ARCADIS
Infrastructure, environment, buildings

GPD GROUP

ALL-AMERICA CITY
AKRON
1981 1995 2008

Akron, Ohio

Little Cuyahoga River Final Hydraulic Report

October 2010

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Apendix

Section 1 Background

In late 2007, the City of Akron initiated a study of a 490-acre area south of I-76 which was selected as the new site for the World Headquarters of the Goodyear Tire and Rubber Co. and associated commercial/residential redevelopment adjacent to the headquarters buildings. The study, called the Eastgate Utility and Hydraulic Study, was completed by the team of GPD and ARCADIS and consisted of an evaluation and mapping of existing utilities within the redevelopment area as well as an analysis of the existing storm sewer system and a flood analysis of the streams flowing through the area. The study was completed and submitted in March 2008.

The stream analysis portion of the Eastgate Utility and Hydraulic Study, completed by ARCADIS, included an evaluation of two proposed alternates for relocating 2,900 feet of the Little Cuyahoga River upstream of Martha Avenue by up to 520 feet to the south of its current location. The project developer, Industrial Realty Group (IRG), intended to relocate the river to the south to open up additional area north of the river to redevelopment. However, subsequent to the March 2008 study, the City and IRG decided the river would be maintained in its current corridor due to environmental, utility, and construction cost constraints. ARCADIS therefore evaluated three additional alternates which would maintain the river in its current corridor. The three additional alternates differed in the modifications to the Goodyear Dam 1,900 feet downstream of Martha Avenue. (See Photo 1.) One alternate included no modifications to the dam; a second alternate included removal of the 15-foot wide gate in the existing dam; the final alternate included lowering the full 40-foot width of the dam to the bottom of gate elevation (an approximate 5-foot lowering of the dam). The three additional alternates assumed the river would be restored to a more natural condition by creating a meandering pattern through the existing river corridor and adding environmental enhancements through riffle pools, bank shaping and vegetation, floodplain design, and a multistage channel configuration.

Subsequently, GPD teamed with Enviroscience, Inc. in a project for IRG to further refine the river restoration improvements in order to obtain permit coverage and to construct the improvements through a design-build project. ARCADIS supported the design team by modeling the refinements to the restoration design and assisting the design team in floodplain permit planning. At the conclusion of this effort, the City and IRG decided that the Goodyear Dam would be lowered for the full width of the dam, which would include removal of the gate as well as lowering of the fixed concrete spillway portions on either side of the gate.

The City was then able to secure outside funding for the river restoration, and, therefore, took the lead in the river restoration effort. The river restoration was also extended downstream to include the river segment from Martha Avenue to the Goodyear Dam. This new segment is referred to as Phase 2 of the river restoration project, while the original segment upstream of Martha Avenue is referred to as Phase 1. The two phases of the river restoration will be bid separately by the City and will be constructed as separate projects. The limits of the river restoration projects are shown in Figure 1.

GPD provided the river restoration final design, and ARCADIS incorporated the final design into the hydraulic model. The modeling effort culminated in a final proposed model which reflects the final design of the proposed improvements. The final model was documented in a CLOMR application which ARCADIS submitted to FEMA in November 2009. The CLOMR specified the modifications to the floodplain limits and elevations derived from the stream restoration and allowed FEMA an opportunity to review and comment on the proposed improvements before they were constructed. The CLOMR was approved by FEMA on August 6, 2010. A copy of the approval letter is included in the appendix. A final LOMR will need to be submitted after the improvements are constructed based on as-built conditions in order to update the FEMA flood maps.

Photo 1 – Goodyear Dam (at Old Kelly Ave. looking east)

Section 2 Existing Analysis

Overview

Two models were used to define the Little Cuyahoga River watershed within the study limits. A hydrologic model was developed to determine the flows within the watershed using the US Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System software (HEC-HMS v. 3.1.0). Peak flows were determined at several locations along the Little Cuyahoga River. A hydraulic model was then developed to determine water surface elevations along the river using the Hydrologic Engineering Center's River Analysis System software (HEC-RAS v. 3.1.3). Limits of the water surface elevation determinations from this model are shown on Figure 1.

The Little Cuyahoga River in the project area drains 43.43 square miles in eastern Summit and western Portage counties as shown on the drainage area map in Figure 2. The watershed is predominantly covered by forests, open fields, and rural residential development with smaller areas of commercial and denser residential development in the western portion of the drainage basin. The watershed contains several large lakes which were constructed for flood control after a destructive flooding event in 1913. These lakes which include Springfield Lake, Wingfoot Lake, Hills Pond, and Mogadore Reservoir provide significant flood storage and reduction of peak flows which would otherwise not occur in the Little Cuyahoga River.

The three storm frequencies used for the hydrologic and hydraulic analyses were the 10, 25, and 100-year storm events. The 10 and 25-year events were selected, because these storm frequencies are frequently used in the design of storm water infrastructure including culverts and bridges. The 100-year event was chosen, because the 100-year frequency is used to establish base flood elevations and floodplains for the FEMA flood insurance program. For the river restoration portion of the Little Cuyahoga River, the 2-year and 500-year flow rates were estimated and used in the HEC-RAS analysis as well. The 2-year flow rate was used to evaluate the bank-full design. The 500-year flow rate was included in the CLOMR analysis as required by FEMA.

Hydrologic Model

Methodology

In order to create a hydrologic model of the watershed, the existing watershed was divided into 15 subareas. The factors taken into consideration for subdividing the watershed included size, homogeneous land use, soil types and key inflow locations along the Little Cuyahoga River and its tributaries. Based on the recommended

application of various hydrologic methods, we determined that the most appropriate method to determine runoff hydrographs and peak flow rates is the United States Geologic Survey (USGS) regression based method described in *Water-Resource Investigation Report 93-4080* for rural watersheds. A few of the subareas in the western portion of the watershed have significant developed areas, so the USGS *Open-File Report 93-135* for urban watersheds was used to develop runoff hydrographs for these subareas. Because this hydrologic method is not embedded in the HEC-HMS software, runoff hydrographs had to be developed remotely using spreadsheets and then copied into the HEC-HMS model.

Hydrologic parameters used in both sets of USGS regression equations include drainage area and main channel slope. The urban equations also use basin development factor and annual precipitation while the rural equations use forested area and storage area as additional parameters. From these hydrologic parameters, the lag time and peak flow rates for each subarea were calculated which were used to develop runoff hydrographs for the 15 subareas following USGS hydrograph generation methodology. The rural regression equations were used for 11 of the 15 subareas, whereas the urban equations were used for the four most developed subareas in the western portion of the watershed. A table providing the pertinent parameters for the 15 subareas as well as calculated lag times and peak flow values is included in the Appendix.

The runoff hydrographs developed using spreadsheets were then copied into the HEC-HMS model. While the HEC-HMS model was not used to develop the hydrographs, other important capabilities of the model were used to determine how the runoff hydrographs are routed, combined and translated downstream. The larger lakes and ponds with significant storage capacity were included in the model as well as river reaches. The Ohio Department of Natural Resources provided stage-storage-discharge data for Springfield Lake, Wingfoot Lake, Hills Pond, and Mogadore Reservoir. As the runoff hydrographs are routed through these features, the hydrograph peaks are attenuated and hydrograph durations are extended. The model also combines hydrographs at defined junctions to create composite hydrographs which provide the peak flow rates that were entered into the hydraulic model. Table 1 lists the flow rates generated by the HEC-HMS model as well as the junction names and locations. Due to attenuation of the hydrographs through the river, the model actually predicted lower flows for a downstream junction (J1) in the Little Cuyahoga River than an upstream junction (J3). The higher values from junction J3 were used in HEC-RAS for the entire downstream reach of the Little Cuyahoga River. Figure 3 provides a schematic of the existing HEC-HMS model representing the Little Cuyahoga River watershed.

Table 1 Peak Flow Rates (cfs)							
Location	HEC-HMS Junction	HEC-RAS River Sta.	2-year Peak Flow	10-year Peak Flow	25-year Peak Flow	100-year Peak Flow	500-year Peak Flow
Little Cuyahoga River							
E. Market St. (SR 18)	J4	7.351	-	881	1134	1527	-
Confluence with Springfield Lake Outlet	J3	7.160	670	1285	1704	2296	2632
Middlebury Run Park	J1	6.573	670	1278	1646	2285	2646
Springfield Lake Outlet							
Massillon Road (SR 241)	J8	36.75	-	452	580	775	-
Confluence with Haley's Ditch	J9	1519	-	513	643	884	-
Haley's Ditch							
Seiberling St.	S-4B	4368	-	264	340	468	-
Confluence with Adam's Ditch	J7	2240	-	445	515	714	-
Adam's Ditch							
Hobart Ave.	S-4A	1216	-	181	264	370	-

Calibration

The hydrologic model was calibrated by comparing the results from the HEC-HMS program to the flow rates determined from the USGS Streamstats application, the FEMA Flood Insurance Study (FIS), Ohio Bulletin No. 45, and historic peak flow rates measured at the USGS flow gage near Massillon Road. Streamstats is a web-based application which uses a state-wide digital terrain model to determine drainage areas and other hydrologic data to predict peak flow rates based on regression equations similar to Report 93-4080. Although Streamstats uses a similar method to the method used for the HEC-HMS model, the Streamstats output was valuable as a comparison tool, because the storage potential in the watershed is evaluated differently. While the HEC-HMS model explicitly analyzes hydrograph attenuation through major ponds and lakes through a routing analysis, Streamstats accounts for storage by measuring the portion of the watershed area where storage would occur and reducing the peak flows by a regression factor. As expected, the flows predicted by the model are lower than those calculated by Streamstats, because the model explicitly accounts for the artificial storage of the watershed, which is a significant feature of this watershed as previously discussed. The HEC-HMS model and Streamstats flow values are presented in Tables 2 and 3.

The HEC-HMS results were also compared to record flow data for the Little Cuyahoga River at Massillon Road collected by USGS. The USGS measured daily mean flows and peak flows at this location from November 1945 to September 1974. The highest flow rate during this record period measured 891 cfs which occurred on January 21, 1959

which the FIS identified as having a 15-year recurrence interval. This flow rate is slightly more than the 10-year flow rate of 881 cfs predicted by the HEC-HMS model at this location. The record event of January 1959, however, was likely a combination of rainfall and snowmelt, which generally produces lower peak flow rates that are maintained for longer durations.

Tables 2 and 3 show that the FEMA FIS flow rates are considerably lower than the flows generated by the HEC-HMS model or predicted by Streamstats or the Bulletin 45 method. According to the FIS, these flows were calculated by straight line extrapolation of flow gage measurements. Based on observed stream levels within the study limits, the FIS flow rates seem to be unreasonably low and the HEC-HMS model appears to provide more reasonable estimates of design storm peak flow rates.

Table 2
10-Year Peak Flow Comparison

Location	HEC-HMS (USGS)	USGS Streamstats	FEMA FIS	Ohio Bulletin No. 45
Little Cuyahoga River				
E. Market St. (SR 18)	881	1350	-	1190
Confluence with Springfield Lake Outlet	1285	1780	640	1264
Middlebury Park	1278	1890	640	1328
Springfield Lake Outlet				
Massillon Road (SR 241)	452	740	213	-
Confluence with Haley's Ditch	513	940	250	-
Haley's Ditch				
Seiberling St.	264	180	-	-
Confluence with Adam's Ditch	445	430	-	1010
Adam's Ditch				
Hobart Ave.	181	340	-	-

Table 3 100-Year Peak Flow Comparison				
Location	HEC-HMS (USGS)	USGS Streamstats	FEMA FIS	Ohio Bulletin No. 45
Little Cuyahoga River				
E. Market St. (SR 18)	1527	2000	-	3010
Confluence with Springfield Lake Outlet	2296	2660	1060	1799
Middlebury Run Park	2285	2830	1060	1894
Springfield Lake Outlet				
Massillon Road (SR 241)	775	1180	398	-
Confluence with Haley's Ditch	884	1500	470	-
Haley's Ditch				
Seiberling St.	468	340	-	-
Confluence with Adam's Ditch	714	760	-	2590
Adam's Ditch				
Hobart Ave.	370	580	-	-

Hydraulic Model

The next stage of the watershed model development consisted of creating an existing hydraulic model of the Little Cuyahoga River. The Hydrologic Engineering Center's River Analysis System (HEC-RAS v. 3.1.3) program was used for the hydraulic model. The Springfield Lake Outlet within the study limits and the Little Cuyahoga River downstream of the Springfield Lake Outlet are included in the FEMA Flood Insurance Study (FIS) and have 100-year base flood elevations established.

The hydraulic analysis followed FEMA required procedures where applicable, so the analysis could be used as part of a future LOMR submittal to FEMA. After creating the duplicate effective model (DEM) for the FEMA studied area from the backup data, it was determined that a corrective effective model (CEM) was needed primarily to update the method of analyzing dams in the Little Cuyahoga River. This was accomplished by using HEC-RAS' capability to directly analyze inline structures which was not available in its precursor program, HEC-2, which was used to create the original FIS model.

The next step in the analysis was to create an existing model from the CEM. We used available plan information supplemented by survey data to revise channel, overbank and structure data for changes which have occurred. These changes included a new pedestrian bridge in Middlebury Run Park (See Photo 2), new bridges at 3rd Avenue (See Photo 3) and relocated Kelly Avenue (See Photo 4), a bridge replacement at Seiberling Street (See Photo 5), and the removal of two railroad bridges and three pedestrian bridges over the Little Cuyahoga River. The existing model also incorporated

the relocation of the river in Middlebury Run Park (see Photo 6) and the stretch between I-76 and Martha Avenue. After the CEM was updated to existing conditions, the existing model was extended to include the full study limits.

The results of the HEC-RAS analysis show that the existing 100-year flood elevations are higher than the corresponding duplicate effective elevations, predominately because the existing model uses a 100-year flow rate that is more than double the FIS flow rate. As discussed in Section 3, the proposed river restoration project would significantly lower the 100-year flood elevations. At the upstream end of the studied portion of the river (at the Springfield Lake Outlet confluence), the proposed 100-year flood elevation is within 0.5 feet of the effective flood elevation (regulatory base flood elevation). The existing 100-year flood limits for the Little Cuyahoga River and the three studied tributaries are shown on Figure 4.

Photo 2 – Downstream Side of Pedestrian Bridge (looking east)

Photo 3 – Downstream Side of 3rd Avenue Bridge (looking southeast)

Photo 4 – Downstream Side of Kelly Avenue Bridge (looking southeast)

Photo 5 – Downstream Side of Seiberling Street Bridge (looking east)

Photo 6 – Relocated River in Middlebury Run Park (at Martha Ave. looking east)

Section 3 Proposed Analysis

In order to facilitate redevelopment of the area and to restore a portion of the Little Cuyahoga River to a more natural condition, the City of Akron has undertaken a river restoration project as previously discussed. The limits of the river restoration are from just upstream of the Martha Avenue culvert to 2,400 feet upstream. The river restoration will essentially maintain the river through its existing corridor; however, the proposed alignment of the low flow channel will meander through this corridor.

The retail portion of the proposed development covers an area now occupied by Middlebury Run Park and several businesses along the south side of Englewood Avenue. As shown on Figure 5, much of this area is contained within the existing 100-year floodplain. In order to lower flood elevations in the area of the redevelopment, the Goodyear Dam downstream of Kelly Avenue will also be modified. The dam modifications will consist of lowering the full 40-foot width of the dam, which would include removal of the 15-foot wide gate as well as lowering of the fixed concrete spillway portions on either side of the gate. This will result in lowering the normal water elevation upstream of the dam by approximately 8 feet.

One objective of the river restoration and dam modification projects is to contain the 100-year flood limits within a 150-corridor. In order to accomplish this, the river restoration design included raising the elevation of the northern edge of the 150-foot corridor to provide sufficient depth of flow for the 100-year storm event. As shown on Figure 5, raising the grade adjacent to the river would create two low areas to the north which are lower than the adjacent 100-year flood elevations. It was not the intent of the river restoration project to design and construct a levee along the north side of the river which would satisfy ODNR and US Army Corps of Engineers requirements. Accordingly, the low areas are not considered to be protected by the northern embankment and are, therefore, included in the proposed 100-year flood limits. This is intended to be a temporary condition as the low areas will be filled above the 100-year flood elevations when this area is redeveloped and will then be removed from the 100-year flood limits. In the HEC-RAS analysis, the 100-year flood peak flow was maintained within the 150-foot river corridor and the low areas to the north were not assumed to convey any portion of the 100-year flow. Subsequent filling of this area will therefore not impact the proposed 100-year flood elevations.

Field survey and visual observations of the river revealed that a significant amount of sediment has been deposited upstream of the dam particularly west of Martha Avenue. If the dam were removed, several feet of sediment would have to be dredged from the river in this area, or it would be naturally removed by the river over time.

Removal of the river bed material could expose the foundations of the bridges at 3rd Avenue and relocated Kelly Avenue and the existing soldier pile walls at various locations between the dam and Martha Avenue. The City investigated the need for modifications to these structures and determined that the Kelley Avenue bridge will be replaced, and the foundation of the 3rd Avenue bridge will be protected with rock channel protection, neither of which is anticipated to have a significant impact to flood elevations upstream of Martha Avenue. The Kelly Avenue and 3rd Avenue bridge improvements are currently being designed with construction anticipated in 2011.

The proposed HEC-RAS model includes the river restoration, lowering of the Goodyear Dam, and removal of the sediment upstream of the dam. The results of the proposed analysis reveal that the 100-year peak flow would be contained within the proposed 150-foot river corridor for the entire length of the relocation. The 100-year flood limits for the proposed river improvements are shown on Figure 5 along with the existing and effective 100-year flood limits (FEMA special flood hazard area).

The proposed 100-year flood elevations are considerably lower than the existing flood elevations within the area of the river restoration. The proposed 100-year flood elevation is within 0.5 feet of the effective flood elevation at the upstream end of the studied portion of the river.

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Appendix

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Infrastructure, buildings, environment, communications

Date: 12/15/10

Analyst: PSB

Project: Little Cuyahoga River

Drainage Area Reference No.	Type of Drainage Area (Urban or Rural)	Drainage Area	Drainage Area	Main Channel Length	Main Channel Length	Amount of Storage	Storage as a % of Total Area	Stream Elev. @ 10% Length of Main Channel	Stream Elev. @ 85% Length of Main Channel	Main Channel Slope (SL)	Rural Basin Lag Time (LT)	Amount of Forested Area	Amount of Forested Area	Q_{10} (Rural 10-Year Peak Discharge)	Q_{10} (Rural 10-Year Peak Discharge Per Ohio Bulletin # 45)	Q_{50} (Rural 50-Year Peak Discharge)	Q_{50} (Rural 50-Year Peak Discharge Per Ohio Bulletin # 45)	Q_{100} (Rural 100-Year Peak Discharge)	Q_{100} (Rural 100-Year Peak Discharge Per Ohio Bulletin No. 45)	Q_{500} (Rural 500-Year Peak Discharge)	Urban Basin Lag Time (LT)	Average Annual Precipitation	Basin Development Factor (BDF) = Use of Storm Sewers, Curbed Pavt Sections, Lined Channels, Channel Improvements (Rank on Scale of 1 to 12)	UQ_{10} (Urban 10-Year Peak Discharge)	UQ_{50} (Urban 50-Year Peak Discharge)	UQ_{100} (Urban 100-Year Peak Discharge)	UQ_{500} (Urban 500-Year Peak Discharge)
		(Mi^2)	(Ac)	(Ft)	(Mi)	(Ac)	(%)	(Ft)	(Ft)	(Ft/Mile)	(Hr)	(Ac)	(%)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(Hr)	(In)		(CFS)	(CFS)	(CFS)	(CFS)
1	Urban	1.86	1190.4	9400	1.780	0.918	0.08	1021.0	1111.0	67.4											0.8946	37	9	767.7	1235.2	1455.5	1892.2
2	Urban	0.36	230.4	5800	1.098	3.874	1.68	1020.0	1148.0	155.4											0.5355	37	9	227.7	343.1	397.7	517.0
3	Urban	1.80	1152.0	14000	2.652	1.406	0.12	1021.0	1155.0	67.4											1.4524	37	6	595.7	989.8	1179.1	1532.9
4A	Rural	0.73	467.2	7300	1.383	0.918	0.20	1015.0	1065.0	48.2	2.30	14.23	3.05	198.3	182.2	318.9	287.7	372.2	337.8	439.2							
4B	Rural	1.49	953.6	12000	2.273	9.000	0.94	1037.0	1090.0	31.1	3.46	5.00	0.52	261.1	241.4	408.2	365.7	472.4	422.8	549.6							
4C	Rural	5.31	3398.4	31000	5.871	148.600	4.37	1027.0	1124.0	22.0	7.99	345.76	10.17	450.9	411.3	677.0	580.0	773.7	654.1	1005.8							
5 (W/O Springfield Lake for Storage)	Rural	3.23	2067.2	11700	2.216	117.670	5.69	1078.0	1107.0	17.4	9.64	148.99	7.21	270.7	248.9	403.1	346.3	459.1	387.6	596.8							
6	Rural	2.00	1280.0	12700	2.405	9.580	0.75	1050.0	1170.0	66.5	2.41	136.70	10.68	407.9	364.3	653.3	564.2	761.6	660.2	990.1							
7	Rural	3.64	2329.6	14400	2.727	31.440	1.35	1026.0	1048.5	11.0	10.76	252.67	10.85	376.3	362.3	563.3	525.7	644.2	597.4	837.5							
8	Rural	4.50	2880.0	21800	4.129	187.590	6.51	1081.0	1152.0	22.9	10.46	674.83	23.43	358.6	324.1	536.1	450.1	611.4	504.6	794.8							
9	Rural	1.34	857.6	9300	1.761	59.640	6.95	1052.0	1068.0	12.1	15.65	128.90	15.03	119.3	111.5	176.1	153.5	199.8	170.4	259.7							
10	Rural	2.83	1811.2	19000	3.598	11.780	0.65	1085.0	1158.0	27.0	5.14	273.13	15.08	435.3	405.6	676.5	614.3	782.4	711.3	1017.2							
11 (W/O Mogadore Reservoir for Storage)	Rural	13.73	8787.2	15200	2.879	372.930	4.24	1110.0	1180.0	32.4	7.02	1935.20	22.02	1032.2	921.7	1559.5	1303.9	1787.1	1478.8	2323.2							
12 (W/O Wingfoot Lake for Storage)	Rural	2.83	1811.2	3000	0.568	158.070	8.73	1155.0	1176.0	49.3	5.59	274.45	15.15	278.1	241.4	425.3	338.5	487.6	381.2	633.8							
13	Urban	0.05	32.0	1800	0.341	0.000	0	995.4	996.4	3.9											0.8698	37	8	48.2	68.0	77.7	101.0

Federal Emergency Management Agency

Washington, D.C. 20472

AUG 06 2010

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CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 10-05-2251R
Community: City of Akron, Ohio
Community No.: 390523

104

The Honorable Donald L. Plusquellic
Mayor, City of Akron
Suite 200 Municipal Building
166 South High Street
Akron, OH 44308

Dear Mayor Plusquellic:

This responds to a request that the Department of Homeland Security's Federal Emergency Management Agency (FEMA) comment on the effects that a proposed project would have on the effective Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report for Summit County, Ohio and Incorporated Areas (the effective FIRM and FIS report for your community), in accordance with Part 65 of the National Flood Insurance Program (NFIP) regulations. In a letter dated January 25, 2010, Mr. Mark R. Dennis, P.E. requested that FEMA evaluate the effects that the proposed redevelopment and restoration of the Little Cuyahoga River would have on the flood hazard information shown on the effective FIRM and FIS report, as well as correcting study with respect to development occurring after the last effective model was completed. The area of revision includes approximately 2,500 feet of the Little Cuyahoga River, beginning at the confluence with Springfield Lake Outlet and continuing downstream to approximately 180 feet downstream of Kelly Avenue.

The proposed project includes a restoration of the Little Cuyahoga River for the purpose of future development from just upstream to approximately 2,400 feet upstream of the North Martha Avenue culvert, the proposed realignment of the low flow channel will add several meanders. The Goodyear Dam downstream of Kelly Avenue will be lowered approximately 5 feet to decrease base flood elevations throughout the study area. Additionally sediment will be removed from directly upstream of the dam.

All data required to complete our review of this request for a Conditional Letter of Map Revision (CLOMR) were submitted with letters from Mr. Mark R Dennis.

We reviewed the submitted data and the data used to prepare the effective FIRM for your community and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. The submitted existing conditions HEC-RAS hydraulic computer model, dated October 29, 2009, based on updated topographic information, was used as the base conditions model in our review of the proposed conditions model for this CLOMR request. We believe that, if the proposed project is constructed as shown on the "Little Cuyahoga River Restoration" plan set, and the data listed below are received, the floodplain boundaries of the base (1-percent-annual-chance) flood and the 0.2-percent-annual-chance flood will be delineated as shown on "Little Cuyahoga River CLOMR, Akron, OH, Figure 4 - Certified Topo Map".

Detailed below are descriptions and locations of proposed changes to Base Flood Elevations, Special

Flood Hazard Areas, and floodways within the City of Akron, OH.

The duplicate effective HEC-RAS model was created from the effective HEC-2 model obtained from FEMA. Our review of the duplicate effective model revealed that the base (1% annual-chance) flood elevations (BFEs) matched the effective BFEs to 0.5 feet. The maximum decrease in BFE, approximately 1.1 feet, occurred approximately 50 feet upstream of the South Seiberling Street Bridge. The maximum increase in BFE, approximately 0.3 feet, occurred approximately 570 feet upstream of South Martha Avenue Bridge.

The corrected effective model was generated to account for the improved modeling capabilities of HEC-RAS 3.1.3 in regards to inline structures analysis. Our review of the corrected effective model revealed that the base (1% annual-chance) flood elevations (BFEs) varied minimally from those of the duplicate effective. Different coefficients were used to analyze the dam structures present in the reach. Our analysis indicated that the differences between the corrected effective and duplicate effective models were due to the differences in structure modeling approach. The maximum decrease in BFE, approximately 2.0 feet, occurred approximately 20 feet upstream of the 3rd Street Bridge. The maximum increase in BFE, approximately 0.4 feet, occurred approximately 110 feet downstream of the South Seiberling Street Bridge.

The existing conditions hydraulic model was based on available plan information, updated survey data, and revised hydrology. Changes in the channel, overbank, and structures were made in order to provide an updated base model. Additionally, revised hydrology was created to increase the discharge values used in analysis of the Little Cuyahoga River flood elevations. The maximum decrease in BFE, approximately 0.4 feet, occurred approximately 400 feet downstream of the South Seiberling Street Bridge.. The maximum increase in BFE, approximately 4.3 feet, occurred approximately 110 feet downstream of the South Seiberling Street Bridge.

The proposed conditions hydraulic model incorporates the affects of the proposed project into the existing conditions hydraulic model. When compared to the existing conditions hydraulic model the BFEs decrease significantly in some areas, due to the changes in dam structures and relocation of the stream. The maximum decrease in BFE, approximately 6.3 feet, will occur approximately 160 feet downstream of the Kelly Avenue Bridge.

As a result of the proposed project and updated topography, the BFEs for the Little Cuyahoga River will increase in some areas and decrease in other areas, as compared to the effective BFEs. The maximum decrease in BFE, approximately 6.0 feet, will occur approximately 200 feet upstream of Kelly Avenue Bridge. The maximum increase in BFE, approximately 0.6 feet, will occur approximately 150 feet upstream of the Martha Avenue Bridge. The width of the Special Flood Hazard Area (SFHA), the area inundated by the base flood, will increase in some areas and decrease in other areas when compared to the effective SFHA width. The maximum increase in SFHA width, approximately 60 feet, will occur approximately 150 feet downstream of South Seiberling Street. The maximum decrease in SFHA width, approximately 350 feet, will occur approximately 750 feet upstream of South Seiberling Street.

As a result of the proposed project and updated topography the floodway width will increase in some areas and decrease in other areas compared to effective regulatory floodway width. The maximum floodway increase is approximately 70 feet, located approximately 650 feet downstream of South Seiberling Street. The maximum floodway decrease is approximately 35 feet, located 220 feet upstream of the 3rd Street.

HEC-HMS was used in combination with USGS regression based methods to determine runoff hydrographs and peak flow rates and construct a watershed model for the watershed feeding into the Little Cuyahoga River. As a result of the revised hydrologic analysis, peak flow volume for the Little Cuyahoga River will increase compared to the effective flow volume. A flow of 2,296 cfs was used for all cross sections of the hydraulic model.

Upon completion of the project, your community may submit the data listed below and request that we make a final determination on revising the effective FIRM and FIS report.

- Detailed application and certification forms, which were used in processing this request, must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview & Concurrence Form," must be included. (A copy of this form is enclosed.)

- The detailed application and certification forms listed below may be required if as-built conditions differ from the preliminary plans. If required, please submit new forms (copies of which are enclosed) or annotated copies of the previously submitted forms showing the revised information.

  Form 2, entitled "Riverine Hydrology & Hydraulics Form"

  Form 3, entitled "Riverine Structures Form"

  Hydraulic analyses, for as-built conditions, of the base flood; the 10-percent-, 2-percent-, and 0.2-percent-annual-chance floods; and the regulatory floodway, together with a topographic work map showing the revised floodplain and floodway boundaries, must be submitted with Form 2.

- Effective January 13, 2010, FEMA revised the fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps. Under this schedule, FEMA has not changed the initial fee for processing map revision requests involving structural measures on alluvial fans. The initial fee for this map revision request will be $5,000 and must be received before we can begin processing the request. Payment of this fee shall be made in the form of a check or money order, made payable in U.S. funds to the National Flood Insurance Program, or by credit card (Visa or MasterCard only). The payment, along with the revision application, must be forwarded to the following address:

  LOMC Clearinghouse
  6730 Santa Barbara Court
  Elkridge, MD 21075

- As-built plans, certified by a registered professional engineer, of all proposed project elements

- Community acknowledgment of the map revision request

- A copy of the public notice distributed by your community stating its intent to revise the regulatory floodway, or a statement by your community that it has notified all affected property owners and affected adjacent jurisdictions

- A letter stating that your community will adopt and enforce the modified regulatory floodway, OR, if the State has jurisdiction over either the regulatory floodway or its adoption by your community, a copy of your community's letter to the appropriate State agency notifying it of the modification to the regulatory floodway and a copy of the letter from that agency stating its approval of the modification

- An officially adopted maintenance and operation plan for the City of Akron, OH. This plan, which may be in the form of a written statement from the community Chief Executive Officer, an ordinance, or other legislation, must describe the nature of the maintenance activities, the frequency with which they will be performed, and the title of the local community official who will be responsible for ensuring that the maintenance activities are accomplished.

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report. Because the Base Flood Elevations (BFEs) would change as a result of the project, a 90-day appeal period would be initiated, during which community officials and interested persons may appeal the revised BFEs based on scientific or technical data.

The basis of this CLOMR is, in whole or in part, a channel-modification project. NFIP regulations, as cited in Paragraph 60.3(b)(7), require that communities assure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management regulations. Consequently, the ultimate responsibility for maintenance of the modified channel rests with your community.

This CLOMR is based on minimum floodplain management criteria established under the NFIP. Your community is responsible for approving all floodplain development and for ensuring all necessary permits required by Federal or State law have been received. State, county, and community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction in the Special Flood Hazard Area. In the case that the State, county, or community have adopted more restrictive or comprehensive floodplain management criteria these criteria take precedence over the minimum NFIP criteria.

If you have any questions regarding floodplain management regulations for your community or the NFIP in general, please contact the Consultation Coordination Officer (CCO) for your community. Information on the CCO for your community may be obtained by calling the Director, Mitigation Division of FEMA in Chicago, Illinois, at (312) 408-5364. If you have any questions regarding this CLOMR, please call our Map Assistance Center, toll free, at 1-877-FEMA MAP (1-877-336-2627).

Sincerely,

David N. Bascom

David N. Bascom, CFM, Program Specialist
Engineering Management Branch
Mitigation Directorate

For: Kevin C. Long, Acting Chief
Engineering Management Branch
Mitigation Directorate

Enclosures: Form 1: Overview & Concurrence
Form 2: Riverine Hydrology & Hydraulics,
Form 3: Riverine Structures

cc: Mr. Ralph Coletta
City of Akron
Akron Engineering Bureau
166 S. High St.
Akron, OH 44308

Ms. Michelle DiFiore
City of Akron
Akron Engineering Bureau
166 S. High St.
Akron, OH 44308

Mr. Mark R. Dennis, P.E.
ARCADIS U.S., Inc.
520 South Main Street, Suite 2400
Akron, Ohio 44311-1010

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U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☐ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301	City of Katy	TX	480301	0005D	02/08/83
480287	Harris County	TX	48201C	0220G	09/28/90

2. a. Flooding Source:

   b. Types of Flooding: ☐ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier:

4. FEMA zone designations affected: (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☐ Physical Change ☐ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

   ☐ Coastal Analysis ☐ Hydraulic Analysis ☐ Hydrologic Analysis ☐ Corrections

   ☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

   ☐ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

   b. The area of revision encompasses the following structures (check all that apply)

   Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

   ☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☐ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name:	Company:	
Mailing Address:	Daytime Telephone No.:	Fax No.:
	E-Mail Address:	
Signature of Requester (required):	Date:	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title:	Community Name:	
Mailing Address:	Daytime Telephone No.:	Fax No.:
	E-Mail Address:	
Community Official's Signature (required):	Date:	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting data. All documents submitted in support of this request are correct to the best of my knowledge. All analyses have been performed correctly and in accordance with sound engineering practices. All project works are designed in accordance with sound engineering practices to provide protection from the 1% annual chance flood. If "as-built" conditions data/plan provided, then the structure(s) has been built according to the plans being certified, is in place, and is fully functioning. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name:	License No.:	Expiration Date:
Company Name:	Telephone No.:	Fax No.:
Signature:		Date:

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☐ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Seal (Optional)

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source:
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section B) ☐ No existing analysis ☐ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☐ Precipitation/Runoff Model
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.)	
			Effective	Proposed/Revised
Downstream Limit				
Upstream Limit				

2. Hydraulic Method/Model Used

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs may help verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. **These tools do not replace engineering judgment.** CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. Review of your submittal and resolution of valid modeling discrepancies may result in reduced review time.

4.

Models Submitted	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Corrected Effective Model*	File Name:	Plan Name:	File Name:	Plan Name:	_____
Existing or Pre-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	_____
Revised or Post-Project Conditions Model	File Name:	Plan Name:	File Name:	Plan Name:	_____
Other - (attach description)	File Name:	Plan Name:	File Name:	Plan Name:	_____

* For details, refer to the corresponding section of the instructions.

☐ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☐ Digital Mapping (GIS/CADD) Data Submitted

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☐ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☐ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations:**
      - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
      - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

   b. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☐ No
      If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☐ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☐ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☐ No

   If Yes, please submit documentation to the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

   For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source:
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam/Basin ..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport..... complete Section F (if required)

Description Of Structure

1. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

2. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

3. Name of Structure:

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)]
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source:

Name of Structure:

1. This revision reflects (check one):

- ☐ Bridge/culvert not modeled in the FIS
- ☐ Modified bridge/culvert previously modeled in the FIS
- ☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8):
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☐ Dimensions (height, width, span, radius, length)
- ☐ Shape (culverts only)
- ☐ Material
- ☐ Beveling or Rounding
- ☐ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☐ Top of Road Elevations – Upstream and Downstream
- ☐ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☐ Cross-Section Locations

4. Sediment Transport Considerations

Was sediment transport considered? ☐ Yes ☐ No If yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

D. DAM/BASIN

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one):

   a. ☐ Federal Dam ☐ State Dam

      Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

      Permit or ID number Permitting Agency or Organization

   b. ☐ Local Government Dam ☐ Private Dam

      Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm?

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☐ upgrading of an existing levee/floodwall system
☐ a newly constructed levee/floodwall system
☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers:
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers:
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers:
4. A layout detail for the embankment protection measures. Sheet Numbers:
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers:

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

c. The range of velocities along the levee during the base flood is: (min.) to (max.)

d. Embankment material is protected by (describe what kind):

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach		Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
						D_{100}	D_{50}	Thickness	
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								
Sta	to								

(Extend table on an added sheet as needed and reference each entry)

E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results:

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is hours.

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

(Note: Extend table on an added sheet as needed and reference)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: acres
Draining to ponding area: acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs

h. The length of levee system used to drive this seepage rate in item g: ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No

Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No If Yes, then fill out Section F (Sediment Transport).
If No, then attach your explanation for why sediment transport was not considered.

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

    a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

    b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations? ☐ Yes ☐ No

    c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations? ☐ Yes ☐ No

    If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

    a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
    If No, please attach supporting documentation.

12. Operations and Maintenance Plan

    Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

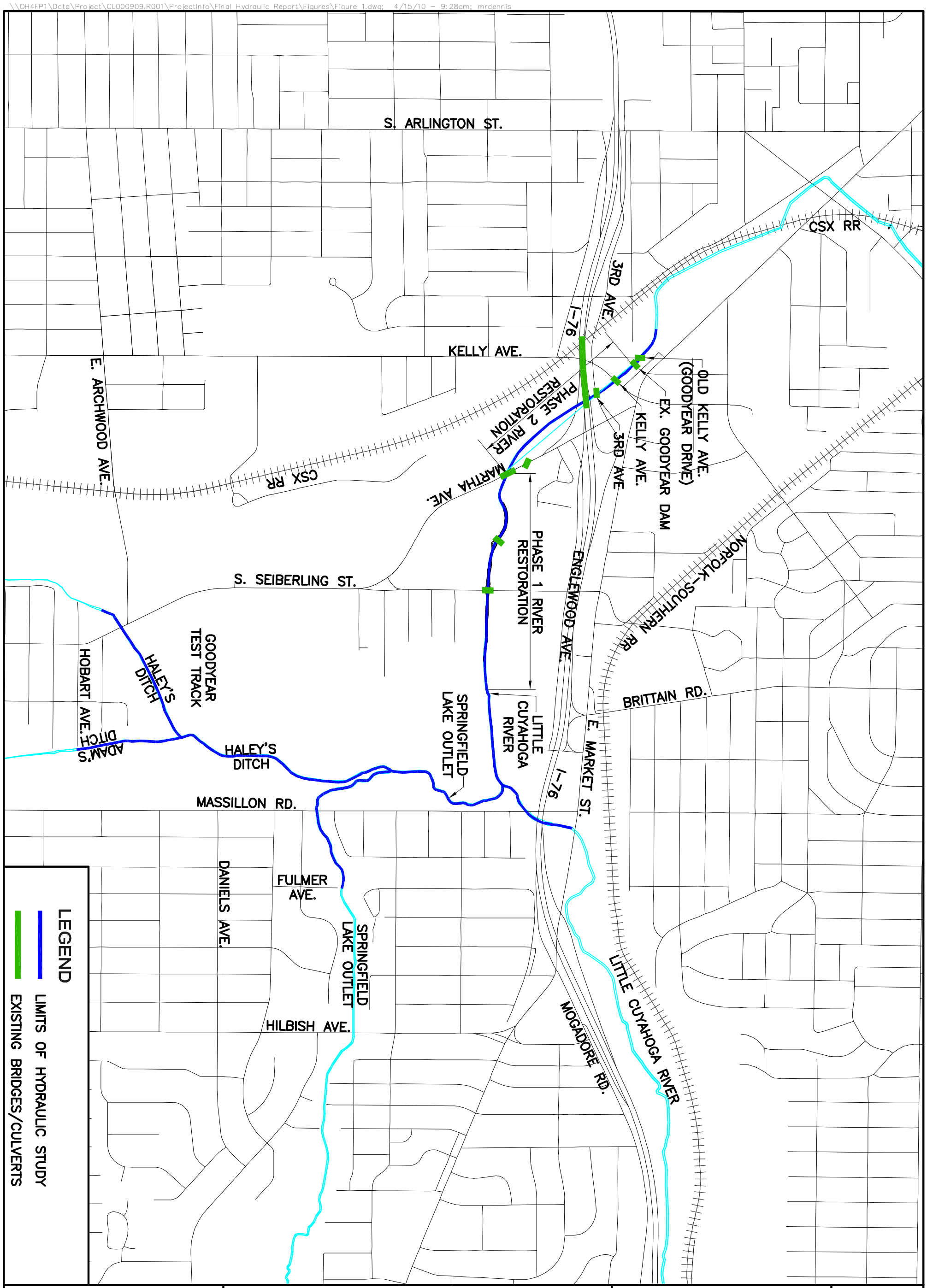
Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

\\OH4FP1\Data\Project\CL000909.R001\ProjectInfo\Final Hydraulic Report\Figures\Figure 1.dwg; 4/15/10 - 9:28am; mrdennis



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LITTLE CUYAHOGA RIVER
FINAL HYDRAULIC STUDY
AKRON, OHIO
FIGURE 1 - STREAM SCHEMATIC PLAN

0 500 1000 1500 2000
1" = 1000 FT.

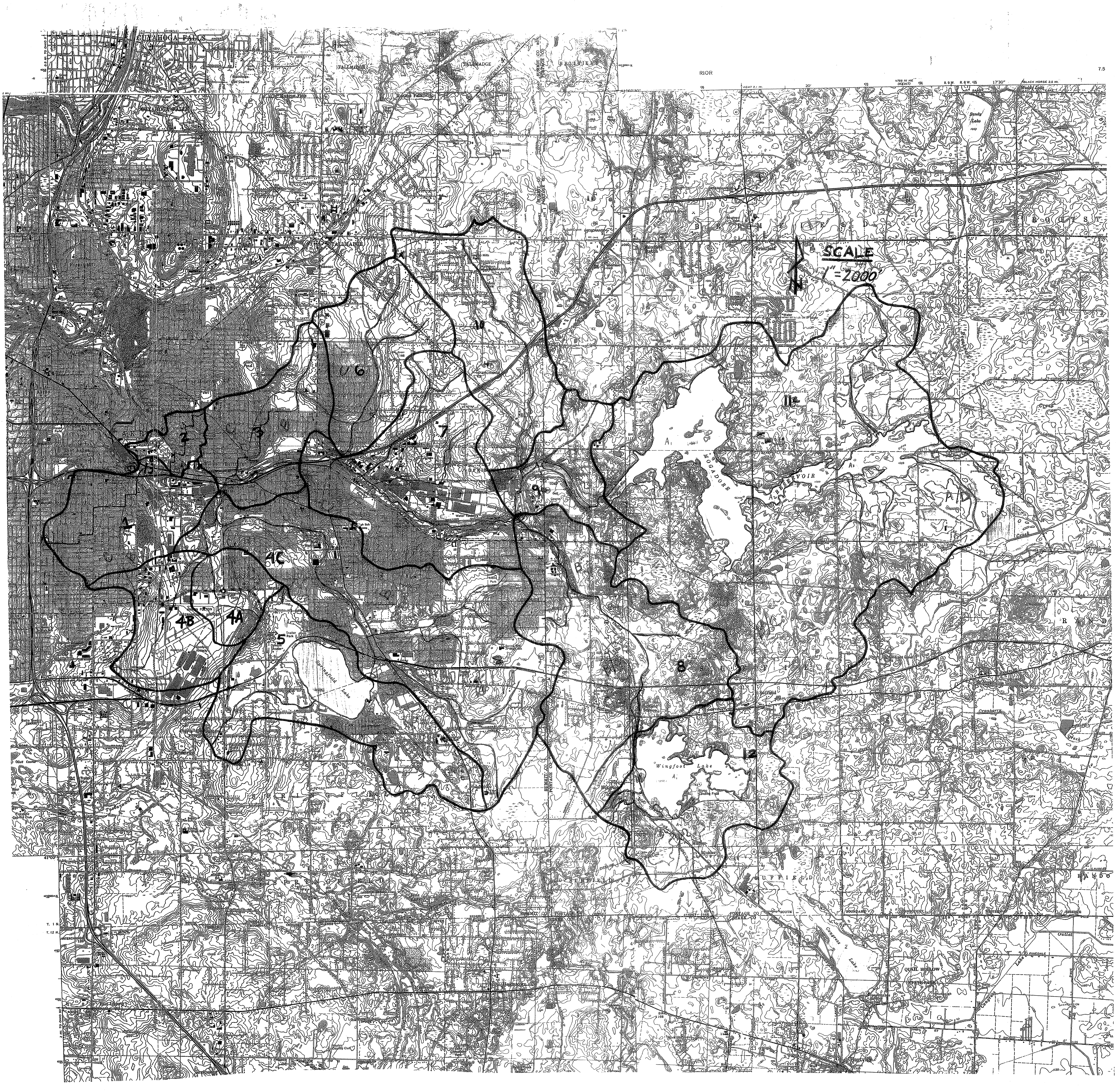
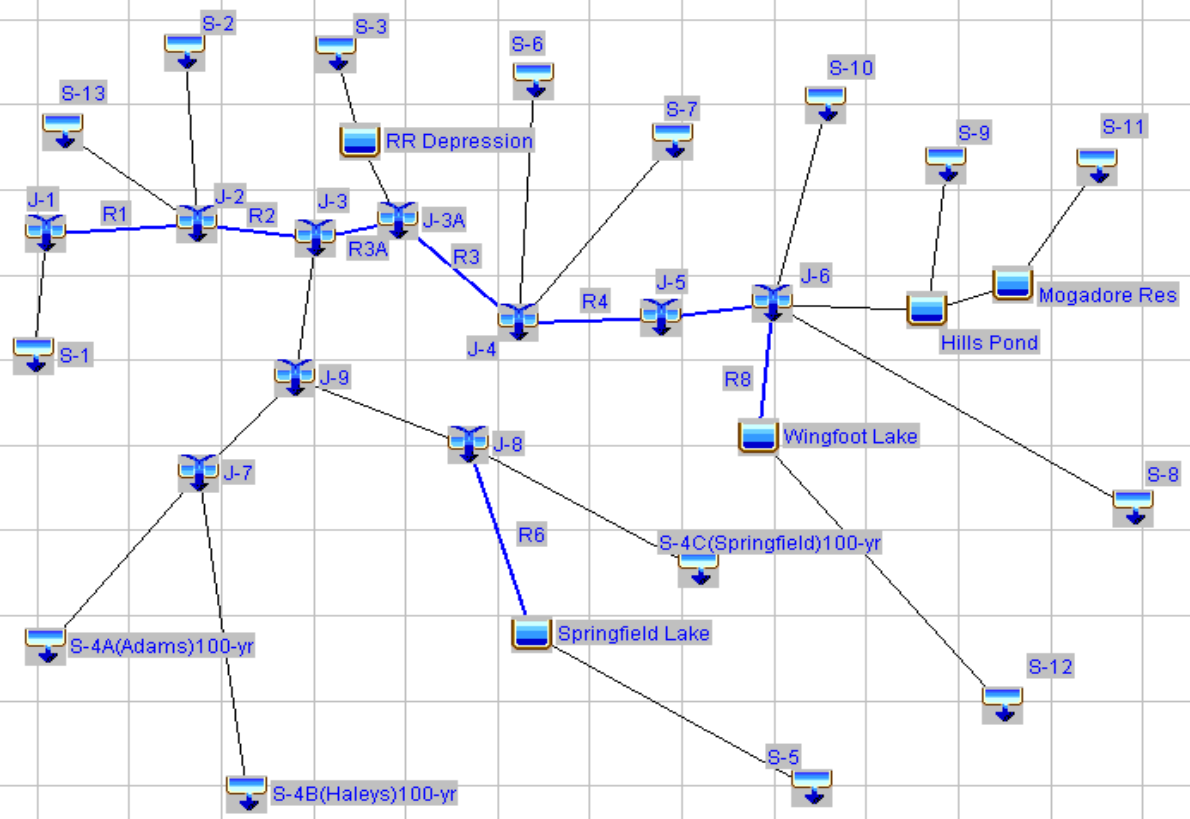
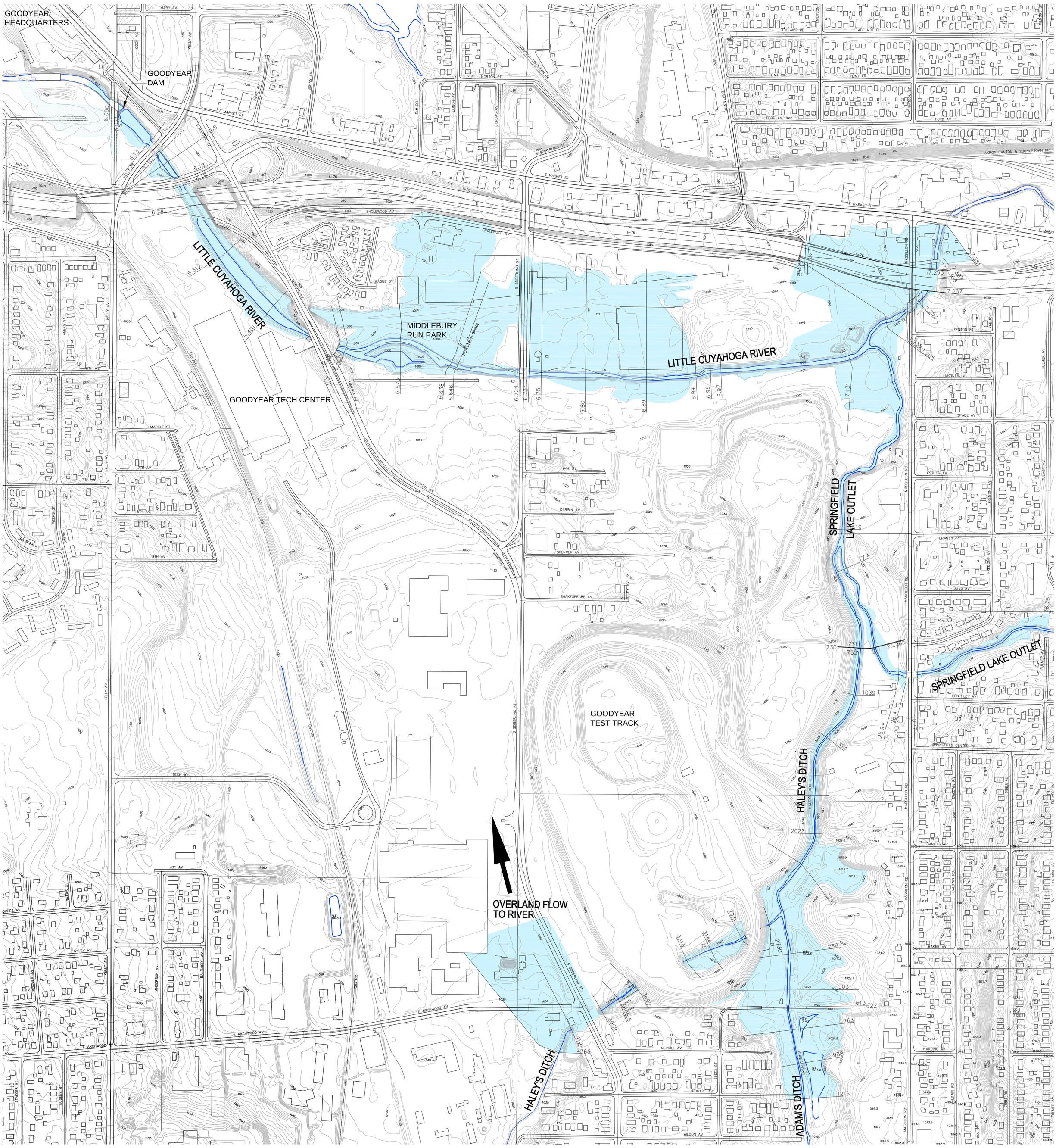

SCALE
1" = 2000'
N
1
2
3
4A
4B
4C
5
U6
7
8
9
10
11
12
A
CUYAHOGA FALLS
TALLMADGE
MOGADORE
RESERVOIR
Brimfield
Springfield Lake
Wingfoot Lake
Suffield
Mishler
Congress Lake
QUAIL HOLLOW
STATE PARK
Hartville
AKRON FULTON INTERNATIONAL AIRPORT
Goodyear Airdock
Sandy Lake
Muddy Lake

FIGURE 2

FIGURE 3


S-2
S-3
S-6
S-10
S-13
S-7
S-9
S-11
RR Depression
J-1
R1
J-2
R2
J-3
J-3A
R3A
R3
J-4
R4
J-5
J-6
Mogadore Res
Hills Pond
S-1
J-9
R8
Wingfoot Lake
J-8
J-7
S-8
R6
S-4C(Springfield)100-yr
S-4A(Adams)100-yr
Springfield Lake
S-12
S-5
S-4B(Haleys)100-yr



LEGEND

EXISTING 100-YEAR FLOOD LIMITS

OVERLAND FLOW
DETAILED FLOOD LIMITS NOT DETERMINED

XXXX HEC-RAS RIVER CROSS SECTIONS AND STATIONS

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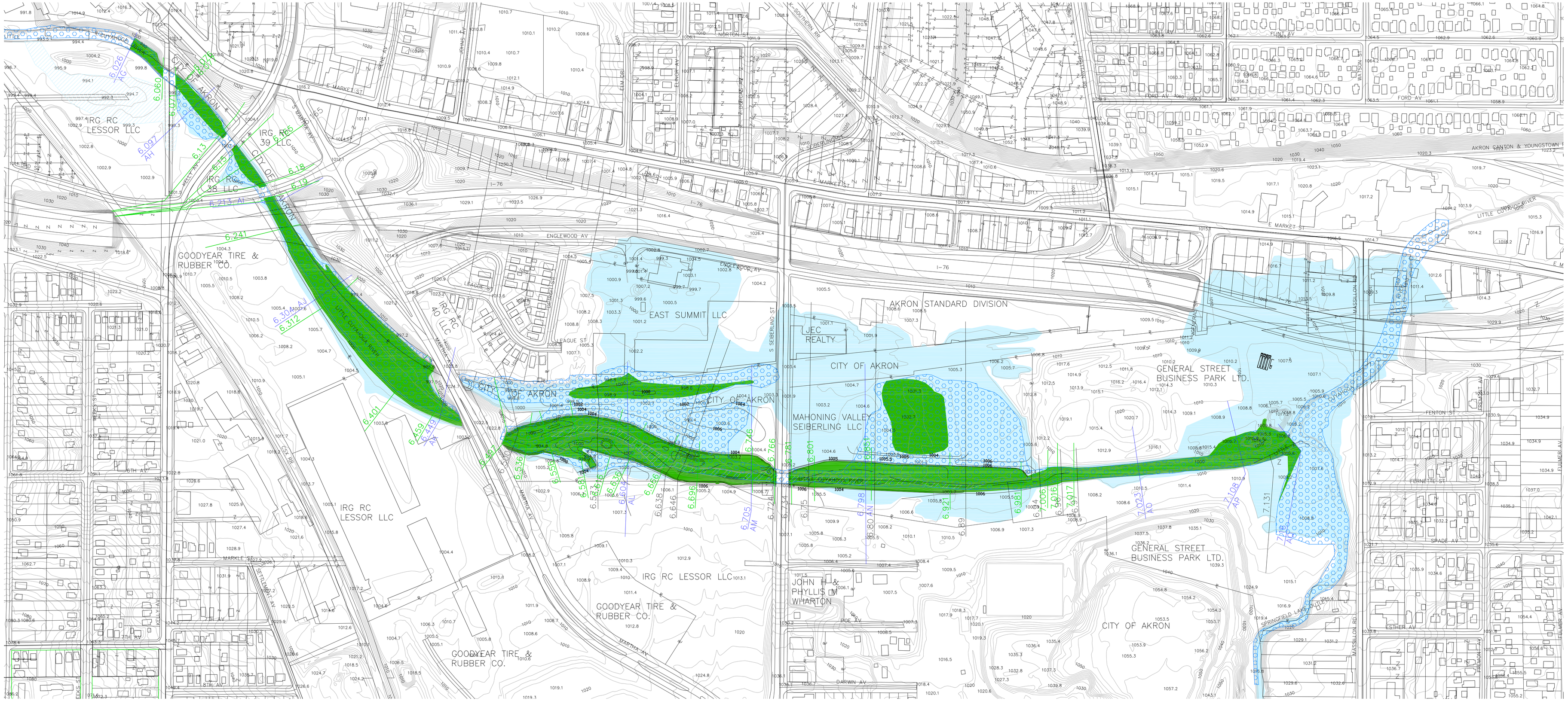
LITTLE CUYAHOGA RIVER FINAL HYDRAULIC STUDY
AKRON, OHIO
FIGURE 4 - EXISTING FLOOD LIMITS MAP

0 300 600 900 1200
1" = 300 FT.

N



LEGEND

- EXISTING 100-YEAR FLOOD LIMITS
- EFFECTIVE 100-YEAR FLOOD LIMITS
- PROPOSED 100-YEAR FLOOD LIMITS
- X.XXX EXISTING CROSS SECTIONS
- X.XXX EFFECTIVE CROSS SECTIONS
- X.XXX PROPOSED CROSS SECTIONS

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LITTLE CUYAHOGA RIVER FINAL HYDRAULIC STUDY
AKRON, OHIO
FIGURE 5 - RIVER RESTORATION FLOOD MAP

0 100 200 300 400

1" = 200 FT.

N