

Prepared in cooperation with the Indiana Office of Community and Rural Affairs

Flood-Inundation Maps for the White River at Newberry, Indiana



Pamphlet accompanies maps
Scientific Investigations Map 3231

Cover: Highway 57 Bridge over the White River, at Newberry, Ind.
(Photograph by Chad Menke, USGS, June 10, 2008.) Insets show map
sheets 1, 16, and 18, flood stages, 8, 23, and 25 feet respectively.

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By Kathleen K. Fowler, Moon H. Kim, and Chad D. Menke

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U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

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1. 8.00 ft and an elevation of 473.15 feet (NAVD88)
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3. 10.00 ft and an elevation of 475.15 feet (NAVD88)
4. 11.00 ft and an elevation of 476.15 feet (NAVD88)
5. 12.00 ft and an elevation of 477.15 feet (NAVD88)
6. 13.00 ft and an elevation of 478.15 feet (NAVD88)
7. 14.00 ft and an elevation of 479.15 feet (NAVD88)
8. 15.00 ft and an elevation of 480.15 feet (NAVD88)
9. 16.00 ft and an elevation of 481.15 feet (NAVD88)
10. 17.00 ft and an elevation of 482.15 feet (NAVD88)
11. 18.00 ft and an elevation of 483.15 feet (NAVD88)
12. 19.00 ft and an elevation of 484.15 feet (NAVD88)
13. 20.00 ft and an elevation of 485.15 feet (NAVD88)
14. 21.00 ft and an elevation of 486.15 feet (NAVD88)
15. 22.00 ft and an elevation of 487.15 feet (NAVD88)
16. 23.00 ft and an elevation of 488.15 feet (NAVD88)
17. 24.00 ft and an elevation of 489.15 feet (NAVD88)
18. 25.00 ft and an elevation of 490.15 feet (NAVD88)
19. 26.00 ft and an elevation of 491.15 feet (NAVD88)
20. 27.00 ft and an elevation of 492.15 feet (NAVD88)
21. 28.00 ft and an elevation of 493.15 feet (NAVD88)
22. 29.00 ft and an elevation of 494.15 feet (NAVD88)

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
square foot (ft ²)	0.0929	square meter (m ²)
square mile (mi ²)	2.590	square kilometer (km ²)
Flow rate		
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)
Hydraulic gradient		
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)

Vertical coordinate information is referenced to either (1) stage, the height above an arbitrary datum established at a streamgage, or (2) elevation, the height above the North American Vertical Datum of 1988 (NAVD 88). Horizontal coordinate information is referenced to either the North American Datum of 1927 (NAD 27) or the North American Datum of 1983 (NAD 83) as noted.

Acknowledgments

The authors wish to thank the agencies that have cooperated in the funding for the operation and maintenance of the gages used for this study, especially the U.S. Army Corps of Engineers, Louisville District, and the Ohio River Valley Water Sanitation Commission. Special thanks are given to the Indiana Office of Community and Rural Affairs for their cooperation in this study and to the National Weather Service for their continued support to the USGS flood-inundation mapping initiative.

Flood-Inundation Maps for the White River at Newberry, Indiana

By Kathleen K. Fowler, Moon H. Kim, and Chad D. Menke

Abstract

Digital flood-inundation maps for a 4.9-mile reach of the White River at Newberry, Indiana (Ind.), were created by the U.S. Geological Survey (USGS) in cooperation with the Indiana Office of Community and Rural Affairs. The inundation maps, which can be accessed through the USGS Flood Inundation Mapping Science Web site at http://water.usgs.gov/osw/flood_inundation/, depict estimates of the areal extent of flooding corresponding to selected water levels (stages) at USGS streamgage 03360500, White River at Newberry, Ind. Current conditions at the USGS streamgage may be obtained on the Internet (http://waterdata.usgs.gov/in/nwis/uv?site_no=03360500). The National Weather Service (NWS) forecasts flood hydrographs at the Newberry streamgage. That forecasted peak-stage information, also available on the Internet, may be used in conjunction with the maps developed in this study to show predicted areas of flood inundation.

For this study, flood profiles were computed for the White River reach by means of a one-dimensional step-backwater model developed by the U.S. Army Corps of Engineers. The hydraulic model was calibrated by using the most current stage-discharge relation at USGS streamgage 03360500, White River at Newberry, Ind., and high-water marks from a flood in June 2008. The calibrated hydraulic model was then used to determine 22 water-surface profiles for flood stages at 1-foot intervals referenced to the streamgage datum and ranging from bankfull to approximately the highest recorded water level at the streamgage. The simulated water-surface profiles were then combined with a geographic information system digital elevation model (derived from Light Detection and Ranging (LiDAR) data) in order to delineate the area flooded at each water level.

The availability of these maps, along with Internet information regarding current stage from the USGS streamgage at Newberry, Ind., and forecasted stream stages from the NWS, provide emergency management personnel and residents with information that is critical for flood response activities such as evacuations and road closures as well as for post-flood recovery efforts.

Introduction

The town of Newberry, Indiana, Ind., is a small rural community with an estimated population of 193 (U.S. Census Bureau, 2010). Newberry has experienced severe flooding numerous times, most recently in 2002, 2005, and 2008. The majority of flood damages have occurred along the White River, which flows through the town. Flood plains within Newberry are moderately developed and contain a mix of residential and commercial structures, along with agricultural areas.

Prior to this study, Newberry officials have relied on several information sources to make decisions on how to best alert the public and mitigate flood damages. One source of information is the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Greene County dated April 29, 2004 (Federal Emergency Management Agency, 2007). A second source is USGS streamgage 03360500, White River at Newberry, Ind., from which current and historical water levels (stage) can be obtained. A third source is the National Weather Service's forecast of peak stage at USGS streamgage 03360500, White River at Newberry, Ind., through their Advanced Hydrologic Prediction Service (AHPS) Web site. Although USGS current stage and NWS forecast stage information is particularly useful for residents in the immediate vicinity of a streamgage, it is of limited use to residents farther upstream or downstream because the water-surface elevation is not constant along the entire stream channel. Also, FEMA and State emergency management mitigation teams and property owners typically lack information related to water depth at locations other than near USGS streamgage or NWS flood-forecast points.

Purpose and Scope

The purpose of this report is to describe the development of a series of estimated flood-inundation maps for the White River at Newberry, Ind. The maps and other useful flood information are available on the USGS Flood Inundation Mapping

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Science Web site and the NWS AHPS Web site. Internet users can select estimated inundation maps that correspond to (1) current stages at the USGS streamgage, (2) the NWS forecasted peak stage, or (3) other desired stream stages.

The scope of the study was limited to the White River reach extending 2.3 mi upstream of the Highway 57 Bridge and 2.6 mi downstream of the same bridge (fig. 1). To develop flood-inundation maps, a hydraulic model of the White River reach was built that provided water-surface profiles for various flood stages. Tasks specific to construction of the water-surface profiles were (1) examination of current and historical data from the streamgage on the White River (table 1), (2) collection of hydrologic and steady-flow data, (3) collection of topographic, geometric (for structures/bridges), and bathymetric data throughout the study reach, (4) determination of energy-loss factors (roughness coefficients) in the stream

channel and flood plain, (5) model calibration and evaluation, and (6) computation of water-surface profiles using the U.S. Army Corps of Engineers' hydraulic modeling software HEC-RAS (U.S. Army Corps of Engineers, 2010).

Maps depicting estimated flood-inundation areas were then produced from the results of the modeled water-surface profiles. Production of estimated flood-inundation maps corresponding to targeted water-surface elevations at the gages (stages) was completed by using the U.S. Army Corps of Engineers' HEC-GeoRas computer program (U.S. Army Corps of Engineers, 2009). HEC-GeoRas is a tool used for processing geospatial data in a Geographical Information System (GIS). An interface tool was then developed that links to USGS real-time streamgage information and NWS forecasted peak stage to facilitate the online display of user-selected flood-inundation maps.

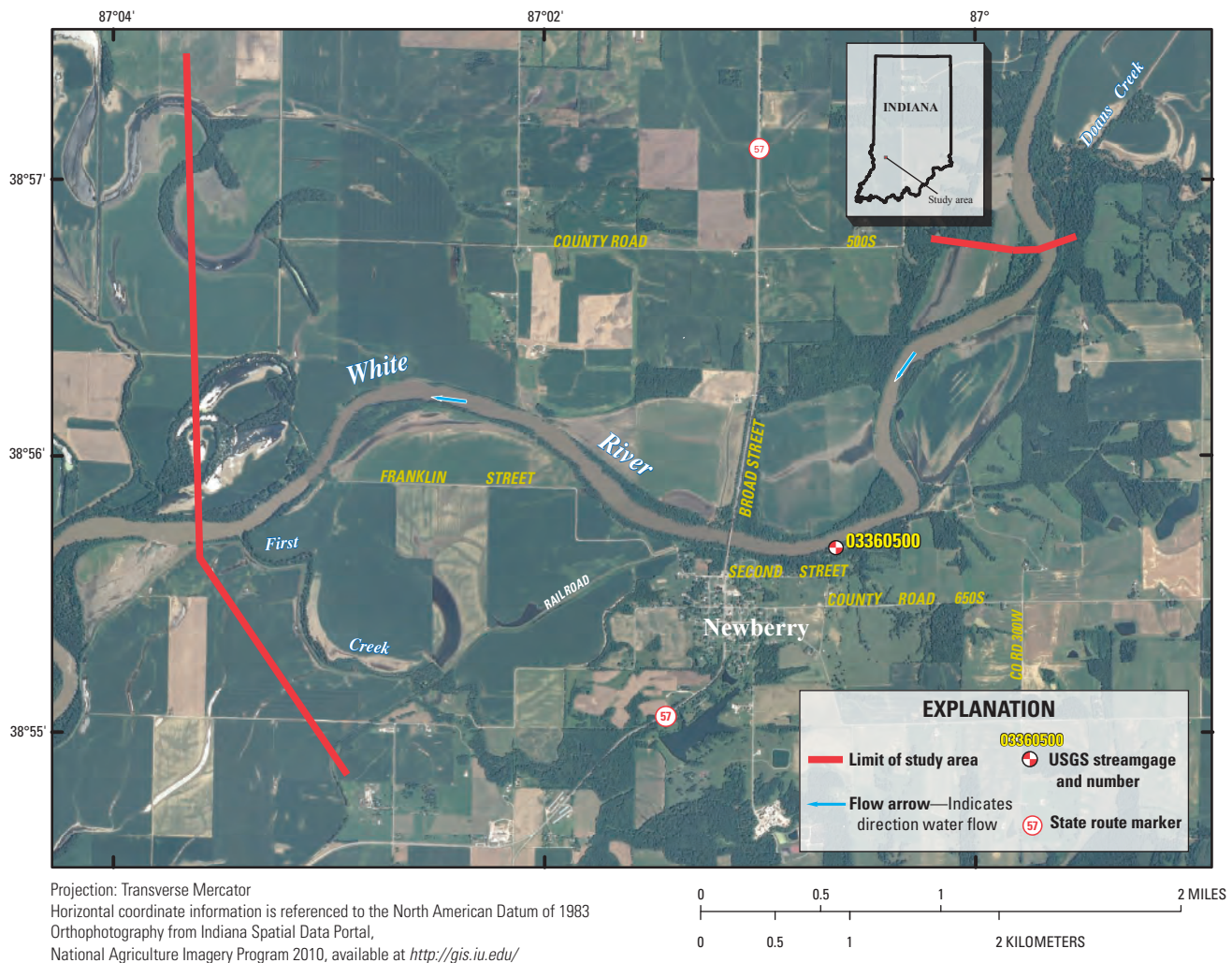


Figure 1. Location of study reach for the White River and location of USGS streamgage and National Weather Service forecast site.

Methods used are generally cited from previously published reports. If techniques varied significantly from previously documented methods due to local hydrologic conditions or available data, they are described in detail in this report. Twenty-two maps were produced for water levels referenced to the water-surface elevation (stage) at USGS streamgage 03360500, White River at Newberry, Ind., and ranging from approximately bankfull to nearly the maximum observed water level at the streamgage.

Study Area Description

The White River reach near the town of Newberry is in southwest Indiana in the Wabash Lowland physiographic section of the Southern Hills and Lowlands Region (Gray, 2000). The drainage area is 4,682 mi² at the upstream end of the study reach, 4,688 mi² at USGS streamgage 03360500, White River at Newberry, and 4,690 mi², at the downstream extent of the study reach. The headwaters originate in Randolph County, and the stream flows generally southwestward before entering the town limits. Doans Creek is the one major tributary (drainage area of 26.9 mi²) to the White River study reach. It joins the main stem just before it flows through Newberry and is upstream of the study extent. Generally, the area has extensive flood plains with broad terraces and is underlain by outwash sand. The study reach is approximately 4.9 mi long and has an average top-of-bank channel width of about 350 ft and an average channel slope of 0.00026 (1.4 ft/mi). Most of the land contiguous to the study reach is classified as agricultural. The study area includes some residential and commercial development, although population decreased 6.3 percent from 206 to 193 between 2000 and 2010 (Town of Newberry, Ind., 2011) <http://www.city-data.com/city/Newberry-Indiana.html>. The study reach has one major road, State Highway 57, crossing the main channel and adjacent flood plain.

Previous Studies

The current FIS for Greene County (Federal Emergency Management Agency, 2007) was completed by EarthTech-AECOM, Inc. The White River near Newberry was studied by approximate methods. A flood hazard boundary map for Newberry was revised in 1976.

Constructing Water-Surface Profiles

The water-surface profiles used to produce the 22 flood-inundation maps in this study were computed by using HEC-RAS, version 4.1.0 (U.S. Army Corps of Engineers, 2010). HEC-RAS is a one-dimensional step-backwater model for simulation of water-surface profiles with steady-state (gradually varied) or unsteady-state flow computation options. The HEC-RAS analysis for this study was done using the steady-state flow computation option.

Hydrologic and Steady-Flow Data

The study area hydrologic network consists of one USGS streamgage (fig. 1; table 1), which has been in operation since 1928. This gage has a continuous record of measured water level (stage) and computed streamflow. Water-surface elevations corresponding to the stages are referenced to the North American Vertical Datum of 1988 (NAVD 88) in this report. The USGS gage is equipped with satellite radio transmitters that allow data to be transmitted routinely on the Internet within an hour of collection. Flow data can be accessed at <http://waterdata.usgs.gov/in/nwis/current/?type=flow> by clicking on station number 03360500.

Table 1. USGS streamgage and miscellaneous site information for the White River at Newberry, Indiana.

[mi², square miles; NAD 27, North American Datum of 1927; NAVD 88, North American Vertical Datum of 1988; ft, feet]

Streamgage name	Streamgage number	Drainage area (mi ²)	Latitude (NAD 27)	Longitude (NAD 27)	Period of record	Datum of gage (NAVD 88)	Maximum recorded flood elevation (NAVD 88) and date
White River at Newberry, Indiana	03360500	4,688	38° 55' 39"	87° 00' 41"	September 1928 to present	465.15 ft	493.74 ft on June 9, 2008 (corresponds to a gage height of 28.59 ft)

The steady-flow data necessary for the hydraulic model consisted of flow regime, boundary conditions (normal depth), and peak-discharge information. The steady-flow data for the model were obtained from field measurements of streamflow at USGS streamgage 03360500, White River at Newberry, Ind. All computations used discharge values with known stages from actual streamflow measurements or the stage-discharge relations at the gage.

Topographic and Bathymetric Data

Channel cross sections were developed from USGS field surveys that were conducted in November 2011. These cross sections provide detailed channel elevation data below the water surface and were collected by using hydroacoustic instrumentation to measure water depth and Differential Global Positioning System (DGPS) instrumentation to determine horizontal position. LiDAR data were used to obtain digital elevation data for the portions of the cross sections that were above the water surface at the time of the surveys. The LiDAR data for the White River at Newberry were collected and post-processed by Aero-Metric, Inc., Sheboygan, Wisconsin (Wis.), in 2010. The original LiDAR data have horizontal accuracy of 1.02 ft with horizontal resolution of 3.9 ft and vertical accuracy of 0.37 ft at a 95-percent confidence level. Although a finer resolution of the digital elevation model (DEM) was possible given the accuracy of the LiDAR data, the final DEM had a grid-cell size of 10 ft by 10 ft in order to decrease the GIS processing time.

Various manmade drainage structures (bridges, culverts, roadway embankments, and embankments) in and along the White River affect or have the potential to affect water-surface elevations during floods along the stream. To properly account for these features in the model, structural dimensions for two bridges on State Highway 57—one over the main channel and another at the northern end of the flood plain—were measured and surveyed in the field concurrently with the stream channel surveys. A detailed description of the methods used to acquire and process the topographic and bathymetric data can be found in Bales and others (2007).

Energy Loss Factors

Field observations and high-resolution aerial photographs obtained from the Indiana Spatial Data Portal, National Agricultural Imagery Program 2010 (<http://gis.iu.edu/>) were used to select initial (pre-calibration) channel and flood-plain friction coefficients. These friction coefficients, commonly called Manning's roughness coefficients or Manning's n values, account for energy (friction) loss in the model calculations. The final unadjusted Manning's n values used ranged from 0.035 to 0.039 for the main channel and 0.07 to 0.12 for the overbank areas modeled in this analysis. For the area near the Highway 57 Bridges, the n values were adjusted by roughness factors (multipliers) that increase or decrease the assigned n values at specified areas and or flows. The application of these factors resulted in main channel n values ranging from 0.0023 to 0.062 and overbank n values from 0.0042 to 0.112. The very low n values were applied at the two highest flows where channel and overbank roughness has less effect. These adjustments were applied because of the complicated hydraulics at the two bridge constrictions on Highway 57, the presence of an old roadbed just upstream of the highway, and the presence of an 1,800-ft-long embankment about 450 ft downstream of the highway. Using the adjusted roughness factors in this short reach allowed better calibration of the model.

Model Calibration and Performance

The hydraulic model was calibrated to the most current stage-discharge relation at USGS streamgage 03360500, White River at Newberry, Ind. Model calibration was accomplished by adjusting Manning's n values and, in some cases, changing the channel cross section or slope until the results of the hydraulic computations closely agreed with the known flood discharge and stage values. Differences between measured and simulated water levels for specified flows were equal to or less than 0.3 ft (table 2). The model was also used to simulate the flood of June 9, 2008. The peak stage for this flood was 28.59 ft, and the estimated peak discharge was 138,200 ft³/s. Differences between measured and simulated water levels of the four high-water marks were within 0.20 ft (table 3). The results demonstrate that the model is capable of simulating accurate water levels over a wide range of flows in the basin. Details on techniques used in model development and calibration can be found in Bales and others (2007).

Table 2. Comparison of measured water-surface elevations at USGS streamgage 03360500, White River at Newberry, Indiana, with water-surface elevations output from the hydraulic model.

[ft, feet; NAVD 88, North American Vertical Datum of 1988]

Stage (ft)	Measured water-surface elevation (ft, NAVD 88)	Modeled water-surface elevation (ft, NAVD 88)	Elevation difference (ft)
8.00	473.15	472.97	0.18
9.00	474.15	474.17	-0.02
10.00	475.15	475.02	0.13
11.00	476.15	475.85	0.30
12.00	477.15	477.05	0.10
13.00	478.15	477.87	0.28
14.00	479.15	479.05	0.10
15.00	480.15	479.86	0.29
16.00	481.15	481.01	0.14
17.00	482.15	482.13	0.02
18.00	483.15	482.93	0.22
19.00	484.15	483.89	0.26
20.00	485.15	484.94	0.21
21.00	486.15	485.99	0.16
22.00	487.15	487.05	0.10
23.00	488.15	487.87	0.28
24.00	489.15	488.98	0.17
25.00	490.15	490.15	0.00
26.00	491.15	491.21	-0.06
27.00	492.15	492.08	0.07
28.00	493.15	493.27	-0.12
29.00	494.15	494.41	-0.26

Table 3. Comparison of hydraulic-model output and surveyed high-water-mark elevations from the flood of June 2008 for the White River at Newberry, Indiana.

[SR, State Road; ft, feet; NAVD 88, North American Vertical Datum of 1988]

Location	High-water mark field identification number ¹	High-water mark elevation (ft, NAVD 88)	Model water-surface elevation (ft, NAVD 88)	Elevation difference (ft)
200 ft downstream of SR 57 bridge	75	490.83	490.63	0.20
250 ft downstream of SR 57 bridge	76	490.52	490.44	0.08
Railroad track and berm	78	487.33	487.32	0.01
Railroad track and berm	77	487.15	487.28	-0.13

¹Indiana Department of Natural Resources high-water marks for the flood of June 9, 2008, collected June 17, 2008.

Development of Water-Surface Profiles

Profiles were developed for a total of 22 stages at 1-ft intervals between 8.0 ft and 29.0 ft as referenced to USGS streamgage 03360500, White River at Newberry, Ind. Discharges corresponding to the various stages were obtained from the most current stage-discharge relation (USGS rating no. 56) at the White River gage.

Discharges for all profiles (table 4) were selected with the assumption that within the 4.9-mi study reach there are no significant inflows. The discharges were estimated to be uniform and steady throughout the study reach.

Inundation Mapping

Flood-inundation maps were created for a stream reach near Newberry, Ind. The maps were created in a GIS by combining the water-surface profiles and digital elevation model data. The DEM data were derived from LiDAR data that were collected during April 2010, by Aero-Metric, Inc., Sheboygan, Wis. Post-processing of these data was completed by Aero-Metric, Inc., on July 14, 2010. The LiDAR data have horizontal accuracy of 1.02 ft with horizontal resolution of 3.9 ft and vertical accuracy of 0.37 ft at a 95-percent confidence level. Estimated flood-inundation boundaries for each simulated profile were developed with HEC-GeoRAS software (U.S. Army Corps of Engineers, 2009). HEC-GeoRAS is a set of procedures, tools, and utilities for processing geospatial data in ArcGIS using a graphical user interface. The interface allows the preparation of geometric data for import into HEC-RAS and processes simulation results exported from HEC-RAS (U.S. Army Corps of Engineers, 2010). USGS personnel then modified the HEC-GeoRAS results to ensure a hydraulically reasonable transition of the boundary between modeled cross sections relative to the contour data for the land surface (Whitehead and Ostheimer, 2009). The maps show estimated flood-inundated areas overlaid on high-resolution, georeferenced, aerial photographs of the study area for each of the water-surface profiles that were generated by the hydraulic model.

White River at Newberry, Indiana, Flood-Inundation Maps on the Internet

The flood-inundation maps and current study documentation are available online at the U.S. Geological Survey Publications Warehouse (<http://pubs.usgs.gov/sim/2012/3231>). Also, a Flood Inundation Mapping Science Web site has been established to provide a portal for USGS flood-inundation study information to the public at http://water.usgs.gov/osw/flood_inundation/. That Web portal has a link (<http://wim.usgs.gov/FIMI/FloodInundationMapper.html>) to an interactive mapping application where flood maps can be downloaded in

several commonly used electronic file formats. In the latter link, each stream reach displayed contains further links to NWISWeb graphs of the current stage and streamflow at USGS streamgage 03360500 to which the inundation maps are referenced. A link also is provided to the NWS AHPS site (<http://water.weather.gov/ahps/>) where the NWS forecasts river stage at Newberry during times of flooding. The estimated flood-inundation maps are displayed in sufficient detail to note the extent of flooding with respect to individual structures so that preparations for flooding and decisions for emergency response can be performed efficiently. Roadways and bridges were closely reviewed and are shown as shaded (inundated and likely impassable) or not shaded (dry and passable) to facilitate emergency planning and use. However, buildings which are shaded do not reflect inundation but denote that bare earth surfaces in the vicinity of the buildings are inundated. When the water depth (as indicated in the Web Mapping Application by holding the cursor over an inundated area) in the vicinity of the building of interest exceeds that building's height, the structure can be considered fully submerged.

Disclaimer for Flood-Inundation Maps

Inundated areas shown should not be used for navigation, regulatory, permitting, or other legal purposes. The USGS provides these maps "as-is" for a quick reference, emergency planning tool but assumes no legal liability or responsibility resulting from the use of this information.

Uncertainty Associated with Inundation Maps

Although the flood-inundation maps represent the boundaries of inundated areas with a distinct line, some uncertainty is associated with these maps. The flood boundaries shown were estimated based on water stages (water-surface elevations) and streamflows at USGS streamgage at 03360500, White River at Newberry, Ind. Water-surface elevations along the stream reaches were estimated by steady-state hydraulic modeling, assuming unobstructed flow, and using discharges and hydrologic conditions anticipated at the USGS streamgage. The hydraulic model reflects the land-cover characteristics and any bridge, dam, levee, or other hydraulic structures existing as of November 2011. Unique meteorological factors (timing and distribution of precipitation) may cause actual discharges along the modeled reach to vary those from assumed during a flood and lead to deviations in the water-surface elevations and inundation boundaries shown. Additional areas may be flooded due to unanticipated conditions such as changes in the streambed elevation or roughness, backwater into tributaries along a main stem river, or backwater from localized debris or ice jams. The accuracy of the floodwater extent portrayed on these maps will vary with the accuracy of the digital elevation model used to simulate the land surface. Additional uncertainties and limitations pertinent to this study are described elsewhere in this report.

Table 4. Stages and water-surface elevations, in feet, with corresponding discharge estimates at USGS streamgage 03360500, White River at Newberry, Indiana, for simulated water-surface profiles.[ft³/s, cubic feet per second; NAVD 88, North American Vertical Datum of 1988; the drainage area is 4,688 square miles.]

Stage, in feet above gage datum at White River (reference datum 465.15 NAVD 88)										
8.0 (473.15)	9.0 (474.15)	10.0 (475.15)	11.0 (476.15)	12.0 (477.15)	13.0 (478.15)	14.0 (479.15)	15.0 (480.15)	16.0 (481.15)	17.0 (482.15)	18.0 (483.15)
Discharge (ft ³ /s)										
7,010	8,502	10,090	11,770	13,350	15,400	17,340	19,360	21,460	23,630	26,100
Stage, in feet above gage datum at White River (reference datum 465.15 NAVD 88)										
19.0 (484.15)	20.0 (485.15)	21.0 (486.15)	22.0 (487.15)	23.0 (488.15)	24.0 (489.15)	25.0 (490.15)	26.0 (491.15)	27.0 (492.15)	28.0 (493.15)	29.0 (494.15)
Discharge (ft ³ /s)										
29,250	33,210	37,800	43,150	49,810	57,630	66,270	75,770	87,850	111,000	160,600

If this series of flood-inundation maps will be used in conjunction with NWS river forecasts, the user should be aware of additional uncertainties that may be inherent or factored into NWS forecast procedures. The NWS uses forecast models to estimate the quantity and timing of water flowing through selected stream reaches in the United States. These forecast models (1) estimate the amount of runoff generated by precipitation or snowmelt, (2) simulate the movement of floodwater as it proceeds downstream, and (3) predict the flow and stage (water-surface elevation) for the stream at a given location (AHPS forecast point) throughout the forecast period (every 6 hours and 3 to 5 days out during periods of high flow). For more information on AHPS forecasts, please see http://water.weather.gov/ahps/pcpn_and_river_forecasting.pdf.

Summary

A series of estimated flood-inundation maps were developed in cooperation with the Indiana Office of Community and Rural Affairs for the White River at Newberry, Ind. The maps were developed using the U.S. Army Corps of Engineers' HEC-RAS one-dimensional step-backwater model to compute 22 water-surface profiles for a 4.9-mi-long reach of the White River. The HEC-GeoRAS program was used to delineate estimated flood-inundation areas at 1-ft increments

of stage as referenced to USGS streamgage 03360500, White River at Newberry, Ind. The modeled stages ranged from 8.0 ft or bankfull to 29.0 ft, which is slightly higher than the maximum recorded stage at the White River streamgage. The hydraulic model was calibrated and showed good agreement between observed and simulated water-surface elevations at the streamgage, as well as with four high-water marks that were surveyed after the flood of June 9, 2008.

The inundation maps show estimated (shaded) flood-inundation areas overlaid on high-resolution, georeferenced, aerial photographs of the study area. The maps were modified, as required, to remove any inundated areas that were detached from the main channel and were erroneously delineated as part of the flood extent and to correctly depict inundation of the State Highway Route 57 bridge surfaces. In addition to maps showing areas of inundation, downloadable GIS raster files and keyhole markup language map files (KML) were produced. Interactive use of the maps using the mouse cursor to click within the shaded areas can give users a general indication of depth of water at any point.

These maps, available at a USGS Web portal, in conjunction with the real-time stage data from USGS streamgage 03360500, White River at Newberry, Ind., and NWS flood-stage forecasts, can help to guide the general public in taking individual safety precautions and can provide local officials with a tool to efficiently manage emergency flood operations and flood mitigation efforts.

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