

## **Hydrologic and Hydraulic Analyses of Selected Stream Reaches in Medina County, Ohio**

Final Proposal to:

Ohio Department of Natural Resources

by

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## Problem

Flooding problems have occurred along low-lying areas near streams in Medina County, Ohio. The majority of Flood Insurance Studies conducted by the Federal Emergency Management Agency (FEMA) in Medina County were published during the early 1980's. Recent commercial and residential development near streams in many areas of the county has resulted in an increase in the number of structures that may be subject to damage from extreme floods. Ohio Department of Natural Resource (ODNR) and Medina County officials believe that flood-boundary data for selected streams within the current FEMA Flood Insurance Study (FEMA, 2008) are outdated (data from hydrologic and hydraulic analyses for the selected streams are republished data from the 1980's) and may not reflect the current conditions along streams within Medina County. Updated analysis of selected streams in Medina County would aid Medina County officials in assessing the flood-risk potential and identification of flood-hazard areas along these streams.

To assess the risk from flooding, Medina County officials need to know estimated peak-flood discharges, water-surface elevation profiles, and floodplain and floodway boundaries along 9 streams for the 10-, 2-, 1-, and 0.2-percent annual-exceedance probability floods (Figure 1). The 9 streams are:

- Branch River East Branch East Fork Black River
- Chippewa Creek
- East Fork East Branch Black River
- Granger Ditch
- Healy Creek
- North Branch Rocky River
- Plum Creek (Liverpool Township)
- Plum Creek (Brunswick Area)
- West Branch Rocky River

## Physical Setting

Medina County is located in north central Ohio about 25 miles south southwest of Cleveland. The estimated population of Medina County is 171,210, making it the 15th most populated county in Ohio (U.S. Bureau of Census, 2008). The City of Brunswick is the largest community in Medina County and its estimated population is nearly 35,000 (U.S. Bureau of Census, 2008).

In general, streams in Medina County empty into the Black, Rocky, or Tuscarawas Rivers. The county covers about 422 square miles and straddles the Allegheny Escarpment, with the Till Plains physiographic region to the west and the Glaciated

Allegheny Plateau physiographic region to the east (Ohio Division of Geological Survey, 1998). The relief of Medina County varies from rolling to hilly in the eastern portion and nearly flat in the western portion, with elevations ranging from 770 to 1,320 feet above sea level.

**Objectives**

The objectives of this proposed study are to (1) obtain additional regional information about floods on streams in north central Ohio, (2) establish water-surface profiles corresponding to floods with 10-, 2-, 1-, and 0.2-percent annual-exceedance probabilities and associated floodways, (3) prepare digital coverages of the flood-plain and floodway boundaries, and (4) provide ODNR, FEMA, and Medina County with data and results of the study, as well as technical documentation describing the data and the methods used for its collection and analyses.

**Scope**

Water-surface profiles corresponding to floods with 10-, 2-, 1-, and 0.2-percent annual-exceedance probabilities and associated floodways will be estimated for the study reaches outlined in Table 1.

**Table 1.** Summary of hydraulic model reaches information.

<b>Stream Name</b>	<b>Downstream Limit</b>	<b>Upstream Limit</b>	<b>Length, in miles</b>
Branch River East Fork East Branch Black River	Mouth	CSX Railroad	0.5
Chippewa Creek	S. County Line	Approx ¼ mi US from SR 162	8.8
East Fork East Branch Black River	U.S. Route 224	North Lodi Corporate Limit	1.7
Granger Ditch	Mouth (Conf. w/ NB Rocky River)	Approx 700 ft US from State Road / County Road 44	4.7
Healy Creek	FIS Cross Section 'H'	FIS Cross Section 'I'	0.9
North Branch Rocky River	Mouth	Approx. 0.3 mi US from Remsen Rd	6.0
Plum Creek (Liverpool Twp)	North County Line	West County Line	4.9
Plum Creek (Brunswick)	Approx 450 ft DS from Plum Creek Pkwy	FIS Cross Section 'A'	0.7
West Branch Rocky River	Smith Road	Approx. 1.0 mi US from SR 162	3.3
Branch River East Fork East Branch Black River	Mouth	CSX Railroad	0.5
<b>Total Length</b>			<b>31.5</b>

## Relevance and Benefits

As a priority issue of the mission of the U.S. Geological Survey (USGS), information from this study will serve to aid flood mitigation efforts that will contribute to protection of life and property. This study aligns with the current USGS strategic direction; A National Hazards, Risk and Resilience Program (USGS, 2007). Benefits of this study will include:

- Flood analyses for each stream will identify areas subject to flooding and can be used by Medina County officials to assess and prioritize where best to concentrate efforts to lessen flood damages and protect life and property.
- All data used to construct the models will be delivered to ODNR and FEMA for inclusion in a new Flood Insurance Study for Medina County. It is assumed by the USGS that FEMA will publish the results of the study in a revised Flood Insurance Study for Medina County.
- All data used to construct the hydraulic models and digital flood-plain boundary data for each stream will be supplied to Medina County for their future use. As future changes occur, the hydraulic models developed in this study can be revised to reflect the new conditions.
- The Multihazard Mitigation Council of the National Institute of Building Sciences report (Multihazard Mitigation Council, 2005) on the benefits of hazard mitigation found that projects aimed at reducing future damages from earthquake, wind and flood over a 10-year period (1993-2003) saved \$4 for every \$1 spent.

## Approach

The Ohio Water Science Center of the USGS, Water Resources Discipline, will use up-to-date engineering methods for the hydrologic and hydraulic analyses and the mapping of flood boundaries. Results and data will be forwarded to ODNR, FEMA, and Medina County to be incorporated into an update of the Flood Insurance Study for Medina County, Ohio. The tasks required to complete the study are presented in the following paragraphs.

### Hydrology

The USGS will conduct hydrologic analyses for each stream studied in order to establish the 10-, 2-, 1-, and 0.2-percent annual-exceedance probability flood-peak discharges. Initial steps of the hydrologic analysis will involve determining the availability of historical streamflow data, assessing whether the basins are significantly affected by regulation<sup>1</sup> and evaluating the potential effect of urbanization.

Estimates of the 10-, 2-, 1-, and 0.2-percent annual-exceedance probability flood-peak discharges may be established by using:

- (1) historical peak-streamflow data from USGS gaging-stations,
- (2) methods described in USGS flood-frequency reports for Ohio for unregulated and ungaged streams (Koltun and others, 2006),

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<sup>1</sup> A basin is considered significantly regulated if 103 (or more) acre-ft./mi<sup>2</sup> of usable reservoir storage capacity is available in the drainage basin (Benson, 1962).

- (3) discharge estimates from previously published FEMA studies (FEMA, 1983),
- (4) development of rainfall-runoff models, and
- (5) contacting appropriate agencies who regulate any of the streams to be studied.

### **Base Mapping**

In 2002, digital mapping (contour information) was developed for Medina County. Medina County will provide the USGS with the contour information. Digital aerial photography and Light Detection And Ranging (LiDAR) elevation data of Medina County was obtained by the State of Ohio in April 2006 as part of its Ohio Statewide Imaging Program (OSIP). The USGS will obtain the applicable digital aerial photography from OSIP. The USGS will use the best available mapping data for this project. The county has also developed numerous digital data layers (coverages) for its Geographic Information System (GIS) that may be requested by the USGS including: streams, water bodies, roads, railroads, and political boundaries. Prior to using the mapping, the Ohio Water Science Center will conduct quality-control surveys to ensure that the County's digital mapping will meet FEMA standards for Flood Insurance Studies (Federal Geographic Data Committee, 1998).

### **Hydraulics**

The USGS will develop hydraulic models for each stream based upon the 10-, 2-, 1-, and 0.2-percent annual-exceedance probability flood-peak discharges determined from the hydrologic analyses as well as floodways. The USGS will use the Hydrologic Engineering Center-River Analysis System (HEC-RAS), a one-dimensional step-backwater hydraulic analysis model, to determine water-surface profiles for each stream. This model has been accepted by FEMA for use in flood insurance studies.

Most of the overbank cross-sectional geometries used in the hydraulic models will be obtained from digital elevation models that will be created from the Medina County mapping data. The maximum distance along the stream channel between any two cross sections in the hydraulic models will not exceed 500 feet. In-channel geometry data will be surveyed by USGS survey personnel at hydraulic-structure approach sections and at supplemental (open channel) cross sections as needed. The in-channel data will be used to estimate channel-slopes and to supplement the overbank cross-sectional data obtained from the digital elevation models. The geometry of all hydraulic structures will also be surveyed and used as input in the hydraulic models. Roughness-coefficient data for stream channels and hydraulic structures will be estimated by experienced USGS personnel.

### **Timetable**

This project will begin March 1, 2010, and final data will be delivered to ODNR, FEMA, and Medina County by August 31, 2011 (see Table 2). These dates are contingent upon the USGS and ODNR signing a cooperative project agreement on or before March 1, 2010. Provisional data and results may be released to ODNR before the end of the study as work is completed on individual streams. The USGS will coordinate the prioritization of the delivery of the provisional data that will be released to ODNR.

**Table 2. Study Timeline.**

Calendar year	2010			2011			
Federal Fiscal Year	2010			2011			
Fiscal Year Quarter	2	3	4	1	2	3	4
Develop Project Proposal	■						
Data Collection	■	■	■				
Data Reduction	■	■	■				
Hydrology	■	■	■				
Hydraulics		■	■	■	■		
Technical Documentation				■	■		
In-house and Section Chief Review					■	■	■
Colleague and DC Review					■	■	■

**Delivery of Study Materials**

The USGS will deliver the completed flood analyses to ODNR, FEMA, and Medina County for publication in a new Flood Insurance Study for Medina County. The flood analyses include the following: (1) determination of 10-, 2-, 1-, and 0.2-percent-annual-chance peak-flood discharges and development of hydraulic models for the selected streams, (2) determination of water-surface elevation profiles and digital flood-plain and floodway mapping, and (3) preparation of a Technical Support Data Notebook (TSDN). The publication date of the new Flood Insurance Study will be dependent upon FEMA's review and publication timetable (which is beyond the control of the USGS). All hydro-logic and hydraulic computations will be peer reviewed by the USGS for adherence to appropriate engineering methods.

**Personnel**

The project chief will be a GS-12, Hydrologist/Engineer with over 15 years experience in conducting flood studies in Ohio. The project chief will be assisted by Ohio Water Science Center staff including: Hydrologists, Hydrologic Technicians, Chief of the Hydrologic and Hydraulic Investigations Section, and the Surface-Water Specialist. The USGS hydrologists have extensive experience in hydrology, hydraulics, geographic information systems, global positioning system surveying, and communicating the results of interpretive analyses.

## References

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## Additional Information Sources

Federal Emergency Management Agency, 2002, Guidelines and Specifications for Flood Hazard Mapping Partners, Volumes 1-3, Appendices A-N.

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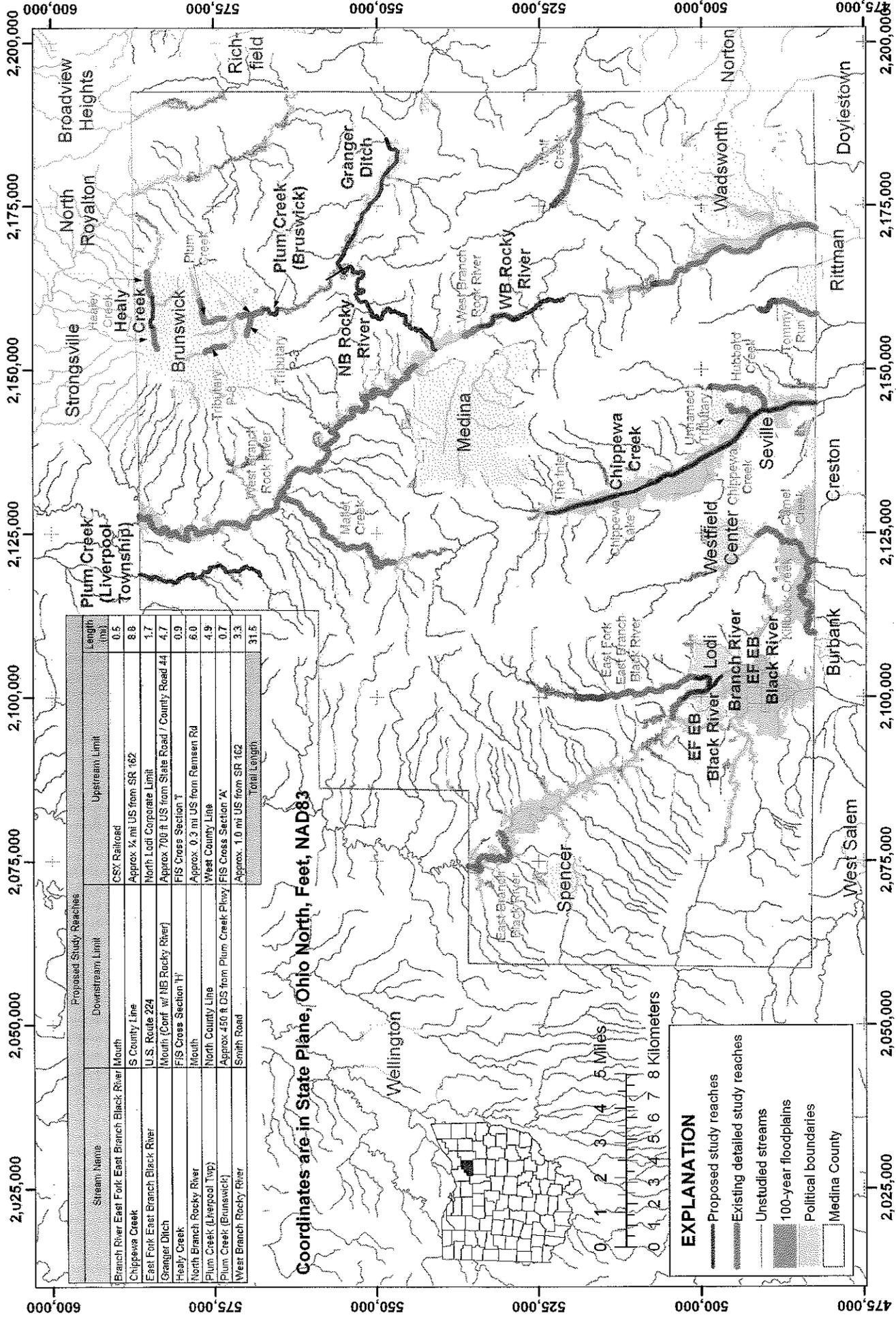


Figure 1. Map of study reaches

