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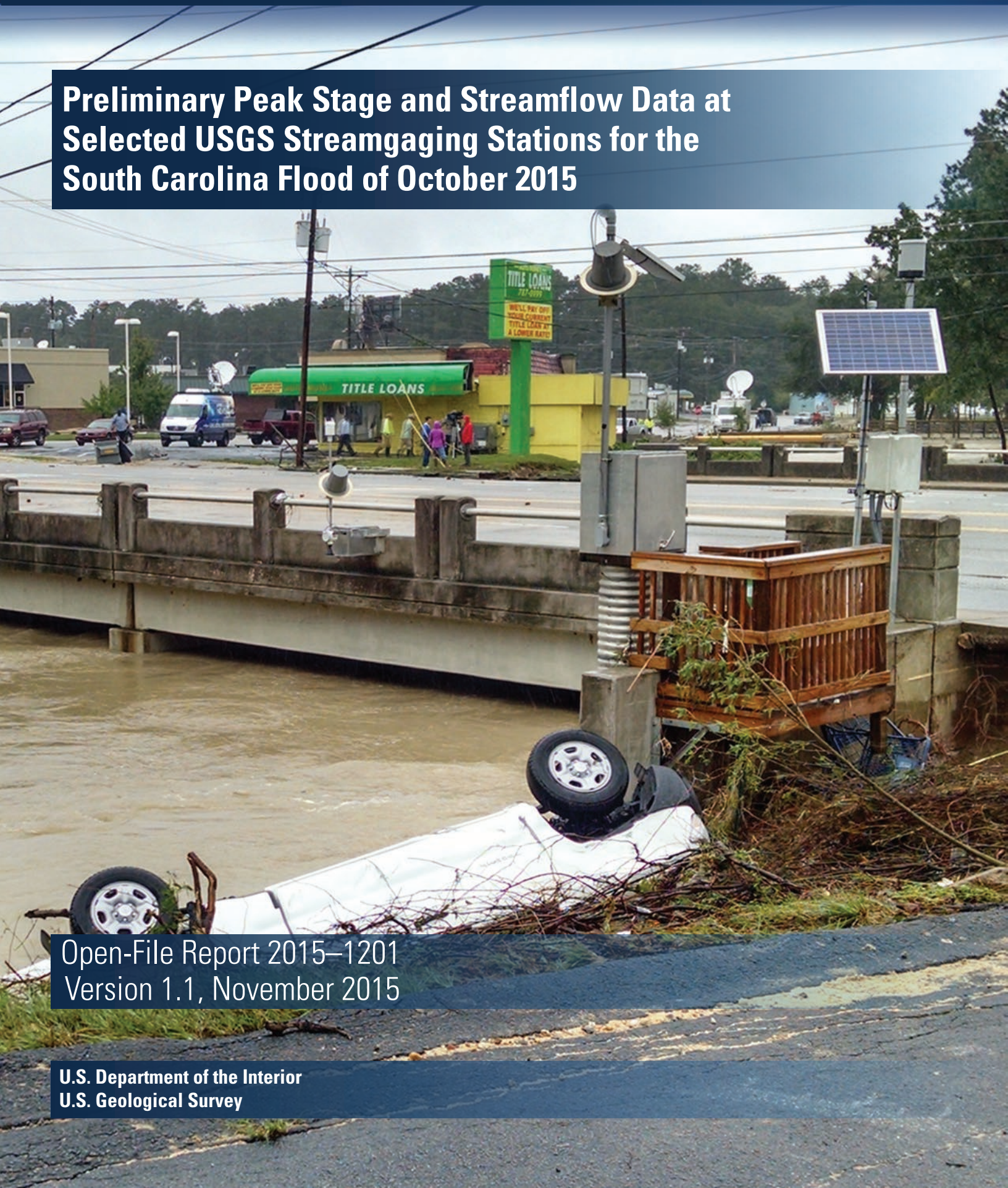
Preliminary Peak Stage and Streamflow Data at Selected USGS Streamgaging Stations for the South Carolina Flood of October 2015



Open-File Report 2015–1201
Version 1.1, November 2015

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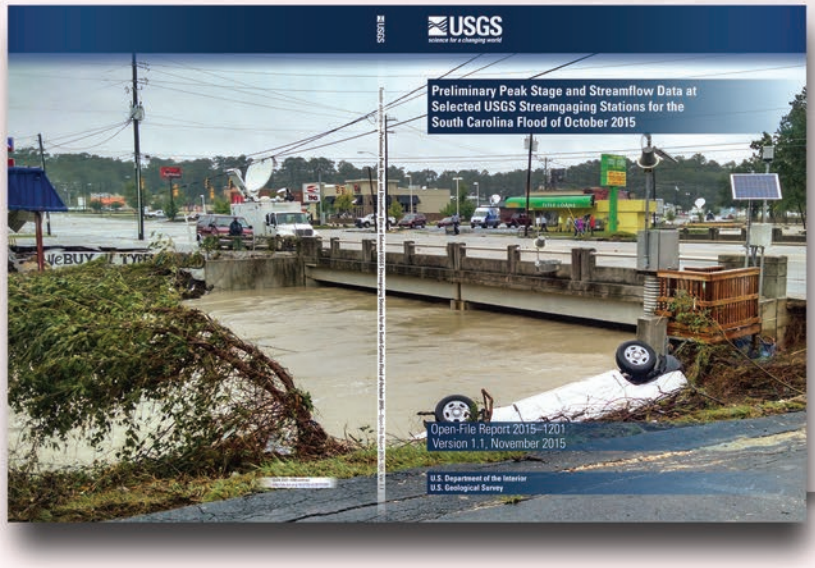

Cover: Left bank looking upstream toward U.S. Geological Survey station 02169570, Gills Creek at Columbia, S.C. Streamgaging station is located on the downstream side of the bridge on U.S. Highways 378 and 76 (Devine St.).

Photograph: Dale F. Skipper, U.S. Geological Survey, October 5, 2015

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U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Preliminary Peak Stage and Streamflow Data at Selected USGS Streamgaging Stations for the South Carolina Flood of October 2015

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Abstract

Heavy rainfall occurred across South Carolina during October 1–5, 2015, as a result of an upper atmospheric low-pressure system that funneled tropical moisture from Hurricane Joaquin into the State. The storm caused major flooding from the central to the coastal areas of South Carolina. Almost 27 inches of rain fell near Mount Pleasant in Charleston County during this period. U.S. Geological Survey streamgages recorded peaks of record at 17 locations, and 15 other locations had peaks that ranked in the top 5 for the period of record. During the October 2015 flood event, U.S. Geological Survey personnel made about 140 streamflow measurements at 86 locations to verify, update, or extend existing rating curves, which are used to compute streamflow from monitored river stage.

Introduction

The presence of an upper atmospheric low-pressure system over the Southeast funneled tropical moisture from Hurricane Joaquin into South Carolina during the period October 1–5, 2015, causing historic rainfall amounts (http://www.weather.com/news/news/stunning-meteorological-images-october-2015-flooding, accessed October 8, 2015) (fig. 1). Widespread, heavy rainfall resulted in major flooding in areas from the central part of the State (fig. 2) to the coast (fig. 3). Some areas experienced more than 20 inches of rainfall over the period October 1–5, 2015 (fig. 4; National Weather Service, written commun., October 7, 2015). One USGS raingage at Black River at Kingstree, South Carolina (USGS station 02136000), recorded 22.89 inches of rain for the period October 1–5, 2015 (fig. 5). Flooding from

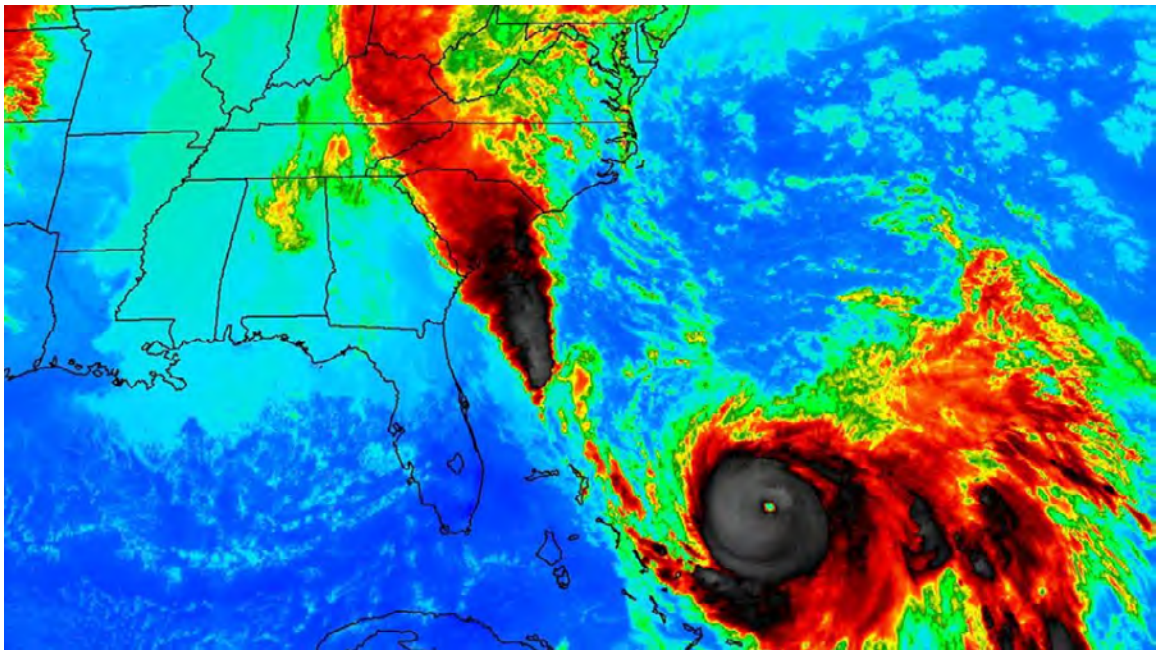

Figure 1. Infrared satellite image of the intense rainfall being funneled into South Carolina during the morning of October 3, 2015. (NASA)

Figure 2. Aerial photograph of flooding in Columbia, South Carolina, at the confluence of the Broad and Saluda Rivers, looking upstream. (Photograph by the South Carolina Army National Guard, October 5, 2015)

Figure 3. Aerial photograph of flooding in Charleston, South Carolina, and surrounding areas, October 5, 2015. (Photograph by Petty Officer 1st Class Stephen Lehmann, U.S. Coast Guard)

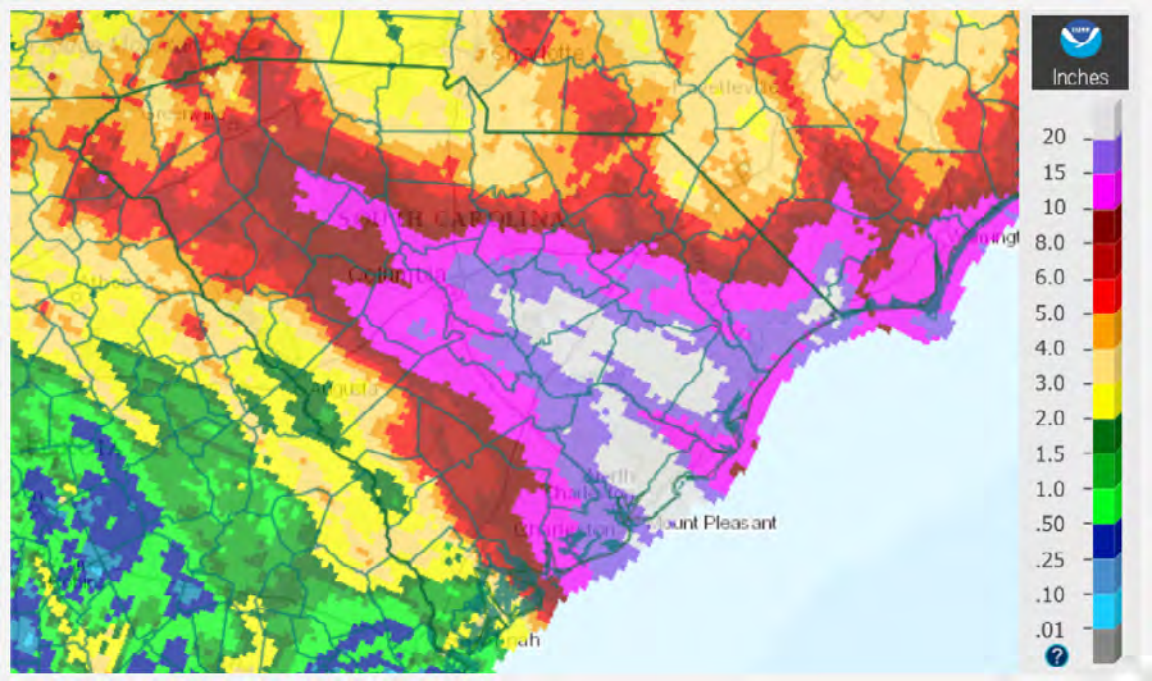

Figure 4. Preliminary National Weather Service rainfall totals for October 1–5, 2015. (National Weather Service)

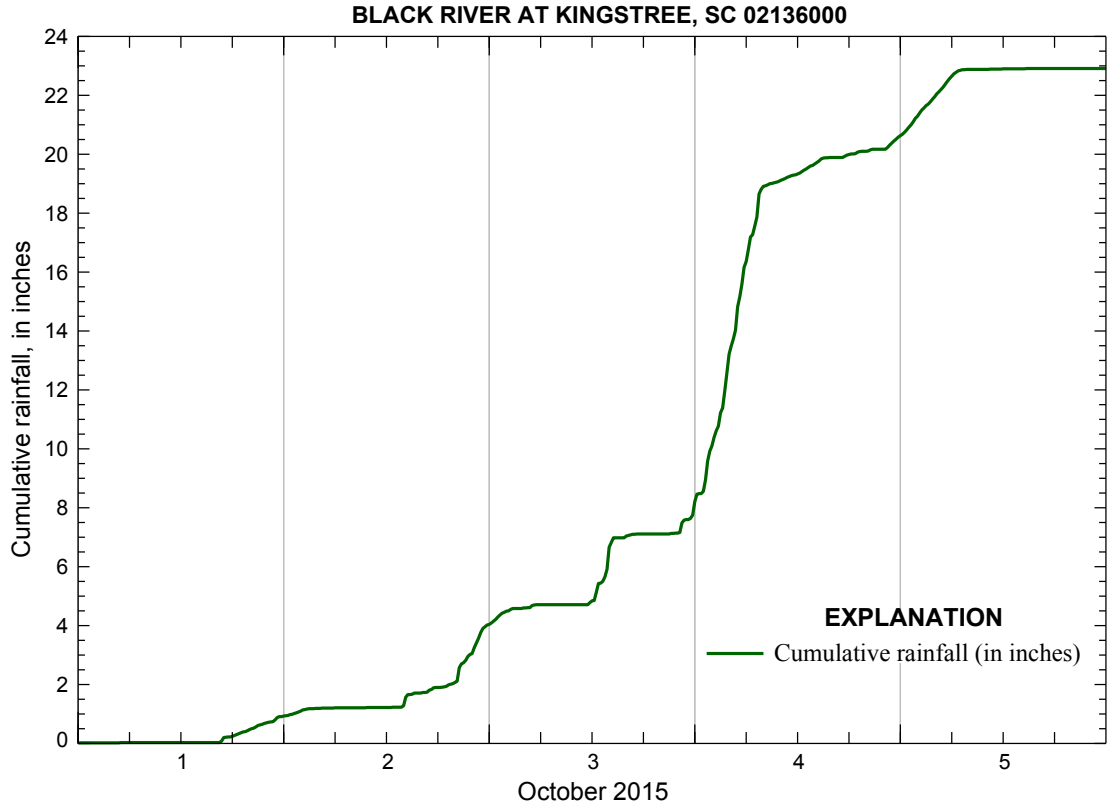

Figure 5. Black River at Kingstree, South Carolina (U.S. Geological Survey station 02136000), cumulative total rainfall for October 1–5, 2015.

this event resulted in at least 17 fatalities (http://www.reuters.com/article/2015/10/07/us-usa-weather-floods-idUSKCN0S11E720151007, accessed October 8, 2015). South Carolina officials have been quoted in media outlets as saying agricultural losses could conservatively be at least $300 million, with cleanup costs across the State that could top $1 billion (http://www.latimes.com/nation/la-na-south-carolina-postcards-20151008-htmlstory.html, accessed October 9, 2015).

The U.S. Geological Survey (USGS) collects and disseminates streamflow data at more than 9,800 streamgages nationwide. In South Carolina, the USGS operates about 170 real-time streamgages, in cooperation with numerous local, State, and Federal agencies, monitoring gage height, streamflow, reservoir elevations, and tidal flow (fig. 6; http://waterdata.usgs.gov/sc/nwis/current/?type=flow). Streamflow data collection serves a variety of purposes including providing information for flood forecasts and documenting flood extent and levels. Leading up to and during flooding, streamflow data are vital for flood warning, forecasting, and emergency management. The long-term, systematic streamflow data are used to assess risk and to mitigate flooding through flood-plain management and in the design or repair of infrastructure (for example, roads, bridges, reservoirs, and pipelines), houses, and buildings.

Purpose and Scope

The purpose of this report is to provide preliminary information documenting the peak streamflows and stages for those rivers and streams in South Carolina that are part of the USGS real-time streamgaging network impacted by the historic rainfall that occurred October 1–5, 2015. The 2015 flood peak flows are placed into context by ranking the October 2015 flood peaks with other annual flood peaks for the period of record at each streamgage as well as historic floods that might precede USGS systematic records. National Weather Service (NWS) flood stage information is also provided for sites where a NWS flood stage has been defined (table 1, at the back of the report).

Study Area

South Carolina is located on the South Atlantic slope adjacent to the Atlantic Ocean, has an area of 31,055 square miles, and is generally divided into three major physiographic provinces: Blue Ridge, Piedmont, and Coastal Plain (Cooke, 1936). The Blue Ridge is a mountainous region of steep terrain with some stream gradients greater than 250 feet (ft) per mile (Bloxham, 1979). Land-surface elevation ranges from 1,000 to more than 3,500 ft above sea level.

The Piedmont is characterized by rolling hills, elongated ridges, and moderately deep to shallow valleys. Piedmont land-surface elevations range from about 1,000 ft above sea level at the Blue Ridge foothills to about 400 ft above sea level at the Fall Line, which is the name given to the boundary between the Piedmont and Coastal Plain regions.

About two-thirds of the State is in the Coastal Plain region (Badr and others, 2004). In the Coastal Plain, bedrock is overlain by sediments, which thicken from just a few feet near the Fall Line to about 3,800 feet at the southernmost corner of the State. At the Fall Line, a narrow, hilly region, known as the Sand Hills, is located where the Piedmont descends to the Coastal Plain (National Oceanic and Atmospheric Administration, 2015). The Sand Hills region is about 30 to 40 miles wide with elevations ranging from about 500 to 200 feet. The lower part of the Coastal Plain consists of low-elevation, flat plains with many swamps, marshes, dunes, barrier islands, and beaches, which typically are lower, flatter, and more poorly drained than the upper part of the Coastal Plain (Omernik, 1987).

In South Carolina, precipitation is principally delivered by storms that move inward from the Gulf of Mexico, the Caribbean Sea, and the Atlantic Ocean (U.S. Geological Survey, 1985). Additionally, local and upwind land surfaces, as well as lakes and reservoirs, provide moisture to the atmosphere by evaporation. In a normal year, monthly precipitation is highest in the winter, reaching a maximum in early March and then decreasing sharply in April and May. Annual rainfall in South Carolina averages as much as 80 inches in the highest elevations of the Blue Ridge to less than 45 inches in parts of the upper portion of the Coastal Plain and Sand Hills regions (National Oceanic and Atmospheric Administration, 2015). In general, the Blue Ridge region receives an average of about 56 inches or more of annual rainfall, the upper portion of the Piedmont about 47 to 55 inches, the lower portion of the Piedmont about 45 to 48 inches, the upper portion of the Coastal Plain about 44 to 49 inches, and the lower portion of the Coastal Plain about 46 to 53 inches. Fall is typically a dry season (except in instances when tropical cyclones occur) with minimal statewide precipitation during October and November.

General Weather Conditions and Precipitation That Contributed to the October 2015 Flooding

The combination of a slow-moving, upper-level low over the Southeastern United States, an area of low pressure at the surface located along a stationary frontal boundary, and a persistent plume of tropical moisture associated with Hurricane Joaquin (fig. 1) produced historic rainfall over portions of South Carolina during the period October 1–5, 2015 (L. Vaughn, National Oceanic and Atmospheric Administration, written commun., October 8, 2015). This system caused significant widespread freshwater flooding throughout the State. Preliminary data show the highest rainfall total of 26.9 inches near Mount Pleasant, S.C. (Charleston County) (fig. 4). Preliminary data also show the Charleston Airport rainfall totals set new records for the

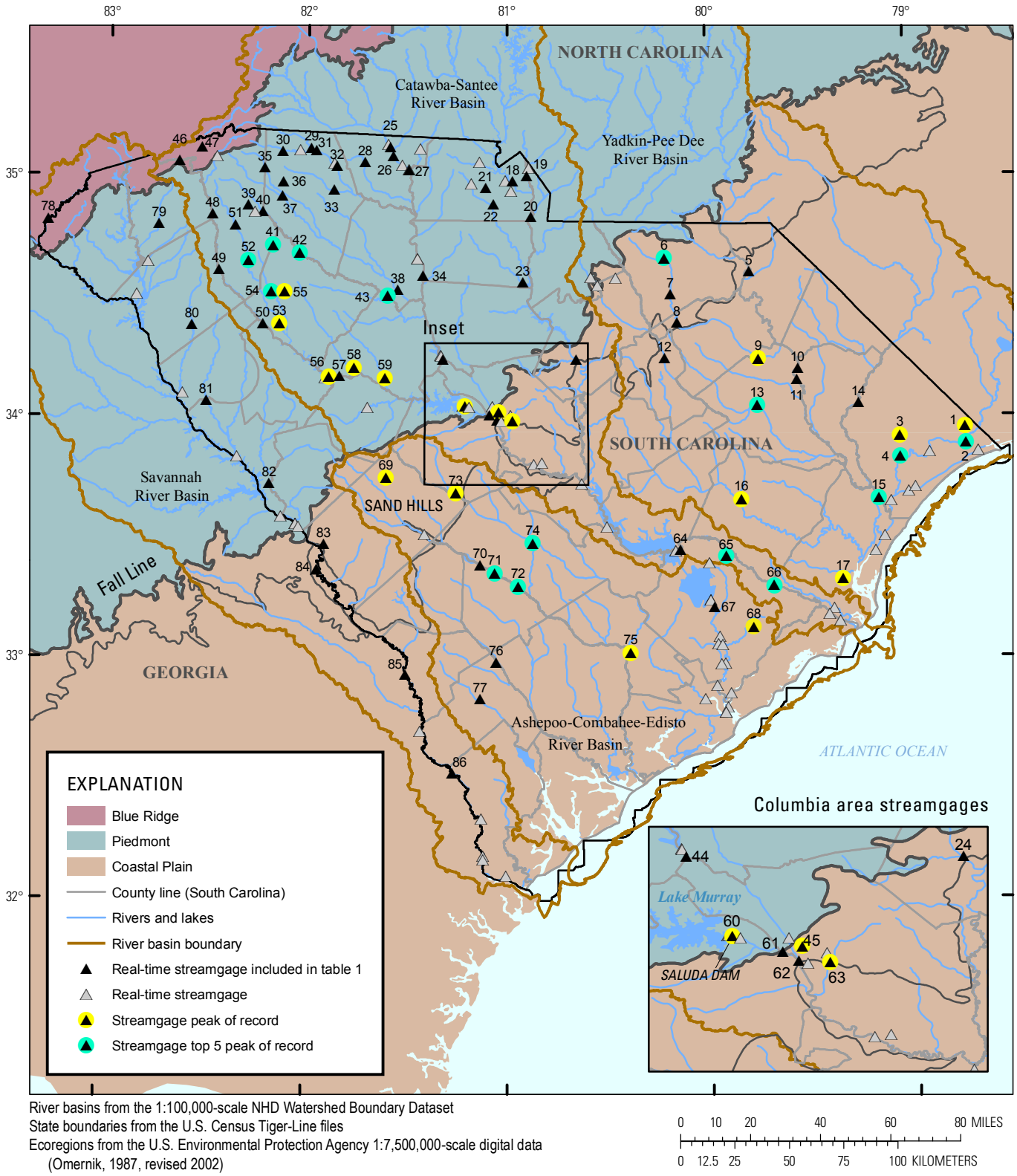

Figure 6. USGS real-time streamgages in South Carolina.

greatest 1-, 2-, 3-, and 4-day totals of 11.50, 14.31, 15.92, and 17.29 inches, respectively (National Weather Service, written commun., October 5, 2015). The previous record totals were 10.52 inches on September 21, 1998; 11.10 inches on June 10–11, 1973; 11.95 inches on June 9–11, 1973; and 16.56 inches on June 7–11, 1973. The downtown Charleston rainfall for October 3, 2015, was the third highest 1-day total rainfall of 9.25 inches with the highest 1-day total rainfall of 10.38 inches occurring on June 11, 1973; October 3–4, 2015, was tied for the highest 2-day total rainfall of 11.74 inches, which occurred on June 10–11, 1973; October 1–3, 2015, set a new record for the greatest 3-day total rainfall of 13.80 inches with the previous high being 12.39 inches on June 9–11, 1973; and October 1–4, 2015, set a record for the greatest 4-day total rainfall of 16.29 inches with the previous high being 13.80 inches on June 7–11, 1973. The Columbia Metropolitan Airport rainfall on October 4, 2015, set a new record for the greatest 1-day rainfall of 6.71 inches, breaking the previous record of 5.79 inches set on July 9, 1959. In addition, the October 3–4, 2015, rainfall set a new record for the greatest 2-day rainfall at the airport of 10.28 inches, breaking the previous record of 7.69 inches on August 16–17, 1949, (http://www.weather.gov/cae/HistoricFloodingOct2015.html, accessed October 13, 2015). The historic rainfall also resulted in moderate to major river flooding at selected NWS river forecast points across South Carolina. At least 20 NWS river forecast locations exceeded established NWS flood stages (table 1).

The impacts of this event were widespread across South Carolina. Approximately 410 roads or bridges were closed during the event including 74 miles of I-95 between I-26 and I-20 (U.S. Department of Interior Office of Emergency Management, written commun., October 8, 2015). At least 17 minor dam failures resulted from the rainfall event. Some major reservoirs, such as the Saluda Dam at Lake Murray, initiated flood control releases. South Carolina emergency management officials reported that more than 200 water rescues were conducted. In addition to flooding, saturated soils along with moderate to strong east/northeasterly winds contributed to the downing of trees and power lines across portions of South Carolina. As a result, about 50,000 residents lost power during the storm as of Monday, October 5, 2015 (L. Vaughn, National Oceanic and Atmospheric Administration, written commun., October 8, 2015).

Methods Used to Collect Streamflow Data

In this report, streamflow data refer to both stage or gage height (in feet) and volumetric streamflow (in cubic feet per second). These data were collected systematically at continuous record streamgages or from field measurements of stage in cases where the gage structure or equipment was damaged by flood waters.

U.S. Geological Survey streamgages operate autonomously by collecting data at regular time intervals (typically either 5 or 15 minutes) depending on watershed size and flashiness of the stream. Typically, streamgages automatically record stage data. The stage data are collected using a variety of methods (float, submersible pressure transducer, non-submersible pressure transducer, or non-contact radar). More information about how USGS streamgages work is available in Lurry (2011). Although stage data are important, streamflow data are often more important for such purposes as streamflow forecasting for flood warning, water-quality loading, flood-frequency analysis, and flood-mitigation planning. Computation of streamflow at a streamgage requires periodic measurements of streamflow over a range of stage. The relation defined between stage and measured streamflow is used to convert the stage data to streamflow. USGS personnel (fig. 7) measure stream velocity and stream depth onsite to determine near-instantaneous streamflow (Turnipseed and Sauer, 2010).

In most cases, the correlation is a simple stage-streamflow relation or rating curve. After construction of the rating curve, continued periodic measurements of streamflow are required at various stages to verify or support changes to a station rating curve. (fig. 8). During the October 2015 flood, USGS personnel made about 140 streamflow measurements at 86 locations in South Carolina to verify, update, or extend existing rating curves.

In some cases, direct measurements of streamflow during a flood are not possible or are impractical. In those instances, indirect measurement methods can be used (Benson and Dalrymple, 1967), whereby water-surface profiles determined by high-water marks and channel roughness and geometry are used in hydraulic equations based on the principles of conservation of energy, conservation of momentum, and continuity to compute the peak streamflow for that particular flood. The high-water marks and channel geometry are determined by

Figure 7. U.S. Geological Survey personnel making a streamflow measurement at station 02110701, Crabtree Swamp at Conway, South Carolina, using an acoustic Doppler current profiler.

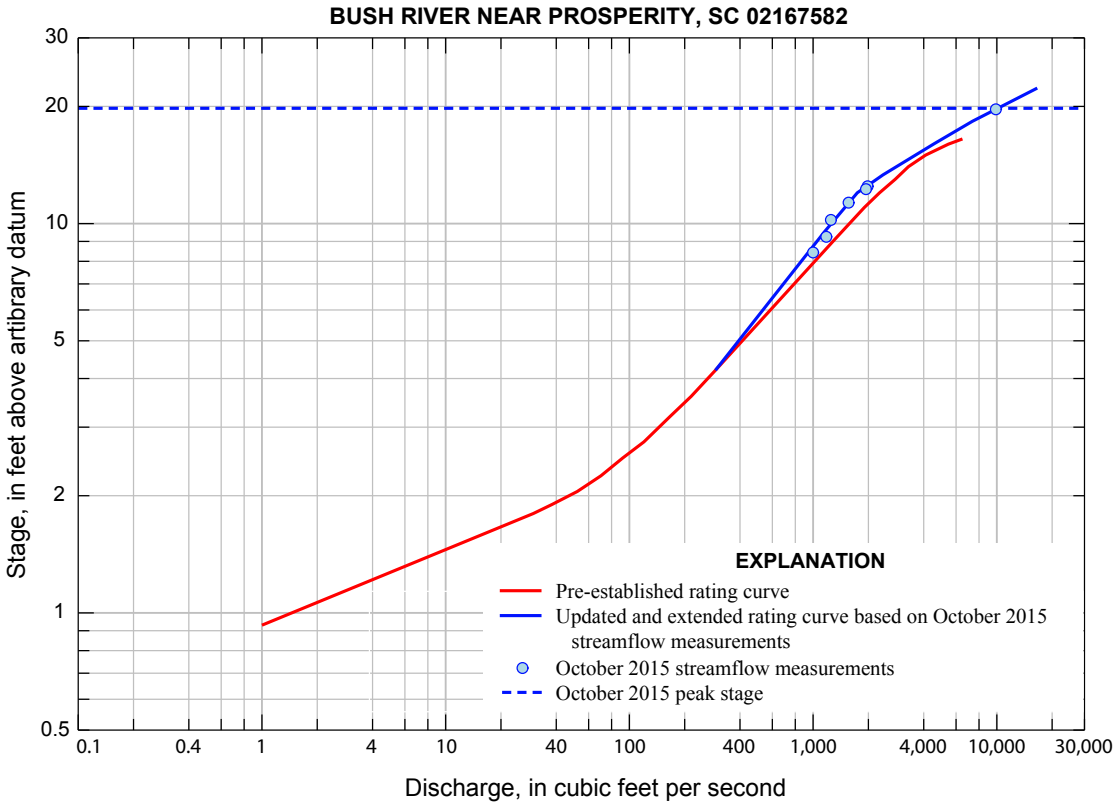

Figure 8. Rating curves developed for use before (red) and after (blue) the October 2015 flood for Bush River near Prosperity, South Carolina (U.S. Geological Survey station 02167582), showing streamflow measurements made during the event.

field survey. Roughness is subjectively determined on the basis of bed material, cross-section irregularities, depth of flow, vegetation, and channel alignment. The USGS assigns uncertainty/accuracy estimates to each indirect measurement on the basis of the hydraulic and geometry conditions found at each field site (Benson and Dalrymple, 1967; Dalrymple and others, 1967; Hulsing, 1967; Matthai, 1967; Bodhaine, 1968). In other cases, high-water marks are documented for the purpose of recording the depth of the flood waters (fig. 9).

Figure 9. U.S. Geological Survey field crews conducting surveys of high-water marks to document the depth of flood waters in Lexington County, South Carolina, for the October 2015 flood.

Peak Streamflow and Stage

Peak streamflow and stage during the October 2015 flood for 86 streamgages are listed in table 1 (at the back of the report), and their site locations are shown in figure 6. The streamgages included in table 1 were chosen because (1) both peak stage and peak streamflow for the October 2015 flood event were monitored at the site, and (2) historic streamflow and (or) stage data were available for comparison. Where the full period of record of peak streamflow is available, comparisons were made on peak streamflow. However, at some sites the peak stage for this event may be lower than a previous peak stage due to backwater conditions, datum changes, or change in the upper end of the rating curve.

The rank for the 2015 peak streamflow at selected streamgages for the period of record is presented in table 1. If for the previous maximum stage the maximum streamflow was undetermined, the rank was based on the peak stage comparison from the flood of October 2015 instead of the peak streamflow and is indicated as such in the Remarks column of table 1. Seventeen of the 86 streamgages had new peaks of record. Of the 61 stations with at least 20 years of record, eight had new peaks of record: 02136000, Black River at Kingstree (87 years) (fig. 10); 02136361, Turkey Creek near Maryville (21 years); 02162093, Smith Branch at North Main Street at Columbia (38 years); 02167450, Little River near Silverstreet (24 years); 02167582, Bush River near Prosperity (24 years); 02168504, Saluda River below Lake Murray Dam near Columbia (26 years); 02169570, Gills Creek at Columbia (50 years); and 02175000, Edisto River near Givhans (81 years).

Along with the 17 streamgages that had new peaks of record, an additional 15 streamgages recorded new peaks that ranked in the top 5 for the period of record. For stations with at least 20 years of record, 13 recorded peaks ranked in the top 5 for the period of record.

Comparison of the October 2015 Flood to Past Floods

In the Pee Dee River Basin, a new period of record peak occurred on October 6, 2015, for station 02136000, Black River at Kingstree, with a stage of 22.65 ft and corresponding streamflow of 83,700 cubic feet per second (ft^3/s) (fig. 10). This was the largest peak in 87 years; the previous maximum peak occurred on June 14, 1973. Annual maximum peak stage data contained in reports of the National Weather Service indicate the October 2015 peak is the largest since 1893. Although not the peak of record, the peak on October 6, 2015, at station 02132000, Lynches River at Effingham, was the third largest peak for the 88 years of record; the maximum peak of record occurred on September 22, 1945. Annual maximum peak stage data contained in reports of the National

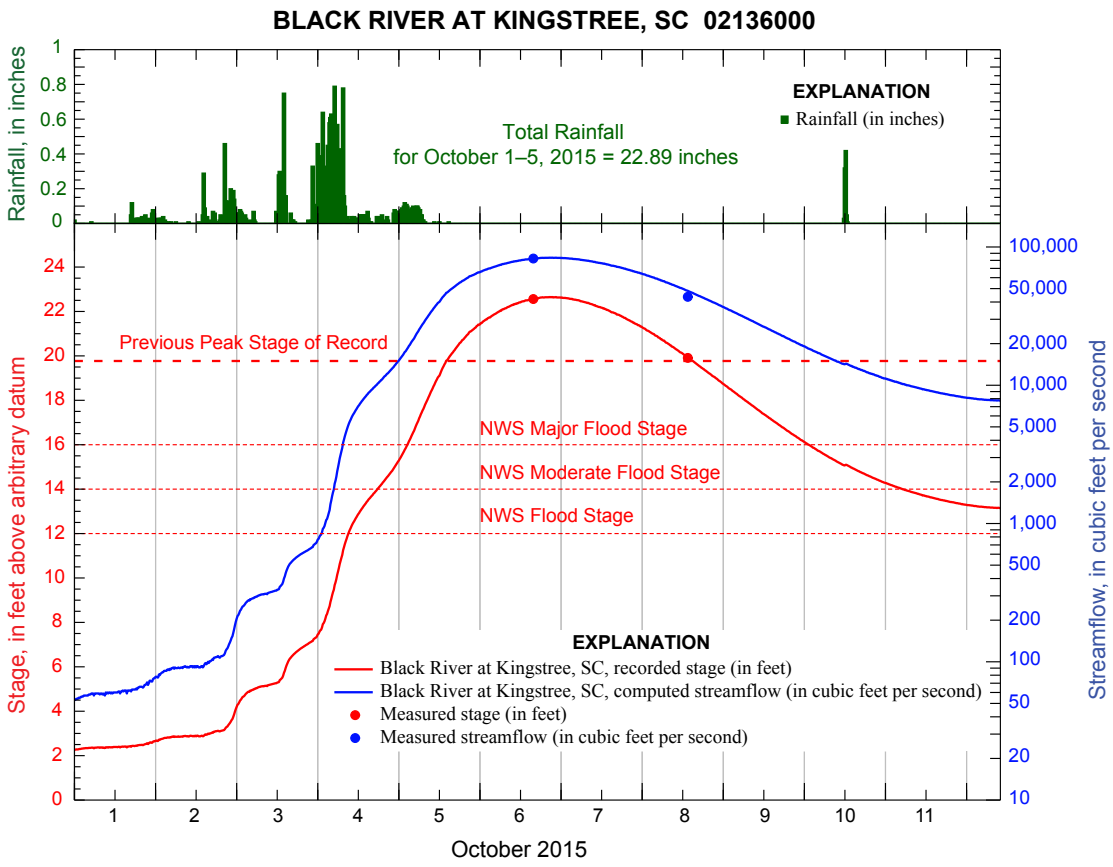

Figure 10. Black River at Kingstree, South Carolina (U.S. Geological Survey station 02136000) stage and streamflow hydrographs and associated rainfall for October 1–11, 2015.

Weather Service indicate the October 2015 peak is the third largest since 1892.

In the Waccamaw River Basin, annual peak stage and streamflow data have been collected at station 02110500, Waccamaw River near Longs, since 1951. For the 2015 flood, the peak occurred on October 6, 2015, and was the second largest peak in 64 years of record. The maximum peak of record occurred on September 22, 1999, and was associated with rainfall from the passage of Hurricane Floyd.

Station 02169500, Congaree River at Columbia, has one of the longest records of annual peak flows of the USGS streamgages in South Carolina, with systematic records of annual peak streamflow from 1892 to present. Additional information for a flood in 1852 is available; therefore, the site is of great value in placing the current flood in context to other historical floods. The Congaree River is formed by the convergence of the Saluda and Broad Rivers at Columbia, SC. The Saluda River is regulated by the Saluda Dam, which was completed in 1929 (Conrads and others, 2008). Low-head dams on the Broad River have regulated low streamflows since the late 1880s and early 1900s, but flood flows are essentially unregulated. The Broad River Basin accounts for approximately two-thirds of the drainage area for the Congaree River at Columbia station.

Conrads and others (2008) assessed the impact that the Saluda Dam has had on the flood frequency of flows on the Congaree River and concluded that the 1-percent chance flood (also referred to as the 100-year flood) is likely reduced by about 18 percent due to regulation on the Saluda River. Consequently, comparison of major floods that have occurred on the Congaree River after construction of the Saluda Dam with those prior to the construction of the Saluda Dam provides insightful information with respect to historical floods. The Congaree River at Columbia peaked at 185,000 ft^3/s at a peak stage of 31.8 ft on October 4, 2015. When compared to the historical flood record, this peak ranks eighth out of 123 years of record with the peak of record being 364,000 ft^3/s at a peak stage of 39.8 ft on August 27, 1908. The last flood to exceed the October 2015 peak at the Congaree River at Columbia site occurred on April 8, 1936, when the river peaked at 231,000 ft^3/s at a peak stage of 33.3 ft.

For a historical perspective on the floods caused by the heavy rainfall during October 1–5, 2015, a chronology of major floods in South Carolina since 1893 is presented in table 2 (at the back of the report) (U.S. Geological Survey, 1985; http://sc.water.usgs.gov/publications/pdf/SCFloodsandDroughts1893-2002.pdf; http://www.dnr.sc.gov/climate/sco/Tropics/hurricane_tracks_affecting_sc.php.)

Summary

During October 1–5, 2015, flooding on numerous streams and rivers from the central to the coastal areas of South Carolina resulted in at least 17 fatalities. South Carolina officials have been quoted in media outlets as saying agricultural losses could conservatively be at least $300 million, with cleanup costs across the State that could top $1 billion. The flooding was the result of large rainfall amounts, including nearly 27 inches of rain in Charleston County. On October 4, 2015, rainfall amounts at the Columbia Metropolitian Airport set a new record for the greatest 1-day rainfall of 6.71 inches, breaking the previous record of 5.79 inches set on July 9, 1959.

Preliminary peak streamflow and stage data, collected by the U.S. Geological Survey (USGS), are documented in this report. New peak streamflow records were set at 17 USGS streamgages, with an additional 15 USGS streamgages having October 2015 peaks that ranked them in the top 5 for the period of record. In the Pee Dee River Basin, a new peak of record was recorded on October 6, 2015, for station 02136000, Black River at Kingstree—the largest peak for the 87 years of record available. Annual maximum peak stage data contained in reports of the National Weather Service indicate the October 2015 peak is the largest since 1893. Although not the peak of record, the peak on October 6, 2015, at station 02132000, Lynches River at Effingham, was the third largest peak for the 88 years of record with the maximum peak of record occurring on September 22, 1945. Annual maximum peak stage data contained in reports of the National Weather Service indicate the October 2015 peak is the third largest since 1892. Peaks of record also were recorded near the city of Columbia at station 02162093, Smith Branch at North Main Street at Columbia, and station 02169570, Gills Creek at Columbia. During the October 2015 flood, U.S. Geological Survey personnel made about 140 streamflow measurements at 86 locations to verify, update, or extend existing rating curves.

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Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
Yadkin-Pee Dee River Basin													
1	02110400	BUCK CREEK NEAR LONGS, SC	49.4	9/1/2006	14.15	1,540	2006-2013	1/8	10/5/2015	15.75	6,120	---	
2	02110500	WACCAMAW RIVER NEAR LONGS, SC	1,110	9/22/1999	17.94	28,200	1951-2014	2/64	10/6/2015	15.17	16,900	---	
3	02110701	CRABTREE SWAMP AT CONWAY, SC	17.8	5/14/2012	13.03	1,510	2006-2014	1/9	10/4/2015	20.2	3,120	---	Tidally influenced, which is overcome by basin runoff at high flows. Previous maximum stage of 16.53 ft occurred on 7/13/2013.
4	02110704	WACCAMAW RIVER AT CONWAY MARINA AT CONWAY, SC	1,440	9/25/1999	17.64	24,100	1995-2014	3/20	10/6/2015	15.93	14,500	11.0	Tidally influenced, which is overcome by basin runoff at high flows.
5	02130561	PEE DEE RIVER NR BENNETTSVILLE, SC	7,600	4/12/2003	89.94	124,000	1992-2014	16/23	10/5/2015	84.05	46,200	---	Regulated
6	02130840	BLACK CREEK BELOW CHESTERFIELD, SC	51.7	11/23/2006	10.07	1,480	2006-2014	4/9	10/3/2015	9.13	712	14.0	
7	02130900	BLACK CREEK NEAR MCBEE, SC	108	10/12/1990	13.07	4,500	1960-2014	16/55	10/4/2015	10.24	1,030	15.0	
8	02130910	BLACK CREEK NEAR HARTSVILLE, SC	173	10/13/1990	12.35	4,450	1961-2014	15/54	10/5/2015	8.75	971	---	
9	02130980	BLACK CREEK NEAR QUINBY, SC	438	9/9/2004	16.80	6,450	2002-2014	1/13	10/4/2015	16.81	6,530	10.0	
10	02131000	PEE DEE RIVER AT PEEDEE, SC	8,830	9/22/1945	33.30	220,000	1939-2014	55/76	10/8/2015	22.81	30,100	19.0	Regulated
11	02131010	PEE DEE RIVER BELOW PEE DEE, SC	8,850	4/16/2003	33.96	99,000	1997-2014	11/18	10/9/2015	29.28	28,100	---	Regulated
12	02131500	LYNCHES RIVER NEAR BISHOPVILLE, SC	675	9/19/1945	22.35	29,400	1943-2014	38/72	10/6/2015	14.59	5,890	---	
13	02132000	LYNCHES RIVER AT EFFINGHAM, SC	1,030	9/22/1945	21.21	25,000	1908, 1928-2014	3/88	10/6/2015	19.73	17,000	14.0	Annual maximum peak stage data contained in reports of the National Weather Service indicate the October 2015 peak is the third largest since 1892.
14	02135000	LITTLE PEE DEE RIVER AT GALIVANTS FERRY, SC	2,790	10/9/1964	13.01	27,600	1942-2014	53/74	10/11/2015	9.17	8,230	9.0	

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
15	02135200	PEE DEE RIVER AT HWY 701 NEAR BUCKSPORT, SC	14,100	4/21/2003	19.54	86,800	2003-2013	3/11	10/10/2015	18.26	56,400	---	Regulated; tidally influenced
16	02136000	BLACK RIVER AT KING-STREE, SC	1,252	6/14/1973	19.77	58,000	1928-2014	1/87	10/6/2015	22.65	83,700	12.0	Annual maximum peak stage data contained in reports of the National Weather Service indicate the October 2015 peak is the largest since 1893.
17	02136361	TURKEY CREEK NEAR MARYVILLE, SC	4.25	8/27/1995	4.56	---	1994-2014	1/21	10/4/2015	5.54	516	---	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
Catawba-Santee River Basin													
18	02146000	CATAWBA RIVER NEAR ROCK HILL, SC	3,050	5/23/1901	24.15	151,000	1896-1903, 1942-2014	</81	10/3/2015	4.70	3,870	---	Regulated. Peak streamflow on 10/3/2015 was less than the minimum annual peak from period of record.
19	02146800	SUGAR CREEK NEAR FORT MILL, SC	262	8/27/2008	27.30	---	2007-2014	6/8	10/3/2015	18.74	7,660	---	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
20	02147020	CATAWBA RIVER BELOW CATAWBA, SC	3,540	4/11/2003	22.69	54,700	1993-2014	</22	10/3/2015	9.74	10,700	---	Regulated. Peak streamflow on 10/3/2015 was less than the minimum annual peak from period of record. Maximum peak stage known since June 1906, 40.4 ft on 7/16/1916 at site and datum then in use, from records furnished by the National Weather Service.
21	021473426	TOOLS FORK CREEK NEAR ROCK HILL, SC	9.60	8/26/2008	10.85	---	1999-2014	</10	10/3/2015	4.21	68	---	Peak stage on 10/3/2015 was less than the minimum annual peak from period of record. Annual peak streamflow of record was undetermined for peak stage of record.
22	021473428	WILDCAT CREEK BELOW ROCK HILL, SC	29.7	3/21/2003	18.61	---	1999-2014	</15	10/3/2015	4.58	270	9.0	Peak stage on 10/3/2015 was less than the minimum annual peak from period of record. Annual peak streamflow of record was undetermined for peak stage of record.

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
23	02147500	ROCKY CREEK AT GREAT FALLS, SC	194	8/23/1967	18.82	31,300	1952-2014	55/58	10/4/2015	7.10	2,090	---	
24	02148000	WATEREE RIVER NEAR CAMDEN, SC	5,070	7/18/1916	40.40	400,000	1905-1910, 1916, 1930-2014	31/124	10/4/2015	29.31	50,900	27.0	Regulated since 1919
25	02153200	BROAD RIVER NEAR BLACKSBURG, SC	1,290	9/8/2004	21.92	---	1998-2014	14/17	10/4/2015	8.57	9,650	16.0	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
26	02153500	BROAD RIVER NEAR GAFFNEY, SC	1,490	8/14/1940	19.78	119,000	1939-1978, 1980-1990, 2011-2014	54/58	10/4/2015	9.33	10,000	16.0	
27	02153551	BROAD RIVER BELOW NINETYNINE ISLAND RESERVOIR,SC	1,550	9/9/2004	40.43	---	1999-2014	</16	10/4/2015	29.14	10,300	45.0	Peak stage on 10/3/2015 was less than the minimum annual peak from period of record. Peak streamflow for peak stage of record was undetermined.
28	02153700	THICKETTY CREEK AT COUNTY ROAD 42 NEAR GAFFNEY, SC	25.0	8/1/2014	8.86	---	2007-2014	</8	10/3/2015	4.05	98	---	Peak stage on 10/3/2015 was less than the minimum annual peak from period of record. Peak streamflow for peak stage of record was undetermined.
29	02154500	NORTH PACOLET RIVER AT FINGERVILLE, SC	116	8/14/1940	27.13	12,500	1931-2014	61/84	10/3/2015	8.42	1,910	---	
30	02154790	SOUTH PACOLET RIVER NR CAMPOBELLO, SC	55.4	8/27/1995	11.33	5,170	1989-2014	14/26	10/3/2015	8.85	1,750	---	
31	02155500	PACOLET RIVER NEAR FINGERVILLE, SC	212	8/14/1940	22.43	22,800	1931-2014	41/83	10/3/2015	10.83	4,630	---	Flood of June 1903 reached a stage of 46 ft, from floodmark (streamflow not determined).
32	021556525	PACOLET RIVER BELOW LAKE BLALOCK NEAR COWPENS, SC	273	8/28/1995	17.10	22,900	1995-2014	12/20	10/3/2015	7.82	4,650	---	Regulated. Previous maximum peak stage of 17.10 ft also occurred on 5/23/2003.
33	02156300	LAWSONS FORK CREEK AT SPARTANBURG SC	74.7	10/12/1990	18.65	---	1967-1970, 1976-1993, 2013-2014	8/23	10/1/2015	13.76	2,980	---	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record. Only peak stage available for 1976–1993 and 2013.

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
34	02156500	BROAD RIVER NEAR CARLISLE, SC	2,790	10/10/1976	31.51	123,000	1939-2014	68/75	10/4/2015	12.20	21,800	30.0	
35	02157470	MIDDLE TYGER RIVER NEAR GRAMLING, SC	34.7	1/25/2010	11.03	3,160	2003-2014	</12	10/4/2015	9.22	492	10.5	Peak streamflow on 10/4/2015 was less than the minimum annual peak from period of record.
36	02157510	MIDDLE TYGER RIVER NEAR LYMAN, SC	69.0	7/8/2005	8.12	---	2000-2014	11/15	10/4/2015	4.24	888	24.0	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
37	02158408	SOUTH TYGER RIVER BELOW DUNCAN, SC	94.4	7/7/2005	16.68	5,360	2003-2014	9/13	10/4/2015	10.19	1,710	17.0	For previous maximum annual peak stage on 7/7/2005, the annual peak streamflow was greater than the indicated value.
38	02160105	TYGER RIVER NEAR DELTA, SC	759	10/11/1976	26.31	37,500	1974-2014	20/41	10/5/2015	16.76	9,800	---	
39	02160325	BRUSHY CREEK NEAR GREENVILLE, SC	9.05	8/27/1995	14.10	---	1986-2014	16/28	10/3/2015	8.43	982	10.0	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
40	02160326	ENOREE RIVER AT PELHAM, SC	84.2	8/27/1995	22.98	11,300	1994-2014	11/21	10/4/2015	11.02	2,490	11.0	
41	02160381	DURBIN CREEK ABOVE FOUNTAIN INN, SC	14.0	8/27/1999	14.58	---	1995-2014	4/20	10/4/2015	8.54	1,570	---	Rank based on stage due to undetermined annual peak streamflow for maximum annual peak stage of record.
42	02160390	ENOREE RIVER NEAR WOODRUFF, SC	249	8/27/1995	29.9	52,200	1994-2014	3/21	10/4/2015	16.45	8,160	---	
43	02160700	ENOREE RIVER AT WHITMIRE, SC	444	8/28/1995	37.32	31,200	1974-2014	3/41	10/5/2015	29.08	18,400	25.0	
44	02161000	BROAD RIVER AT ALSTON, SC	4,790	6/7/1903	29.02	140,000	1897-1907, 1981-2014	13/45	10/4/2015	22.16	73,200	20.0	
45	02162093	SMITH BRANCH AT NORTH MAIN ST AT COLUMBIA, SC	5.67	7/21/2013	15.12	3,820	1977-2014	1/38	10/4/2015	18.87	---	9.0	The peak stage for 10/4/2015 was determined from high-water marks because the gage structure or equipment was damaged by flood waters. The 10/4/2015 maximum peak streamflow exceeded 4,180 ft³/s (for stage of 16.00 ft), which is the upper limit of the current rating curve.

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
46	02162290	SOUTH SALUDA RIVER NEAR CLEVELAND, SC	17.8	9/8/2004	9.58	3,720	2000-2005, 2013-2014	6/8	10/3/2015	3.10	86	9.0	
47	02162350	MIDDLE SALUDA RIVER NEAR CLEVELAND, SC	21.0	6/11/1986	11.21	5,190	1981-2014	31/32	10/3/2015	3.58	359	---	
48	02162500	SALUDA RIVER NEAR GREENVILLE, SC	298	10/7/1949	19.38	11,000	1942-2014	69/71	10/4/2015	4.69	1,660	9.5	
49	02163001	SALUDA RIVER NEAR WILLIAMSTON, SC	414	9/8/2004	14.12	12,410	1996-2014	12/19	10/4/2015	9.72	5,220	22.0	
50	02163500	SALUDA RIVER NEAR WARE SHOALS, SC	580	8/27/1995	22.95	20,900	1939-2014	20/76	10/4/2015	17.38	11,800	42.0	
51	02164000	REEDY RIVER NEAR GREENVILLE, SC	48.6	7/29/2004	11.21	5,830	1942-2014	31/63	10/4/2015	7.40	2,430	12.0	
52	02164110	REEDY RIVER ABOVE FORK SHOALS, SC	110	8/27/1995	21.77	8,200	1994-2014	2/21	10/4/2015	18.05	7,290	20.0	
53	021650905	REEDY RIVER NEAR WATERLOO, SC	251	1/26/2010	15.56	4,560	2005-2014	1/10	10/4/2015	17.29	6,160	30.0	
54	02165200	SOUTH RABON CREEK NEAR GRAY COURT, SC	29.5	9/14/1973	9.86	4,100	1968-1981, 1991-2014	5/38	10/4/2015	6.29	1,830	---	
55	021652801	NORTH RABON CREEK NEAR HICKORY TAVERN, SC	36.9	1/25/2010	10.34	---	2009-2014	1/6	10/4/2015	11.02	---	---	Rank based on stage due to undetermined annual peak streamflow for previous maximum annual peak stage of record. The 10/4/2015 maximum peak streamflow exceeded 1,060 ft³/s (for stage of 9.62 ft), which is the upper limit of the current rating curve.
56	02166501	LAKE GREENWOOD TAILRACE NEAR CHAPPELLS, SC	1,170	2/5/1998	28.46	18,400	1997-2014	1/18	10/4/2015	31.79	21,800	---	Regulated
57	02167000	SALUDA RIVER AT CHAPPELLS, SC	1,360	10/2/1929	31.50	63,700	1927-2014	8/110	10/5/2015	26.49	34,800	14.0	Regulated since 1940. The flood of 8/26/1908 reached a stage of 36.7 ft (present site and datum), from reports of National Weather Service.
58	02167450	LITTLE RIVER NEAR SILVERSTREET, SC	230	4/19/2003	15.73	8,760	1991-2014	1/24	10/5/2015	18.46	14,800	11.0	
59	02167582	BUSH RIVER NEAR PROSPERITY, SC	115	1/15/1995	16.06	5,570	1991-2014	1/24	10/4/2015	19.74	10,000	11.0	

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi^2, square miles; ft, feet; ft^3/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi^2)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft^3/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft^3/s)		
60	02168504	SALUDA RIVER BELOW LAKE MURRAY DAM NEAR COLUMBIA, SC	2,420	3/9/1996	15.88	22,100	1989-2014	1/26	10/4/2015	27.5	---	---	Regulated. The peak stage for 10/4/2015 was determined from high-water marks because the gage structure or equipment was damaged by flood waters. The 10/4/2015 maximum peak streamflow exceeded 19,000 ft^3/s (for stage of 16.35 ft), which is the upper limit of the current rating curve. The rank is based on the peak stage on 10/4/2015.
61	02169000	SALUDA RIVER NEAR COLUMBIA, SC	2,520	10/2/1929	15.22	67,000	1926-2014	---/89	10/4/2015	14.26	---	---	Regulated since 1930. The peak stage for 10/4/2015 was determined from high-water marks because the gage structure or equipment was damaged by flood waters. The 10/4/2015 maximum peak streamflow exceeded 58,000 ft^3/s (for stage of 14.00 ft), which is the upper limit of the current rating curve.
62	02169500	CONGAREE RIVER AT COLUMBIA, SC	7,850	8/27/1908	39.80	364,000	1900-2014	8/123	10/4/2015	31.81	185,000	19.0	Regulation from the Saluda River since 1929.
63	02169570	GILLS CREEK AT COLUMBIA, SC	59.6	2/24/1979	8.66	2,880	1965-2014	1/50	10/4/2015	19.6	---	6.7	The peak stage for 10/4/2015 was determined from high-water marks because the gage structure or equipment was damaged by flood waters. The 10/4/2015 maximum peak streamflow exceeded 2,380 ft^3/s (for stage of 9.11 ft), which is the upper limit of the current rating curve. The rank is based on the peak stage on 10/6/2015.
64	02171500	SANTEE RIVER NEAR PINEVILLE, SC	14,700	9/23/1945	31.10	155,000	1943-2013	11/71	10/8/2015	27.98	83,400	---	Regulated
65	02171645	REDIVERSION CANAL AT SANTEE RIVER NEAR ST STEPHEN, SC	14,800	11/17/1989	28.00	31,200	1987-2014	4/28	10/11/2015	28.60	28,000	---	Regulated. Previous maximum streamflow is a maximum daily average. For flood of October 2015, peak stage was 29.6 ft and occurred on 10/10/2015.

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
66	02171700	SANTEE RIVER NEAR JAMESTOWN, SC	10,750	3/28/2003	22.84	102,000	1987-2000, 2002-2014	2/27	10/10/2015	22.13	96,600	10.0	Regulated. Tidally influenced, which is overcome by basin runoff at high flows.
67	02172002	LAKE MOULTRIE TAILRACE CANAL AT MONCKS CORNER, SC	14,800	2/27/2003	10.40	27,100	1986-1990, 2002-2014	12/18	10/4/2015	13.24	16,500	---	Regulated
68	02172035	TURKEY CREEK ABOVE HUGER, SC	22.7	10/25/2008	9.52	1,410	2006-2014	1/9	10/4/2015	13.4	---	---	The peak stage for 10/4/2015 was determined from high-water marks because the gage structure or equipment was damaged by flood waters. The 10/4/2015 maximum peak streamflow exceeded 1,910 ft³/s (for stage of 10.00 ft), which is the upper limit of the current rating curve. The rank is based on the peak stage for 10/4/2015.
Ashepoo-Combahee-Edisto River Basin													
69	02172300	MCTIER CREEK (RD 209) NEAR MONETTA, SC	15.6	3/7/1996	7.48	536	1996-1997, 2002-2014	1/15	10/4/2015	6.98	782	13.0	
70	02173000	SOUTH FORK EDISTO RIVER NEAR DENMARK, SC	720	Oct. 1929	11.7	17,100	1930, 1932-1979, 1981-2014	49/83	10/8/2015	7.94	2,110	11.0	
71	02173030	SOUTH FORK EDISTO RIVER NEAR COPE, SC	757	5/8/1998	10.86	7,610	1992-2014	4/23	10/6/2015	10.27	3,880	---	
72	02173051	SOUTH FORK EDISTO RIVER NEAR BAMBERG, SC	807	5/9/1998	13.71	8,640	1992-2014	4/23	10/6/2015	12.35	4,770	16.0	
73	02173212	CEDAR CREEK NEAR THOR, SC	44.1	12/25/2009	4.78	---	2009-2014	1/5	10/4/2015	7.15	193	10.0	Rank based on stage due to undetermined annual peak streamflow for previous maximum annual peak stage of record.
74	02173500	NORTH FORK EDISTO RIVER AT ORANGEBURG, SC	683	Sept. 1928	14.7	10,000	1928, 1939-1988, 1990-2014	3/77	10/5/2015	13.64	8,640	8.0	
75	02175000	EDISTO RIVER NEAR GIVHANS, SC	2,730	Feb. 1925	17.5	24,900	1925, 1928, 1939-2014	1/81	10/8/2015	16.06	25,600	10.0	
76	02175500	SALKEHATCHIE RIVER NEAR MILEY, SC	341	10/9/1992	5.79	4,360	1952-2014	7/63	10/7/2015	5.31	2,920	---	

Table 1. Preliminary peak stage and streamflow data at selected streamgages in South Carolina for the flood of October 2015.—Continued

[mi², square miles; ft, feet; ft³/s, cubic feet per second; ---, data not available. Yellow shading indicates streamgages that recorded peaks of record for the October 2015 flood; green shading indicates streamgages that recorded peaks that ranked in the top 5 for the period of record; Period of record is given in water years, which is the period October 1–September 30 and is identified by the year in which the period ends; < in the Rank column indicates the peak flow for the October 2015 flood was less than the minimum annual peak flow of record]

Map site number (fig. 6)	Station number	Station name	Contributing drainage area (mi²)	Flood data								National Weather Service flood stage (ft)	Remarks
				Previous maximum streamflow			Beginning and ending water year for period of record	Flood of October 2015					
				Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		Rank / Number of annual peak streamflows in record	Date of peak streamflow	Peak stage (ft)	Peak streamflow (ft³/s)		
77	02176500	COOSAWHATCHIE RIVER NEAR HAMPTON, SC	203	10/10/1992	7.92	8,910	1952-2014	63/63	10/6/2015	6.50	267	---	
Savannah River Basin													
78	02177000	CHATTOOGA RIVER NEAR CLAYTON, GA	207	9/17/2004	11.21	33,300	1915, 1917-1929, 1940-2014	88/89	10/4/2015	3.70	3,000	15.0	
79	02186000	TWELVEMILE CREEK NEAR LIBERTY, SC	106	6/27/2006	14.78	8,260	1955-1964, 1990-2014	29/35	10/4/2015	6.84	1,900	10.0	
80	02187910	ROCKY RIVER NEAR STARR, SC	111	4/18/1998	17.70	6,260	1989-2014	14/25	10/5/2015	11.45	1,560	---	
81	02192500	LITTLE RIVER NEAR MT. CARMEL, SC	217	8/14/1940	29.60	20,800	1940-2014	8/75	10/5/2015	22.73	9,040	---	
82	02196000	STEVENS CREEK NEAR MODOC, SC	545	8/14/1940	41.08	35,100	1931, 1940-1978, 1984-2014	18/71	10/5/2015	30.44	17,100	19.0	
83	02196690	HORSE CREEK AT CLEARWATER, SC	155	6/3/2013	15.85	---	2006-2014	</9	10/5/2015	12.73	429	17.0	Peak stage on 10/5/2015 was less than the minimum annual peak from period of record. Peak streamflow was undetermined for peak stage of record.
84	02197000	SAVANNAH RIVER AT AUGUSTA, GA	7,510	10/2/1929	45.10	350,000	1796, 1840, 1852, 1864-1865, 1875-2014	134/144	10/6/2015	110.82	21,000	117.5	Regulated since 1953
85	02197500	SAVANNAH RIVER AT BURTONS FERRY BRIDGE NEAR MILLHAVEN, GA	8,650	Oct. 1929	30.80	220,000	1929, 1940-1970, 1983-2014	57/63	10/8/2015	12.19	14,300	15.0	Regulated since 1953
86	02198500	SAVANNAH RIVER NEAR CLYO, GA	9,850	10/6/1929	29.70	270,000	1925-2014	87/90	10/10/2015	9.55	12,500	11.0	Regulated since 1953

Table 2. Chronology of major and other memorable floods in South Carolina since 1893.

[From U.S. Geological Survey, 1985; http://sc.water.usgs.gov/publications/pdf/SCFloodsandDroughts1893-2002.pdf; http://www.dnr.sc.gov/climate/sco/Tropics/hurricane_tracks_affecting_sc.php. mph, miles per hour]

Date	Area affected	Remarks
Aug. 27, 1893	Southern coast of South Carolina	North-northeast through South Carolina Midlands. Winds 96–120 mph; tremendous storm surge; major damage; moved north near Columbia, then northeast. Deaths, 2,000; damage, $10 million.
June 1903	Santee River Basin	Deaths, 50; damage, $3.5 million.
Aug. 26–30, 1908	Statewide	Most extensive flood in State; rainfall, 12 inches in 24 hours at Anderson.
July 18, 1916	Eastern two-thirds of State	Record rainfall, 13 inches in 24 hours at Effingham; damage, $10–11 million.
Aug. 15–17, 1928	Statewide	Bridges destroyed, roads and railways impassable.
Sept. 21–24, 1928	Lower Pee Dee River Basin and southern South Carolina	Flooding was severe. Rainfall 10–12 inches. Deaths, 5; damage, $4–6 million.
Oct. 2, 1929	Savannah and Santee River Basins	Entered Aiken as extratropical storm; intense rains on saturated soil caused severe flooding.
Aug. 11–19, 1940	Statewide	Hurricane related flooding. Deaths, about 34; property and crop damage, $10 million.
Sept. 17–23, 1945	Statewide	Hurricane related, severe flooding. Deaths, 1; damage, $6–7 million.
Oct. 15, 1954	Lower Pee Dee River Basin	Hurricane Hazel. One of most severe storms in State to date. Storm surge, 16.9 feet; western half of State having drought. Deaths, 1; damage, $27 million.
Sept. 29–30, 1959	Eastern, southern, and central South Carolina	Hurricane Gracie. Winds 140 mph at landfall. Six foot storm surge. Rainfall, 6–8 inches. Deaths, 7; Excessive property damage along the coast as well as heavy crop damage, $20 million.
Nov. 1, 1969	Coastal, northwest corner of the State	Rainfall, 13.6 inches on Edisto Island. Deaths, 1; flood damage to homes.
Sept. 14, 1973	Northwestern South Carolina, Savannah and Santee River Basins	Major flash flood in Laurens. Saluda River at Ware Shoals had highest crest since 1929 flood. Damage, $4–6 million.
Aug. 19, 1981	Lower Pee Dee River Basin	Hurricane Dennis, greater than 6 inches of rain caused significant flood damage in low-lying areas. Greatest flood on upper Waccamaw River since 1945.
Sept. 21, 1989	Eastern two-thirds of State	Hurricane Hugo made landfall at Isle of Palms, S.C. Winds 140 mph. Gusts 160 mph. Costliest storm in South Carolina's history. Deaths, 35; damage, more than $6 billion. Storm surge over 20 feet. Severe inland damage as winds gusted to 109 mph at Sumter, S.C.
Oct. 10–12, 1990	Central South Carolina	The remnants from tropical storms Klaus and Marco caused heavy rains and flooding; 10–11 inches rain reported in Spartanburg County; 120 dams failed statewide; 80 bridge failures. Deaths, 5.
Oct. 8–9, 1992	Southern South Carolina	Rainfall, 9 inches in 24 hours. Bridge failures; homes damaged; 90-car train derailed.
Aug. 25–29, 1995	Northwestern Piedmont South Carolina	Tropical Storm Jerry tracked through the upstate of South Carolina, causing flash floods and dumping 8–10 inches of rain in about an 8-hour period. Some rain totals exceeded 20 inches. Several large dams broke causing flooding across the State. Estimated $4–5 million worth of damage to roads and bridges.
Sept. 16, 1999	Waccamaw and Lower Pee Dee River Basins	Hurricane Floyd: Rainfall was heavy along coastal counties; 12 inches in Georgetown County; 18 inches in eastern Horry County. The heavy rains caused flooding to many roads and buildings. Waves were reported to be 15 feet at the pier at Cherry Grove where damage was the greatest.

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For more information concerning this publication contact
Toby Feaster
South Atlantic Water Science Center
U.S. Geological Survey
720 Gracern Road
Stephenson Center, Suite 129
Columbia, SC 29210
(803) 750-6100

Or visit the South Atlantic Water Science Center Web site at
http://sc.water.usgs.gov

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United States Department of the Interior

U.S. GEOLOGICAL SURVEY
South Carolina Water Science Center
720 Gracern Road, Suite 129
Columbia, SC 29210
(803) 750-6100

July 26, 2016

Mr. Thomas Knight, P.E.
South Carolina Department of Transportation
955 Park Street
Post Office Drawer 191
Columbia, South Carolina 29202

Dear Mr. Knight:

Enclosed is a spreadsheet that lists the provisional high-water mark (HWM) elevations for 50 selected bridges in South Carolina. The HWMs document the October 2015 flooding caused by rainfall from Hurricane Joaquin.

The HWMs associated with flooding from October 4 to October 6, 2015 were flagged and surveyed by U.S. Geological Survey personnel on both banks, upstream and downstream of selected bridges (four quadrants at each bridge). Generally speaking, HWM information was sought one bridge-width opening upstream from each bridge as well as at or near the downstream bridge exits. If marks at these locations were not available, crews extended their search area several hundred feet further upstream or downstream as necessary. The horizontal coordinates (latitude and longitude) of each mark was determined by Global Positioning System (GPS) equipment relative to the North American Datum of 1983 (NAD 83), and the elevations of these marks were surveyed to North American Vertical Datum of 1988 (NAVD88). The individual HWM elevations for each site are provided separately in the accompanying spreadsheet. At many sites, reliable HWMs were difficult to find because data collection began 3 weeks after the historic flooding, and subsequent rainfall events, wind, or anthropogenic activity had degraded or eliminated any distinct marks. As a result, engineering judgment was used to estimate the peak water-surface elevations for each site or quadrant. Information that describes the rationale used to estimate the peak elevations is included in the "Remarks" column of the spreadsheet if available. Note that the peak water surface elevation could not be determined at some sites due to no data or insufficient data.

The HWM elevations and descriptive data have been compiled and will be loaded into the U.S. Geological Survey's (USGS) Short-Term Network (STN). The STN is a national-scale application and database designed to support USGS event-based sensor deployments and HWM data-collection efforts. The URL for the STN website is https://stn.wim.usgs.gov/STNWeb/#/.

The Flood Event Viewer option can be used to inspect data for selected events; menus at the STN Data Portal can be used to download data by event, state, and more. Please note that the STN uses functionality that is not completely supported by Internet Explorer; the preferred browser is Chrome.

For your information, be aware that these data are considered provisional until they are posted on the USGS STN. We will inform you when these data are posted. The USGS appreciates the opportunity to collaborate with the S.C. Department of Transportation in documenting this historic flood. If you have any questions or need additional information, please contact me at (803) 750-6155.

Sincerely,

Wladmir B. Guimaraes
Hydrologist

USGS
science for a changing world

Prepared in cooperation with the Federal Emergency Management Agency

Flood-Inundation Maps of Selected Areas Affected by the Flood of October 2015 in Central and Coastal South Carolina

Open-File Report 2016–1019

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

Cover. Flooded home off Big Dam Swamp Road, Andrews, South Carolina, October 11, 2015. Photograph by Lynn Torak, U.S. Geological Survey.

Flood-Inundation Maps of Selected Areas Affected by the Flood of October 2015 in Central and Coastal South Carolina

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

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Director

U.S. Geological Survey, Reston, Virginia: 2016

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Conversion Factors

Inch/Pound to International System of Units

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)	0.09290	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)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

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

Elevation, as used in this report, refers to distance above the vertical datum.

Supplemental Information

Stage, as used in this report, is the height of the water surface above an arbitrary datum established at the gage (gage datum).

Abbreviations

AEP	annual exceedance probability
DEM	digital elevation model
FEMA	Federal Emergency Management Agency
GIS	geographic information system
GPS	global positioning system
HWM	high-water mark
lidar	light detection and ranging
NWS	National Weather Service
USGS	U.S. Geological Survey

Flood-Inundation Maps of Selected Areas Affected by the Flood of October 2015 in Central and Coastal South Carolina

By Jonathan W. Musser, Kara M. Watson, Jaime A. Painter, and Anthony J. Gotvald

Abstract

Heavy rainfall occurred across South Carolina during October 1–5, 2015, as a result of an upper atmospheric low-pressure system that funneled tropical moisture from Hurricane Joaquin into the State. The storm caused major flooding in the central and coastal parts of South Carolina. Almost 27 inches of rain fell near Mount Pleasant in Charleston County during this period. U.S. Geological Survey (USGS) streamgages recorded peaks of record at 17 locations, and 15 other locations had peaks that ranked in the top 5 for the period of record. During the October 2015 flood event, USGS personnel made about 140 streamflow measurements at 86 locations to verify, update, or extend existing rating curves (which are used to compute streamflow from monitored river stage). Immediately after the storm event, USGS personnel documented 602 high-water marks, noting the location and height of the water above land surface. Later in October, 50 additional high-water marks were documented near bridges for South Carolina Department of Transportation. Using a subset of these high-water marks, 20 flood-inundation maps of 12 communities were created. Digital datasets of the inundation area, modeling boundary, and water depth rasters are all available for download.

Introduction

The presence of an upper atmospheric low-pressure system over the Southeast funneled tropical moisture from Hurricane Joaquin into South Carolina during the period October 1–5, 2015, causing historic rainfall amounts (http://www.weather.com/news/news/stunning-meteorological-images-october-2015-flooding, accessed October 8, 2015) (fig. 1). Widespread heavy rainfall resulted in major flooding in areas from the central part of the State to the coast. Some areas received more than 20 inches of rainfall over the period October 1–5, 2015 (fig. 2; National Weather Service, written commun., October 7, 2015). U.S. Geological Survey (USGS) personnel made about 140 streamflow measurements at 86 locations to verify, update, or extend existing rating curves (which are used to compute streamflow from monitored river stage). One USGS raingage at Black River at Kingstree, SC (02136000) recorded 22.89 inches of rain for the period October 1–5, 2015 (fig. 2). Flooding from this event resulted in at least 17 fatalities (http://www.reuters.com/article/2015/10/07/us-usa-weather-floods-idUSKCN0S11E720151007, accessed October 8, 2015). In the rural counties, conservative estimates of agricultural losses are expected to be at least $300 million, and total damages across the State will likely exceed $1 billion (http://www.latimes.com/nation/la-na-south-carolina-postcards-20151008-htmlstory.html, accessed October 9, 2015).

Purpose and Scope

The purpose of this report is to document the data collection, flood peak magnitudes, and flood-inundation products generated by the USGS in support of the Federal Emergency Management Agency (FEMA) response and recovery operations following the October 1–5, 2015, flood event throughout central and coastal South Carolina. High-water mark identification and surveying methods as well as flood-inundation maps depicting estimates of the areal extent and depth of flooding are presented and described.

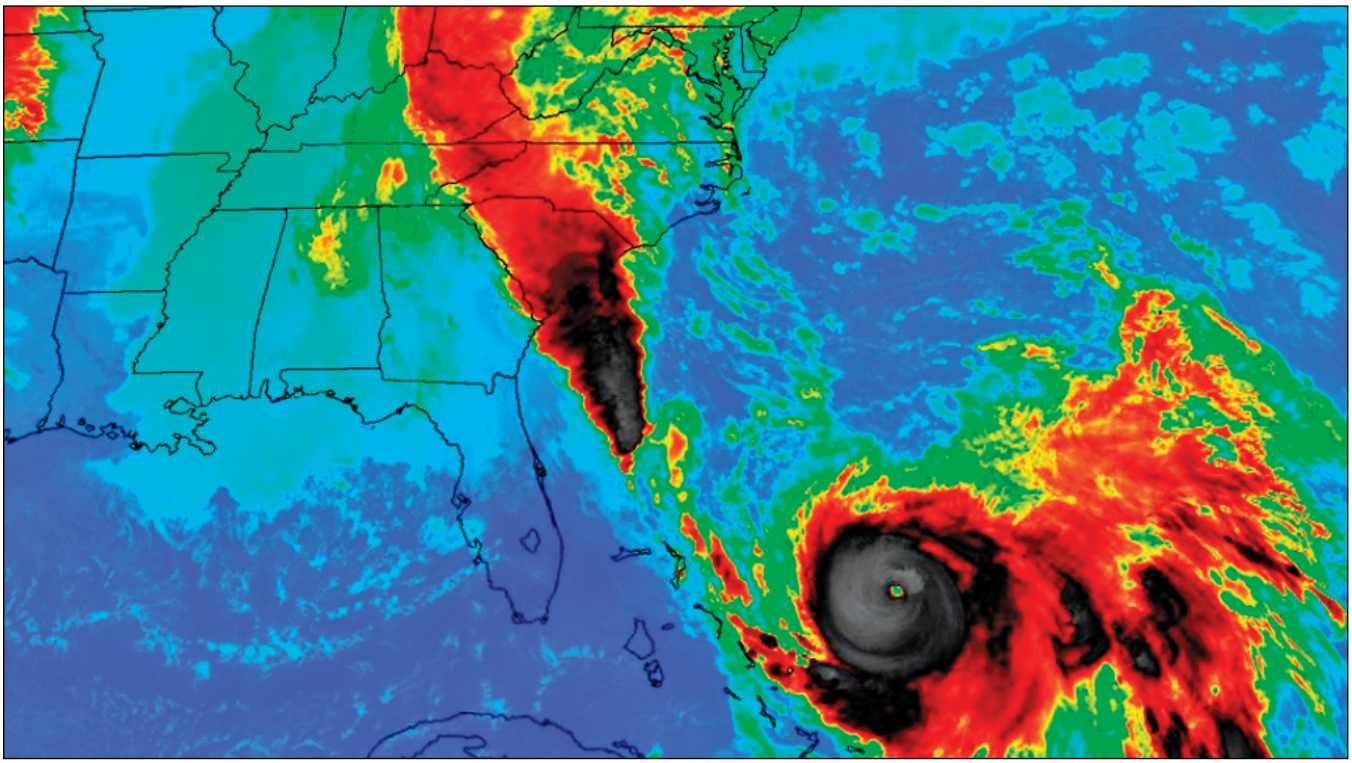

Figure 1. Infrared satellite image of the intense rainfall in South Carolina during the morning of October 3, 2015 (from Feaster and others, 2015; National Aeronautics and Space Administration). Black areas show the highest rainfall amounts.

Description of the Study Area

South Carolina is located in the southeastern United States, adjacent to the Atlantic Ocean, and has an area of 31,055 square miles. Most of the State is within two physiographic regions: Piedmont and Coastal Plain (Cooke, 1936; fig. 3). The Piedmont is characterized by rolling hills, elongated ridges, and moderately deep to shallow valleys. Piedmont land-surface elevations range from about 1,000 feet (ft) above sea level at the Blue Ridge foothills to about 400 ft above sea level at the Fall Line, which is the name given to the boundary between the Piedmont and Coastal Plain regions (fig. 3; Feaster and others, 2015).

About two-thirds of the State is in the Coastal Plain region (Badr and others, 2004). In the Coastal Plain, bedrock is overlain by sediments, which thicken from just a few feet near the Fall Line to about 3,800 ft at the southernmost corner of the State. At the Fall Line, a narrow, hilly region, known as the Sand Hills (fig. 3), is located where the Piedmont descends to the Coastal Plain (National Oceanic and Atmospheric Administration, 2015). The Sand Hills region is about 30 to 40 miles wide with elevations ranging from about 500 to 200 ft. The lower part of the Coastal Plain consists of low-elevation, flat plains with many swamps, marshes, dunes, barrier islands, and beaches, which typically are lower, flatter, and more poorly drained than the upper part of the Coastal Plain (Omernik, 1987; Feaster and others, 2015).

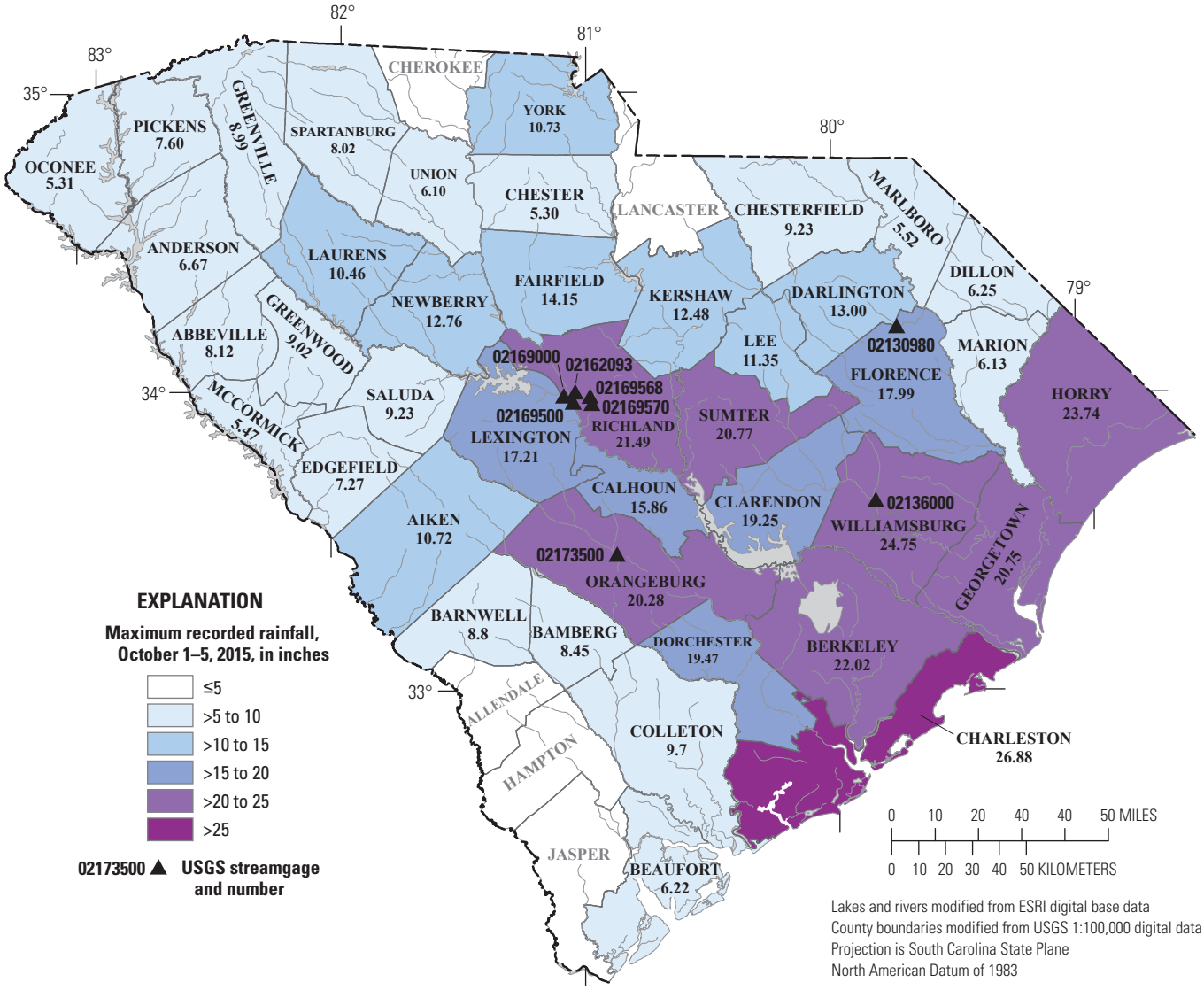

Figure 2. Counties in South Carolina with one or more National Weather Service or U.S. Geological Survey rainfall gages recording more than 5 inches of rainfall for October 1–5, 2015, and U.S. Geological Survey streamgages with associated flood-inundation maps.

Figure 3. Study area showing location of flood-inundation mapping sites in central and coastal South Carolina.

Conditions Leading to the Flood of October 2015

Heavy rainfall occurred across South Carolina during October 1–5, 2015, as a result of an upper atmospheric low-pressure system that funneled tropical moisture from Hurricane Joaquin into the State. The storm caused major flooding in the central and coastal areas of South Carolina (Feaster and others, 2015). The National Weather Service (NWS) and the USGS recorded record rainfall at multiple locations. Table 1 and figure 2 show the largest recorded rainfall for counties where a rainfall value was greater than 5 inches (http://www.weather.gov/media/chs/products/PNS/PNS_20151005_1602.pdf and http://www.weather.gov/cae/HistoricFloodingOct2015.html, accessed January 12, 2016; National Weather Service, written commun., January 21, 2016, and February 10, 2016).

Methods Used

The methods by which high-water marks (HWM) caused by heavy rainfall from Hurricane Joaquin in South Carolina were identified, documented, and referenced are discussed in this section. The methods by which these HWMs were used to create flood-inundation maps are also discussed as well as the methods by which the estimation of flood magnitude and frequency were developed through analysis of the annual peak streamflows at nine USGS streamgages that are within the areas of the flood-inundation maps.

Collection of High-Water Mark Data

High-water marks are the evidence of the highest water levels during a flood. The best HWMs are formed from small seeds or floating debris carried by flood waters that adhere to smooth surfaces or lodge in tree bark to form a distinct line. Stain lines on buildings, fences, and other structures also provide excellent marks. HWMs are best identified immediately following the peak stage because time and weather (wind, rain, sun) may blow, wash, or fade away the evidence of the peak water line. Care was taken to identify HWMs as far from the main channel as feasible where velocities generally are small and where wave action and pileup or drawdown effects of fast-moving waters are best avoided.

USGS field crews identified 602 HWMs in South Carolina with a depth above land surface measurement in feet and surveyed for elevation above land surface. Identification of HWMs began on October 7 and continued through October 16, 2015. After an acceptable HWM was found, a more permanent identification mark was established, such as a Parker-Kalon (PK) nail with a disk, a stake, a chiseled mark, or a paint line; if possible, the identification marks were accompanied by orange flagging. Written descriptions,

Table 1. Counties in South Carolina with one or more National Weather Service or U.S. Geological Survey rainfall gages recording more than 5 inches of rainfall for October 1–5, 2015.

[USGS, U.S. Geological Survey; CoCoRahs, Community Collaborative Rain, Hail and Snow Network; Coop, National Weather Service Cooperative Observer Program; E, east; N, north; S, south; W, west]

County	National Weather Service or U.S. Geological Survey reporting location	Rainfall amount
Abbeville	Due West 2 S CoCoRahs	8.12
Aiken	McTier Creek USGS—Monetta	10.72
Anderson	Anderson 8 SE CoCoRahs	6.67
Bamberg	Bamberg Coop	8.45
Barnwell	Barnwell Coop	8.80
Beaufort	4 NNE Beaufort CoCoRahs	6.22
Berkeley	1 NNW Limerick Raws	22.02
Calhoun	ENE St. Matthews CoCoRahs	15.86
Charleston	6 NE Mount Pleasant CoCoRahs	26.88
Chester	Chester 1 SE Coop	5.30
Chesterfield	Chesterfield Coop	9.23
Clarendon	Manning 8.2 S CoCoRahs	19.25
Colleton	3 ENE Walterboro CoCoRahs	9.70
Darlington	Darlington 7 SSW CoCoRahs	13.00
Dillon	Dillon 4 NW CoCoRahs	6.25
Dorchester	3 NW Summerville	19.47
Edgefield	Edgefield 11 N CoCoRahs	7.27
Fairfield	Longtown Coop	14.15
Florence	Coward 5 NNW CoCoRahs	17.99
Georgetown	Georgetown 4 SSW Coop	20.75
Greenville	KSCSIMPS9 Supplementary	8.99
Greenwood	Greenwood 3.4 NNW CoCoRahs	9.02
Horry	Longs Coop	23.74
Kershaw	Lugoff Coop	12.48
Laurens	Clinton 1.7 SSW CoCoRahs	10.46
Lee	Bishopville Coop	11.35
Lexington	Chapin 1.4 S CoCoRahs	17.21
Marion	Mullins 1 SSE Coop	6.13
Marlboro	Bennetsville 1 SE CoCoRahs	5.52
McCormick	Little R. USGS Mt Carmel	5.47
Newberry	Little Mountain Coop	12.76
Oconee	Seneca 2.6 WSW CoCoRahs	5.31
Orangeburg	Holly Hill 0.4 N CoCoRahs	20.28
Pickens	Clemson 0.8 NE CoCoRahs	7.60
Richland	Gills Creek Rcwinds—Columbia	21.49
Saluda	Saluda USGS	9.23
Spartanburg	KSCENORE4 Supplementary	8.02
Sumter	Sumter 0.3 NNE CoCoRahs	20.77
Union	Whitmire Raws 5 NE Coop	6.10
Williamsburg	Kingstree weather spotter	24.75
York	KSCYORK5 Supplementary	10.73

sketches, photographs, and global positioning system (GPS) horizontal measurements obtained with a hand-held GPS unit were made so the marks could easily be found later and surveyed to the standard vertical datum, North American Vertical Datum of 1988 (NAVD 88). The HWMs were grouped by location, and 20 of these locations were identified as inundation mapping sites where there were at least three HWMs and flooding was apparent in a nearby city or town. Fifty additional HWMs were documented in late October as part of a project funded by the South Carolina Department of Transportation. During the mapping process, the HWMs were identified and checked for location and elevation accuracy through comparison of field note diagrams and descriptions to aerial photography and detailed street and parcel maps. If the location could not be determined accurately or the elevation was substantially different than other HWMs in the area, the HWM was not used. A total of 494 HWMs from the initial 602 marks were used, as well as 16 HWMs from the late October survey. The complete list of the 510 HWMs used in the analysis is provided in appendix 1. (One HWM is listed twice because it was used in two different flood-inundation maps.) The HWM data listed in appendix 1 are taken from field notes made by different people on different days. In some cases during the recording of waterbody names, a HWM on a small tributary of a stream was recorded as being on the stream itself. Although an attempt was made for consistent recording of information, some data may be incomplete.

Flood-Inundation Mapping

Flood-inundation maps for a total of 20 locations in 12 communities from central to coastal South Carolina were generated using a geographic information system (GIS). These maps depict estimates of the areal extent and depth of flooding that correspond to the HWMs identified and surveyed by the USGS following the flood event. Table 2 lists the community, waterbody, reach length, and number of HWMs used to generate the flood-inundation maps. The first step in the generation of the flood-inundation maps was the creation of a flood-elevation raster surface. Flood extent and depth surfaces were created independently for each community, using the HWM elevations and one of three interpolation/geoprocessing techniques that was deemed most appropriate to use for the type of flooding that existed within the community. A geographic limit was placed on the extent of the generated surface based on the distribution of HWMs and an understanding of the natural hydrologic flow in the area of each community.

Table 2. Communities, waterbodies, reach lengths, and number of high-water marks used to generate flood-inundation maps.

Community	Waterbody	Reach length (miles)	Number of high-water marks
Andrews	Black River	50.6	19
Charleston	Ashley River and tributaries	34.1	35
Charleston	Atlantic Ocean	2.3	12
Columbia	Gills Creek and tributaries	19.9	215
Columbia	Kinley Creek	4.0	15
Columbia	Mill Creek and tributaries	0.3	14
Columbia	Rawls Creek	2.4	26
Columbia	Rocky Branch	2.0	23
Columbia	Saluda, Broad, and Congaree Rivers	18.0	22
Columbia	Smith Branch	2.6	17
Columbia	Stoop Creek	2.9	15
Conway	Crab Tree Swamp	1.5	10
Darlington	Black Creek and tributaries	5.1	3
Florence	Black Creek and tributaries	4.5	5
Georgetown	Sampit, Great Pee Dee, and Waccamaw Rivers	1.8	8
Kingstree	Black River and tributaries	4.9	18
Manning	Pocotaligo River	6.3	7
North Myrtle Beach	Atlantic Ocean	2.4	13
Orangeburg	North Fork Edisto River	4.7	6
Sumter	Green Swamp and tributaries	5.9	28

One flood-elevation interpolation method used the HWM elevations as points and interpolated between these elevations to generate the elevation surface using the ArcGIS "Topo to Raster" tool with the point interpolation procedure (http://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/how-topo-to-raster-works.htm, accessed November 2015). This approach was used when the flooded area was adjacent to a large, low gradient, body of water such as a swamp or when the flooded area was a coastal community on the Atlantic Ocean.

A second method used the "Topo to Raster" tool with the cross sections interpolation procedure (http://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/how-topo-to-raster-works.htm, accessed November 2015). A cross section was drawn through the location of the HWM and was run perpendicular to the direction of the flood flow. If there were multiple HWMs in an area with the same or similar elevations, one cross section was drawn that either passed through the HWMs or through the center of a group of HWMs. The elevation of the HWM was assigned to the water-surface elevation of the cross section. This method was used when flooding was a result of overtopped banks of rivers or streams.

A third method used a regional flood-elevation approach by grouping HWMs with similar water-surface elevations into a single flood-elevation region. A constant value elevation surface based on one point or an average of multiple points was used as the water surface for an area. This method was used when (1) an interpolation between HWMs was not possible because of the paucity of HWMs, (2) there was very little variation in elevations among the HWMs, and (3) flooding in the community was a result of a variety of unrelated reasons, such as localized flooding from tributaries or poor drainage rather than from the main (mapped) channel.

The flood-elevation surface that was created by using one of the three described methods was then combined with a 10-ft cell size digital elevation model (DEM). The DEM was derived from light detection and ranging (lidar) data having an 18.4-centimeter vertical root-mean-square error and a 1.4-meter nominal point spacing (http://www.dnr.sc.gov/GIS/lidar.html). An inundated area was depicted where the flood-elevation surface was higher than the DEM land surface. The depth of flooding was determined as the difference between the flood-elevation surface and the DEM land surface. Because of the large number of bridges involved in the flood-inundation mapping, the inundation surfaces were not clipped to show any bridges that were not inundated.

Some uncertainties exist with the flood-inundation mapping due to the methods of mapping as well as the numbers of HWMs. The flood-elevation surfaces were all created using interpolation between HWM elevations without any direct hydraulic modeling. As a result, changes in the physical nature of the flood plain, such as change in slope or width, are not accounted for. Additionally, the distance between HWMs has an effect on how accurate the interpolation is between them. The greater the distance between HWMs, the greater the possibility for a less accurate flood-elevation surface. Finally, some extrapolation was done beyond the most upstream and downstream HWMs. In many cases, the boundary was extended to a road or a bridge crossing.

Flood Probabilities of Peak Streamflows

Information commonly needed immediately after a major flood includes the frequency of peak discharges at the magnitudes observed during the event. Flood-frequency analyses for streamgages with sufficient record can provide insight into the occurrence or re-occurrence of peak discharges of varying magnitudes. The annual exceedance probability (AEP) for a particular streamflow is the probability of that streamflow being equaled or exceeded in any given year. For example, an AEP of 0.01 means there is a 1 percent (AEP×100) chance of that flow magnitude being equaled or exceeded in any given year. Stated another way, the odds are 1 in 100 that the indicated flow will be equaled or exceeded in any given year. The traditional concept of recurrence interval is directly related to the AEP. By definition, the recurrence interval (in years) corresponding to a particular AEP is equal to one divided by the flood probability. For example, the AEP of 0.01 (or 1 percent) corresponds to the 100-year flood. Table 3 lists the correspondence between AEP in percent and recurrence intervals for commonly used flood probabilities.

Updated at-site flood-frequency discharges for selected AEPs (50-, 20-, 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent) were computed for USGS streamgages in the areas where flood-inundation maps were created using the computer program PEAKFQ, version 7.2 (Flynn and others, 2006; Veilleux and others, 2014). The PEAKFQ program is based on guidelines provided by the Interagency Advisory Committee on Water Data (1982) in Bulletin 17B. The October 2015 peak streamflows were included in the PEAKFQ analyses per guidance from USGS Office of Surface Water Technical Memorandum 2013.01 (Mason, 2013).

Table 3. Selected recurrence intervals and the associated annual exceedance probability.

Recurrence interval (years)	Annual exceedance probability (percent)
2	50
5	20
10	10
25	4
50	2
100	1
200	0.5
500	0.2

The updated at-site flood-frequency discharges computed using PEAKFQ were weighted with the regression equation estimates from Feaster and others (2009) for rural streamgages or with the regression equations estimates from Feaster and others (2014) for urban streamgages. The weighting method used is outlined in Bulletin 17B (Interagency Advisory Committee on Water Data, 1982, appendix 8). The weighted discharge estimates were then used to determine the AEP associated with the October 2015 peak streamflow. Updated flood-frequency estimates were not computed for the regulated streamgage, Congaree River at Columbia, SC (02169500), because of the complexities of the regulation and detailed statistical analysis that would be needed to update the flood-frequency estimates. Given that the October 2015 discharge peak was not the peak of record, the most recent published values in Federal Emergency Management Agency (2001) were used to estimate the AEP associated with the peak streamflow for that streamgage.

Estimated Magnitudes and Flood Probabilities of Peak Streamflows

Peak gage-height data, peak streamflow data, and the corresponding AEPs (in percent) determined from the October 2015 flood for the nine USGS streamgages that record annual peak streamflow in the areas where flood-inundation maps were created are presented in table 4. The

Table 4. Flood-peak gage heights, peak streamflows, and estimated annual exceedance probabilities for the October 2015 flood at selected U.S. Geological Survey streamgages in South Carolina.

[Data shown are considered provisional as of the date of publication. Peak of record shown in bold. Abbreviations: USGS, U.S. Geological Survey; mi^2, square miles; ft^3/s, cubic feet per second, ft, feet; AEP, annual exceedance probability. <, less than; —, not applicable or not available]

USGS station number (fig. 3)	Station name	Map identification	Drainage area (mi^2)	Gage period of record ([1]water year)	Type
02110701	Crabtree Swamp at Conway, S.C.	Crab Tree Swamp at Conway (fig. 2–12)	17.8	2006–present	Rural
02130980	Black Creek near Quinby, S.C.	Black Creek at Florence (fig. 2–14)	438	2002–present	Rural
02136000	Black River at Kingstree, S.C.	Black River at Kingstree (fig. 2–16)	1,250	1928–present	Rural
02162093	Smith Branch at North Main St at Columbia, S.C.	Smith Creek in Columbia (fig. 2–10)	5.67	1977–present	Urban
02169000	Saluda River near Columbia, S.C.	Saluda, Broad, and Congaree Rivers near Columbia (fig. 2–9)	2,520	1926–present	Regulated
02169500	Congaree River at Columbia, S.C.	Saluda, Broad, and Congaree Rivers near Columbia (fig. 2–9)	7,850	1900–present	Regulated
02169568	Pen Branch at Columbia, S.C.	Gills Creek in Columbia (fig. 2–4)	2.26	1986–present	Urban
02169570	Gills Creek at Columbia, S.C.	Gills Creek in Columbia (fig. 2–4)	59.6	1965–present	Urban
02173500	North Fork Edisto River at Orangeburg, S.C.	North Fork Edisto River at Orangeburg (fig. 2–19)	683	1928, 1939–present	Rural

[1]Water year refers to the period from October 1 to September 30 and is identified by the year in which the period ends. For example, October 1, 2001, to September 30, 2002, is water year 2002.

[2]Determined using AEP estimates that were computed using PEAKFQ and weighted with regional regression equation estimates from Feaster and others (2009).

[3]Peak streamflow currently (January 2016) not available.

[4]Determined using AEP estimates from Federal Emergency Management Agency (2001).

flood-inundation map identification name associated with each streamgage is listed in table 4. The streamgage locations are shown in figure 3 as well as in the flood-inundation maps in appendix 2. The data listed in table 4 currently (January 2016) are considered provisional until final approval of the data. New gage-height records were set at six of the nine USGS streamgages listed in table 4. The peak discharge currently (January 2016) is not available for four of the six streamgages with peak gage height of record, so the AEPs were not estimated for these four streamgages (noted in table 4). Further analyses using indirect discharge measurement methods are being performed to estimate the peak discharge for these four streamgages. The flood-frequency statistics computed for this study are presented in table 5. The weighted flood-frequency statistics in table 5 were used to determine the AEP (in percent) associated with the October 2015 flood peak in table 4.

Table 4. Flood-peak gage heights, peak streamflows, and estimated annual exceedance probabilities for the October 2015 flood at selected U.S. Geological Survey streamgages in South Carolina.—Continued

[Data shown are considered provisional as of the date of publication. Peak of record shown in bold. Abbreviations: USGS, U.S. Geological Survey; mi^2, square miles; ft^3/s, cubic feet per second, ft, feet; AEP, annual exceedance probability. <, less than; —, not applicable or not available]

Maximum prior to October 2015 flood			Maximum for October 2015 flood				USGS station number (fig. 3)
Date	Gage height (ft)	Streamflow (ft^3/s)	Date	Gage height (ft)	Streamflow (ft^3/s)	Estimated annual exceedance probability (percent)	
5/14/12	13.03	1,510	**10/4/15**	**20.20**	**3,120**	[2]1 to 0.5	02110701
9/9/2004	16.80	6,450	**10/4/2015**	**16.81**	**6,530**	[2]4 to 2	02130980
6/14/1973	19.77	58,000	**10/6/2015**	**22.65**	**83,700**	[2]<0.2	02136000
7/21/2013	15.12	3,820	**10/4/2015**	**18.87**	[3]	—	02162093
10/2/1929	15.22	67,000	10/4/2015	14.26	[3]	—	02169000
8/27/1908	39.80	364,000	10/4/2015	31.81	185,000	[4]10 to 4	02169500
7/24/1997	9.10	2,350	**10/4/2015**	**11.33**	[3]	—	02169568
2/24/1979	8.66	2,880	**10/4/2015**	**19.60**	[3]	—	02169570
Sept. 1928	14.70	10,000	10/4/2015	13.64	8,640	[2]2 to 1	02173500

Table 5. Flood-frequency statistics for selected U.S. Geological Survey streamgages in South Carolina.

[USGS, U.S. Geological Survey. AEP, annual exceedance probability: G, estimated from the Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) analysis of the streamgaging station; R, estimated from the regression equation; and W, weighted estimate]

USGS station number	Number of annual peaks	Historic period of record (years)	Streamflow, in cubic feet per second								
			50-percent chance AEP			20-percent chance AEP			10-percent chance AEP		
			G	R	W	G	R	W	G	R	W
02110701[1]	11	0	970	390	799	1,590	748	1,290	2,060	1,030	1,650
02130980[1]	15	0	1,440	2,830	1,690	2,670	4,780	3,210	3,740	6,240	4,530
02136000[1,2]	89	124	4,970	6,130	5,060	10,500	10,600	10,500	15,900	13,900	15,600
02173500[1,2]	79	124	2,260	3,900	2,300	3,630	6,550	3,730	4,710	8,550	4,880

USGS station number	Number of annual peaks	Historic period of record (years)	Streamflow, in cubic feet per second								
			4-percent chance AEP			2-percent chance AEP			1-percent chance AEP		
			G	R	W	G	R	W	G	R	W
02110701[1]	11	0	2,720	1,410	2,130	3,270	1,740	2,520	3,860	2,100	2,950
02130980[1]	15	0	5,400	8,140	6,480	6,880	9,680	8,060	8,590	11,200	9,700
02136000[1,2]	89	124	25,100	18,200	23,700	33,900	21,900	30,800	44,700	25,700	38,800
02173500[1,2]	79	124	6,260	11,100	6,560	7,560	13,200	8,000	8,980	15,300	9,590

USGS station number	Number of annual peaks	Historic period of record (years)	Streamflow, in cubic feet per second					
			0.2-percent chance AEP			0.5-percent chance AEP		
			G	R	W	G	R	W
02110701[1]	11	0	4,500	2,430	3,370	5,430	2,940	4,010
02130980[1]	15	0	10,600	12,800	11,600	13,600	14,900	14,300
02136000[1,2]	89	124	57,900	29,100	47,200	79,700	34,300	59,700
02173500[1,2]	79	124	10,600	17,500	11,300	12,800	20,400	13,900

[1]Regression equation estimates from Feaster and others (2009).

[2]Historic adjustment.

Flood-Inundation Maps

Twenty flood-inundation maps for 12 communities are provided in appendix 2. The following sections describe each inundation mapping location. Descriptive tables of HWMs used in the inundation mapping are included in appendix 1. Digital flood-inundation data can be downloaded from http://water.usgs.gov/floods/events/2015/Joaquin/data_ofr20161019/.

Black River Near Andrews

The Black River flows east through the community of Andrews in Georgetown and Williamsburg Counties. A total of 19 HWMs were identified and surveyed within the community of Andrews. Eight HWMs were documented along a 30-mile stream reach of the Black River, four along a 6.5-mile reach of the Black Mingo Creek, five along Big Dam Swamp, one along Gin Branch, and one along Choppee Creek. Seventeen cross sections—10 on the Black River, 4 on Black Mingo Creek, 2 on Big Dam Swamp, and 1 on Choppee Creek—were created and used to generate a flood-elevation surface. The flood elevations ranged from 6.8 ft along the Black River to 23.4 ft along Big Dam Swamp. The flood-inundation map for this location is shown in figure 2–1.

Ashley River Near Charleston

The Ashley River is located in Dorchester and Charleston Counties and flows generally southeastward, emptying into the Atlantic Ocean. A total of 35 HWMs were documented—18 on the Ashley River, 8 near Church Creek, 6 on Popperdam Creek, and 3 on Eagle Creek. Twenty-one cross sections—15 on the Ashley River, 4 on Eagle Creek, and 2 on Popperdam Creek—were created and used to generate a flood-elevation surface. Two areas near Church Creek used a constant value surface. The HWMs ranged in elevation from 25.5 ft near Big Bird Lane to 5.5 ft near Great Oak Drive. An additional water-surface elevation was obtained from the USGS streamgage, Ashley River near North Charleston, SC (021720869), which peaked at 5.5 ft on October 4, 2015. The flood-inundation map for this location is shown in figure 2–2.

Coastal Charleston

The city of Charleston is a coastal community located in Charleston County adjacent to the Atlantic Ocean. Twelve HWMs were identified in the community and used to generate a flood-elevation surface. The HWMs ranged in elevation from 4.0 ft at Ashley Street to 9.3 ft near King Street and Huger Street. The flood-inundation map for this location is shown in figure 2–3.

Columbia

The city of Columbia and its suburbs are located in Richland and Lexington Counties in the central part of South Carolina. The Saluda and Broad Rivers, which join to form the Congaree River, are the largest flowing waterbodies in the metropolitan area. HWMs were documented along seven tributaries as well as on these three rivers. The inundation mapping in the Columbia area was divided into a total of eight different maps—one for each of seven tributaries and one for the three large rivers.

Gills Creek in Columbia

Gills Creek and its tributaries are located in Richland County in the vicinity of the city of Columbia. Gills Creek flows generally southwestward and empties into the Congaree River. A total of 215 HWMs were documented, and 193 cross sections were created to map the inundated area. At the downstream end of the basin, the lowest HWM on Shop Road was 138.7 ft. At the upstream end of Gills Creek, the highest HWM was 191.5 ft near Northshore Road. HWMs were surveyed on six different tributaries of Gills Creek. The highest HWM on each tributary is as follows: 193.5 ft near Washington Road on Wildcat Creek; 213.6 ft near Budon Court on Pen Branch; 257.5 ft near Blue Bird Lane on Eightmile Branch; 219.0 ft near Fireland Road on Little Jackson Creek; 241.8 ft near Windsor Shores Drive on an unnamed tributary of Jackson Creek; and 231.7 near Parliament Lake Drive on Windsor Lake on Jackson Creek. The extent of the mapped inundation area (fig. 2–4) is bounded by the location of the lowest HWM at the downstream end of Gills Creek and approximately 1,500 ft upstream from the location of the highest HWM. The extents of the mapped inundation area for the six tributaries are located the following distances upstream from the most upstream HWM: 960 ft for a tributary of Wildcat Creek; 760 ft for Pen Branch; 240 ft for Little Jackson Creek; 60 ft for an unnamed tributary of little Jackson Creek; and 1,800 ft for Jackson Creek. On October 4, 2015, at the USGS streamgage, Gills Creek at Columbia, SC (02169570), a peak stage of 19.6 ft was recorded, and at Pen Branch at Columbia, SC (02169568), a peak stage of 11.33 was recorded. The flood-inundation map for this location is shown in figure 2–4.

Kinley Creek Near Columbia

Kinley Creek is in Lexington County near the city of Irmo northwest of Columbia. The creek flows generally southeastward and empties into the Saluda River. A total of 15 HWMs were documented—13 on Kinley Creek and 2 on an unnamed tributary. The HWMs ranged in elevation from 227.8 ft near Harbison Boulevard to 187.3 ft on St. Andrews Road. On the unnamed tributary, the peak HWM was 235.6 ft

near Foxfire Drive. Fifteen cross sections—11 on Kinley Creek and 4 on the unnamed tributary—were created and used to generate a flood-elevation surface. On the unnamed tributary, one cross section was created at each of the HWM locations at the upstream and downstream ends of the reach. Two other cross sections were spaced equidistant between the first two. The water-surface elevations that were assigned to the intermediate cross section were determined by using a ratio of the difference in elevation between the upstream and downstream HWMs and the distance between the cross sections. This prevented the cross sections on Kinley Creek from affecting the water-surface elevation on the tributary. The inundation area boundary is approximately 830 ft upstream from the location of the highest HWM on Kinley Creek and approximately 230 ft upstream from the location of the highest HWM on the unnamed tributary. The inundation area boundary is approximately 30 ft downstream from the location of the lowest HWM. The flood-inundation map for this location is figure 2–5.

Mill Creek Near Columbia

Mill Creek and its tributaries are located in Richland County near the city of Columbia. The creek flows generally southward and empties into the Congaree River. A total of 14 HWMs were documented in three separate areas. In the first area, 11 HWMs, ranging from 213.4 ft upstream on a small lake to 203.5 ft downstream, were documented on Mill Creek near Caughman Road. Seven cross sections were created to map the inundation area. The inundation boundary for this area is approximately 610 ft upstream from the location of the highest HWM and approximately 150 ft downstream from the location of the lowest HWM. In the second area, one HWM was measured on a small pond on an unnamed tributary of Mill Creek near Cardington Drive. A constant water surface at the value of this HWM, 239.1 ft, was used to model the inundated area of this pond and its adjacent area. In the third area, two HWMs were documented near Rawlinson Road on an unnamed tributary of Mill Creek. One HWM was on Ulmers Lake (238.0 ft) and one was on Griffin Lake (243.1 ft). Constant water-surface elevations, those of the HWMs, were used to model the inundated area for each of these lakes. The flood elevation in the intervening area between the lakes was interpolated from the two HWMs. The flood-inundation map for these locations is shown in figure 2–6.

Rawls Creek Near Columbia

Rawls Creek is in Lexington County near the city of Irmo northwest of Columbia. The creek flows generally southeastward and empties into the Saluda River. A total of 26 HWMs were documented—25 on Rawls Creek and 1 on Koon Branch. The HWMs ranged in elevation from 236.2 ft on Coldstream Drive to 193.0 ft at Saluda Shoals Park located on Bush River Road. Twenty-three cross sections were created to generate the flood-elevation surface. The inundation area boundary is approximately 125 ft upstream from the location of the highest HWM and approximately 200 ft downstream from the location of the lowest HWM. The flood-inundation map for this location is shown in figure 2–7.

Rocky Branch in Columbia

Rocky Branch flows through the city of Columbia in Richland County. Rocky Branch flows generally southwestward and empties into the Congaree River. A total of 23 HWMs were documented. The HWMs ranged in elevation from 223.5 ft at a spot upstream from Pavillion Street to 148.7 ft at South Parker Street. Twenty cross sections were created to generate the flood-elevation surface. The inundation area boundary is approximately 350 ft upstream from the location of the highest HWM and approximately 310 ft downstream from the location of the most downstream HWM near Olympia Avenue. The flood-inundation map for this location is shown in figure 2–8.

Saluda, Broad, and Congaree Rivers Near Columbia

The Saluda, Broad, and Congaree Rivers flow through Lexington and Richland Counties near and in the city of Columbia. In this area the Saluda River generally flows southeast and the Broad River flows south. The Saluda and Broad Rivers join to form the Congaree River, which flows southeast through the area. A total of 22 HWMs were documented in the area—10 on the Saluda River and tributaries to the Saluda River, 6 on the Broad River, and 6 on the Congaree River. The highest HWM elevations were 193.6 ft near Inlet Road on the Saluda River and 165.8 ft upstream from Interstate 20 on the Broad River. The lowest HWM elevation was 134 ft at Interstate 77 on the Congaree River. Twenty-one cross sections were created to generate the flood-elevation surface, with seven cross sections on the Saluda River, seven cross sections on the Broad River, and seven cross sections on the Congaree River. The upstream inundation area boundaries on the Saluda and Broad Rivers were approximately 290 ft and approximately 730 ft, respectively, upstream from the locations of the highest HWMs. The downstream inundation area boundary was approximately 4,400 ft downstream from the location of the lowest HWM on the Congaree River. About 6,000 ft downstream from the U.S. Highways 21/176/321 bridge, the Congaree River flood plain widens substantially. There was extensive flooding along the Congaree River south of Interstate 77, but no HWMs were documented along this reach. The Columbia Canal runs adjacent to the Broad and Congaree Rivers and was breached during the flood event. The HWMs documented near the canal were all on the river side,

so no mapping of the flood extent along the canal could be completed. The canal south of the U.S. Highway 176 bridge was not mapped. The flood-inundation map for this location is shown in figure 2–9. The following inundation areas intersect and overlap the inundation area delineated for the Saluda, Broad, and Congaree Rivers (fig. 2–9): Rawls Creek (fig. 2–7), Kinley Creek (fig. 2–5), Stoop Creek (fig. 2–11), Smith Branch (fig. 2–10), and Gills Creek (fig. 2–4).

Smith Branch in Columbia

Smith Branch is in Richland County and flows through the city of Columbia. Smith Branch flows generally westward and empties into the Broad River. A total of 17 HWMs were documented. The elevations of the HWMs ranged from 220.9 ft upstream from Harden Street Extension to 165.6 ft near Williamsburg Drive. Twelve cross sections were created to generate the flood-elevation surface. The inundation area boundary is approximately 190 ft upstream from the location of the highest HWM and approximately 60 ft downstream from the location of the lowest HWM. At the USGS streamgage, Smith Branch at North Main Street at Columbia, SC (02162093), a peak stage of 18.87 ft was recorded on October 4, 2015 (Feaster and others, 2015). The flood-inundation map for this location is shown in figure 2–10.

Stoop Creek Near Columbia

Stoop Creek is in Lexington and Richland Counties between the cities of Irmo and Columbia. The creek flows generally southward and empties into the Saluda River. A total of 15 HWMs were documented. The elevations of the HWMs ranged from 249.0 ft on Bonnie Forest Boulevard to 183.5 ft downstream from Bush River Road. Fifteen cross sections were created to generate the flood-elevation surface. The inundation area boundary is approximately 220 ft upstream from the location of the highest HWM and approximately 410 ft downstream from the location of the lowest HWM. The flood-inundation map for this location is shown in figure 2–11.

Crab Tree Swamp at Conway

The city of Conway is a coastal community centrally located in Horry County. The flooded area of the community flanked Crab Tree Swamp on the north and south and extended as far west as Main Street and east into Grier Swamp. The USGS streamgage, Crabtree Swamp at Conway, SC (02110701), recorded a peak stage of 20.2 ft on October 5, 2015. Ten HWMs were documented and used to generate a flood-elevation surface. The HWMs ranged in elevation from 10.3 ft at Busbee Street to 11.7 ft on Main Street, U.S. Highway 701. The flood-inundation map for this location is shown in figure 2–12.

Black Creek at Darlington

Black Creek flows southeast through the city of Darlington in Darlington County. Three HWMs were identified and surveyed along a 2.5-mile reach of Black Creek and 5 miles of tributary including Swift Creek and Bellyache Creek. The elevations of the HWMs on Black Creek ranged from 92.1 ft near Woods Dargan Road to 96.5 ft near Darlington Country Club. The HWM located on Lawson Road near Bellyache Creek had an elevation of 116.0 ft. Three cross sections were created to generate the flood-elevation surface: one near the junction of Swift Creek and Black Creek, one on Black Creek, and one on Bellyache Creek. The flood-elevation surface of Black Creek was generated separately from the flood-elevation surface of Swift Creek and Bellyache Creek. The two flood-elevation surfaces were then merged. Because of the lack of HWMs and the difference in HWM elevations for Swift Creek and Bellyache Creek, the area of inundation is uncertain for this part of the flood-inundation map. The flood-inundation map for this location is shown in figure 2–13.

Black Creek at Florence

Black Creek flows east through the community of Florence in Florence and Darlington Counties. Five HWMs were identified and surveyed along a 4.5-mile stream reach and ranged in elevation from 66.5 ft at Crooked Creek Road to 80.9 ft near Meadowbrook Drive. Five cross sections were created to generate the flood-elevation surface. The USGS streamgage, Black Creek near Quinby, SC (02130980), recorded a peak stage of 16.81 ft and streamflow discharge of 6,530 cubic feet per second (ft^3/s) on October 4, 2015 (Feaster and others, 2015). The flood-inundation map for this location is shown in figure 2–14.

Coastal Georgetown

The city of Georgetown is located in Williamsburg County on the west side of Winyah Bay, which is formed by the confluence of the Sampit River and the Great Pee Dee and Waccamaw Rivers. Eight HWMs, ranging in elevation from 4.5 ft near Front and Meeting Streets to 14.7 ft at Hawkins Street, were identified and used in the creation of a flood-elevation surface. The flood-elevation surface was generated using a regional elevation approach. The flood-elevation surface for two small regions in the northwest part of town were created by using the average elevations of 14.6 ft for one area and 8.6 ft from a single HWM for the second area. A third region of 4.8 ft included the area along Front Street near the Sampit River southeast to the bank of the Waccamaw-Great Pee Dee Rivers confluence. A regional flood elevation of 4.8 ft based on three HWMs was used for this area. The flood-inundation map for this location is shown in figure 2–15.

Black River at Kingstree

The town of Kingstree is located in Williamsburg County at the confluence of the Black River and two tributaries. Kingstree Swamp Canal is on the west side of Kingstree, and an unnamed tributary of the Black River flows through the eastern part of the town. Flooding depth of as much as 4.7 ft occurred on three sides of Kingstree. Localized flooding was identified in the center of town (1.2–1.6 ft depth) at Live Oak Avenue and Green Street. A total of 18 HWMs were documented—four on the Black River, four on Kingstree Swamp Canal, eight on an unnamed tributary, and two in the center of Kingstree. The HWM elevations ranged from 64.2 ft at Live Oak Avenue to 46.6 ft at two HWMs near E. Main Street. The highest HWM on Kingstree Swamp Canal, near Sandy Bay Road, had an elevation of 49.1 ft. Sixteen cross sections were created to generate the flood-elevation surface. The USGS streamgage, Black River at Kingstree (02136000), recorded a peak stage of 22.65 ft on October 6, 2015. The flood-inundation map for this location is shown in figure 2–16.

Pocotaligo River at Manning

The Pocotaligo River flows east through the city of Manning in Clarendon County. A total of seven HWMs were documented—six on the Pocotaligo River and one on Ox Swamp. Four cross sections were created to generate the flood-inundation surface. The HWM elevations ranged from 86.8 ft near Walker Street to 89.1 ft near Interstate 95. The flood-inundation map for this location is shown in figure 2–17.

Coastal North Myrtle Beach

North Myrtle Beach is a coastal community located in Horry County adjacent to the Atlantic Ocean. The inundated region of the community spanned approximately 2.4 miles along the coast from 62nd Avenue North to 20th Avenue North. Thirteen HWMs were documented, which ranged in elevation from 4.8 ft at 62nd Avenue North to 6.4 ft at 31st Avenue North and 22nd Avenue North. These HWMs were used to create a flood-inundation surface. The flood-inundation map for this location is shown in figure 2–18.

North Fork Edisto River at Orangeburg

The city of Orangeburg is located in central South Carolina on the North Fork Edisto River in Orangeburg County. Six HWMs were identified along a 4.7-mile stretch and ranged in elevation from 176.4 ft at Shillings Bridge Road to 161.6 ft at the U.S. 301 bridge. Six cross sections were created to generate the flood-elevation surface. The flood-inundation map for this location is shown in figure 2–19.

Green Swamp Near Sumter

The Green Swamp flows in a southeastern direction through the city of Sumter in Sumter County. A total of 28 HWMs were identified and surveyed within the city of Sumter. Ten HWMs were along a 4-mile stream reach of Green Swamp and Mush Swamp and eight HMWs were along Shot Pouch Branch. Seventeen cross sections were created from these HWMs to generate the flood-elevation surface. Additionally, 10 HWMs were located in low-lying areas separated from these streams. Nine cross sections were created from these HWMs to generate the flood-elevation surface for these areas. The two flood-elevation surfaces were then combined. The HWMs ranged in elevation from 142.7 ft near Capri Drive to 177.9 ft in a low-lying area on Clematis Trail. The flood-inundation map for this location is shown in figure 2–20.

Effects and Damages of the Flood of October 2015

During October 2015, flooding on numerous streams and rivers in the central and coastal parts of South Carolina resulted in at least 17 fatalities. In the rural counties, conservative estimates of agricultural losses are expected to be at least $300 million, and total damages will likely exceed $1 billion (Feaster and others, 2015).

Summary

During October 1–5, 2015, flooding occurred on numerous streams and rivers in the central and coastal areas of South Carolina. The U.S. Geological Survey (USGS) documented 602 high-water marks during the period October 7 to 16, and 50 additional high-water marks were documented later in October. The high-water marks were used to create 20 maps showing the areas of inundation in 12 communities. Additionally, the depth of the water in the mapped inundated areas was calculated, and a water depth raster was created. The flood-inundation maps, water depth rasters, and mapping boundaries are all available as downloadable data. Flood-peak gage heights, peak streamflows, and estimated annual exceedance probabilities were calculated for eight USGS streamgages located within the inundation map areas. Additional information, including a download portal for high-water mark information, can be found on the USGS Appalachian Floods and Hurricane Joaquin Web page at http://water.usgs.gov/floods/events/2015/Joaquin/.

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Glossary

The following definitions, except where noted, are from Langbein and Iseri (1960).

cubic feet per second A unit expressing rates of discharge. One cubic foot per second is equal to the discharge of a stream of rectangular cross section, 1 foot wide and 1 foot deep, flowing water an average velocity of 1 foot per second.

flood peak The highest value of the stage or discharge attained by a flood—thus, peak stage or peak discharge. Flood crest has nearly the same meaning, but because it connotes the top of the flood wave, it is properly used only in referring to stage—thus, crest stage, but not crest discharge.

flood probability The probability that a given event magnitude will be exceeded or equaled in any given year. Flood probability is directly related to recurrence interval. For example, there is a 1-percent chance that the 100-year peak flow will be exceeded or equaled in any given year. A flood probability of 0.01 has a recurrence interval of 100 years. The recurrence interval corresponding to a particular flood probability is equal to one divided by the flood probability (Interagency Advisory Committee on Water Data, 1982).

gage height The water-surface elevation referred to some arbitrary gage datum. Gage height is often used interchangeably with the more general term stage although gage height is more appropriate when used with a reading on a streamgage.

recurrence interval (return period) The average interval of time within which the given flood will be equaled or exceeded once. The recurrence interval is directly related to the flood probability. The recurrence interval corresponding to a particular flood probability is equal to one divided by the flood probability. For example, a 100-year recurrence interval has a flood probability of 0.01 (Interagency Advisory Committee on Water Data, 1982).

stream A general term for a body of flowing water. In hydrology the term is generally applied to the water flowing in a natural channel as distinct from a canal.

streamflow The discharge that occurs in a natural channel. Although the term discharge can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course.

streamgage For the purposes of this report, the term is used to denote a gaging station where a continuous record of gage height (stage), velocity, or other parameters are collected for the purpose of determining streamflow (Interagency Advisory Committee on Water Data, 1982).

Appendix 1

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Black River near Andrews							
11816	Mingo Crk/Swamp	15094	Debris	Good	Grey two story home with white trim at end of road, with stable/kennel located beyond (east of) hous	33.59054	–79.42964
11817	Black River	15095	Debris	Good	Camanche Dr 0.30 miles southwest from Hesterville Rd on right side of Camanche Dr	33.54173	–79.41123
11818	Black River	15096	Debris	Good	Near Browns Ferry Park	33.54809	–79.40178
11819	Tributary of Mingo Crk	15097	Debris	Good	Rhews Pentacostal Holiness Church near intersection with County Rd 5-22-37	33.57657	–79.43286
11831	Black River	15109	Debris	Good	Dunbar Rd, bridge over Black R, 4 pilings NW of 1st power pole on NE side of road, SE side of Black	33.5468	–79.36014
11832	Mingo Crk Swamp	15110	Debris	Good	End of Pisgah Rd of Rose Hill Rd (CR-6)	33.58246	–79.40496
11833	Black Mingo Creek	15111	Debris	Good	Tan one story home with grey roof and green mailbox on white pole marked “Canada1;” east side of roa	33.61588	–79.4333
11834	Black River	15112	Mud	Good	White one story home, 500’ N of road, left d/s side of river; 4-bay garage 200 ft from road in front	33.51987	–79.42791
11835	Choppee Crk	15113	Debris	Good	Entrance Rustic Lane at east side of Choppee Rd (Across from Rose Hill Rd)	33.55956	–79.34252
11836	Black River	15114	Debris	Good	Canteen Ln off Choppee Rd, ~120 ft past Marg George Ln	33.5337	–79.34053
11837	Black River	15115	Seed line	Good	Off Whitmine, off Postfoot Rd, which is off SC51	33.5032	–79.32213
11838	Black River	15116	Seed line	Good	Two story dark green house, SE corner post facing river	33.50122	–79.29665
11839	Black River	15117	Debris	Good	Freeman Rd off Hwy 701, 0.3 miles south of Black River Bridge	33.47689	–79.27801
11810	Big Dam Swamp	15088	Mud	Good	One story white house, black roof and shutters, brick foundation located on NE side of road; marker	33.50036	–79.51517
11811	Big Dam Swamp	15089	Seed line	Good	One story brown vertical wood siding house on north side of road; driveway on west side of house	33.49906	–79.51241
11812	Big Dam Swamp	15090	Seed line	Good	Brick one story on south side of road; submerged	33.5003	–79.51535
11813	Big Dam Swamp	15091	Mud	Good	South side of SC Hwy 41 County Line Rd #16100-16550 driveway with black fence/ copper post tops; whit	33.49868	–79.53409
11814	Big Dam Swamp	15092	Debris	Good	Submerged; near Wallace Cemetary, guard rail on SE side of Hwy	33.51551	–79.49979
11815	Big Dam Swamp	15093	Debris	Good	Intersection of County Line Rd and Garnette Dr, south side of County Line Rd	33.51621	–79.49825
Ashley River near Charleston							
11250	Church Creek	14428	Debris	Fair	Center fence post of backyard fence, on left side at dead end of Par Drive	32.84315	–80.078
11251	Church Creek	14429	Debris	Fair	On wall/fence at sidewalk entrance to garage	32.84354	–80.07808
11252	Church Creek	14430	Stain line	Fair	Mark type not indicated, but noted as inside mark…transferred outside?...Sharpie line on mailbox, si	32.84362	–80.08128
11253	Church Creek	14431	Debris	Fair	On mailbox post under mailbox, side facing driveway	32.84399	–80.08182
11254	Church Creek	14432	Debris	Fair	On small fence surrounding garbage can on side of house	32.84434	–80.08244

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Black River near Andrews							
14.2	Nail and HWM tag	0.52	Gate post to east of house, betwee house and stable/ kennel; marked with nail and disc	Rural	10/11/2015	10/15/2015	Yes
16.4	Marker	2.97	Orange and white GTE buried cable junction box	Urban	10/11/2015	10/15/2015	Yes
14.4	Nail and HWM tag	1.16	South side of driveway on post of stair to yellow garage facing yellow house on river	Rural	10/11/2015	10/15/2015	Yes
14.3	Nail and HWM tag	2.74	Left side near back of church 10’ 6x6 wooden post (turkey shoot pulley)	Rural	10/11/2015	10/14/2015	Yes
11.6	Paint	0.64	River side of piling	Rural	10/12/2015	10/15/2015	No
14.2	Nail and HWM tag	0.14	One story beige house at end of gravel drive ~500’ past bar barricade, on first right post of dock o	Urban	10/12/2015	10/14/2015	Yes
14.7	Nail	1.63	Mailbox post	Rural	10/12/2015	10/15/2015	Yes
18.6	Stake	0	Red stake attached to rebar, 40 ft from NE corner of house; NE of wooden retaining wall, near river	Rural	10/12/2015	10/16/2015	No
11.7	Stake	0.90	Rt side of entrance gate 3rd post from gate	Rural	10/12/2015	10/14/2015	Yes
11.3	Nail and HWM tag	0.56	Base of pine tree near GTE cable marker	Rural	10/12/2015	10/14/2015	Yes
10.1	Stake	0.85	River side of one story gabled house on metal retaining wall down five steps on approach to dock	Urban	10/12/2015	10/14/2015	No
8.2	Nail and HWM tag	1.34	—	Rural	10/12/2015	10/14/2015	No
6.8	Stake	0.89	On left arrow - 10 mph sign post about 135 ft from Hwy 701	Rural	10/12/2015	10/14/2015	Yes
23.4	Marker	2.52	Black wrought iron marker pole at foot of driveway; “Bryant 599” marked on pole	Rural	10/11/2015	10/15/2015	No
23.3	Nail	2.38	Pine tree, 5 inch diameter, 50’ west of driveway, 25’ south of poultry cage (chain link structure)	Rural	10/11/2015	10/16/2015	No
23.3	Marker	7.22	Porch post marked with black marker	Rural	10/11/2015	10/15/2015	No
22.9	Marker	4.07	RHS gate post, flagging tape; marked on post	Rural	10/11/2015	10/16/2015	Yes
22.5	Marker	0.95	SE side of guard rail post, marked on guard rail, also flagged	Rural	10/11/2015	10/15/2015	No
23.2	Nail and HWM tag	2.29	Wooden post supporting telephone switching box on right side of Garnette Dr	Urban	10/11/2015	10/15/2015	Yes
Ashley River near Charleston							
10.8	Marker	1.23	Colored flagging above marker	Urban	10/8/2015	10/10/2015	Yes
10.8	Marker	0.85	—	Urban	10/8/2015	10/10/2015	Yes
10.7	Marker	2.73	Colored flagging below marker	Urban	10/8/2015	10/10/2015	Yes
10.7	Marker	2.95	Colored flagging below marker	Urban	10/8/2015	10/10/2015	Yes
10.7	Marker	2.65	Colored flagging above marker	Urban	10/8/2015	10/10/2015	Yes

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Ashley River near Charleston—Continued							
11450	Eagle Creek	14748	Seed line	Good	1013 Harrison Rd, back yard side fence right side of property	32.96348	–80.15023
11451	Ashley River	14749	Seed line	Good	Bacons Bridge Rd (Hwy 16S bridge) Utility poll 300 ft from bridge	32.95881	–80.2004
11452	Ashley River	14750	Seed line	Good	Hwy 16S- Bacons Bridge Rd. End of white picket fence	32.95112	–80.20218
11453	Ashley River	14751	Seed line	Good	129 History Lane-Hwy 61. Alligators sign	32.94635	–80.24002
11454	Ashley River	14752	Seed line	Good	Cane Acre Rd, utility pole 30 ft from road	32.95828	–80.26158
11455	Ashley River	14753	Debris	Good	1049 Blockade Runner Pkwy, headwall near kids playground	32.96746	–80.2473
11456	Ashley River	14754	Seed line	Good	238 Helms Dr, near back step below pool	33.01197	–80.28886
11457	Ashley River	14755	Debris	Fair	Near Big Bird Lane - 50 ft off the back corner of maintenance building	33.06374	–80.28858
11458	Ashley River	14756	Seed line	Good	428 Twin Lakes Dr (Rogers Way) New posts set near wooden walkway on right side of house	33.00159	–80.2813
11330	Ashley River	14508	Seed line	Good	SC-DOR-505; side wooden fence near garage	32.9543	–80.1859
11331	Ashley River	14509	Seed line	Good	SC-DOR-506; fence at right property line; bottom of fence at S of property line	32.95413	–80.18375
11332	Ashley River	14510	Seed line	Fair	SC-DOR-507; 3rd maibox, post on mailbox #104 Park Lane	32.94933	–80.168
11333	Ashley River	14511	Seed line	Fair	SC-DOR-508; 6 x 6 post on back side of dumpster enclosure	32.94905	–80.16168
11334	Ashley River	14512	Seed line	Good	SC-DOR-509; Summer Bend on the Ashley approx. 15-20 ft from dock follow line of flags	32.9017	–80.1179
11335	Ashley River	14513	Seed line	Good	SC-DOR-510 (no comments)	32.89416	–80.10246
11336	Ashley River	14514	Seed line	Good	SC-DOR-511; right side of boat ramp; near Great Oak Drive	32.87122	–80.06382
11337	Ashley River	14515	Seed line	Good	SC-CHA-512; right side of dock near shore; near Great Oak Drive	32.87482	–80.07894
11338	Ashley River	14516	Seed line	Good	SC-CHA-513; bottom of stairs right side facing river	32.88092	–80.07875
11339	Eagle Creek	14517	Seed line	Good	SC-DOR-514; left side wooden fence in front yard	32.95351	–80.15869
11340	Eagle Creek	14518	Seed line	Good	SC-DOR-515; back of fence right side of house	32.95726	–80.15589
11685	Popperdam Crk	14962	Seed line	Good	One story brick house at bend in road with redwood stained stockade fence	32.94048	–80.08304
11686	Popperdam Crk	14963	Seed line	Good	One story grey house with chain link fence	32.94051	–80.08222
11687	Popperdam Crk	14964	Seed line	Good	Two story grey house/black trim on creekside of road with weathered stockade fence on NW side of pro	32.94178	–80.08063
11689	Popperdam Crk	14966	Seed line	Good	One story brick house w/weathered stockade fence on west side of yard	32.94036	–80.08139
11690	Popperdam Crk	14967	Seed line	Good	One story brick/tan stucco, white/black trim, with shed in backyard, north side of house	32.94022	–80.08209
11691	Popperdam Crk	14968	Seed line	Good	One story brick house, backs up to channel, dark red trim, “7771” above front door	32.93849	–80.08308
11910	Ashley River	15248	Mud	Good	—	32.95262	–80.17
12150	Church Creek	15368	Debris	Fair	On mailbox post under mailbox facing driveway	32.8412	–80.07828
12151	Church Creek	15369	Debris	Fair	On green electrical house on golf course	32.84021	–80.0788
12152	Church Creek	15370	Debris	Fair	On mailbox post facing driveway	32.83483	–80.0681

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Ashley River near Charleston—Continued							
13.4	Nail	2.48	—	Urban	10/9/2015	10/11/2015	Yes
12.0	Nail	0.85	—	Rural	10/9/2015	10/11/2015	Yes
12.4	Nail	1.05	—	Rural	10/9/2015	10/11/2015	Yes
14.4	Nail	0.95	—	Urban	10/9/2015	10/11/2015	Yes
15.8	Nail	3.60	—	Rural	10/9/2015	10/11/2015	Yes
14.0	Marker	4.61	—	Urban	10/9/2015	10/10/2015	Yes
22.3	Nail	1.91	—	Rural	10/9/2015	10/10/2015	Yes
25.5	Nail	2.70	Faint	Rural	10/9/2015	10/10/2015	Yes
22.0	Nail	4.20	—	Rural	10/9/2015	10/10/2015	Yes
11.2	Nail	0.88	—	Urban	10/8/2015	10/12/2015	Yes
10.6	Tape	0.75	SC-DOR-506; also disc identifier	Urban	10/8/2015	10/12/2015	Yes
9.2	Nail and HWM tag	1.68	SC-DOR-507; disc identifier	Urban	10/8/2015	10/12/2015	Yes
8.7	Nail and HWM tag	1.44	SC-DOR-508; disc identifier; only fair seed line due to flow	—	10/8/2015	10/12/2015	No
5.7	Nail	0.70	—	Rural	10/8/2015	10/12/2015	Yes
5.9	Nail	0.45	—	Rural	10/8/2015	10/12/2015	Yes
5.5	Nail	1.60	—	Urban	10/8/2015	10/12/2015	Yes
5.5	Nail	2.03	—	Rural	10/8/2015	10/12/2015	Yes
5.7	Nail	1.06	—	Rural	10/8/2015	10/12/2015	Yes
10.5	Nail	2.88	—	Urban	10/8/2015	10/11/2015	Yes
11.1	Tape	4.68	SC-DOR-515; also disc	Urban	10/8/2015	10/11/2015	Yes
14.7	Nail	3.14	HWM marked with nail, marker, and colored flagging; HWM nailed to 3rd fence post from SE corner of f	Urban	10/10/2015	10/11/2015	No
14.7	Marker	2.00	Fence post on SW side of house, marked with marker and colored flagging	Urban	10/10/2015	10/11/2015	No
14.8	Nail	4.40	NW corner of stockade fence adjacent to channel; Marked with nail, marker, and colored flagging	Urban	10/10/2015	10/11/2015	No
14.7	Nail	1.10	Fourth fence post from front of yard, marked with nail, marker, and colored flagging	Urban	10/10/2015	10/11/2015	No
14.9	Nail	2.38	East corner of shed in back yard; marked with nail, marker, and colored flagging	Urban	10/10/2015	10/11/2015	Yes
14.9	Marker	3.46	Fence post in SW corner of backyard	Urban	10/10/2015	10/11/2015	No
7.7	Marker	0	Dorchester Crk? Tidally influenced; flow toward Ashley River	Urban	10/11/2015	10/11/2015	Yes
10.7	Marker	2.57	Sharpie line on mailbox with colored flagging	Urban	10/8/2015	10/10/2015	Yes
10.7	Marker	2.94	Mark on house on corner facing creek; near door to block house near bridge	Urban	10/8/2015	10/10/2015	Yes
9.7	Marker	2.30	—	Urban	10/8/2015	10/10/2015	Yes

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Coastal Charleston							
11390	Horse Reach	14608	Stain line	Fair	Cream colored gate post	32.78088	–79.92812
11391	Horse Reach	14609	Debris	Fair	Restaurant entracent, in white cabinet concealing electrical utilities	32.78085	–79.92882
11289	Ashley River	14464	Seed line	Fair	Shell gas station at 737 King St, Chrlstn, Mark is 9’ NW of SE end of 5’ gray block wall on sw bound	32.80006	–79.94879
11290	Ashley River	14465	Seed line	Fair	2 story yellow house at 351 Huger St, Chrlstn near intersection of King St & Huger St. Mark located	32.79995	–79.94879
11291	Ashley River	14466	Seed line	Poor	Sacred Heart Catholic Church, corner of King & Huger Sts. On NW corner of church @ steps on NE face	32.80009	–79.94789
11292	Ashley River	14467	Seed line	Poor	2 story grey house NW corner of Vanderhorst St & Smith St; mark located on the N face of 6x6 privacy	32.78575	–79.94363
11293	Ashley River	14468	Seed line	Poor	2 story yellow multi-family house on corner of Vanderhorst & Ogier. Mark located on south side of ho	32.78527	–79.94402
11296	Atlantic Ocean	14471	Debris	Poor	Pink house at 25 E Battery St, corner with Atlantic St. Poor Seed line on side of house blw porch, on	32.77203	–79.92796
11297	Atlantic Ocean	14472	Debris	Good	46 S Battery St. Trash line on back side of concrete wall in front of front steps approx. 3’ from ga	32.77069	–79.93282
11298	Atlantic Ocean	14473	Seed line	Good	139 S Battery St, Seed line on back side of brick fence post @ front of house	32.77264	–79.9409
11299	Atlantic Ocean	14474	Debris	Good	146 S Battery St, Good trash line on PP located near road. Location is subject to wave action from p	32.77317	–79.94142
11300	Atlantic Ocean	14475	Seed line	Good	Seed line on back side of 5th concrete fence support on Ashley St@ park. It is directly across from	32.77438	–79.94111
Gills Creek and tributaries in Columbia							
11359	Gills Creek	14537	Seed line	Good	D/s right out side of Gills Creek Bridge @ Rosewood. 10’ from end of bridge	33.98742	–80.97702
11360	Gills Creek	14538	Mud	Good	Drive-through window of Church’s Chicken, front corner. d/s left bank of gage at Devine & Rosewood	33.98895	–80.97405
11361	Gills Creek	14539	Other (Note in description box)	Good	D/S right bank of gage. Ruby Tuesday left side building under 2nd awning	33.9902	–80.97538
11362	Gills Creek	14540	Stain line	Unknown/ historical	U/S right bank, title loan, 4701 Crowson Dr, side corner facing Devine St	33.99007	–80.97441
11363	Gills Creek	14541	Seed line	Good	Indoors, U/S left bank at Jersey Mike’s, 4717 Devine St, front [illegible] on Devine St, left side o	33.98969	–80.97389
11364	Gills Creek	14542	Seed line	Excellent	Left side of house at 710 Rickenbacker Rd, on a/c unit	33.99319	–80.97308
11365	Gills Creek	14543	Seed line	Excellent	Right side of house at 820 Burwell Lane	33.99337	–80.97179
11366	Gills Creek	14544	Seed line	Excellent	839 Burwell Ln, Rt front of door, just right of shelter	33.99437	–80.97163
11367	Gills Creek	14545	Seed line	Excellent	4807 Datura Rd, intersects Rickenbacker, rt side entrance to home	33.99527	–80.97121
11368	Gills Creek	14546	Seed line	Excellent	926 Rickenbacker Rd, Far right window of home on left of window	33.99606	–80.97068

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Coastal Charleston							
6.1	—	1.19	Linear dirt stain consistent with staff reports of water encroachment into steps of restaurant	Urban	10/8/2015	10/12/2015	Yes
5.7	—	0	Sharpie line of left side of cabinet	Urban	10/8/2015	10/12/2015	Yes
9.0	Marker	1.97	Mark has both flagging and marker	Urban	10/8/2015	10/17/2015	Yes
9.3	Marker	2.00	Flagging and marker, located just under third step to the house	Urban	10/8/2015	10/17/2015	Yes
8.9	Marker	1.59	Flagging & marker	Urban	10/8/2015	10/17/2015	Yes
4.9	Marker	1.63	Flagging & marker	Urban	10/8/2015	10/12/2015	Yes
4.8	Marker	1.67	Flagging & marker; located on S side of house, approx 15’ E of SW corner of house, below 2 windows n	Urban	10/8/2015	10/12/2015	Yes
5.8	Marker	0.55	—	Urban	10/8/2015	10/10/2015	Yes
5.3	Marker	0.55	flagging on fence rail	Urban	10/8/2015	10/10/2015	Yes
4.9	Other (Note in description box)	1.05	Pencil line	Urban	10/8/2015	10/10/2015	Yes
4.4	Nail	0.63	—	Urban	10/8/2015	10/10/2015	Yes
4.0	Marker	0.72	—	Urban	10/8/2015	10/10/2015	Yes
Gills Creek and tributaries in Columbia							
151.8	Marker	0	0.17 above ledge, 0.6 below concrete handrail	Urban	10/8/2015	10/12/2015	No
155.9	Marker	2.40	2.4 above road	Urban	10/8/2015	10/13/2015	No
155.0	Marker	0.50	Mudline and stain	Urban	10/8/2015	10/13/2015	No
155.3	Marker	4.80	—	Urban	10/8/2015	10/13/2015	No
155.3	Marker	5.30	—	Urban	10/8/2015	10/13/2015	No
158.1	Marker	0.70	—	Urban	10/8/2015	10/13/2015	No
158.4	Marker	6.40	—	Urban	10/8/2015	10/13/2015	No
159.1	Marker	11.40	6.36’ above brick window ledge (black square on brick) or 11.4’ above ground	Urban	10/8/2015	10/13/2015	No
159.2	Marker	6.70	5.7’ above porch, 6.7’ above ground	Riverine	10/8/2015	10/13/2015	No
159.4	Marker	4.80	—	Urban	10/8/2015	10/13/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11369	Gills Creek	14547	Seed line	Excellent	4862 Kilbourne Rd, Right side garage	33.99694	–80.96989
11212	Pen Branch	14390	Seed line	Good	SC-RIC-716; (no notes)	34.00904	–80.96544
11213	Pen Branch	14391	Seed line	Excellent	SC-RIC-717; Seed line in corner of back of house and corner of porch	34.00846	–80.96588
11214	Pen Branch	14392	Seed line	Good	SC-RIC-718; (no notes)	34.00796	–80.96640
11215	Pen Branch	14393	Seed line	Good	SC-RIC-719; Seed line on block retaining next to parking lot at Columbia Medical Group behind and at	34.00763	–80.96756
11216	Pen Branch	14394	Seed line	Good	SC-RIC-720; seed line in group of trees	34.00796	–80.96912
11217	Pen Branch	14395	Seed line	Good	SC-RIC-721; very good seed line on house side of fence 20’ from driveway, on Trenholm Road side of h	34.00840	–80.97036
11218	Pen Branch	14396	Seed line	Excellent	SC-RIC-722; (no notes)	34.0091	–80.97129
11219	Pen Branch	14397	Seed line	Good	SC-RIC-723; good seed line on 36” white oak, if facing house tree on right side of home	34.00985	–80.97366
11220	Pen Branch	14398	Seed line	Good	SC-RIC-724; seed line in 18” dia tree coming toward creek, 25’ from house 25’ from Rt fence	34.00913	–80.97243
11221	Pen Branch	14399	Seed line	Good	SC-RIC-725; seed line in 24” dia sweet gum in ctr of backyeard shed to side has good seed line as we	34.01025	–80.97521
11222	Pen Branch	14400	Seed line	Good	SC-RIC-726; seed line inside corner of back porch, on covered over concrete pad	34.01087	–80.97594
11223	Pen Branch	14401	Seed line	Good	SC-RIC-727; seed line on crawl space door frame on back side of home	34.01142	–80.97667
11224	Pen Branch	14402	Seed line	Good	SC-RIC-728; seed line on door way frame going under house nr. Corner of house and steps going up to	34.01213	–80.97805
11225	Pen Branch	14403	Seed line	Good	SC-RIC-729; seed line on sweet gum 24” dia, 45 ft away and down hill from house, 35’ from right fenc	34.01273	–80.97871
11342	Gills Creek	14521	Seed line	Excellent	Crawlspace door at 915 Tall Pines Cir Apt C, end brickhouse Triplex, mark on south side building	33.9641	–80.98167
11343	Gills Creek	14522	Seed line	Excellent	Apt 1828, 902 Tall Pines Cir , right corner of building, meter box	33.96521	–80.98219
11344	Gills Creek	14523	Seed line	Excellent	SC-RIC-903A: Apt 1721 Tall Pines Cir, front right window	33.96612	–80.98344
11345	Gills Creek	14523	Seed line	Excellent	SC-RIC-903B; Apt 1721 Tall Pines Cir, meter box	33.96613	–80.98351
11346	Gills Creek	14524	Seed line	Excellent	Apt 1637 Tall Pines Cir house, left side brick	33.96658	–80.98375
11347	Gills Creek	14525	Seed line	Excellent	Link fence between 1515 and 1511 Tall Pines Cir	33.96971	–80.98344
11348	Gills Creek	14526	Other (Note in description box)	Excellent	Corner of Timberlane & 1500 Tall Pines Cir. Front of house above brick on 1st siding board. Type not	33.97015	–80.98306
11349	Gills Creek	14527	Seed line	Excellent	Downspout at 1344 Glenhaven Dr, back rt corner of house	33.97063	–80.98258
11350	Gills Creek	14528	Debris	Excellent	Brick house at corner of Glenhaven & Whispering Pines; garage side behind bush	33.9724	–80.98184
11351	Gills Creek	14529	Debris	Excellent	1226 Glenhaven Dr; left of entry door, front above brick	33.97384	–80.98118
11352	Gills Creek	14530	Other (Note in description box)	Excellent	1100 Glenhaven Dr; Front house left of front door	33.97519	–80.9808
11354	Gills Creek	14532	Seed line	Excellent	4210 Mikell Ln; off S Beltline Dr; door facing Gills Creek. Plus extra mark left fron corner brick,	33.98106	–80.97903

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
159.6	Marker	4.90	—	Urban	10/8/2015	10/13/2015	No
161.7	Nail	2.99	Also colored flagging	Urban	10/8/2015	10/13/2015	No
161.9	Marker	3.98	Also colored flagging	Urban	10/8/2015	10/13/2015	No
161.9	Marker	2.95	Also colored flagging	Urban	10/8/2015	10/13/2015	No
163.5	Marker	1.89	Also colored flagging and spray paint	Urban	10/8/2015	10/13/2015	No
165.3	Nail	3.00	Also colored flagging and spray paint	Urban	10/8/2015	10/13/2015	No
171.3	Nail	2.21	Also colored flagging and marker	Urban	10/8/2015	10/13/2015	No
172.7	Nail	2.52	Also colored flagging	Urban	10/8/2015	10/13/2015	Yes
174.0	Nail	3.87	Also colored flagging	Urban	10/8/2015	10/14/2015	No
173.0	Nail	5.94	Also colored flagging	Urban	10/8/2015	10/14/2015	No
175.2	Nail	3.72	Also colored flagging	Urban	10/8/2015	10/14/2015	No
176.4	Nail	1.07	HWM measured above raised patio; also colored flagging	Urban	10/8/2015	10/14/2015	No
178.5	Nail	2.42	Also colored flagging	Urban	10/8/2015	10/13/2015	No
185.8	Nail	5.09	Also colored flagging	Urban	10/8/2015	10/13/2015	No
186.5	Nail	3.82	Also colored flagging	Urban	10/8/2015	10/14/2015	No
148.2	Marker	2.48	Seed and Trash line notes say “2’ 48” above ground” [sic]	Urban	10/8/2015	10/12/2015	No
148.3	Marker	4.60	—	Urban	10/8/2015	10/12/2015	No
148.4	Marker	5.20	—	Urban	10/8/2015	10/12/2015	No
148.4	Marker	5.30	—	Urban	10/8/2015	10/12/2015	No
148.5	Marker	1.32	—	Urban	10/8/2015	10/12/2015	No
148.5	Marker	0.40	—	Urban	10/8/2015	10/12/2015	No
148.5	Marker	6.60	Type not noted	Urban	10/8/2015	10/12/2015	No
148.6	Marker	3.20	—	Urban	10/8/2015	10/12/2015	No
148.9	Marker	4.60	—	Urban	10/8/2015	10/12/2015	No
148.8	Marker	0.90	Height is above wood sill on top of brick	Urban	10/8/2015	10/12/2015	No
149.0	Marker	5.80	Seed and debris line’ 5.8 above grd, 3.95 above step	Urban	10/8/2015	10/12/2015	No
149.5	Marker	2.80	—	Urban	10/8/2015	10/12/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11355	Gills Creek	14533	Seed line	Excellent	Leasing office of Shandon Cross Apts, 504 S Beltline Blvd, garage door rt side at end of building	33.98448	–80.97906
11356	Gills Creek	14534	Seed line	Excellent	Withers Dr Apt 12 B, seed line on rt side of house away from creek (west side)	33.98498	–80.97958
11357	Gills Creek	14535	Seed line	Excellent	9B Withers Dr, Woodland Terrace Apt; Front Door seed line triangle	33.98567	–80.97804
11358	Gills Creek	14536	Mud	Excellent	Corner of 4126 Beecliff Dr & Rosewood. Just before Gills Creek. Stain mark on Hot water "Heat Hut"	33.98644	–80.97925
11471	Eightmile Branch	14768	Seed line	Good	Located at 205 Juarez Ct; HWM seed line located on front porch right column	34.02583	–80.9763
11490	Gills Creek	14788	Seed line	Excellent	TD to seed line from top of ds handrail (box mark in sharpie) at left abutment on Shop Road @ Gills C	33.95478	–80.98069
11491	Gills Creek	14789	Seed line	Good	TRt front corner of house just above water faucet on house 0.32' above bottom of brick wrap-around s	33.96457	–80.97842
11492	Gills Creek	14790	Seed line	Excellent	SC-RIC-1003-A; Exc seed line on storage shed 1.03' below moulding (see pic #4) back side of shed clo	33.96629	–80.97754
11493	Gills Creek	14790	Seed line	Good	SC-RIC-1003-B; good seed line on palm tree in front yard on Rt side of home; 730 Hampton Creek Way	33.96657	–80.97721
11494	Gills Creek	14791	Seed line	Excellent	SC-RIC-1004A; HWM (exc seed) on wall at garage door. ~ Back corner of house; 129 Rock Branch Lane	33.96791	–80.97705
11495	Gills Creek	14791	Seed line	Excellent	SC-RIC-1004-B; Exc seed line at base of new storage shed behind home (see pic 1); 124 Rock Branch La	33.96858	–80.97714
11496	Gills Creek	14792	Seed line	Good	SC-RIC-1005-A; Good seed line in 6" hickory on back right edge of backyard approx 50' from rear corn	33.9696	–80.9776
11497	Gills Creek	14792	Seed line	Excellent	SC-RIC-1005-B; Exc seed line on white storage shed in backyard; 636 Hampton Chase Lane	33.96974	–80.97742
11498	Gills Creek	14792	Seed line	Excellent	SC-RIC-1005-C; Exc seed line on fence at left of house in back yard; 636 Hampton Chase Lane	33.96958	–80.97715
11554	Eightmile Branch	14832	Seed line	Excellent	—	34.0202	–80.96462
11556	Eightmile Branch	14834	Seed line	Excellent	—	34.02122	–80.96642
11557	Eightmile Branch	14835	Seed line	Excellent	—	34.02001	–80.96655
11558	Eightmile Branch	14836	Seed line	Excellent	Forest Lake Garden	34.01975	–80.96586
11559	Eightmile Branch	14837	Seed line	Excellent	—	34.01927	–80.96515
11560	Eightmile Branch	14838	Seed line	Excellent	—	34.02242	–80.96828
11561	Eightmile Branch	14839	Seed line	Excellent	—	34.02400	–80.97032
11562	Eightmile Branch	14840	Seed line	Excellent	—	34.02346	–80.97116
11563	Eightmile Branch	14841	Seed line	Good	—	34.02398	–80.97204
11564	Eightmile Branch	14842	Seed line	Excellent	—	34.02441	–80.97533
11570	Gills Creek	14848	Seed line	Good	4614 Lelias Ct Rinnai Box on right side of house. Left side box facing street.	34.00023	–80.96938

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

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Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
150.6	Marker	3.40	2.9’ above slab, 3.4’ above ground, back side of building, good seed line # 40	Urban	10/8/2015	10/12/2015	No
150.5	Marker	6.51	—	Urban	10/8/2015	10/12/2015	No
150.7	Marker	5.30	5.3 from stoop slab	Urban	10/8/2015	10/12/2015	No
151.6	Marker	2.60	—	Urban	10/8/2015	10/12/2015	No
182.2	Marker	4.73	Flagging & marker	Urban	10/9/2015	10/16/2015	No
138.7	Other (Note in description box)	5.90	Sharpie/ ds left hr (?) abut Shop Road	Urban	10/8/2015	10/11/2015	Yes
148.2	Other (Note in description box)	2.10	Black sharpie mark on brick	—	10/8/2015	10/11/2015	No
148.3	Other (Note in description box)	6.89	SC-RIC-1003-A; black sharpie	Urban	10/8/2015	10/11/2015	Yes
148.2	Nail	2.30	SC-RIC-1003-B; other - flagging	Urban	10/8/2015	10/11/2015	Yes
148.5	—	3.89	—	Urban	10/8/2015	10/11/2015	Yes
148.5	—	2.50	—	Urban	10/8/2015	10/11/2015	Yes
148.9	Nail	3.09	SC-RIC-1005-A; also flagged	Urban	10/8/2015	10/11/2015	Yes
148.9	Marker	5.91	SC-RIC-1005-B; sharpie line	Urban	10/8/2015	10/11/2015	Yes
148.9	Marker	4.97	SC-RIC-1005-C; black sharpie	Urban	10/8/2015	10/11/2015	Yes
168.5	Other (Note in description box)	2.35	HWM marked with pencil; Right side of right stairway; 10th course of bricks	—	10/9/2015	10/14/2015	No
168.2	Tape	3.10	On front porch of 5309 W Trenholm Rd next to street number sign - 7th brick course down	Urban	10/9/2015	10/14/2015	No
168.2	Marker	2.05	On right most front window on left side frame	Urban	10/9/2015	10/14/2015	No
167.7	Nail	8.90	Front porch 3rd 4x4 post from right	Urban	10/9/2015	10/15/2015	No
167.5	Marker	6.50	Metal back proch/stream side	Urban	10/9/2015	10/15/2015	No
170.8	Tape	2.75	Left side of garage; flagging and pencil mark	Urban	10/9/2015	10/15/2015	No
172.2	Other (Note in description box)	5.20	HWM marked with pencil	Urban	10/9/2015	10/15/2015	No
173.8	Tape	4.40	HWM marked with flagging and pencil; right side of big front window on siding	Urban	10/9/2015	10/15/2015	No
173.6	Marker	0	On garage, right side-stream side 4th brick, 5’ back from front	Urban	10/9/2015	10/15/2015	No
179.9	Tape	2.40	On left side of house on wooden fence to left of gate; colored flagging and pencil mark	Urban	10/9/2015	10/16/2015	No
160.8	Marker	5.30	Marked with triangle, seed line was along brick	Urban	10/9/2015	10/13/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11571	Gills Creek	14849	Other (Note in description box)	Excellent	4624 Lelias Ct Right garage door, left side triangle on left side of house	34.00085	–80.9687
11572	Gills Creek	14850	Seed line	Excellent	4632-4618 Perry Ct Fence line (Front) edge; nail in fence on 4618 Perry Ct side fence next to trash	34.00309	–80.96852
11573	Gills Creek	14851	Seed line	Excellent	464 Pinegrove Ct, front left of home right of driveway on rain downspout	34.00394	–80.96753
11574	Gills Creek	14852	Seed line	Excellent	5 Lake Point Rd, left door frame, outdoor side, left side house @ pool gate entrance	34.00556	–80.96431
11575	Gills Creek	14853	Seed line	Excellent	1656 Kathwood Dr, Left side 1 garage door, frame closest to street	34.00769	–80.96285
11576	Gills Creek	14854	Seed line	Excellent	Trenholm Dr Shopping Center Post Office rear, closest to Gills Creek; back wall, perpendicular to cr	34.01692	–80.96333
11577	Gills Creek	14855	Seed line	Excellent	15 D Urban Nirvana. Mark on pipe below 7 electrical boxes, d/s Forest Drive right bank, left side of	34.01817	–80.96345
11578	Gills Creek	14856	Seed line	Good	SC-RIC-936A; Country Club Ct end of cul-de-sac (Gated). Seed line on tree left side chainlink fence j	34.02285	–80.96335
11579	Gills Creek	14856	Seed line	Good	SC-RIC-936B; County Club ct end of cul-de-sac (gated); seed line on tree left side chain link fence d	34.02299	–80.96348
11580	Gills Creek	14856	Seed line	Excellent	SC-RIC-936C; Country Club ct end of cul-de-sac (gated). Seed line on electric post, left side of chai	34.02290	–80.96350
11581	Gills Creek	14857	Seed line	Excellent	320 Country Club Dr, Gutter downspout back yard left of french doors	34.02589	–80.96081
11583	Gills Creek	14859	Seed line	Excellent	612 Spring Lake Rd on left basement door around back on rt side of house facing lake	34.03096	–80.95662
11619	Gills Creek	14896	Seed line	Excellent	SC-RIC-1019A; 4990 Quail Lane, 1 story white brick home; front door, 1.6’ above sharpee square on pa	34.01117	–80.95823
11620	Gills Creek	14896	Seed line	Excellent	SC-RIC-1019B; 4990 Quail Lane, 1 story white brick house; TD= 1.02’ above square at right corner pos	34.01098	–80.95794
11621	Gills Creek	14897	Seed line	Excellent	SC-RIC-1020A; 30 Tupelo Trail; right front corner of house next to brick stairs leading to side entr	34.01292	–80.95738
11622	Gills Creek	14897	Seed line	Good	SC-RIC-1020B; 30 Tupelo Trail; in crepe myrtle at left side of front porch	34.01254	–80.95753
11623	Gills Creek	14898	Seed line	Excellent	515 Alexander Cir; on brick wall (short) leading into left side of garage	34.01448	–80.9578
11624	Gills Creek	14899	Seed line	Excellent	545 Alexander Cir; right frame board of left garage bay	34.016	–80.95903
11625	Gills Creek	14900	Seed line	Excellent	Cormas Nutritional Supplements next to Tuesday Morning on 4903B Forest Dr; located on back of store-	34.01993	–80.9621
11626	Gills Creek	14901	Seed line	Excellent	4905 Forest Dr- Tuesday Morning; on wall at back of loading dock	34.02024	–80.96198
11627	Gills Creek	14902	Seed line	Good	5361 Lakeshore Dr; on electrical outlet poll inside tree line near the water’s edge, located near po	34.02536	–80.95458
11628	Gills Creek	14903	Seed line	Excellent	5139 Lakeshore Dr; on left rear side of house-corner by bathroom, marked on bricks	34.02322	–80.95943
11629	Gills Creek	14904	Seed line	Excellent	5727 Lakeshore Dr; on left side of garage door frame	34.0287	–80.9525

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
160.8	Marker	0	Seed & mudline, 3.8’ above cement floor slab	Urban	10/9/2015	10/13/2015	No
160.9	Nail	1.60	Flagging & nail	Urban	10/9/2015	10/13/2015	No
160.9	Marker	0	3.9’ above concrete slab	Urban	10/9/2015	10/13/2015	No
160.8	Marker	0.10	—	Urban	10/9/2015	10/13/2015	No
161.2	Marker	5.60	See field notes for personal connection	Urban	10/9/2015	10/13/2015	No
164.8	Marker	2.70	—	Urban	10/9/2015	10/13/2015	No
165.6	Marker	2.40	—	Urban	10/9/2015	10/13/2015	No
178.5	Nail	4.10	Flagging & nail	Urban	10/9/2015	10/14/2015	No
178.5	Nail	2.50	Flagging & nail	Urban	10/9/2015	10/14/2015	No
178.6	Nail	1.80	Flagging & nail	Urban	10/9/2015	10/14/2015	No
178.6	Marker	6.50	—	Urban	10/9/2015	10/14/2015	No
178.7	Marker	0	1.3’ above slab	Urban	10/9/2015	10/14/2015	No
162.9	Marker	3.06	1.2’ differential in HWMs on house; possible pileup of water on house; 2nd HWM on back of house for	Urban	10/9/2015	10/12/2015	No
161.8	Marker	0	Square and arrow in Sharpie	Urban	10/9/2015	10/12/2015	Yes
164.3	Marker	2.11	Arrow marked in Sharpie	Urban	10/9/2015	10/12/2015	Yes
164.3	Nail	2.12	Nail & flagging	Urban	10/9/2015	10/12/2015	Yes
164.3	Marker	2.39	TD from top of wall to Sharpee arrow is 1.10’	Urban	10/9/2015	10/12/2015	Yes
164.4	Marker	4.94	Tape up from square on concrete = 4.94’	Urban	10/9/2015	10/12/2015	Yes
167.3	Marker	3.16	Arrow and square on concrete	Urban	10/9/2015	10/12/2015	No
167.6	Marker	0	Double peaks: 1st 3.62’, 2nd 2.55’	Urban	10/9/2015	10/12/2015	No
178.6	Nail	3.07	Nail & flagging	Urban	10/9/2015	10/13/2015	No
178.6	Marker	1.86	Marked with arrow in Sharpie	Urban	10/9/2015	10/13/2015	No
178.5	Marker	2.45	Sharpie with arrow and square on concrete	Urban	10/9/2015	10/13/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11630	Gills Creek	14905	Seed line	Excellent	5625 Lakeshore Dr; on large oak tree at rear-left of back yard, approx. 30’ from water.	34.02714	–80.95338
11631	Gills Creek	14906	Seed line	Excellent	SC-RIC-1029A; 5841 Lakeshore Dr; on concrete wall in back yard, right side, ~15’ from breezeway 2nd	34.03077	–80.95062
11632	Gills Creek	14906	Seed line	Excellent	SC-RIC-1029B; 5841 Lakeshore Dr; on left side of 4-bay garage. Marked on the side of electrical mete	34.03056	–80.95075
11633	Gills Creek	14907	Seed line	Fair	5931 Lakeshore Dr; on 20” pine tree in right rear of yard near fence; approx 125’ from house, 4th pi	34.03254	–80.95097
11634	Gills Creek	14908	Other (Note in description box)	Excellent	6049 Lakeshore Dr; on right front corner of garage on bricks; evidence around back of multiple peaks	34.03466	–80.95253
11635	Gills Creek	14909	Seed line	Fair	6101 Lakeshore Dr; on brick wall at steps leading from garage to backyardl next to right side of gar	34.03628	–80.95086
11636	Gills Creek	14910	Seed line	Excellent	6141 Lakeshore Dr; on storage room door @ garage entrance.	34.03743	–80.95159
11637	Gills Creek	14911	Seed line	Excellent	6219 Lakeshore Dr; on storage room door inside garage	34.0384	–80.95076
11650	Gills Creek	14928	Seed line	Fair	Fair seed line marked with nail & flag in 8” pine on right rear property line~150 ‘ below house ~30”	34.03893	–80.94749
11651	Gills Creek	14929	Seed line	Fair	Fair/poor seed lines on cyclone fence posts at right rear property line 1st post nearest water by bo	34.03914	–80.9465
11652	Gills Creek	14930	Seed line	Good	Good seed line in sapling on left rear property line next to 2 large pines, approx 20’ from sea wall	34.03927	–80.94258
11653	Little Jackson Creek	14931	Seed line	Excellent	Exc seed line behind US Mattress in Tillman Plaza DS LT bank @ bridge considered ds lt bank	34.06776	–80.95306
11654	Little Jackson Creek	14932	Seed line	Excellent	Exc seed line on Title Loan building; marked on end of last window frame on side of building closest	34.06917	–80.95308
11655	Little Jackson Creek	14933	Seed line	Excellent	Exc seed lines at bathrooms @ Cheap Way Gas Station, marked on left corner of building next to door	34.06738	–80.95484
11656	Little Jackson Creek	14934	Seed line	Excellent	Exc seed line protected by sign leaning against right side of metal building -> Jackies Alterations	34.06617	–80.95525
11657	Little Jackson Creek	14935	Seed line	Excellent	Exc seed line on building next to Fire Lane Road, marked on SE corner of building	34.07301	–80.95158
11658	Eightmile Branch	14936	Seed line	Good	Good seed line on north side of house on side door just below door knob	34.02722	–80.97694
11659	Eightmile Branch	14937	Seed line	Excellent	Excellent seed line on greenhouse door	34.02917	–80.97917
11660	Eightmile Branch	14938	Seed line	Good	Good seed line on north side door (green) of building (lime green doors)	34.03167	–80.98194
11661	Eightmile Branch	14939	Seed line	Excellent	Excellent seed line on streamward side of garage door opening	34.03611	–80.98222
11662	Eightmile Branch	14940	Seed line	Excellent	Excellent seed line on front side of yellow storage shed	34.03917	–80.98389
11663	Eightmile Branch	14941	Seed line	Good	Fair seed lne on east end front of house	34.04194	–80.98611
11664	Eightmile Branch	14942	Seed line	Good	Good seed line on (inside) carport (shed) east side of creek	34.04556	–80.99139
11665	Eightmile Branch	14943	Debris	Fair	Fair/poor drift/trash line on/at fenceline near trash cans on right bank just upstream of pipe inlet	34.04889	–80.99194

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
178.6	Nail	4.78	Multiple bands- owner said levels fluctuated with dam breaks	Urban	10/9/2015	10/13/2015	No
178.7	Marker	5.64	—	Urban	10/9/2015	10/13/2015	No
178.7	Marker	5.35	—	Urban	10/9/2015	10/13/2015	No
178.6	Nail	1.99	Nail & flagging	Urban	10/9/2015	10/13/2015	No
178.9	Marker	1.31	Foam & mud/stain line; Sharpie arrow & square marker	Urban	10/9/2015	10/13/2015	No
186.3	Marker	2.25	Sharpie triangle and square	Urban	10/9/2015	10/13/2015	No
186.1	Marker	0.82	Sharpie arrow & square marker; TD= 0.68' above square	Urban	10/9/2015	10/13/2015	No
186.1	Marker	0.60	Sharpie arrow and square	Urban	10/9/2015	10/13/2015	No
191.6	Nail	2.40	Also colored flagging	Urban	10/10/2015	10/14/2015	No
191.3	Marker	1.57	#1 and 1.57 (#2)	Riverine	10/10/2015	10/14/2015	No
191.6	Nail	1.89	Also colored flagging	Urban	10/10/2015	10/14/2015	No
216.2	Marker	0.99	Other: sharpie "triangle pointing downward"	Urban	10/10/2015	10/14/2015	Yes
216.3	Marker	5.11	Other: sharpie "arrow down to line" & "square"	Urban	10/10/2015	10/14/2015	No
215.8	Marker	6.29	Other: sharpie "arrow down to line" & "square"	Urban	10/10/2015	10/14/2015	No
215.8	Marker	3.80	Other: sharpie "arrow down to line"	Urban	10/10/2015	10/14/2015	No
218.8	Marker	3.66	Other: sharpie "arrow down to line"	Urban	10/10/2015	10/14/2015	No
183.9	Marker	5.00	also colored flagging	Urban	10/10/2015	10/15/2015	Yes
189.5	Marker	2.20	Also colored flagging	Urban	10/10/2015	10/15/2015	Yes
202.6	Marker	2.30	Also colored flagging	Urban	10/10/2015	10/15/2015	No
210.8	Marker	2.60	Also colored flagging	Urban	10/10/2015	10/15/2015	Yes
219.5	Marker	2.20	Also colored flagging	Urban	10/10/2015	10/15/2015	No
225.7	Marker	0.50	Also colored flagging	Riverine	10/10/2015	10/15/2015	No
247.9	Marker	1.85	Also colored flagging	Urban	10/10/2015	10/15/2015	No
257.5	Nail	0	Also colored flagging, other: in tree root	Urban	10/10/2015	10/15/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11666	Eightmile Branch	14944	Seed line	Good	Good seed line on rock faced building (business), front west edge of building	34.045	–80.99028
11670	Wildcat Creek	14948	Seed line	Good	Approx. 80 yards west of southbound lanes of I-77; in 7” pine tree, on left bank. About 15 yards rig	33.995	–80.96163
11671	Wildcat Creek	14949	Seed line	Good	4963 Fort Jackson Blvd; on glass door of barber shop	33.99529	–80.957
11672	Wildcat Creek	14950	Seed line	Good	Approx. 50 yards upstream Ft Jackson Blvd, 15 yards East of Kings Grant Dr. 15” sweet gum	33.99473	–80.95886
11673	Wildcat Creek	14951	Seed line	Fair	SC-RIC-1104A; 15 yards east of gated entrance; 1 yard north of Kings Grant Dr. Oak tree	33.99362	–80.9558
11675	Wildcat Creek	14952	Seed line	Good	15 yards downhill from Gazebo for the Pool Rec Center. 3” oak north of club around back on hillslope	33.99361	–80.95049
11698	Jackson Creek	14975	Debris	Good	Sharpie mark on rear (roadside) of screened gazebo in rear of house	34.0668	–80.93931
11700	Jackson Creek	14977	Seed line	Good	Sharpie mark on corner of shop just off the carport	34.06861	–80.93661
11701	Jackson Creek	14978	Debris	Fair	Nail in large split pine on downstream side in middle of Bay Springs Road down near water’s edge	34.06821	–80.93528
11702	Jackson Creek	14979	Seed line	Good	Sharpie and flagging on DS post of dock in rear of house	34.06821	–80.93528
11703	Jackson Creek	14980	Seed line	Good	Nail in tree behind house. Marked with flagging	34.07027	–80.9351
11704	Jackson Creek	14981	Seed line	Good	Sharpie mark and nail w/ flagging on primary fence behind house on lake side of fence	34.07563	–80.92924
11705	Jackson Creek	14982	Seed line	Good	Nail and disc in tree behind house. Marked with flagging.	34.07566	–80.9259
11676	Wildcat Creek	14953	Seed line	Excellent	5 Coggins Point, house on culdesac, water mark on front of house on gutter drain	33.99306	–80.9483
11677	Wildcat Creek	14954	Seed line	Good	29 Castle Hall Lane; on retaining wall	33.99028	–80.94858
11678	Wildcat Creek	14955	Seed line	Excellent	21 Castle Hall Lane; downspout on south-east corner of house	33.99056	–80.94913
11679	Wildcat Creek	14956	Seed line	Excellent	Brown metal shed with hydraulic pipes 10 ft from the intersection of Hall St and Foster St. Behind t	33.99528	–80.94858
11680	Wildcat Creek	14957	Seed line	Excellent	East side of abandoned bldg 1609 at intersection of Washington & Lee streets. On downstream right ba	33.99479	–80.94254
11682	Jackson Creek	14959	Seed line	Fair	5” tree next to parking lot, 100 yards east of Decker Blvd, near Boeshreen Resaturant	34.06153	–80.95195
11684	Jackson Creek	14961	Seed line	Good	Tulip poplar tree east of O’Neil Court road; 40 ft off road	34.06334	–80.9488
11582	Gills Creek	14858	Seed line	Good	340 Country Club Dr; Forest Lake Club end of Country Club Dr. Pool side entrance around back (facing	34.02699	–80.95847
11584	Gills Creek	14860	Seed line	Excellent	628 Spring Lake Rd, back entrance of basement around back, Back right side of house	34.03202	–80.95593
11585	Gills Creek	14861	Seed line	Excellent	3850 Northshore Rd, Inside door under deck, left side of house	34.04136	–80.95231
11586	Gills Creek	14862	Seed line	Good	3654 Northshore Rd, cinderblock column, backyard, between neighbor’s yar boundary. Edge of Lake. Lef	34.04025	–80.94698
11587	Gills Creek	14863	Seed line	Excellent	3446 Northshore Rd, shed in back yard, left side of yard, right side of entrance door	34.03957	–80.94106
11588	Jackson Creek	14864	Seed line	Good	Residence	34.06499	–80.94435

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
247.8	Marker	1.70	Also colored flagging	Urban	10/10/2015	10/15/2015	No
161.0	Nail	4.50	Nail and flagging	Urban	10/9/2015	10/12/2015	No
164.7	Other (Note in description box)	1.60	Marker, nail, and flagging	Urban	10/9/2015	10/12/2015	No
170.7	Nail	7.80	Nail and flagging	—	10/9/2015	10/12/2015	No
192.5	Nail	6.00	Nail and flagging	Urban	10/9/2015	10/13/2015	No
192.6	Nail	4.00	Nail and flagging	Urban	10/9/2015	10/13/2015	No
224.2	Marker	2.17	Also colored flagging	Urban	10/10/2015	10/14/2015	No
223.6	Marker	1.17	Also colored flagging	Urban	10/10/2015	10/14/2015	Yes
227.5	Nail	1.85	Also colored flagging	Urban	10/10/2015	10/14/2015	No
232.8	Marker	1.69	Also colored flagging	Urban	10/10/2015	10/14/2015	No
225.7	Nail	1.22	Also colored flagging	Urban	10/10/2015	10/14/2015	Yes
231.8	Nail	2.44	Also colored flagging and marker	Urban	10/10/2015	10/14/2015	No
231.7	Nail	1.99	Also colored flagging and disc	Urban	10/10/2015	10/14/2015	Yes
192.8	Marker	6.80	Flagging and marker	Urban	10/9/2015	10/13/2015	No
192.7	Marker	2.80	Flagging and marker	Urban	10/9/2015	10/13/2015	No
192.8	Marker	5.30	Flagging and marker	Urban	10/9/2015	10/13/2015	No
192.7	Marker	1.20	Flagging and marker	Urban	10/9/2015	10/12/2015	No
192.8	Marker	2.50	Flagging and marker	Urban	10/9/2015	10/12/2015	No
203.1	Nail	5.00	Nail and flagging	Urban	10/9/2015	10/13/2015	No
205.5	Nail	5.40	Nail and flagging	Urban	10/9/2015	10/14/2015	No
178.6	Marker	1.20	—	Urban	10/9/2015	10/14/2015	No
178.7	Marker	0	3.5’ above slab	Urban	10/9/2015	10/14/2015	No
192.2	Marker	2.00	—	Urban	10/9/2015	10/14/2015	No
191.6	Marker	2.20	—	Urban	10/9/2015	10/14/2015	No
191.5	Other (Note in description box)	2.00	Mark type not specified	Urban	10/9/2015	10/14/2015	No
205.5	Marker	6.55	Seed line located on northeast corner of home on a gutter downspout, marked with sharpie and flagged	Urban	10/10/2015	10/13/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11589	Jackson Creek	14865	Seed line	Fair	Residence	34.07107	–80.93881
11590	Jackson Creek	14866	Seed line	Good	—	34.07093	–80.93685
11591	Jackson Creek	14867	Seed line	Good	—	34.0747	–80.93605
11592	Jackson Creek Tributary	14868	Seed line	Good	—	34.07707	–80.93606
11593	Jackson Creek	14869	Seed line	Good	—	34.07311	–80.9332
11594	Jackson Creek	14870	Seed line	Good	—	34.07486	–80.92946
11610	Eightmile Branch	14888	Seed line	Excellent	—	34.02708	–80.97779
11611	Eightmile Branch	14889	Seed line	Excellent	—	34.02853	–80.97939
11612	Eightmile Branch	14890	Seed line	Poor	Covenant Rd fenceline on upstream right bank for Recycling Facility on Robert Spring	34.0313	–80.982
11613	Eightmile Branch	14891	Seed line	Excellent	—	34.03468	–80.98211
11614	Eightmile Branch	14892	Seed line	Excellent	—	34.03648	–80.98244
11615	Eightmile Branch	14893	Seed line	Excellent	Split rancher	34.03744	–80.9828
11617	Gills Creek	14895	Seed line	Good	SC-RIC-1018A; 4779 Heath Hill Rd, 2 story brick home; right brick post of gate entrance to back yard	34.01052	–80.95789
11618	Gills Creek	14895	Seed line	Excellent	SC-RIC-1018B; 4779 Heath Hill Rd, 2 story brick house; front door and entry way. TD=0.80' from HWM	34.01063	–80.95786
11638	Gills Creek	14912	Seed line	Excellent	3711 Overcreek Rd; group of river birches @ shore line. Approx. ~75' from end of garage; nail on str	34.0397	–80.95018
11499	Gills Creek	14793	Seed line	Excellent	SC-RIC-1006-A; Exc seed line all around 2 story home. Measure at siding on Chimney at right side of	33.97135	–80.97601
11500	Gills Creek	14793	Seed line	Excellent	SC-RIC-1006-B; Exc seed line at front corner of house at front door (pic #1) at extension of garage	33.97136	–80.97579
11501	Gills Creek	14794	Seed line	Excellent	Exc seed line in back right corner of fence in back yard	33.97297	–80.97577
11502	Gills Creek	14795	Seed line	Fair	SC-RIC-1008-A; Fair seed line in 20" pine about 100' S of entrance to Hampton Courts Apts across dra	33.98024	–80.97582
11503	Gills Creek	14795	Seed line	Fair	SC-RIC-1008-B; Fair seed line in 12" sweet gum	33.98006	–80.97565
11504	Gills Creek	14796	Seed line	Good	Good seed line on siding at stairs of apt 8 inside stairwell at N wall	33.98324	–80.9752
11505	Gills Creek	14797	Seed line	Excellent	SC-RIC-1010-A; 4465 Jackson Blvd; 2 story brick duplex Northwest corner on side door @ Gills Cr Brid	33.99264	–80.97126
11506	Gills Creek	14797	Seed line	Good	SC-RIC-1010-B; Latter Day Saints Church @ Jackson Blvd on ds Lf bank @ bridge over Gills Creek; Good	33.99181	–80.97163

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
225.8	Marker	0.92	Seed line located on fence on northeast side of property next to a gate, marked with sharpie and flag	Urban	10/10/2015	10/13/2015	Yes
225.6	Marker	1.35	Seed line located on handicap parking sign post, marked with sharpie and flagged	Urban	10/10/2015	10/13/2015	Yes
225.0	Marker	3.03	Seed line located on dock behind windsor shores apartments office, HWM measured from dock floor	Urban	10/10/2015	10/13/2015	Yes
241.8	Marker	0.81	Seed line located at windsor shores apartments building 2 in the breezeway between E and F	Urban	10/10/2015	10/13/2015	Yes
225.2	Nail and HWM tag	1.50	Seed line located on dock southeast of building 2100; HWM measured from dock floor	Urban	10/10/2015	10/13/2015	Yes
231.8	Other (Note in description box)	6.25	HWM marked with concrete anchor and flagging; Seed line located on Bridge Pier on north end of bridge	Rural	10/10/2015	10/13/2015	No
184.3	Stake	1.60	Retaining wall behind school near main building; HWM marked with stake, marker, and colored flagging	Urban	10/10/2015	10/15/2015	No
189.3	Marker	2.50	Second shed on far side of school, net to field on right side of door frame; HWM marked with marker	Urban	10/10/2015	10/15/2015	No
202.4	Marker	2.20	Corner post 15’ from guard rail, 30’ from stream; HWM marked with marker and colored flagging	Urban	10/10/2015	10/15/2015	No
205.4	Tape	1.40	On right hand side of garage door on frame; HWM marked with colored flagging and pencil	Urban	10/10/2015	10/15/2015	No
213.3	Marker	4.10	Upstream/stream side corner on galvanized hot water heater encloser; HWM marked with marker and colo	Urban	10/10/2015	10/16/2015	No
216.1	Marker	0.60	Brick 3rd course up, behind holly bush; HWM marked with marker and colored flagging	Urban	10/10/2015	10/16/2015	No
161.9	Marker	4.12	—	Urban	10/9/2015	10/12/2015	No
162.0	Marker	3.31	HWM marked with square	Urban	10/9/2015	10/12/2015	Yes
191.5	Nail	1.59	Nail & flagging	—	10/9/2015	10/13/2015	No
148.7	Marker	1.30	SC-RIC-1006-A; black sharpie	Urban	10/8/2015	10/11/2015	Yes
148.7	Marker	1.49	SC-RIC-1006-B; sharpie	Urban	10/8/2015	10/11/2015	Yes
148.8	Marker	3.03	Sharpie	Urban	10/8/2015	10/11/2015	Yes
149.5	—	4.10	—	Urban	10/8/2015	10/11/2015	No
149.4	Nail	4.15	SC-RIC-1008-B; also colored flagging	Urban	10/8/2015	10/11/2015	No
150.2	Marker	1.53	Sharpie	Urban	10/8/2015	10/11/2015	Yes
158.0	Other (Note in description box)	6.28	SC-RIC-1010-A; sharpie ‘square’ on doorstep tape up to mark = 0.58’ tape down from doorstep to groun	Urban	10/8/2015	10/11/2015	No
157.2	Marker	1.41	SC-RIC-1010-B; other - black sharpie	Urban	10/8/2015	10/11/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11507	Gills Creek	14797	Other (Note in description box)	Fair	SC-RIC-1010-C; Latter Day Saints Church @ Jackson Blvd - embankment in front of churchnear church si	33.99223	–80.97121
11508	Gills Creek	14797	Seed line	Excellent	SC-RIC-1010-D; 4346 Jackson Blvd; Business - Chex Top Payday Loans @ corner of Crawson & Jackson Blv	33.99169	–80.97379
11509	Gills Creek	14797	Seed line	Excellent	SC-RIC-1010-E; Business - Chocolate Nirvana Bakery & Café @ Jackson Blvd located on upstream right b	33.99213	–80.97309
11510	Gills Creek	14798	Seed line	Excellent	SC-RIC-1011-A; 15 Downing Street; Access to shed from back yard. Shed is in neighbor's yard (11 Down	33.99392	–80.96957
11511	Gills Creek	14798	Seed line	Excellent	SC-RIC-1011-B; 9 Downing Street; single story brick ranch style house; Exc seed line on NE corner ma	33.99366	–80.9698
11512	Gills Creek	14799	Seed line	Excellent	Exc seed line on front door -> survey 'square" on door sill 0.42' above sharpie 'square' at door ste	33.99508	–80.96621
11513	Gills Creek	14800	Seed line	Excellent	Survey from concrete at garage entrance - bricks have sharpie mark 'square' on garage floor @ mark	33.99896	–80.96282
11514	Gills Creek	14801	Seed line	Excellent	Exc seed line on N side of house next to fence & gate. Sharpie mark on fence, 2nd board from house	34.00076	–80.96178
11515	Gills Creek	14802	Seed line	Good	Good seed line on bricks - survey 'square with x in middle' on curb	34.00261	–80.96051
11516	Gills Creek	14803	Seed line	Excellent	Exc seed line on concrete wall on South side of property approx 10' from end of driveway	34.0048	–80.95761
11517	Gills Creek	14804	Seed line	Excellent	Exc seed line at shed in backyard. Sharpie mark on corner closest to house	34.00797	–80.95554
11518	Gills Creek	14795	Seed line	Good	SC-RIC-1008-C; good seed line in 12" water oak	33.97996	–80.97558
11526	Pen Branch	14812	Seed line	Excellent	Excellent seed line back of house storage shed inside door	34.00888	–80.96364
11527	Pen Branch	14813	Seed line	Excellent	Right side of car port, corner @ porch	34.00744	–80.96932
11528	Pen Branch	14814	Seed line	Excellent	Back right corner house, inside electrical box closet to street	34.00767	–80.96979
11530	Little Jackson Creek	14816	Seed line	Excellent	#9 back entrance door, Rt side. Door next to satellite dish on roof.	34.06874	–80.95455
11531	Little Jackson Creek	14817	Seed line	Excellent	Stairwell/door 228-B/business closet to O'Neil Court	34.06997	–80.95406
11532	Little Jackson Creek	14818	Debris	Poor	Poor trash line on shrubs/Dumpster housing Rt wall	34.07052	–80.95426
11533	Little Jackson Creek	14819	Seed line	Good	Deer Park Apartments/top 4th brick, Apt D3 corner next to gutter facing creek	34.07306	–80.95409
12010	Pen Branch	15055	Seed line	Fair	SC-RIC-737-B; On opposite side of Falcon Rd than AC Flora baseball field	34.01434	–80.98371
12030	Little Jackson Creek	14815	Seed line	Good	SC-RIC-947-B; Right D/S side of bridge	34.06455	–80.95324
12050	Wildcat Creek	15328	Seed line	Good	Near building 2609 Ft Jackson	33.99506	–80.94064
11730	Jackson Creek	15008	Seed line	Fair	Intersection of Spring Lake Rd & Shorebrook Rd, on bank of Spring Lake. Large pine, inline with powe	34.03721	–80.95733
11731	Jackson Creek	15009	Seed line	Excellent	Sharpie mark on right frame of crawl space door on right side of house at 4125 Shorebrook Dr	34.03803	–80.95741
11733	Jackson Creek	15011	Seed line	Good	Rockbridge Club @ pool house. Front left of wooden storage building. Left of pool house down in grav	34.04683	–80.9583

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
157.7	Stake	0	—	Urban	10/8/2015	10/11/2015	No
156.6	Marker	3.51	SC-RIC-1010-D; other - sharpie line	Urban	10/8/2015	10/11/2015	No
156.9	Marker	0	SC-RIC-1010-E; other - sharpie line & ‘square’	Urban	10/8/2015	10/11/2015	No
159.2	Marker	5.63	SC-RIC-1011-A; other - sharpie line	Urban	10/8/2015	10/11/2015	No
159.1	Marker	2.18	SC-RIC-1011-B; other - sharpie line	Urban	10/8/2015	10/11/2015	No
160.4	Marker	2.58	Above ground	Urban	10/8/2015	10/11/2015	Yes
160.7	Marker	3.51	Other - Sharpie	Urban	10/8/2015	10/11/2015	Yes
160.8	Marker	1.19	Other - Sharpie line	Urban	10/8/2015	10/12/2015	Yes
160.9	Marker	1.76	Other - ‘square with x in the middle’ on curb with sharpie	—	10/8/2015	10/12/2015	No
161.0	Marker	2.17	Other - Sharpie line	Riverine	10/8/2015	10/12/2015	Yes
161.7	Marker	4.55	Other - Sharpie line	Urban	10/8/2015	10/12/2015	No
149.4	Nail	0	SC-RIC-1008-C; also colored flagging	Urban	10/8/2015	10/11/2015	No
161.5	Marker	6.90	Above patio	Urban	10/10/2015	10/13/2015	No
164.6	Marker	1.70	Above car port	Urban	10/10/2015	10/13/2015	No
166.5	Marker	3.10	—	Urban	10/10/2015	10/13/2015	No
216.3	Marker	3.68	Above top platform 7.2’ above grd.	Urban	10/10/2015	10/14/2015	No
216.3	Marker	5.30	0.2’ above 7th step	Urban	10/10/2015	10/14/2015	No
217.7	Marker	3.14	Above concrete curb	Urban	10/10/2015	10/14/2015	No
219.0	Marker	0.70	Abv ground	Urban	10/10/2015	10/14/2015	No
195.8	Nail	2.21	Seed line in 28” birch/oak on road side of ditch, 10’ from flagged guard rail; pointer painted on roa	Urban	10/9/2015	10/14/2015	No
205.9	Marker	3.60	—	Urban	10/10/2015	10/14/2015	No
193.5	Nail	2.40	30” pine tree, 75’ upstream, right bank	Urban	10/12/2015	10/12/2015	No
186.5	Nail and HWM tag	3.93	Marked with flagging, nail and disc	Urban	10/9/2015	10/14/2015	Yes
186.4	Marker	2.91	Flagging and marker	Urban	10/9/2015	10/14/2015	Yes
189.9	Nail and HWM tag	1.49	Marked with flagging, nail and disc	Urban	10/9/2015	10/14/2015	Yes

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11734	Jackson Creek	15012	Seed line	Fair	208 Arcadia Lakes Dr E at bridge crossing. In pine on upstream right bank of Carys Lake in line with	34.04877	–80.95844
11735	Jackson Creek	15013	Seed line	Good	6704 Cary Lane, Sharpie line on back corner of garage	34.05191	–80.95844
11736	Jackson Creek	15014	Seed line	Good	6748 Cary Lane, Sharpie mark on entry door left of garage on side of house	34.05536	–80.95708
11737	Jackson Creek	15015	Seed line	Unknown/ historical	6808 Pine Tree Cir; on mailbox brick structure.	34.05707	–80.95541
11738	Jackson Creek	15016	Seed line	Fair	6800 Pine Tree Cir; on privacy fence between House and N Trenholm Rd	34.05641	–80.95683
11739	Jackson Creek	15017	Seed line	Good	6711 N Trenholm Rd. Access HWM by turning on Arcadia Lakes Dr. Blue shed behind residence. Rear corn	34.05273	–80.9597
11740	Jackson Creek tributary	15018	Seed line	Good	6601 Wisteria Ln, house at end of Wisteria Lane beyond gate. On right corner of wood shed in drivewa	34.05261	–80.9617
11741	Jackson Creek tributary	15019	Seed line	Good	35 Lakecrest Dr. USGS monitoring well on left edge of driveway (green cover flush to ground). Sharpi	34.05178	–80.96136
11742	Jackson Creek tributary	15020	Seed line	Good	2 Lakecrest Dr. House on corner of Lakecrest & Trenholm Rd. In Pine near waters edge behind house ne	34.05083	–80.95992
11743	Jackson Creek	15021	Seed line	Good	6185 Eastshore Rd at intersection with Shorebrook. On Right side of right garage at front of house	34.03698	–80.9547
11744	Jackson Creek	15022	Seed line	Good	6205 Eastshore Rd, on brick mailbox	34.03921	–80.95489
11770	Pen Branch	15048	Seed line	Good	Facing house, taked fence in on right to back of lot, exit backyard thru gate	34.01263	–80.98022
11771	Pen Branch	15049	Seed line	Excellent	New house under construction next to 1036 Brentwood	34.01300	–80.98190
11772	Pen Branch	15050	Seed line	Excellent	Facing house, to left toward Pen Branch	34.01254	–80.98188
11773	Pen Branch	15051	Seed line	Good	Fence gate is to right of house	34.01280	–80.98207
11774	Pen Branch	15052	Seed line	Good	If facing house, HWM on left side between driveway and house	34.01359	–80.98205
11775	Pen Branch	15053	Seed line	Good	Off of Beltline Blvd	34.01246	–80.98359
11776	Pen Branch	15054	Seed line	Good	Sato Sushi Restaurant	34.01322	–80.9844
11778	Pen Branch	15056	Seed line	Excellent	Behind residence	34.01233	–80.98606
11779	Pen Branch	15057	Seed line	Good	In very back of property; need to get permission from landowner	34.01247	–80.98656
11780	Pen Branch	15058	Seed line	Good	In front yard	34.01450	–80.98892
11781	Pen Branch	15059	Seed line	Good	Backside underneath in parking area near Verizon Wireless employee parking	34.01540	–80.98965
11782	Pen Branch	15060	Seed line	Good	Facing house HWM is to the left on front corner	34.01867	–80.99522
11783	Pen Branch	15061	Seed line	Good	Golden Chick	34.01484	–80.98745
11784	Pen Branch	15062	Seed line	Good	Firestone tire behind building on left back corner area	34.01413	–80.98604
11785	Pen Branch	15063	Seed line	Good	—	34.01144	–80.97730

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
199.4	Nail and HWM tag	4.02	Marked with flagging, nail and disc	Urban	10/9/2015	10/13/2015	Yes
199.8	Marker	5.59	Flagging and marker	Urban	10/9/2015	10/13/2015	Yes
199.8	Marker	2.12	Flagging and marker	Urban	10/9/2015	10/13/2015	Yes
199.8	Marker	2.30	Flagging and marker	Urban	10/9/2015	10/13/2015	Yes
199.6	Nail and HWM tag	3.87	Marked with flagging, nail and disc	Urban	10/9/2015	10/13/2015	No
200.0	Nail and HWM tag	3.34	Marked with flagging, nail and disc	Urban	10/9/2015	10/14/2015	Yes
200.1	Nail	5.38	Nail and flag	Urban	10/9/2015	10/14/2015	No
199.8	Marker	3.28	Flagging and marker	Urban	10/9/2015	10/13/2015	Yes
198.2	Nail and HWM tag	2.20	Marked with flagging, nail and disc	Urban	10/9/2015	10/13/2015	No
186.1	Marker	1.35	Flagging and marker	Urban	10/9/2015	10/14/2015	No
186.1	Marker	2.54	Flagging and marker	Urban	10/9/2015	10/14/2015	No
186.7	Nail	3.26	Seed line on 28” hardwood, just below and outside of fenceabout 25’; tree is located in the center o	Urban	10/9/2015	10/14/2015	No
187.1	Marker	4.38	Seed or mudline on inside garage wall facing road about 4’ from garage door opening	Urban	10/9/2015	10/14/2015	Yes
187.5	Nail	1.98	Seed line on inside of door to crawl space of house	Urban	10/9/2015	10/14/2015	Yes
187.6	Nail	2.55	Seed line on inside of fence approx 5’ from gate	Urban	10/9/2015	10/14/2015	No
187.7	Nail	3.82	Seed line on double tree in front yard of residence, 200’ from Pen Branch, 20’ from road	Urban	10/9/2015	10/14/2015	No
196.4	Tape	3.09	Seed line on shoreward side of Cond near fireplace foundation	Urban	10/9/2015	10/14/2015	Yes
196.5	Marker	2.53	Seed line on outside streamward wall, mark is on AC unit which is 25’ from back of building	Urban	10/9/2015	10/14/2015	No
196.6	Nail	4.45	Seed line inside of shed, nail set in back molding of entry door. Shed located behind residence	Urban	10/9/2015	10/14/2015	Yes
196.8	Nail	1.83	Seed line on dog house in pen at very bak of residence	Urban	10/9/2015	10/14/2015	Yes
198.1	Nail	2.23	Seed line on 24” dia Pine on left side of driveway going into residence	Urban	10/9/2015	10/14/2015	No
198.4	Marker	1.19	Seed line/dirtline underneath mall on support pier	Urban	10/9/2015	10/14/2015	Yes
213.6	Nail	3.15	Seed line on side of house, behind hedges close to font of house	Urban	10/9/2015	10/14/2015	No
197.1	Marker	1.72	Seed line on retaining wall on the right side of building; ~60’ from Pen Branch which is in back of p	Urban	10/9/2015	10/14/2015	Yes
196.7	Marker	1.24	Seed line on back of building, mark is ~9’ from back left corner ~6’ from gutter	Urban	10/9/2015	10/14/2015	Yes
179.9	Nail	1.25	Seed line inside of garden shed at left back near corner of lot	Urban	10/9/2015	10/15/2015	Yes

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Gills Creek and tributaries in Columbia—Continued							
11786	Pen Branch	15064	Seed line	Good	—	34.00920	–80.97424
11787	Pen Branch	15065	Seed line	Good	—	34.00878	–80.97256
11950	Gills Cr	15288	Seed line	Excellent	Location of dam failure	34.03575	–80.95172
11951	Wildcat Creek	15289	Seed line	Fair	At end of cul-de-sac	33.99329	–80.94402
11959	Carys Lake	15297	Seed line	Good	—	34.05371	–80.95323
11960	Carys Lake	15298	Seed line	Good	—	34.04271	–80.95549
Kinley Creek near Columbia							
11230	Kinley Creek	14408	Seed line	Good	Unoccupied house; frame of garage	34.05587	–81.15165
11231	Kinley Trib	14409	Seed line	Good	Brick/yellow vinyl house	34.05695	–81.14992
11272	Kinley Creek	14450	Seed line	Good	SC-LEX-616-A; Upstream side left bank abutment	34.04678	–81.14922
11273	Kinley Creek	14450	Seed line	Good	SC-LEX-616-B; Downstream side left bank abutment	34.04658	–81.14925
11274	Kinley Creek	14451	Seed line	Good	Front porch of brick home, right banister upright	34.05465	–81.15297
11275	Kinley Creek	14452	Seed line	Good	Left side of right garage door face	34.05754	–81.15308
11276	Kinley Creek	14453	Seed line	Good	Located on power transformer box behind residence	34.0663	–81.1591
11277	Kinley Creek	14454	Seed line	Good	Located besides gutter at garage on front of house	34.06112	–81.15565
11278	Kinley Creek	14455	Seed line	Good	SC-LEX-621A; Found on SW corner (of residence) on gutter	34.0719	–81.16311
11279	Kinley Creek	14455	Seed line	Good	SC-LEX-621B; Located at back of residence on garage personal door	34.07159	–81.16277
11280	Kinley Creek	14455	Seed line	Good	SC-LEX-621C; Located at side of residence between 2 A/C units	34.072	–81.16277
11281	Kinley Creek	14456	Seed line	Fair	Located behind house on large frame wood dog house	34.06399	–81.15858
10978	Kinley Creek	14035	Seed line	Good	Streamward face of landward 4x4 post at first sign to right of path inside park.	34.05111	–81.15083
10979	Kinley Creek	14036	Seed line	Good	In white oak on the east side of field 4	34.05164	–81.15225
[1]11466	Trib to Kinley Creek	14763	Seed line	Good	Country Walk Apts on Foxfire Dr. Seed line located on back of apartments on a gutter down spout. 500-	34.06939	–81.14621
Mill Creek and tributaries near Columbia							
11890	Mill Creek	15228	Seed line	Fair	SC-RIC-1701A; 9” hardwood tree in woods behind	33.96275	–80.91052
11891	Mill Creek	15228	Seed line	Poor	SC-RIC-1701B; 18” hardwood next to SC-RIC-1701F	33.96275	–80.91052
11892	Mill Creek	15228	Seed line	Poor	SC-RIC-1701C; 6” tree ~35’ ds of 1701A and 1701B.	33.96275	–80.91052
11893	Mill Creek	15229	Seed line	Poor	SC-RIC-1702B; 6’ pine tree ~75 from Caughman Rd on DS right bank, DS from dam	33.96427	–80.91073
11894	Mill Creek	15229	Seed line	Poor	SC-RIC-1702A; DS rt side of stream just ds of dam on Caughman Rd. Coughman Road was overtopped. 6” h	33.96416	–80.91070
11895	Mill Creek	15229	Seed line	Poor	SC-RIC-1702C; DS rt of Coughman Rd. 18” pine tree 65 feet from rd about 10 ft ds of 1702B	33.96414	–80.91086
11896	Mill Creek	15230	Seed line	Good	SC-RIC-1703A; Caughman Rd Dam from Mill Creek below Sun View Lake.	33.96485	–80.91101
11897	Mill Creek	15230	Seed line	Good	SC-RIC-1703B; Caughman Rd Dam from Mill Creek. Pine tree (12”) ~ 35 ft from Caughman Rd on US right	33.96485	–80.91101

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Gills Creek and tributaries in Columbia—Continued							
174.6	Nail	2.52	Seed line on front of house, 15’ to right of front door	Urban	10/9/2015	10/14/2015	No
172.9	Nail	2.92	Seed line in group of trees at corner of parking lot	Urban	10/9/2015	10/13/2015	Yes
184.9	Marker	1.40	Exc seed line on door to back yard inside garage. Recovered mark to better define profile	Riverine	10/13/2015	10/13/2015	Yes
192.8	Marker	1.04	Front of 34 Coton Hope Ln, front on vent below right most window	Urban	10/13/2015	10/13/2015	No
199.9	Nail and HWM tag	5.95	Survey marker in tree ~30 ft from fence on south and 120’ from lakefront on landward side; next to b	Rural	10/9/2015	10/15/2015	No
187.0	Nail and HWM tag	0	Survey marker on north side of back deck	Rural	10/9/2015	10/14/2015	No
Kinley Creek near Columbia							
198.2	Marker	2.10	Marked with marker and flagging on frame of garage, right side	Urban	10/8/2015	10/15/2015	No
200.7	Marker	2.27	Mark on right side of left garage	Urban	10/8/2015	10/15/2015	Yes
187.3	Other (Note in description box)	1.82	3/8” wedge anchor set in US LEB abutment (with colored flagging)	Urban	10/8/2015	10/12/2015	No
188.3	Other (Note in description box)	4.29	3/8” wedge anchor set in DS LEB bridge near abutment (with colored flagging)	Urban	10/8/2015	10/12/2015	No
197.0	Marker	3.00	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
200.1	Marker	2.23	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
215.5	Marker	1.55	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
209.2	Marker	1.89	Colored flagging above marker	Urban	10/8/2015	10/15/2015	Yes
227.8	Marker	4.24	Colored flagging below marker	Urban	10/8/2015	10/16/2015	No
227.8	Marker	4.40	—	Urban	10/8/2015	10/16/2015	No
227.8	Marker	5.12	Colored flagging below marker	Urban	10/8/2015	10/16/2015	Yes
211.9	Marker	2.03	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
192.9	Nail	3.83	Nail with flagging	—	10/7/2015	10/12/2015	No
192.9	Nail and HWM tag	2.41	Nail with disc and flagging	Riverine	10/7/2015	10/12/2015	Yes
235.6	Nail and HWM tag	1.37	Nail, disc, flagging	Urban	10/9/2015	10/16/2015	No
Mill Creek and tributaries near Columbia							
203.5	Nail	2.30	Flagging and nail	Rural	10/9/2015	10/14/2015	No
203.7	Nail	1.83	Flagging and nail	Rural	10/9/2015	10/14/2015	No
203.5	Nail	2.67	Flagging and nail	Rural	10/9/2015	10/14/2015	No
210.6	Nail	2.25	Flagging and nail	Rural	10/9/2015	10/14/2015	No
210.1	Nail	1.42	Flagging and nail; poor seed line with some splash a little higher	Rural	10/9/2015	10/14/2015	No
210.4	Nail	1.42	Flagging and nail	Riverine	10/9/2015	10/14/2015	No
213.2	Nail	2.17	Flagging and nail	Rural	10/9/2015	10/14/2015	No
213.2	Nail	2.33	Flagging and nail	Rural	10/9/2015	10/14/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Mill Creek and tributaries near Columbia—Continued							
11898	Mill Creek	15231	Mud	Poor	SC-RIC-1704A; Caughman Rd Dam to Mill Creek DS of Sun View Lake. 3” hardwood ~100 ft from Caughman R	33.96344	–80.91006
11899	Mill Creek	15231	Seed line	Fair	SC-RIC-1704B; Caughman Rd Dam to Mill Creek ds of Sun View Lake; Leaning hardwood tree 75 ft from Co	33.96341	–80.90998
11900	Mill Creek	15232	Seed line	Excellent	House at 7921 Teague Rd; call before surveying, dangerous dogs. On carport behind house, near lake o	33.96532	–80.91014
11901	Mill Creek Trib	15233	Seed line	Excellent	Cardington Rd, behind house. On an above-ground pool in backyard. On front of pool on a ribpost (4th	33.97491	–80.90742
11902	Mill Creek Trib	15234	Seed line	Unknown/ Histor-ical	Dam between Ulmers Pond and Captain Jim’s Pond. Mark on brik near front door, near 2nd crawlspace ve	33.96891	–80.89312
11903	Mill Creek Trib	15235	Seed line	Excellent	Dam between Ulmers Pond and Griffin at 1 Trotwood Rd. Mark on gutter spout on front of house, on Ra	33.96926	–80.89269
Rawls Creek near Columbia							
[2]11233	Rawls Creek	14411	Seed line	Good	Cross foot bridge and Green info sign under power lines on end of foot bridge	34.05177	–81.1861
11234	Rawls Creek	14412	Seed line	Good	—	34.05653	–81.18764
11235	Koon Branch	14413	Seed line	Good	Along privacy fence on left side yard	34.05783	–81.18619
11236	Rawls Creek	14414	Seed line	Good	—	34.05845	–81.20003
11237	Rawls Creek	14415	Seed line	Fair	Brick home	34.05688	–81.1993
11238	Rawls Creek	14416	Seed line	Good	Vinyl sided house	34.05727	–81.19728
11239	Rawls Creek	14417	Seed line	Good	—	34.05668	–81.19537
11240	Rawls Creek	14418	Other (Note in description box)	Good	Yellow vinyl sided house	34.05622	–81.19193
11282	Rawls Creek	14457	Seed line	Good	Located on gutter downspout at concrete retaining wall next to garage	34.05783	–81.1893
11283	Rawls Creek	14458	Seed line	Good	Located on northwest corner of home	34.05774	–81.19318
11284	Rawls Creek	14459	Seed line	Good	Located on left garage door molding	34.05798	–81.19464
11285	Rawls Creek	14460	Seed line	Good	Located on gutter on southwest corner of home	34.05751	–81.1959
11286	Rawls Creek	14461	Seed line	Good	Located on northwest corner of home	34.06027	–81.19793
11287	Rawls Creek	14462	Seed line	Good	Located on left garage door	34.06132	–81.19857
11288	Rawls Creek	14463	Seed line	Good	Located at back of residence at crawl space entrance beside A/C unit	34.06424	–81.20083
11459	Rawls Creek	14757	Seed line	Good	121 Old Arms Ct, Seed line located on inside of shed door transferred to outside with sharpie and fla	34.06801	–81.20437
11460	Rawls Creek	14758	Seed line	Fair	Beverly Brandes Community Park on Coldstream Dr; seedling located on a tree east of slides marked wi	34.06826	–81.20803
11461	Rawls Creek	14759	Seed line	Good	SC-LEX-632A; Residence located on 112 Baden Ct; Seed line located on southwest corner of home.	34.06879	–81.20501
11462	Rawls Creek	14759	Seed line	Good	SC-LEX-632B; Residence located at 107 Baden Ct; seed line located on garage door molding on left.	34.06872	–81.20511
11463	Rawls Creek	14760	Seed line	Good	180 Cannon Dale Rd; seed line located on garage door molding.	34.06755	–81.20507

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Mill Creek and tributaries near Columbia—Continued							
205.4	Nail	4.50	Flagging and nail	Rural	10/9/2015	10/14/2015	No
204.7	Nail	4.25	Flagging and nail	Rural	10/9/2015	10/14/2015	No
213.4	Marker	2.75	—	Rural	10/9/2015	10/13/2015	No
239.1	Marker	1.33	—	Urban	10/9/2015	10/14/2015	No
238.0	Marker	1.08	—	Urban	10/9/2015	10/14/2015	No
243.1	Marker	1.50	—	Urban	10/9/2015	10/14/2015	No
Rawls Creek near Columbia							
193.0	Marker	6.14	Sharpie line on right post of green info board near end of foot bridge downstream of Rawls Crk Bridg	Urban	10/8/2015	10/15/2015	No
201.4	Marker	6.88	Sharpie mark on bath house near entrance left of Awning left side of entrance	Urban	10/8/2015	10/15/2015	Yes
196.9	Nail and HWM tag	1.10	Nail and disc in privacy fence along the left side yard at 2033 Cedarbrook dr	Urban	10/8/2015	10/15/2015	Yes
206.7	Nail and HWM tag	1.35	Nail and disc on shed in rear of house just left of black door	—	10/8/2015	10/15/2015	No
206.6	Nail and HWM tag	2.32	Nail with disc on wooden shed in backyard left of house	Urban	10/8/2015	10/15/2015	No
206.5	Marker	4.26	Marker and flagging	Urban	10/8/2015	10/15/2015	No
206.2	Marker	2.93	Sharpie mark on right corner of house near palm tree	Urban	10/8/2015	10/15/2015	Yes
206.1	Marker	2.79	Sharpie line of left side of 104 Wilton Hill Rd left of garage; HWM type not noted on field form	Urban	10/8/2015	10/15/2015	Yes
205.7	Marker	3.63	Colored flagging below marker	Urban	10/8/2015	10/15/2015	No
206.0	Marker	1.46	Colored flagging above marker	Urban	10/8/2015	10/15/2015	Yes
206.1	Marker	0.62	Colored flagging above marker	Urban	10/8/2015	10/15/2015	Yes
206.1	Marker	5.29	Colored flagging below marker	Urban	10/8/2015	10/15/2015	No
206.9	Marker	5.08	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
207.6	Marker	3.37	Colored flagging above marker	Urban	10/8/2015	10/15/2015	No
214.3	Marker	2.12	Inside mark transferred outside, colored flagging below marker	Urban	10/8/2015	10/15/2015	No
227.2	Marker	2.67	Flagging & marker	Urban	10/9/2015	10/14/2015	Yes
236.2	Nail and HWM tag	3.20	Nail, disc, flagging	Urban	10/9/2015	10/14/2015	No
229.0	Marker	2.26	Marked with Sharpie and flagged	Urban	10/9/2015	10/14/2015	No
229.0	Marker	1.56	Flagging & marker	Urban	10/9/2015	10/14/2015	No
227.2	Marker	3.20	Flagging & marker	Urban	10/9/2015	10/14/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Rawls Creek near Columbia—Continued							
11464	Rawls Creek	14761	Seed line	Good	138 Cannon Dale Rd; seed line located on a/c unit behind residence.	34.06527	–81.20317
11465	Rawls Creek	14762	Seed line	Good	104 Ashridge Ct; seed line located on utility room	34.06257	–81.19983
11952	Rawls Creek	15290	Seed line	Good	156 Cannon Dale Rd. Creek side of fencing attached to back of south side of house	34.06623	–81.20376
11953	Rawls Creek	15291	Seed line	Good	118 Cannon Dale Rd. Survey marker nailed in house on back, north side corner	34.06435	–81.2026
11954	Rawls Creek	15292	Seed line	Good	259 Danby Ct, back of house between chimney and window	34.06069	–81.19921
11955	Rawls Creek	15293	Seed line	Good	273 Danby Ct, survey marker on north side of black shed	34.05979	–81.19879
Rocky Branch in Columbia							
11144	Rocky Branch	14359	Seed line	Good	SC-RIC-711; Old PE Ctr on Wheat street, rt bank of Rocky Branch	33.99217	–81.02488
11145	Rocky Branch	14360	Seed line	Fair	SC-RIC-712; Just above culvert crossing Sumter St on above Mech Engineering Bldg	33.99096	–81.02686
[1]11146	Rocky Branch	14361	Seed line	Good	SC-RIC-713; Near Heyward St;	33.98365	–81.03147
11147	Rocky Branch	14362	Seed line	Fair	SC-RIC-750; Underneath train trestle crossing on support I-beam	33.99104	–81.02715
11148	Rocky Branch	14363	Debris	Poor	SC-RIC-751; Catawba Street at bridge crossing	33.98964	–81.02731
11149	Rocky Branch	14364	Debris	Excellent	SC-RIC-752; Located underneat train trestle that crosses Whaley St nrs Assembly St, Located on west	33.98755	–81.02889
11150	Rocky Branch	14365	Debris	Excellent	SC-RIC-753; Located at the back of house at 109 S Parker St	33.9836	–81.03423
11210	Rocky Branch	14388	Seed line	Good	SC-RIC-714; Seed line on loading dock @big red door 30’ from parking lot, 100’ from east corner of b	33.98283	–81.0352
11211	Rocky Branch	14389	Seed line	Good	SC-RIC-715; Seed line on back of small warehouse, volleyball and basketball courts on leftif facing	33.98170	–81.03638
11130	Rocky Branch	14348	Seed line	Good	SC-RIC-701A; seed line on utility building; 40’ u/s of culvert [illegible] on rt bank, ~20 ft from	34.00062	–81.01474
11131	Rocky Branch	14348	Seed line	Good	SC-RIC-701B; Perm. Marker on brick memorial wall below Second Calvary Baptist Church. Plaque wall is	34.0009	–81.01454
11132	Rocky Branch	14348	Seed line	Good	SC-RIC-701C; on streamside or southside of fountain wall in RD floodplain	34.00084	–81.01468
11133	Rocky Branch	14348	Seed line	Good	SC-RIC-701D; large 4’ diameter oak just next on greench bench by walkway	34.00068	–81.01493
11134	Rocky Branch	14349	Seed line	Good	SC-RIC-702A; USPS in 5 Pts loading dock	34.00001	–81.01576
11135	Rocky Branch	14350	Seed line	Fair	SC-RIC-703A; Telephone pole btwn Harpers & BofA; Pole # SCE&G 23783	33.99921	–81.01533
11136	Rocky Branch	14351	Seed line	Good	SC-RIC-704; seed line inside of the building/ garage behind the house @ 621/623 Saluda Ave	33.99771	–81.01842
11137	Rocky Branch	14352	Seed line	Fair	SC-RIC-704X; used 704 twice; railroad bridge just above Maxcy Greg Park	33.99678	–81.01916
11138	Rocky Branch	14353	Seed line	Fair	SC-RIC-705; In Maxcy Gregg Park on right bank of Rocky Br across from Finley Tower	33.99653	–81.02034
11139	Rocky Branch	14354	Seed line	Good	SC-RIC-706; in Maxcy Gregg Park next to Blossom St	33.99621	–81.02186
11140	Rocky Branch	14355	Seed line	Good	SC-RIC-707; Maxcy Gregg Park bridge . Pool side, left bank	33.99579	–81.02187

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Rawls Creek near Columbia—Continued							
220.0	Marker	2.72	Flagging & marker	Urban	10/9/2015	10/15/2015	No
208.8	Marker	3.49	Flagging & marker	Urban	10/9/2015	10/15/2015	No
221.6	Nail	2.00	Flagging and nail	—	10/9/2015	10/15/2015	No
218.9	Nail and HWM tag	0	Height not recorded	—	10/9/2015	10/15/2015	No
207.5	Nail and HWM tag	2.4	Marker, nail and flagging	—	10/9/2015	10/15/2015	No
206.9	Nail and HWM tag	2.00	Marker, nail and flagging	—	10/9/2015	10/15/2015	No
Rocky Branch in Columbia							
195.5	Marker	1.00	Flagging and marker; seed line on corner of NE corner of bldg. About 4’ from top of concrete culvert	Urban	10/7/2015	10/12/2015	No
192.5	Marker	2.26	Flagging, marker & spray paint. Seed line inside I beam of stand pile bent from left end of bridge, f	Urban	10/7/2015	10/12/2015	No
178.0	Nail	2.66	Flagging and nail. Seed line on fence on streamside of house. Fence surrounds backyard on outside	Urban	10/7/2015	10/12/2015	Yes
190.9	Marker	2.78	Flagging, marker & spray paint	Urban	10/7/2015	10/12/2015	Yes
187.5	Tape	1.87	—	Urban	10/7/2015	10/12/2015	Yes
179.6	Marker	2.63	—	Urban	10/7/2015	10/12/2015	Yes
148.7	Marker	0	Height not given; Flagging + marker + brick	Urban	10/7/2015	10/12/2015	No
149.4	Marker	0.99	Also colored flagging	Urban	10/8/2015	10/12/2015	No
149.0	Marker	0.55	Also colored flagging; near Olympia Avenue	Urban	10/8/2015	10/12/2015	No
223.3	Tape	3.31	Evidence of double peak	Urban	10/7/2015	10/11/2015	No
222.4	Marker	0.99	—	Urban	10/7/2015	10/11/2015	Yes
223.5	Marker	1.89	—	Rural	10/7/2015	10/11/2015	No
223.3	Tape	2.30	Outside	Urban	10/7/2015	10/11/2015	No
221.6	Marker	2.36	Yellow post on loading; if facing loading door left side post	Urban	10/7/2015	10/13/2015	Yes
220.4	Nail	1.21	Flagged with both flagging tape and nail	Urban	10/7/2015	10/11/2015	Yes
213.9	Marker	1.69	Seed line inside, mark outside	Urban	10/7/2015	10/11/2015	Yes
212.9	Nail	2.90	Rotten tree leaning toward creek on left floodplain about 50’ upstream of bridge; marked with flaggi	Urban	10/7/2015	10/11/2015	No
209.1	Nail	2.12	Nail in tree 30’ from right bank w/ pink flagging; 16” diameter birch w/ poison ivy on it, approx 60	Urban	10/7/2015	10/11/2015	No
208.6	Nail	2.09	Nail and flagging tape. 5’ diameter oal located on rt floodplain approx. 120’ u/s of walk bridge. Ga	Urban	10/7/2015	10/11/2015	No
208.5	Marker	0.76	Flagging and Sharpie. Seed line on downstream side of bridge on loft abutment	Urban	10/7/2015	10/11/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Rocky Branch in Columbia—Continued							
11141	Rocky Branch	14356	Seed line	Good	SC-RIC-708; downstream and of Maxcy Gregg Park; just upstream of Pickens St	33.99512	–81.02326
11142	Rocky Branch	14357	Seed line	Fair	SC-RIC-709; ds of culvert crossing; Pickens St on left floodplain between stream and fence	33.99441	–81.02414
11143	Rocky Branch	14358	Seed line	Good	SC-RIC-710; upstream of culvert crossing; Wheat St just upstream of old PE ctr	33.99355	–81.02468
Saluda, Broad, and Congaree Rivers near Columbia							
11232	Saluda River	14410	Seed line	Excellent	—	34.04794	–81.18802
[3]11233	Rawls Creek	14411	Seed line	Good	Cross foot bridge and Green info sign under power lines on end of foot bridge	34.05177	–81.1861
11270	Kinley Creek	14448	Seed line	Good	Frame of right garage	34.03825	–81.14764
11271	Kinley Creek	14449	Seed line	Good	Left side of garage	34.03667	–81.14539
10976	Kinley Creek	14033	Seed line	Good	Near front door	34.03667	–81.14639
11016	Saluda River	14074	Seed line	Good	—	34.03339	–81.13753
SC DOT Survey	Broad River	—	Seed line	Fair	I-126 Broad River Upstream	34.01236	–81.05906
SC DOT Survey	Broad River	—	Seed line	Excellent	I-126 Broad River Downstream	34.00894	–81.05861
SC DOT Survey	Broad River	—	Seed line	Excellent	I-20 Broad River Upstream	34.04897	–81.07838
SC DOT Survey	Broad River	—	Mud line	Poor	I-20 Broad River Downstream	34.04784	–81.0737
SC DOT Survey	Saluda River	—	Seed line	Excellent	I-26 Saluda River Upstream	34.02468	–81.10645
SC DOT Survey	Saluda River	—	Seed line	Excellent	I-26 Saluda River Downstream	34.02374	–81.1035
SC DOT Survey	Broad River	—	Seed line	Fair	US176 Broad River Upstream	34.02861	–81.06833
SC DOT Survey	Broad River	—	Mud line	Excellent	US176 Broad River Downstream	34.02594	–81.06861
SC DOT Survey	Congaree River	—	Gage data	Excellent	US21/176/321 Congaree River Upstream	33.99306	–81.0502
SC DOT Survey	Congaree River	—	Seed line	Excellent	US21/176/321 Congaree River Downstream	33.98778	–81.04806
SC DOT Survey	Congaree River	—	Seed line	Excellent	US1/378 Congaree River Upstream	34.00261	–81.05431
SC DOT Survey	Congaree River	—	Seed line	Excellent	US1/378 Congaree River Downstream	33.99522	–81.05294
SC DOT Survey	Saluda River	—	Seed line	Excellent	I-20 Saluda River Upstream	34.02496	–81.13062
SC DOT Survey	Saluda River	—	Seed and Wash lines	Fair, Poor, Poor	I-20 Saluda River Downstream	34.02693	–81.12619
SC DOT Survey	Congaree River	—	Mud and Seed lines	Fair, Poor	I-77 Congaree River Upstream	33.94193	–81.04078
SC DOT Survey	Congaree River	—	Seed line	Excellent	I-77 Congaree River Downstream	33.94184	–81.00297
Smith Branch in Columbia							
11370	Smith Branch	14589	Seed line	Good	Sunset Drive crossing of Smith Branch; 40 yards right of culvert	34.03061	–81.04892
11371	Smith Branch	14590	Seed line	Good	25 yards upstream of sunset on left end of floodplain	34.03	–81.04972
11372	Smith Branch	14591	Other (Note in description box)	Fair	30 yards downstream of Sunset Drive	34.03056	–81.04944

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Rocky Branch in Columbia—Continued							
206.6	Nail	1.15	Flagging and nail. 40 ft upstream of culverts on left bank. 8- from EOW, 10” sweetgum	Urban	10/7/2015	10/11/2015	No
204.2	Nail	3.60	Flagging and nail; seed line on 32” dia tree 20 ft from lt EOW and 20 from chain link fence (in ctr)	Urban	10/7/2015	10/11/2015	No
202.8	Nail	2.65	Seed line in 16” dia oak on rt bank of creek about 30’ u/s of culvert face; flagging and nail and spr	Urban	10/7/2015	10/12/2015	No
Saluda, Broad, and Congaree Rivers near Columbia							
193.6	Marker	5.49	Sharpie line on brick at recessed window nearest men’s side door of restrooms at Water Oak Pavillion	Urban	10/8/2015	10/15/2015	Yes
193.0	Marker	6.14	Sharpie line on right post of green info board near end of foot bridge downstream of Rawls Crk Bridg	Urban	10/8/2015	10/15/2015	No
186.8	Marker	2.59	Colored flagging above marker	Urban	10/8/2015	10/11/2015	No
187.0	Marker	4.34	Colored flagging above marker	Urban	10/8/2015	10/11/2015	No
187.2	Nail and HWM tag	7.32	—	Urban	10/7/2015	10/11/2015	Yes
185.8	Nail and HWM tag	1.91	—	Urban	10/7/2015	10/15/2015	No
151.4	Nail	2.00	Nail in 15-inch hardwood tree	Urban	10/27/2015	11/5/2015	No
149.0	Marker	3.80	Sharpie line on bridge pile	Urban	10/27/2015	11/13/2015	No
165.8	Marker	—	Sharpie line inside old concrete pipe	Rural	10/29/2015	11/17/2015	Yes
162.7	Marker	4.80	Line on bridge pile	Rural	10/29/2015	11/17/2015	No
173.7	Marker	3.70	Sharpie line on inside of shed	Urban	10/29/2015	11/6/2015	Yes
168.6	Marker	4.40	HWM painted on bridge pier	Urban	10/29/2015	11/16/2015	No
157.2	Nail	3.80	Nail in tree approx 1,000 ft upstream from bridge	Urban	10/27/2015	11/5/2015	No
151.9	Marker	7.10	Sharpie line on downstream left pier near stream	Urban	10/27/2015	11/5/2015	No
144.8	Gage	—	Peak gage height recorded on October 4, 2015, at USGS streamflow gaging station 02169500	Urban		10/4/2015	
143.3	Marker	8.20	Mark on first peir from right end of bridge	Urban	10/28/2015	11/13/2015	No
146.4	Marker	2.10	Mark on inside of old pump house	Urban	10/28/2015	11/4/2015	Yes
144.4	Marker	5.50	Sharpie line on downstream, right concrete abutment	Urban	10/28/2015	11/16/2015	No
185.6	Marker	—	Sharpie line on house	Urban	10/29/2015	11/18/2015	No
181.9	Stake and Nails	0, 2.40, —	Elevation is the average of 3 marks.	Urban	10/29/2015	11/18/2015 11/30/2015	No
134.8	Nails	6.00	Elevation is the average of two marks.	Rural	10/26/2015	12/10/2015	Yes
134	Marker	—	Mark on bridge pile	Rural	10/26/2015	11/30/2015	No
Smith Branch in Columbia							
208.7	Tape	2.42	Upstream side (right end) of Sunset Drive on power pole flagged with orange flagging	Urban	10/8/2015	10/15/2015	No
208.5	Tape	2.33	Seed line in 24” pine marked with orange flagging	Urban	10/8/2015	10/15/2015	No
199.7	Stake	0	Wash/cut line in right bank	Urban	10/8/2015	10/15/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Smith Branch in Columbia—Continued							
11373	Smith Branch	14592	Seed line	Good	SC-RIC-815-A; approx 200 yards from road	34.03139	–81.05333
11374	Smith Branch	14593	Seed line	Excellent	35-40 yards behind house	34.03556	–81.05583
11375	Smith Branch	14594	Seed line	Good	Westwood ave, upstream of clement rd (approx 60 yards)	34.03833	–81.05944
11376	Smith Branch	14595	Seed line	Excellent	40 yards downstream of Clement Rd near Mountain Dr	34.03861	–81.06056
11377	Smith Branch	14596	Seed line	Good	Behind house	34.03722	–81.06611
11079	Smith Branch	14131	Seed line	Fair	SC-RIC-804-A; 20’ away from Harden St Ext 3440 SC Department of Disabilities and Speacial Needs Sign	34.02586	–81.03319
11080	Smith Branch	14131	Seed line	Poor	SC-RIC-804-B; 25’ away from Harden St Ext 3440 SC Department of Disabilities and Special Needs Sign	34.02586	–81.03319
11081	Smith Branch	14132	Seed line	VP	SC-RIC-805-A; 400 yards away from Harden St Ext	34.02506	–81.03186
11082	Smith Branch	14132	Seed line	VP	SC-RIC-805-B; 400 yards away from Harden St Ext	34.02489	–81.03189
11084	Smith Branch	14134	Seed line	Good	SC-RIC-807A: Rt flood plain, culvert exit	34.02569	–81.03467
11085	Smith Branch	14134	Seed line	Good	SC-RIC-807B: Left flood plain, culvert exit	34.02569	–81.03467
11086	Smith Branch	14135	Other (Note in description box)	Excellent	—	34.02733	–81.04189
12070	Smith Branch	15348	Debris	Fair	Earlewood Park about 200-300 ft DS of gage	34.02833	–81.0425
12110	Smith Branch	14592	Other (Note in description box)	Good	SC-RIC-815-B; approx 200 yards from road	34.03139	–81.05333
Stoop Creek near Columbia							
10950	Stoop Creek	14008	Seed line	Good	Inside waste water treatment plant at tan metal building behind holding tank “B”.	34.029	–81.11461
10951	Stoop Creek	14009	Seed line	Fair	Between residences 1905 and 1915 in vacant lot	34.03214	–81.11400
10952	Stoop Creek	14010	Seed line	Good	SC-LEX-603-A; Back of property inside 6 foot chain link fence on 20 ton A/C unit; streamward side of	34.03319	–81.11797
10970	Stoop Creek	14028	Seed line	Good	SC-LEX-604A; On back of Jones & Frank building.	34.03361	–81.11556
10971	Stoop Creek	14028	Seed line	Unknown/ historical	SC-LEX-604B; At warehouse entrance at Jones & Frank at DSS of loading dock	34.03333	–81.11556
10972	Stoop Creek	14029	Debris	Poor	At base of tree	34.03944	–81.11472
10973	Stoop Creek	14030	Seed line	Good	On large green power box labeled 156-2-39	34.03564	–81.11628
10974	Stoop Creek	14031	Debris	Fair	Power pole number 156-02-007 located behind first building left of leasing office and pool	34.03722	–81.11528
10975	Stoop Creek	14032	Seed line	Good	On house corner, right of right garage door	34.03972	–81.11667
11467	Stoop Creek	14764	Seed line	Good	Willow Creek Apts; seed line located on building across from apt 106	34.04816	–81.11783
11468	Stoop Creek	14765	Seed line	Good	Residence on 433 Brookgreen Dr; seed line located on back of home	34.06182	–81.12166
11469	Stoop Creek	14766	Seed line	Good	Residence at 4512 Bonnie Forest Blvd; Seed line located of southwest front corner of home on gutter d	34.06377	–81.1236
11470	Stoop Creek	14767	Seed line	Good	Residence located at 4716 Bonnie Forest Blvd. Seed line located on garage door molding.	34.06657	–81.12586

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Smith Branch in Columbia—Continued							
187.6	Tape	2.67	Seed line on 7” sweetgum approx 30 yards from right bank about 15 yards from manhole on utility line	Riverine	10/8/2015	10/16/2015	No
180.1	Marker	1.58	Good seed line on privacy fencse about 35 yards from back of house	Urban	10/8/2015	10/15/2015	No
177.2	Nail	6.67	Seed line on 14” leaning tree approx 12’ from edge of westwood ave	Urban	10/8/2015	10/11/2015	No
174.3	Marker	2.80	Seed line on storage building (streamward side) about 25 yards right of Mountain Dr	Urban	10/8/2015	10/11/2015	No
165.6	Nail	4.67	Seed/mudline on 14” sweetgum tree on top left bank behind house	Urban	10/8/2015	10/11/2015	No
220.7	Tape	1.50	—	Urban	10/7/2015	10/11/2015	No
220.8	Tape	1.17	Small tree	Urban	10/7/2015	10/11/2015	No
220.9	Tape	2.67	Cluster of pines before chain link fence, between parking and Smith Branch	Urban	10/7/2015	10/12/2015	No
220.9	Tape	2.33	Cluster of pines before chain link fence, between parking and Smith Branch	Urban	10/7/2015	10/12/2015	No
220.3	Tape	2.00	This HWM associated with field notes for SC-RIC-807.	Riverine	10/7/2015	10/11/2015	No
219.3	Tape	1.83	This HWM associated with field notes for SC-RIC-808, but since at same location as SC-RIC-807A consi	Riverine	10/7/2015	10/11/2015	No
218.6	Paint	2.17	Trashline marked with paint and colored flagging	Urban	10/7/2015	10/15/2015	No
210.1	Stake	0	Good trash line on DS right bank below gage at Earlewood Park	Urban	10/15/2015	10/15/2015	No
187.7	Tape	2.67	Wash/cut line on utility easement access rd; approx 40 yards from right bank	Urban	10/8/2015	10/16/2015	No
Stoop Creek near Columbia							
183.5	Marker	4.70	—	Urban	10/7/2015	10/14/2015	Yes
185.2	Nail	3.89	—	Urban	10/7/2015	10/11/2015	No
185.7	Marker	1.56	—	Urban	10/7/2015	10/14/2015	No
186.6	Marker	1.52	—	Urban	10/7/2015	10/11/2015	Yes
186.0	Marker	2.00	—	Urban	10/7/2015	10/11/2015	Yes
187.5	Nail and HWM tag	1.22	Nail with green disc, pink flagging	Urban	10/7/2015	10/11/2015	No
192.3	Marker	1.30	Marker and orange paint	Urban	10/7/2015	10/11/2015	Yes
193.4	Nail and HWM tag	1.87	—	Urban	10/7/2015	10/11/2015	No
199.0	Marker	2.12	Marked small with sharpie to minimize disturbance to home	—	10/7/2015	10/11/2015	Yes
217.0	Stake	4.35	Stake, flagging, marker	Urban	10/9/2015	10/14/2015	No
241.1	Marker	2.70	Flagging & marker	Urban	10/9/2015	10/14/2015	No
241.9	Marker	1.39	Flagging & marker	Urban	10/9/2015	10/14/2015	No
249.0	Marker	1.41	Flagging & marker	Urban	10/9/2015	10/14/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

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HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Stoop Creek near Columbia—Continued							
11956	Stoop Creek	15294	Seed line	Good	173 Wood Ct (Google Maps says 173 Timber Ct); on back patio wall of 173 Wood ct (3rd from rd)	34.05442	–81.11856
11990	Stoop Creek	15308	Seed line	Good	Willow Creek Apartments Complex Building 112; nail in 2x4 against building on patio of apt 112C faci	34.04925	–81.11805
Crab Tree Swamp at Conway							
11416	Crab Tree Swamp	14714	Seed line	Unknown/ historical	165 Busbee St, Nail in 36” Oak in field to left of house	33.85556	–79.04441
11415	Crab Tree Swamp	14713	Other (Note in description box)	Excellent	Fence Corner of backyard at 147 Sherwood Dr at intersection of Long Ave. (Corner with Long Ave) Acro	33.85748	–79.04541
11414	Crab Tree Swamp	14712	Mud	Excellent	At residence 181 Long Ave, front steps to house on right handrail at base, see field notes for owner	33.85792	–79.04474
11423	Crab Tree Swamp	14721	Debris	Fair	Off Main St/701 near Classic Car Wash and across Street from Hess Gas. Adjacent (right of) pumpstati	33.86024	–79.05568
11417	Crab Tree Swamp	14715	Other (Note in description box)	Excellent	Nail in powerpole # 36656 in front of 218 Long Ave	33.85466	–79.04757
11418	Crab Tree Swamp	14716	Debris	Excellent	Nail in back of sign for Trinity Methodist Church @ Junction St 26-698 & Sherwood Dr	33.85802	–79.04476
11419	Crab Tree Swamp	14717	Mud	Excellent	Buried cable junction box @ 118 Sherwood Dr	33.86313	–79.0454
11420	Crab Tree Swamp	14718	Mud	Excellent	Across the street from 304 Crabtree Dr, next to power pole # 3654	33.86297	–79.04305
11421	Crab Tree Swamp	14719	Mud	Excellent	Marked line on mailbox at 103 Azalea Dr	33.86261	–79.04034
11422	Grier Swamp	14720	Mud	Excellent	Between Bill Mack Blvd and Kingston Ln on Long Ave Extension; marked line in orange telephone juncti	33.86557	–79.03785
Black Creek and tributaries at Darlington							
11519	Bellyache Creek	14805	Seed line	Good	Mark on frame of garage door (garage door closet to street)	34.32230	–79.87539
11521	Black Creek	14807	Seed line	Excellent	Marker line on NW corner of house (wood siding) flagged	34.30996	–79.84481
11522	Black Creek	14808	Mud	Good	Marker line in front of house under 3rd window from S side (right)	34.29636	–79.82978
Black Creek and tributaries at Florence							
11410	Black Creek	14708	Mud	Excellent	2518 Nena Lane, Quimby, SC; Nail w/ flagging on power pole KQ78-BM on left side of house	34.24856	–79.72211
11411	Black Creek	14709	Mud	Fair	At intersection of Crooked Creek Rd and Redbreast Pt on telephone pole KR02BM Carolina Power light	34.25007	–79.72094
11412	Black Creek	14710	Other (Note in description box)	Good	On East Black Creek Rd before Black Creek near intersection of Highland Bluff Ct on poperty line. HW	34.24551	–79.73106
11413	Black Creek	14711	Other (Note in description box)	Fair	At residence 627 Split Rail Dr, near E Black Crk Rd. On fence in back of property. House with dog ke	34.24488	–79.7343
11520	Black Creek	14806	Seed line	Good	Marker line on W side of trailer (horse); *dogs roaming area	34.26592	–79.77636

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

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Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Stoop Creek near Columbia—Continued							
224.4	Nail and HWM tag	2.30	Marker, nail and flagging	—	10/9/2015	10/14/2015	No
217.3	Nail and HWM tag	2.67	—	—	10/9/2015	10/14/2015	No
Crab Tree Swamp at Conway							
10.3	Tape	2.82	—	Urban	10/8/2015	10/15/2015	Yes
11.0	Nail	1.65	Seed line & debris line; Flagging and nail	Rural	10/8/2015	10/16/2015	Yes
10.9	Nail	0.72	Flagging and nail	Rural	10/8/2015	10/16/2015	Yes
11.7	Stake	0	Top of pine stake in ground at debris line; 0 ft at HWM debris line	Urban	10/8/2015	10/15/2015	Yes
10.9	Nail	1.74	Seed line & debris line; Flagging and nail	Rural	10/8/2015	10/15/2015	Yes
10.8	Nail	1.54	Flagging, marker, and nail	Urban	10/8/2015	10/16/2015	Yes
11.1	Marker	1.49	—	Urban	10/8/2015	10/15/2015	Yes
10.9	Tape	1.81	Flagging and sharpie	Urban	10/8/2015	10/15/2015	Yes
11.0	Marker	0.95	Flagging and sharpie	Urban	10/8/2015	10/15/2015	Yes
11.5	Marker	1.24	Flagging and sharpie	Urban	10/8/2015	10/15/2015	Yes
Black Creek and tributaries at Darlington							
116.0	Marker	1.53	Still water - yes in backyard	Urban	10/9/2015	10/12/2015	No
96.5	Marker	3.08	Also colored flagging	Urban	10/9/2015	10/12/2015	No
92.1	Marker	1.04	—	Urban	10/9/2015	10/12/2015	No
Black Creek and tributaries at Florence							
68.4	Nail	1.11	Flagging and nail	Rural	10/8/2015	10/13/2015	Yes
66.5	Nail	1.34	Flagging and nail	Rural	10/8/2015	10/13/2015	Yes
70.7	Nail	2.94	Debris & Mudline Flagging and nail	Rural	10/8/2015	10/12/2015	Yes
72.1	Nail	1.70	Debris & Mudline Flagging and nail	Rural	10/8/2015	10/12/2015	Yes
80.9	Marker	3.10	Also colored flagging	Rural	10/9/2015	10/13/2015	No

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HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
				Coastal Georgetown			
11425	Sampit River	14723	Seed line	Fair	Georgetown City Fire Dept HQ building. Located behind fire station @ grey wood-sided storage shed.	33.37225	–79.29040
11426	Sampit River	14724	Seed line	Fair	1818 Hawkins St, yellow wood-sided single family house. See field notes relative to dog. Mark on SE	33.36840	–79.30041
11427	Sampit River	14725	Seed line	Fair	605-A Canal St. Tan one story single-family home. Mark located on rear SW face of home @ S corner.	33.36813	–79.30147
11428	Sampit River	14726	Seed line	Fair	1813 Hawkins St, Beige one story hardi-plank sided house. Mark on SW face of garage wall in rear of	33.36787	–79.30026
11429	Sampit River	14727	Seed line	Excellent	Good seed line on inside of building at 909 Front St on left as you walk in door. See field notes fo	33.36761	–79.28522
11430	Sampit River	14728	Debris	Fair	Trash line on south side of building, 15ft east from front door	33.36415	–79.28061
11710	Winyah Bay	14988	Debris	Good	Near the intersection of Front & Meeting Streets, toward Smith Street. On power pole engraved with A	33.36218	–79.27807
11711	Winyah Bay	14989	Debris	Good	On Front Street near interesction of E Bay St in East Bay Park near road on side opposite residence	33.36107	–79.27586
				Black River at Kingstree			
11190	Un. trib. of Black River	14371	Seed line	Excellent	206 E Main Street, Kingstree, Family Dollar E parking lot	33.6639	–79.82823
11191	Un. trib. of Black River	14372	Stain line	Excellent	217 E Main St, Kingstree, D& M Seafood, line on W window left of front door frame	33.66449	–79.82802
11192	Un. trib. of Black River	14373	Seed line	Good	Intersection of Tomlinson St & N Brooks St near playground entrance	33.66814	–79.82466
11193	Black River	14374	Seed line	Unknown/ historical	513 Gilland Ave; crawl space door, frame of crawl space on W side of house, on south end of the fram	33.66780	–79.83959
11194	Black River	14375	Seed line	Good	701 Virginia St; right side of front door, near right hand rail	33.67101	–79.83942
11195	Un. trib. of Black River	14376	Seed line	Excellent	Dogs in Backyard; 1016 Woodland Dr or Co Rd S-45-185, on backyard fence siding, e post end, below ra	33.67647	–79.84208
11090	Un. trib. of Black River	14268	Seed line	Excellent	On left door sill of Williamsburg Chiropractic 3030 E Main Street	33.66497	–79.82655
11091	Un. trib. of Black River	14269	Seed line	Excellent	Carquest Auto Parts, Kingstree, NE corner	33.66381	–79.82722
11092	Un. trib. of Black River	14270	Seed line	Excellent	NE corner of house 306 S Longstreet St	33.65978	–79.83243
11093	Black River	14271	Other (Note in description box)	Excellent	Cutline - house on river behind Carolinas Hospital System	33.66294	–79.83689
11094	Black River	14272	Other (Note in description box)	Excellent	Cutline- BoBo's on the River/Hydrick's Service Center	33.66181	–79.83745
11095	Un. trib. of Black River	14273	Debris	Poor	Near 403 Nelson Blvd; stake in ground at SE corner of property; land surface as base of stake	33.65859	–79.82766
11096	Un. trib. of Black River	14274	Other (Note in description box)	Excellent	Cutline; 705 Lawrence St; HWM on back NW corner of house	33.67229	–79.82239
11097	Kingstree	14275	Seed line	Fair	Green HWM disc on power pole between 636 & 632 Green St	33.67410	–79.83365
11098	Kingstree	14276	Seed line	Good	Green HWM disc on power pole between 715 & 712 Live Oak St	33.67469	–79.83255
11523	Kingstree Swamp Canal	14809	Seed line	Excellent	Marker line (flagged) on backyard fence post @ gate entrance	33.68144	–79.84198
11524	Kingstree Swamp Canal	14810	Seed line	Good	HWM disc on front porch; located on North side of porch on first wooden post closet to the road	33.69050	–79.83824
11525	Kingstree Swamp Canal	14811	Seed line	Good	Underground fiber optic cable marker post west of road	33.69455	–79.84095

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

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Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Coastal Georgetown							
8.6	Marker	1.72	Flood water was due to heavy rains causing drainage basins to back up and pool water in city streets	Urban	10/9/2015	10/13/2015	Yes
14.7	Marker	2.42	Flagging & marker. No visible creeks in area. Flooding due to poor drainage	Urban	10/9/2015	10/13/2015	Yes
14.6	Marker	3.63	Flagging & Marker. Heavy rain and poor drainage attributed to flood water	Urban	10/9/2015	10/13/2015	Yes
14.5	Marker	3.22	Flagging & Marker. Poor drainage and heavy rain caused storm drains to back up	Urban	10/9/2015	10/13/2015	Yes
4.8	Marker	1.65	—	Urban	10/9/2015	10/13/2015	Yes
4.8	Marker	0.90	—	Urban	10/9/2015	10/13/2015	Yes
4.5	Nail	1.07	Flagging and nail; due to street flooding	Urban	10/9/2015	10/16/2015	Yes
4.8	Nail	1.87	Flagging and nail; due to street flooding	—	10/9/2015	10/16/2015	No
Black River at Kingstree							
46.6	Nail and HWM tag	2.41	Seed line marked w/HWM disc + nail on wooden fence around dumpster on E side of Family Dollar bldg	Urban	10/8/2015	10/8/2015	Yes
46.7	Marker	4.73	Marker line on W window (left of front door) frame	Urban	10/8/2015	10/8/2015	Yes
46.8	Other (Note in description box)	0.53	Marker and flagging on white fence, on 1st post closest to road	Urban	10/8/2015	10/13/2015	No
48.1	Marker	4.04	—	Urban	10/8/2015	10/13/2015	Yes
48.2	Other (Note in description box)	3.06	Pencil mark of seed line	Urban	10/8/2015	10/13/2015	No
48.7	Marker	2.51	—	Urban	10/8/2015	10/13/2015	Yes
46.8	Marker	1.90	Sharpie line of left of doorsill	Urban	10/8/2015	10/14/2015	Yes
46.6	Marker	3.60	Sharpie line on NE corner of Carquest Store	Urban	10/8/2015	10/14/2015	Yes
46.7	Marker	3.30	Sharpie line NE corner of house	—	10/8/2015	10/14/2015	No
47.7	Other (Note in description box)	4.00	Pencil Mark on left door sill in back of the house	Urban	10/8/2015	10/14/2015	Yes
47.2	Marker	2.08	Sharpie on SE Corner of buildig	Urban	10/8/2015	10/14/2015	No
46.7	Stake	0	Picture card says 114	—	10/8/2015	10/14/2015	Yes
51.3	Marker	2.26	Sharpie on back nw corner of house	Urban	10/8/2015	10/14/2015	Yes
63.8	Nail and HWM tag	1.60	Green Disc Spray painted	Urban	10/8/2015	10/14/2015	Yes
64.2	Nail and HWM tag	1.20	Green HWM disc	Urban	10/8/2015	10/14/2015	Yes
48.6	Tape	5.67	Also marker	Urban	10/9/2015	10/13/2015	Yes
49.1	Nail and HWM tag	0.96	—	Urban	10/9/2015	10/13/2015	No
49.0	Marker	1.30	Also colored flagging	Urban	10/9/2015	10/13/2015	No

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HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Pocotaligo River at Manning							
11424	Ox Swamp	14722	Debris	Good	Side of trailer in back near SE corner of trailer at 205 Walker St	33.69048	–80.20316
11745	Pocotaligo River	15023	Mud	Excellent	E & E Farm Garden & Pet Store, 2236 Sumter Hwy. Located indoors through garage door on west side of	33.7076	–80.20625
11746	Pocotaligo River	15024	Seed line	Excellent	End Time Harvest Church, next door to Burger Chick on Sumter Hwy. Through front door of building, 3	33.70732	–80.20718
11747	Pocotaligo River	15025	Debris	Poor	SC-CLA-1503A; S-N-Tee's Golf Cars, Sumter Hwy, across street from Burger Chick. HWM is to the right	33.70788	–80.20719
11748	Pocotaligo River	15025	Debris	Good	SC-CLA-1503B; Storage units across street from Burger Chick on Sumter Hwy. HWM is on west side of bu	33.70816	–80.20757
11750	Pocotaligo River	15027	Seed line	Poor	Tire Shop on right bank down stream off Sumter Hwy. Located on chain link fence behind tire shop. We	33.7074	–80.20585
11801	Pocotaligo River	15071	Debris	Fair	SC-CLA-1510C; HWM is at the end of guard rail of last bridge of I-95 upstream side. Mile 120.5	33.7249	–80.22523
Coastal North Myrtle Beach							
11172	House Creek	14370	Seed line	Good	319 62nd Ave N, NMB, SC, end of 62nd Ave, white fence, s end, nail on mark	33.84230	–78.60627
11170	House Creek	14368	Seed line	Good	317 31st Ave N, North Myrtle Beach, SC; back fence under carport, south of house	33.83194	–78.67778
11171	House Creek	14369	Seed line	Good	320 45th Ave N, NMB, SC; wooden pole under carport, north of house, middle row, blue poles	33.83584	–78.62444
11030	Atlantic Ocean	14089	Seed line	Good	Seed line on fence in SE corner of property	33.82871	–78.64654
11031	Atlantic Ocean	14090	Seed line	Good	Seed line on SW corner of property	33.82772	–78.64623
11032	Atlantic Ocean	14091	Seed line	Good	Seed line on white fence	33.82986	–78.64704
11050	Atlantic Ocean	14108	Seed line	Good	Intersection of 22nd Ave and Nixon St; seed line on west side of house near spicket	33.82917	–78.64528
11051	Atlantic Ocean	14109	Seed line	Good	South side of house on cinder block base; closest intersection is 22nd Ave and Duffy	33.83083	–78.64583
11052	Atlantic Ocean	14110	Seed line	Good	On pole in the carport; row closest to house; 3rd pole from rd; south of downstairs	33.83167	–78.64667
11053	Atlantic Ocean	14111	Seed line	Good	Wooden pillars holding AC unit, south of house	33.83361	–78.64639
11054	Atlantic Ocean	14112	Seed line	Good	Back pole under car port farthest south of house, closest to water	33.83417	–78.64667
11055	Atlantic Ocean	14113	Seed line	Good	Seed line on west side of building in back alley	33.83028	–78.64389
11056	Atlantic Ocean	14114	Seed line	Good	Seed line on white fence; fence is NW of the house	33.83150	–78.64248
North Fork Edisto River at Orangeburg							
11713	North Fork Edisto River	14991	Other (Note in description box)	Good	Seed & debris line; US301- 1595 John C Calhoun Dr; SE side of highway, billboard vertical support po	33.48319	–80.8716
11714	North Fork Edisto River	14992	Other (Note in description box)	Excellent	Seed & debris line; 1290 Riverbank Dr, brick 1-story residence at end of Riverbank Dr, on private dr	33.49698	–80.88252
11715	North Fork Edisto River	14993	Seed line	Good	1121 Putter Path Rd, on left downstream side of boardwalk at rear of property	33.50063	–80.89407
11716	North Fork Edisto River	14994	Debris	Good	Form illegible, including lat/long, this is best guess at what it says; Azalea Garden Stage handicap	33.48705	–80.87254

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Pocotaligo River at Manning							
86.8	Marker	3.97	Flagging and Sharpie	Urban	10/9/2015	10/14/2015	
87.3	Marker	3.00		Urban	10/9/2015	10/14/2015	
87.3	Marker	1.07	Indoors	Urban	10/9/2015	10/14/2015	
87.4	Marker	1.00		Urban	10/9/2015	10/14/2015	
87.5	Marker	1.15		Urban	10/9/2015	10/14/2015	
86.8	Tape	4.30		Urban	10/9/2015	10/14/2015	
89.1	Tape	0	Also marker	Rural	10/10/2015	—	
Coastal North Myrtle Beach							
4.8	Nail	0.70	Nail on marker	Urban	10/8/2015	10/8/2015	No
6.3	Marker	0.40	—	Urban	10/8/2015	10/8/2015	No
5.2	Marker	1.13	—	Urban	10/8/2015	10/8/2015	No
6.0	Other (Note in description box)	0.85	Marked with pencil	Riverine	10/7/2015	10/7/2015	No
6.4	Other (Note in description box)	0.87	Marked with pencil	Urban	10/7/2015	10/7/2015	No
6.1	Other (Note in description box)	0.48	Marked with pencil	Urban	10/7/2015	10/7/2015	No
6.2	Marker	1.09	—	Urban	10/7/2015	10/7/2015	No
6.3	Marker	1.07	—	Urban	10/7/2015	10/7/2015	No
6.1	Marker	1.16	—	Urban	10/7/2015	10/7/2015	No
6.1	Marker	0.62	—	Urban	10/7/2015	10/7/2015	No
6.1	Marker	0.31	—	—	10/7/2015	10/7/2015	No
6.1	Marker	0.54	—	Urban	10/7/2015	10/7/2015	No
5.3	Marker	0.78	—	Urban	10/7/2015	10/7/2015	No
North Fork Edisto River at Orangeburg							
161.6	Other (Note in description box)	1.35	Seed & debris line; marked with flagging, marker, and spray paint	Urban	10/9/2015	10/12/2015	Yes
163.1	Other (Note in description box)	1.43	Seed & debris line; marked with Marker and flag	Urban	10/9/2015	10/12/2015	No
163.7	Other (Note in description box)	2.18	Disc and flagging	Urban	10/9/2015	10/12/2015	Yes
161.6	Other (Note in description box)	1.55	Flagging, marker, and nail	Urban	10/9/2015	10/12/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
North Fork Edisto River at Orangeburg—Continued							
11717	North Fork Edisto River	14995	Other (Note in description box)	Good	Seed and debris line at 812 Shillings Bridge Rd, 1/2 story brick cream siding w/ burgundy shutters w	33.52498	–80.94825
11718	North Fork Edisto River	14996	Other (Note in description box)	Good	Seed and debris line. Form illiegible; apparent address and lat/long on form do not match; 2 story b	33.52598	–80.9464
Green Swamp near Sumter							
11850	Green Swamp	15188	Seed line	Excellent	According to homeowners, neighbors on either side barely had water up to house.	33.93552	–80.39643
11851	Green Swamp	15189	Seed line	Excellent	According to homeowners, high water due to flow from uphill (east) and not from Green Swamp.	33.93669	–80.39401
11852	Second Millpond	15190	Seed line	Excellent	—	33.92046	–80.38221
11853	Green Swamp	15191	Seed line	Excellent	—	33.91522	–80.37599
11854	Green Swamp	15192	Seed line	Excellent	—	33.91389	–80.37153
11855	Green Swamp	15193	Seed line	Excellent	Neighborhood just south on Capri Drive unaffected. Train tracks may have diverted water.	33.91025	–80.36927
11856	Green Swamp	15194	Seed line	Excellent	Access from Garden Street via West Liberty Street	33.91516	–80.36845
11857	Shot Pouch Branch	15195	Debris	Fair	—	33.92574	–80.36671
11858	Shot Pouch Branch	15195	Debris	Fair	—	33.92591	–80.36605
11859	Green Swamp	15196	Seed line	Excellent	—	33.94876	–80.40238
11868	Mush Swamp	15205	Seed line	Excellent	High water due to runoff into a “bowl”; green swamp over slight hill just to the west	33.94793	–80.39122
11869	Mush Swamp	15206	Seed line	Excellent	High water due to runoff into a “bowl”; appears extent of high water was between (the two addressed	33.94851	–80.38967
11870	Mush Swamp	15207	Seed line	Excellent	High water due to poor drainage in “bowl”. Extent appears to have been between (two addresses liste	33.94688	–80.39152
11871	Mush Swamp	15208	Seed line	Excellent	Appears that extent of high water around intersection of Red Bud Parl & Bay Blossom Road, to SW, (??	33.94491	–80.38632
11872	Green Swamp	15209	Seed line	Excellent	Graystone Subdivision to the south unaffected	33.94589	–80.38650
11873	Second Millpond	15210	Seed line	Excellent	—	33.92949	–80.38134
11757	Shot Pouch Branch	15031	Seed line	Excellent	Sharpie line directly under left corner of left window of Strong Arms Gun Store. Every store in La M	33.93508	–80.36507
11758	Shot Pouch Branch	15032	Seed line	Excellent	Sharpie line on streamward corner of concrete block dumpster enclisure. At top of first row of block	33.93709	–80.36407
11759	Shot Pouch Branch	15033	Seed line	Good	Nail in tree 18.5 ft east of paved greenway trail running on east side of Shot Pouch Branch. Beside	33.93588	–80.36432
11760	Shot Pouch Branch	15034	Seed line	Excellent	Sharpie line on east side of “US Tobacco Store” on west side of Shot Pouch Branch, just north of Bus	33.94010	–80.36375

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
North Fork Edisto River at Orangeburg—Continued							
176.4	Marker	4.00	Flagging and marker	Rural	10/9/2015	10/12/2015	No
175.1	Other (Note in description box)	2.69	Flagging, marker, and nail; seed and debris line	Rural	10/9/2015	10/12/2015	No
Green Swamp near Sumter							
152.6	Marker	2.60	Sharpie line on center brick pillar of fence on right side of address listed. HWM at mortar joint b	Urban	10/10/2015	10/13/2015	Yes
152.6	Marker	0	Pencil line on corner of A/C unit around right side of address listed	Urban	10/10/2015	10/13/2015	No
149.7	Marker	1.16	Pencil line on siding just to the right of stone patio of address listed	Urban	10/10/2015	10/13/2015	Yes
144.7	Marker	3.68	Sharpie mark on vinyl siding, where it meets brick on left corner of house at address listed.	Urban	10/10/2015	10/14/2015	No
142.7	Marker	5.58	Pencil line on left side of right most window sill under carport at address listed.	Urban	10/10/2015	10/13/2015	No
142.7	Marker	1.99	Pencil line on inside of middle wooden post supporting right side of car port at address listed.	Urban	10/10/2015	10/13/2015	No
143.1	Marker	2.28	Sharpie line on backsideof SC State Gardens Dept Maintenance Bldg. Mark is on white metal siding in	Urban	10/10/2015	10/14/2015	No
149.4	Stake	0	SC-SUM-1626A; Wooden stake driven on south side (downstream) of Haynesworth St, 75 feet west of Brid	Urban	10/10/2015	10/14/2015	No
149.2	Stake	0	SC-SUM-1626B; Wooden stake driven on south side (upstream) of Haynesworth St, 35 feet east of Bridge	Urban	10/10/2015	10/14/2015	No
157.4	Marker	1.49	Mark @ 6th grout seam above concrete pad at whate PVC vent pipe. Mark is within brick enclosure con	Urban	10/10/2015	10/14/2015	Yes
177.9	Marker	2.75	Sharpie line on left side of wooden mailbox post	Urban	10/10/2015	10/13/2015	Yes
177.0	Marker	1.20	Sharpie line on backside of street sign for Rolling Hill Lane. At intersection of Roling Hill Lane &	Urban	10/10/2015	10/13/2015	Yes
177.8	Marker	1.48	Sharpie line on right side of wooden mailbox post for 975 Shadow Trail.	Urban	10/10/2015	10/13/2015	Yes
174.7	Marker	3.90	Sharpie line on “End Road Work” sign between 905 Sassafras Dr and 911 Sassafras Drive	Urban	10/10/2015	10/13/2015	Yes
174.7	Marker	2.64	Sharpie line on wooden fence at corner along driveway for 919 Sassafras	Urban	10/10/2015	10/13/2015	Yes
170.8	Nail	0.56	Also colored flagging. Nail and flagging in wooden post of mailbox at address listed.	Urban	10/10/2015	10/14/2015	Yes
154.1	Marker	0	0.32 ft above concrete sidewalk, 0.96 ft below window	Urban	10/9/2015	10/14/2015	No
154.2	Marker	0.68	—	Urban	10/9/2015	10/14/2015	No
154.3	Nail	3.20	Nail and flagging tape	Urban	10/9/2015	10/14/2015	No
157.9	Marker	0	1.19 ft above concrete footing	Urban	10/9/2015	10/14/2015	No

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

HWM ID	Waterbody	Site ID	HWM type	HWM quality	HWM location description	Latitude	Longitude
Green Swamp near Sumter—Continued							
11761	Shot Pouch Branch	15035	Debris	Excellent	Sharpie line on corner fence post of gated opening of greenway. 10.5 ft east of greenway, and 300ft	33.93414	–80.36446
11762	Shot Pouch Branch	15036	Other (Note in description box)	Fair	Debris and trash line; wooden stake driven above culvert on downstream side of N Guignard Dr. 10ft w	33.92857	–80.36597
11763	Green Swamp	15037	Seed line	Excellent	Sharpie line on metal side door frame on SE side of Elks Lodge # 855. There is a concrete walkway th	33.91626	–80.38190
11764	Green Swamp	15038	Seed line	Excellent	978 W Liberty St; Mark on back corner of green shed behind house. Tenant took photos during flooding	33.91864	–80.37939
11765	Green Swamp	15039	Seed line	Excellent	Cul-de-sac on Erskine Ct. High Water due to runoff into low lying area with railroad tracks acting a	33.90808	–80.38892
11766	Green Swamp	15040	Seed line	Poor	High water due to runoff into low lying area, with RR tracks essentially acting as a dam. Water was	33.90953	–80.38813
11767	Green Swamp	15041	Seed line	Good	Homeowner blames runoff from construction across the street for high water? Nail in telephone pole o	33.94329	–80.38592
11768	Green Swamp	15042	Seed line	Excellent	Almost entire street had water damage. Line on fence marked with Sharpie right where wooden fence me	33.94217	–80.38545

[1]The elevation is based on the height above ground plus the elevation of the lidar based digital elevation model.

[2]Also used on Saluda, Broad, and Congaree Rivers near Columbia.

[3]Also used on Rawls Creek near Columbia.

Appendix 1. High-water marks used to generate flood-inundation maps of selected areas affected by the flood of October 2015 in central and coastal South Carolina.—Continued

[Methods for data collection for high-water marks are described in Rydlund and Densmore, 2012. Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Location descriptions and HWM notes may be truncated. Abbreviations: ID, identification; HWM, high-water mark; Un. trib., unnamed tributary. —, no data]

Elevation (feet)	Marker type	Height above ground (feet)	High-water mark notes	HWM environment	Flag date	Survey date	Still water
Green Swamp near Sumter—Continued							
152.1	Marker	1.24	Marker and flagging tape	Urban	10/9/2015	10/14/2015	No
149.8	Stake	0	Stake and flagging; debris and trash line	Urban	10/9/2015	10/14/2015	No
148.8	Marker	0.49	—	Urban	10/9/2015	10/13/2015	Yes
146.1	Marker	4.45	—	Urban	10/9/2015	10/13/2015	No
174.3	Marker	1.04	—	Urban	10/9/2015	10/13/2015	Yes
174.3	Marker	3.46	Marker and flagging tape; High water due to overflow from north side of W Oakland Ave; appears to ha	Urban	10/9/2015	10/13/2015	Yes
174.8	Nail	2.42	Nail and flagging tape	Urban	10/9/2015	10/13/2015	No
174.7	Marker	0.49	—	Urban	10/9/2015	10/13/2015	Yes

Appendix 2. Flood-Inundation Maps of Selected Areas in Central and Coastal South Carolina, October 1–5, 2016

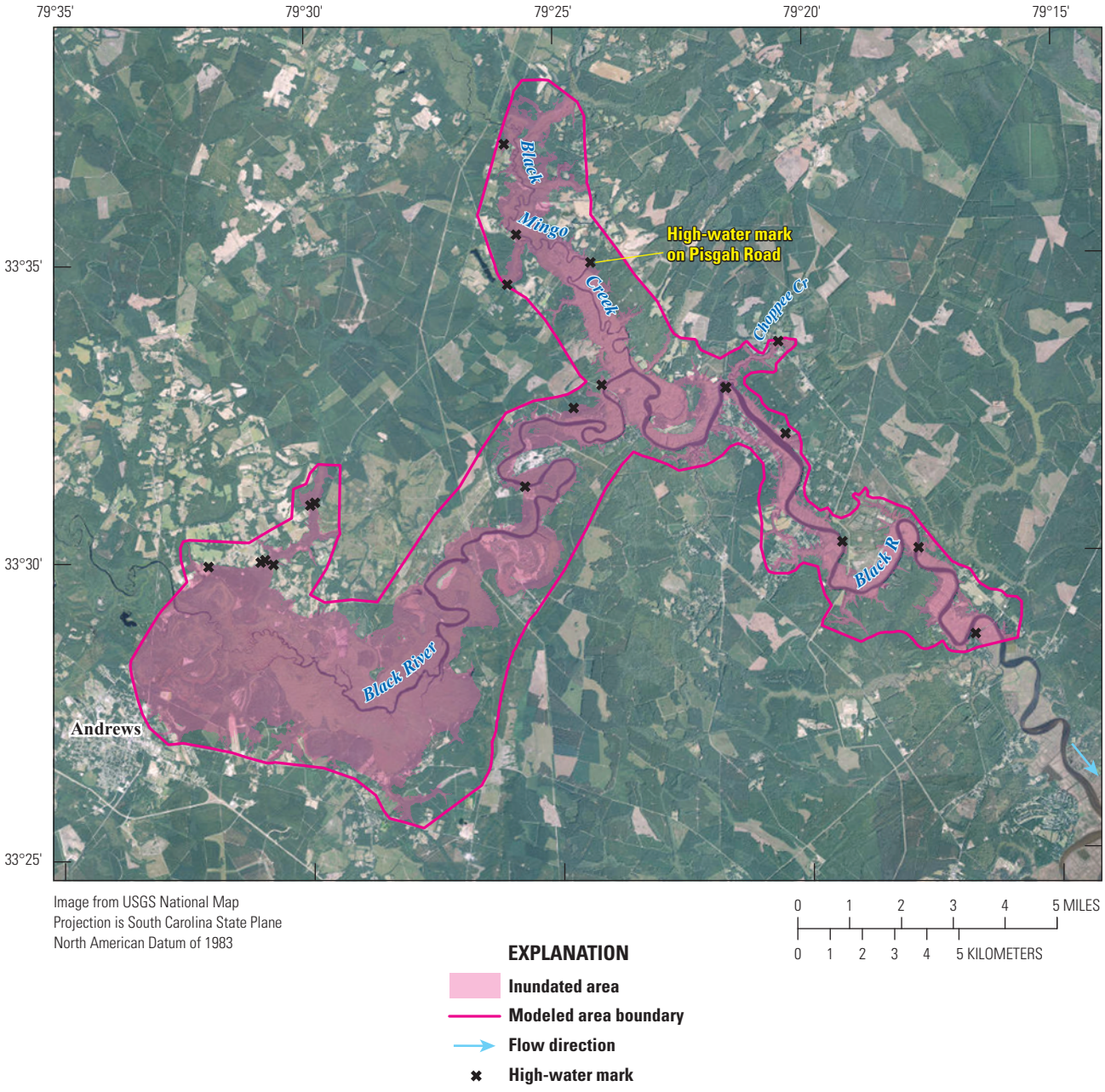

Figure 2–1. Flood-inundation map of the Black River near Andrews, South Carolina, October 1–5, 2015. See figure 3 for location.

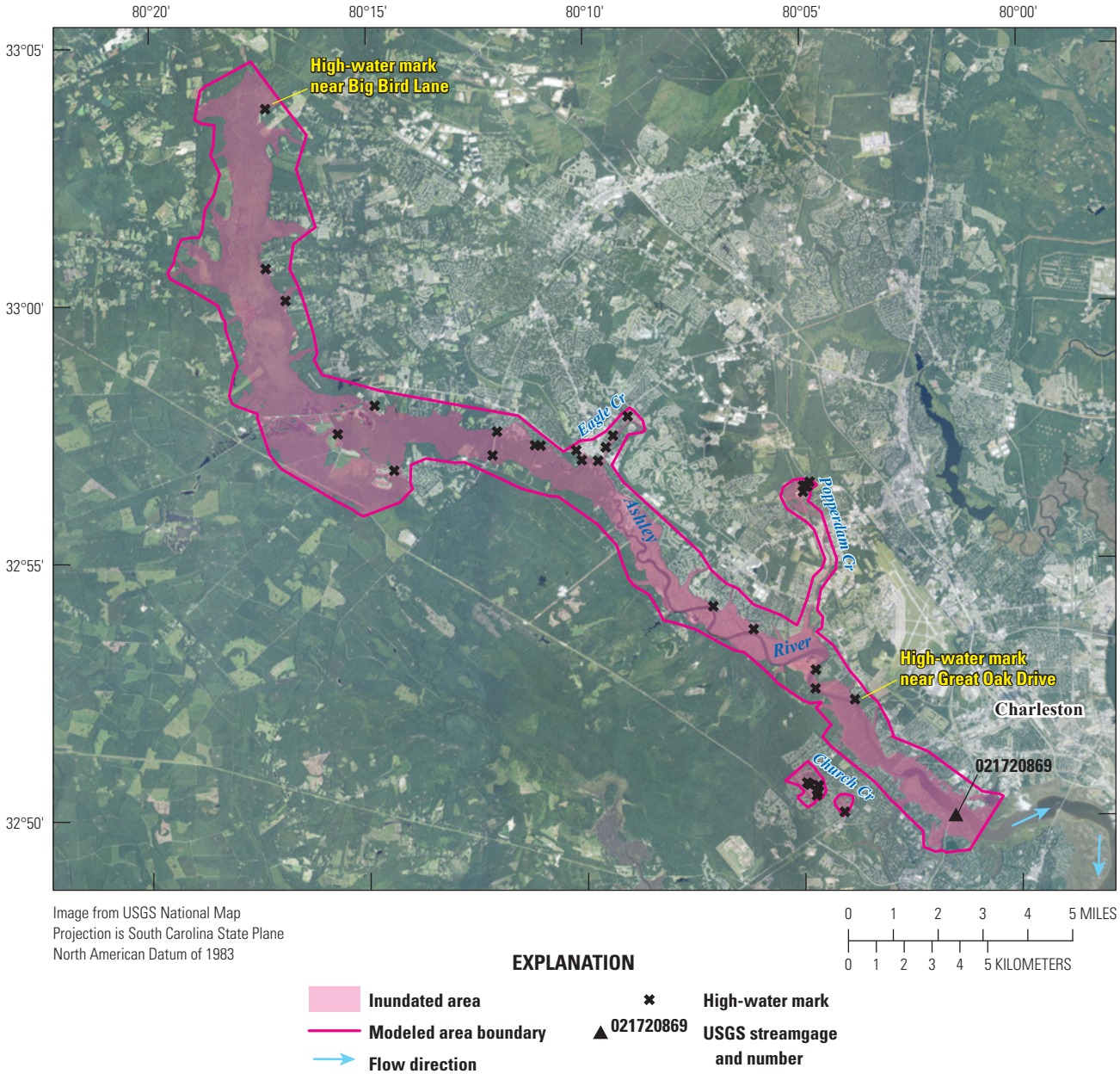

Figure 2–2. Flood-inundation map of the Ashley River near Charleston, South Carolina, October 1–5, 2015. See figure 3 for location.

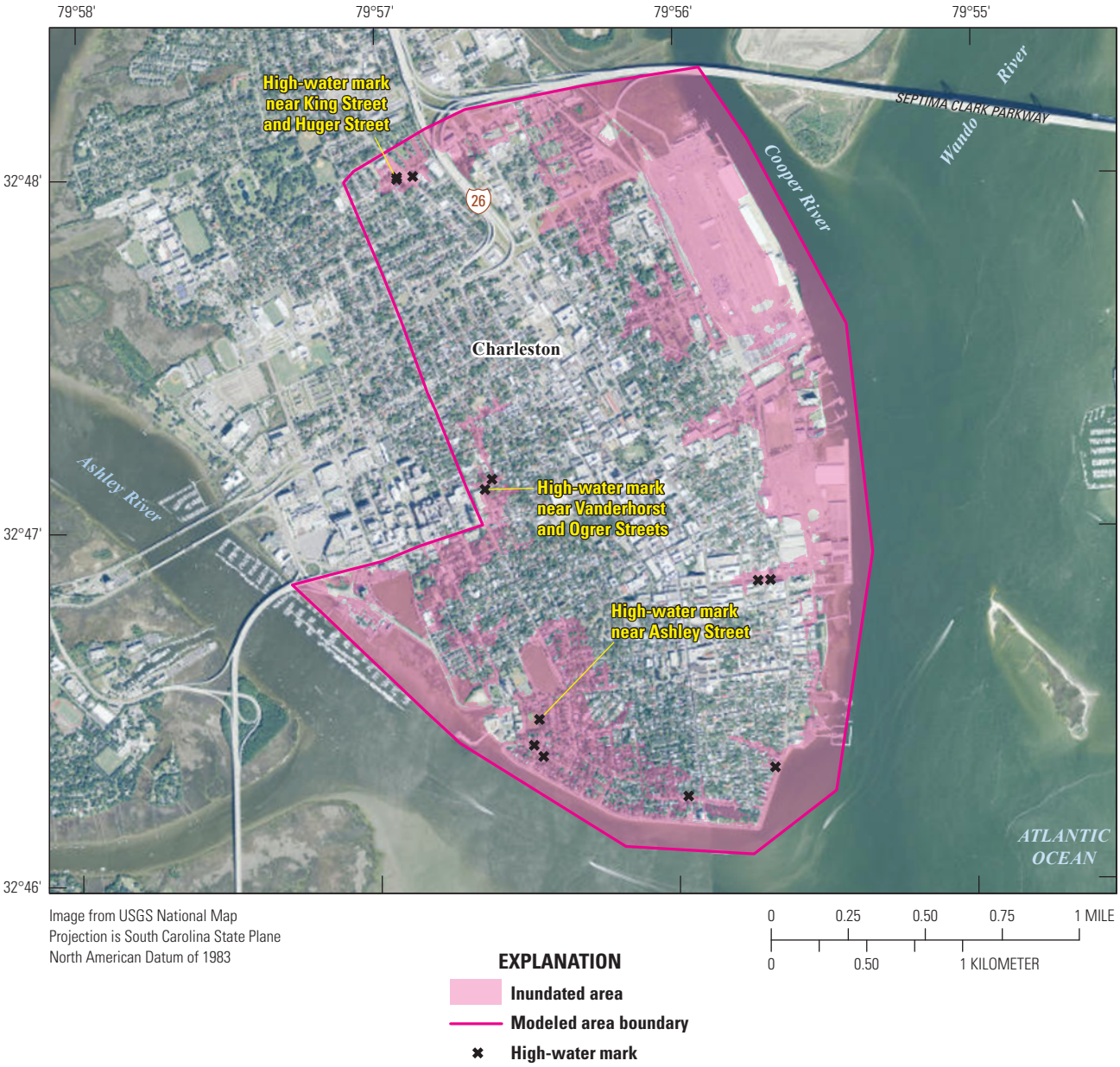

Figure 2–3. Flood-inundation map of coastal Charleston, South Carolina, October 1–5, 2015. See figure 3 for location.

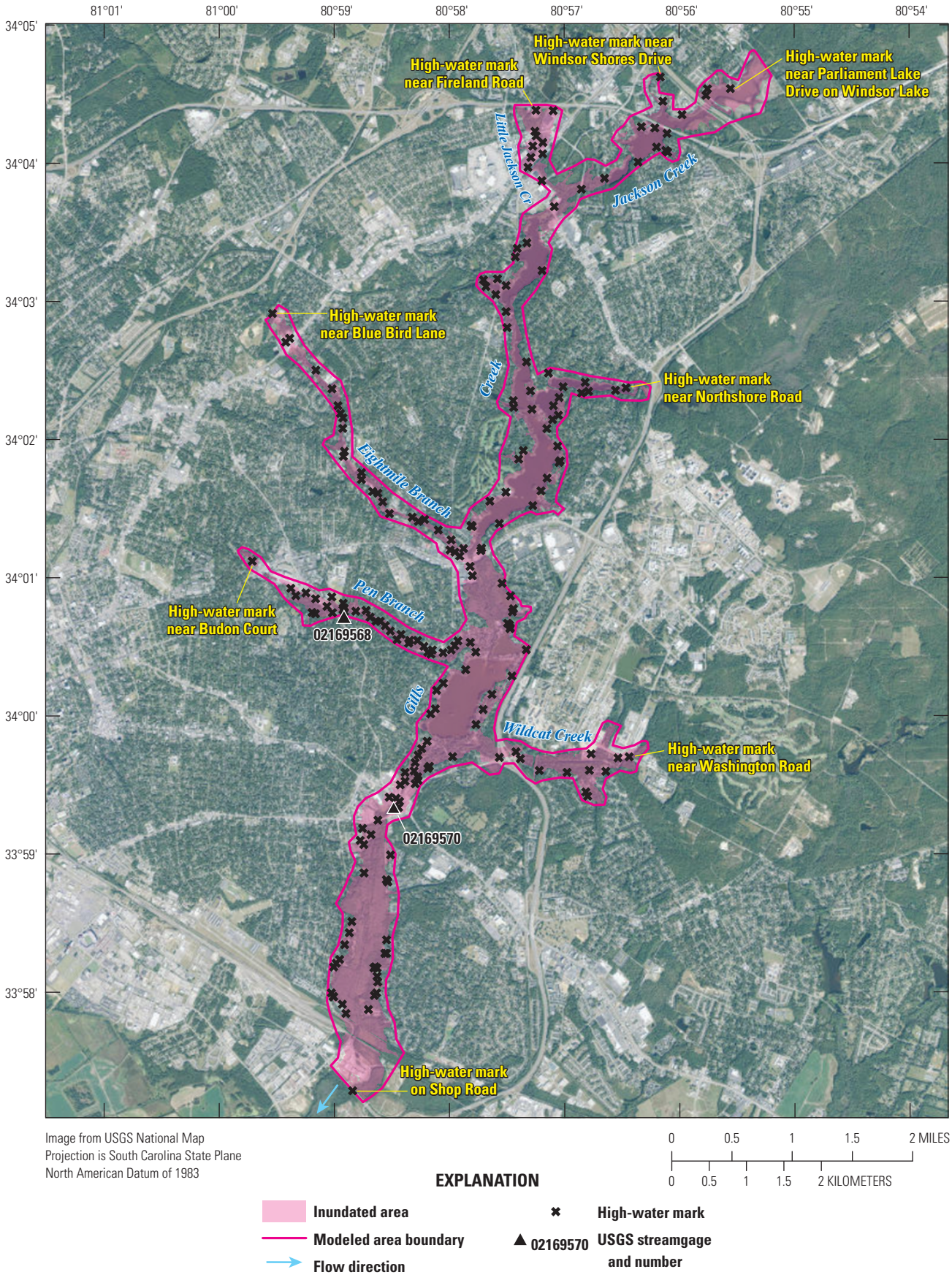

Figure 2–4. Flood-inundation map of Gills Creek in Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

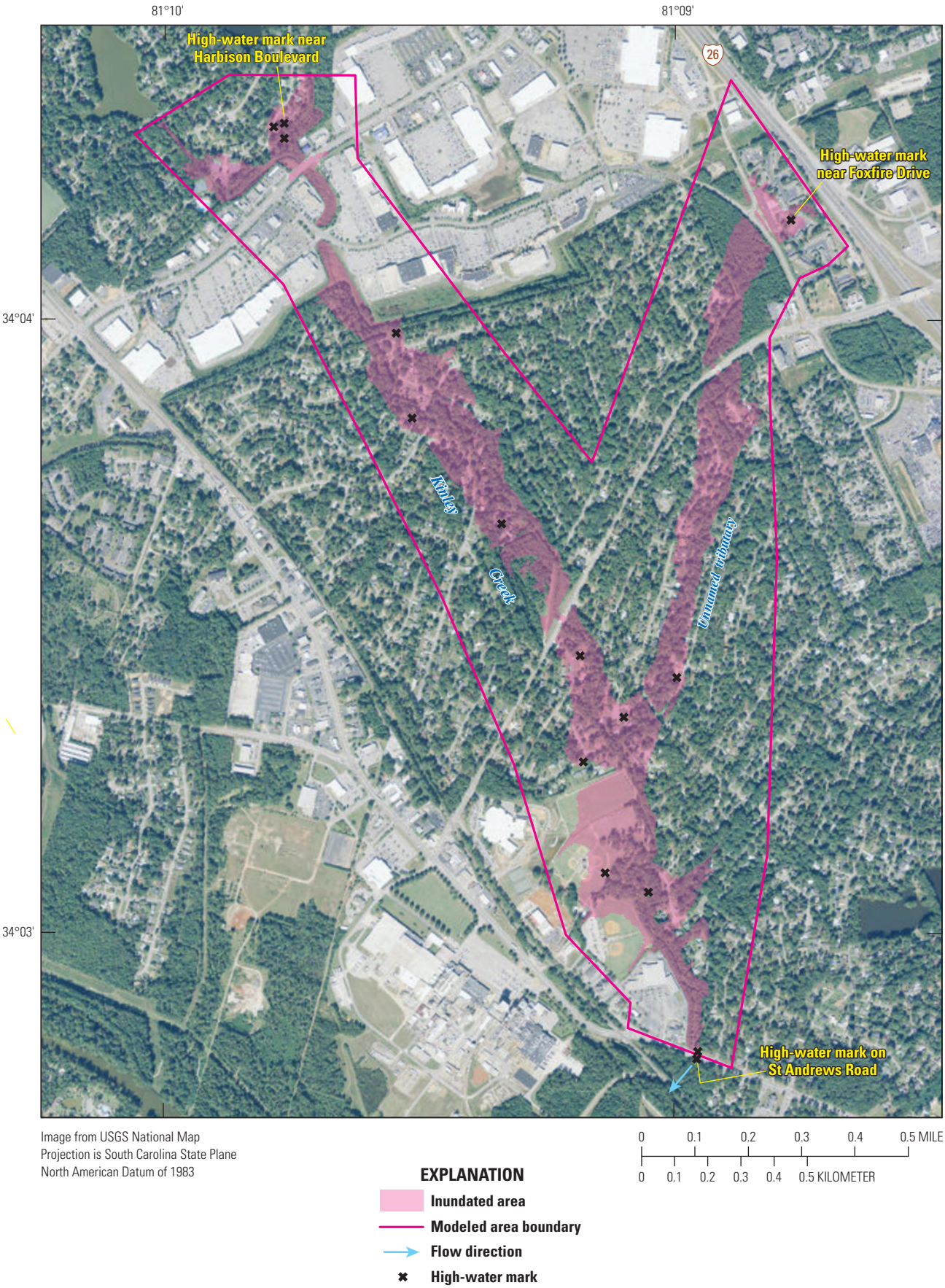

Figure 2–5. Flood-inundation map of Kinley Creek near Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

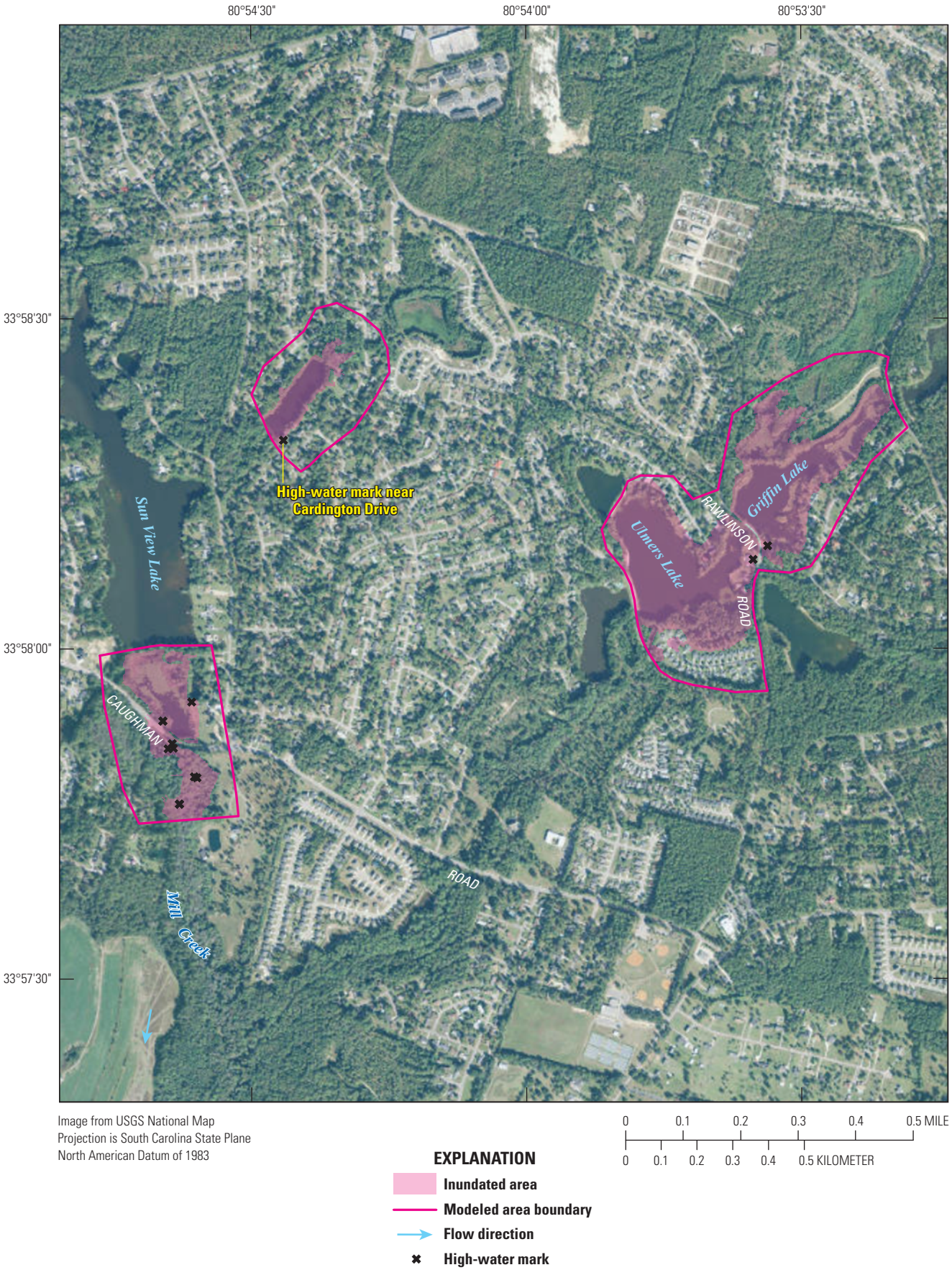

Figure 2–6. Flood-inundation map of Mill Creek near Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

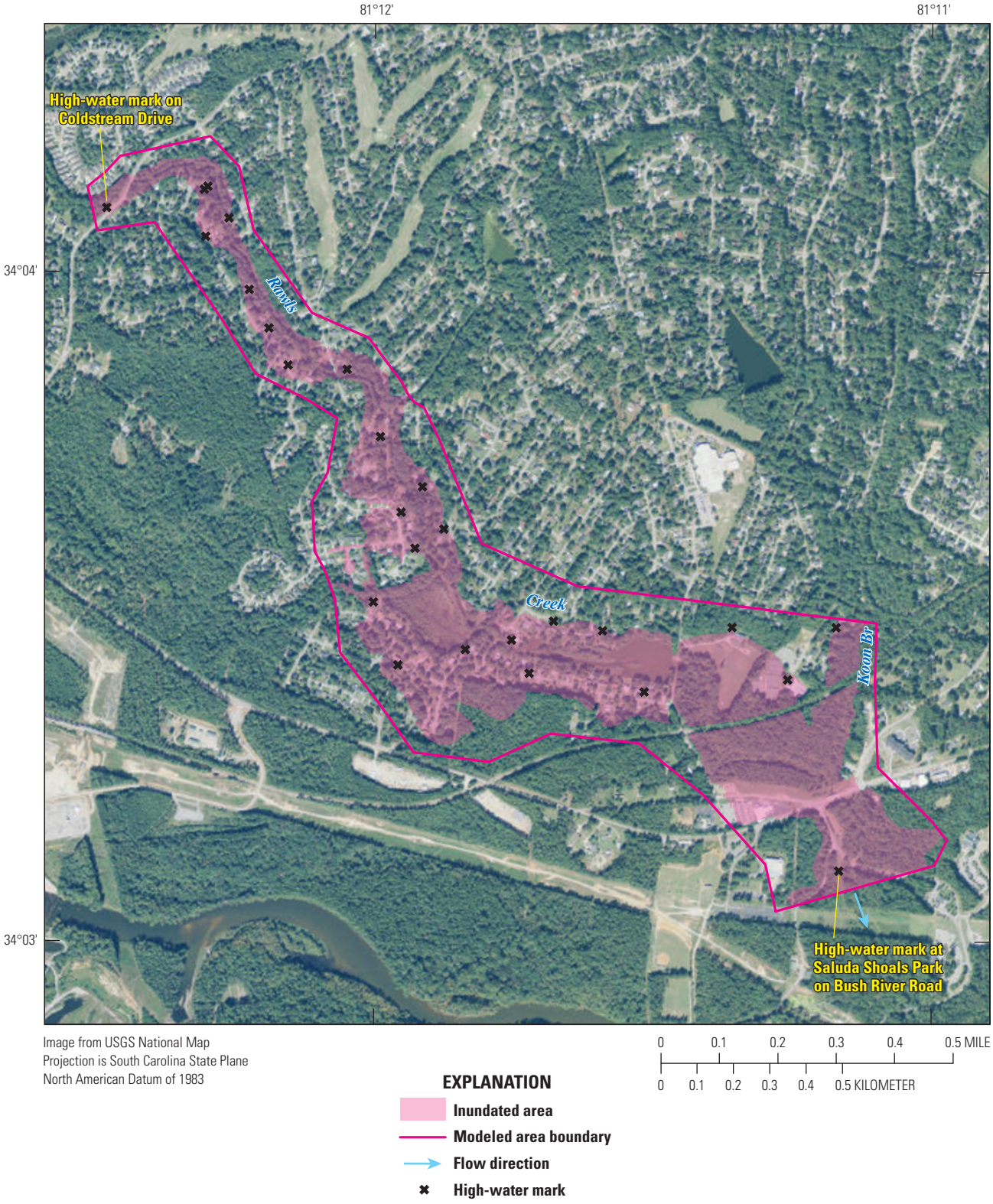

Figure 2–7. Flood-inundation map of Rawls Creek near Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

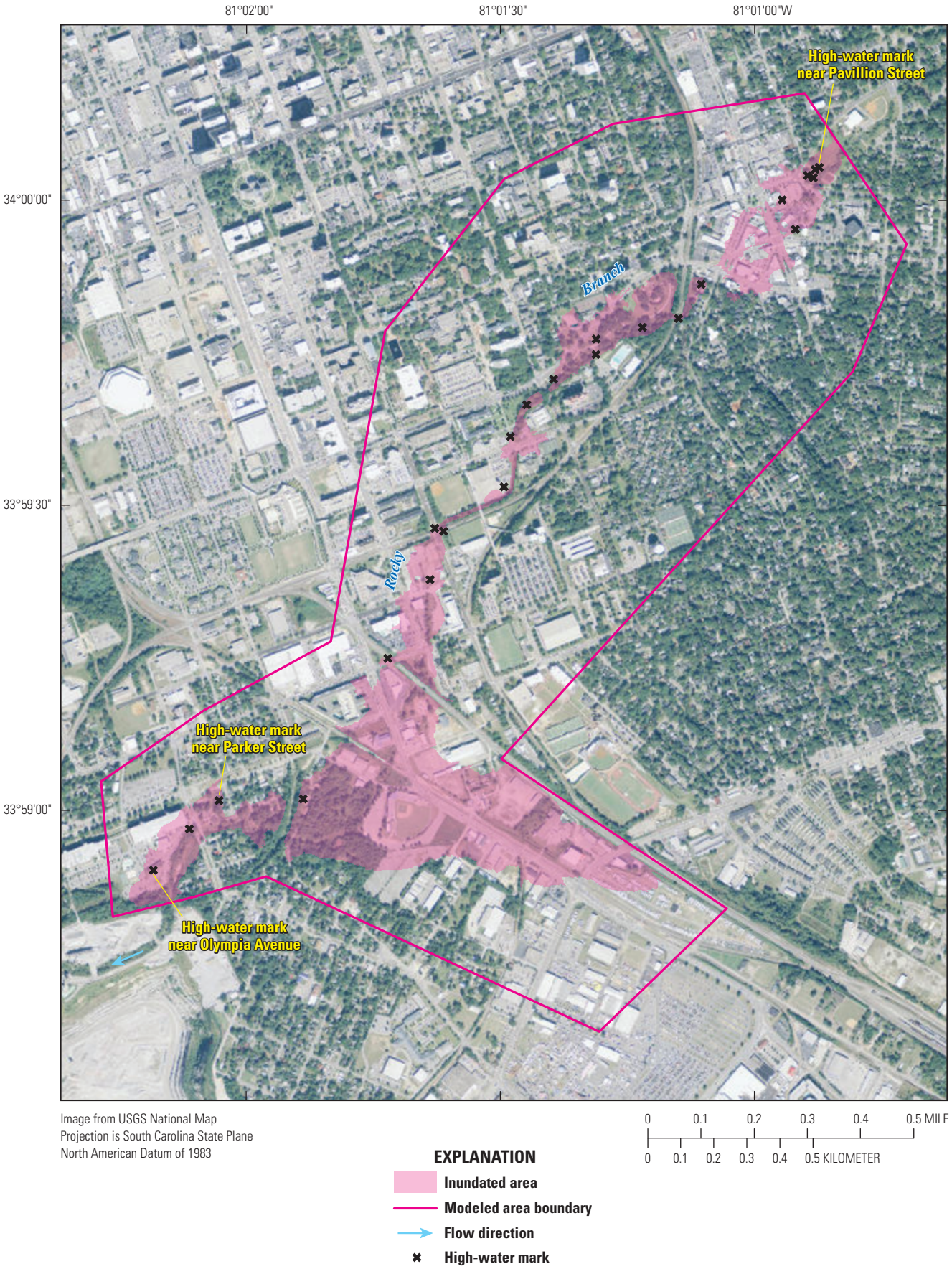

Figure 2–8. Flood-inundation map of Rocky Branch in Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

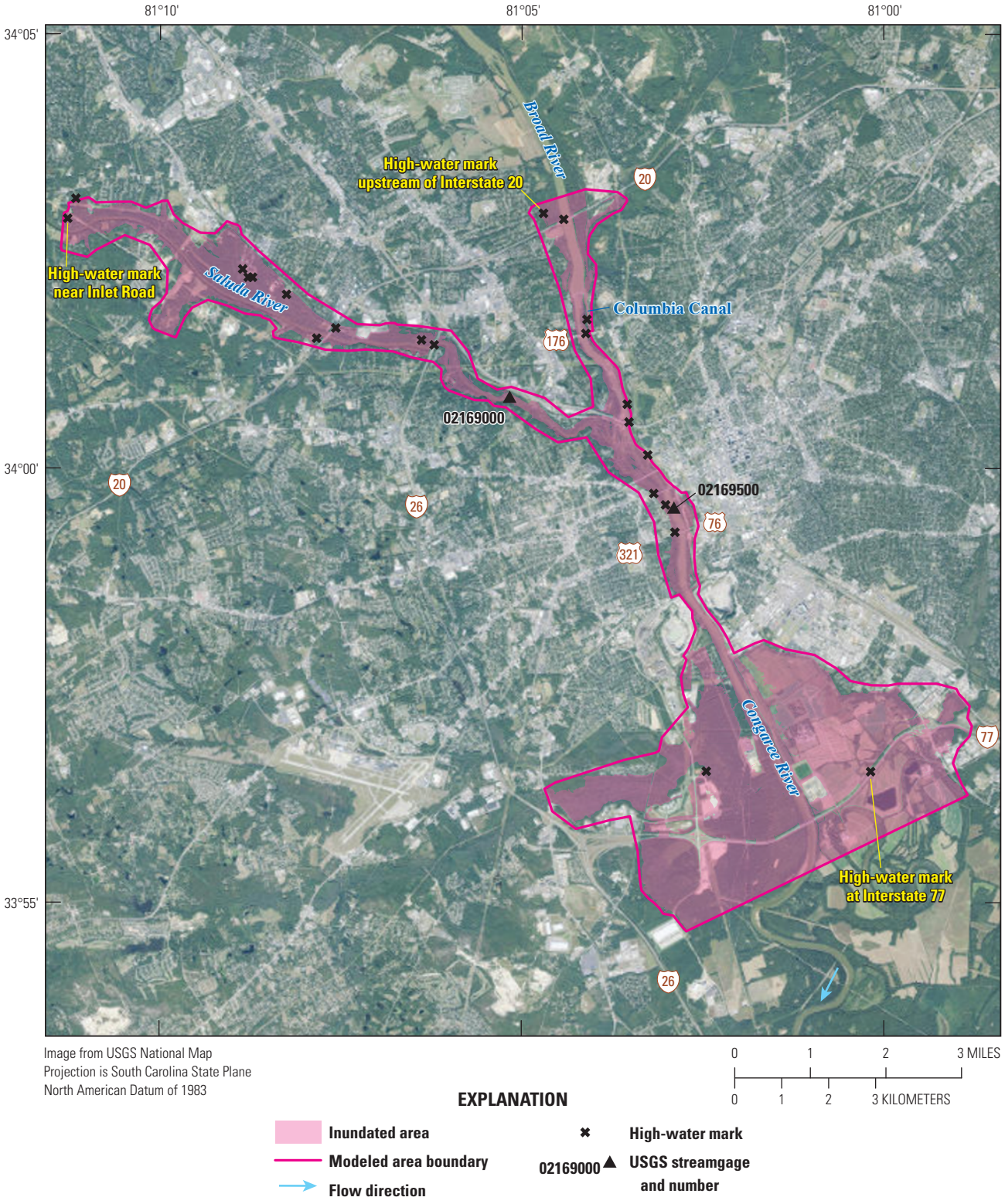

Figure 2–9. Flood-inundation map of Saluda, Broad, and Congaree Rivers near Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

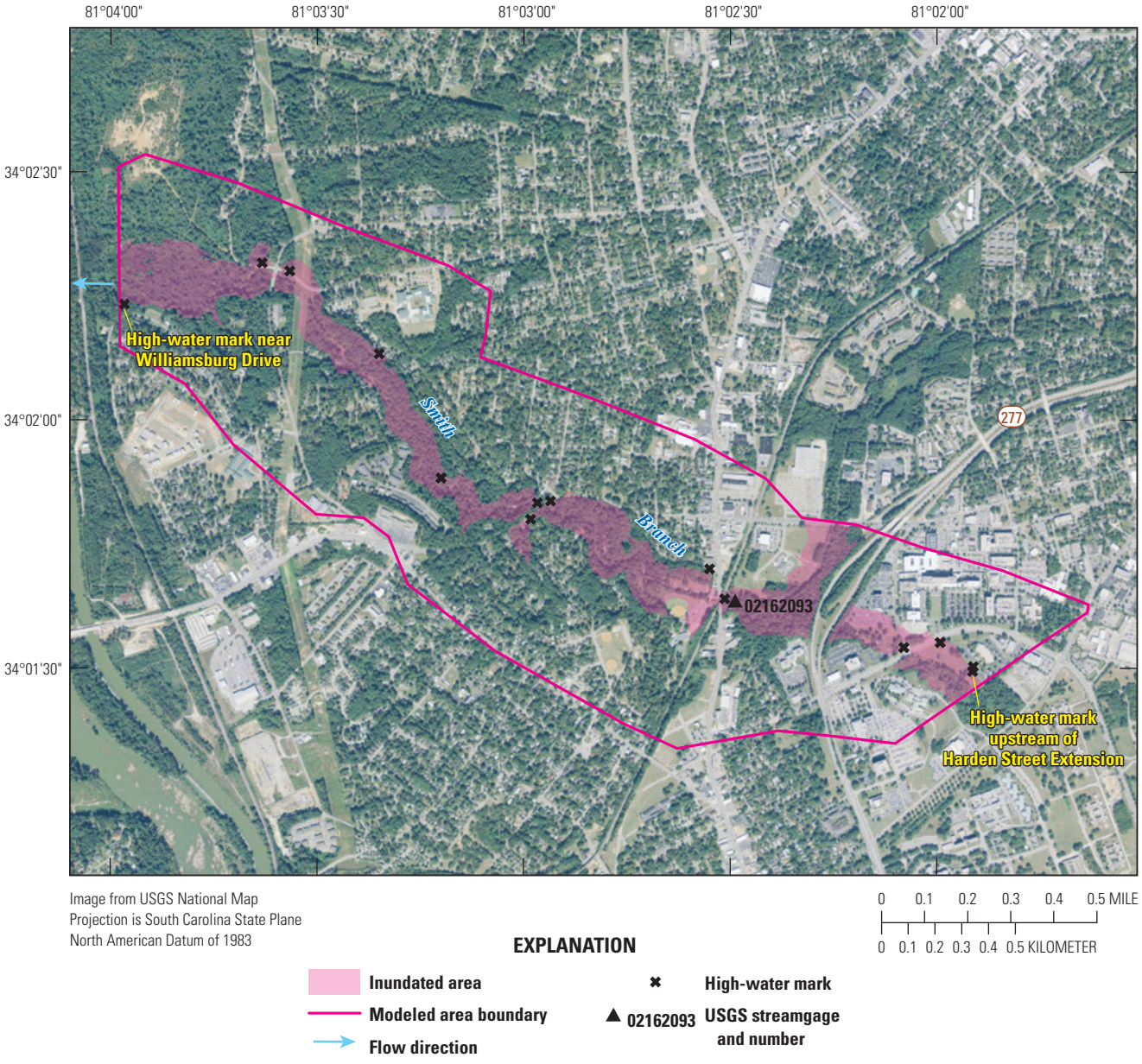

Figure 2–10. Flood-inundation map of Smith Branch in Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

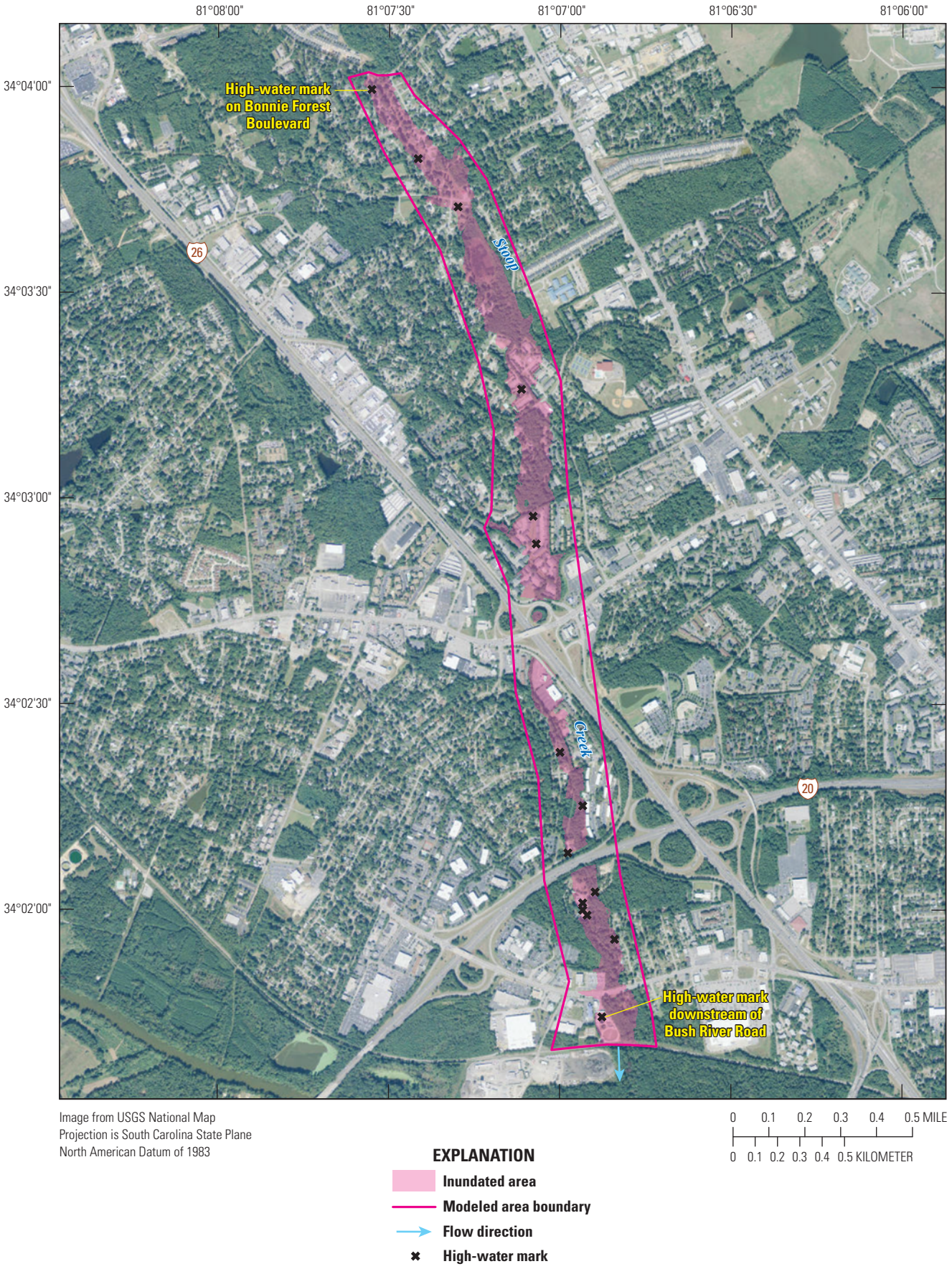

Figure 2–11. Flood-inundation map of Stoop Creek near Columbia, South Carolina, October 1–5, 2015. See figure 3 for location.

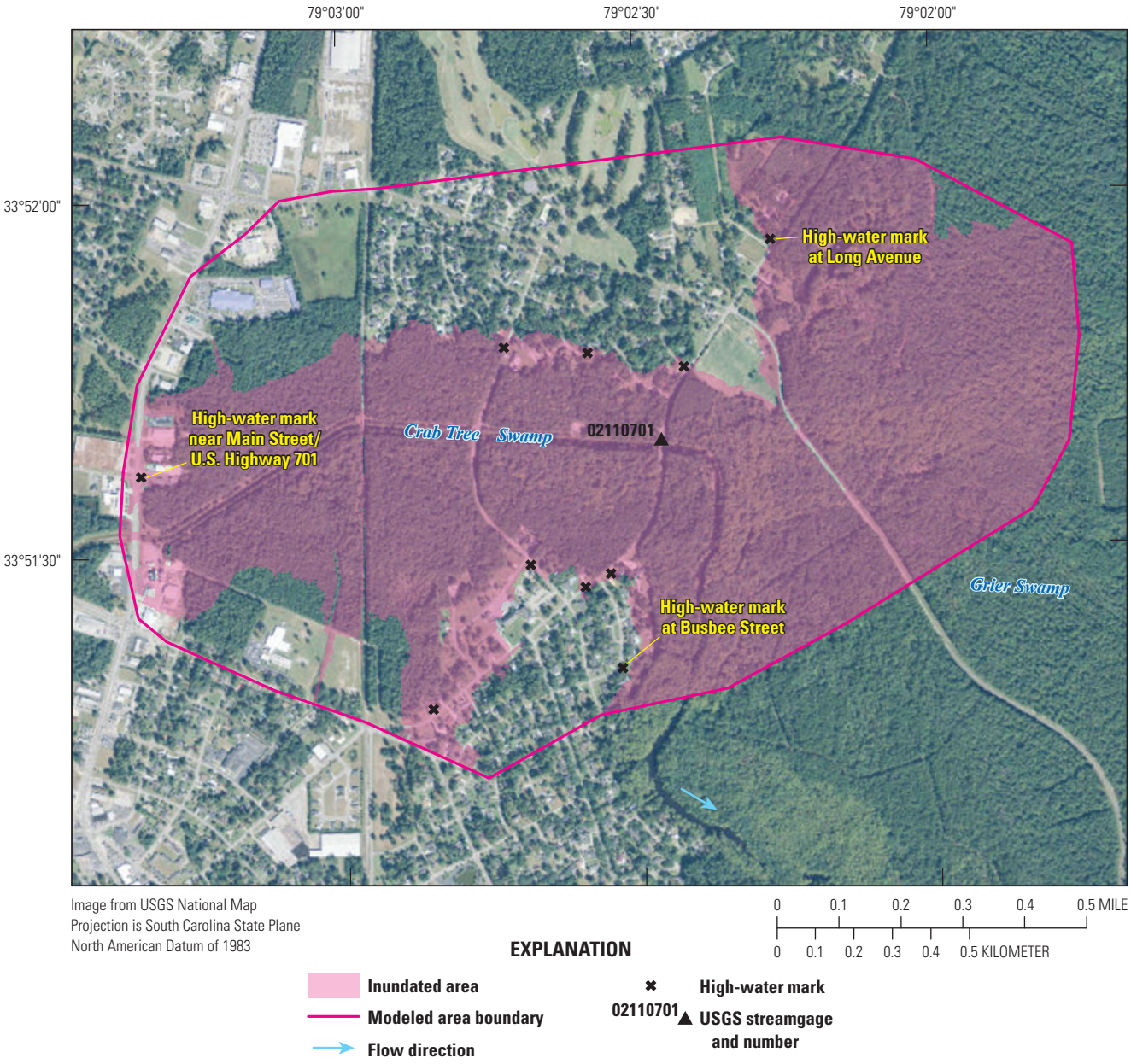

Figure 2–12. Flood-inundation map of Crab Tree Swamp at Conway, South Carolina, October 1–5, 2015. See figure 3 for location.

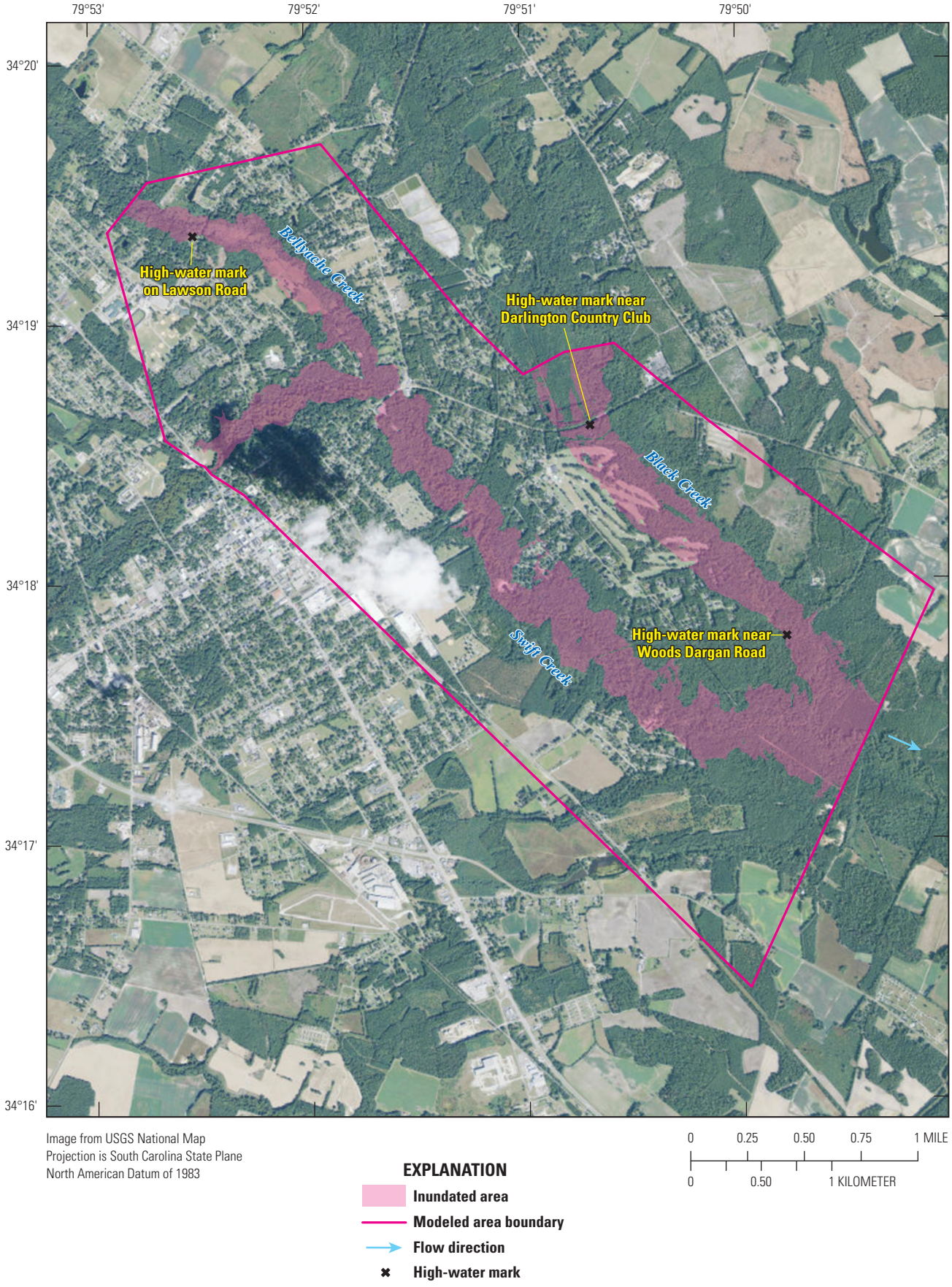

Figure 2–13. Flood-inundation map of Black Creek at Darlington, South Carolina, October 1–5, 2015. See figure 3 for location.

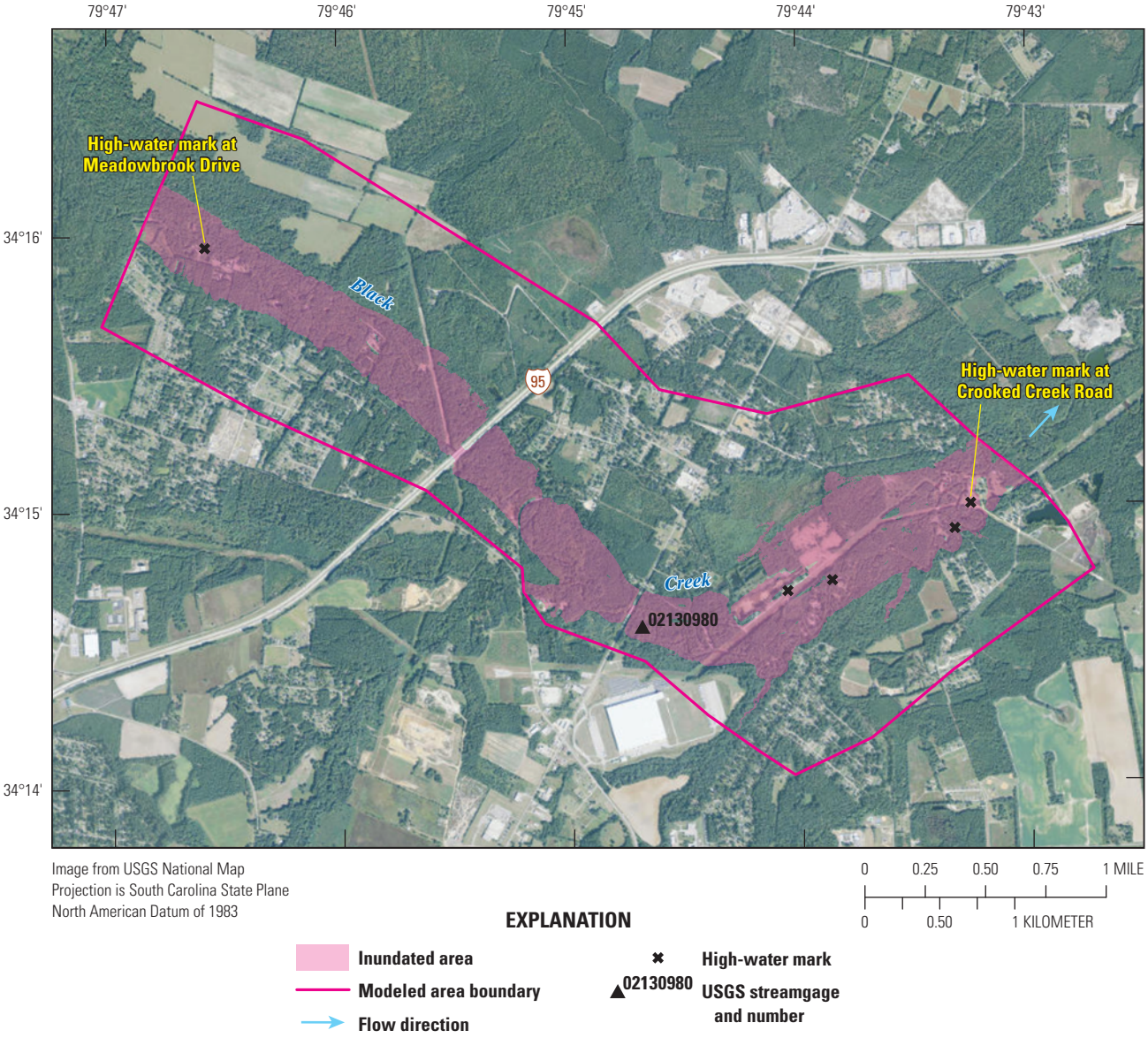

Figure 2–14. Flood-inundation map of Black Creek at Florence, South Carolina, October 1–5, 2015. See figure 3 for location.

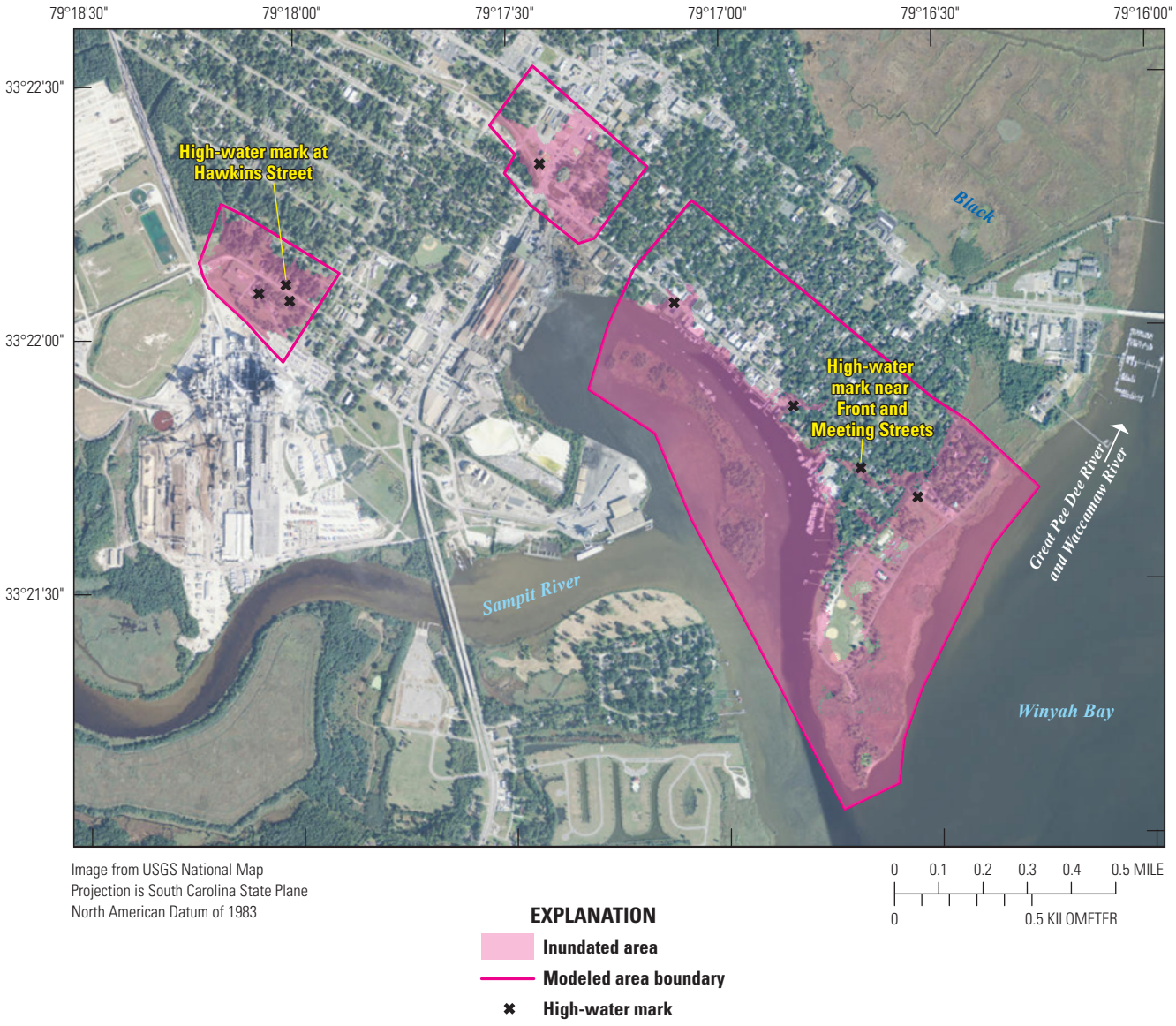

Figure 2–15. Flood-inundation map of coastal Georgetown, South Carolina, October 1–5, 2015. See figure 3 for location.

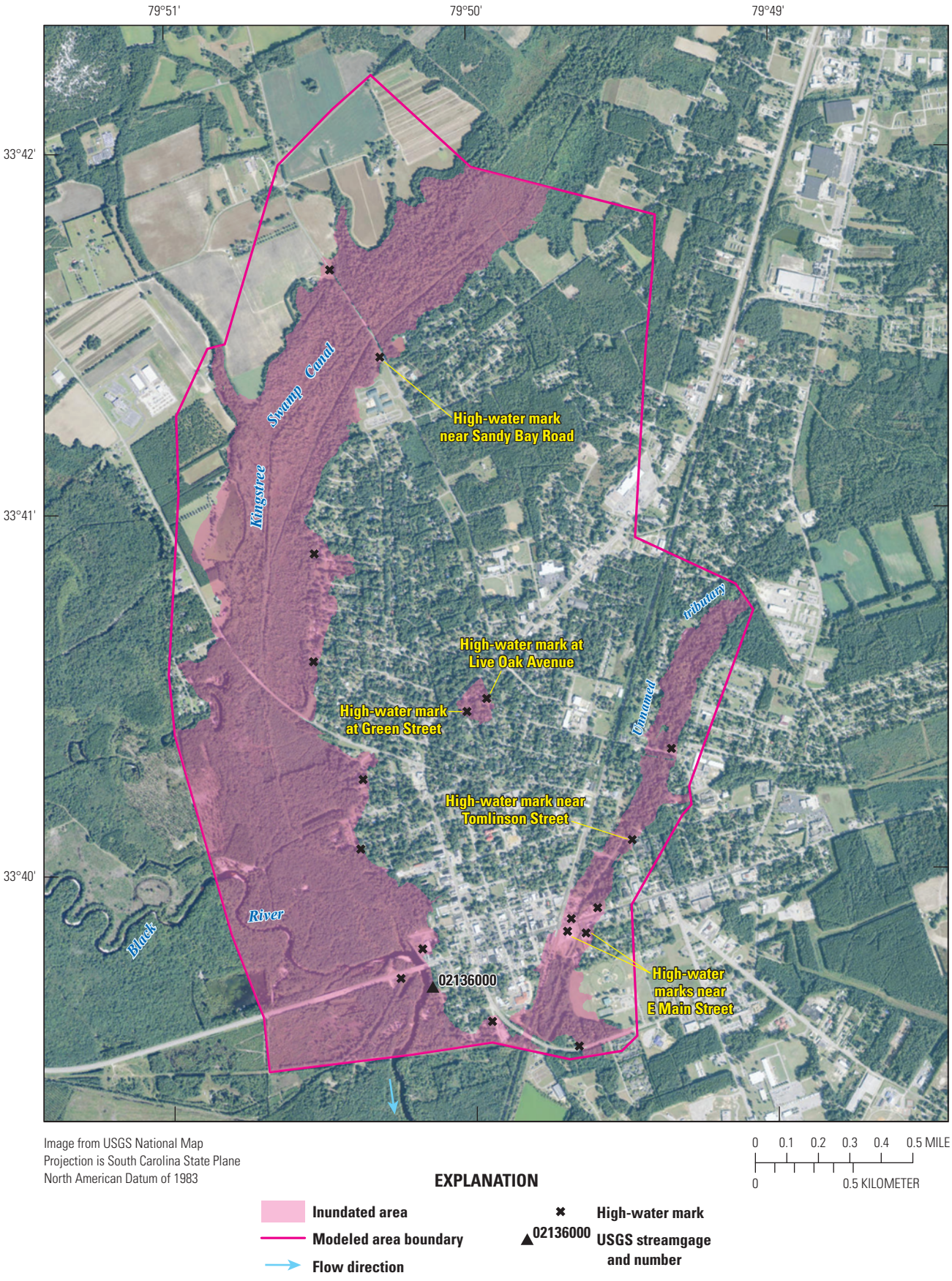

Figure 2–16. Flood-inundation map of Black River at Kingstree, South Carolina, October 1–5, 2015. See figure 3 for location.

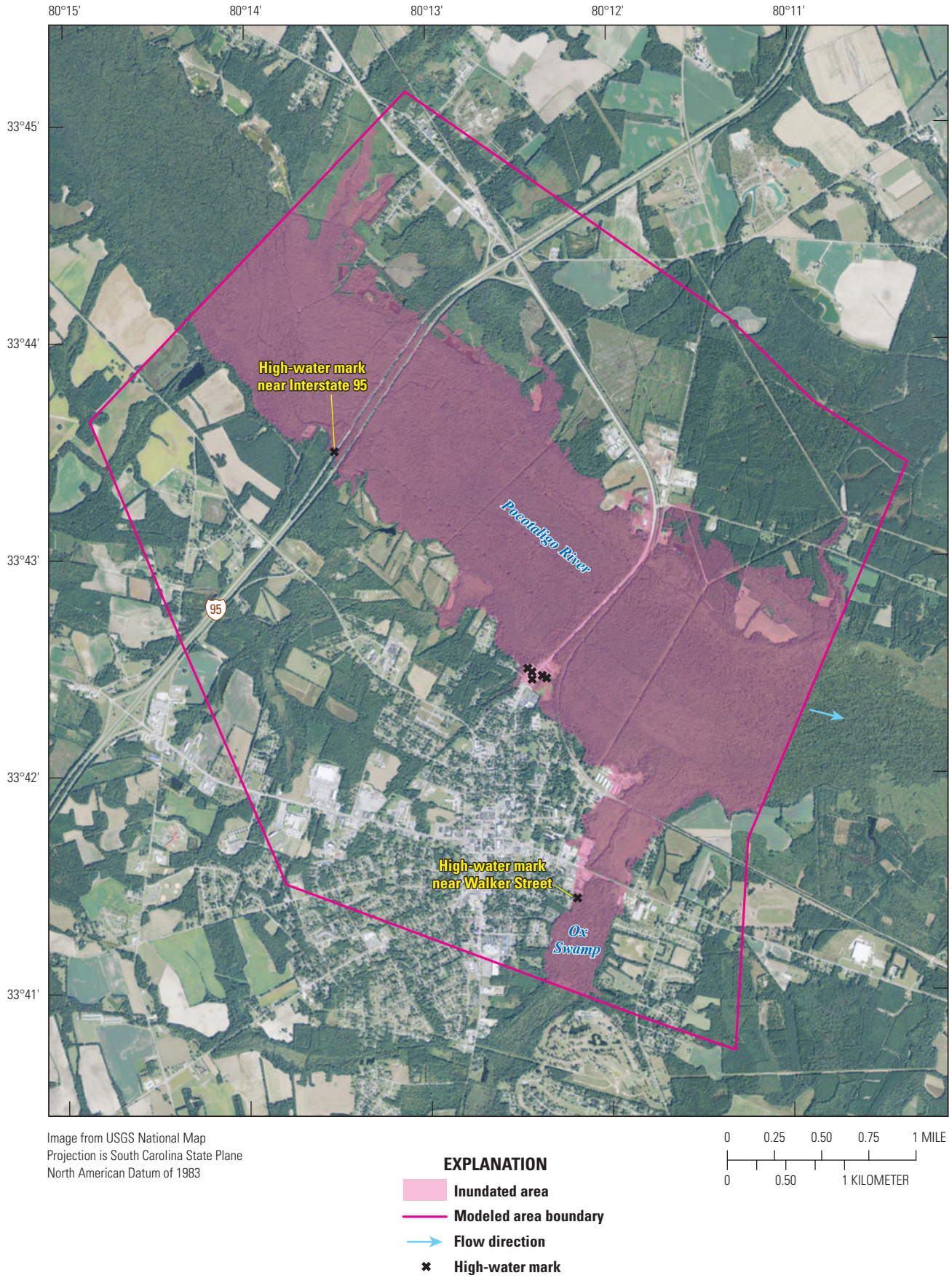

Figure 2–17. Flood-inundation map of the Pocotaligo River at Manning, South Carolina, October 1–5, 2015. See figure 3 for location.

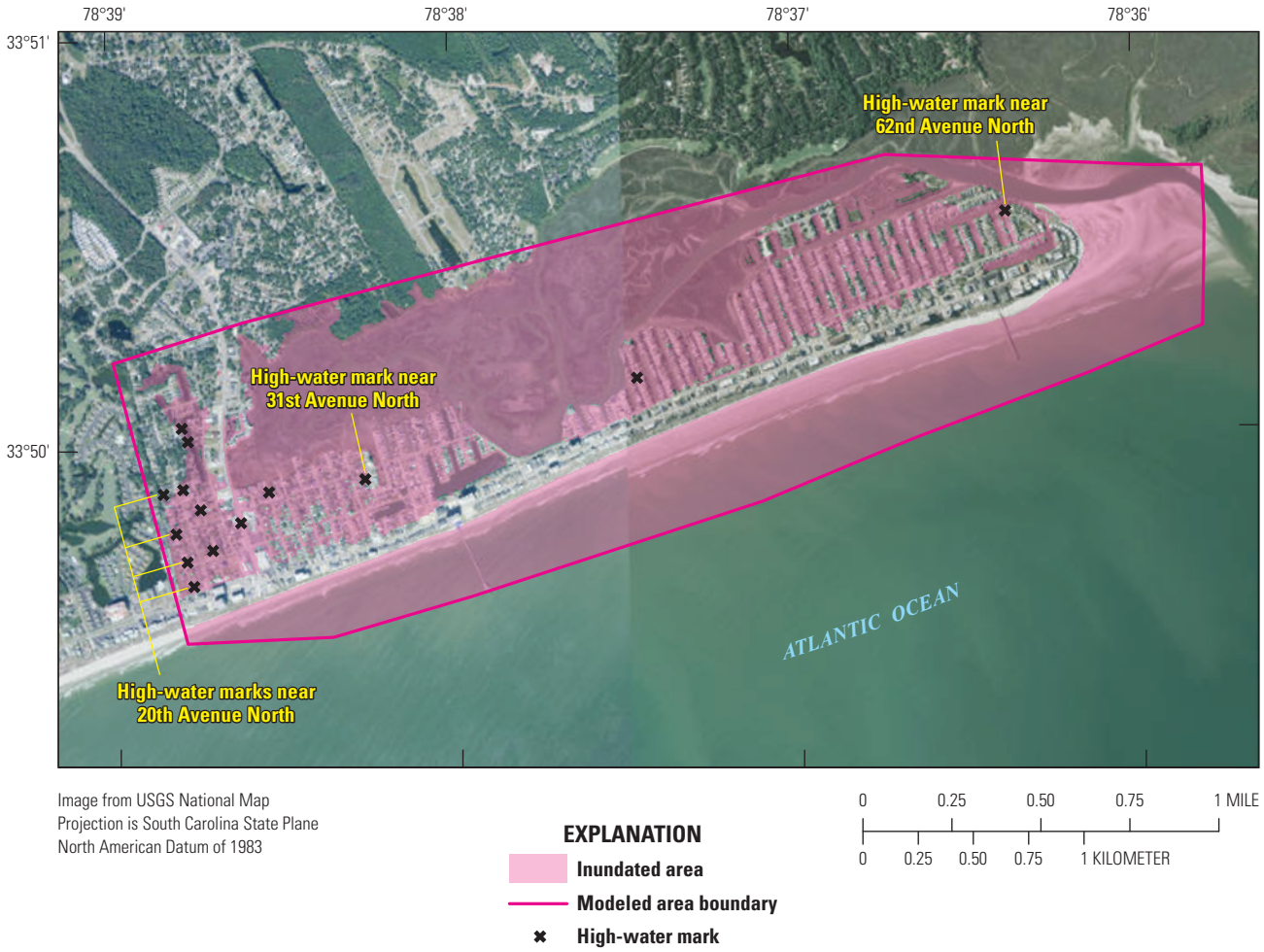

Figure 2–18. Flood-inundation map of coastal North Myrtle Beach, South Carolina, October 1–5, 2015. See figure 3 for location.

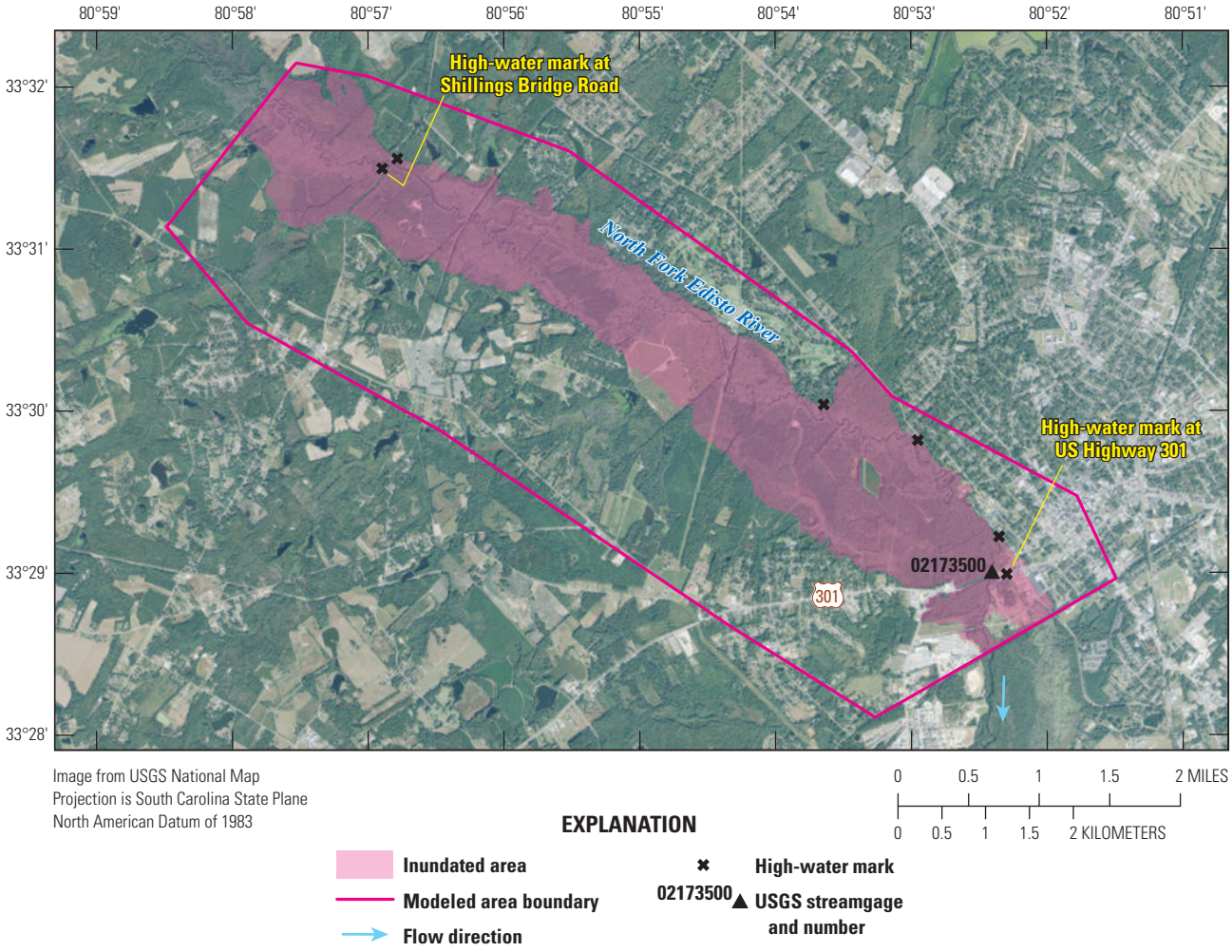

Figure 2–19. Flood-inundation map of the North Fork Edisto River at Orangeburg, South Carolina, October 1–5, 2015. See figure 3 for location.

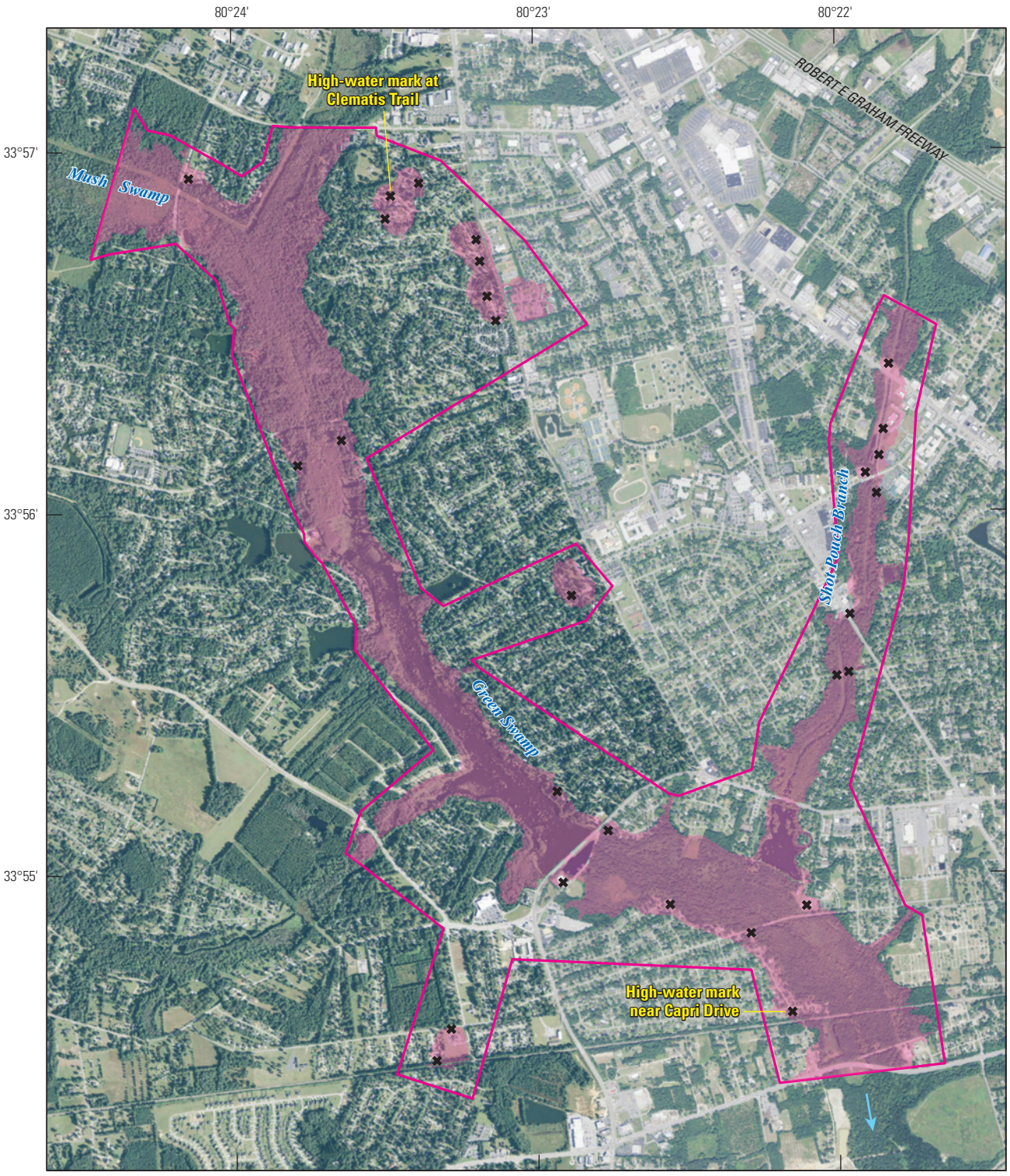

Figure 2–20. Flood-inundation map of Green Swamp near Sumter, South Carolina, October 1–5, 2015. See figure 3 for location.

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Edited by Kay P. Naugle
Illustrations and layout by Caryl J. Wipperfurth

For more information about this publication contact:
Director, South Atlantic Water Science Center
U.S. Geological Survey
720 Gracern Road
Columbia, SC 29210
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October 2015 Historic Flood

OPEN-FILE REPORT

South Carolina Department of Natural Resources
Land, Water and Conservation Division
South Carolina State Climatology Office

Compiled by: Wes Tyler
December 2015

A Narrative of the

South Carolina's Record Rains and Flooding of October 1-6, 2015

The coastal sunrise on October 1, 2015, was obscured by low clouds on the eastern horizon. The Georgetown AP had already received early morning rains of 2.75 inches. This was the slow beginning of South Carolina's record rains and flooding of October 1-6, 2015.

Between the forcing of a nearly stationary upper level area of low pressure near the Alabama-Georgia border, high pressure just north of the Great Lakes and a distant Category 3 Hurricane Joaquin near the Bahamas Islands, moist air was channeled from the Atlantic's warm Gulf Stream waters into South Carolina. Over a lifting field of northeast to east surface winds, that river of air was condensed into historic rain.

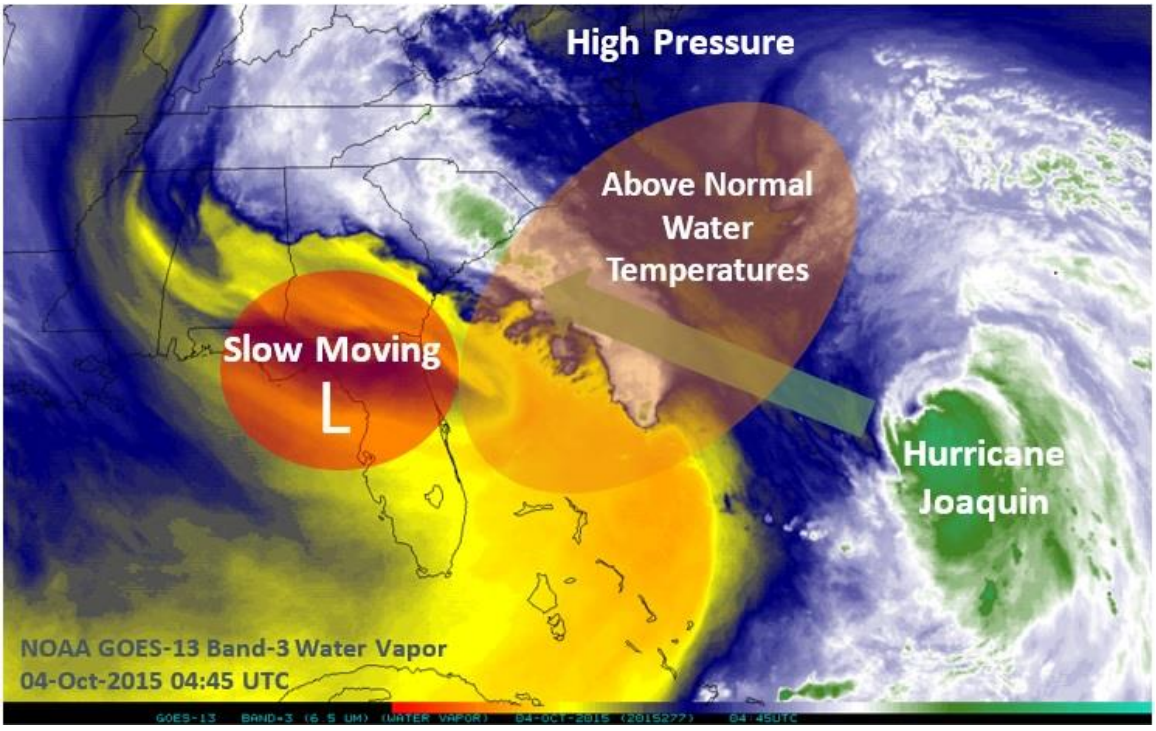

Figure 1. NOAA Water Vapor with Overlay of Parameters Contributing to the Heavy Rain

At 1:56 p.m. on Thursday, October 1, the Charleston AP reported heavy rain that closed streets on the city's peninsula. A foot of water had entered homes near the Charlestown Landing. At midnight, 3.14 inches of rain had fallen on Charleston City with steady rain continuing. A CoCoRaHS volunteer observer at Folly Beach reported an overnight rainfall of 5.46 inches. Up the coast, an axis of torrential rain was falling over Horry and Georgetown counties.

The Friday, October 2, 5:22 a.m. observation at N Myrtle Beach noted north-northeast winds gusting at 31 mph and heavy rain. Intensities at N Myrtle Beach climbed to 1.27 inches per hour at 4:53 p.m. and 1.72 inches per hour at 7:53 p.m. Flooded roadways and parking lots in Horry County were littered with groups of abandoned cars. At 9:15 p.m., the USGS rain gage at Buck Creek near Longs had accumulated a running 24-hour total of 9.79 inches. At midnight, the N Myrtle Beach AP had received 7.88 inches of rain and its greatest calendar-day amount since the flooding caused by Hurricane Floyd in August 1999. Florence Regional AP received 4.73 inches on October 2. Two NWS CWOP (Citizen Weather Observer Program) volunteers reported overnight rainfalls taken on Saturday morning, October 3, of 16.00 inches in Little River and 15.86 inches in N Myrtle Beach. Rainfall as far away as Chesterfield had then reached 5.85 inches for the 24-hours ending at 7:00 a.m. At the same time, a Charleston National Weather Service employee rainfall measurement, taken 6.4 miles northeast of Mount Pleasant, indicated 7.76 inches had fallen over the previous 24-hours, yielding a three-day total of 11.33 inches. Extensive road flooding, closures and detours were observed within Charleston, Dorchester and Berkeley counties from daylight into the evening hours.

Figure 2. Dorchester County, South Carolina
Photo Source: DNR Law Enforcement

At 10:56 a.m., water was reported to be “waist deep” on parts of Johns Island. Springmaid Pier at Myrtle Beach recorded east winds gusting 46 mph at 11:54 a.m. and a near time high tide value of 8.30 feet (+2.25’ above predicted) that resulted in nearby tidal flooding to low elevation streets and property.

The Charleston AP 1:12 p.m. surface weather observation noted rain with thunder, east-southeast winds gusting at 36 mph. Kingstree's 3:00 p.m. 15-minute rainfall of 0.75 inches had increased their 36-hour total to 5.59 inches. At around 5:00 p.m., Williamsburg County began to report flooding. Just before 6:00 p.m., portions of Wadmalaw Island were under three feet of water. Access to Kiawah Island was stopped due to impassable roads. During the evening hours winds gusted to 60 mph in the Charleston Harbor and 53 mph at Sullivan's Island. Wind driven waves, on top of elevated tides, broke against and over the Charleston peninsula's southeast battery. Rainfall rates at Charleston AP increased to 2.06 inches per hour by 10:00 p.m. The calendar-day-ending total of 11.50 inches at the Charleston AP established the greatest 24-hour rainfall since recordkeeping began at that location in 1938. In addition, the October 1-3 total of 14.48 inches bested the full 31-day October record of 12.11 inches set in 1994. Well before sunrise on Sunday, October 4, record and deadly rains expanded into Clarendon, Orangeburg, Williamsburg, Florence, Sumter, Kershaw, Richland and Lexington counties with rainfalls of 10 inches or higher. An automated Forestry Service rain gage near Santee in Clarendon County indicated that as of 1:44 a.m. 9.81 inches of rain had fallen over the previous 24-hours.

Figure 3. Clarendon County, South Carolina
Photo Source: DNR Law Enforcement

In the seemingly endless hours of intense rain before Sunday's light, fast moving water coursed over heavily used roads and freeways. The intersection of Highway 601 and 378 was closed at 4:29 a.m. Cars were stalled along highway 378 near the McEntire ANG AP. The Interstate 20/Interstate 26 west exit ramp was closed. The SC Highway Patrol closed a portion of Interstate 26 in Clarendon County at 6:00 a.m. due to flooding.

Figure 4. Clarendon County, South Carolina
Photo Source: DNR Law Enforcement

Hourly rainfall rates at the Forest Acres Richland County Emergency Services Gills Creek automated gage (Forest Drive and I-77) recorded 1.76 inches from 2-3:00 a.m., 3.76 inches from 3-4:00 a.m., 3.00 inches from 4-5:00 a.m. and 2.12 inches from 5-6:00 a.m. yielding an unprecedented 10.64 inches over four hours. At 7:00 a.m., the Gill's Creek site had accumulated 12.68 inches of rain since midnight. Spillways and dams along the Arcadia Lakes watershed were overwhelmed. As dawn arrived, so did a succession of dam failures that included the Pine Tree Lake Dam (just below Windsor Lake), the Havird Pond on Arcadia Road, the Cary Lake Dam at Skii Lane and the Semmes Lake Dam on Fort Jackson, sending a flash flood downstream.

Figure 5. Cary Lake Dam Failure at Skii Lane
Photo Source: Wes Tyler, SC Climatology Office

Daylight revealed overflowing roadside ditches moving into streams and creeks and rapidly filling ponds and lakes. Vehicles were being swept off of Dentsville's Decker Boulevard near the intersection of O'Neil Court, trapping the occupants and requiring teams of rescue response.

Figure 6. Richland County, South Carolina
Photo Source: DNR Law Enforcement

Hurried swift water specialists from multiple agencies performed emergency rescues throughout the morning removing homeowners from the Lake Katharine community downstream into the Garners Ferry Road business section.

Figure 7. Richland County, South Carolina. Assisting Swift Water Rescue Teams.
Photo Source: DNR Law Enforcement

Many one story homes were submerged. A USGS gage along Gills Creek at Fort Jackson Boulevard was destroyed after transmitting a height of 17.1 feet. A USGS post flooding survey analysis would indicate a peak stage of 19.6 feet. At noon, the Forest Acres Gills Creek gage rainfall amount had risen to an incredible 15.51 inches for the past twelve hours. Not even the oldest of inhabitants had ever witnessed such an event. The Rocky Creek Branch stage at South Main and Whaley in downtown Columbia climbed to its second highest stage of record when it crested at 12.28 feet on Sunday afternoon. So much rain fell over the Twelve Mile Creek basin in Lexington County the historic Lexington Mill Pond earthen dam failed, sweeping away much of the restored mill's business property and taking out a portion of Highway 1. A CoCoRaHS observer in Lexington reported a 24-hour total, ending at 7:00 a.m. on Sunday morning of 8.40 inches. Urban and rural washouts along rail and roadway beds, shoulders, overpasses and bridges resulted in barricades and lengthy detours from the Midlands south into the Lowcountry and eastward into the Pee Dee.

Figure 8. Lexington County, South Carolina
Photo Source: DNR Law Enforcement

A Coast Guard helicopter was called to rescue service in lifting a mother and child from rising water in Huger. The Columbia Metro AP 24-hour rainfall of 8.74 inches established an all-time record for any month. At 6:45 p.m., the Congaree River at Columbia reached a peak and "major flood" stage of 31.81 feet with a calculated flow of 185,000 cubic feet per second. It was discovered during the earliest minutes of daylight on Monday morning, October 5, the 120-year-old Broad River diversionary Columbia Canal had breached, compromising the availability

of treated drinking water for the service area populace**.** A combined "around the clock" effort to stabilize the canal failure was performed and completed by the engineering leadership represented by the City of Columbia, the U. S. Geological Survey, Federal Emergency Management Agency and the U. S. Army and National Guard.

Figure 9. Columbia Canal breech
Photo Source: Wes Tyler, SC Climatology Office

Georgetown's 12.32-inch total over Saturday and Sunday turned the county into a lake. The USGS Black River gage at Kingstree indicated a Sunday 24-hour rain total of 12.83 inches. The city of Kingstree was surrounded by rising water and residents were evacuated. The Gills Creek gage midnight ending rainfall total of 16.69 inches was the greatest known amount ever

Figure 10. Title Max building collapse in Garners Ferry Road business section.
Photo Source: Wes Tyler, SC Climatology Office

measured in South Carolina over 24-hours. According to the National Weather Service Hydrometeorological Design Studies Center, that amount exceeded the 1,000 year average recurrence interval for any location in the state. At the end of the day, many citizens experienced restrictions to travel, overnight curfews, forced relocation and widespread losses of water and electricity. Confirmed vehicle drownings had risen to 4, some were missing. The unstoppable rain kept falling.

At 12:15 a.m. on Monday morning, October 5, Shaw AFB in Sumter reported north-northeast winds gusting to 37 mph. There were scattered reports of mature trees toppling onto cars, power lines and residential property as root systems gave way to the overly saturated soils. Twenty-four-hour overnight rainfall amounts reported on Monday morning, October 5, included 10.00 inches at Myrtle Beach and 9.29 inches at the Crabtree Swamp near Conway. Periods of rain, sometimes heavy, fell through the day before tapering off during the evening hours. Running "event" rainfall totals had reached 21.49 inches for the Forest Acres Gills Creek gage, 19.81 inches at Shaw AFB in Sumter and an incredible 26.92 inches was measured by a Charleston NWS employee at Mt. Pleasant. The USGS gage on the Black River at Kingstree recorded an October 1-5 rainfall amount of 22.91 inches. On Tuesday, October 6 at 9:30 p.m., the Black River at Kingstree reached an all-time record stage of 22.65 feet surpassing the previous record flood stage of 19.77 feet set on June 14, 1973.

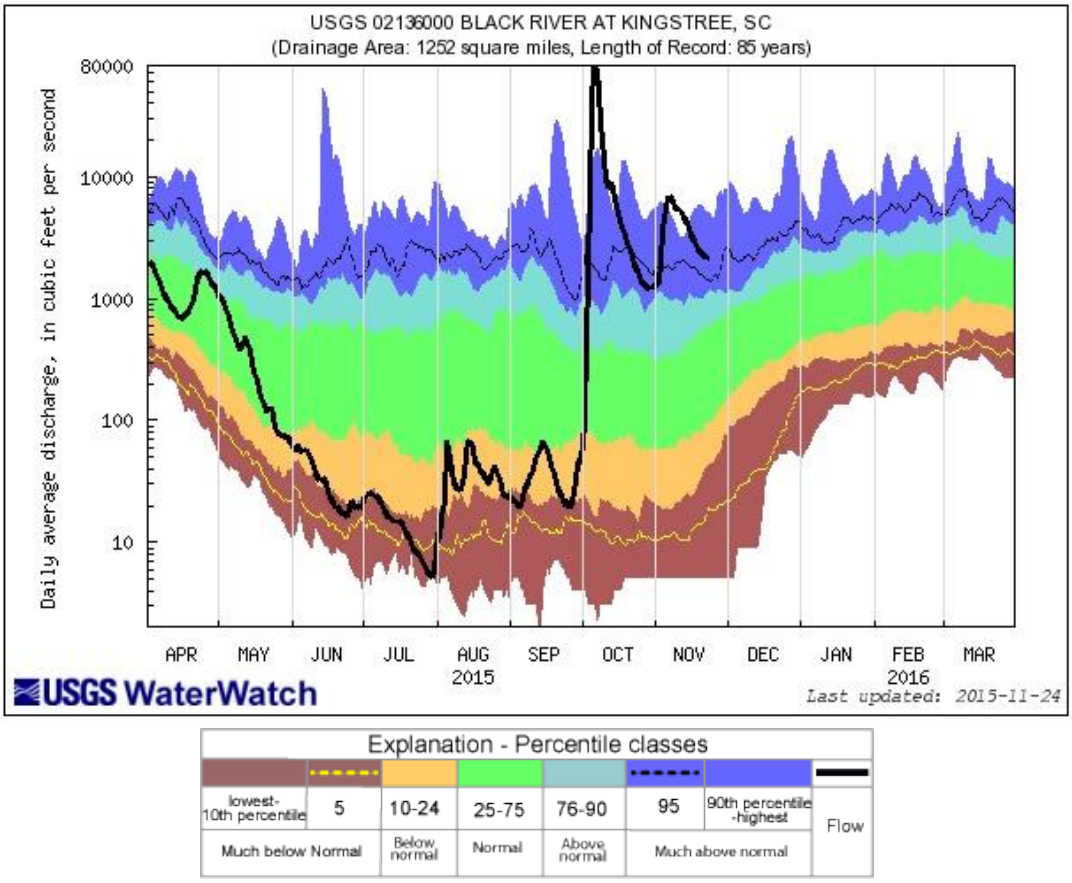

Figure 11. Black River at Kingstree, SC: Daily Mean Discharge
Photo Source: U.S. Geological Survey

Records began January 1, 1894. Travel within Williamsburg County required the familiarity of known high water markers and a boat. The official NWS Cooperative volunteer observer at Summerville reported 25.35 inches of rain over the six-day period ending on October 6. FAA automated instruments at the Georgetown County AP had measured 23.88 inches.

NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

HURRICANE JOAQUIN

(AL112015)

28 September – 7 October 2015

Robbie Berg
National Hurricane Center
12 January 2016

NOAA GOES-EAST VISIBLE SATELLITE IMAGE (TRUE-COLOR BACKGROUND) OF HURRICANE JOAQUIN AT 1900 UTC 1 OCTOBER WHILE IT WAS CENTERED NEAR THE CENTRAL AND SOUTHEASTERN BAHAMAS

Joaquin was a category 4 hurricane (on the Saffir-Simpson Hurricane Wind Scale) whose strong winds and storm surge devastated Crooked Island, Acklins, Long Island, Rum Cay, and San Salvador in the central and southeastern Bahamas. Joaquin took the lives of 34 people—all at sea—including the 33 crewmembers of the cargo ship *El Faro*, which sunk during the storm northeast of Crooked Island. Joaquin is the strongest October hurricane known to have affected the Bahamas since 1866 and the strongest Atlantic hurricane of non-tropical origin in the satellite era.

Hurricane Joaquin

28 SEPTEMBER – 7 OCTOBER 2015

SYNOPTIC HISTORY

Joaquin's formation is notable in that the cyclone did not have tropical origins, which is rare for a major hurricane. The incipient disturbance can be traced back to 8 September when a weak mid- to upper-tropospheric low developed over the eastern Atlantic Ocean west-southwest of the Canary Islands. A piece of this system moved westward across the Atlantic for over a week, and amplified into a more significant mid- to upper-level low over the central Atlantic northeast of the Leeward Islands on 19 September. This feature continued to move westward for several more days and gradually acquired more vertical depth, with a stronger perturbation forming in the lower troposphere late on 25 September. Satellite images indicated that a small but well-defined surface low developed by 1800 UTC 26 September about 355 n mi east-northeast of San Salvador Island in the central Bahamas. The low was displaced to the northwest of a small area of disorganized showers and thunderstorms for another day or so, but deep convection developed close enough to the center for the low to be designated as a tropical depression at 0000 UTC 28 September, while centered about 360 n mi northeast of San Salvador. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

Moderate north-northwesterly shear prevented the depression from strengthening for about a day, but the cyclone became a tropical storm at 0000 UTC 29 September while centered about 295 n mi northeast of San Salvador. A blocking ridge of high pressure located over the western Atlantic forced Joaquin to move slowly southwestward, and while the shear increased a bit and turned out of the north, Joaquin moved over very warm waters of about 30°C near the Bahamas. A 60-h period of rapid intensification began at 0600 UTC 29 September, and Joaquin became a hurricane at 0600 UTC 30 September about 170 n mi east-northeast of San Salvador, and then a major hurricane at 0000 UTC 1 October about 90 n mi east of San Salvador. Sea surface temperatures in the area where Joaquin formed and rapidly intensified (Fig. 4) were about 1.1°C higher than normal and were the warmest on record for the period between 18 and 27 September.

Meanwhile, a mid- to upper-level trough over the eastern United States deepened on 1 and 2 October, causing Joaquin to slow down and make a clockwise hairpin turn over the southeastern and central Bahamas. Joaquin continued to strengthen, reaching a relative peak in intensity as a 120-kt category 4 hurricane between 0000 and 0600 UTC 2 October. About 15 kt of north-northeasterly shear was still affecting Joaquin at this time, and despite the very cold cloud

[1] A digital record of the complete best track, including wind radii, can be found on line at ftp://ftp.nhc.noaa.gov/atcf. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

tops seen in infrared satellite imagery, Joaquin did not have a clear eye typical of category 4 hurricanes (Fig. 5). Joaquin made landfall as a major hurricane on several islands of the Bahamas on 1 and 2 October, first on Samana Cay at 1200 UTC 1 October, then on Rum Cay at 1600 UTC 2 October and San Salvador at 2100 UTC 2 October. In addition, Joaquin's eyewall moved over Crooked Island, Long Cay, and Long Island. Even though it weakened slightly on 2 October, Joaquin was a major hurricane the entire time that it moved through the southeastern and central Bahamas, and it was the strongest October hurricane known to have affected the Bahamas since 1866 (although the records for the Bahamas may be incomplete before the aircraft reconnaissance era began in the 1940s).

By 3 October, the deep-layer low over the eastern United States and a second mid- to upper-level low northeast of Joaquin had completely dissolved the western Atlantic ridge, causing the hurricane to accelerate northeastward away from the Bahamas. At the same time, Joaquin re-intensified, with data from an Air Force Reserve Hurricane Hunter aircraft indicating that the hurricane reached a peak intensity around 135 kt, just shy of category 5 strength, at 1200 UTC that day (Figs. 6a and 6b). However, soon thereafter increasing northwesterly shear eroded the western eyewall (Fig. 6c), and Joaquin lost its status as a major hurricane by 1200 UTC 4 October.

The flow around the deep-layer low located over the southeastern United States caused Joaquin to move north-northeastward over the western Atlantic late on 4 and 5 October. Weakening continued, but Joaquin's intensity stabilized near 75 kt for about a day. Joaquin made its closest approach to Bermuda, about 60 n mi west-northwest of the island, around 0000 UTC 5 October. The hurricane turned northeastward and east-northeastward on 6 and 7 October as it became embedded in the mid-latitude westerlies, and increasing shear and colder sea surface temperatures caused the cyclone to weaken to a tropical storm by 1200 UTC 7 October while centered about 420 n mi southeast of Cape Race, Newfoundland. With strong west-southwesterly shear displacing the remaining deep convection well away from Joaquin's less-defined center, the cyclone became post-tropical by 0000 UTC 8 October about 385 n mi west-northwest of the northwestern Azores. Although Joaquin had begun to merge with a frontal boundary as early as 6 October, the cyclone did not complete extratropical transition until 0000 UTC 9 October after it was fully embedded in the frontal zone over the north Atlantic (Figs. 7a and 7b).

The extratropical low moved eastward and southeastward over the northeastern Atlantic from 9 October until 12 October, with its center moving inland just north of Lisbon, Portugal, around 1200 UTC 12 October. The low then turned southward, weakened below gale force, and moved back over the Atlantic waters off the coast of Portugal on 13 October. The low ultimately dissipated after 0000 UTC 15 October between Portugal and Morocco over the Gulf of Cádiz.

METEOROLOGICAL STATISTICS

Observations in Joaquin (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program

(DMSP) satellites, among others, were also useful in constructing the best track of Joaquin. Aircraft observations include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from 12 flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command. The NOAA Aircraft Operations Center (AOC) G-IV aircraft flew four synoptic surveillance flights around Joaquin. In addition, a NASA WB-57 aircraft flew several flights into Joaquin and deployed dropwindsondes in support of the Office of Naval Research's Tropical Cyclone Intensity (TCI) Experiment. Ship reports of winds of tropical storm force associated with Joaquin are given in Table 2, and selected surface observations from land stations and data buoys are given in Table 3.

Flooding rains and coastal flooding affected portions of the United States East Coast during the first several days of October while Joaquin was near the Bahamas, but the hurricane only indirectly contributed to these hazardous conditions. A cut-off low aloft that developed over the southeastern U.S. on 1 October drew a steady plume of upper-level moisture from Joaquin northwestward into South Carolina; this moisture contributed to a multi-day rainfall event that caused historic flooding in that state's two largest cities of Charleston and Columbia. Contributing to the coastal flooding was a strong pressure gradient off the New England coast behind a frontal boundary that produced a long fetch of northeasterly gales directed at the mid-Atlantic coast at the start of the month, while tides were already running higher than normal. Although the gales were not part of Joaquin's circulation, the pressure gradient increased when the hurricane moved northward from the Bahamas, and swell from Joaquin also emanated northwestward toward the U.S. East Coast. All of these factors contributed to coastal flooding along portions of the U.S. East Coast even while Joaquin remained well offshore. Selected wind, rainfall, and storm surge observations along the East Coast of the United States associated with the indirect effects of Joaquin are given in Table 4.

Winds and Pressure

Joaquin reached tropical storm status at 0000 UTC 29 September, as evidenced by Dvorak satellite intensity estimates of T2.5/35 kt from TAFB and SAB, as well as two ASCAT passes at 0120 UTC and 0215 UTC that showed 35-kt winds. The storm is estimated to have become a hurricane at 0600 UTC 30 September based on a Dvorak estimate of T4.0/65 kt from TAFB, and an interpolation between SFMR surface winds of 59 kt measured at 1818 UTC 29 September and 70 kt measured at 1231 UTC 30 September. Joaquin became a major hurricane at 0000 UTC 1 October—an analysis supported by a peak 700-mb flight-level wind of 113 kt at 2352 UTC 30 September and an SFMR wind of 102 kt at 2351 UTC 30 September.

Joaquin reached its first of two relative peaks in intensity at 0000 UTC 2 October, with estimated maximum sustained winds of 120 kt when its eye was located between Crooked Island and Long Island in the southeastern and central Bahamas (Fig. 5). There were several SFMR observations between 115 kt and 120 kt from Air Force Reserve reconnaissance flights on 1 and 2 October, and it is estimated that Joaquin's intensity reached 120 kt at 0000 UTC 2 October, coincident with a peak in objective and subjective satellite intensity estimates.

The hurricane's minimum central pressure occurred coincidently with the first relative peak in intensity, with the analyzed minimum based on data from a dropsonde released into the eye at 2312 UTC 1 October. The sonde measured a surface pressure of 932 mb with 12 kt of wind, yielding an estimated minimum central pressure of 931 mb.

Joaquin's absolute peak in intensity occurred around 1200 UTC 3 October while the hurricane was moving away from the Bahamas. A reconnaissance flight during the morning measured a peak 700-mb flight-level wind of 144 kt and a peak SFMR surface wind of 138 kt at 1446 UTC. Although the SFMR observation suggests that Joaquin could have attained category 5 intensity, the flight-level winds suggest a lower intensity, near 130 kt. The best track peak intensity of 135 kt blends the surface and flight-level data, in consideration of the inherent uncertainties of the various observations. With this intensity, Joaquin is by far the strongest Atlantic hurricane of non-tropical origin to form during the satellite era. The previous strongest hurricanes of non-tropical origin in the satellite era were Diana (1984) and Claudette (1991), each of which had peak intensities of 115 kt.

Microwave data showed that Joaquin's eyewall moved over several islands in the southeastern and central Bahamas. It is likely that sustained category 3 winds, and possibly sustained category 4 winds, affected portions of Samana Cay, Crooked Island, Long Island, Rum Cay, and San Salvador Island. An Automatic Observing Weather Station (AWOS) in Cockburn Town on San Salvador measured a maximum sustained wind of 59 kt, but this measurement appears too low since the eyewall of the hurricane passed directly over the island. In fact, Joaquin's eye moved over San Salvador, and a weather station on the island reported a minimum pressure of 944.0 mb at 2100 UTC 2 October. A personal weather station from the Weather Underground network in the Church Grove area on Crooked Island reported a sustained wind of 99 kt and a gust to 129 kt before it stopped transmitting. Elsewhere, sustained hurricane-force winds also likely affected Acklins and southern portions of the Exumas and Cat Island. Sustained tropical-storm-force winds affected the remainder of the Exumas and Cat Island, Eleuthera Island in the northwestern Bahamas, and Mayaguana and the Inagua Islands in the southeastern Bahamas. Surface observations (Table 3) also suggest that sustained tropical-storm-force winds likely affected the Turks and Caicos Islands and portions of eastern Cuba.

Sustained tropical-storm-force winds and gusts to hurricane force affected Bermuda late on 4 October and early on 5 October. An offshore sensor located at the Crescent on the North Channel measured a 1-min sustained wind of 55 kt with a gust to 69 kt, while the airport reported a 10-min sustained wind of 49 kt and a gust to 63 kt. At an elevation of 290 ft, RCC Bermuda Radio measured a 1-min sustained wind of 80 kt and a gust to 100 kt.

Storm Surge[2]

According to the Bahamas Department of Meteorology, Joaquin produced storm surges of 12 to 15 ft on Rum Cay, Crooked Island, and Acklins. Staff from the department visited Rum Cay, San Salvador, Crooked Island, and Acklins after the hurricane and measured water marks as high as 15 ft in some areas.

[2] Several terms are used to describe water levels due to a storm. **Storm surge** is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tide, and is expressed in terms of height above normal tide levels. Because storm surge represents the deviation from normal water levels, it is not referenced to a vertical datum. **Storm tide** is defined as the water level due to the combination of storm surge and the astronomical tide, and is expressed in terms of height above a vertical datum, i.e. the North American Vertical Datum of 1988 (NAVD88) or Mean Lower Low Water (MLLW). **Inundation** is the total water level that occurs on normally dry ground as a result of the storm tide, and is expressed in terms of height above ground level. At the coast, normally dry land is roughly defined as areas higher than the normal high tide line, or Mean Higher High Water (MHHW).

Some coastal flooding due to Joaquin occurred in the Turks and Caicos Islands, Haiti, and Cuba, but no water level observations are available from those areas.

Higher-than-normal tides, onshore gale-force winds behind a frontal boundary, and swells propagating away from Joaquin all contributed to storm surge flooding along the U.S. East Coast, with the worst flooding occurring in South Carolina, North Carolina, and Virginia. The highest storm surges reported by NOS gauges were 4.19 ft above normal tide levels at Oyster Landing, South Carolina, and 4.11 ft at Money Point, Virginia. The storm surge resulted in inundation of 2-3 ft above ground level along portions of the coasts of North and South Carolina, and as much as 3-4 ft above ground level around portions of Hampton Roads, Virginia. A maximum storm tide of 3.8 ft above Mean Higher High Water (MHHW) was reported at Money Point, Virginia. Farther north, inundation of 1-3 ft above ground level occurred along the coast from Maryland to New York. The storm surge flooding in the United States is not considered directly attributable to Joaquin.

Rainfall and Flooding

No official rainfall observations are available from the Bahamas, but the Bahamas Department of Meteorology estimated that Joaquin produced 5 to 10 inches of rainfall in portions of the central and southeastern Bahamas.

Moisture advected away from Joaquin contributed to an historic rainfall and flooding event in South Carolina and parts of southern North Carolina. Rainfall amounts exceeding 15 inches occurred in a swath extending from the South Carolina Lowcountry northwestward through the Midlands, as well as along the coast near the North Carolina/South Carolina border. In the Lowcountry, rainfall amounts greater than 20 inches occurred in Charleston and Berkeley Counties, with a maximum rainfall amount of 26.88 inches measured near Mt. Pleasant. One-, two-, three-, and four-day rainfall records were set at the Charleston International Airport according to reports from the National Weather Service Weather Forecast Office (WFO) in Charleston. The airport measured a one-day rainfall amount of 11.50 inches on 3 October and a four-day total of 17.29 inches between 1-4 October. The flooding in Downtown Charleston and surrounding areas was exacerbated by higher-than-normal tides, which kept rainwater from draining into Charleston Harbor. In the Midlands, rainfall amounts greater than 20 inches occurred in Richland, Sumter, and Orangeburg Counties. WFO Columbia reported that one-, two-, and three-day rainfall records were also set at the Columbia Metro Airport, with 6.71 inches measured on 4 October and 11.44 inches for the whole event. In North Carolina, a maximum rainfall amount of 18.79 inches was reported near Sunset Beach in Brunswick County.

CASUALTY AND DAMAGE STATISTICS

Joaquin is directly responsible for 34 deaths[3] in the waters off the Bahamas and Haiti. Almost all of the deaths occurred when the U.S.-flagged cargo ship *El Faro* was lost at sea near the Bahamas while Joaquin was moving through the area. The *El Faro* left Jacksonville, Florida, on the evening of 29 September, bound for San Juan, Puerto Rico. The ship sailed east of the Bahamas and got caught in the hazardous winds and seas associated with Joaquin, and on the morning of 1 October the shipmaster reported that the vessel had lost propulsion and was listing 15 degrees. The National Transportation Safety Board reports that the *El Faro* sent a distress signal to the U.S. Coast Guard at 1115 UTC 1 October while located 36 n mi northeast of Acklins and Crooked Island. Hurricane conditions in the area initially hampered the Coast Guard's search for the ship, but a damaged lifeboat, two damaged life rafts, and a deceased crewmember wearing an immersion suit were found on 4 October. A debris field and oil slick were spotted the next day, and the Coast Guard declared that the *El Faro* was lost. The unsuccessful search for survivors was suspended at sunset on 7 October. The 33 crewmembers (28 Americans and 5 Polish nationals) of the *El Faro* are presumed to have perished when the ship sank near the Bahamas. A U.S. Navy search team located the wreckage of the *El Faro* in 15,000 ft of water on 31 October, but investigators ended their search for the vessel's voyage data recorder on 16 November.

The Caribbean Disaster Emergency Management Agency (CDEMA) reported that a fisherman in his 30s drowned when his and another fisherman's boat capsized in rough seas off the coast of Haiti between Petit-Trou-de-Nippes and Grand Boucan.

Bahamas

The prime minister of the Bahamas and the Bahamas Department of Meteorology estimate that the damage caused by Joaquin is well over $60 million USD[4]. Figure 8 provides some examples of damage on Long and Crooked Islands.

Crooked Island and Long Cay: 70% of Crooked Island was flooded with at least 5 ft of water. The entire island lost power, and there was significant damage to buildings and homes. All houses on the eastern side of the island had severe roof damage. Water was heavily contaminated with fecal matter due to seepage from septic tanks, and water from wells was not suitable for drinking.

Acklins: Significant flooding was reported on the island, with an estimated 20 homes destroyed. The main bridge was completely destroyed, and 90% of the homes in Lovely Bay, Chester, and Snug Corner were severely damaged or completely destroyed.

[3] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

[4] Virgil, K. (15 October 2015). $60m+ to Rebuild: Pm Reveals Cost of Hurricane Joaquin Repairs. *Tribune242*. http://www.tribune242.com/news/2015/oct/15/60m-rebuild-pm-reveals-cost-hurricane-joaquin-repa/

Long Island: Power lines were downed, private fresh water wells were flooded, and structural damage occurred to homes. Over two-thirds of the island remained inundated with 4-6 ft of water by 7 October. The marina was severely damaged, and coastal roads were impassable due to flooding and debris. Severe damage occurred to vegetation, even a considerable distance inland. The main cause of damage to buildings was high wind, but several houses were damaged due to storm surge in low-lying areas. The local fishing fleet in Clarence Town was destroyed.

Rum Cay: Severe flooding, downed trees, impassable roads, and downed power lines and poles were reported across the island. The airport was flooded, and the government dock was destroyed.

San Salvador: Flooding, downed power lines and poles, and significant damage to homes were reported throughout the island. Many roads were impassable, and the airport building was completely destroyed.

Mayaguana: Minor damage to homes was reported.

Exuma: Extreme flooding and downed power lines were reported.

Turks and Caicos Islands

Flooding was reported in downtown Providenciales, and two boats reportedly sank at the ferry terminal. Storm surge and rain caused some roads to be partially or fully impassable. Road damage accounted for 90% of all damage on the islands.

Haiti

In the northwestern part of Haiti, a tree fell onto two homes, resulting in minor injuries to two people. More than 100 homes flooded in coastal towns, especially in Gonaives and Anse-Rouge due to storm surge, large waves, and higher-than-normal tides. River flooding and landslides were also reported.

Cuba

Coastal flooding affected more than 100 homes along the southern coast of Cuba in the municipalities of Niquero and Manzanillo in the province of Granma. Some coastal flooding also occurred along the northern coast in the state of Ciego de Avila.

Bermuda

The Bermuda Weather Service reported that damage on Bermuda was considerably less than that caused by Hurricanes Fay and Gonzalo in 2014. There was some relatively minor damage to vegetation, and some structural damage occurred to the Bermuda Maritime Museum in Dockyard, which was still undergoing renovations from the previous year's hurricanes.

FORECAST AND WARNING CRITIQUE

The genesis of Joaquin was poorly forecast. The precursor disturbance was introduced in the Tropical Weather Outlook (TWO) and given a low (< 40%) chance of genesis during the ensuing 48- and 120-h periods only 48 h before genesis occurred. The system was given a

medium (40 – 60%) chance of formation during both forecast periods 24 h before genesis, and the probability was only raised to a high (> 60%) chance at the time of genesis. Table 5 provides the number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in each likelihood category. The numerical models showed little to no deepening of the mid- to upper-level low over the western Atlantic in the days leading up to genesis, and forecasters were unable to recognize that tropical cyclone formation was even a possibility until 48 h before genesis occurred.

A verification of NHC official track forecasts for Joaquin is given in Table 6a. Official forecast track errors were lower than the mean official errors for the previous 5-yr period at 12 h but were higher between 24 and 120 h. In fact, official forecast track errors between 72 and 120 h were more than double the mean official errors for the previous 5-yr period. However, Joaquin was not a particularly well-behaved storm in terms of its track, and climatology and persistence model (OCD5) errors were larger than their respective mean errors during the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 6b. The European Centre for Medium-Range Weather Forecasting model (EMXI) had the lowest errors out of all the dynamical models, and it beat the NHC official forecast at all forecast times. The various model consensus aids also had lower errors than the official forecasts, led by GFEX, an average of the EMXI and the National Weather Service's Global Forecast System (GFSI). The Florida State Superensemble (FSSE) also had lower errors than the official forecasts at all forecast times.

Much of the error in the forecast track resulted from Joaquin's atypical southwestward motion toward the Bahamas from 0000 UTC 28 September through 1800 UTC 1 October. Figure 9 shows forecast track plots from the NHC official forecasts and several of the dynamical models and model consensus aids for forecasts beginning within this time period. Most of the models, as well as the official forecast, indicated that Joaquin would move northwestward or westward once it became a tropical cyclone, and they were late in showing the southwestward motion that persisted for several days. The ECMWF model did, however, accurately depict a definitive southwestward motion, with only its first two post-genesis runs showing an immediate westward or northwestward turn. The ECMWF's success may be partly due to its deepening of the cyclone more than the other models, with a deeper-layer flow subsequently pushing Joaquin southwestward. Figure 10 shows that the ECMWF predicted a deeper cyclone compared to the GFS model, but it also showed a different orientation of the western Atlantic ridge, which pushed Joaquin southwestward toward the Bahamas. To a large degree, the ECMWF model's overall low errors are a result of the model's ability to accurately depict a track closer to the Bahamas at the beginning of Joaquin's life.

The spread among the track models yielded greater-than-normal uncertainty regarding if and how Joaquin would affect the eastern United States. A majority of the track models showed Joaquin taking a track close to or inland over the eastern United States, and the GFS and HWRF models in particular depicted landfall along the East Coast for several model cycles (Figs. 9b and 9d, respectively). On the other hand, the ECMWF consistently depicted a much sharper turn toward the northeast with a close approach to Bermuda (Fig. 9c). The large spread among the typically most reliable track models led to low confidence in the track forecast and presented NHC with a unique communications challenge (see below).

A verification of NHC official intensity forecasts for Joaquin is given in Table 7a. Official forecast intensity errors were greater than the mean official errors for the previous 5-yr period at all forecast times. However, as with the track forecasts, OCD5 errors were also larger than their respective 5-yr means, indicating that Joaquin's intensity was more difficult to forecast than for a typical tropical cyclone. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 7b. The official intensity forecasts were generally very competitive with the various intensity models and generally had lower average errors than the models at 96 and 120 h. Overall, the HWRF and the FSSE had the lowest intensity errors, but only between 12 and 72 h.

Figure 11 shows composites of the individual NHC official intensity forecasts and the model intensity forecasts from the HWRF, FSSE, and the IVCN consensus. The figure shows that the first few official forecasts and model forecasts indicated that there would be little to no strengthening of Joaquin. After about a day, the models began indicating that Joaquin would strengthen during the next few days, but only the HWRF (Fig. 11b) showed intensification rates similar to what was observed with the hurricane. Interestingly, the SHIPS Rapid Intensification (RI) Index was never very high for Joaquin, and it only showed an 8% chance of a 30-kt increase in intensity over the next 24 h when RI began at 0600 UTC 29 September. The RI Index reached a peak value of 36% for a 30-kt increase in winds over 24 h only after Joaquin had already become a major hurricane. Despite the HWRF's success in showing strengthening, the model weakened Joaquin too quickly after the hurricane reached its first relative peak intensity, and no model anticipated Joaquin's re-intensification to its peak intensity of 135 kt.

Given the substantial forecast uncertainties associated with Joaquin, and the expectation of inclement weather over parts of the eastern United States irrespective of Joaquin's evolution, NHC took special care in highlighting the most important forecast and preparedness themes associated with the storm. Between the morning of 30 September and the evening of 2 October, NHC provided a set of "key messages" via its Tropical Cyclone Discussions for Joaquin and its various social media accounts. The key messages detailed NHC's lack of confidence in its track and intensity forecasts for Joaquin and focused attention on the direct—and indirect—effects of the hurricane on the Bahamas and the eastern United States despite the forecast uncertainties.

Watches and warnings associated with Joaquin are given in Table 8.

ACKNOWLEDGMENTS

Data in Tables 3 and 4 were derived from storm reports issued by National Weather Service Forecast Offices (WFOs) in Charleston and Columbia, South Carolina; the Weather Prediction Center; National Data Buoy Center; and the National Ocean Service Center for Operational Oceanographic Products and Services. The Bahamas Department of Meteorology and the Bermuda Weather Service provided data and damage reports from their respective countries, and the Caribbean Disaster Emergency Management Agency also provided reports on the post-storm aftermath in the central and southeastern Bahamas. The NOAA Hurricane Research Division quality controlled SFMR data around the time of Joaquin's peak intensity.

Table 1. Best track for Hurricane Joaquin, 28 September – 7 October 2015.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
26 / 1800	26.8	68.7	1011	20	low
27 / 0000	26.9	68.6	1011	20	"
27 / 0600	27.0	68.5	1010	20	"
27 / 1200	27.1	68.6	1009	25	"
27 / 1800	27.2	68.8	1007	30	"
28 / 0000	27.4	69.0	1007	30	tropical depression
28 / 0600	27.6	69.3	1007	30	"
28 / 1200	27.7	69.7	1006	30	"
28 / 1800	27.4	70.0	1003	30	"
29 / 0000	26.9	70.1	1002	35	tropical storm
29 / 0600	26.5	70.3	1002	35	"
29 / 1200	26.2	70.5	999	45	"
29 / 1800	26.0	70.8	992	55	"
30 / 0000	25.8	71.3	985	60	"
30 / 0600	25.4	71.8	978	65	hurricane
30 / 1200	24.9	72.2	971	70	"
30 / 1800	24.4	72.5	961	80	"
01 / 0000	23.9	72.9	951	100	"
01 / 0600	23.5	73.3	947	110	"
01 / 1200	23.1	73.7	942	115	"
01 / 1800	23.0	74.2	936	115	"
02 / 0000	22.9	74.4	931	120	"
02 / 0600	23.0	74.7	935	120	"
02 / 1200	23.4	74.8	937	115	"
02 / 1600	23.6	74.8	940	110	"
02 / 1800	23.8	74.7	941	110	"
02 / 2100	24.1	74.5	942	110	"
03 / 0000	24.3	74.3	943	115	"
03 / 0600	24.8	73.6	945	120	"
03 / 1200	25.4	72.6	934	135	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
03 / 1800	26.3	71.0	934	130	"
04 / 0000	27.4	69.5	941	115	"
04 / 0600	28.9	68.3	949	105	"
04 / 1200	30.4	67.2	956	95	"
04 / 1800	31.6	66.5	958	85	"
05 / 0000	32.6	66.0	961	75	"
05 / 0600	33.6	65.6	964	75	"
05 / 1200	34.4	65.2	964	75	"
05 / 1800	35.3	64.5	964	75	"
06 / 0000	36.2	63.6	967	75	"
06 / 0600	37.0	62.3	970	75	"
06 / 1200	37.9	60.4	974	70	"
06 / 1800	38.8	58.0	974	70	"
07 / 0000	39.6	54.9	974	70	"
07 / 0600	40.3	51.5	977	65	"
07 / 1200	41.0	47.5	977	60	tropical storm
07 / 1800	41.5	43.3	977	60	"
08 / 0000	41.9	39.1	977	55	low
08 / 0600	42.4	35.0	977	50	"
08 / 1200	43.0	31.0	980	45	"
08 / 1800	43.5	27.3	984	45	"
09 / 0000	43.9	24.1	987	45	extratropical
09 / 0600	44.1	21.9	988	45	"
09 / 1200	44.2	19.9	988	45	"
09 / 1800	44.1	18.2	989	40	"
10 / 0000	43.8	16.4	992	35	"
10 / 0600	43.4	15.0	993	35	"
10 / 1200	43.1	13.9	996	35	"
10 / 1800	42.8	12.9	998	30	"
11 / 0000	42.5	12.0	999	30	"
11 / 0600	42.2	11.3	1000	30	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
11 / 1200	41.8	10.8	1001	35	"
11 / 1800	41.2	10.5	1001	35	"
12 / 0000	40.4	10.2	1002	35	"
12 / 0600	39.8	9.7	1002	35	"
12 / 1200	39.5	9.1	1003	35	"
12 / 1800	39.1	8.8	1005	30	"
13 / 0000	38.6	8.9	1007	25	"
13 / 0600	38.0	9.1	1009	20	"
13 / 1200	37.3	9.2	1010	20	"
13 / 1800	36.6	9.1	1010	20	"
14 / 0000	36.0	9.0	1011	20	"
14 / 0600	35.5	8.7	1011	20	"
14 / 1200	35.1	8.4	1011	20	"
14 / 1800	35.0	8.0	1012	15	"
15 / 0000	35.2	7.7	1012	15	"
15 / 0600					dissipated
02 / 0000	22.9	74.4	931	120	minimum pressure
03 / 1200	25.4	72.6	934	135	maximum winds
01 / 1200	23.1	73.7	942	115	landfall on Samana Cay
02 / 1600	23.6	74.8	940	110	landfall on Rum Cay
02 / 2100	24.1	74.5	942	110	landfall on San Salvador Island

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Joaquin, 28 September – 7 October 2015.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
29 / 2100	9HA348	25.0	71.2	270 / 40	998.0
30 / 0000	9HA348	24.9	70.4	180 / 45	1001.0
30 / 0300	9HA348	25.2	68.7	160 / 36	1005.0
30 / 0600	J8PE4	26.1	78.1	*** / 53	1009.0
01 / 0700	H3VU	21.7	74.8	250 / 57	998.0
01 / 2000	H3VR	20.5	73.2	180 / 50	999.0
01 / 2300	H3VR	20.5	73.9	180 / 46	998.0
02 / 0500	C6ZL6	21.1	75.0	210 / 55	993.0
02 / 0600	H3VR	21.3	75.8	230 / 45	995.0
02 / 0900	H3VR	21.7	76.7	260 / 50	995.0
03 / 0300	ZCEI3	20.5	74.2	210 / 40	1001.8
03 / 0600	ZCEI3	20.3	73.1	240 / 40	1004.8
03 / 0600	DGHJ	21.2	75.0	250 / 35	1001.0
03 / 1100	H3GR	25.4	77.4	290 / 40	998.0
04 / 1200	3FCD9	37.8	67.8	040 / 42	1014.0
04 / 1800	3FCD9	38.5	65.3	050 / 45	1015.0
05 / 0600	3FCD9	39.8	61.0	090 / 39	1017.0
05 / 1800	PHDL	39.2	69.3	040 / 35	1010.9
06 / 0600	PHDL	40.2	67.0	010 / 35	1007.9
06 / 1200	A8MB5	35.1	60.5	240 / 42	1004.5

Table 3. Selected surface observations for Hurricane Joaquin, 28 September – 7 October 2015.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed		
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)
Bahamas					
Cockburn Town, San Salvador (MYSM) (24.06N 74.52W)			2/1500	59	
Church Grove, Crooked Island				99[u]	129[u]
San Salvador (M089) (24.07N 74.50W)	2/2100	944.0			
Turks and Caicos Islands					
Providenciales (MBPV) (21.77N 72.27W)			1/1400	32	46
Cuba					
Guantanamo Bay NAS (MUGM) (19.90N 75.13W)	2/0756	1000.8	2/1138	34	48
Santiago de Cuba (MUCU) (19.97N 75.84W)	2/0752	1001.0	1/2123	27	38
Punta Lucrecia (78365) (21.07N 75.62W)	2/0900	997.6			
Bermuda					
L. F. Wade International Airport (TXKF) (32.36N 64.68W) (40 ft.)	5/0055	990.7	5/0105	49 (10 min)	63
RCC Bermuda Radio (32.38N 64.48W) (290 ft.)	4/2300	990.0	5/0100	80 (1 min)	100
The Crescent – North Channel Marker (20 ft.)	4/2300	990.0	5/0154	55 (1 min)	69
Buoys					
NOAA					
East of Bahamas (41046) (23.89N 68.36W)	3/1847	1002.4	3/1446	29	34
NE of Bahamas (41047) (27.52N 71.48W)	3/2048	985.8	3/1845	43	49
W of Bermuda (41048) (31.87N 69.57W)	4/0837	999.3	4/0948	31	36

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for buoys are 8 min.
[u] Unofficial observations

Table 4. Selected surface observations along the East Coast of the United States due to the indirect effects of with Hurricane Joaquin.

Location	Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)[f]
	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Florida							
Mayport (Bar Pilots Dock)	2/0400	22	26	2.25	3.94	2.0	
Fernandina Beach	5/1648	18	21	2.98	4.88	2.2	
Georgia							
Fort Pulaski	3/1830	24	34	2.74	5.89	2.4	
South Carolina							
Charleston	4/0030	30	37	2.79	5.15	2.5	
Oyster Landing (N Inlet Estuary)				4.19	5.07	2.7	
Springmaid Pier	3/1554	33	40	3.25	5.14	2.7	
Mount Pleasant 6 NE							26.88
Kingstree							24.75
Boone Hall Plantation 3 NNE							24.23
Shadowmoss 3 SSW							24.10
Longs							23.74
Charleston 5 SSE							23.61
Limerick 1 NNW							22.02
Folly Beach 3 SW							21.45
Huger 5 NNW							21.04
Georgetown 4 SSW							20.75
Gills Creek							20.28
Summerville 3 NW							19.47
Shaw AFB							19.32
Wateree							18.90
Kiawah Island 4 NNW							18.25
Effingham 2 W							17.95
Myrtle Beach 8 WNW							17.40
Charleston (KCHS)							17.29

Location	Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)[f]
	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
James Island County Park 1 NNE							17.00
Little River 1 N							16.00
Garris Landing 2 NNW							15.81
Santee							14.84
Huger 3 NNE							14.68
Sangaree 2 NE							14.51
Florence 5 W							14.34
Charleston NWS							13.88
Darlington 7 SSW							13.00
Goose Creek 5 E							11.26
Columbia Metro Airport							10.77
Wando 1 SSW							8.76
North Carolina							
Wrightsville Beach	4/1854	40	54	3.40	4.90	3.1	
Wilmington				2.85		2.2	
Beaufort	5/1542	26	36	2.65		2.4	
USCG Station Hatteras	5/1548	25	34	2.28		2.6	
Oregon Inlet Marina	4/1854	27	37	1.98	2.25	1.8	
Duck	4/1700	37	42	3.19	4.65	3.2	
Smith Reynolds Airport			37				
Sunset Beach 2 WNW							18.79
Longwood 1 NNW							17.83
Longwood 1 NW							13.63
Southport 1 NE							13.42
Bayshore 1 ENE							12.74
Wilmington 4 SE							12.30
Tabor City 4 NE							12.29
Bolivia 8 SSW							11.48
Topsail Beach 1 E							10.17
Wilmington (KILM)							8.79
Lake Waccamaw 3 S							8.63

Location	Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)[f]
	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Elizabethtown 4 NNE							8.01
Oakboro 1 WNW							7.76
Pope AFB							7.33
Fort Bragg							7.00
Benson 1 SSW							6.87
Cameron 8 E							6.71
Wilson 2 NNW							6.52
Anson County Airport							6.32
Pinetops							5.79
Raleigh-Durham International Airport							3.76
Virginia							
Money Point	4/1518	19	32	4.11		3.8	
Chesapeake Bay Bridge Tunnel	2/1700	36	42	3.89		3.6	
Sewells Point				4.02	4.89	3.7	
Yorktown USCG Training Center	4/0524	31	39	3.42		3.4	
Windmill Point				2.79		3.0	
Lewisetta	3/2212	32	41	2.81	2.99	2.3	
Kiptopeke	2/1742	23	37	3.20	3.97	2.9	
Wachapreague	2/2300	38	48	3.90		3.5	
District of Columbia							
Washington	1/0024	13	20	2.77	4.01	2.2	
Maryland							
Solomons Island	3/1806	24	32	2.51	2.04	1.4	
Annapolis				2.30	2.66	2.0	
Baltimore	4/0406	18	25	2.11	2.58	1.8	
Chesapeake City	3/2018	19	31	2.09		1.2	
Tolchester Beach	1/0218	22	26	1.80		1.6	
Cambridge	3/0006	26	36	2.19	2.73	1.8	

Location	Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)[f]
	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
Bishops Head	4/0054	28	38	2.19	2.68	1.9	
Ocean City Inlet	3/0430	26	43	2.65	3.08	2.3	
Oxford 2 NNW			35				
Delaware							
Lewes	3/0248	42	54	4.00	4.94	2.9	
Brandywine Shoal Light	2/2212	44	54	3.45		2.6	
Reedy Point				2.81	4.43	1.6	
Delaware City	2/2218	28	35	2.82		2.0	
Big Stone Beach 18 SE			50				
Lewes Beach			39				
Rehoboth Beach			36				
Pennsylvania							
Newbold	2/2212	17	34	2.30		1.2	
Philadelphia				2.30	5.20	1.6	
Landenberg			46				
New Jersey							
Burlington, Delaware River	2/2230	22	32	2.09		1.4	
Ship John Shoal	2/2242	32	42	3.39		2.1	
Cape May	3/1912	24	42	3.21	5.05	2.6	
Atlantic City				2.08	4.14	2.2	
Sandy Hook	3/2354	23	34	2.52	4.60	2.2	
Cape May			54				
Seaside Heights			49				
Tuckerton			48				
Little Sheepshead Creek			47				
Long Beach Island			41				
Ocean City			41				
Port Norris 19 ESE			39				
South Seaside Park			39				

Location	Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Estimated Inundation (ft)[e]	Total rain (in)[f]
	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)				
New York							
Bergen Point West Reach				2.53		2.1	
The Battery				2.32	4.43	2.2	
Kings Point	1/0048	23	32	2.72		2.2	
Montauk				1.45	2.43	1.5	
Rhode Island							
Charlestown			40				
Massachusetts							
Nantucket			41				
Oak Bluffs			39				

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.
[c] Storm surge is water height above normal astronomical tide level.
[d] Storm tide is water height above the North American Vertical Datum of 1988 (NAVD88).
[e] Estimated inundation is the maximum height of water above ground. For NOS tide gauges, the height of the water above Mean Higher High Water (MHHW) is used as a proxy for inundation.
f Rainfall amounts in North and South Carolina are storm total amounts from 8 AM EDT 1 October through 10 PM EDT 5 October.

Table 5. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the "Low" category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	48	48
Medium (40%-60%)	24	24
High (>60%)	0	0

Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Joaquin, 28 September – 7 October. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**26.3**	50.6	79.7	121.0	231.7	360.9	450.4
OCD5	52.5	127.0	203.7	276.6	413.9	586.0	682.7
Forecasts	38	36	34	32	28	23	17
OFCL (2010-14)	28.4	45.0	60.4	77.1	113.1	157.8	210.0
OCD5 (2010-14)	48.3	101.5	161.5	222.6	329.8	412.6	483.9

Table 6b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Joaquin, 28 September – 7 October. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 6a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	24.6	44.2	69.3	106.4	203.7	287.2	421.1
OCD5	52.8	130.9	207.8	278.0	398.2	586.4	814.1
GFSI	27.7	47.6	72.1	**102.1**	**195.7**	291.4	431.4
EMXI	**23.0**	**36.8**	**49.8**	**62.0**	**106.3**	**150.0**	**177.6**
EGRI	28.5	50.9	72.1	**95.1**	**189.4**	291.9	553.5
NGVI	40.0	78.3	123.7	186.0	405.5	616.1	783.6
CMCI	35.7	68.9	110.1	170.8	361.1	518.3	619.8
GHMI	28.0	55.5	84.6	124.7	278.2	480.4	567.8
HWFI	29.1	54.8	80.2	114.6	226.7	384.8	590.7
GFNI	32.1	65.0	104.5	162.4	370.9	648.4	778.9
TCON	**23.7**	**43.4**	**64.1**	**90.1**	**197.5**	324.3	476.8
TVCA	**22.5**	**39.4**	**58.0**	**81.7**	**171.2**	**277.2**	**399.2**
TVCX	**22.6**	**37.5**	**53.9**	**75.2**	**154.3**	**247.6**	**349.9**
GFEX	**22.5**	**38.1**	**53.9**	**72.3**	**124.7**	**179.4**	**259.0**
FSSE	**24.0**	**40.1**	**60.4**	**85.5**	**190.1**	**276.0**	**371.1**
AEMI	28.5	52.6	79.0	114.3	220.7	307.4	**420.0**
BAMS	80.3	169.8	255.4	335.4	511.9	755.5	1143.5
BAMM	43.3	92.4	145.5	205.6	349.0	556.7	870.7
BAMD	36.7	76.1	129.0	184.6	312.7	457.0	681.8
Forecasts	31	31	29	27	23	17	12

Table 7a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Joaquin, 28 September – 7 October 2015. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	7.2	11.0	15.0	17.3	24.8	25.9	21.5
OCD5	8.5	12.4	16.5	20.3	27.5	27.3	25.8
Forecasts	38	36	34	32	28	23	17
OFCL (2010-14)	6.2	9.4	11.5	13.3	14.6	14.6	15.8
OCD5 (2010-14)	7.3	10.8	13.3	15.3	17.7	17.8	17.6

Table 7b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Joaquin. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 7a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	8.4	10.5	13.4	13.9	17.0	15.8	12.7
OCD5	9.4	11.9	15.9	18.7	21.9	18.9	20.2
DSHP	9.3	11.6	13.5	15.3	**16.8**	**15.4**	20.8
LGEM	8.9	11.8	14.2	15.9	**15.7**	16.2	22.5
GHMI	10.0	14.0	16.6	16.7	19.6	28.1	28.2
HWFI	**7.8**	**9.6**	13.8	**13.5**	**14.2**	25.3	31.6
GFNI	11.3	16.4	21.2	23.9	26.3	39.7	32.7
ICON	8.5	11.2	**13.1**	14.0	**15.2**	18.8	24.2
IVCN	8.5	11.2	**13.1**	14.0	**15.2**	18.8	24.2
FSSE	**7.8**	**10.3**	**12.4**	**13.7**	**16.3**	16.6	13.9
GFSI	10.2	15.4	21.6	25.6	37.1	36.0	28.4
EMXI	11.4	15.8	21.8	27.7	36.8	38.1	27.1
Forecasts	31	31	29	27	23	18	13

Table 8. Watch and warning summary for Hurricane Joaquin, 28 September – 7 October 2015.

Date/Time (UTC)	Action	Location
30 / 0300	Hurricane Watch issued	Central Bahamas
30 / 0900	Hurricane Watch changed to Hurricane Warning	Central Bahamas
30 / 0900	Hurricane Watch issued	Northwestern Bahamas excluding Andros Island
30 / 2100	Hurricane Watch changed to Hurricane Warning	Northwestern Bahamas excluding Andros Island and Bimini
30 / 2100	Tropical Storm Warning issued	Southeastern Bahamas
1 / 0300	Tropical Storm Warning and Hurricane Watch issued	Andros Island
1 / 0935	Tropical Storm Warning changed to Hurricane Warning	Acklins, Crooked Island, and Mayaguana in the southeastern Bahamas
1 / 1500	Tropical Storm Warning issued	Turks and Caicos Islands
2 / 0000	Tropical Storm Warning issued	Cuban provinces of Camaguey, Las Tunas, Holguin, and Guantanamo
2 / 2100	Tropical Storm Watch issued	Bermuda
2 / 2100	Tropical Storm Warning discontinued	Cuban provinces of Camaguey, Las Tunas, Holguin, and Guantanamo
3 / 0300	Tropical Storm Watch changed to Tropical Storm Warning	Bermuda
3 / 0300	Hurricane Watch issued	Bermuda
3 / 0300	Hurricane Warning discontinued	Northwestern Bahamas
3 / 0300	Tropical Storm Warning discontinued	Andros Island
3 / 0300	Hurricane Watch discontinued	Bimini and Andros Island
3 / 1200	Hurricane Warning discontinued	All
3 / 1200	Tropical Storm Warning discontinued	Remainder of southeastern Bahamas and Turks and Caicos Islands
4 / 0300	Tropical Storm Warning and Hurricane Watch changed to Hurricane Warning	Bermuda
5 / 0600	Hurricane Warning changed to Tropical Storm Warning	Bermuda
5 / 1800	Tropical Storm Warning discontinued	All

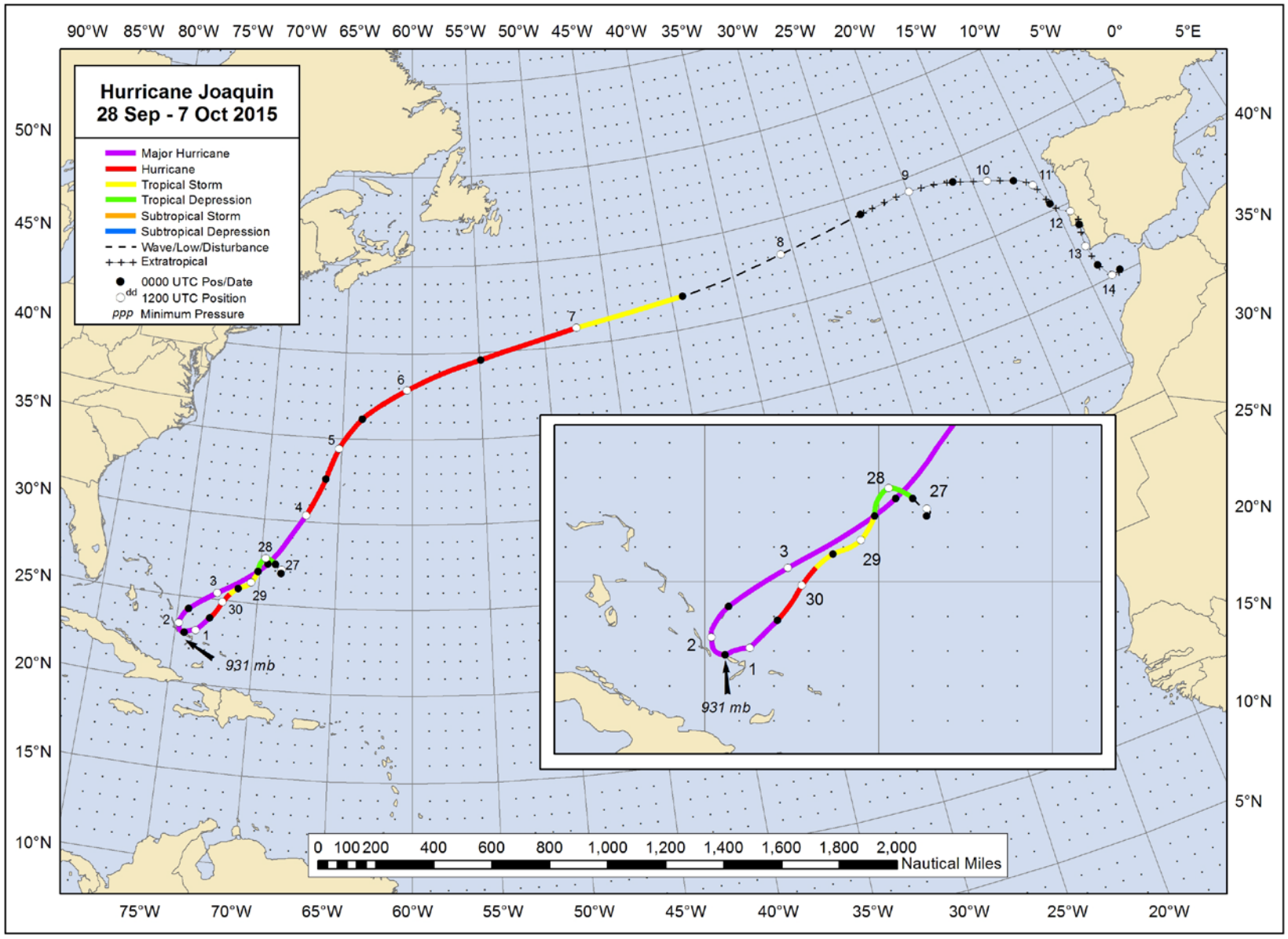

Figure 1. Best track positions for Hurricane Joaquin, 28 September – 7 October 2015. The track during the post-tropical stage is partially based on analyses from the NOAA Ocean Prediction Center.

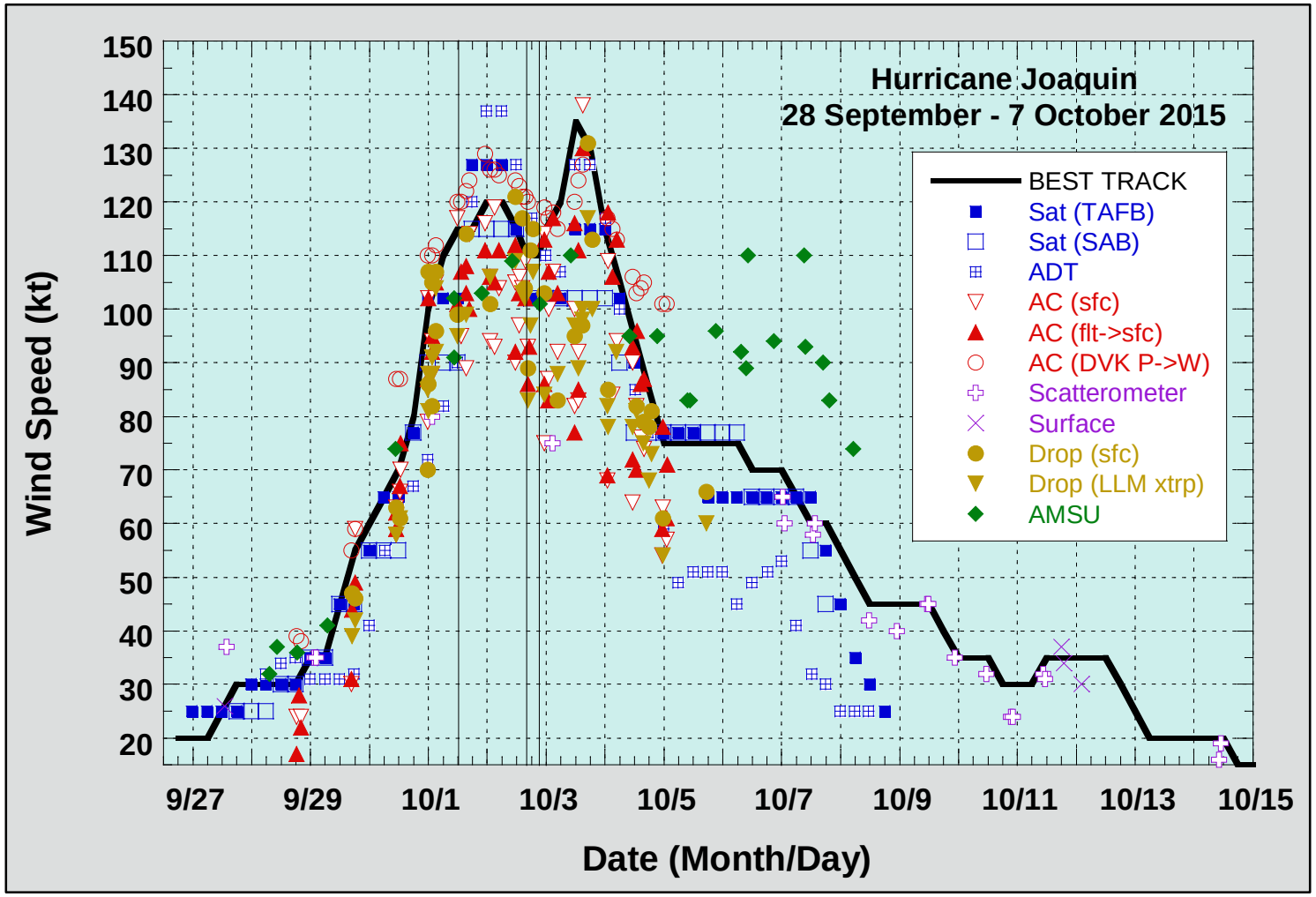

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Joaquin, 28 September – 7 October 2015. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

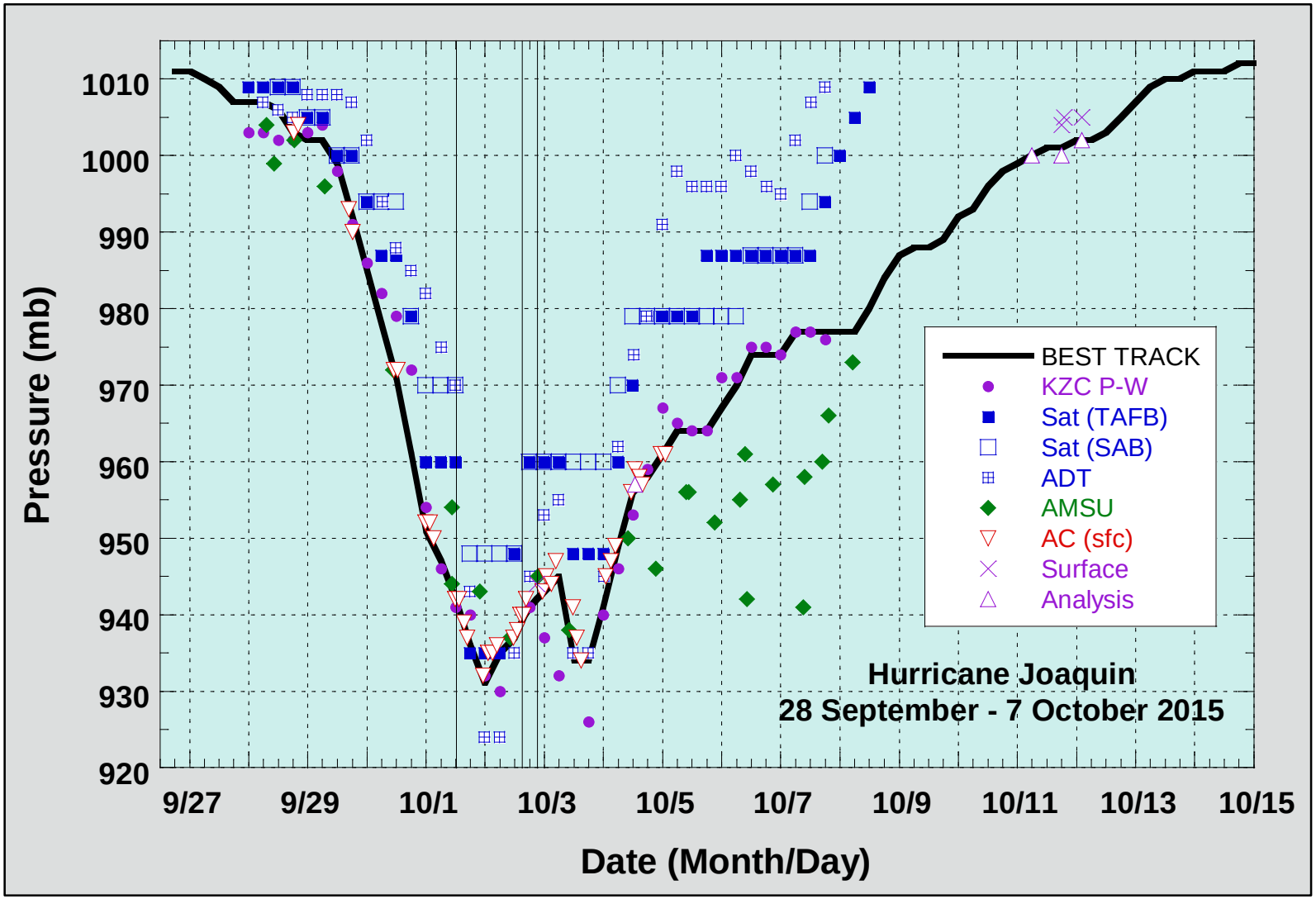

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Joaquin, 28 September – 7 October 2015. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.

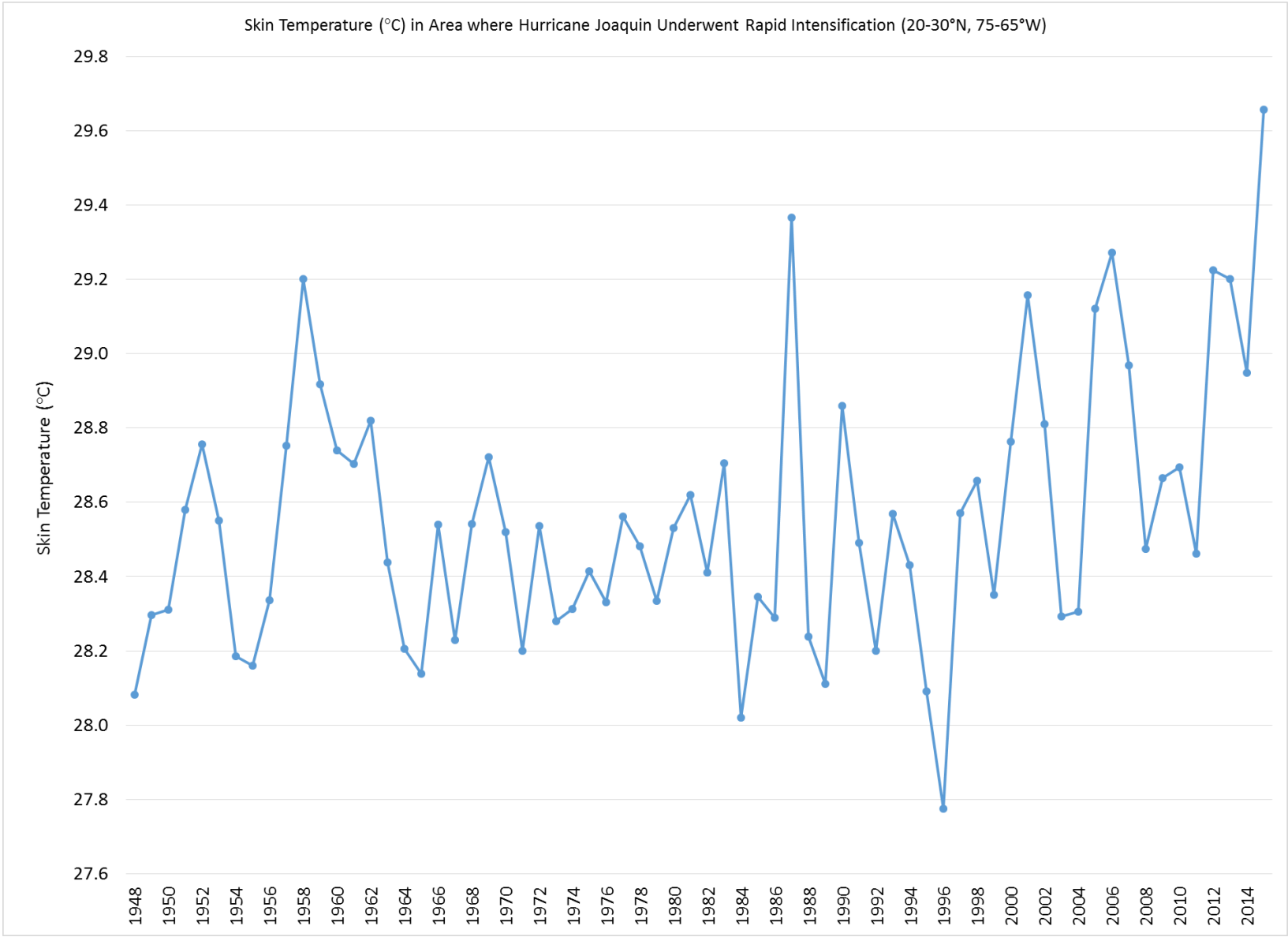

Figure 4. NCEP/NCAR reanalysis of yearly sea surface skin temperatures (°C) from 1948 to 2015 averaged over the 10-day period from 18 to 27 September in an area over the western Atlantic Ocean from 20° to 30°N between 65° and 75°W.

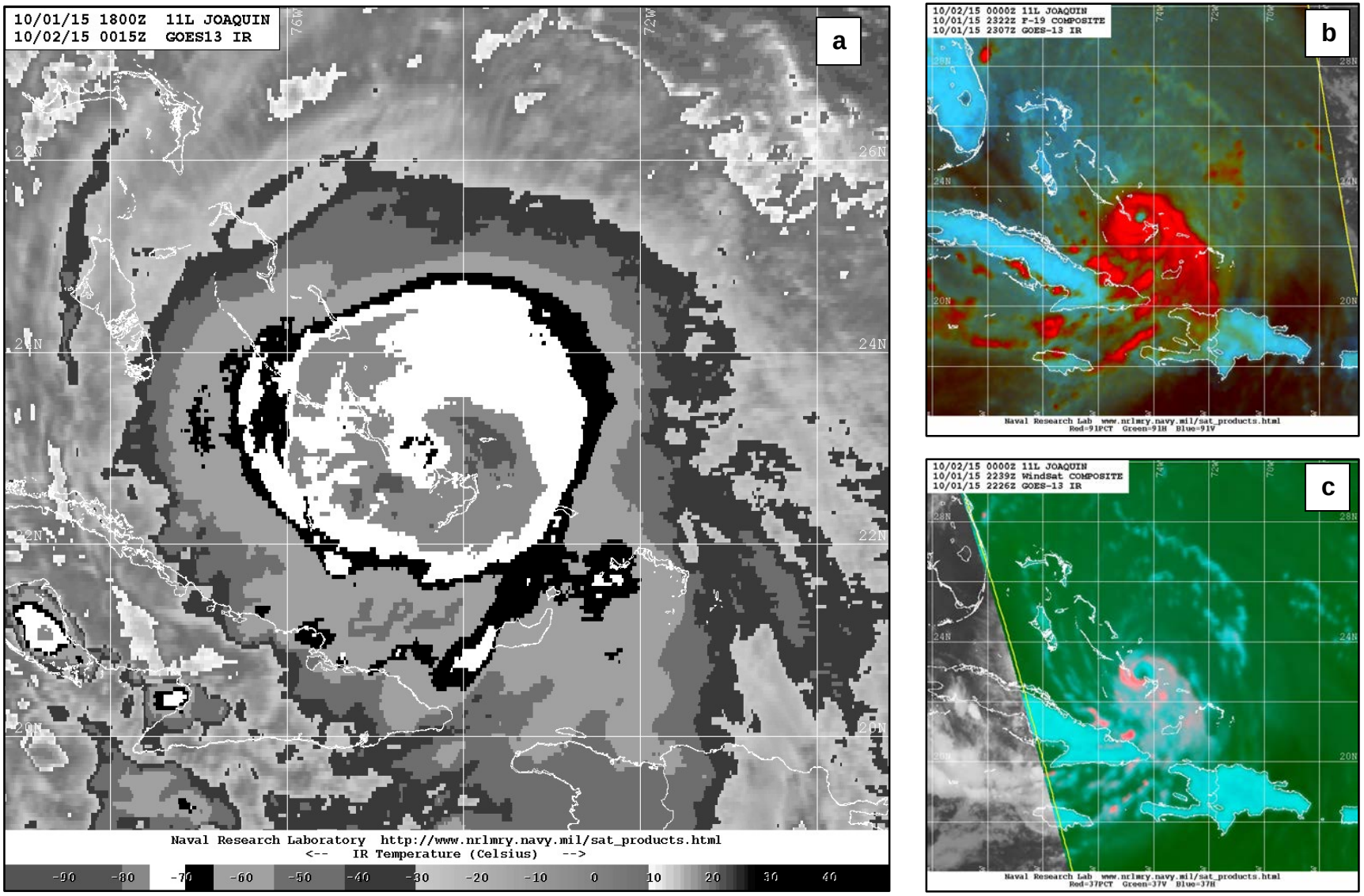

Figure 5. (a) GOES-13 infrared satellite image (using the Dvorak BD enhancement curve) of Hurricane Joaquin at 0015 UTC 2 October 2015 at the time of its first relative peak in intensity as a 120-kt category 4 hurricane. (b) 91-GHz color composite SSMI/S image of Joaquin at 2322 UTC 1 October and (c) 37-GHz color composite WindSat image at 2239 UTC 1 October. Images courtesy of the Naval Research Laboratory.

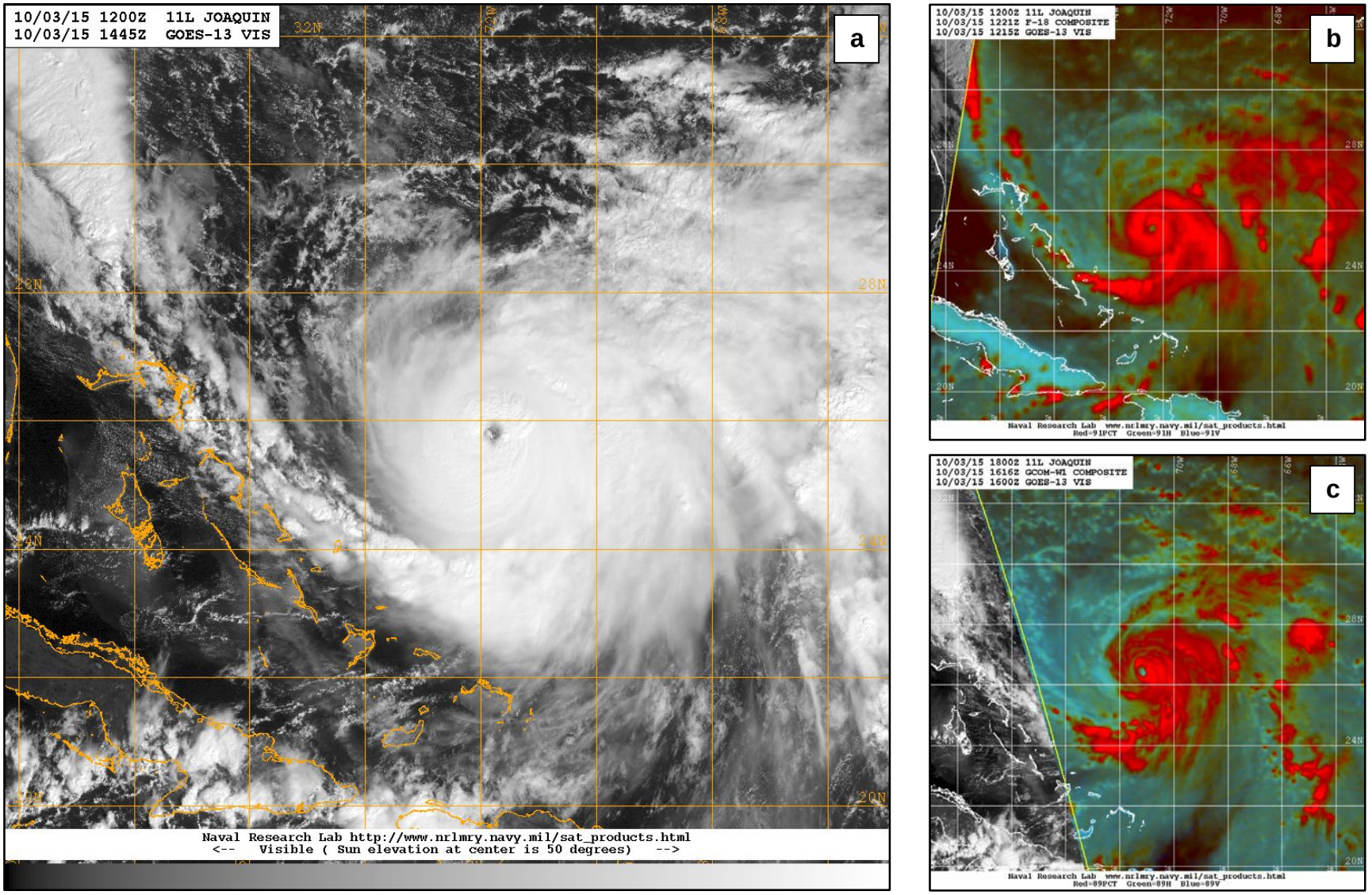

Figure 6. (a) GOES-13 visible satellite image of Hurricane Joaquin at 1445 UTC 3 October 2015, near the time that an Air Force Reserve reconnaissance mission measured winds supporting an absolute peak intensity of 135 kt. (b) 91-GHz color composite SSMI/S image of Joaquin at 1221 UTC 1 October and (c) 91-GHz color composite GCOM image at 1616 UTC 1 October showing the quick erosion of the western eyewall. Images courtesy of the Naval Research Laboratory.

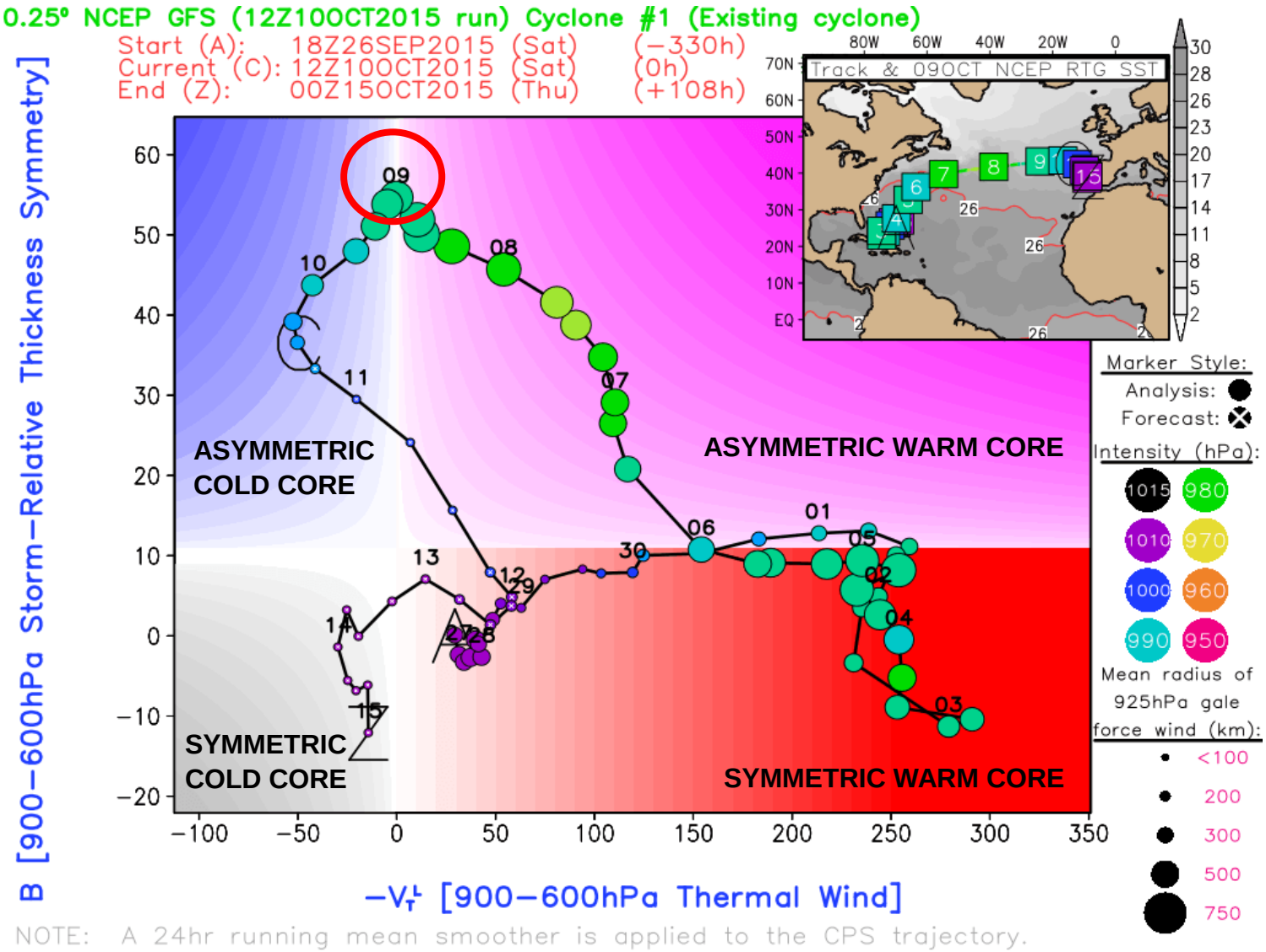

Figure 7a. Cyclone phase-space diagram of Hurricane Joaquin based on analyses and forecasts from the GFS model. Along with Fig. 7b (see below), the analysis shows that Joaquin completed extratropical transition by 0000 UTC 9 October, when it went from being asymmetric shallow warm core to asymmetric deep cold core (indicated by the red circle). Image courtesy of Dr. Robert Hart at Florida State University.

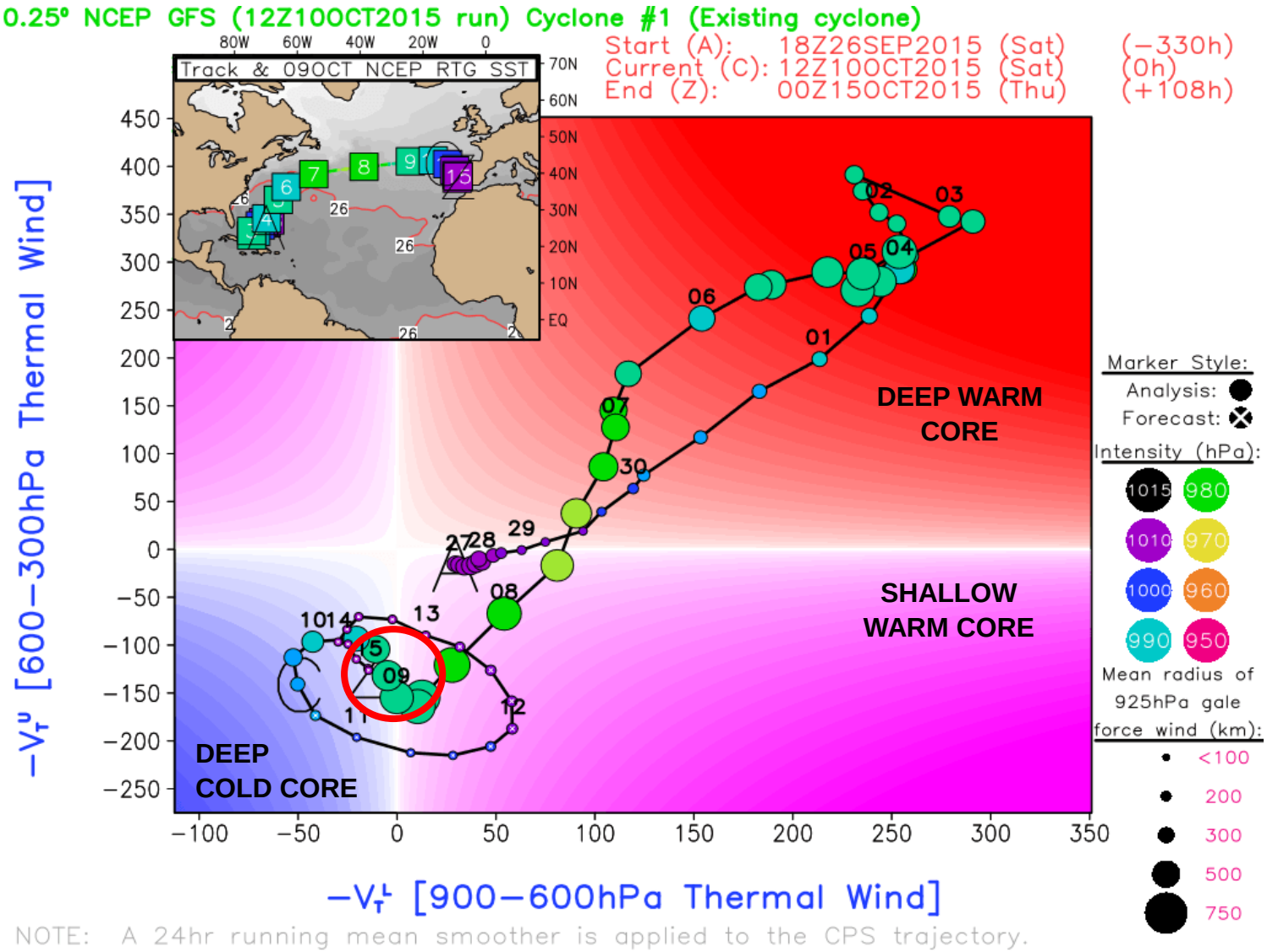

Figure 7b. Cyclone phase-space diagram of Hurricane Joaquin based on analyses and forecasts from the GFS model. Along with Fig. 7a (see above), the analysis shows that Joaquin completed extratropical transition by 0000 UTC 9 October, when it went from being asymmetric shallow warm core to asymmetric deep cold core (indicated by the red circle). Image courtesy of Dr. Robert Hart at Florida State University.

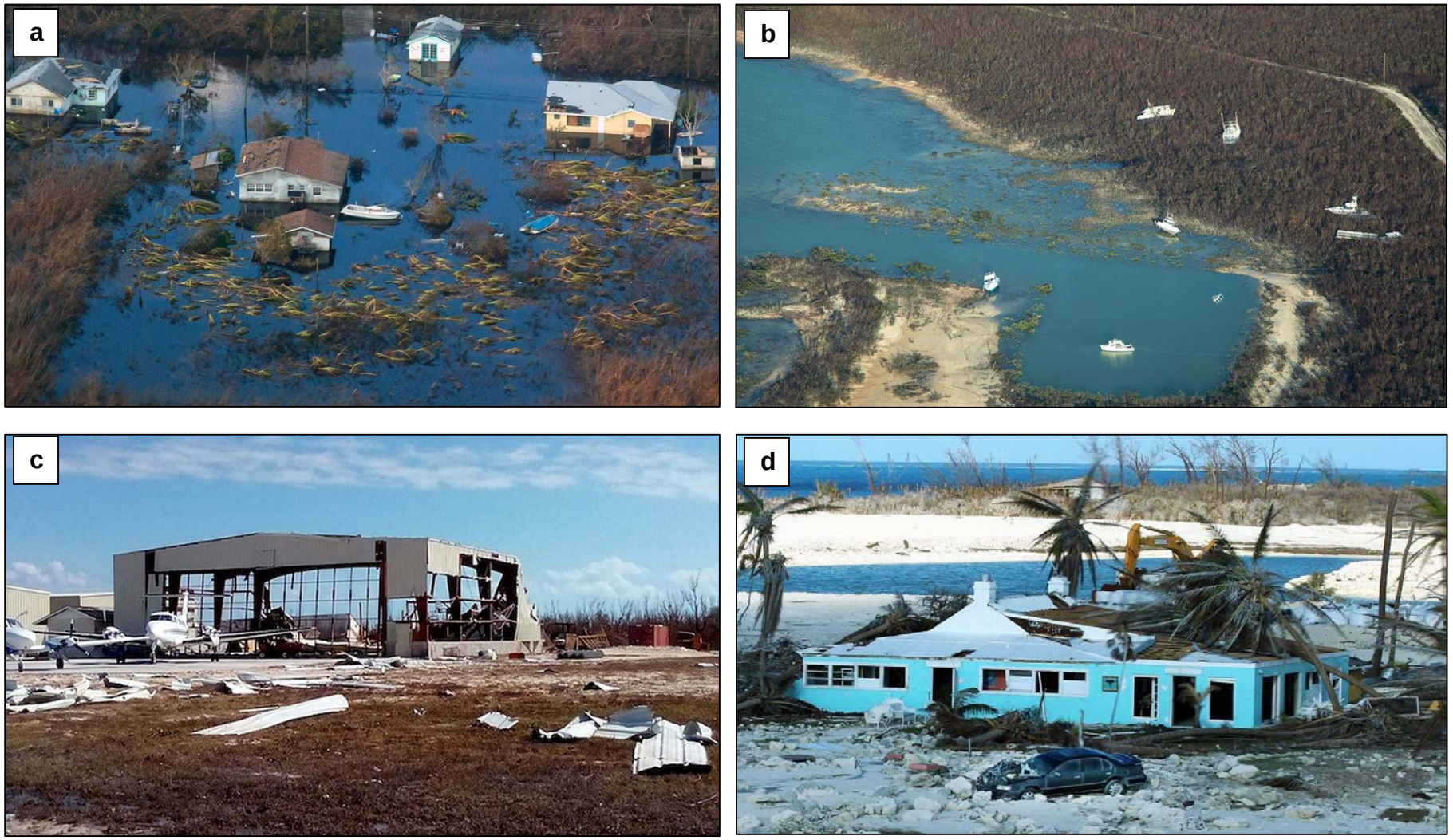

Figure 8. Damage photos from the Bahamas after Hurricane Joaquin. (a) South Long Island (AP/Tim Auyen) (b) South Long Island (AP/Tim Auyen) (c) Crooked Island airport (*Tribune 242*) (d) Pittstown on Crooked Island (*El Nuevo Herald*/Pedro Portal)

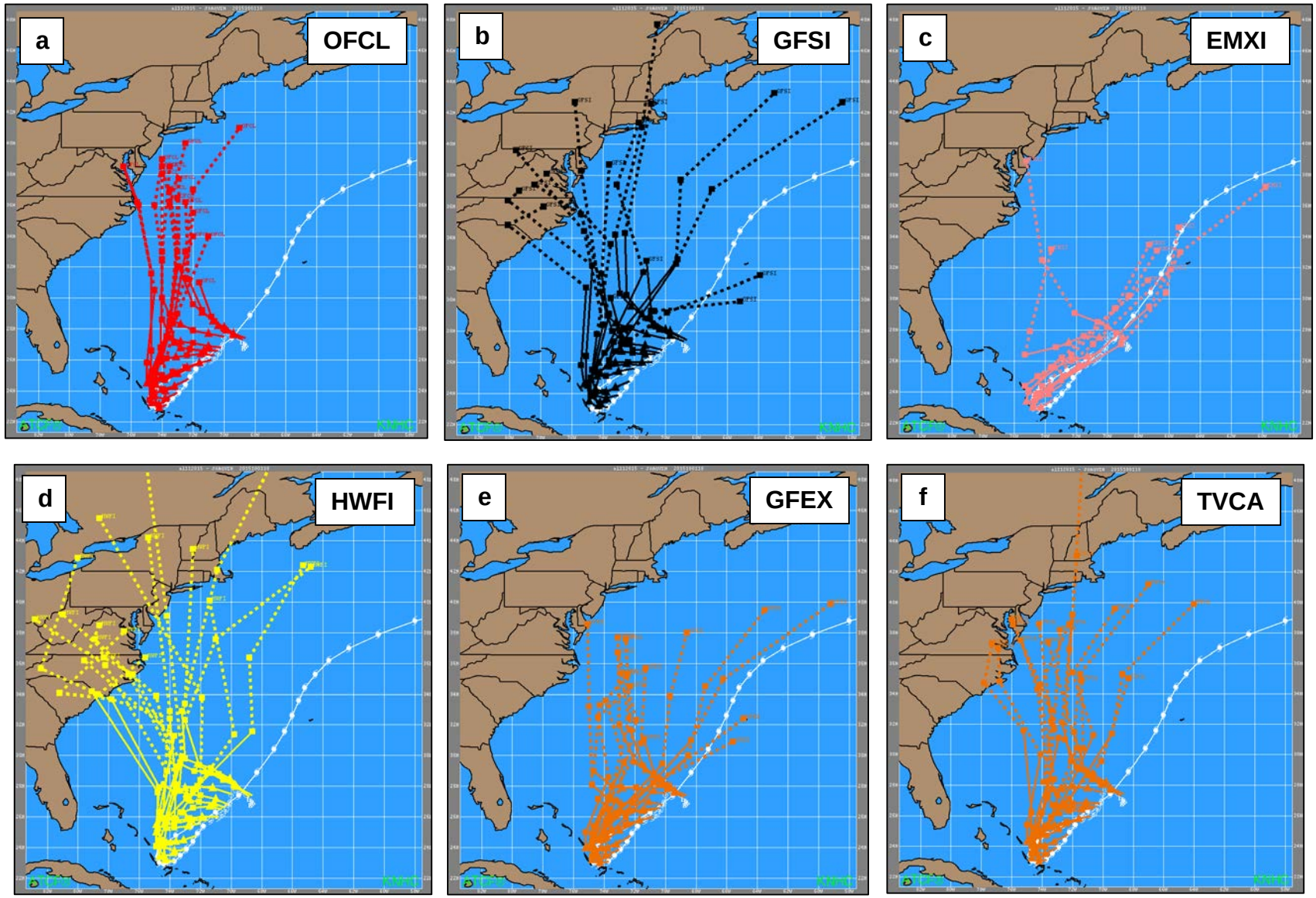

Figure 9. Five-day forecast track plots of the (a) NHC official forecasts (OFCL), (b) GFSI, (c) EMXI, (d) HWFI, (e) GFEX, and (f) TVCA for the forecast cycles between 0000 UTC 28 September and 1800 UTC 1 October 2015 for Hurricane Joaquin. The best track of Joaquin is indicated by the white lines with six-hourly tropical cyclone positions.

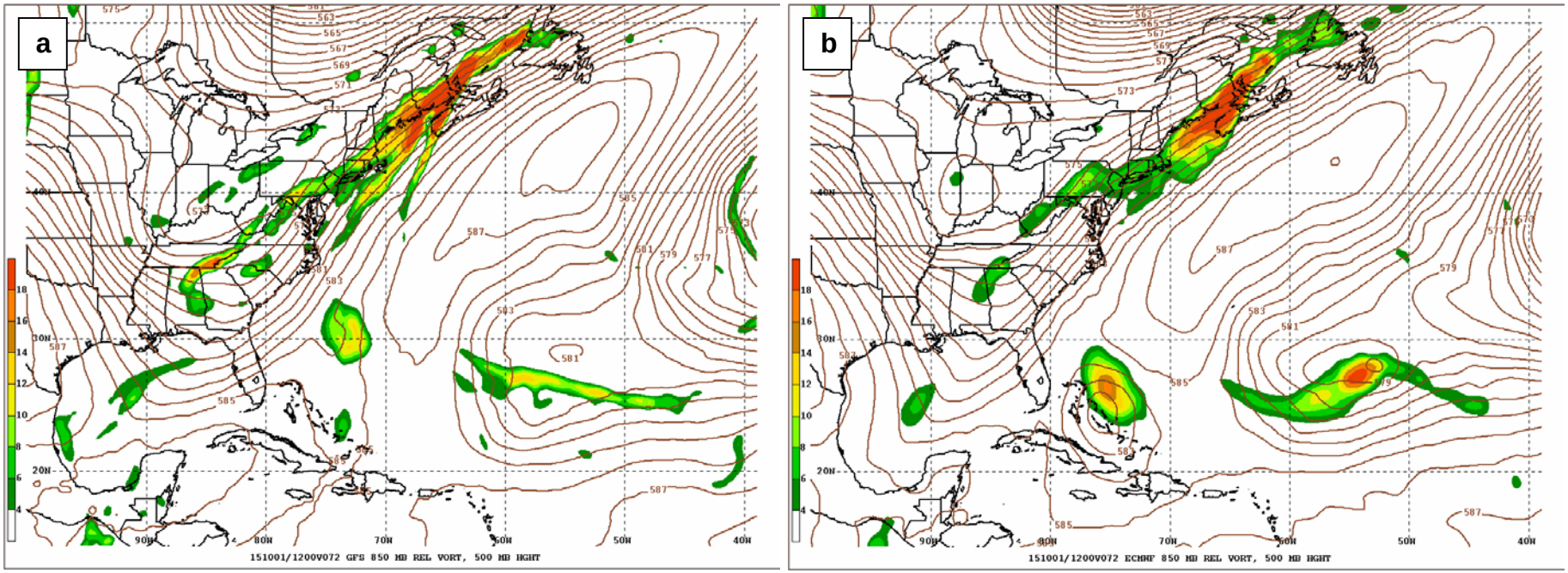

Figure 10. 72-h model forecast fields of 850-mb relative vorticity (× 10^{-5} s^{-1}, colored shading) and 500-mb geopotential height (× 10 m, solid brown lines) valid at 1200 UTC 1 October 2015 from the (a) GFS and (b) ECMWF models. The fields reveal that the GFS showed a weaker vortex for Joaquin being picked up by the eastern U.S. trough while the ECMWF showed a stronger Joaquin being blocked and pushed southwestward by a western Atlantic mid-level ridge.

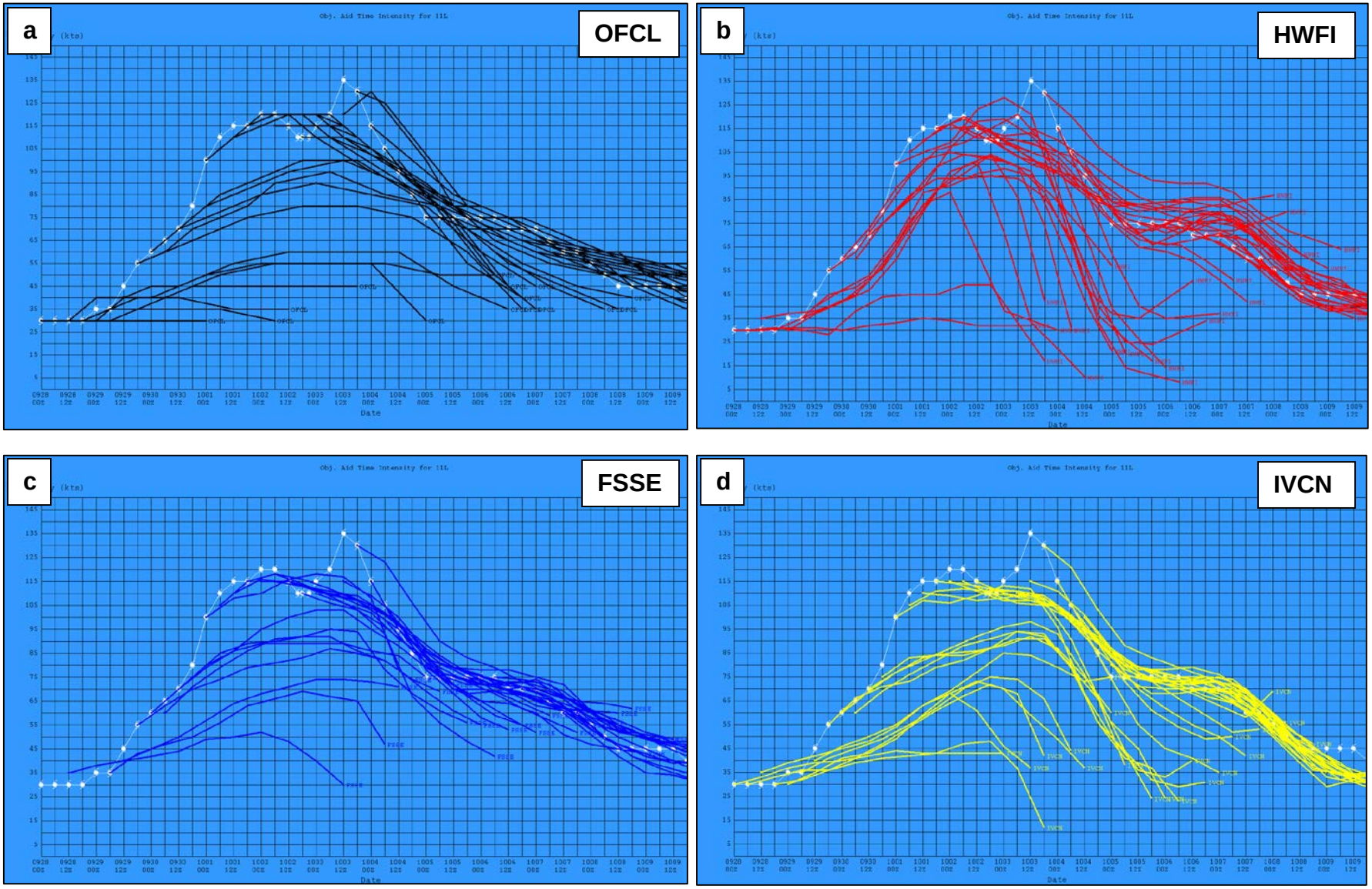

Figure 11. Intensity plots of the (a) NHC official forecasts (OFCL), (b) HWFI, (c) FSSE, and (d) IVCN for the forecast cycles between 0000 UTC 28 September and 0000 UTC 8 October 2015 for Hurricane Joaquin. The best track intensity of Joaquin is indicated by the white lines on each figure.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
South Carolina Water Science Center
720 Gracern Road, Suite 129
Columbia, SC 29210
(803) 750-6100

July 26, 2016

Mr. Thomas Knight, P.E.
South Carolina Department of Transportation
955 Park Street
Post Office Drawer 191
Columbia, South Carolina 29202

Dear Mr. Knight:

Enclosed is a spreadsheet that lists the provisional high-water mark (HWM) elevations for 50 selected bridges in South Carolina. The HWMs document the October 2015 flooding caused by rainfall from Hurricane Joaquin.

The HWMs associated with flooding from October 4 to October 6, 2015 were flagged and surveyed by U.S. Geological Survey personnel on both banks, upstream and downstream of selected bridges (four quadrants at each bridge). Generally speaking, HWM information was sought one bridge-width opening upstream from each bridge as well as at or near the downstream bridge exits. If marks at these locations were not available, crews extended their search area several hundred feet further upstream or downstream as necessary. The horizontal coordinates (latitude and longitude) of each mark was determined by Global Positioning System (GPS) equipment relative to the North American Datum of 1983 (NAD 83), and the elevations of these marks were surveyed to North American Vertical Datum of 1988 (NAVD88). The individual HWM elevations for each site are provided separately in the accompanying spreadsheet. At many sites, reliable HWMs were difficult to find because data collection began 3 weeks after the historic flooding, and subsequent rainfall events, wind, or anthropogenic activity had degraded or eliminated any distinct marks. As a result, engineering judgment was used to estimate the peak water-surface elevations for each site or quadrant. Information that describes the rationale used to estimate the peak elevations is included in the "Remarks" column of the spreadsheet if available. Note that the peak water surface elevation could not be determined at some sites due to no data or insufficient data.

Comment [BLR1]: How about "HWMs associated with flooding from DATE to DATE were flagged and surveyed by USGS personnel on both banks, upstream and downstream of selected bridges (four quadrants at each bridge).

The HWM elevations and descriptive data have been compiled and will be loaded into the U.S. Geological Survey's (USGS) Short-Term Network (STN). The STN is a national-scale application and database designed to support USGS event-based sensor deployments and HWM data-collection efforts. The URL for the STN website is https://stn.wim.usgs.gov/STNWeb/#/.

The Flood Event Viewer option can be used to inspect data for selected events; menus at the STN Data Portal can be used to download data by event, state, and more. Please note that the STN uses functionality that is not completely supported by Internet Explorer; the preferred browser is Chrome.

For your information, be aware that these data are considered provisional until they are posted on the USGS STN. We will inform you when these data are posted. The USGS appreciates the opportunity to collaborate with the S.C. Department of Transportation in documenting this historic flood. If you have any questions or need additional information, please contact me at (803) 750-6155.

Sincerely,

Wladmir B. Guimaraes
Hydrologist

ısportation (SCDOT) Stream Crossings for the Floods of October 2015 associate

ıbject to change following additional quality-assurance checks.

[U/S, upstream; D/S, downstream; HWM, high-water mark; US, United States; SC, South Carolina; I,

Site No.	Road	Crossing	County
1	I-126	Broad River	Richland
2	I-20	Broad River	Richland
3	I-20	Saluda River	Lexington
4	I-26	Cypress Swamp	Berkeley
5	I-26	Four Hole Swamp	Dorchester
6	I-26	Saluda	Richland/Lexington
7	I-77	Congaree	Richland
8	I-95	Black River	Clarendon
9	I-95	Edisto	Colleton / Dorchester
10	I-95	Four Hole Swamp	Orangeburg
11	I-95	Pocotaligo River	Clarendon
12	I-95	Tearcoat Branch	Clarendon
13	US1/378	Congaree River	Richland/Lexington
14	US 15	Edisto River	Colleton / Dorchester
15	US15	Pocotaligo	Sumter
16	US 17	Waccamaw River	Georgetown
17	US 17-ALT	Edisto River	Colleton

18	US 17 A	Sampit River	Georgetown
20	US 176	Broad River	Richland
21	US 176	Cannon's Creek	Newberry
22	US 76	Dean Swamp	Orangeburg/Berkeley
23	US 178	Bull Swamp Creek	Orangeburg
24	US 21	Edisto River	Bamberg/Orangeburg
25	US 21/176/321	Congaree River	Richland/Lexington
26	US 301	Black River	Clarendon
27	US 301	Pocotaligo River	Clarendon
28	US 301	Pudding Swamp	Clarendon
29	US 378	Black River	Sumter
30	US 378	Great Pee Dee River	Marion/Florence
31	US 401	Scape Ore Swamp	Sumter
32	US 52	Santee River	Berkeley / Williamsburg
33	US 521	Deep Creek	Clarendon
34	US 601	Congaree River	Richland/Calhoun
35	US 76	Black River	Sumter
36	US 76	Scape Ore Swamp	Sumter
37	US 78	Cypress Swamp	Dorchester
38	US 78	Edisto River	Orangeburg/Bamberg
39	US 78/178	Four Hole Swamp	Dorchester

40	SC 377	Black River	
41	SC 402	Wadboo Swamp Creek	Berkeley
42	SC 41	Black River	Williamsburg
43	SC41/51	Black Mingo Creek	Williamsburg
44	SC 45	Wambaw Creek	Berkeley/Charleston
45	SC51	Black River	Georgetown
46	S-22-38	Big Dam Creek	Georgetown
47	S-36-350	Hellers Creek	Newberry
48	S-41-449	Clouds Creek	Saluda
49	S-43-32	Pocotaligo River	Sumter
50	SC 512	Paisley Swamp	Williamsburg
51	S-40-37	Myers Creek	Richland

d with Hurricane Joaquin

Interstate; S, secondary route; UL upstream left; UR upstream right; DL,

SCDOT Structure Number (Main channel only, if applicable)	Bridge Deck elevation, ft
4010012640100	167.6
4010002000100	177.5
3210002000400	191.6
0810002640400	35.4
0810002640100	56.9
3210002600400	186.4
3210007730500	Not determined
1410009531300	95.2
1810009530100	Not determined
3810009530300	92.8
1410009530800	Not determined
140009511100	Not determined
4020000100100	163.7
1820001500100	Not determined
4320001530100	128.2/128.4
2220001700500	9.9
1820001707100	34.4

222001707300	7.7
402001760100	179.4
3620017601000	Not determined
0820017600100	67.3
3820017800300	225.1
0520002100100	102.3
3220002100800	159.4
1420030101300	88.6
142003010100	83.1
3120040100100	90.3
4320037840200	110.1
3420037800100	Not determined
3120040100100	154.0
0820005201100	51.3
1420052100100	82.9
0920060100300	Not determined
4320007601300	126.1
4320007601200, 4320007601100, 432000760100, 4320007600900	129.5/131.2
3820007800100	26.5
3820007800100	114.9
1820007800500	51.9

4540037700100	43.9
0840040200100	Not determined
4540004100200	27.1
4540004100500	19.6
1040004500100	12.6
2240005100300	19.0
2270003800100	17.5
3670035000100	Not leveled
4170044900100	445.8
4370003200200	104.2
4540051200200	34.7
4070003700100	Not leveled

downstream left; DR, downstream right; E, excellent; G, good; F, fair; P poor; VP, very poor]

Location
Downstream left corner on dowstream bridge
Right downstream corner of bridge
Right upstream corner of bridge
Upstream left corner of the upstream bridge
Upstream right corner of upstream bridge
Downstream left corner of bridge
All temporary benchmarks were set (1) below the bridge on the floodplain or (2) approximately 1,000 ft upstream from the bridge.
Right downstream corner of southbound main- channel bridge
Not safe, heavy traffic on Interstate
Upstream left corner of upstream bridge
Not safe, heavy traffic on Interstate
Not safe, heavy traffic on Interstate
Downstream Right corner of Bridge
Temporary benchmark was not on bridge, but on side road about 300-400 ft from bridge. Levels were run under bridge from road to the HWMs and not to the top of bridge.
Center of downstream bridge/ Center of upstream bridge
Right downstream corner of Bridge
Left downstream corner of Bridge

Left downstream corner of bridge
Right upstream and downstream corners of bridge
Bridge was destroyed.
Left upstream corner of bridge
Center line of bridge
Downstream right corner of bridge.
Right upstream corner of bridge.
Centerline of bridge
Left upstream corner of bridge
Top of curb on upstream left corner of bridge
Center of downstream bridge on top of curb on downstream side
Did not survey.
Top of curb at center of bridge on upstream side.
Right downstream corner of bridge.
Right upstream corner of bridge
Temporary benchmarks were not located near bridge.
Center of upstream side of bridge.
Upstream center of right most bridge/ Upstream center of left most bridge.
Right downstream corner of bridge.
Left upstream corner of bridge.
Right downstream corner of bridge

Left downstream corner of bridge
Temporary benchmark was not close to bridge.
Left downstream corner of bridge
Downtream left corner of bridge
Right upstream corner of bridge
Left upstream corner of bridge.
Right upstream corner of bridge.
Upstream center of bridge
Center of bridge
Bridge destroyed.