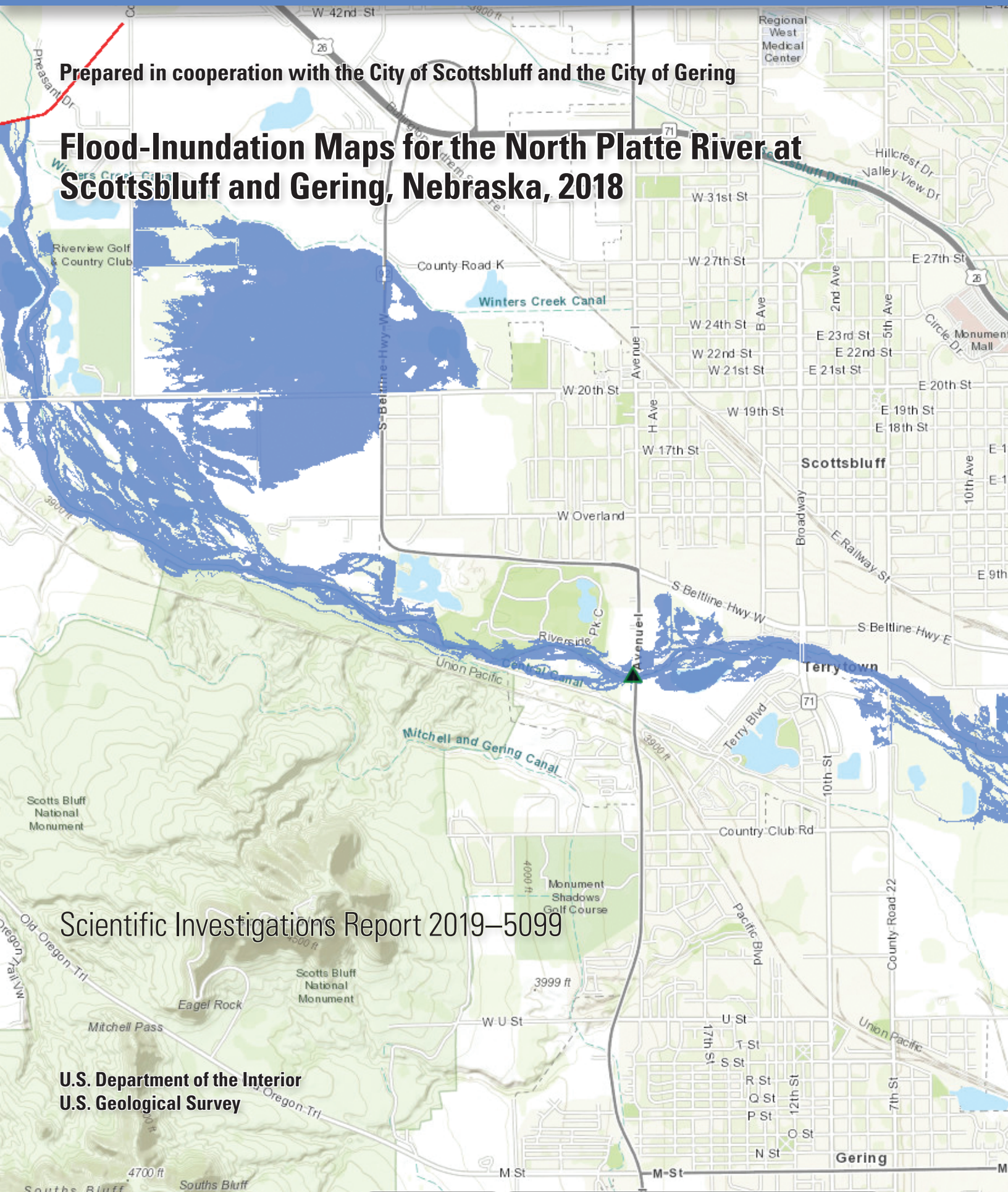
USGS
science for a changing world

Prepared in cooperation with the City of Scottsbluff and the City of Gering

Flood-Inundation Maps for the North Platte River at Scottsbluff and Gering, Nebraska, 2018



Scientific Investigations Report 2019–5099

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

Front cover. Screen shot of U.S. Geological Survey flood inundation mapper at a stage of 13 feet gage datum at U.S. Geological Survey station number 06680500, Scottsbluff, Nebraska.

Flood-Inundation Maps for the North Platte River at Scottsbluff and Gering, Nebraska, 2018

By Kellan R. Strauch

Prepared in cooperation with the City of Scottsbluff and the City of Gering

Scientific Investigations Report 2019–5099

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

U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2019

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit https://www.usgs.gov or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit https://store.usgs.gov.

Suggested citation:
Strauch, K.R., 2019, Flood-inundation maps for the North Platte River at Scottsbluff and Gering, Nebraska, 2018: U.S. Geological Survey Scientific Investigations Report 2019–5099, 9 p., https://doi.org/10.3133/sir20195099.

Associated data for this publication:
Strauch, K.R., 2019, Flood-inundation geospatial datasets for the North Platte River at Scottsbluff and Gering, Nebraska: U.S. Geological Survey data release, https://doi.org/10.5066/P9NCAIKN.

ISSN 2328-0328 (online)

Acknowledgments

The author wishes to thank the Cities of Scottsbluff and Gering for funding the operation and maintenance of the streamgage used for this study. Special thanks are given to the National Weather Service for their continued support of the U.S. Geological Survey flood-inundation mapping program.

Contents

Figures

Tables

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
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)

Datum

Vertical coordinate information is referenced to to (1) stage, the height above an arbitrary datum established at a streamgage, and (2) elevation, the height above the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

DEM	digital elevation model
FEMA	Federal Emergency Management Agency
FIM	Flood Inundation Mapping [Program]
GIS	geographic information system
HEC–RAS	U.S. Army Corps of Engineers Hydrologic Engineering Centers River Analysis System
lidar	light detection and ranging
NWS	National Weather Service
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

Flood-Inundation Maps for the North Platte River at Scottsbluff and Gering, Nebraska, 2018

By Kellan R. Strauch

Abstract

Digital flood-inundation maps for an 8.8-mile reach of the North Platte River, from 1.5 miles upstream from the Highway 92 bridge to 3 miles downstream from the Highway 71 bridge in Scottsbluff County, were created by the U.S. Geological Survey (USGS) in cooperation with the Cities of Scottsbluff and Gering, Nebraska. The flood-inundation maps, which can be accessed through the Flood Inundation Mapping (FIM) Program website at https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program?qt-science_center_objects=0#qt-science_center_objects, depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at the USGS streamgage on the North Platte River at Scottsbluff, Nebr. (station number 06680500). Near-real-time stages at this streamgage may be obtained on the internet from the USGS National Water Information System at https://doi.org/10.5066/F7P55KJN or from the National Weather Service Advanced Hydrologic Prediction Service (site SBRN1) at https://water.weather.gov/ahps2/hydrograph.php?wfo=cys&gage=sbrn1.

Flood profiles were computed for the stream reach by means of a one-dimensional step-backwater model. The model was calibrated by using the current (2018) stage-discharge relation at the North Platte River at Scottsbluff, Nebr., streamgage.

The hydraulic model was then used to compute 10 water-surface profiles for flood stages at 1-foot (ft) intervals referenced to the streamgage datum and ranging from 9 ft, or near bankfull, to 18 ft, which exceeds the stage that corresponds to the estimated 1-percent annual exceedance probability flood (100-year recurrence interval flood). The simulated water-surface profiles were then combined with a geographic information system digital elevation model derived from light detection and ranging data having a 0.6-ft root mean square error and 2-ft horizontal resolution resampled to a 6-ft grid 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, may 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 postflood recovery efforts.

Introduction

The Cities of Scottsbluff and Gering, Nebraska, are in the western part of the state and have populations of 15,039 and 8,500, respectively (U.S. Census Bureau, 2010). The North Platte River separates the two cities, with Scottsbluff along the north and Gering along the south of the river. Both cities recently experienced flooding in 2011 and again in 2013.

Before this study, emergency responders in Scottsbluff and Gering relied on several information sources (all of which are available on the internet) to make decisions on how to best alert the public and mitigate flood damages. One source is the 1978 Federal Emergency Management Agency (FEMA) flood insurance study for Scottsbluff (FEMA, 1978). A second source of information is the U.S. Geological Survey (USGS) streamgage, North Platte River at Scottsbluff, Nebr. (station number 06680500), from which current (USGS, 2018a) water levels can be obtained. A third source of flood-related information is the National Weather Service (NWS) Advanced Hydrologic Prediction Service, which contains the USGS stage data from the Scottsbluff streamgage (National Weather Service, 2017).

Although the current stage at a USGS streamgage 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 reach. Also, knowledge of a water level at a streamgage is difficult to translate into depth and areal extent of flooding at points distant from the streamgage. One way to address these informational gaps is to produce a library of flood-inundation maps that are referenced to the stages recorded at the USGS streamgage. By referring to the appropriate map and the streamgage data, emergency responders can discern the severity of potential flooding (depth of water and areal extent), identify roads that are or will soon be flooded, and make plans for notification or evacuation of residents at risk of flooding for some distance upstream and downstream from the streamgage. In addition, the capability to visualize the potential extent of flooding has been shown to motivate residents to take precautions and heed warnings that they previously might have disregarded. In 2018, the USGS, in cooperation with the Cities of Scottsbluff and Gering, conducted a study to produce a library of flood-inundation maps for the North Platte River at Scottsbluff, Nebr.

Purpose and Scope

This report describes the development of a series of estimated flood-inundation maps for the North Platte River at Scottsbluff, Nebr., and identifies where the maps can be found online and where ancillary data (geographic information system [GIS] flood polygons and depth grids) can be downloaded. The study covers an 8.8-mile (mi) reach of the North Platte River from 1.5 mi upstream from the Highway 92 bridge to 2 mi downstream from the Highway 71 bridge (fig. 1).

The maps were produced for flood levels referenced to the stage recorded at the USGS streamgage on the North Platte River at Scottsbluff, Nebr. (fig. 1; table 1); the streamgage is on the upstream side of Avenue I [Five Rocks Road].

The maps cover a range in stage from 9 to 18 feet (ft) above an arbitrary gage datum. The 9-ft stage is approximately bankfull, and the 18-ft stage exceeds the stage that corresponds to the estimated 1-percent annual exceedance probability flood (100-year recurrence interval flood). The geospatial datasets used in this study are available through a data release at https://doi.org/10.5066/P9NCAIKN (Strauch, 2019).

Study Area Description

The study reach of the North Platte River is in Scotts Bluff County in the western part of Nebraska (fig. 1). The drainage area for the streamgage at North Platte River at Scottsbluff is 24,500 square miles. The North Platte River headwaters originate in Colorado and flow north into Wyoming before heading east into Nebraska. The North Platte River heads southeast through the Nebraska Panhandle until joining the South Platte River in North Platte, Nebr., to form the Platte River. The North Platte River above the study reach is regulated by several reservoirs in Wyoming. The study reach is 8.8 mi long and has an approximate channel slope of 0.001 (5.5 feet per mile). Land use along the study reach varies among residential, commercial, recreational, and agricultural development. The main channel within the study reach has five road crossings that can affect the water-surface profiles.

Previous Studies

The current flood insurance study for Scottsbluff (FEMA, 1978) was completed by the U.S. Army Corps of Engineers (USACE) in 1977. However, updated hydrology and hydraulic analyses have been completed more recently by the USACE as part of a study on the North Platte River from the Nebraska state line to Lake McConaughey (USACE, Omaha District in Association with Nebraska Silver Jackets, 2013; USACE, Omaha District Flood Risk and Floodplain Management Section, 2018). Both studies provided information for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability peak discharges for locations near the study reach (table 2).

Table 1. U.S. Geological Survey streamgage information for the North Platte River at Scottsbluff, Nebraska.

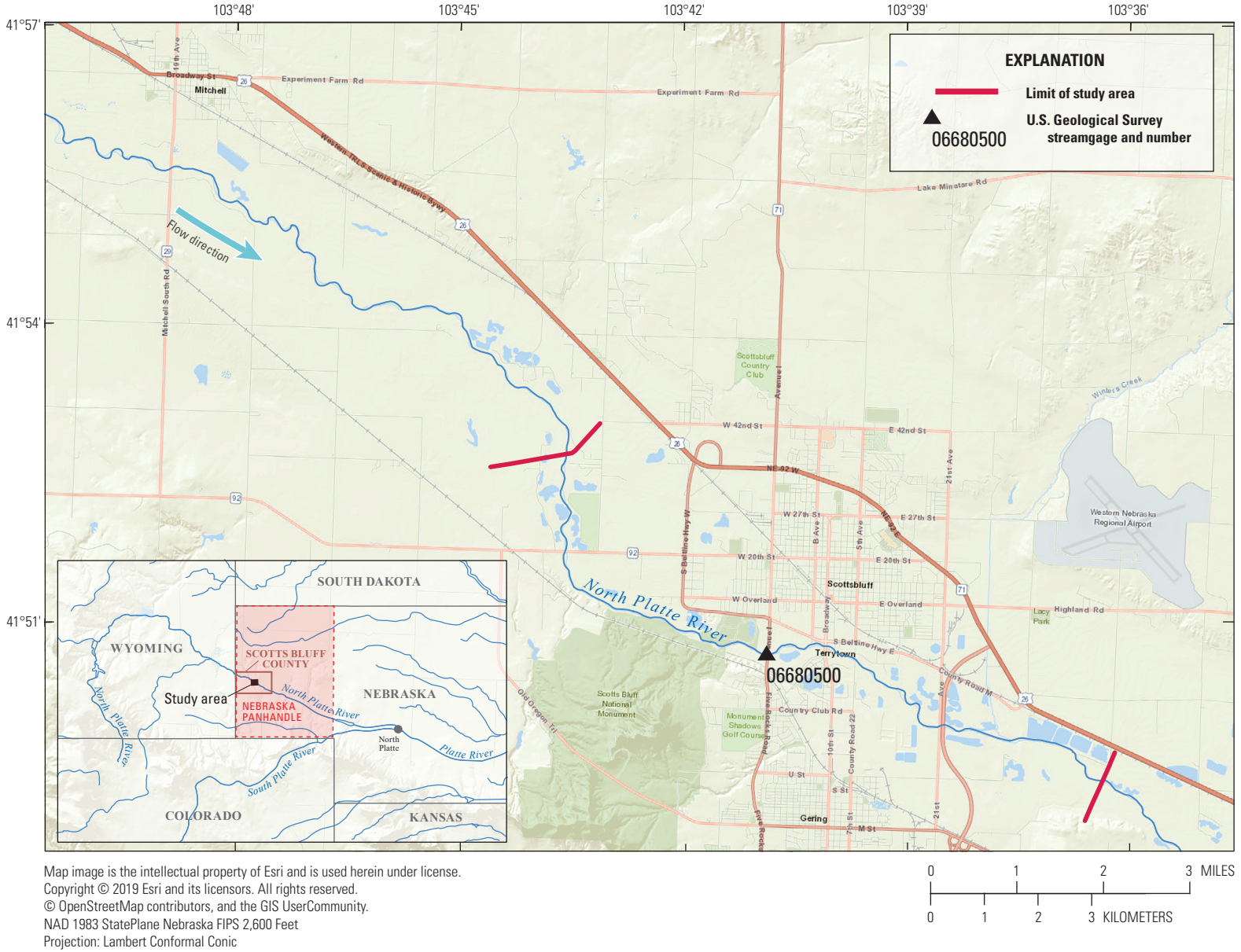
[Station location is shown in figure 1. NAD 83, North American Datum of 1983; °, degree; ′, minute; ″, second]

Station name	Station number	Drainage area, in square miles	Latitude, NAD 83	Longitude, NAD 83
North Platte River at Scottsbluff, Nebraska	06680500	24,500	41°50′59.8″	103°40′32.0″

Table 2. Peak discharges for selected annual exceedance probabilities for North Platte River near Scottsbluff, Nebraska.

[mi^2, square mile; ft^3/s, cubic foot per second; FEMA, Federal Emergency Management Agency; USACE, U.S. Army Corps of Engineers; --, data not available in report]

Location on North Platte River	Data reference	Drainage area (mi^2)	Estimated discharges (ft^3/s) for indicated annual exceedance probabilities (in percent)			
			10	2	1	0.2
Scottsbluff Eastern Corporate Limit	FEMA (1978)	28,500	7,100	14,300	18,500	41,500
Mitchell, Nebraska	USACE (2013)	--	9,060	15,100	18,300	22,600



NAD 1983 StatePlane Nebraska FIPS 2,600 Feet
Projection: Lambert Conformal Conic

Figure 1. Location of study reach for the North Platte River at Scottsbluff, Nebraska, and location of U.S. Geological Survey streamgage.

Creation of Flood-Inundation-Map Library

The USGS has standardized the procedures for creating flood-inundation maps for flood-prone communities (USGS, 2018b) so that the process followed and products produced are similar regardless of which USGS office is responsible for the work. Tasks specific to development of the flood maps for Scottsbluff, Nebr., include (1) installation of a streamgage on the North Platte River at Scottsbluff, Nebr. (table 1); (2) acquisition of the hydraulic model that was used as part of a Silver Jackets' project for the North Platte River (USACE, Omaha District Flood Risk and Floodplain Management Section, 2018); (3) verification of energy-loss factors (roughness coefficients) in the stream channel and flood plain and determination of steady-flow data; (4) production of estimated flood-inundation maps at various stream stages using the USACE Hydrologic Engineering Centers Geospatial River Analysis System computer program (Ackerman, 2012) and GIS; and (5) preparation of the maps, as shapefile polygons that depict the areal extent of flood inundation and as depth grids that provide the depth of floodwaters for specified streamgage heights, for display on a USGS flood-inundation mapping application.

Computation of Water-Surface Profiles

The water-surface profiles used to produce the 10 flood-inundation maps in this study were computed by using the USACE Hydrologic Engineering Centers River Analysis System (HEC–RAS), version 5.0.3 (Brunner, 2016a, 2016b). 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.

Hydrologic Data

The study reach includes one streamgage (fig. 1; table 1). The streamgage established for this study has been in operation since April 2015. Stage is measured every 15 minutes, transmitted hourly by a satellite radio, and made available through the USGS National Water Information System web interface (USGS, 2018a). Stage data from this streamgage are referenced to a local datum but can be converted to water-surface elevations referenced to the North American Vertical Datum of 1988 (NAVD 88) by adding 3,863.32 ft.

The peak flows used in the model simulations (table 3) were taken from the current stage-discharge relation (number 1, effective October 1, 2015) and corresponded with the target stages. For peak flows that were above the current stage-discharge rating (greater than 8,366 cubic feet per second), the calibrated HEC–RAS model developed for the current study was used to extend the rating. No major tributaries join the North Platte River within the 8.8mi study reach; therefore, the gage-derived discharges were not adjusted for tributary inflows but were held constant throughout the study reach for a given profile.

Between 1897 and 1918, a streamgage was operated intermittently at a site 1 mile downstream using the same station number (06680500) as that used in this report (Boohar and Provaznik, 1996). During its operation, seven peak streamflows were estimated, including a 27,900 cubic feet per second estimate in 1897. However, corresponding stages were not furnished. As a result, the historical streamflow record prior to 2015 was not included in the mapping analysis.

Topographic and Bathymetric Data

All topographic data used in this study are referenced vertically to NAVD 88 and horizontally to the North American Datum of 1983. Cross-section elevation data were obtained from a digital elevation model (DEM) that was derived from light detection and ranging (lidar) data that were collected during November 2011 by Fugro Horizons Inc., Houston, Texas. The original lidar data have horizontal resolution of 4.5 ft and vertical accuracy of 1.18 ft at a 95 percent confidence level for the "open terrain" land-cover category (root mean square error of 0.6 ft). By these criteria, the lidar data support production of 2-ft contours (Dewberry, 2012); the final DEM, which was resampled to a 6 ft grid-cell size to decrease the GIS processing time, has a vertical accuracy of plus or minus 1 ft. In-channel geometry data for the models were obtained from surveyed cross sections as described in the hydraulic study done by the USACE (USACE, Omaha District Flood Risk and Floodplain Management Section, 2018).

Hydraulic Structures

A total of five road crossings (Highway 92, Avenue I [Five Rocks Road], 10th Street, 21st Avenue [Sugar Factory Road], and Highway 71; fig. 2) have the potential to affect water-surface elevations during floods along the stream. Bridge-geometry data were obtained from bridge plans, and field surveys were conducted by personnel from the Nebraska Department of Natural Resources for the USACE study (USACE, Omaha District Flood Risk and Floodplain Management Section, 2018).

Energy-Loss Factors

Hydraulic analyses require the estimation of energy losses that result from frictional resistance exerted by a channel on streamflow. These energy losses are quantified by the Manning's roughness coefficient ("*n*" value) (Barnes, 1967). Initial (precalibration) *n* values were selected based on field observations and high-resolution aerial photographs. As part of the calibration process, the initial *n* values were varied by flow and adjusted until the differences between simulated and observed water-surface elevations at the streamgage were minimized. The final *n* values were 0.035 for the main channel and ranged from 0.015 to 0.12 for the overbank areas simulated in this analysis.

Hydraulic Model

The HEC–RAS analysis for this study was done by using the steady-state flow computation option. Steady-state flow data consisted of flow regime, boundary conditions, and peak flows that produced water-surface elevations at the streamgage cross section that matched target water-surface elevations. These target elevations coincided with even 1-ft increments of stage, referenced to the local gage datum. Subcritical (tranquil) flow regime was assumed for the simulations. Normal depth, based on an estimated average water-surface slope of 0.001, was used as the reach's downstream boundary condition. The calculation of normal depth was estimated from the slope of the channel bottom of the three downstream cross sections in the model. The flows that were used in the model were discussed in the "Hydrologic Data" section.

The HEC–RAS model was calibrated to the current stage-discharge relation at the North Platte River at Scottsbluff streamgage. Model calibration was completed by adjusting Manning's *n* values until the results of the hydraulic computations closely agreed with the observed water-surface elevations for given flows. The absolute value of differences between observed and simulated water-surface elevations for the nine simulated flows at the USGS streamgage were equal to or less than 0.33 ft (table 4).

Table 3. Estimated discharges for corresponding stages and water-surface elevations at the streamgage used in the hydraulic model of the North Platte River at Scottsbluff, Nebraska.

[NAVD 88, North American Vertical Datum of 1988]

Stage of water-surface profile, in feet[1]	Water-surface elevation, in feet above NAVD 88	Estimated discharge at indicated location, in cubic feet per second, at upstream end of study reach
9.00	3,872.32	2,760
10.00	3,873.32	3,860
11.00	3,874.32	5,160
12.00	3,875.32	6,660
13.00	3,876.32	[2]8,370
14.00	3,877.32	[2]9,420
15.00	3,878.32	[2]12,200
16.00	3,879.32	[2]16,100
17.00	3,880.32	[2]20,800
18.00	3,881.32	[2]25,300

[1]Stage is referenced to the gage datum of the U.S. Geological Survey streamgage, North Platte River at Scottsbluff, Nebraska (station 06680500).

[2]Discharge for the stage of the water-surface profile was determined using the calibrated model to extend the stage-discharge rating at U.S. Geological Survey streamgage, North Platte River at Scottsbluff, Nebraska (station number 06680500).

Table 4. Calibration of hydraulic model to target water-surface elevations at the U.S. Geological Survey streamgage on North Platte River at Scottsbluff, Nebraska (station number 06680500).

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

Stage of water-surface profile (ft)	Target water-surface elevation (ft, NAVD 88)	Modeled water-surface elevation (ft, NAVD 88)	Difference in elevation (ft)
9.00	3,872.32	3,872.00	–0.32
10.00	3,873.32	3,873.22	–0.10
11.00	3,874.32	3,874.35	0.03
12.00	3,875.32	3,875.49	0.17
13.00	3,876.32	3,876.65	0.33

Development of Water-Surface Profiles

The calibrated hydraulic model was used to generate water-surface profiles for a total of 10 stages at 1-ft intervals between 9 ft and 18 ft as referenced to the local datum of the North Platte River at Scottsbluff, Nebr., streamgage. These stages correspond to elevations of 3,872.32 ft and 3,881.32 ft, North American Vertical Datum of 1988, respectively. Discharges corresponding to the various stages were obtained from the current stage-discharge rating for the North Platte River at Scottsbluff, Nebr., streamgage (table 3).

Development of Flood-Inundation Maps

Flood-inundation maps for the 8.8-mi reach of the North Platte River at Scottsbluff, Nebr., were created in a GIS by combining the water-surface profiles and DEM data. The DEM data were derived from the same lidar data described previously in the "Topographic and Bathymetric Data" section and, therefore, have an estimated vertical accuracy of 2 ft (that is, plus or minus 1 ft). Estimated flood-inundation boundaries for each simulated water-surface profile were developed with USACE Hydrologic Engineering Centers Geospatial River Analysis System software (Ackerman, 2012), which prepares input geometric data for import into HEC–RAS and processes simulation results exported from HEC–RAS (Brunner, 2016a, b). Shapefile polygons and depth grids of the inundated areas for each profile were modified, as required, in the ArcMap application of ArcGIS (Esri, 2018) to ensure a hydraulically reasonable transition of the flood boundaries between simulated cross sections.

Any inundated areas that were detached from the main channel were examined to identify subsurface connections with the main river, such as through culverts under roadways. Where such connections existed, the mapped inundated areas were retained in their respective flood maps; otherwise, the erroneously delineated parts of the flood extent were deleted. The flood-inundation areas are overlaid on high-resolution, georeferenced, aerial photographs of the study area. Bridge surfaces are shown as noninundated up to the lowest flood stage that intersects the lowest structural chord of the bridge. In these latter circumstances, the bridge surface is depicted as being inundated. Estimates of water depth can be obtained from the depth-grid data that are included with the presentation of the flood maps on an interactive USGS mapping application described in the following section, "Flood-Inundation Map Delivery." The flood map corresponding to the highest simulated water-surface profile, a stage of 18 ft, is presented in figure 2.

Flood-Inundation Map Delivery

The current study documentation is available online at the U.S. Geological Survey Publications Warehouse (https://doi.org/10.3133/sir20195099). Also, a Flood Inundation Mapping Science website (https://water.usgs.gov/osw/flood_inundation) (USGS, 2018b) has been established to make USGS flood-inundation study information available to the public. That site links to a mapping application that presents map libraries and provides detailed information on flood extents and depths for sites included in the model. The mapping application enables the production of customized flood-inundation maps from the map library for the North Platte River at Scottsbluff, Nebr. A link on this website connects to the USGS National Water Information System (USGS, 2018a), which presents the current stage and streamflow at the USGS streamgage 06680500 to which the inundation maps are referenced. The estimated flood-inundation maps are displayed in sufficient detail so that preparations for flooding and decisions for emergency response can be performed efficiently. Depending on the flood magnitude, roadways are shown as shaded (inundated and likely impassable) or not shaded (dry and passable) to facilitate emergency planning and use. Bridge surfaces are shown as noninundated up to the lowest flood stage that intersects the lowest structural chord of the bridge. A shaded building should not be interpreted to mean that the structure is completely submerged, rather that bare earth surfaces in the vicinity of the building are inundated. In these instances, the water depth (as indicated in the mapping application by holding the cursor over an inundated area) near the building would be an estimate of the water level inside the structure, unless flood-proofing measures had been implemented.

Disclaimer for Flood-Inundation Maps

The flood-inundation maps 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.

Uncertainties and Limitations Regarding Use of Flood-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 on the basis of water stages and streamflows at selected USGS streamgages. Water-surface elevations along the stream reaches were estimated by steady-state hydraulic modeling, assuming unobstructed flow, and using streamflows and hydrologic conditions anticipated at the USGS streamgage(s). The hydraulic model reflects the land-cover characteristics and any bridge, dam,

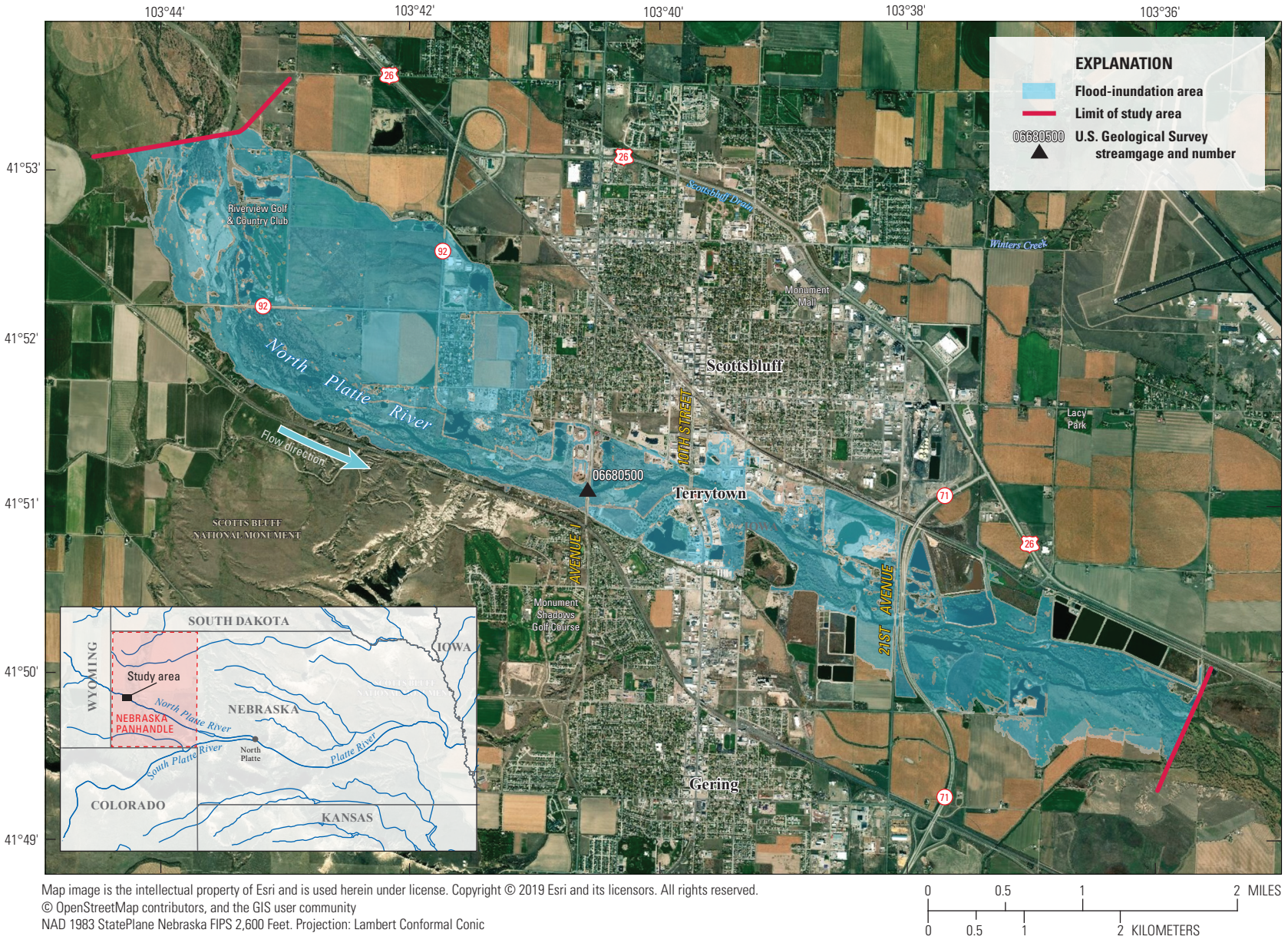


Figure 2. Flood-inundation map corresponding to a stage of 18.00 feet at the North Platte River at Scottsbluff, Nebraska, streamgage (station number 06680500).

levee, or other hydraulic structures existing as of October 2018. Unique meteorological factors (timing and distribution of precipitation) may cause actual streamflows along the model reach to vary from those assumed during a flood, which may 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 major 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.

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 and snowmelt, (2) simulate the movement of floodwater as it proceeds downstream, and (3) predict the flow and stage (and water-surface elevation) for the stream at a given location (Advanced Hydrologic Prediction Service forecast point) throughout the forecast period (every 6 hours and 3 to 5 days out in many locations). For more information on Advanced Hydrologic Prediction Service forecasts, please see: https://water.weather.gov/ahps/pcpn_and_river_forecasting.pdf. Additional uncertainties and limitations pertinent to this study may be described elsewhere in this report.

Summary

A series of 10 digital flood-inundation maps were developed by the U.S. Geological Survey in cooperation with the Cities of Scottsbluff and Gering for the North Platte River at Scottsbluff, Nebraska. The maps cover a reach about 8.8 miles long, extending 1.5 miles upstream from the Highway 92 bridge to 2 miles downstream from the Highway 71 bridge. The maps were developed using the U.S. Army Corps of Engineers Hydrologic Engineering Centers River Analysis System and Hydrologic Engineering Centers Geospatial River Analysis System programs to compute water-surface profiles and to delineate estimated flood-inundation areas and depths of flooding for selected stream stages. The Hydrologic Engineering Centers River Analysis System hydraulic one-dimensional step-backwater model was calibrated to the current stage-discharge relation at the North Platte River at Scottsbluff, Nebr., streamgage. The model was used to compute 10 water-surface profiles for flood stages at 1-foot (ft) intervals referenced to the streamgage datum and ranging from 9 ft, or near bankfull, to 18 ft, which exceeds the stage that corresponds to the estimated 1-percent annual exceedance probability flood (100-year recurrence interval flood). The simulated water-surface profiles were then combined with a geographic information system digital elevation model derived from light detection and ranging data having a 0.6-ft root mean square error and 2-ft horizontal resolution resampled to a 6-ft grid to delineate estimated flood-inundation areas as shapefile polygons and depth grids for each profile. These flood-inundation polygons were overlaid on high-resolution, georeferenced aerial photographs of the study area. The flood maps are available through a mapping application that can be accessed on the U.S. Geological Survey Flood Inundation Mapping Science website (https://water.usgs.gov/osw/flood_inundation).

Interactive use of the maps on this mapping application can give users a general indication of depth of water at any point by using the mouse cursor to click within the shaded areas. These maps, in conjunction with the real-time stage data from the U.S. Geological Survey streamgage, North Platte River at Scottsbluff, Nebr. (station number 06680500), will help to guide the general public in taking individual safety precautions and will provide emergency management personnel with a tool to efficiently manage emergency flood operations and postflood recovery efforts.

References Cited

Ackerman, C.T., 2012, HEC–GeoRAS, GIS tools for support of HEC–RAS using ArcGIS 10—User's manual (ver. 10): Davis, Calif., U.S. Army Corps of Engineers, 242 p.

Barnes, H.H., Jr., 1967, Roughness characteristics of natural channels: U.S. Geological Survey Water-Supply Paper 1849, 219 p.

Boohar, J.A., and Provaznik, M.K., 1996, Peak flows for the period of record for current and discontinued streamflow stations in Nebraska: U.S. Geological Survey Open-File Report 96–101, 518 p., https://doi.org/10.3133/ofr96101.

Brunner, G.W., 2016a, HEC–RAS river analysis system—Hydraulic reference manual (ver. 5.0, February 2016): Davis, Calif., U.S. Army Corps of Engineers, 446 p.

Brunner, G.W., 2016b, HEC–RAS river analysis system—User's manual (ver. 5.0, February 2016): Davis, Calif., U.S. Army Corps of Engineers, 960 p.

Dewberry, 2012, National Enhanced Elevation Assessment: Fairfax, Va., 84 p., accessed July 9, 2019, at http://www.dewberry.com/services/geospatial/national-enhanced-elevation-assessment.

Esri, 2018, About ArcGIS (version 10.5): accessed October 4, 2018, at https://www.esri.com/software/arcgis/.

Federal Emergency Management Agency [FEMA], 1978, Flood insurance study, city of Scottsbluff, Scotts Bluff County, Nebraska: Washington D.C., 19 p., 4 pl.

National Weather Service, 2017, Advanced Hydrologic Prediction Service, North Platte River at Scottsbluff: National Oceanic and Atmospheric Administration web page, accessed June 20, 2017, at https://water.weather.gov/ahps2/hydrograph.php?wfo=iwx&gage=SBRN1.

Strauch, K.R., 2019, Flood-inundation geospatial datasets for the North Platte River at Scottsbluff and Gering, Nebraska: U.S. Geological Survey data release, https://doi.org/10.5066/P9NCAIKN.

U.S. Army Corps of Engineers [USACE], Omaha District Flood Risk and Floodplain Management Section, 2018, Scottsbluff Nonstructural Mitigation Identification and Development Decision Support Hydraulics Report, 34 p.

U.S. Army Corps of Engineers [USACE], Omaha District in Association with Nebraska Silver Jackets, 2013, Regulated flood frequency analysis for the North Platte River at North Platte, NE: Project completion report, 159 p., accessed October 4, 2018, at https://floods.nebraska.gov/Library/13_North%20Platte%20Final%20Report.pdf.

U.S. Census Bureau, 2010, 2010 Census interactive population search, NE–Nebraska: U.S. Census Bureau web page, accessed October 4, 2018, at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

U.S. Geological Survey [USGS], 2018a, USGS 06680500 North Platte River at Scottsbluff, Nebr., *in* USGS water data for the Nation: U.S. Geological Survey National Water Information System database, accessed September 20, 2018, at https://doi.org/10.5066/F7P55KJN. [Site information directly accessible at https://waterdata.usgs.gov/nwis/inventory/?site_no=06680500&agency_cd=USGS&amp.]

U.S. Geological Survey [USGS], 2018b, USGS Flood Inundation Mapping (FIM) Program: U.S. Geological Survey Water Resources web page, accessed October 3, 2018, at https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program?qt-science_center_objects=0#qt-science_center_objects.

For more information about this publication, contact:
Director,
USGS Nebraska Water Science Center
5231 South 19th Street
Lincoln, NE 68512
402–328–4100

For additional information, visit:
https://www.usgs.gov/centers/ne-water

Publishing support provided by the
Madison and Rolla Publishing Service Centers

Back cover, top. North Platte River at Scottsbluff, Nebraska, near the Tri-State Diversion Reservoir. Photograph taken by Dennis Strauch, June 1, 2016.

Back cover, center. North Platte River at Scottsbluff, Nebraska (U.S. Geological Survey station number 06680500), downstream from bridge at a gage height of 6.17 feet gage datum. Photograph taken by Nebraska Department of Natural Resources, September 9, 2015.

Back cover, bottom. North Platte River at Scottsbluff, Nebraska (U.S. Geological Survey station number 06680500), downstream from bridge at a gage height of 12.41 feet gage datum. Photograph taken by Dennis Strauch, June 1, 2016.

ISSN 2328-0328 (online)
https://doi.org/10.3133/sir20195099