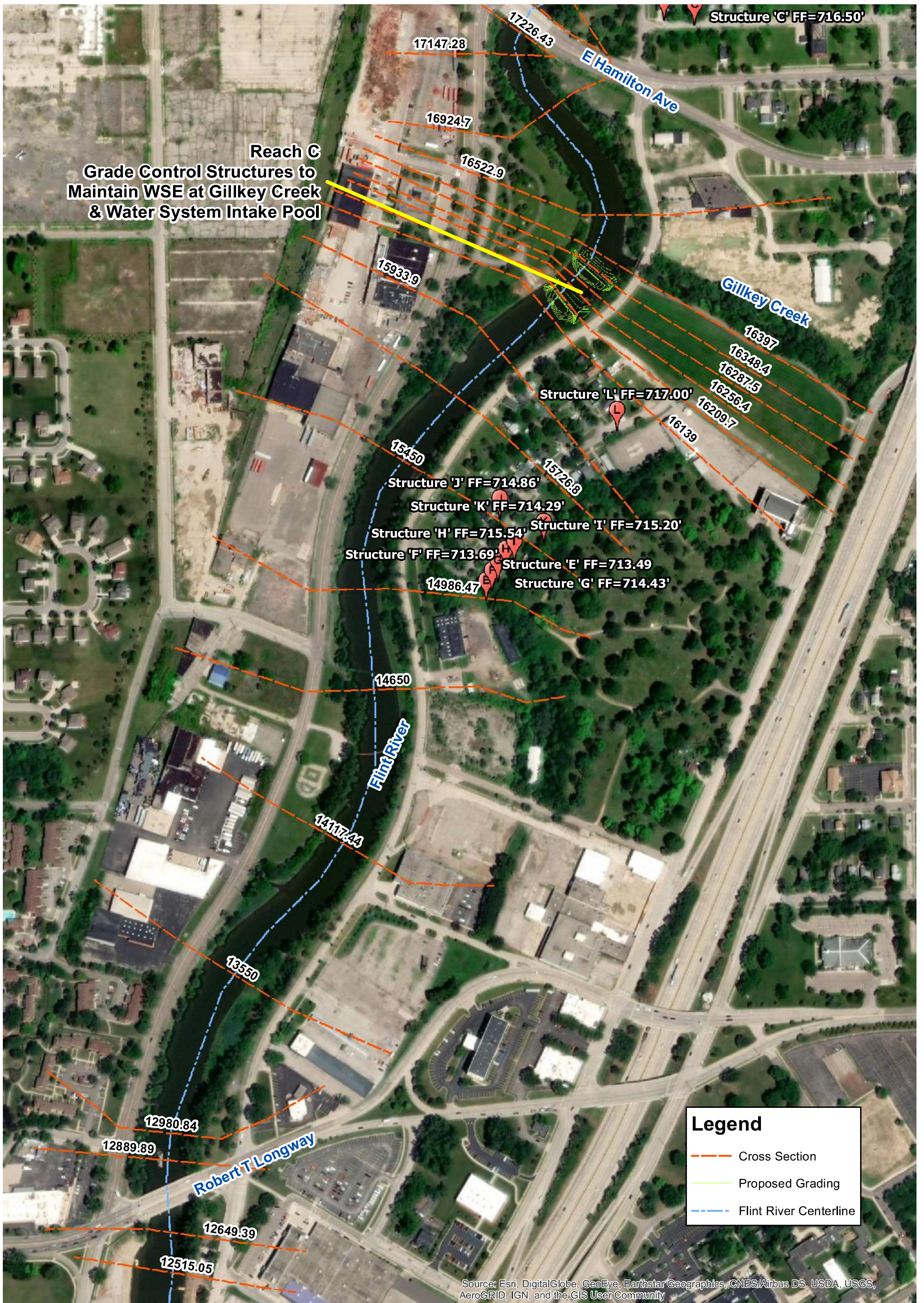
# APPENDIX C: HYDRAULIC MODEL CROSS-SECTION PLANVIEW

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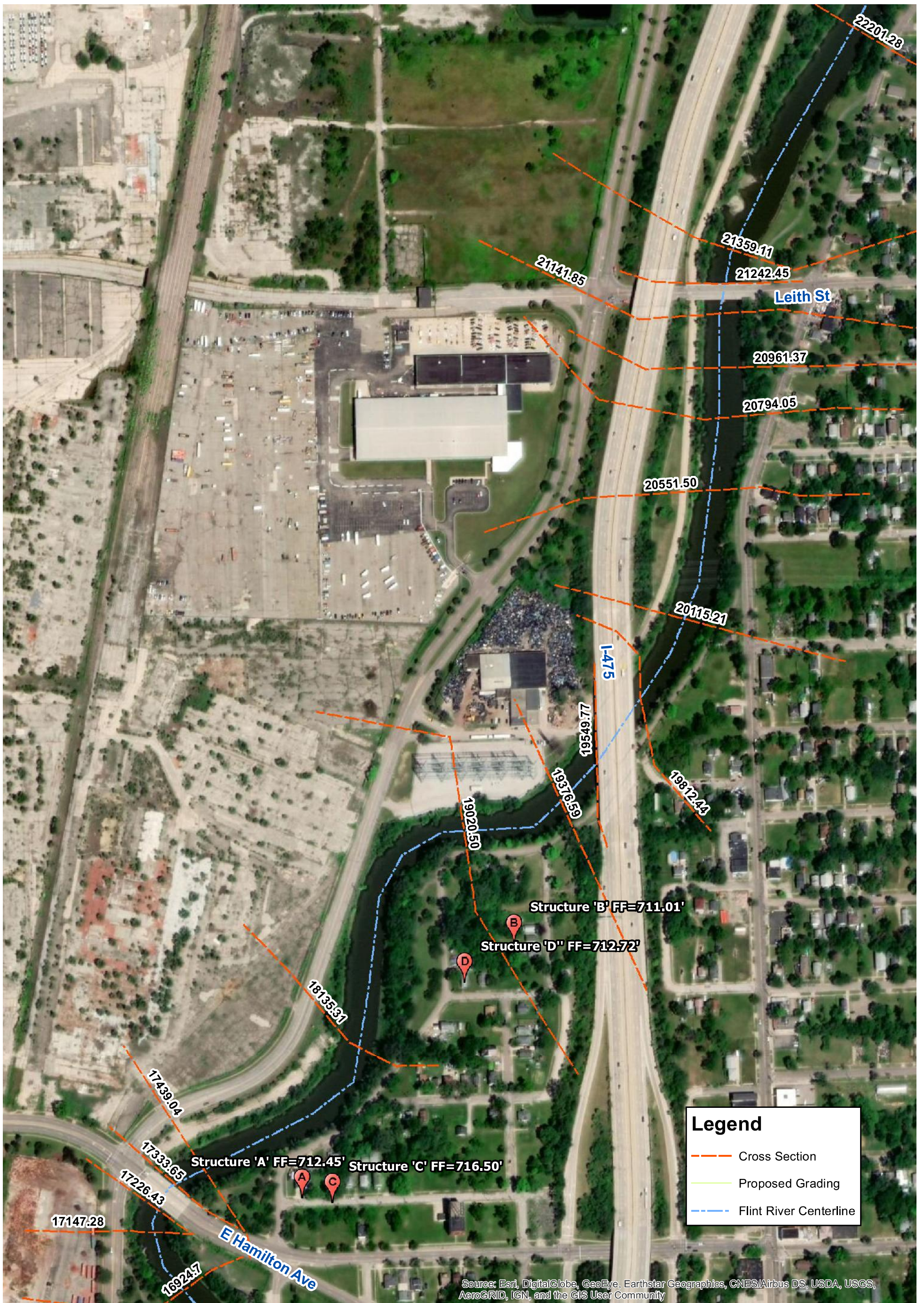
Flint Riverfront Restoration Project  
 HEC-RAS Model Cross Section Locations  
 Sheet 1





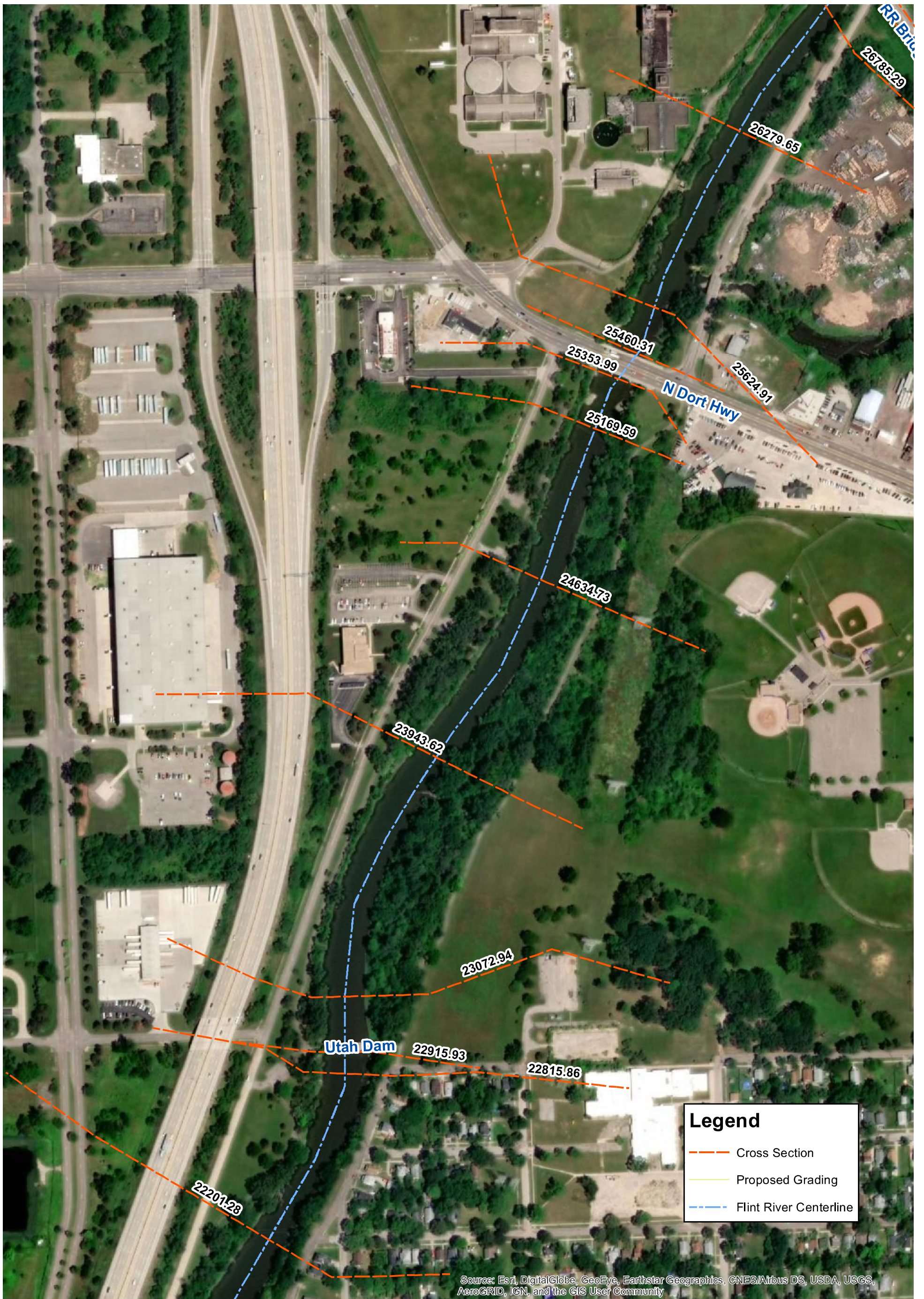
Flint Riverfront Restoration Project  
HEC-RAS Model Cross Section Locations  
Sheet 2





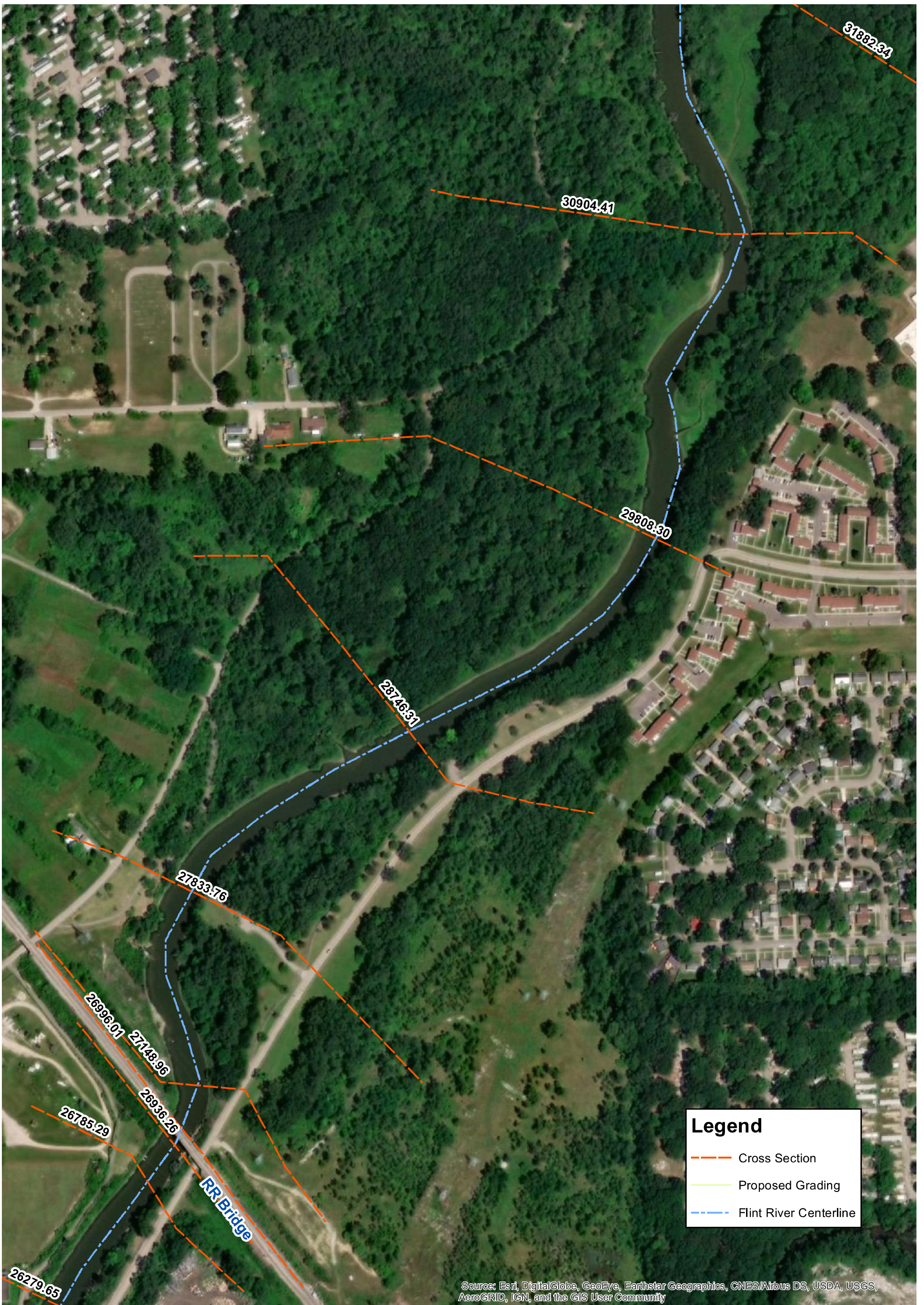
Flint Riverfront Restoration Project  
 HEC-RAS Model Cross Section Locations  
 Sheet 3





Flint Riverfront Restoration Project  
 HEC-RAS Model Cross Section Locations  
 Sheet 4





Flint Riverfront Restoration Project  
 HEC-RAS Model Cross Section Locations  
 Sheet 5



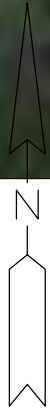


Flint Riverfront Restoration Project  
 HEC-RAS Model Cross Section Locations  
 Sheet 6



# APPENDIX D: HAMILTON DAM WEIR CREST AS-BUILT INFORMATION

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**WADE TRIM**  
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Genesee Parks  
Flint, MI

Hamilton Dam  
Weir Elevations

JOB NO.  
GPA2002

SHEET  
1

# APPENDIX E: HYDRAULIC MODEL RESULTS

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HEC-RAS Plan: EC - Conc Weir River: FlintRiver Reach: FlintReach

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FlintReach	17315.93		Bridge									
FlintReach	17226.43	2 Year	4000.00	697.00	708.42		708.59	0.000392	3.24	1234.16	140.82	0.19
FlintReach	17226.43	5 Year	5800.00	697.00	710.22		710.45	0.000527	3.89	1491.76	146.57	0.21
FlintReach	17226.43	10 Year	6000.00	697.00	711.26		711.47	0.000447	3.64	1646.84	149.91	0.19
FlintReach	17226.43	25 Year	9000.00	697.00	712.67		713.03	0.000758	4.84	1861.17	154.61	0.25
FlintReach	17226.43	50 Year	8600.00	697.00	713.39		713.68	0.000612	4.36	1972.92	157.45	0.22
FlintReach	17226.43	100 Year	10000.00	697.00	714.38		714.72	0.000703	4.69	2130.61	161.77	0.23
FlintReach	17226.43	500 Year	12500.00	697.00	716.00		716.42	0.000867	5.21	2400.24	170.99	0.25
FlintReach	17147.28	2 Year	4000.00	696.07	708.38		708.55	0.000416	3.34	1196.89	135.47	0.20
FlintReach	17147.28	5 Year	5800.00	696.07	710.15		710.40	0.000553	4.02	1441.85	140.65	0.22
FlintReach	17147.28	10 Year	6000.00	696.07	711.21		711.43	0.000464	3.77	1591.90	143.72	0.20
FlintReach	17147.28	25 Year	9000.00	696.07	712.57		712.96	0.000818	5.03	1791.04	149.22	0.26
FlintReach	17147.28	50 Year	8600.00	696.07	713.31		713.62	0.000673	4.52	1902.33	153.05	0.23
FlintReach	17147.28	100 Year	10000.00	696.07	714.28		714.65	0.000793	4.87	2054.18	158.14	0.24
FlintReach	17147.28	500 Year	12500.00	696.07	715.88		716.34	0.000986	5.40	2313.40	166.17	0.26
FlintReach	16924.74	2 Year	4000.00	697.19	708.24		708.43	0.000758	3.48	1149.78	171.23	0.24
FlintReach	16924.74	5 Year	5800.00	697.19	710.00		710.24	0.000952	3.94	1472.36	195.06	0.25
FlintReach	16924.74	10 Year	6000.00	697.19	711.10		711.29	0.000763	3.54	1693.96	209.98	0.22
FlintReach	16924.74	25 Year	9000.00	697.19	712.40		712.72	0.001239	4.55	1979.66	228.31	0.27
FlintReach	16924.74	50 Year	8600.00	697.19	713.18		713.43	0.000936	3.98	2163.62	244.30	0.23
FlintReach	16924.74	100 Year	10000.00	697.19	714.16		714.43	0.000973	4.16	2418.89	279.35	0.23
FlintReach	16924.74	500 Year	12500.00	697.19	715.77		716.07	0.000994	4.40	3027.24	487.78	0.23
FlintReach	16522.88	2 Year	4000.00	695.92	708.12		708.23	0.000287	2.68	1501.23	261.51	0.19
FlintReach	16522.88	5 Year	5800.00	695.92	709.88		710.01	0.000299	2.97	2077.05	385.89	0.19
FlintReach	16522.88	10 Year	7100.00	695.92	710.96		711.10	0.000301	3.11	2531.39	462.42	0.19
FlintReach	16522.88	25 Year	9000.00	695.92	712.30		712.46	0.000301	3.28	3220.89	553.50	0.19
FlintReach	16522.88	50 Year	10100.00	695.92	713.07		713.22	0.000291	3.32	3654.53	581.90	0.18
FlintReach	16522.88	100 Year	11500.00	695.92	714.06		714.22	0.000278	3.36	4256.98	670.65	0.18
FlintReach	16522.88	500 Year	14100.00	695.92	715.72		715.86	0.000247	3.33	5398.50	707.91	0.17
FlintReach	16397.01	2 Year	4000.00	697.05	708.06		708.18	0.000521	2.74	1503.99	272.50	0.19
FlintReach	16397.01	5 Year	5800.00	697.05	709.82		709.96	0.000531	3.06	2014.92	343.61	0.19
FlintReach	16397.01	10 Year	7100.00	697.05	710.90		711.05	0.000495	3.22	2483.45	480.04	0.19
FlintReach	16397.01	25 Year	9000.00	697.05	712.24		712.41	0.000455	3.40	3189.18	679.77	0.19
FlintReach	16397.01	50 Year	10100.00	697.05	713.01		713.18	0.000425	3.45	3636.96	954.88	0.18
FlintReach	16397.01	100 Year	11500.00	697.05	714.00		714.18	0.000400	3.54	4265.29	1181.40	0.18
FlintReach	16397.01	500 Year	14100.00	697.05	715.68		715.83	0.000304	3.38	6818.46	1556.34	0.16
FlintReach	16348.42	2 Year	4000.00	697.75	708.03	702.01	708.15	0.000717	2.76	1450.59	228.22	0.19
FlintReach	16348.42	5 Year	5800.00	697.75	709.78	702.89	709.93	0.000815	3.08	1881.93	263.56	0.20
FlintReach	16348.42	10 Year	7100.00	697.75	710.86	703.47	711.02	0.000802	3.23	2312.21	453.61	0.20
FlintReach	16348.42	25 Year	9000.00	697.75	712.22	704.24	712.38	0.000767	3.35	2982.54	540.54	0.19
FlintReach	16348.42	50 Year	10100.00	697.75	712.99	704.69	713.15	0.000725	3.36	3416.26	584.64	0.19
FlintReach	16348.42	100 Year	11500.00	697.75	713.99	705.23	714.14	0.000665	3.29	4031.87	764.96	0.18
FlintReach	16348.42	500 Year	14100.00	697.75	715.68	706.10	715.80	0.000515	3.08	6213.60	1533.91	0.16
FlintReach	16287.46	2 Year	4000.00	698.09	707.96		708.10	0.000692	3.00	1333.22	205.17	0.21
FlintReach	16287.46	5 Year	5800.00	698.09	709.70		709.88	0.000863	3.37	1720.68	240.68	0.22
FlintReach	16287.46	10 Year	7100.00	698.09	710.78		710.97	0.000873	3.54	2097.81	417.11	0.22
FlintReach	16287.46	25 Year	9000.00	698.09	712.13		712.33	0.000849	3.69	2729.57	574.86	0.22
FlintReach	16287.46	50 Year	10100.00	698.09	712.91		713.10	0.000785	3.65	3186.97	592.57	0.21
FlintReach	16287.46	100 Year	11500.00	698.09	713.93		714.10	0.000691	3.54	3801.14	613.61	0.19
FlintReach	16287.46	500 Year	14100.00	698.09	715.62		715.77	0.000528	3.37	5660.28	1462.27	0.17
FlintReach	16256.41	2 Year	4000.00	698.64	707.93		708.08	0.000773	3.08	1298.82	200.55	0.21
FlintReach	16256.41	5 Year	5800.00	698.64	709.66		709.85	0.000935	3.48	1667.85	229.51	0.23
FlintReach	16256.41	10 Year	7100.00	698.64	710.73		710.94	0.000977	3.65	2021.41	397.71	0.23
FlintReach	16256.41	25 Year	9000.00	698.64	712.08		712.30	0.000935	3.82	2627.39	566.87	0.22
FlintReach	16256.41	50 Year	10100.00	698.64	712.87		713.08	0.000861	3.77	3080.31	583.89	0.21
FlintReach	16256.41	100 Year	11500.00	698.64	713.90		714.08	0.000754	3.65	3690.15	607.09	0.20
FlintReach	16256.41	500 Year	14100.00	698.64	715.60		715.75	0.000576	3.47	5354.96	1399.42	0.18
FlintReach	16209.7	2 Year	4000.00	698.46	707.88		708.04	0.000867	3.20	1249.84	200.88	0.23
FlintReach	16209.7	5 Year	5800.00	698.46	709.60		709.80	0.000988	3.59	1616.66	226.44	0.24
FlintReach	16209.7	10 Year	7100.00	698.46	710.67		710.89	0.000991	3.79	1941.18	372.03	0.23
FlintReach	16209.7	25 Year	9000.00	698.46	712.02		712.26	0.000981	4.00	2507.74	549.98	0.23
FlintReach	16209.7	50 Year	10100.00	698.46	712.81		713.03	0.000907	3.96	2951.99	574.18	0.22
FlintReach	16209.7	100 Year	11500.00	698.46	713.84		714.04	0.000803	3.83	3562.81	607.85	0.21

HEC-RAS Plan: EC - Conc Weir River: FlintRiver Reach: FlintReach (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FlintReach	16209.7	500 Year	14100.00	698.46	715.56		715.73	0.000592	3.59	5167.98	1047.95	0.18
FlintReach	16138.96	2 Year	4000.00	698.17	707.82		707.98	0.000929	3.23	1236.62	203.56	0.23
FlintReach	16138.96	5 Year	5800.00	698.17	709.53		709.73	0.001116	3.60	1611.93	237.52	0.24
FlintReach	16138.96	10 Year	7100.00	698.17	710.59		710.82	0.001119	3.78	1907.44	327.30	0.24
FlintReach	16138.96	25 Year	9000.00	698.17	711.94		712.18	0.001094	3.97	2436.90	469.73	0.24
FlintReach	16138.96	50 Year	10100.00	698.17	712.74		712.97	0.001011	3.96	2850.95	532.42	0.23
FlintReach	16138.96	100 Year	11500.00	698.17	713.77		713.99	0.000859	3.86	3413.89	551.70	0.21
FlintReach	16138.96	500 Year	14100.00	698.17	715.51		715.68	0.000636	3.65	5003.97	1004.13	0.19
FlintReach	15933.91	2 Year	4000.00	697.60	707.65		707.80	0.000754	3.16	1267.34	207.08	0.22
FlintReach	15933.91	5 Year	5800.00	697.60	709.33		709.53	0.000858	3.57	1646.91	243.16	0.23
FlintReach	15933.91	10 Year	7100.00	697.60	710.39		710.61	0.000917	3.81	1915.21	270.87	0.23
FlintReach	15933.91	25 Year	9000.00	697.60	711.72		711.98	0.000916	4.11	2312.20	326.69	0.23
FlintReach	15933.91	50 Year	10100.00	697.60	712.50		712.77	0.000889	4.21	2624.37	447.45	0.23
FlintReach	15933.91	100 Year	11500.00	697.60	713.56		713.82	0.000777	4.20	3143.18	535.93	0.22
FlintReach	15933.91	500 Year	14100.00	697.60	715.32		715.55	0.000627	4.15	4486.85	880.24	0.20
FlintReach	15726.53	2 Year	4000.00	696.95	707.49		707.65	0.000780	3.13	1279.08	193.38	0.21
FlintReach	15726.53	5 Year	5800.00	696.95	709.14		709.34	0.000901	3.60	1634.22	223.69	0.22
FlintReach	15726.53	10 Year	7100.00	696.95	710.18		710.41	0.000989	3.87	1870.20	233.83	0.23
FlintReach	15726.53	25 Year	9000.00	696.95	711.50		711.77	0.001037	4.22	2207.00	293.53	0.24
FlintReach	15726.53	50 Year	10100.00	696.95	712.28		712.57	0.001004	4.37	2464.07	372.61	0.23
FlintReach	15726.53	100 Year	11500.00	696.95	713.34		713.64	0.000925	4.46	2907.30	469.06	0.23
FlintReach	15726.53	500 Year	14100.00	696.95	715.11		715.40	0.000781	4.50	4199.31	891.50	0.22
FlintReach	15450	2 Year	4000.00	697.89	707.38		707.50	0.000333	2.80	1430.03	212.04	0.19
FlintReach	15450	5 Year	5800.00	697.89	709.02		709.18	0.000373	3.23	1794.13	232.42	0.21
FlintReach	15450	10 Year	7100.00	697.89	710.05		710.23	0.000394	3.48	2039.54	244.79	0.21
FlintReach	15450	25 Year	9000.00	697.89	711.36		711.58	0.000423	3.80	2371.50	260.49	0.22
FlintReach	15450	50 Year	10100.00	697.89	712.15		712.38	0.000422	3.92	2650.72	631.47	0.22
FlintReach	15450	100 Year	11500.00	697.89	713.22		713.46	0.000396	3.96	3384.28	735.11	0.21
FlintReach	15450	500 Year	14100.00	697.89	715.02		715.25	0.000348	3.97	4828.70	850.04	0.20
FlintReach	14986.47	2 Year	4000.00	696.32	707.07		707.24	0.001132	3.28	1220.39	175.04	0.22
FlintReach	14986.47	5 Year	5800.00	696.32	708.64		708.87	0.001405	3.84	1509.30	192.12	0.24
FlintReach	14986.47	10 Year	7100.00	696.32	709.64		709.91	0.001441	4.18	1710.51	217.05	0.25
FlintReach	14986.47	25 Year	9000.00	696.32	710.91		711.24	0.001467	4.61	2015.14	260.99	0.25
FlintReach	14986.47	50 Year	10100.00	696.32	711.70		712.05	0.001425	4.77	2225.15	276.10	0.25
FlintReach	14986.47	100 Year	11500.00	696.32	712.79		713.14	0.001293	4.84	2748.35	603.94	0.25
FlintReach	14986.47	500 Year	14100.00	696.32	714.67		714.98	0.001021	4.74	4036.49	743.76	0.22
FlintReach	14650	2 Year	4000.00	697.43	706.83		707.00	0.000474	3.29	1214.28	198.73	0.23
FlintReach	14650	5 Year	5800.00	697.43	708.38		708.60	0.000519	3.77	1539.89	221.98	0.25
FlintReach	14650	10 Year	7100.00	697.43	709.38		709.63	0.000533	4.03	1768.61	236.85	0.26
FlintReach	14650	25 Year	9000.00	697.43	710.65		710.95	0.000552	4.36	2091.49	292.83	0.26
FlintReach	14650	50 Year	10100.00	697.43	711.45		711.76	0.000535	4.46	2354.53	366.16	0.25
FlintReach	14650	100 Year	11500.00	697.43	712.57		712.88	0.000484	4.48	2870.94	557.86	0.24
FlintReach	14650	500 Year	14100.00	697.43	714.50		714.77	0.000380	4.32	4287.32	880.45	0.21
FlintReach	14117.44	2 Year	4000.00	695.12	706.60		706.75	0.000459	3.12	1282.70	184.37	0.21
FlintReach	14117.44	5 Year	5800.00	695.12	708.09		708.30	0.000595	3.69	1571.57	202.70	0.23
FlintReach	14117.44	10 Year	7100.00	695.12	709.06		709.31	0.000666	4.00	1774.46	214.64	0.25
FlintReach	14117.44	25 Year	9000.00	695.12	710.31		710.60	0.000754	4.39	2050.87	229.84	0.26
FlintReach	14117.44	50 Year	10100.00	695.12	711.10		711.42	0.000767	4.51	2237.33	239.52	0.26
FlintReach	14117.44	100 Year	11500.00	695.12	712.24		712.57	0.000717	4.56	2559.62	400.89	0.25
FlintReach	14117.44	500 Year	14100.00	695.12	714.22		714.52	0.000554	4.52	3525.14	557.42	0.23
FlintReach	13550	2 Year	4000.00	696.71	706.31		706.47	0.000535	3.21	1245.74	202.01	0.23
FlintReach	13550	5 Year	5800.00	696.71	707.74		707.96	0.000588	3.77	1550.70	222.22	0.24
FlintReach	13550	10 Year	7100.00	696.71	708.69		708.95	0.000611	4.08	1767.06	235.51	0.25
FlintReach	13550	25 Year	9000.00	696.71	709.90		710.21	0.000645	4.50	2061.43	252.46	0.26
FlintReach	13550	50 Year	10100.00	696.71	710.69		711.02	0.000632	4.64	2266.41	263.63	0.26
FlintReach	13550	100 Year	11500.00	696.71	711.86		712.20	0.000582	4.70	2584.42	280.07	0.25
FlintReach	13550	500 Year	14100.00	696.71	713.88		714.23	0.000482	4.76	3351.67	437.35	0.23
FlintReach	12980.84	2 Year	4000.00	695.47	705.96		706.13	0.000656	3.28	1218.21	181.89	0.22
FlintReach	12980.84	5 Year	5800.00	695.47	707.31		707.56	0.000883	3.94	1471.54	192.57	0.25
FlintReach	12980.84	10 Year	7100.00	695.47	708.22		708.50	0.001011	4.31	1648.34	199.67	0.26
FlintReach	12980.84	25 Year	9000.00	695.47	709.36		709.72	0.001185	4.78	1882.41	208.71	0.28
FlintReach	12980.84	50 Year	10100.00	695.47	710.15		710.53	0.001218	4.93	2049.91	214.94	0.28
FlintReach	12980.84	100 Year	11500.00	695.47	711.35		711.74	0.001182	4.97	2313.17	224.33	0.27



HEC-RAS Plan: EC - Conc Weir River: FlintRiver Reach: FlintReach (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FlintReach	10817.09	2 Year	4000.00	681.38	700.01		700.04	0.000052	1.52	2625.48	212.38	0.08
FlintReach	10817.09	5 Year	5800.00	681.38	702.48		702.54	0.000061	1.84	3189.65	258.93	0.08
FlintReach	10817.09	10 Year	7200.00	681.38	704.28		704.34	0.000063	2.02	3669.29	274.88	0.09
FlintReach	10817.09	25 Year	9000.00	681.38	706.54		706.62	0.000063	2.20	4315.08	294.32	0.09
FlintReach	10817.09	50 Year	10300.00	681.38	707.69		707.78	0.000067	2.36	4658.48	303.78	0.09
FlintReach	10817.09	100 Year	11800.00	681.38	709.17		709.27	0.000068	2.50	5118.33	331.09	0.09
FlintReach	10817.09	500 Year	14400.00	681.38	711.38		711.49	0.000072	2.74	5850.61	458.06	0.10
FlintReach	10752	2 Year	4000.00	678.76	700.01		700.04	0.000037	1.46	2737.90	174.17	0.06
FlintReach	10752	5 Year	5800.00	678.76	702.48		702.53	0.000048	1.83	3204.15	221.26	0.08
FlintReach	10752	10 Year	7200.00	678.76	704.27		704.33	0.000054	2.06	3623.28	245.76	0.08
FlintReach	10752	25 Year	9000.00	678.76	706.53		706.61	0.000058	2.28	4206.93	271.37	0.09
FlintReach	10752	50 Year	10300.00	678.76	707.68		707.77	0.000063	2.47	4536.56	299.63	0.09
FlintReach	10752	100 Year	11800.00	678.76	709.16		709.26	0.000066	2.63	4999.53	324.70	0.09
FlintReach	10752	500 Year	14400.00	678.76	711.36		711.48	0.000071	2.90	5767.14	422.66	0.10
FlintReach	10681.63	2 Year	4000.00	683.70	699.97		700.03	0.000086	1.99	2011.75	149.66	0.10
FlintReach	10681.63	5 Year	5800.00	683.70	702.43		702.52	0.000106	2.44	2403.69	190.24	0.11
FlintReach	10681.63	10 Year	7200.00	683.70	704.21		704.32	0.000113	2.70	2785.63	234.48	0.11
FlintReach	10681.63	25 Year	9000.00	683.70	706.47		706.60	0.000114	2.94	3385.53	302.88	0.12
FlintReach	10681.63	50 Year	10300.00	683.70	707.61		707.76	0.000120	3.14	3739.78	318.02	0.12
FlintReach	10681.63	100 Year	11800.00	683.70	709.09		709.25	0.000122	3.30	4261.98	401.09	0.12
FlintReach	10681.63	500 Year	14400.00	683.70	711.30		711.47	0.000123	3.52	5187.01	439.46	0.12
FlintReach	10643.36	2 Year	4000.00	683.50	699.97		700.03	0.000083	2.01	1993.91	142.87	0.09
FlintReach	10643.36	5 Year	5800.00	683.50	702.42		702.52	0.000105	2.47	2371.67	184.91	0.11
FlintReach	10643.36	10 Year	7200.00	683.50	704.20		704.32	0.000113	2.75	2737.75	228.50	0.11
FlintReach	10643.36	25 Year	9000.00	683.50	706.46		706.60	0.000115	3.00	3338.81	352.16	0.12
FlintReach	10643.36	50 Year	10300.00	683.50	707.60		707.76	0.000122	3.21	3697.31	388.69	0.12
FlintReach	10643.36	100 Year	11800.00	683.50	709.08		709.25	0.000123	3.36	4214.22	411.06	0.12
FlintReach	10643.36	500 Year	14400.00	683.50	711.28		711.47	0.000124	3.60	5042.13	453.29	0.13
FlintReach	10558.13	2 Year	4000.00	687.01	699.87	692.74	700.00	0.000271	2.89	1385.52	140.52	0.16
FlintReach	10558.13	5 Year	5800.00	687.01	702.31	693.74	702.48	0.000283	3.35	1758.42	189.21	0.17
FlintReach	10558.13	10 Year	7200.00	687.01	704.08	694.32	704.28	0.000270	3.58	2107.48	201.97	0.17
FlintReach	10558.13	25 Year	9000.00	687.01	706.34	695.00	706.56	0.000247	3.79	2593.06	233.04	0.17
FlintReach	10558.13	50 Year	10300.00	687.01	707.48	695.47	707.72	0.000252	4.00	2865.30	247.71	0.17
FlintReach	10558.13	100 Year	11800.00	687.01	708.95	695.99	709.20	0.000244	4.15	3245.30	265.89	0.17
FlintReach	10558.13	500 Year	14400.00	687.01	711.14	696.88	711.42	0.000240	4.44	3860.28	305.78	0.17
FlintReach	10527.29		Bridge									
FlintReach	10457.07	2 Year	4000.00	688.33	699.80		699.94	0.000295	2.98	1342.19	140.78	0.17
FlintReach	10457.07	5 Year	5800.00	688.33	702.23		702.42	0.000299	3.44	1693.82	164.17	0.18
FlintReach	10457.07	10 Year	7200.00	688.33	704.00		704.21	0.000291	3.70	1994.54	170.53	0.18
FlintReach	10457.07	25 Year	9000.00	688.33	706.25		706.49	0.000269	3.94	2393.10	181.12	0.17
FlintReach	10457.07	50 Year	10300.00	688.33	707.37		707.64	0.000278	4.19	2595.45	181.30	0.18
FlintReach	10457.07	100 Year	11800.00	688.33	708.83		709.12	0.000274	4.39	2860.03	181.52	0.18
FlintReach	10457.07	500 Year	14400.00	688.33	710.98		711.32	0.000278	4.76	3251.28	181.85	0.19
FlintReach	10411.87	2 Year	4000.00	688.40	699.80		699.92	0.000248	2.86	1400.17	138.46	0.16
FlintReach	10411.87	5 Year	5800.00	688.40	702.23		702.40	0.000261	3.34	1756.48	173.02	0.17
FlintReach	10411.87	10 Year	7200.00	688.40	704.00		704.20	0.000256	3.61	2067.18	180.25	0.17
FlintReach	10411.87	25 Year	9000.00	688.40	706.25		706.47	0.000239	3.85	2512.27	204.99	0.17
FlintReach	10411.87	50 Year	10300.00	688.40	707.36		707.62	0.000250	4.11	2766.90	245.11	0.17
FlintReach	10411.87	100 Year	11800.00	688.40	708.82		709.10	0.000245	4.29	3129.65	249.31	0.17
FlintReach	10411.87	500 Year	14400.00	688.40	710.98		711.29	0.000243	4.59	3679.56	316.10	0.18
FlintReach	10241.22	2 Year	4000.00	687.64	699.76		699.88	0.000207	2.79	1477.35	170.08	0.15
FlintReach	10241.22	5 Year	5800.00	687.64	702.19		702.36	0.000222	3.29	1880.67	240.96	0.16
FlintReach	10241.22	10 Year	7200.00	687.64	703.96		704.15	0.000221	3.57	2205.30	253.62	0.16
FlintReach	10241.22	25 Year	9000.00	687.64	706.21		706.43	0.000214	3.85	2650.27	301.16	0.16
FlintReach	10241.22	50 Year	10300.00	687.64	707.33		707.58	0.000223	4.10	2898.09	338.69	0.17
FlintReach	10241.22	100 Year	11800.00	687.64	708.79		709.06	0.000222	4.29	3222.32	438.62	0.17
FlintReach	10241.22	500 Year	14400.00	687.64	710.94		711.25	0.000227	4.65	3705.30	477.98	0.17
FlintReach	10130.28	2 Year	4000.00	688.43	699.73	692.10	699.86	0.000237	2.86	1398.05	146.59	0.15
FlintReach	10130.28	5 Year	5800.00	688.43	702.15	692.98	702.33	0.000258	3.38	1727.68	210.80	0.16
FlintReach	10130.28	10 Year	7200.00	688.43	703.92	693.59	704.13	0.000258	3.67	1999.46	219.98	0.17
FlintReach	10130.28	25 Year	9000.00	688.43	706.17	694.31	706.41	0.000248	3.96	2361.83	232.55	0.17
FlintReach	10130.28	50 Year	10300.00	688.43	707.27	694.82	707.55	0.000261	4.23	2548.28	239.17	0.18
FlintReach	10130.28	100 Year	11800.00	688.43	708.72	695.37	709.03	0.000263	4.47	2834.24	393.60	0.18

HEC-RAS Plan: EC - Conc Weir River: FlintRiver Reach: FlintReach (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FlintReach	10130.28	500 Year	14400.00	688.43	710.87	696.25	711.23	0.000267	4.83	3295.04	493.06	0.18
FlintReach	10114.56		Bridge									
FlintReach	10028.20	2 Year	4000.00	688.43	699.36		699.48	0.000240	2.88	1388.32	147.15	0.16
FlintReach	10028.20	5 Year	5800.00	688.43	701.77		701.95	0.000264	3.40	1712.20	199.78	0.17
FlintReach	10028.20	10 Year	7200.00	688.43	703.53		703.75	0.000264	3.70	1985.52	215.51	0.17
FlintReach	10028.20	25 Year	9000.00	688.43	705.79		706.03	0.000254	3.99	2370.21	297.17	0.17
FlintReach	10028.20	50 Year	10300.00	688.43	706.89		707.17	0.000266	4.26	2589.03	311.76	0.18
FlintReach	10028.20	100 Year	11800.00	688.43	708.34		708.65	0.000264	4.48	2879.53	314.87	0.18
FlintReach	10028.20	500 Year	14400.00	688.43	710.50		710.86	0.000270	4.85	3325.68	439.22	0.18
FlintReach	9935.708	2 Year	4000.00	686.76	699.35		699.45	0.000181	2.64	1536.09	145.72	0.14
FlintReach	9935.708	5 Year	5800.00	686.76	701.76		701.91	0.000195	3.10	2040.63	245.60	0.15
FlintReach	9935.708	10 Year	7200.00	686.76	703.54		703.70	0.000189	3.31	2483.87	254.23	0.15
FlintReach	9935.708	25 Year	9000.00	686.76	705.80		705.98	0.000175	3.49	3073.04	266.93	0.15
FlintReach	9935.708	50 Year	10300.00	686.76	706.92		707.11	0.000181	3.70	3372.45	274.51	0.15
FlintReach	9935.708	100 Year	11800.00	686.76	708.37		708.58	0.000178	3.86	3791.88	314.28	0.15
FlintReach	9935.708	500 Year	14400.00	686.76	710.54		710.78	0.000177	4.12	4578.40	450.14	0.15
FlintReach	9828.580	2 Year	4000.00	685.55	699.34		699.43	0.000144	2.47	1740.78	197.34	0.12
FlintReach	9828.580	5 Year	5800.00	685.55	701.76		701.89	0.000164	2.95	2270.47	243.02	0.14
FlintReach	9828.580	10 Year	7200.00	685.55	703.52		703.68	0.000167	3.21	2712.64	274.72	0.14
FlintReach	9828.580	25 Year	9000.00	685.55	705.79		705.96	0.000163	3.46	3440.79	338.71	0.14
FlintReach	9828.580	50 Year	10300.00	685.55	706.90		707.09	0.000171	3.68	3820.72	343.26	0.15
FlintReach	9828.580	100 Year	11800.00	685.55	708.35		708.56	0.000170	3.85	4344.51	385.39	0.15
FlintReach	9828.580	500 Year	14400.00	685.55	710.51		710.76	0.000177	4.19	5329.47	551.08	0.15
FlintReach	9765.99	2 Year	4000.00	686.17	699.28	691.99	699.41	0.000258	2.92	1369.00	135.36	0.16
FlintReach	9765.99	5 Year	5800.00	686.17	701.68	692.86	701.86	0.000274	3.42	1706.68	155.84	0.17
FlintReach	9765.99	10 Year	7200.00	686.17	703.44	693.48	703.65	0.000271	3.71	2012.94	196.00	0.17
FlintReach	9765.99	25 Year	9000.00	686.17	705.69	694.21	705.93	0.000255	3.97	2483.63	231.78	0.17
FlintReach	9765.99	50 Year	10300.00	686.17	706.78	694.71	707.06	0.000266	4.24	2730.22	255.35	0.18
FlintReach	9765.99	100 Year	11800.00	686.17	708.22	695.27	708.52	0.000264	4.45	3080.01	300.80	0.18
FlintReach	9765.99	500 Year	14400.00	686.17	710.37	696.19	710.71	0.000267	4.80	3759.40	426.30	0.18
FlintReach	9712.188	2 Year	4000.00	686.93	699.31	691.05	699.38	0.000119	2.10	1902.45	177.69	0.11
FlintReach	9712.188	5 Year	5800.00	686.93	701.73	691.77	701.82	0.000131	2.49	2334.61	202.17	0.12
FlintReach	9712.188	10 Year	7200.00	686.93	703.50	692.27	703.61	0.000132	2.71	2715.46	216.40	0.12
FlintReach	9712.188	25 Year	9000.00	686.93	705.75	692.85	705.89	0.000128	2.93	3205.16	217.40	0.12
FlintReach	9712.188	50 Year	10300.00	686.93	706.86	693.27	707.01	0.000135	3.15	3445.37	217.89	0.13
FlintReach	9712.188	100 Year	11800.00	686.93	708.30	693.72	708.47	0.000137	3.33	3766.45	258.93	0.13
FlintReach	9712.188	500 Year	14400.00	686.93	710.46	694.44	710.66	0.000143	3.65	4529.77	421.60	0.14
FlintReach	9701.19		Bridge									
FlintReach	9620.237	2 Year	4000.00	688.17	699.29		699.37	0.000135	2.17	1843.08	180.89	0.12
FlintReach	9620.237	5 Year	5800.00	688.17	701.70		701.80	0.000144	2.54	2279.96	181.40	0.13
FlintReach	9620.237	10 Year	7200.00	688.17	703.47		703.59	0.000147	2.77	2600.72	181.78	0.13
FlintReach	9620.237	25 Year	9000.00	688.17	705.64		705.78	0.000147	3.01	2994.83	182.24	0.13
FlintReach	9620.237	50 Year	10300.00	688.17	706.68		706.84	0.000159	3.23	3185.55	182.46	0.14
FlintReach	9620.237	100 Year	11800.00	688.17	708.04		708.23	0.000165	3.44	3434.32	182.79	0.14
FlintReach	9620.237	500 Year	14400.00	688.17	710.18		710.40	0.000175	3.75	3938.82	331.32	0.14
FlintReach	9472.496	2 Year	4000.00	686.55	699.21		699.33	0.000203	2.77	1443.15	131.41	0.15
FlintReach	9472.496	5 Year	5800.00	686.55	701.59		701.76	0.000230	3.30	1759.43	139.41	0.16
FlintReach	9472.496	10 Year	7200.00	686.55	703.33		703.54	0.000238	3.62	2003.03	139.62	0.16
FlintReach	9472.496	25 Year	9000.00	686.55	705.48		705.72	0.000239	3.95	2309.60	146.48	0.17
FlintReach	9472.496	50 Year	10300.00	686.55	706.50		706.78	0.000257	4.26	2463.02	152.31	0.18
FlintReach	9472.496	100 Year	11800.00	686.55	707.84		708.16	0.000265	4.54	2667.53	152.73	0.18
FlintReach	9472.496	500 Year	14400.00	686.55	709.93		710.32	0.000279	4.98	3078.73	311.64	0.19
FlintReach	9240.003	2 Year	4000.00	685.44	699.16		699.28	0.000217	2.79	1433.20	131.70	0.15
FlintReach	9240.003	5 Year	5800.00	685.44	701.53		701.70	0.000245	3.32	1750.82	145.95	0.16
FlintReach	9240.003	10 Year	7200.00	685.44	703.28		703.48	0.000248	3.63	2040.83	179.08	0.17
FlintReach	9240.003	25 Year	9000.00	685.44	705.43		705.66	0.000242	3.92	2449.56	202.81	0.17
FlintReach	9240.003	50 Year	10300.00	685.44	706.45		706.71	0.000257	4.20	2662.65	214.32	0.17
FlintReach	9240.003	100 Year	11800.00	685.44	707.79		708.09	0.000260	4.43	2965.59	237.01	0.18
FlintReach	9240.003	500 Year	14400.00	685.44	709.90		710.24	0.000263	4.77	3726.45	516.68	0.18
FlintReach	9079.90	2 Year	4000.00	684.80	699.14		699.24	0.000157	2.52	1584.90	129.85	0.13
FlintReach	9079.90	5 Year	5800.00	684.80	701.51		701.66	0.000189	3.06	1898.14	152.51	0.14

HEC-RAS Plan: EC - Conc Weir River: FlintRiver Reach: FlintReach (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
FlintReach	9079.90	10 Year	7200.00	684.80	703.26		703.44	0.000198	3.38	2198.13	190.80	0.15
FlintReach	9079.90	25 Year	9000.00	684.80	705.41		705.62	0.000200	3.69	2630.46	211.13	0.15
FlintReach	9079.90	50 Year	10300.00	684.80	706.43		706.67	0.000215	3.97	2850.79	220.61	0.16
FlintReach	9079.90	100 Year	11800.00	684.80	707.78		708.04	0.000221	4.20	3165.12	283.09	0.16
FlintReach	9079.90	500 Year	14400.00	684.80	709.89		710.19	0.000229	4.56	3957.42	441.80	0.17
FlintReach	8969.76	2 Year	4000.00	685.52	699.12	690.03	699.22	0.000159	2.55	1567.75	128.54	0.13
FlintReach	8969.76	5 Year	5800.00	685.52	701.49	690.88	701.64	0.000193	3.10	1873.22	137.54	0.14
FlintReach	8969.76	10 Year	7200.00	685.52	703.23	691.52	703.41	0.000218	3.41	2152.90	177.23	0.15
FlintReach	8969.76	25 Year	9000.00	685.52	705.38	692.24	705.59	0.000216	3.70	2568.13	236.16	0.16
FlintReach	8969.76	50 Year	10300.00	685.52	706.40	692.76	706.64	0.000231	3.98	2789.69	306.29	0.16
FlintReach	8969.76	100 Year	11800.00	685.52	707.75	693.31	708.02	0.000235	4.21	3093.36	391.55	0.17
FlintReach	8969.76	500 Year	14400.00	685.52	709.85	694.23	710.16	0.000242	4.57	3607.62	475.18	0.17
FlintReach	8904.531	2 Year	4000.00	684.64	699.12		699.21	0.000153	2.48	1610.41	132.90	0.13
FlintReach	8904.531	5 Year	5800.00	684.64	701.48		701.62	0.000184	3.01	1925.88	140.93	0.14
FlintReach	8904.531	10 Year	7200.00	684.64	703.23		703.40	0.000197	3.33	2188.61	156.70	0.15
FlintReach	8904.531	25 Year	9000.00	684.64	705.37		705.58	0.000204	3.67	2534.93	172.91	0.15
FlintReach	8904.531	50 Year	10300.00	684.64	706.39		706.63	0.000222	3.97	2715.63	320.53	0.16
FlintReach	8904.531	100 Year	11800.00	684.64	707.72		708.00	0.000232	4.24	2997.52	439.50	0.16
FlintReach	8904.531	500 Year	14400.00	684.64	709.82		710.15	0.000244	4.63	3500.78	510.23	0.17
FlintReach	8756.70	2 Year	4000.00	688.00	699.00	691.84	699.16	0.000313	3.21	1245.88	119.88	0.18
FlintReach	8756.70	5 Year	5800.00	688.00	701.34	692.77	701.56	0.000349	3.80	1526.46	126.60	0.19
FlintReach	8756.70	10 Year	7200.00	688.00	703.06	693.42	703.33	0.000356	4.15	1761.37	138.91	0.19
FlintReach	8756.70	25 Year	9000.00	688.00	705.19	694.19	705.51	0.000365	4.50	2058.03	142.42	0.20
FlintReach	8756.70	50 Year	10300.00	688.00	706.19	694.73	706.55	0.000406	4.84	2205.30	238.01	0.21
FlintReach	8756.70	100 Year	11800.00	688.00	707.51	695.31	707.92	0.000409	5.11	2420.67	406.63	0.21
FlintReach	8756.70	500 Year	14400.00	688.00	709.59	696.25	710.06	0.000416	5.55	2854.55	521.26	0.22
FlintReach	8736.686	2 Year	4000.00	688.01	698.97	692.27	699.15	0.000362	3.42	1170.07	116.96	0.19
FlintReach	8736.686	5 Year	5800.00	688.01	701.30	693.20	701.55	0.000396	4.02	1442.97	123.64	0.20
FlintReach	8736.686	10 Year	7200.00	688.01	703.02	693.84	703.32	0.000400	4.37	1670.92	135.22	0.21
FlintReach	8736.686	25 Year	9000.00	688.01	705.15	694.63	705.50	0.000399	4.73	1959.12	136.84	0.21
FlintReach	8736.686	50 Year	10300.00	688.01	706.14	695.17	706.54	0.000428	5.09	2097.62	277.18	0.22
FlintReach	8736.686	100 Year	11800.00	688.01	707.46	695.75	707.90	0.000435	5.39	2295.32	383.87	0.22
FlintReach	8736.686	500 Year	14400.00	688.01	709.52	696.72	710.04	0.000447	5.87	2705.18	522.58	0.23
FlintReach	8718.172		Inl Struct									
FlintReach	8671.75	2 Year	4000.00	688.13	698.57	692.23	698.80	0.000466	3.81	1049.09	106.78	0.21
FlintReach	8671.75	5 Year	5800.00	688.13	700.92	693.24	701.23	0.000504	4.46	1300.22	106.96	0.23
FlintReach	8671.75	10 Year	7200.00	688.13	702.62	693.95	702.98	0.000511	4.85	1505.25	130.16	0.23
FlintReach	8671.75	25 Year	9000.00	688.13	704.71	694.78	705.14	0.000506	5.25	1778.20	130.48	0.23
FlintReach	8671.75	50 Year	10300.00	688.13	705.66	695.36	706.15	0.000572	5.65	1905.90	140.25	0.25
FlintReach	8671.75	100 Year	11800.00	688.13	706.98	695.98	707.52	0.000573	5.96	2099.03	330.80	0.25
FlintReach	8671.75	500 Year	14400.00	688.13	709.04	697.01	709.68	0.000582	6.47	2468.66	472.21	0.26

# APPENDIX F: HYDRAULIC MODEL PROFILES

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