WFO Mobile Low-Water Crossings

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ABSTRACT

This study was undertaken to improve inundation forecasting and to advance the warning system associated with floodwater. This was accomplished by gathering a map of several flood-prone roadway locations within the National Weather Service Mobile county warning area and generating a low-water crossing map. The map was created so that radar imagery can be overlaid using the National Weather Service's Advanced Weather Interactive Processing System (AWIPS). On October 22, 2017, the low-water crossing map was successfully utilized in real-time for Mobile and Baldwin Counties of southwest Alabama. Low-lying areas were verified and new points were noted. Having the additional information from the low-water crossings map, eases operations by allowing forecasters to more readily reference flood-prone roadways in real-time products. This ultimately provides local communities with the service of knowing potential impacts on a more precise scale.

INTRODUCTION

The study of flood-prone regions has an inherent importance as flooding is one of the leading causes of deaths associated with weather in the United States (Becker et al. 2015). It is defined as any high flow, overflow, or inundation of water which causes or threatens damage to people and property. Simultaneously, flooding is a consequence of atmospheric and land processes interacting on spatial and temporal scales (Georgakakos 1986).

As seen in Figure 1, flooding has climatologically been the second leading cause of weather-related fatalities in comparison to heat in the United States since 1987 (National 2017). However, in 2016 and 2015, flooding was the leading cause of weather-related fatalities (National 2016, 2017). Ashley et al. (2008) also found that during a 47 year period (1959-2005), a total of 4586 fatalities were reported in the contiguous U.S. due to flooding. This averaged to approximately 97.6 fatalities per year with a median value of 81 fatalities per year. Each state was also ranked by the frequency of flood fatalities during 1959-2005. Out of the lower forty eight states, Alabama ranked twenty second, Florida ranked twentieth and Mississippi ranked seventh. The main flood type associated with many of these fatalities was floods from heavy rain totals over a minimal time period.

Hence, the purpose of this project is to improve the ability to predict inundation and to advance the warning system associated with floodwater by generating a map of all flood-prone roadways within the National Weather Service Mobile forecast area. The Mobile Weather Forecast Office (WFO) forecasts for twenty counties throughout southern Mississippi, Alabama, and Florida (Fig. 2). As of April 1, 2010, the NWS Mobile county warning area (CWA) had a population of 1.5 million people (Data 2010).

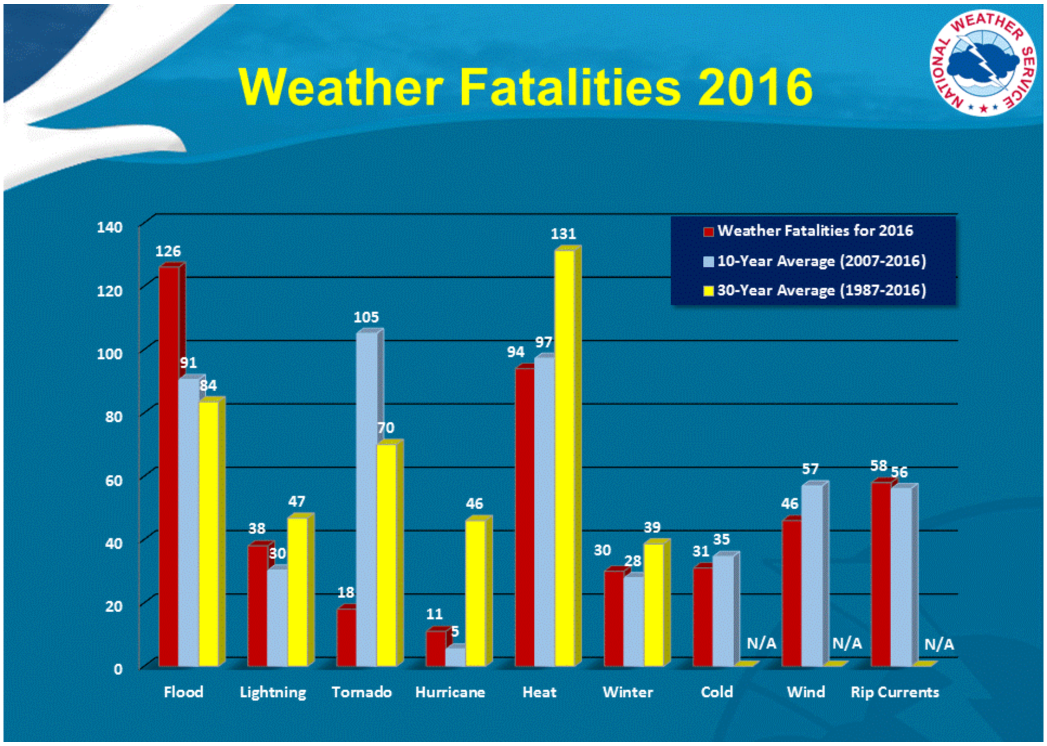

FIG. 1. National hazard statistics illustrating flooding as the leading cause of weather-related fatalities in 2016 and the second leading cause of weather-related fatalities over a thirty year average.

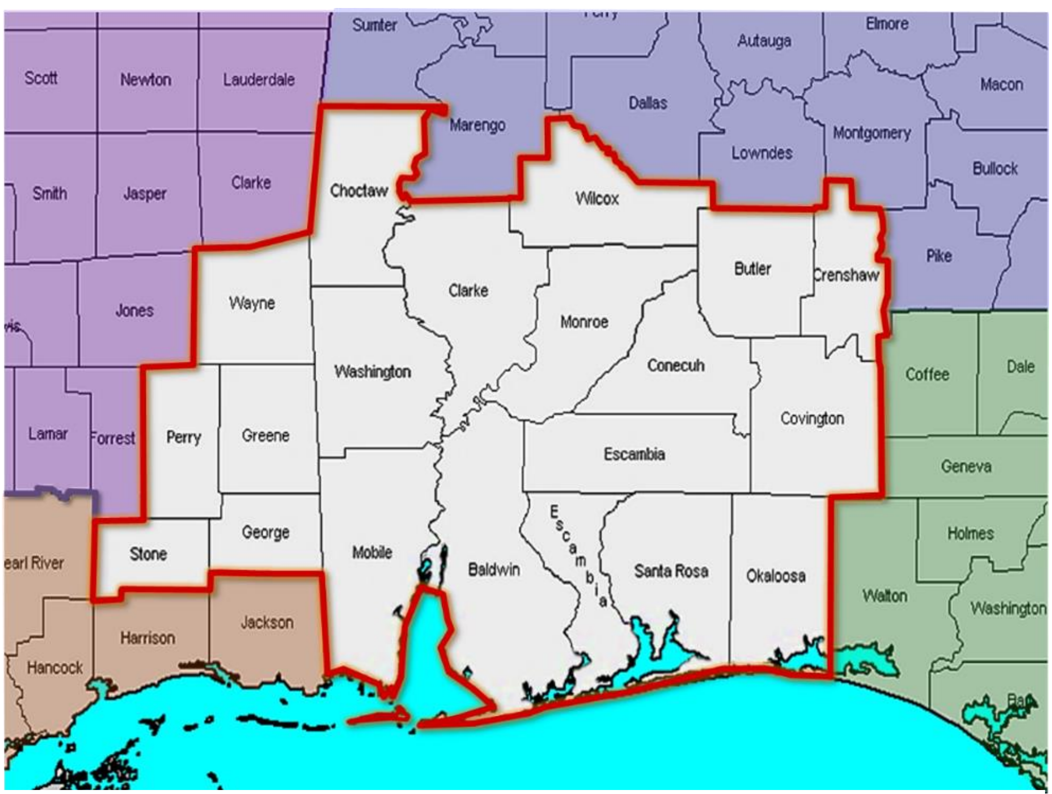

FIG. 2. The WFO Mobile CWA comprises twenty counties within southern Mississippi, Alabama, and Florida.

Due to the risks of flooding, it is necessary for a more localized and geographical approach to warn citizens about flooding during heavy rainfall events. Specifically, a means in which to warn communities on a scale much smaller than county or city wide is needed. For this project the focus was on individual streets. This approach was chosen because people tend to respond better to warnings when they know there is potential for direct impact. A recent study investigated how the public reacts to flood watches and warnings proved this theory as many citizens voiced they were more likely to take action if they knew their specific neighborhood or community was threatened instead of the entire county (Carr et al. 2016). By creating a forecast system specific to a smaller area, many limitations are removed. Another reason for choosing streets was that

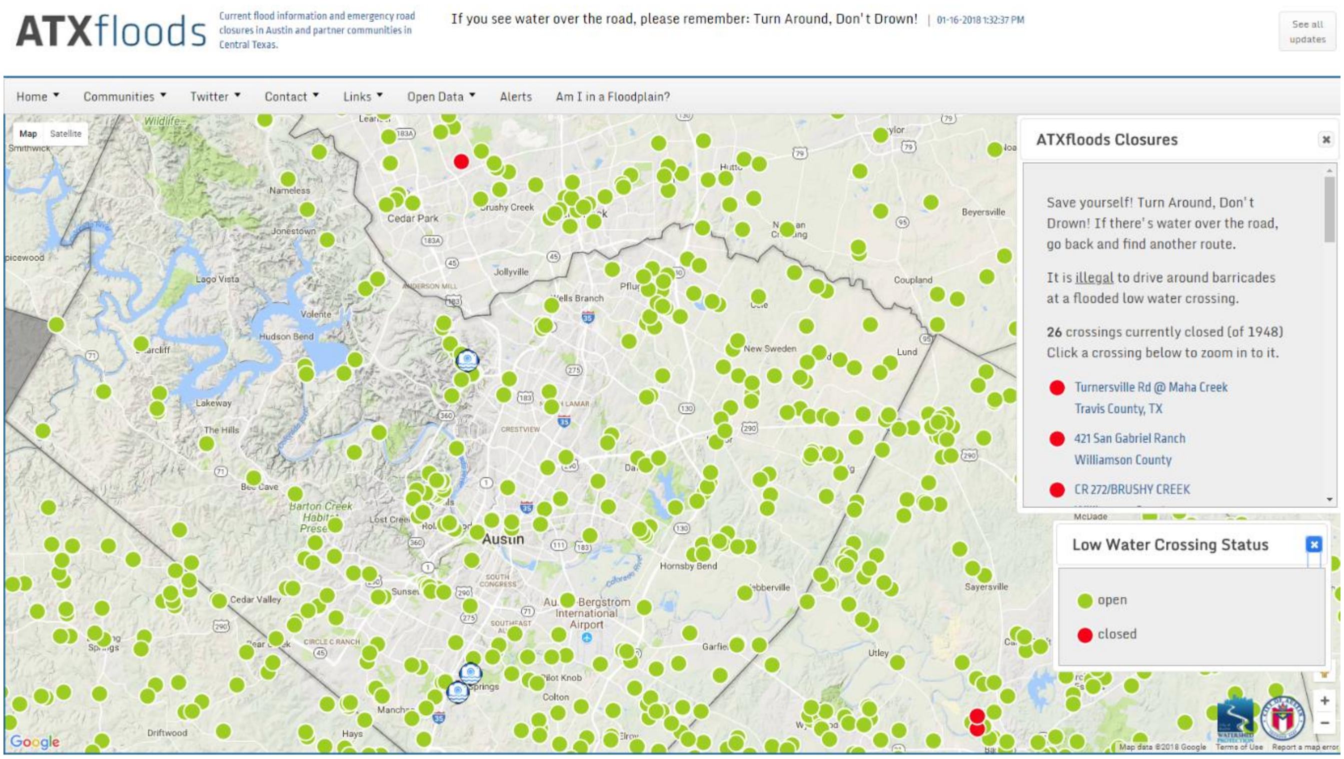

FIG. 3. Homepage of the ATXfloods website. If the low-water crossing point is closed, the point will be red, but if the low-water crossing point is open, the point will be green. Image taken from ATXfloods.com.

drivers are typically more vulnerable to rising floodwater. In fact, more than 75% of flood related deaths are associated with motor vehicles (Becker et al. 2015). Many motorists underestimate the speed and power of moving water and the risk and depth of standing water on roadways. Familiarity of roads also plays a role when drivers consider entering flooded roads because they underestimate the risks and have a higher confidence of being able to safely cross flooded streets. Becker et al. (2015) conducted a study in Texas concerning the 140 flood fatalities within the state during 2009. The study found that thirty-eight of the victims were within close proximity to their homes or on their daily commutes. Twenty-seven of the thirty-eight (71%) were considered to have roadway familiarity. By utilizing a warning system specific to street names and intersections emergency managers (EMAs) will be provided with more time to close flood-prone roads and allow drivers to find alternate routes before the flooding actually occurs.

The Flood Early Warning System (FEWS) team in Austin, Texas is a prime example of site specific cautions. FEWS maintains a real-time low-water crossing road closure map accessible to the public through continuous weather and roadway conditions on a website called ATX Floods (https://www.atxfloods.com/). This map is extremely useful in that the information goes directly into the hands of the public (Fig. 3).

While ATX Floods map has a similar concept involving site specific inundation zones, the purpose of the WFO Mobile low-water crossing (LWC) map is to ease operations by allowing forecasters to more readily reference flood-prone roadways in real-time products which in return provides local communities with the service of knowing where to exercise caution.

METHODS

Data was acquired through emergency managers, county engineers, road and highway departments, and GIS analysts in order to determine the locations of any low-water crossings within the respective county. Responses were given as street names, river crossings, latitudes/ longitudes, and geographic information system (GIS) maps. In some counties, low-water crossings were too

TABLE 1. Example of the low-water points in CSV format.

Latitude	Longitude	County	ID	LowwaterName	LowwaterCity
31.55657	-86.61617	Butler	Whittle Bridge Road	Whittle Bridge Road	Georgiana
31.63328	-86.75910	Butler	West Mill Street (CR-16)	West Mill Street (CR-16)	Georgiana
31.55163	-86.81900	Butler	North Garland Road (CR-8)	North Garland Road (CR-8)	McKenzie
31.52031	-87.89160	Clarke	Forest Avenue and Jackson Street	Forest Avenue and Jackson Street	Jackson
31.77702	-87.96650	Clarke	Norris Road	Norris Road	Grove Hill
31.87343	-87.72780	Clarke	Rural Road	Rural Road	Thomasville

common to name so in these cases, only predominate areas were noted. Some counties only provided data from the most recent flood events. At the time of this project, no data was available for the following counties: Choctaw, Covington, Escambia AL, Escambia FL, Okaloosa, Stone, Washington, and Wilcox.

Once all locations were gathered, the data was put into a CSV (comma-delimited) file within Microsoft Excel. This CSV included a latitude, longitude, county, ID, street name or intersection, and city for each low-water crossing location (Table 1).

The file was then converted and imported by Ray Ball (the office Information Technology Officer) into the Advanced Weather Interactive Processing System (AWIPS) which the National Weather Service uses in forecast operations to display meteorological, hydrological, satellite, and radar data. Once in AWIPS, forecasters were able

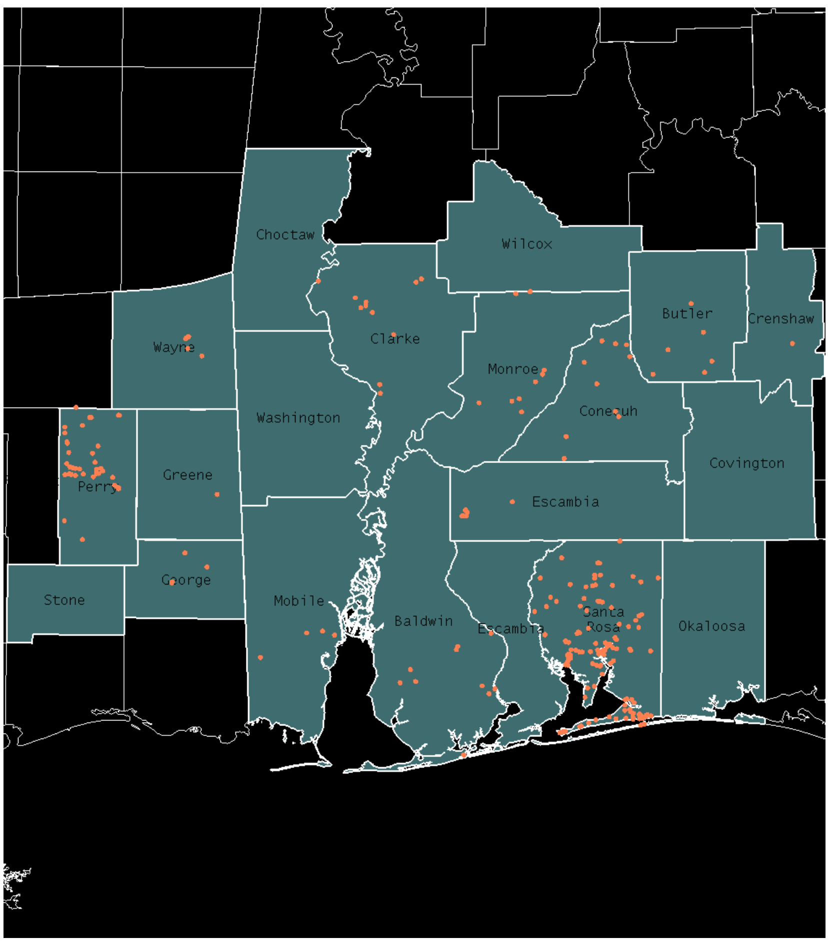

FIG. 4. Low-water crossing map customized in AWIPS with original 1,439 points.

to customize the map, overlay a preferred radar, and utilize it during the warning processes for heavy rainfall events (Fig. 4).

RESULTS

On Sunday, October 22, and Monday, October 23, 2017, the low-water crossing map was employed in real-time.

The major threat associated with this event was flooding and heavy rainfall rates. The Weather Prediction Center (WPC) predicted a localized flood threat with batches of slow-moving convection eastward. Rainfall rates were expected to be near 3.00 inches per hour (Fig. 5).

The Mobile CWA was on the favored side of the jet for enhanced deep layer ascent within an anomalously high moist environment. Precipitable water values (PWAT's) were near 2.00 inches. Warm rain processes were also a contributor of the high rainfall totals.

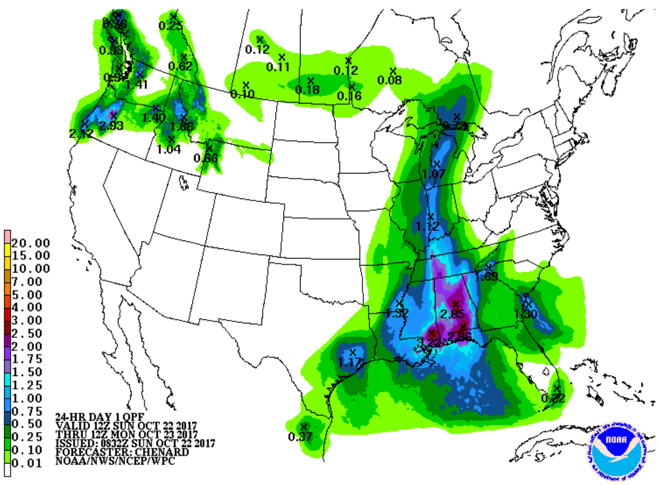

FIG. 5. Quantitative Precipitation Forecast (QPF) showing precipitation amounts in the Mobile CWA at 2.86-3.22 inches on October 22 at 12 UTC to October 23 at 12 UTC.

During the event, flash-flood warnings issued by WFO Mobile were cross-referenced against points identified on the low-water crossing map to examine how well the points matched flash flood reports.

In all, WFO Mobile issued a total of thirty-eight advisories and warnings between 0500 UTC on October 22 and 0459 UTC on October 23, 2017. These included ten areal flood advisories, five areal flood warnings, three flood warnings, five flash flood warnings, seven marine warnings, and eight tornado warnings. The flash flood warnings were issued for George, Mobile, Baldwin, and Okaloosa Counties.

Eight flood related local storm reports were made with several additional social media posts regarding Mobile and Baldwin Counties. Hence, Mobile and Baldwin Counties were the focus of point verification on the low-water crossing map.

At the time of the event, Mobile County had four LWC points and Baldwin County had ten LWC points which can be seen in Tables 2 and 3.

TABLE 2. Low-water crossings for Mobile county as of October 22, 2017

ID	Latitude	Longitude
Government Street and S Ann Street	30.682393	-88.066324
Old Shell Road and University Boulevard	30.689408	-88.173771
Old Shell Road at Railroad Overpass	30.695969	-88.112717
S Grand Bay Wilmer Road	30.606661	-88.353271

TABLE 3. Low-water crossings for Baldwin county as of October 22, 2017

ID	Latitude	Longitude
Barrineau Park Road	30.688407	-87.456931
County Road 48	30.523658	-87.810788
County Road 54	30.56729	-87.770902
County Road 55	30.527639	-87.750839
Goat Cooper Road	30.633895	-87.592266
Jubilee Point Road	30.281469	-87.564553
Kings Landing Road	30.486566	-87.466112
Linholm Road	30.644362	-87.58683
Lost River Road	30.50226	-87.442514
Vaughn Road	30.513031	-87.492931

Mobile County received its first rounds of rainfall around 1600 UTC (11 AM CDT) as a mid- to upper-level trough extending from south-central Canada to east Texas was moving into the Central Plains with widespread showers and thunderstorms ahead of the trough and cold front (Fig. 6).

At 1719 UTC, the first flash flood warning (event 88) for northwestern Mobile County was issued. At this time, up to two inches of rain had already fallen in this area. The second flash flood warning (event 89) was issued for Mobile County at 1857 UTC. Three to four inches of rain had fallen at this time. The first point to verify was on Old

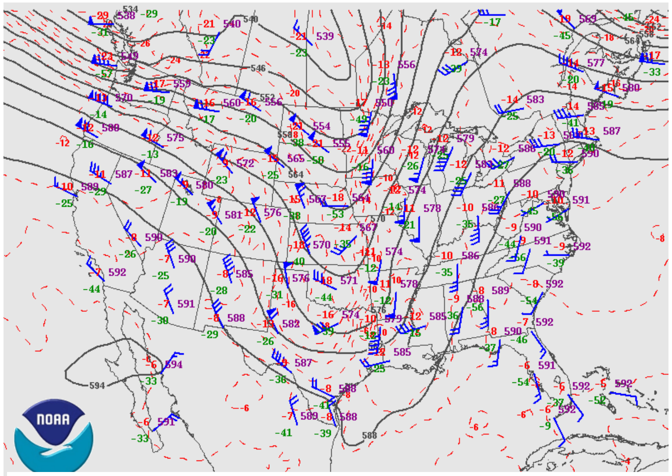

FIG. 6. Storm Prediction Center's 500mb upper air map illustrated the upper-level trough extending over the central plains on October 22 at 12 UTC.

Shell Road at the railroad overpass. A tweet was posted on twitter by the Mobile Traffic account at 1913 UTC making this report.

By 2215 UTC, a third flash flood warning (event 90) was issued for central Mobile County and Baldwin County.

At 2308 UTC there was a water rescue report on County Road 55 at Camellia Road made by the Baldwin County Department of Highways. This report made County Road 55 the second confirmed low-water crossing point.

By 0200 UTC on October 23, the rain had begun to exit Baldwin County. Shortly after, Baldwin County Emergency Management tweeted a list of impassible roadways in the county. These roads included Barrineau Park Road- at Perdido River and County Road 48- at Fish River. Another tweet regarding County Road 48 was posted at 2030 UTC (Fig. 7). At this time the roadway was still closed.

FIG. 7. Photo tweeted by Baldwin County EMA at 2030 UTC showing the low-water crossing point on County Road 48 near the Fish River Bridge.

By 0400 UTC the showers and thunderstorms were well out of the area. The cold front pushed through the CWA early that morning leaving behind cooler temperatures, clear skies, and much drier conditions.

Total rainfall accumulation was gathered from four automated surface observing systems (ASOS) on October 22. A precipitation record of 4.07 inches was broken at the Mobile Regional Airport ASOS on October 22 breaking the previous record of 3.28 inches set back in 1919 (Table 4).

TABLE 4. Total rainfall from ASOS sites in Mobile and Baldwin Counties for October 22, 2017.

ASOS Site	Rainfall Total (inches)
Mobile Downtown	4.59
Mobile Regional Airport	**4.07R**
Gulf Shores	2.09
Fairhope	1.97

DISCUSSION AND CONCLUSIONS

During the October 22-23, 2017 heavy rainfall event, Mobile County had one point out of the four on the low-water crossing map confirm. The point that verified was on Old Shell Road at the Railroad Overpass. Baldwin County had three points out of the ten verify. The three points to validate comprise Barrineau Park Road, County Road 48, and County Road 55.

It is also worth noting that this event introduced four new points in Mobile County and two new points in Baldwin County. These locations will be monitored and potentially added to the map in the future (Table 5). It is hoped that upcoming events and communications with county EMAs will assist in the addition of new points. Highly populated counties would benefit immensely.

Forecasters can now utilize the low-water crossing map with confidence by readily referencing flood-prone roadways in real-time products due to the confirmation of these points. Local communities benefit as a result in that they are serviced with the knowledge of potential impacts on a more precise scale. It is extremely

TABLE 5. Potential new low-water crossing points in CSV format from the October 22-23, 2017 heavy rainfall event.

Latitude	Longitude	County	ID	LowwaterName	LowwaterCity
30.471979	-88.343422	Mobile	Potter Tract Road south of Saeger Road	Potter Tract Road south of Saeger Road	Grand Bay
30.487658	-88.308987	Mobile	US 90 east of Ramsey Road	US 90 east of Ramsey Road	Grand Bay
30.672692	-88.058619	Mobile	Virginia Street and Gayle Street	Virginia Street and Gayle Street	Mobile
30.611478	-88.157009	Mobile	Halls Mill and Demetropolis Road	Halls Mill and Demetropolis Road	Mobile
30.581486	-87.755357	Baldwin	Powell Road west of County Road 55	Powell Road west of County Road 55	Loxley
30.618343	-87.770034	Baldwin	County Road 64 west of Highway 59	County Road 64 west of Highway 59	Loxley

important for society to be aware beforehand so that these flood-prone areas can be avoided.

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