

**Development of Flood-Inundation Mapping for:  
Scioto River at Columbus, Ohio  
Scioto River at 5<sup>th</sup> Avenue at Columbus, Ohio  
Scioto River below O'Shaughnessy Dam near Dublin, Ohio**

Proposal to:

City of Columbus

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## BACKGROUND

The State of Ohio has experienced substantial and widespread damage from flooding, with economic impacts of contemporary flood events estimated at \$290 million (Straub and others, 2009 and Sherwood and other, 2007). Flooding has occurred in low-lying areas along the Scioto River in the cities of Columbus, Dublin, Upper Arlington, Marble Cliff, and Grandview Heights, Ohio. The Scioto River had experienced severe floods numerous times, notably in March of 1913, January of 1959, and January of 2005.

The United State Geological Survey (USGS) operates 3 streamgages along the Scioto River within the City of Columbus, Ohio (Table 1). The streamgage, Scioto River at Columbus, Ohio (station number 03227500; USGS, 2025d, Figure 1), hereafter referred to as the Columbus streamgage has been operating since October 1, 1924. Prior to the installation, a staff gage was established on May 11, 1906. The USGS streamgage, Scioto River at 5th Avenue at Columbus, Ohio (station number 03221646; USGS, 2025c; Figure 1), hereafter referred to as the 5<sup>th</sup> Avenue streamgage, was installed on October 1, 2014. The USGS streamgage, Scioto River below O’Shaughnessy Dam near Dublin, Ohio, (station number 03221000; USGS, 2025b; Figure 1), hereafter referred to as the Dublin streamage, was installed in April 1, 1921.

**Table 1. Summary of streamgages along the Scioto River in Columbus, Ohio.**

Station Name	Station Number	Drainage Area square miles	Installation Date	Years of record
Scioto River at Columbus, Ohio	03227500	1629	01 Oct 1924	101
Scioto River at 5th Avenue at Columbus, Ohio	03221615	1050	01 Oct 2014	11
Scioto River below O’Shaughnessy Dam near Dublin, Ohio	03221000	980	01 Apr 1921	104

The National Weather Service (NWS) has the statutory responsibility for forecasting river stages<sup>1</sup> throughout the Nation. Flood forecasts for the City of Columbus, Ohio, which are based in part on a network of precipitation gages and streamflow-gaging stations, originate with the NWS River Forecast Center in Wilmington, Ohio. Flood forecasts are then issued to the public by the regional office of the NWS in Cleveland, Ohio. Forecasts are available for the Columbus streamgage; however, the NWS currently does not issue predictions for the 5<sup>th</sup> Avenue or Dublin streamgages.

<sup>1</sup> Stage refers to a stream’s height above a reference point. Stage, together with a reference datum, can be used to determine water-surface elevation.

Predicted flood stage alone can be hard to interpret but can become more meaningful when understood in terms of areas that will be inundated by flood waters. By using gage data along with hydraulic modeling and digital elevation data, flood boundaries can be predetermined for a series of flood stages. This library of flood boundaries can then be used in combination with NWS predicted flood stages and digital orthophotographs to help visualize areas expected to flood. The USGS has developed a Web application (USGS, undated b) as part of its Flood Inundation Mapping (FIM) Program (USGS, 2025a) that serves the predicted flood stages along with the corresponding flood boundaries overlain on an orthophotograph. The FIM application is a useful tool for disseminating this important information to both emergency managers and the public so they can take preventive measures to minimize flood damages.

## **OBJECTIVES**

The objectives of this proposed study are to:

- (1) Prepare two libraries of flood boundaries: one for a reach that includes the Columbus and 5<sup>th</sup> Avenue streamgages (hereafter referred to as the Lower Reach) and one for a reach that includes the Dublin streamgage (hereafter referred to as the Upper Reach) (Figure 1). The Lower reach flood boundary library will include predicted flood-inundation extents corresponding to 15 stages, in 1-foot increments (16 to 30 feet), at the Columbus streamgage and 12 stages, in 1-foot increments (24 to 35 feet), at the 5<sup>th</sup> Avenue streamgage. The Upper reach flood boundary library will show predicted flood-inundation extents corresponding to 11 stages, in 1-foot increments (15 to 25 feet), at the Dublin streamgage.
- (2) Post the libraries to a publicly accessible website (the USGS's FIM application) to show flood-inundation maps of current and/or projected conditions based on NWS flood predictions.
- (3) Publish online, two USGS Reports (one for each map library) that describe the methods, and results of the study.
- (4) Work with the National Weather Service, River Forecast Center to add the 5<sup>th</sup> Avenue and Dublin streamgages as forecast sites.

## **BENEFITS**

The ability of emergency management officials and the public to visualize current and forecasted flooding conditions, will contribute to public officials' efforts to assess the potential for flooding and take appropriate steps to reduce flood damages and protect life and property. The National Hydrologic Warning Council (2006) reports that "Forecasting and warning, when coupled with effective response plans, enable citizens and public servants to act to protect people and property before floodwaters reach critical levels". In addition, the ability to visualize the potential area of flooding on a map can motivate residents to take precautions and heed warnings that they previously may have disregarded (Kuser Olsen and others, 2018)

In his 1970 study, Day proposed a relationship (Figure 2) that estimates the percent reduction in damages as a function of warning time. That relationship indicates that a 12-hour warning may lead to about a 22 percent reduction in damages. Residents can benefit directly with advanced flood warning and enhanced flood forecasts by being able to temporarily move property to higher locations within multistory homes or businesses. Public officials can use the lead time to make decisions about if or when to close utilities and infrastructure to protect people and property and minimize the disruption of important community resources.

## **APPROACH**

To help emergency management officials' efforts to assess flood conditions and take appropriate steps to reduce flood damages and protect life and property the USGS proposes to develop two families of flood-inundation maps.

### **Study Reaches**

The USGS will provide two libraries of flood boundaries, one for the Lower Reach and one for the Upper Reach. The Lower Reach library will be for a 21.4-mile reach of the Scioto River with a downstream limit at the Franklin/Pickaway County line and extending upstream to just below the Griggs Reservoir Dam (Figure 1) and be associated with both the Columbus and 5<sup>th</sup> Avenue streamgages. The Upper Reach will be for a 9.9-mile reach of the Scioto River, with a downstream limit at Griggs Reservoir Dam, extending upstream to approximately 500 feet downstream from the O'Shaughnessy Reservoir Dam (Figure 1) and will be associated with the Dublin streamgage.

#### **Lower Reach**

For the Columbus streamgage, the mapping will correspond to 15 levels from stages 16 to 30 feet in increments of 1 foot. These ranges of stages correspond to the NWS Action stage (16 ft) through greater than a Major Flood stage of 27 ft (NWS, 2025b; Table 2). The proposed range also encompasses the range from below the 10%-annual exceedance probability (AEP) flood stage (near stage 24 ft) to above the 1%-AEP flood stage, which is near stage 29 ft (FEMA, 2011). Table 2 shows a summary comparison of selected stages presented by NWS, FEMA and the proposed range of stages for this effort.

For the 5<sup>th</sup> Avenue streamgage the mapping will correspond to 12 levels from stages 24 to 35 feet in increments of 1 foot. These ranges of stages correspond to just less than a 10%-AEP flood to greater than a 1%-AEP flood (FEMA, 2011; Table 2). The NWS (NWS, 2026a) has not established Action or Major flood stages for the 5<sup>th</sup> Avenue streamgage yet. The values for these stages can be addressed by discussions between the USGS and NWS to have the 5<sup>th</sup> Avenue streamgage added to the NWS forecast site list.

Because the Olentangy River enters the Scioto River between the two streamgages and provides a large increase in drainage area (543 mi<sup>2</sup> at its confluence with the Scioto River), the total combination of different discharge input scenarios for the Olentangy River will be assessed. The total combination of profiles would be 180 (the number of profiles at the 5<sup>th</sup> Avenue streamgage [12] multiplied by the number of profiles at the Columbus streamgage [15]). However, some of the 180 profiles will not be logically possible. For example, the combination of stage 24 ft (with an estimated discharge of 21,900 cubic feet per second [cfs]) at the 5<sup>th</sup> Avenue streamgage and stage 16 ft at the Columbus streamgage (with an associated discharge of 12,400 cfs) is implausible, since this combination represents a loss of 9,500 cfs as the flood moves downstream from one streamgage to another. It is estimated that only about half of the 180 combinations will be plausible, so the final product (FIM library profiles) may be closer to 90 profiles rather than the mathematical number of possibilities of 180.

The modeling and mapping of the Scioto River will push water up all tributaries. A level water-surface elevation determined from the Scioto River modeling will be mapped up the Olentangy River to the 3<sup>rd</sup> Avenue Bridge in Grandview (Figure 1), and up to Rowe Road for Big Walnut Creek (Figure 1) from the

point where each tributary enters the Scioto River (i.e., no hydraulic modeling will be done on the Olentangy River nor Big Walnut Creek).

Additionally, mapping for the Scioto River will be developed showing the floodplain boundaries with- and without- the protection of the Franklinton floodwall (Figure 3). The without-protection mapping will allow the display of information on flooding extents and depths behind the floodwall if the floodwall should fail and provide users with an estimate of the amount of protection provided by the floodwall for each flooding scenario.

### Upper Reach

For the Dublin streamgage, the mapping will correspond to 11 stage levels from 15 to 25 feet in increments of 1 foot. These ranges of stages correspond approximately to less than a 10% annual exceedance probability (AEP) flood to just below a 0.2%-year AEP flood (Table 2; FEMA, 2011). The NWS (NWS, 2026c) has not established Action or Major flood stages for the Dublin streamgage yet. The values for these stages can be addressed by discussions between the USGS and NWS to have the Dublin streamgage added to the NWS forecast site list.

**Table 2. Summary of selected labeled stages from NWS, FEMA, and USGS (proposed stages) in feet.**

FIM site location	NWS		FEMA		USGS proposed FIM	
	Stage (ft)	Name	Stage (ft)	Flood	Stage (ft)	Mapping Limit
Scioto River at Columbus, Ohio	16	Action	24.1	10%-AEP	16	Minimum
	27	Major	28.8	1%-AEP	30	Maximum
Scioto River at 5th Avenue at Columbus, Ohio	n/a		24.4	10%-AEP	24	Minimum
			32.5	1%-AEP	35	Maximum
Scioto River below O’Shaughnessy Dam near Dublin, Ohio	n/a		15.8	10%-AEP	15	Minimum
			22.5	1%-AEP	25	Maximum

### **Flood Modeling and Inundation Mapping**

Water-surface profiles (used to estimate flood-inundation areas for each streamflow) will be determined by means of a step-backwater hydraulic model developed using Hydrologic Engineering Center – River Analysis System (HEC-RAS; USACE, undated) – using the one-dimensional, steady-state conditions. The estimated area of flood-inundation will assume unobstructed flow. Should the local flow conditions for the Scioto River not meet these assumptions, flood-inundation areas may differ from those estimated.

The base mapping used for the project will be a digital elevation model (DEM) made using 3D Elevation Program (USGS, undated a) data obtained from the Ohio Geographically Referenced Information Program (OGRIP, undated). Surveys of in-channel elevations (bathymetry) will be conducted by the USGS throughout both study reaches. Structural geometric (bridges, dams, weirs, etc.) data will be a combination of data field collected by the USGS, as-built plans (provided by the City of Columbus), and geometry data taken from the effective Federal Emergency Management Agency (FEMA) Flood Insurance Study HEC-RAS model(s) for the Scioto River, dated June 2011.

The estimated flood boundaries determined for each stage will be superimposed over digital orthographic photos. An example of an estimated flood inundation boundary, showing the area protected by levee, which is overlain on an orthographic photo is shown in Figure 3. The USGS Flood Inundation Mapper (USGS, undated b) will host a web page to disseminate the appropriate flood-inundation maps and images based on the current conditions of the streamflow-gaging stations and the estimated flood stages forecasted by the NWS.

## **REPORT**

Two online USGS reports will present the study methods and the results of the investigations including flood inundation maps. The draft texts of the final reports will be reviewed by peers and editorial staff to ensure accuracy, logical organization, and readability. The reports will be made available to stakeholders and the public through the USGS Publications Warehouse.

## **BUDGET and TIMETABLE**

The total cost for the proposed study is \$1,005,000. The USGS may be able to contribute up to \$150,800 (approximately 15%) of the total cost using USGS Federal—State Cooperative Program funds (subject to availability). This project is proposed to begin August 1, 2026, and results and data will be delivered by December 31, 2028. These dates are contingent upon the USGS and the City of Columbus signing a cooperative project agreement on or before August 1, 2026. The following tables show: 1) description of the proposed task and cost associated with them and 2) proposed funding levels by quarter for the project.

Description of Proposed Study Tasks	Cost
<p style="text-align: center;">LOWER REACH</p> Develop maps corresponding to the combination of: 15 inundation profiles (from stage 16 to stage 30) for the Columbus streamgage with 12 inundation profiles (from stage 24 to stage 35) for the 5 <sup>th</sup> Avenue streamgage for a total of up to 180 maps	\$771,000
<p style="text-align: center;">UPPER REACH</p> Develop maps corresponding to 11 inundation profiles from stage 16 to stage 26 for the Dublin streamgage	\$214,000
Prepare 2 reports and complete peer and editorial reviews	\$20,000
<b>Total Study Cost</b>	<b>\$1,005,000</b>

Proposed Funding Levels												
Federal Fiscal Year	2026		2027				2028				2029	Totals
Calendar year	2026		2027				2028					
Dates	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec		
Columbus	\$144,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$80,000	\$70,200	
USGS	\$17,000	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$14,000	\$21,800	\$150,800
<b>Totals</b>	<b>\$161,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$94,000</b>	<b>\$92,000</b>	<b>\$1,005,000</b>

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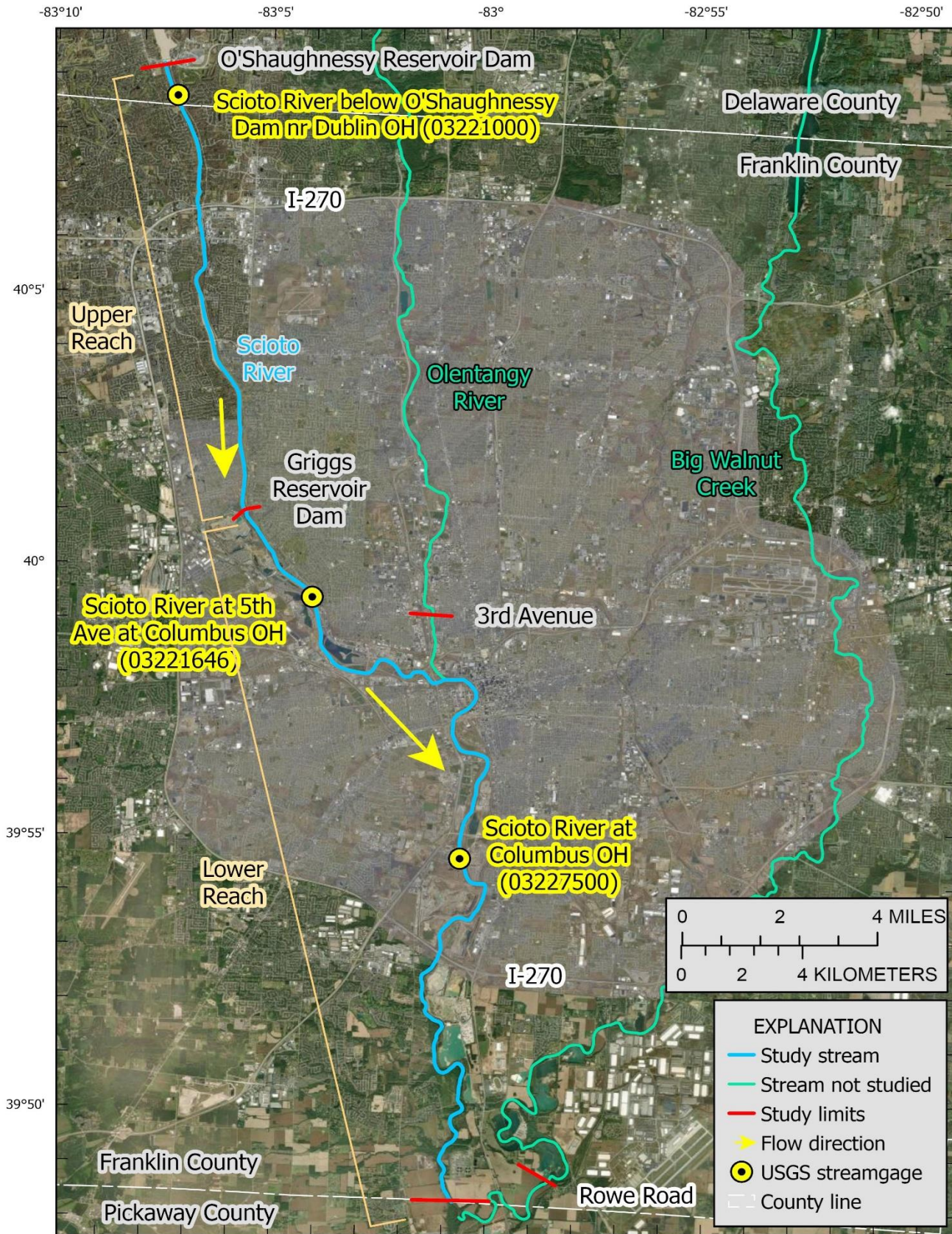
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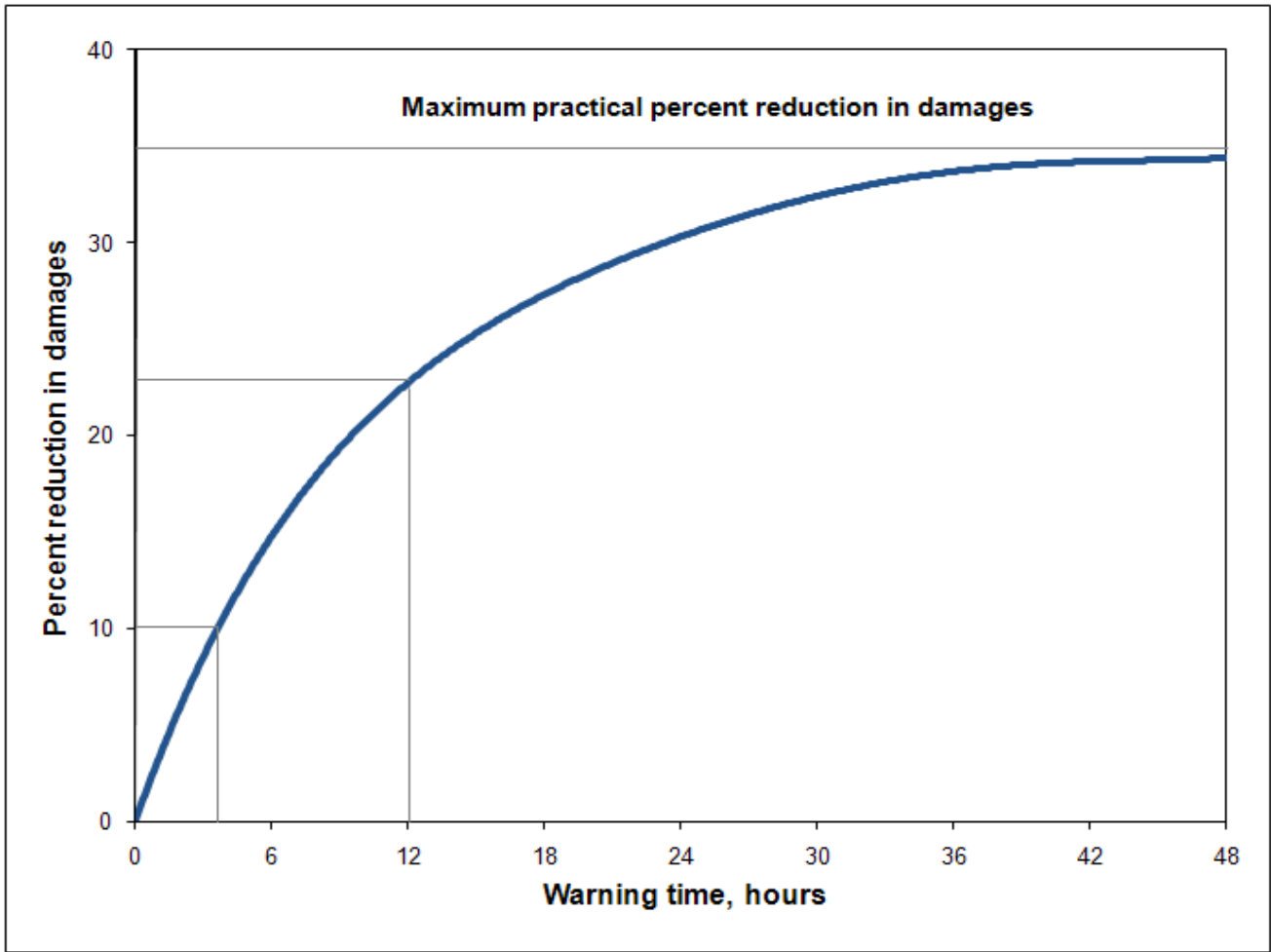
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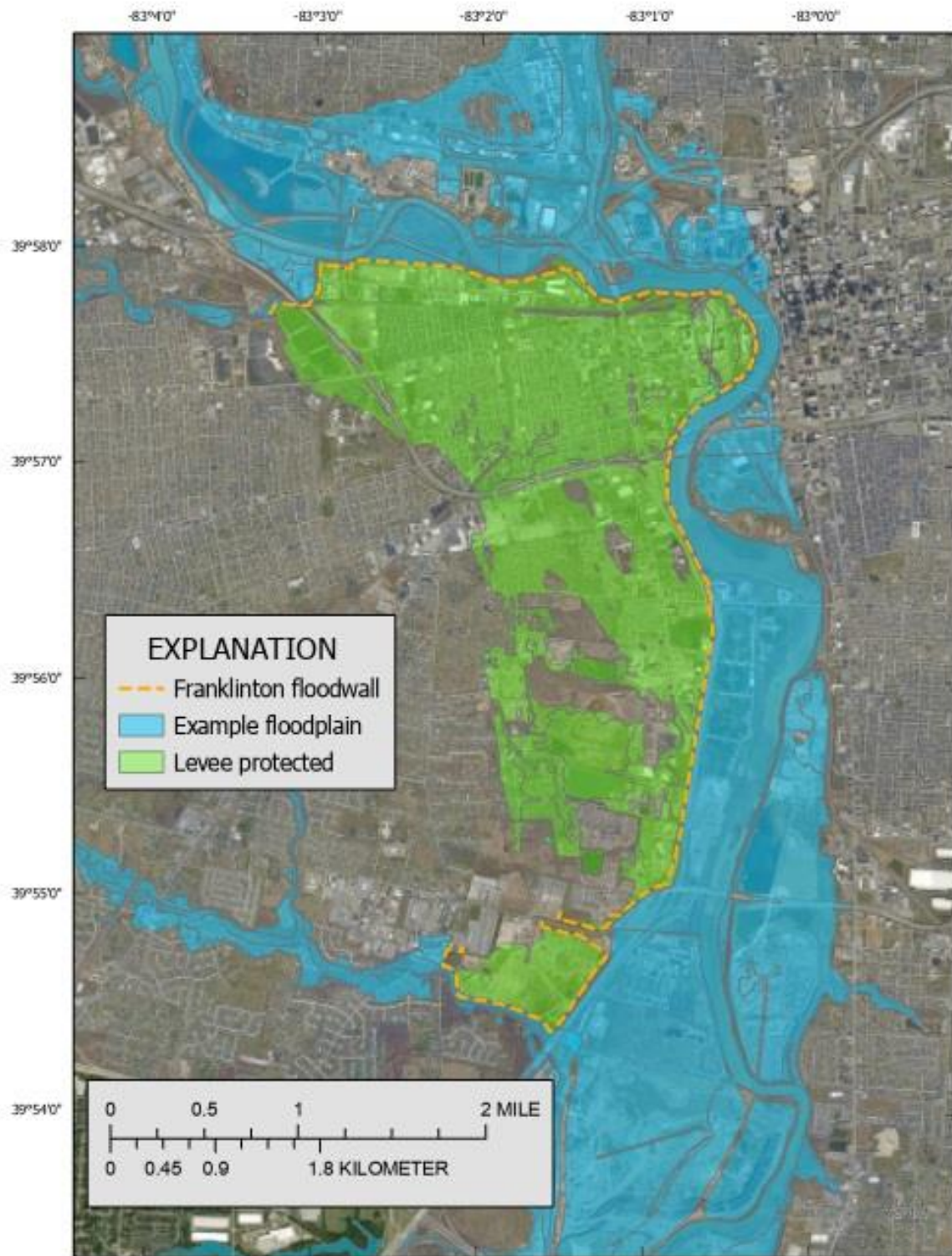
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**Figure 1.** Map of proposed Scioto River study reaches near Columbus, Ohio.



**Figure 2.** Day's curve for estimating flood warning benefit. (Day, 1970)



**Figure 3.** Example of typical forecasted flood inundation boundary overlain on an orthographic image.