4 HAZARD IDENTIFICATION

Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.
Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

This section describes the Hazard Identification and Risk Assessment process for the development of the Chatham County Floodplain Management Plan. It describes how the County met the following requirements from the 10-step planning process:

- Planning Step 4: Assess the Hazard
- Planning Step 5: Assess the Problem

As defined by FEMA, risk is a combination of hazard, vulnerability, and exposure. "It is the impact that a hazard would have on people, services, facilities, and structures in a community and refers to the likelihood of a hazard event resulting in an adverse condition that causes injury or damage."

This flood risk assessment covers the unincorporated areas of Chatham County. The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The process allows for a better understanding of a jurisdiction's potential risk to natural hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events. This risk assessment followed the methodology described in the FEMA publication Understanding Your Risks—Identifying Hazards and Estimating Losses (FEMA 386-2, 2002), which breaks the assessment down to a four-step process:

Data collected through this process has been incorporated into the following sections of this chapter:

- **Section 4**: **Hazard Identification** identifies the natural flood hazards that threaten the planning area.
- **Section 5**: **Hazard Profiles** discusses the threat to the planning area and describes previous occurrences of flood hazard events and the likelihood of future occurrences.
- **Section 6: Vulnerability Assessment** assesses the planning area's exposure to natural flood hazards; considering assets at risk, critical facilities, and future development trends.
- **Section 7: Capability Assessment** inventories existing mitigation activities and policies, regulations, and plans that pertain to mitigation and can affect net vulnerability.

Chatham County's FMPC conducted a hazard identification study to determine the natural flood hazards that threaten the planning area.

4.1 RESULTS AND METHODOLOGY

Using existing flood hazard data and input gained through planning meetings, the FMPC agreed upon a list of natural flood hazards that could affect the County. Flood hazard data from the Chatham County Hazard Mitigation Plan, Georgia Emergency Management Agency (GEMA), FEMA, the National Centers for Environmental Information (NCEI), and other sources were examined to assess the significance of these hazards to the planning area. Significance was measured in general terms and focused on key criteria such as frequency and resulting damage, which includes deaths and injuries, as well as property and economic damage.

The flood hazards identified in Table 4.1 were evaluated as part of this plan. Only the more significant hazards with the potential to cause significant human and/or monetary losses in the future have a more detailed hazard profile and are analyzed further in Section 6 Vulnerability Assessment.

Table 4.1 – Summary of Flood Hazard Evaluation

Flood Hazard	Included in 2014 State HMP?	Included in Chatham County HMP?	Identified as a Significant Hazard to be included in the Chatham FMP?
Flood: 100-/500-year	Yes	Yes	Yes
Flood: Stormwater/Localized Flooding	No	No	Yes
Coastal/Stream Bank Erosion	No	Yes	Yes
Dam/Levee Failure	Yes	Yes	Yes
Hurricane/Tropical Storm	Yes	Yes	Yes
Climate Change/Sea Level Rise	No	Yes	Yes

4.2 DISASTER DECLARATION HISTORY

The FMPC researched past events that resulted in a federal and/or state emergency or disaster declaration in the planning area for Chatham County in order to identify known flood hazards. Federal and/or state disaster declarations may be granted when the Governor certifies that the combined local, county and state resources are insufficient and that the situation is beyond their recovery capabilities. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state government capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

Records of designated counties for FEMA major disaster declarations start in 1964. Since then, Chatham County has been designated in only one major disaster declaration: Hurricane Matthew on October 8, 2016.

A lack of historical disaster declarations is not necessarily indicative of a lack of hazard risk. As such, the FMPC identified the above list of six flood-related hazards based on existing planning documents and local knowledge of flood risks.

5 HAZARD PROFILES

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

The hazards identified in Section 4 Hazard Identification, are profiled individually in this section. Information provided by members of the FMPC has been integrated into this section with information from other data sources.

Each hazard is profiled in the following format:

Hazard Description

This section provides a description of the hazard followed by details specific to the Chatham County planning area. Where available, this section also includes information on the hazard extent, seasonal patterns, speed of onset/duration, magnitude and any secondary effects.

Past Occurrences

This section contains information on historical events, including the extent or location of the hazard within or near the Chatham County planning area.

Probability of Future Occurrence

This section gauges the likelihood of future occurrences based on past events and existing data. The frequency is determined by dividing the number of events observed by the number of years on record and multiplying by 100. This provides the percent chance of the event happening in any given year according to historical occurrence (e.g. 10 hurricanes or tropical storms over a 30-year period equates to a 33 percent chance of experiencing a hurricane or tropical storm in any given year). The likelihood of future occurrences is categorized into one of the classifications as follows:

- ***Highly Likely*** – Near 100 percent chance of occurrence within the next year
- ***Likely*** – Between 10 and 100 percent chance of occurrence within the next year (recurrence interval of 10 years or less)
- ***Possible*** – Between 1 and 10 percent chance of occurrence within the next year (recurrence interval of 11 to 100 years)
- ***Unlikely*** – Less than 1 percent chance or occurrence within the next 100 years (recurrence interval of greater than every 100 years)

Those hazards determined to be of high or medium significance were characterized as priority hazards that required further evaluation in Section 6 Vulnerability Assessment. Significance was determined by frequency of the hazard and resulting damage, including deaths/injuries and property, crop and economic damage. Hazards occurring infrequently or having little to no impact on the Chatham County planning area were determined to be of low significance and not considered a priority hazard. These criteria allowed the FMPC to prioritize hazards of greatest significance and focus resources where they are most needed.

The National Oceanic and Atmospheric Administration's National Center for Environmental Information (NCEI) has been tracking various types of severe weather since 1950. Their Storm Events Database contains an archive of destructive storm or weather data and information which includes local, intense and damaging events. NCEI receives storm data from the National Weather Service (NWS). The NWS receives their information from a variety of sources, which include but are not limited to: county, state and federal emergency management officials, local law enforcement officials, SkyWarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others. This database contains 83 unique records of flood-related severe weather events that occurred in Chatham County between January 1996 and March 2017. Table 5.1 summarizes these events. These NCEI events are provided in more detail within each hazard profile. Where duplicate entries existed in the NCEI database for the same event, the impacts (damages, deaths, and injuries) have been condensed into a single line of data to simplify reporting in this plan and provide an overall count of events.

Table 5.1 – NCEI Severe Weather Reports for Chatham County, January 1996 – March 2017

Type	# of Events	Property Damage	Crop Damage	Deaths	Injuries
Coastal Flood	17	$40,000	$0	0	0
Flash Flood	36	$8,405,000	$0	0	2
Flood	2	$0	$0	0	0
Heavy Rain	3	$0	$0	0	0
Hurricane/Typhoon	4	$0	$0	0	0
Storm Surge/Tide	2	$0	$0	0	0
Tropical Storm	19	$14,500	$0	0	0
Total:	**83**	**$8,459,500**	**$0**	**0**	**2**

Source: National Center for Environmental Information Events Database, July 2017
Note: Losses reflect totals for all impacted areas for each event.

The following subsections provide profiles of the natural flood hazards that the FMPC identified in Table 4.1 Summary of Flood Hazard Evaluation.

5.1 CLIMATE CHANGE AND SEA LEVEL RISE

Hazard Description

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014). Climate change is a natural occurrence in which the earth has warmed and cooled periodically over geologic time. The recent and rapid warming of the earth over the past century has been cause for concern, as this warming is due to the accumulation of human-caused greenhouse gases, such as CO_2, in the atmosphere (IPCC, 2007). This warming is occurring almost everywhere in the world which suggests a global cause rather than changes in localized weather patterns.

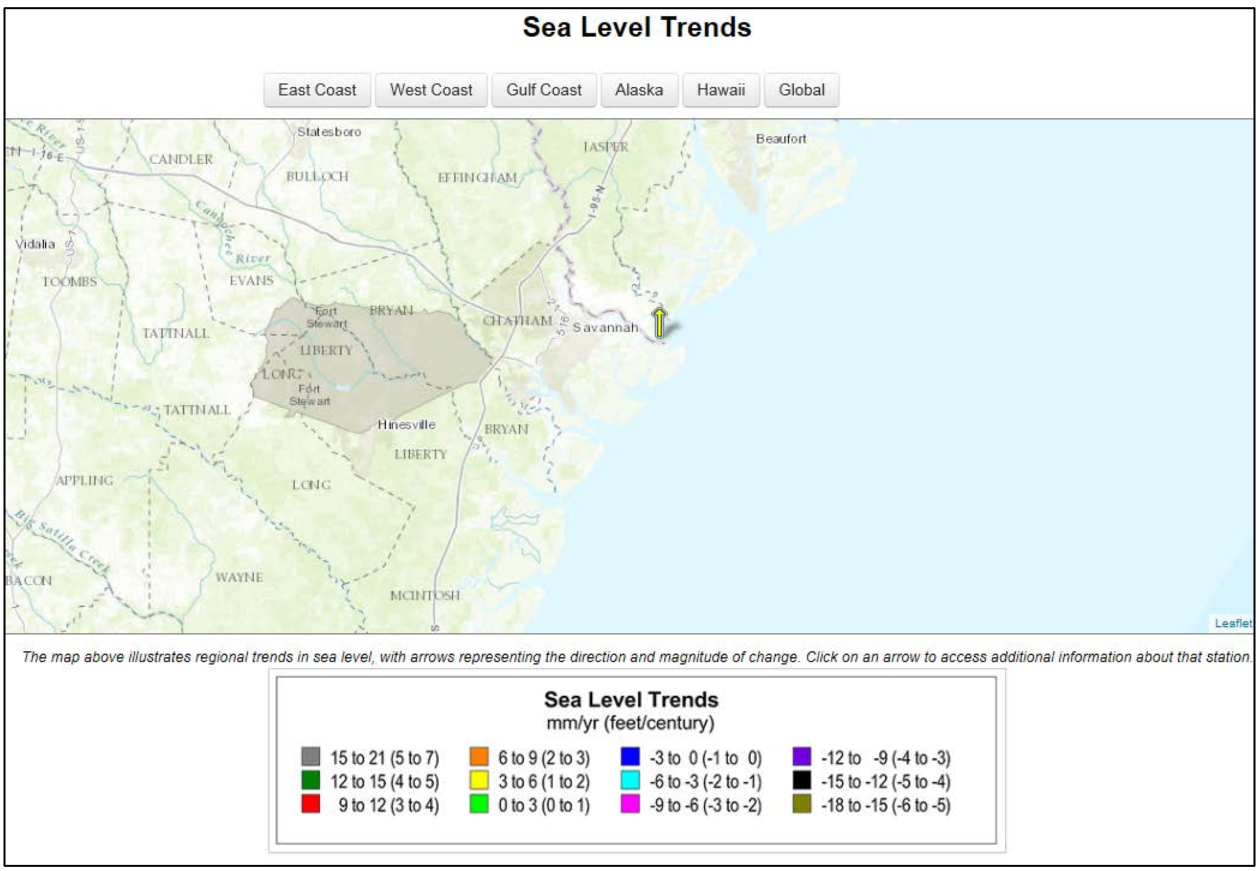
Due to sea-level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion. The population and assets projected to be exposed to coastal risks as well as human pressures on coastal ecosystems will increase significantly in the coming decades due to population growth, economic development, and urbanization (IPCC, 2014).

It can reasonably be assumed that the following climate risks could impact the Chatham County planning area: 1) increasing temperatures; 2) increasing frequency and strength of severe weather events; 3) more heavy rain/flooding; and 4) more frequent and prolonged drought. A discussion of the effect of these climate risks on the individual hazards profiled in this plan has been included in the “Probability of Future Occurrence” subsection for each flood hazard as applicable.

Past Occurrences

There are generally two separate mechanics involved in global sea level rise. The first is directly attributed to global temperature increases, which warm the oceans waters and cause them to expand. The second is attributed to the melting of ice over land which simply adds water to the oceans. Global sea level rise is likely caused by a combination of these two mechanics and can be exasperated on the local level by factors such as erosion and subsidence. The rate of sea level rise has varied throughout geologic history, and studies have shown that global temperature and sea level are strongly correlated.

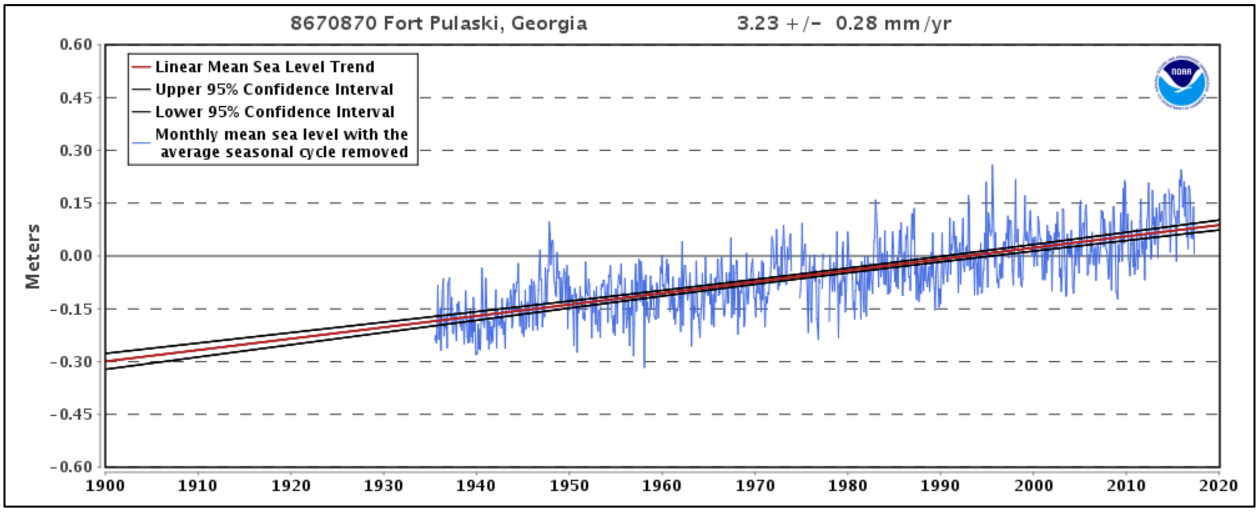
Historic trends in local MSL are best determined from tide gauge records. The Center for Operational Oceanographic Products and Services (CO-OPS) has been measuring sea level for over 150 years, with tide stations operating on all U.S. coasts. Changes in Mean Sea Level (MSL), either a sea level rise or sea level fall, have been computed at 128 long-term water level stations using a minimum span of 30 years of observations at each location. These measurements have been averaged by month to remove the effect of higher frequency phenomena (e.g. storm surge) in order to compute an accurate linear sea level trend. Figure 5.1 illustrates regional trends in sea level from NOAA. At the Fort Pulaski, GA station (indicated by the yellow arrow), the mean sea level trend is 3.23 mm/year with a 95% confidence interval of +/- 0.28 mm/year based on monthly mean sea level data from 1953 to 2015 which is equivalent to a change of 1.06 feet in 100 years.



Source: http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

Figure 5.1 – Gulf/Atlantic Coast Sea Level Trends

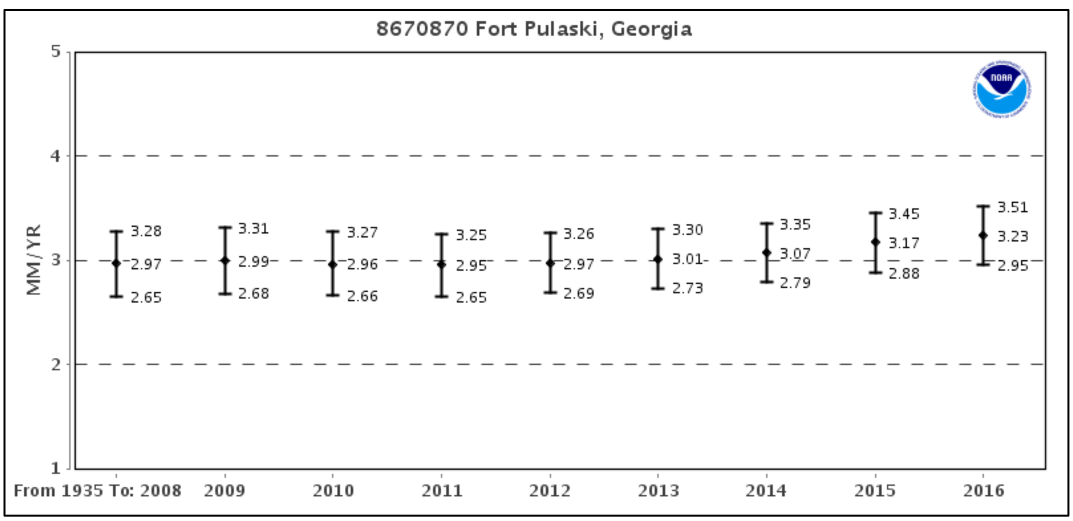
Figure 5.2 shows the monthly mean sea level at NOAA's Fort Pulaski, GA station without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents. The long-term linear trend is also shown, including its 95% confidence interval. The plotted values are relative to the most recent Mean Sea Level datum established by CO-OPS.



Source: NOAA Tides and Currents, July 2017

Figure 5.2 – Mean Sea Level Trend for Fort Pulaski, Georgia

As more data are collected at water level stations, the linear mean sea level trends can be recalculated each year. Figure 5.3 compares linear mean sea level trends and 95% confidence intervals calculated from the beginning of the Forst Pulaski, GA station record to recent years. The values do not indicate the trend in each year, but the trend of the entire data period up to that year.



Source: http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

Figure 5.3 – Previous Mean Sea Level Trends for Fort Pulaski, GA

Since 1901, the average surface temperature across the contiguous 48 states has risen at an average rate of 0.14°F per decade. Average temperatures have risen more quickly since the late 1970s (0.29 to 0.46°F per decade since 1979). Nine of the top 10 warmest years on record for the contiguous 48 states have occurred since 1998, and 2016, 2015, and 2014 have been the three warmest years on record.

Worldwide, 2016 was the warmest year on record and 2007–2016 was the warmest decade on record since thermometer-based observations began. Global average surface temperature has risen at an average rate of 0.15°F per decade since 1901, similar to the rate of warming within the contiguous 48 states. Since the late 1970s, however, the United States has warmed faster than the global rate.

Figure 5.4, based on data from NOAA and prepared by the EPA, shows how annual average air temperatures have changed in different parts of the United States since 1901.

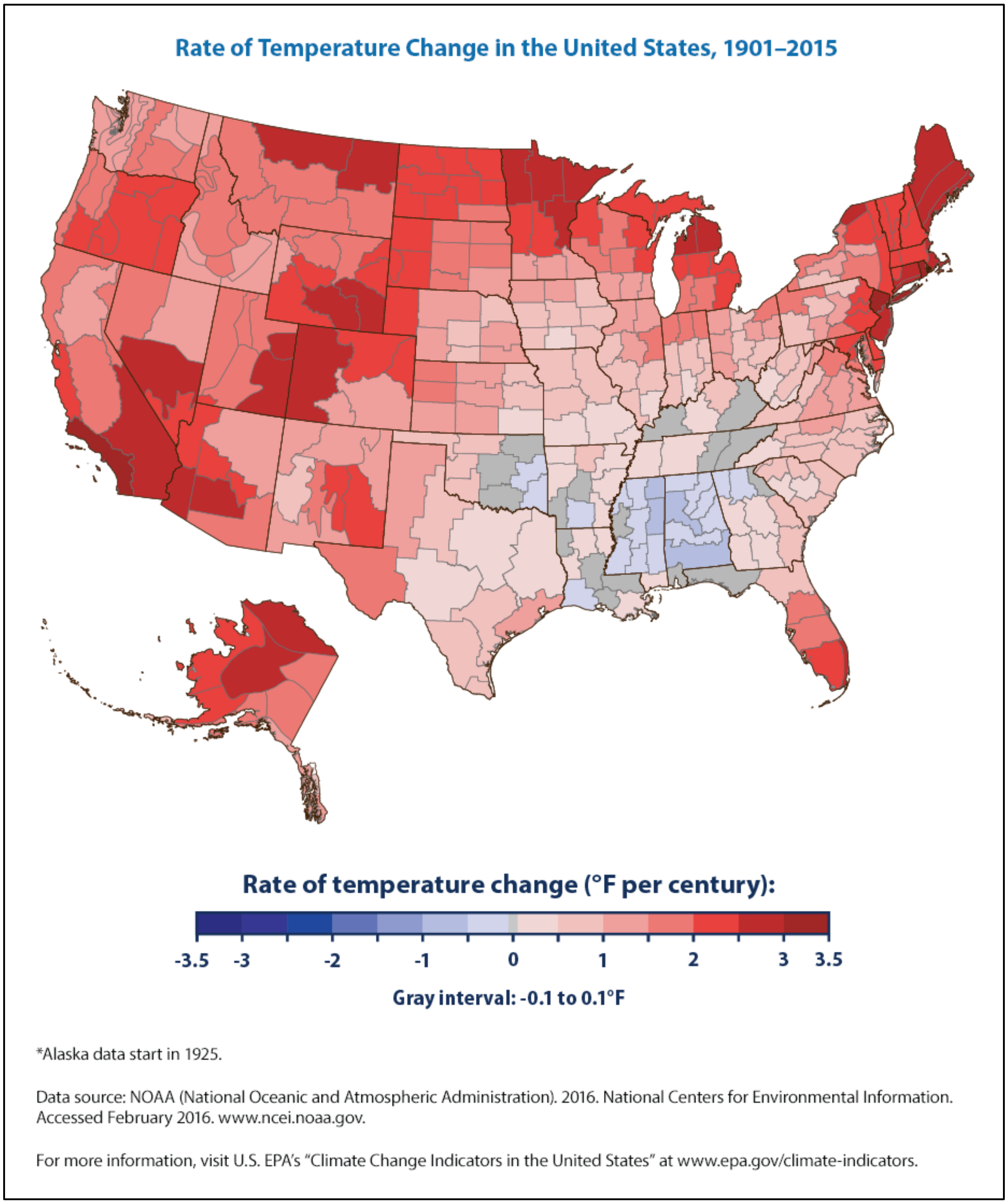


Figure 5.4 – Temperature Change in the United States, 1901-2015

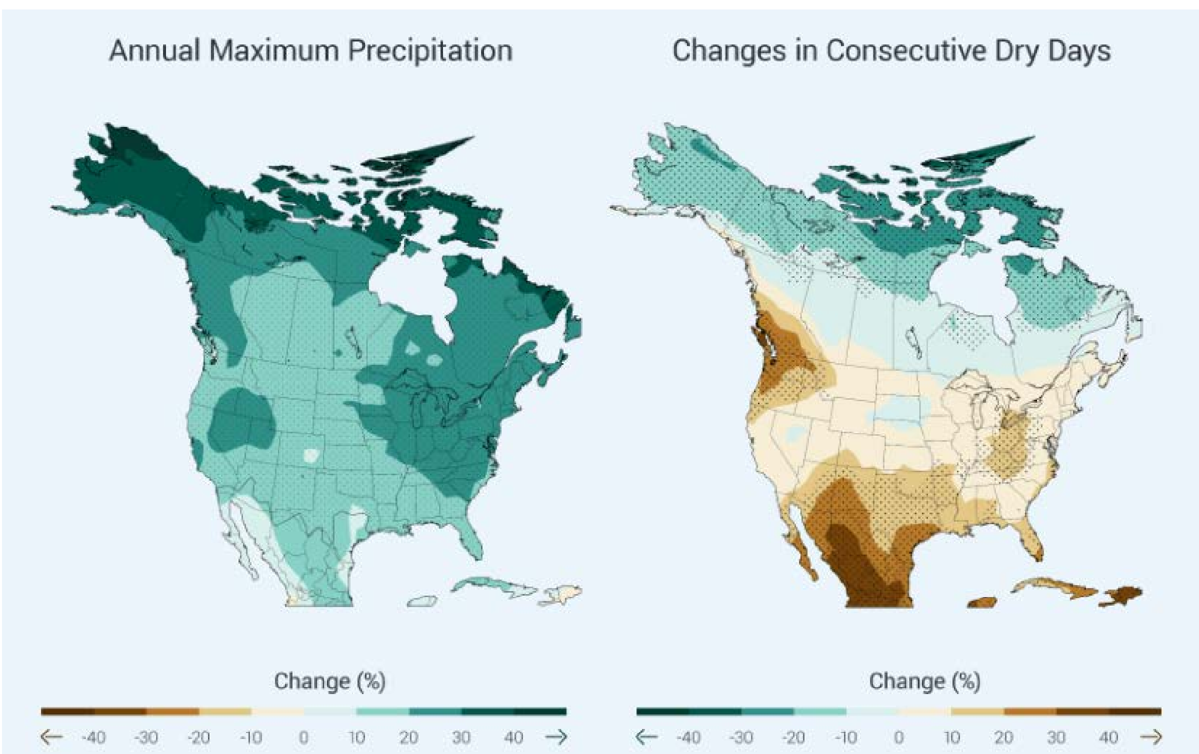
According to the 2014 National Climate Assessment, average annual precipitation in the U.S. has increased by 5% since 1900. However, there is significant regional variability in these changes. The southeastern U.S. has experienced changes in the frequency and intensity of rainfall, with a 27% increase in very heavy precipitation events. Recent increases in hurricane frequency and intensity have also been recorded as a result of increased sea surface temperature.

Probability of Future Occurrence

Highly Likely – Under current climate change models, changes in global temperatures, hydrologic cycles, and storm frequency and intensity are expected to continue. Current science projects that the southeastern United States could experience a general increase in average temperatures anywhere from 4.5°F to 9°F in the coming century (Karl et al, 111).

With continued high emissions, annual consecutive dry days are expected to increase in the southeastern U.S. in 2070-2099 compared to 1971-2000, as shown in Figure 5.55. Along with this increase in consecutive dry days, drought is also expected to increase over most of the southern U.S. Annual maximum precipitation may increase or may remain constant, but precipitation is more likely to occur in fewer overall days, meaning heavy rain events are expected to increase. However, rainfall may also increase as a result of increased hurricane activity. The overall number of hurricanes is projected to decline slightly, but the number of strong storms (Category 4 and 5) is expected to increase. Additionally, hurricane precipitation rates are expected to increase by up to 20%. The combination of higher temperatures and increased incidence of drought along with increased heavy precipitation events suggests that the likelihood of flood events may increase as a result of climate change.

Additionally, sea level rise rates are expected to continue to increase. According to tools and analysis from Climate Central, NOAA's 2017 intermediate sea level rise scenario predicts 4.1 feet of sea level rise compared to a 1992 baseline by year 2100. Similarly, the 2012-2014 National Climate Assessment intermediate scenarios range from 2.1 to 4.2 feet of sea level rise by 2100.



Source: National Climate Assessment, 2014

Figure 5.5 – Precipitation Change Projections for 2070-2099

5.2 DAM/LEVEE FAILURE

Hazard Description

Dam Failure

A dam is a barrier constructed across a watercourse that stores, controls, or diverts water. Dams are usually constructed of earth, rock, or concrete. The water impounded behind a dam is referred to as the reservoir and is measured in acre-feet. One acre-foot is the volume of water that covers one acre of land to a depth of one foot. Dams can benefit farm land, provide recreation areas, generate electrical power, and help control erosion and flooding issues.

A dam failure is the collapse or breach of a dam that causes downstream flooding. Dam failures may be caused by natural events, human-caused events, or a combination. Due to the lack of advance warning, failures resulting from natural events, such as hurricanes, earthquakes, or landslides, may be particularly severe. Prolonged rainfall and subsequent flooding is the most common cause of dam failure.

Dam failures usually occur when the spillway capacity is inadequate and water overtops the dam or when internal erosion in dam foundation occurs (also known as piping). If internal erosion or overtopping cause a full structural breach, a high-velocity, debris-laden wall of water is released and rushes downstream, damaging or destroying anything in its path. Overtopping is the primary cause of earthen dam failure in the United States.

Dam failures can result from any one or a combination of the following:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross-section of the dam and abutments, or maintain gates, valves, and other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including the failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams on the same waterway; and
- High winds, which can cause significant wave action and result in substantial erosion.

Water released by a failed dam generates tremendous energy and can cause a flood that is catastrophic to life and property. A catastrophic dam failure could challenge local response capabilities and require evacuations to save lives. Impacts to life safety will depend on the warning time and the resources available to notify and evacuate the public. Major casualties and loss of life could result, as well as water quality and health issues. Potentially catastrophic effects to roads, bridges, and homes are also of major concern. Associated water quality and health concerns could also be issues. Factors that influence the potential severity of a full or partial dam failure are the amount of water impounded; the density, type, and value of development and infrastructure located downstream; and the speed of failure.

Each state has definitions and methods to determine the Hazard Potential of a dam. In Georgia, dams are recognized by the state if they are 25 feet or more in height or impound 100 acre-feet or more. The height of a dam is from the highest point on the crest of the dam to the lowest point on the downstream toe, and the storage capacity is the volume impounded at the elevation of the highest point on the crest of the dam. A dam is regulated only if it is deemed that its failure would result in loss of human life.

Georgia Safe Dams Program engineers determine the "hazard potential" of a dam, meaning the probable damage that would occur if the structure failed, in terms of loss of human life. Dams are assigned one of two categories based on the nature of their hazard potential:

1. Category II (Low Hazard) includes dams located where failure will not cause loss of human life.
2. Category I (High Hazard) includes dams located where failure will likely cause loss of human life.

Category I dams are then further classified by their size with corresponding minimum spillway design requirements expressed in terms of probable maximum precipitation (PMP), as follows:

- Small: 25% PMP
- Medium: 33.3% PMP
- Large: 50% PMP
- Very Large: 100% PMP

Category I dams are assessed bi-annually by Georgia Environmental Protection Division staff and quarterly by their owners to ensure safety and compliance with regulations. Category II dams are reevaluated every 5 years for any hazard potential. The Safe Dams Program notes that there is a significant backlog in work which means many Category II and proposed dams throughout the state need further study

Table 5.2 provides details for four dams listed in the Georgia Safe Dams Program Inventory as of February 2017 that are located within Chatham County. None of these dams is considered a high hazard. Note that the Ottowa Farms Lake Dam is currently only proposed. In addition to these dams, the Army Corps of Engineers' National Inventory of Dams (NID) database identified two federally owned and operated dams located off stream and operated for fish and wildlife ponds, detailed in Table 5.3. Figure 5.6 on the following page reflects the location of these dams within the County.

Table 5.2 – Georgia Dam Inventory Listings for Chatham County, GA

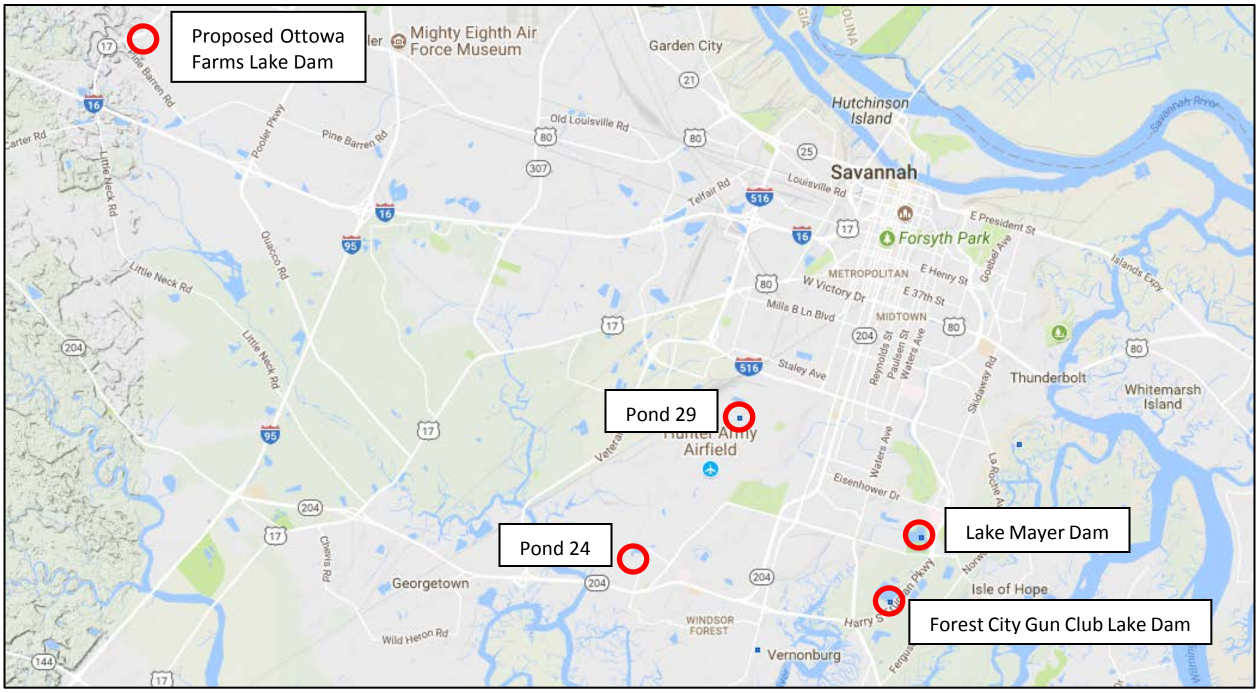
Dam Name	NIDID	Owner	Height (Ft.)	NID Storage (acre-feet)	Primary Purpose	Hazard Category
Lake Mayer Dam	GA00927	Local Government	9	382	Recreation	II
Forest City Gun Club Lake Dam	GA00928	Private	10	273	Recreation	II
Proposed Ottowa Farms Lake Dam	GA04907	Private	8.5	144	n/a	II

Source: Georgia Dam Inventory, 2017

Table 5.3 – National Inventory of Dams Additional Listings for Chatham County, GA

Dam Name	NIDID	Owner	Height (Ft.)	NID Storage (acre-feet)	Primary Purpose	Hazard Category
Pond 29	GA82309	Federal	19	71	Recreation, Fish & Wildlife Pond	n/a
Pond 24	GA82208	Federal	26	45	Recreation, Fish & Wildlife Pond	n/a

Source: National Inventory of Dams, July 2017



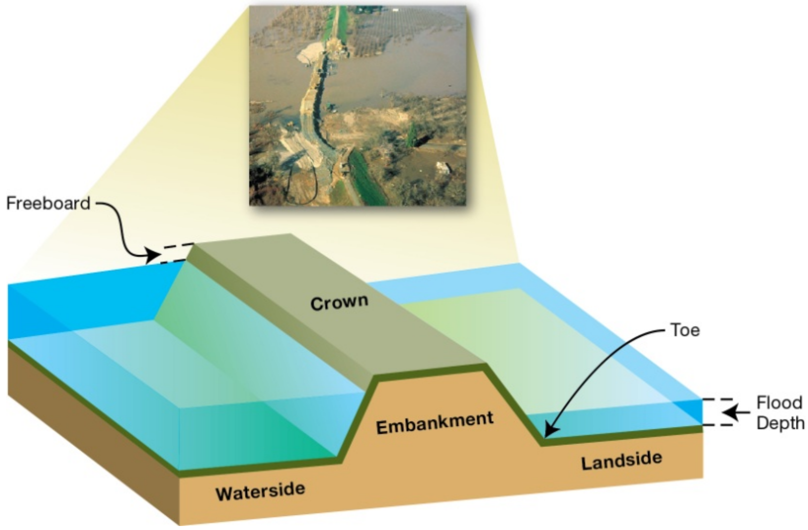
Source: National Inventory of Dams, July 2017
Note: Location of proposed dam in an approximation

Figure 5.6 – Location of Dams in Chatham County, GA

Levee Failure

FEMA defines a levee as "a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water in order to reduce the risk from temporary flooding." Levee systems consist of levees, floodwalls, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices. Levees often have "interior drainage" systems that work in conjunction with the levees to take water from the landward side to the water side. An interior drainage system may include culverts, canals, ditches, storm sewers, and/or pumps.

Levees and floodwalls are constructed from the earth, compacted soil or artificial materials, such as concrete or steel. To protect against erosion and scouring, earthen levees can be covered with grass and gravel or hard surfaces like stone, asphalt, or concrete. Levees and floodwalls are typically built parallel to a waterway, most often a river, in order to reduce the risk of flooding to the area behind it. Figure 5.7 shows the components of a typical levee.



Source: FEMA, *What is a Levee Fact Sheet*, August 2011

Figure 5.7 – Components of a Typical Levee

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events. Levees reduce, not eliminate, the risk to individuals and structures behind them. A levee system failure or overtopping can create severe flooding and high water velocities. It is important to remember that no levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

The U.S. Army Corps of Engineers National Levee Database (NLD) does not identify any levees within Chatham County.

Past Occurrences

There are no past reported dam breaches or levee failures within Chatham County.

Probability of Future Occurrence

Unlikely – There are three low hazard dams within Chatham County that could impact the County, but a flooding hazard from future dam failure is unlikely. There are no significant levees located within the County.

Climate Change and Dam Failure

Studies have been conducted to investigate the impact of climate change scenarios on dam safety. Dam failure is already tied to flooding and the increased pressure flooding places on dams. Climate change impacts on dam failure will most likely be those related to changes in precipitation and flood likelihood. Climate change projections suggest that precipitation may increase and occur in more extreme events, which may increase risk of flooding, putting stress on dams and increasing likelihood of dam failure. The safety of dams for the future climate can be based on an evaluation of changes in design floods and the freeboard available to accommodate an increase in flood levels. The results from the studies indicate that the design floods with the corresponding outflow floods and flood water levels will increase in the future, and this increase will affect the safety of the dams in the future. Studies concluded that the total hydrological failure probability of a dam will increase in the future climate and that the extent and depth of flood waters will increase by the future dam break scenario (Chernet, 2013).

5.3 FLOOD: 100-/500-YEAR

Hazard Description

Flooding is defined by the rising and overflowing of a body of water onto normally dry land. As defined by FEMA, a flood is a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties. Flooding can result from an overflow of inland waters or an unusual accumulation or runoff of surface waters from any source.

Certain health hazards are also common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where farm animals are kept or their wastes are stored can contribute polluted waters to the receiving streams.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as e.coli and other disease causing agents.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. If the County's water system loses pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and personal belongings destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

Sources and Types of Flooding

Flooding within Chatham County can be attributed to three main sources as noted below. Due to its low-lying coastal setting, flooding can occur anywhere in the County.

Coastal Tidal Flooding: All lands bordering the coast along the Atlantic Ocean and in low-lying coastal plains are susceptible to tidal effects and flooding. Coastal land such as sand bars, barrier islands and deltas provide a buffer zone to help protect human life and real property relative to the sea much as flood plains provide a buffer zone along rivers and other bodies of water. Coastal floods usually occur because of abnormally high tides or tidal waves, storm surge and heavy rains in combination with high tides, tropical storms and hurricanes. As noted in the 2014 Flood Insurance Study (FIS) report, Chatham County is particularly susceptible to coastal flooding due to its openness to Atlantic Ocean surges and unfavorable bathymetry extending offshore. Many of the large streams near the coast have wide mouths and are bordered by extensive areas of low marsh. In addition, the terrain at the coast is generally too low to provide an effective barrier, and the offshore ocean depths are shallow for great distances, generating a high Atlantic Ocean surge.

***Riverine Flooding*:** Chatham County has numerous rivers and canals running throughout its jurisdiction that are susceptible to overflowing their banks during and following excessive precipitation events. While flash flooding caused by surface water runoff is not uncommon in Chatham County, riverine flood events (such as the "100-year flood") will cause significantly more damage and economic disruption for the area. Chatham County's Effective FIRM is dated July 7, 2014.

***Flash or Rapid Flooding*:** Flash flooding is the result of heavy, localized rainfall, possibly from slow-moving intense thunderstorms that cause small streams and drainage systems to overflow. Flash flood hazards caused by surface water runoff are most common in urbanized cities, where greater population density generally equates to more impervious surface (e.g., pavement and buildings) which increases the amount of surface water generated. Flooding can occur when the capacity of the stormwater system is exceeded or if conveyance is obstructed by debris, sediment and other materials that limit the volume of drainage.

Flooding and Floodplains

In the case of riverine flooding, the area adjacent to a channel is the floodplain, as shown in Figure 5.8. A floodplain is flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. Floodplains are made when floodwaters exceed the capacity of the main channel or escape the channel by eroding its banks. When this occurs, sediments (including rocks and debris) are deposited that gradually build up over time to create the floor of the floodplain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream.

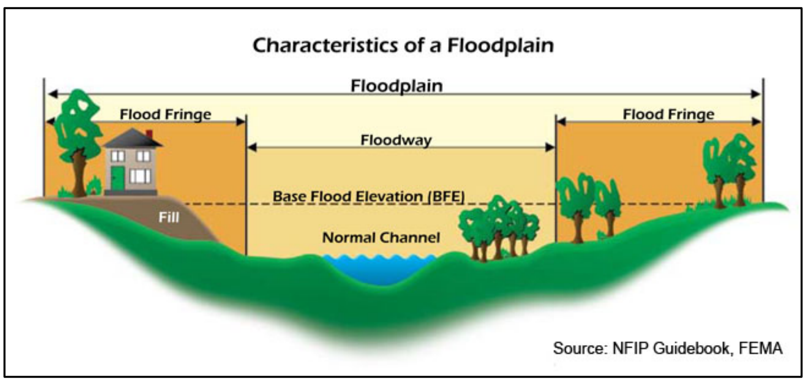
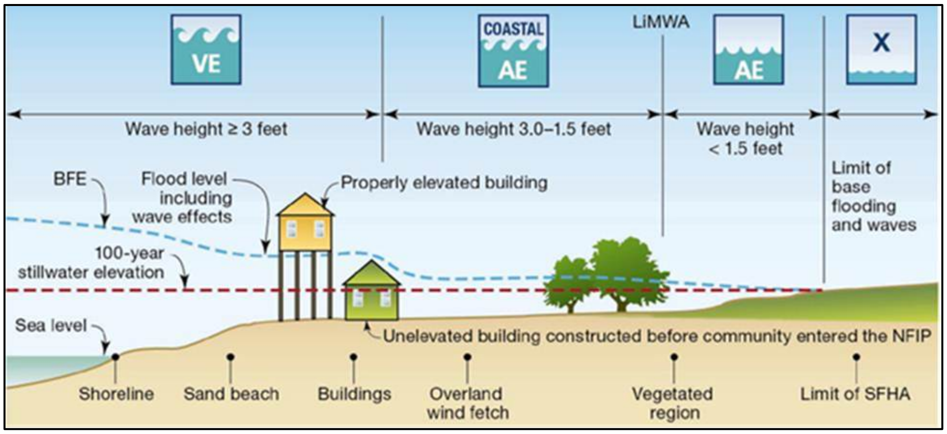


Figure 5.8 – Characteristics of a Floodplain

In coastal areas, flooding occurs due to high tides, tidal waves, storm surge, or heavy rains in combination with these other sources. In these areas, flood hazards typically include the added risk of wave action delineated by the VE Zone and Coastal AE Zone. Wave height and intensity decreases as floodwaters move inland. Figure 5.9 shows the typical coastal floodplain and the breakdown of flood zones in these settings. These flood zones are discussed further in Table 5.3.



Source: FEMA

Figure 5.9 – Characteristics of a Coastal Floodplain

In its common usage, the floodplain most often refers to that area that is inundated by the "100-year flood," which is the flood that has a 1% chance in any given year of being equaled or exceeded. The 500-year flood is the flood that has a 0.2 percent chance of being equaled or exceeded in any given year. The potential for flooding can change and increase through various land use changes and changes to land surface, which result in a change to the floodplain. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

The 100-year flood, which is the minimum standard used by most federal and state agencies, is used by the NFIP as the standard for floodplain management and to determine the need for flood insurance. Participation in the NFIP requires adoption and enforcement of a local floodplain management ordinance which is intended to prevent unsafe development in the floodplain, thereby reducing future flood damages. Participation in the NFIP allows for the federal government to make flood insurance available within the community as a financial protection against flood losses. Since floods have an annual probability of occurrence, have a known magnitude, depth and velocity for each event, and in most cases, have a map indicating where they will occur, they are in many ways often the most predictable and manageable hazard.

Regulated floodplains are illustrated on inundation maps called Flood Insurance Rate Maps (FIRMs). It is the official map for a community on which FEMA has delineated both the SFHAs and the risk premium zones applicable to the community. SFHAs represent the areas subject to inundation by the 100-year flood event. Structures located within the SFHA have a 26-percent chance of flooding during the life of a standard 30-year mortgage. Flood prone areas were identified within Chatham County using the Effective FIRMs. Table 5.3 summarizes the flood insurance zones identified by the DFIRMs.

Table 5.4 – Mapped Flood Insurance Zones within Chatham County, GA

Zone	Description
VE	Also known as the coastal high hazard areas. They are areas subject to high velocity water including waves; they are defined by the 1% annual chance (base) flood limits (also known as the 100-year flood) and wave effects 3 feet or greater. The hazard zone is mapped with base flood elevations (BFEs) that reflect the combined influence of stillwater flood elevations, primary frontal dunes, and wave effects 3 feet or greater.
AE	AE Zones, also within the 100-year flood limits, are defined with BFEs that reflect the combined influence of stillwater flood elevations and wave effects less than 3 feet. The AE Zone generally extends from the landward VE zone limit to the limits of the 100-year flood from coastal sources, or until it reaches the confluence with riverine flood sources. The AE Zones also depict the SFHA due to riverine flood sources,

Zone	Description
	but instead of being subdivided into separate zones of differing BFEs with possible wave effects added, they represent the flood profile determined by hydrologic and hydraulic investigations and have no wave effects. The Coastal AE Zone is differentiated from the AE Zone by the Limit of Moderate Wave Action (LiMWA), and includes areas susceptible to wave action between 1.5 to 3 feet.
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
0.2% Annual Chance (shaded Zone X)	Moderate risk areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by a levee. No BFEs or base flood depths are shown within these zones. (Zone X (shaded) is used on new and revised maps in place of Zone B.)
Zone X (unshaded)	Minimal risk areas outside the 1-percent and .2-percent-annual-chance floodplains. No BFEs or base flood depths are shown within these zones. Zone X (unshaded) is used on new and revised maps in place of Zone C.

Figure 5.10 reflects the effective mapped flood insurance zones for Chatham County. Approximately 76% of the County's unincorporated areas fall within the SFHA. Table 5.4 below summarizes acreage of land area and water area by flood zone on the effective and preliminary maps.

Table 5.5 – Flood Zone Acreage in Chatham County

Jurisdiction	**Flood Zone Acreage**							
	Zone A	**Zone AE**	**Zone A99**	**Zone VE**	**Open Water (100-year)**	**Zone X Shaded (500-year)**	**Zone X Unshaded**	**Total**
Unincorporated Chatham County	559.78	64,892.65	3,030.79	73,540.53	8,693.09	9,043.57	26,302.39	186,062.80

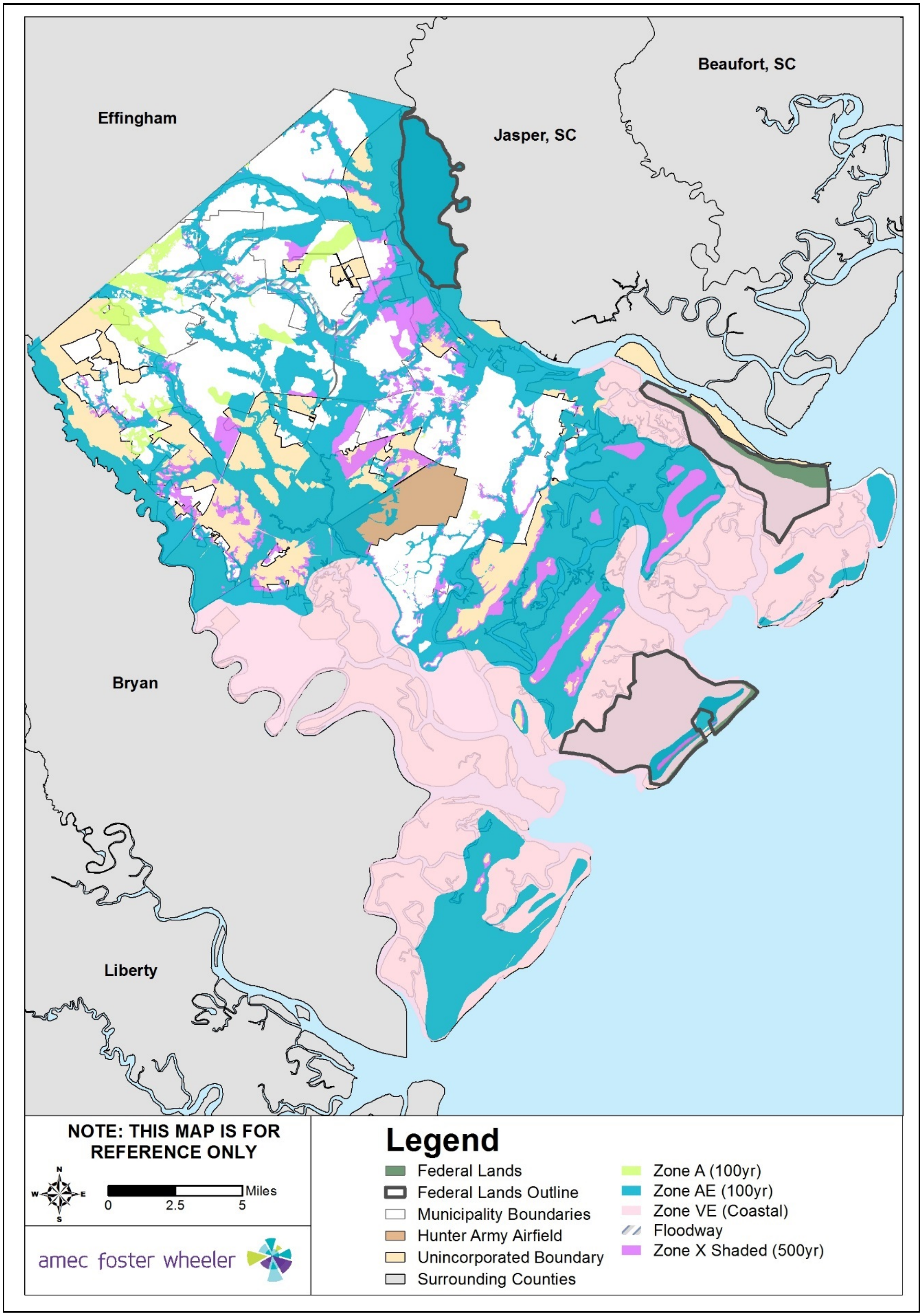


Figure 5.10 - Chatham County Effective DFIRM Flood Zones

The NFIP utilizes the 100-year flood as a basis for floodplain management. The Flood Insurance Study (FIS) defines the probability of flooding as flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 100-year period (recurrence intervals). Or considered another way, properties within a 100-year flood zone have a one percent probability of being equaled or exceeded during any given year. Mortgage lenders require that owners of properties with federally-backed mortgages located within SFHAs purchase and maintain flood insurance policies on their properties. Consequently, newer and recently purchased properties in the community are typically insured against flooding.

Past Occurrences

Table 5.5 shows detail for flood events reported by the NCEI since 1996 for Chatham County.

Table 5.6 – NCEI Flooding in Chatham County – January 1996 to March 2017

Location	Date	Event Type	Injuries /Deaths	Property Damage	Crop Damage
COASTAL CHATHAM (ZONE)	9/30/2007	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	6/22/2009	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	6/23/2009	Coastal Flood	0/0	$25,000	$0
COASTAL CHATHAM (ZONE)	1/30/2010	Coastal Flood	0/0	$15,000	$0
COASTAL CHATHAM (ZONE)	5/7/2012	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	6/5/2012	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	6/6/2012	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	8/19/2013	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	9/28/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	9/29/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	9/30/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	10/27/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	10/28/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	11/25/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	11/26/2015	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	10/17/2016	Coastal Flood	0/0	$0	$0
COASTAL CHATHAM (ZONE)	11/13/2016	Coastal Flood	0/0	$0	$0
WALTON (ZONE)	9/7/2004	Flood	0/0	$0	$0
WALTON (ZONE)	7/11/2005	Flood	0/0	$0	$0
WALTON (ZONE)	3/1/2001	Heavy Rain	0/0	$0	$0
WALTON (ZONE)	10/6/2002	Heavy Rain	0/0	$0	$0
CHATHAM CO.	6/23/2014	Heavy Rain	0/0	$0	$0
		Total	**0/0**	**$40,000**	**$0**

Source: NCEI, July 2017

The following provides details on select flood events recorded in the NCEI database. These scenarios represent the types of flood events that can be expected in the future in the Chatham County.

June 22, 2009 – Anomalously high Perigean Spring Tides resulted in significant coastal flooding along the Georgia coast. The Chatham County Emergency Manager reported numerous yards flooded in Wilmington Island and Burnside areas of the County. Highway 80 was severely flooded between Bull Street and Tybee Island. Law Enforcement reported flooding on 5th Avenue, 10th Street, 14th Street, and the intersection of 6th Street and Lewis Avenue in Savannah.

January 30, 2010 – The combination of astronomical high tides and strong easterly winds due to strong high pressure north of the region and strong low pressure to the south, resulted in coastal flooding along the Georgia coast. The Tybee Island, Georgia Police reported that Highway 80 between Savannah and Tybee Island was flooded for around 20 to 30 minutes near the time of high tide Saturday morning. One lane was closed in various sections due to salt water flooding. Two cars were stuck in the flooding and it took about an hour to remove both vehicles. Several properties on Tybee Island, mainly on 6th Street were also flooded as waters rose from nearby creeks. The Fort Pulaski tide gauge peaked at 9.95 feet mean lower low water at 8:06 am.

June 23, 2014 – A line of stationary thunderstorms produced between 4-10 inches of rain across Chatham County, which resulted in flash flooding. KSAV observed the wettest June day on record since observations began in 1871. A trained spotter measured 4.75 inches of rainfall in under two hours. The Savannah Airport ASOS measured 6.65 inches of rainfall for the day.

October 27, 2015 – A combination of persistent and strong east/northeast winds, the Perigean spring tide and a full moon produced 2 days of elevated high tide cycles along the southeast Georgia coast. Major coastal flood stage levels were recorded at the Fort Pulaski, GA (FPKG1) tide gauge on Oct 27, 2015, which claimed 3rd place on the all-time historic crest list with a high tide of 10.43 feet mean lower low water. Moderate coastal flood stage levels were also recorded at the Fort Pulaski, GA (FPKG1) tide gauge on Oct 28, 2015, which claimed 9th place on the all-time historic crest list. Roads reported closed included Highway 80 between Savannah and Tybee Island; Shipyard Road to Burnside Island; La Roche Avenue near Norwood Avenue and Raleigh Drive; Barley Drive near the Islands Expressway; the road to Elba Island; Jones Avenue, 6th Avenue, 10th Street, Chatham Avenue and Lewis Avenue in Tybee Island; Mercer Road; Whippoorwill Road and Bobwhite Road on Wilmington Island; and Catalina Boulevard leading to Spanish Hammock Island.

November 13, 2016 – A combination of astronomical and meterological influences resulted in a very high high tide cycle along the southeast Georgia coast. A full moon and the annual proxigee produced an elevated astronomical influence and elevated northeast winds further locally enhanced the tide. The result was a high tide measured at Fort Pulaski, GA that ranked in the top 10 highest on record, at 10.05 feet above Mean Lower Low Water.

Probability of Future Occurrence

Possible – By definition of the 100-year flood event, SFHAs are defined as those areas that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. Properties located in these areas have a 26 percent chance of flooding over the life of a 30-year mortgage.

Climate Change and Flooding

It is likely (66-100% probability) that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase in the 21st century across the globe. More specifically, it is "very likely" (90-100% probability) that most areas of the United States will exhibit an increase of at least 5% in the maximum 5-day precipitation by late 21st century. The mean change in the annual number of days with rainfall over 1 inch for the Southeastern United States is 0.5 to 1.5 days. As the number of heavy rain events increase, more flooding and pooling water can be expected (Romero-Lankao, et.al 2014).

5.4 FLOOD: LOCALIZED/STORMWATER FLOODING

Hazard Description

Localized stormwater flooding can also occur throughout Chatham County. Localized stormwater flooding occurs when heavy rainfall and an accumulation of runoff overburden the stormwater drainage system. The cause of localized stormwater flooding in Chatham County can be attributed to its generally flat topography, abundance of water features, and the large amount of developed and impervious land, which limits ground absorption and increases surface water runoff. A list of "Hot Spot" flooding locations is maintained by the Chatham County Public Works Department. These hot spots are divided into four areas: Westside, Georgetown, Eastside, and Islands. The identified locations are known to have issues during major rainfall events and are separate from sea level rise flooding.

The areas of localized flooding noted by the Lexington County Public Works Department are listed below in Table 5.6.

Table 5.7 – Areas of Localized Flooding

Area	Location	Street Name or Intersection	Type of Flooding
Eastside	1	Leghorn Street	Heavy rain
Eastside	2	Jacquelyn Drive at LaRoche Avenue	Heavy rain
Eastside	3	Garland Drive	Heavy rain
Eastside	4	Area around Ferguson Avenue	Heavy rain
Eastside	5	Aquatic Center parking lot	Heavy rain
Eastside	6	Marian Circle	Heavy rain
Islands	1	Ashley Road at end of cul-de-sac	Heavy rain
Islands	2	Talbot Road	Heavy rain
Islands	3	Surrey Road	Heavy rain
Islands	4	Montford Road	Heavy rain
Islands	5	Area around 1024 Wilmington Island Road	Heavy rain
Islands	6	Salisbury Circle	Heavy rain
Islands	7	Battery Circle	Heavy rain
Islands	8	Oatland Island Road at Islands Expressway	Heavy rain
Islands	9	Oemler Loop	Heavy rain
Islands	10	Pelican Drive	Heavy rain
Westside	1	Diggs Avenue	Heavy rain
Westside	2	Brandlewood Drive	Heavy rain
Westside	3	Mark Circle	Heavy rain
Westside	4	Lamarville Park Area	Heavy rain
Westside	5	Westlake Apartment Area	Heavy rain
Westside	6	Gamble Rd Lake outfall (Going under Veteran's Parkway)	Heavy rain
Westside	7	Holiday Circle at Larchmont Drive	Heavy rain
Westside	8	Quacco Rd near Regency Trailer Park	Heavy rain
Westside	9	Gulfstream Road near the canal	Heavy rain
Westside	10	Gateway Blvd at Henderson Blvd (lake outfall)	Heavy rain
Westside	11	Henderson Blvd at Brown Thrush Rd	Heavy rain
Westside	12	Osteen Road	Heavy rain
Westside	13	Bluegill Lane	Heavy rain
Georgetown	1	Red Fox Drive	Heavy rain
Georgetown	2	Dovetail Crossing	Heavy rain
Georgetown	3	East Sagebrush Lane	Heavy rain
Georgetown	4	East White Hawthorn	Heavy rain
Georgetown	5	King George Boulevard	Heavy rain

Localized flooding may be caused by the following issues:

Inadequate Capacity – An undersized/under capacity pipe system can cause water to back-up behind a structure which can lead to areas of ponded water and/or overtopping of banks.

Clogged Inlets – Debris covering the asphalt apron and the top of grate at catch basin inlets may contribute to an inadequate flow of stormwater into the system. Debris within the basin itself may also reduce the efficiency of the system by reducing the carrying capacity.

Blocked Drainage Outfalls – Debris blockage or structural damage at drainage outfalls may prevent the system from discharging runoff, which may lead to a back-up of stormwater within the system.

Improper Grade – Poorly graded asphalt around catch basin inlets may prevent stormwater from entering the catch basin as designed. Areas of settled asphalt may create low spots within the roadway that allow for areas of ponded water.

Figure 5.11 on the following page depicts the areas of localized stormwater flooding identified by the FMPC. Figure 5.12 through Figure 5.15 show localized flooding hot spots in greater detail, by area.

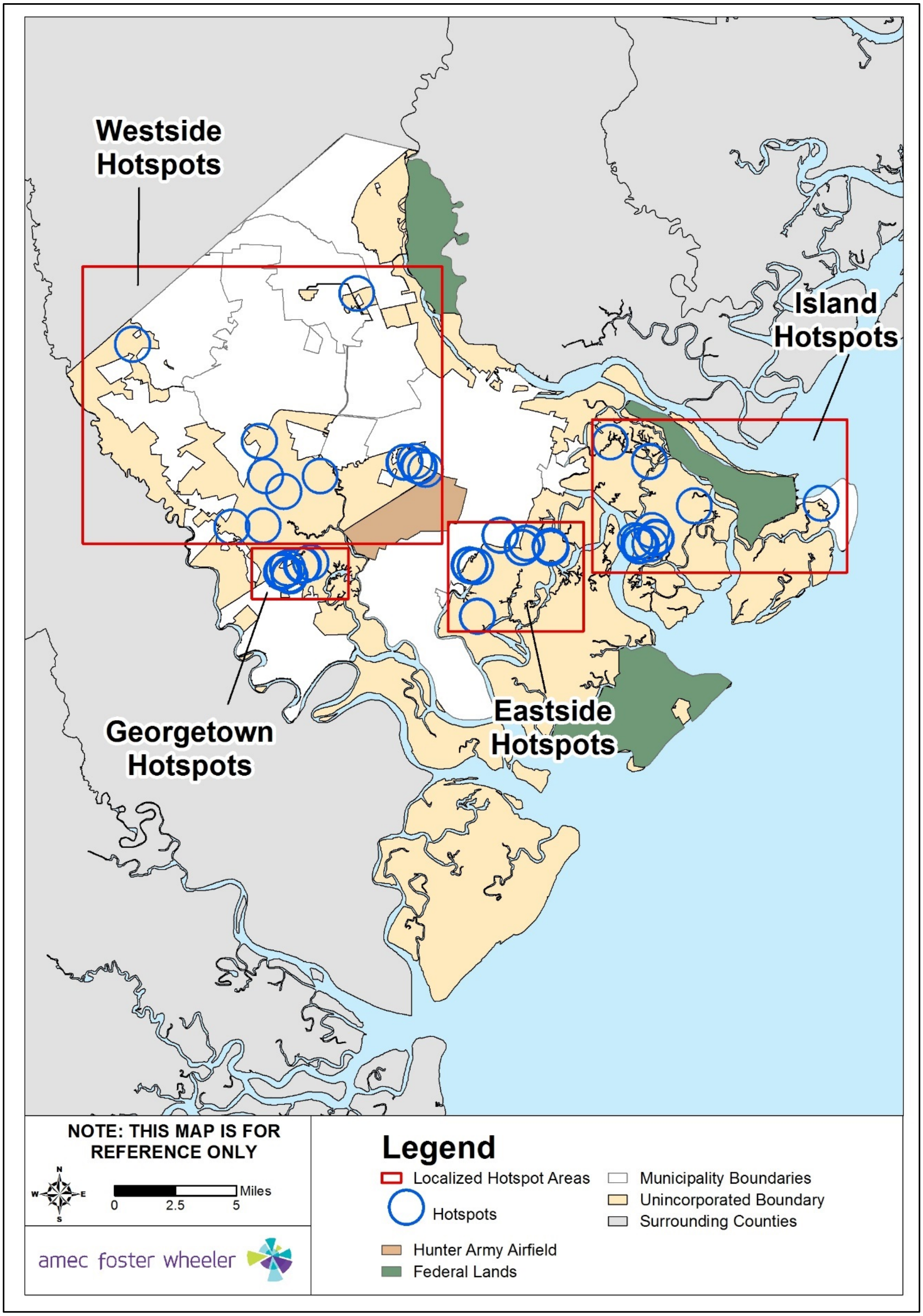
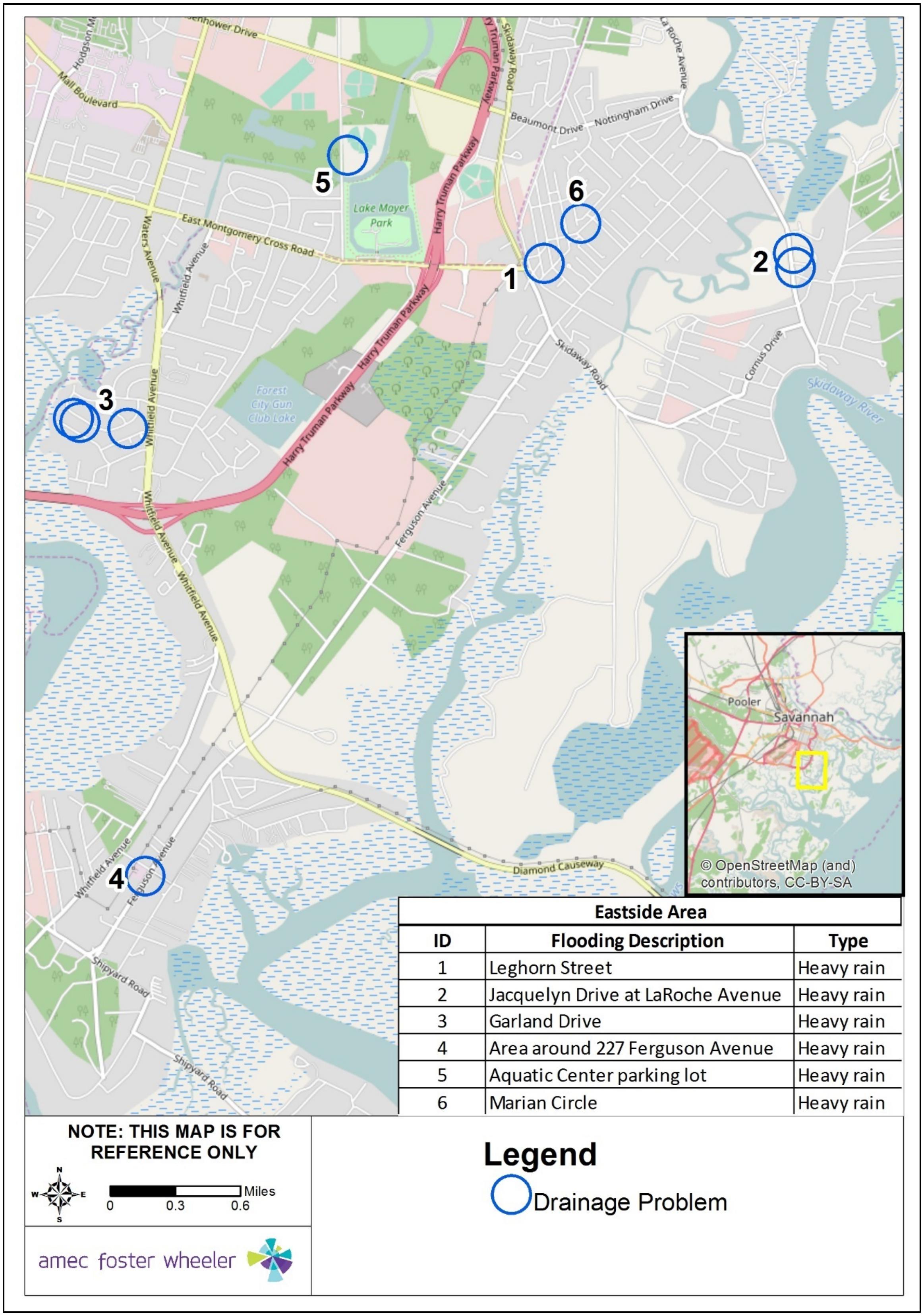


Figure 5.11 – Localized Flooding Locations Index Map

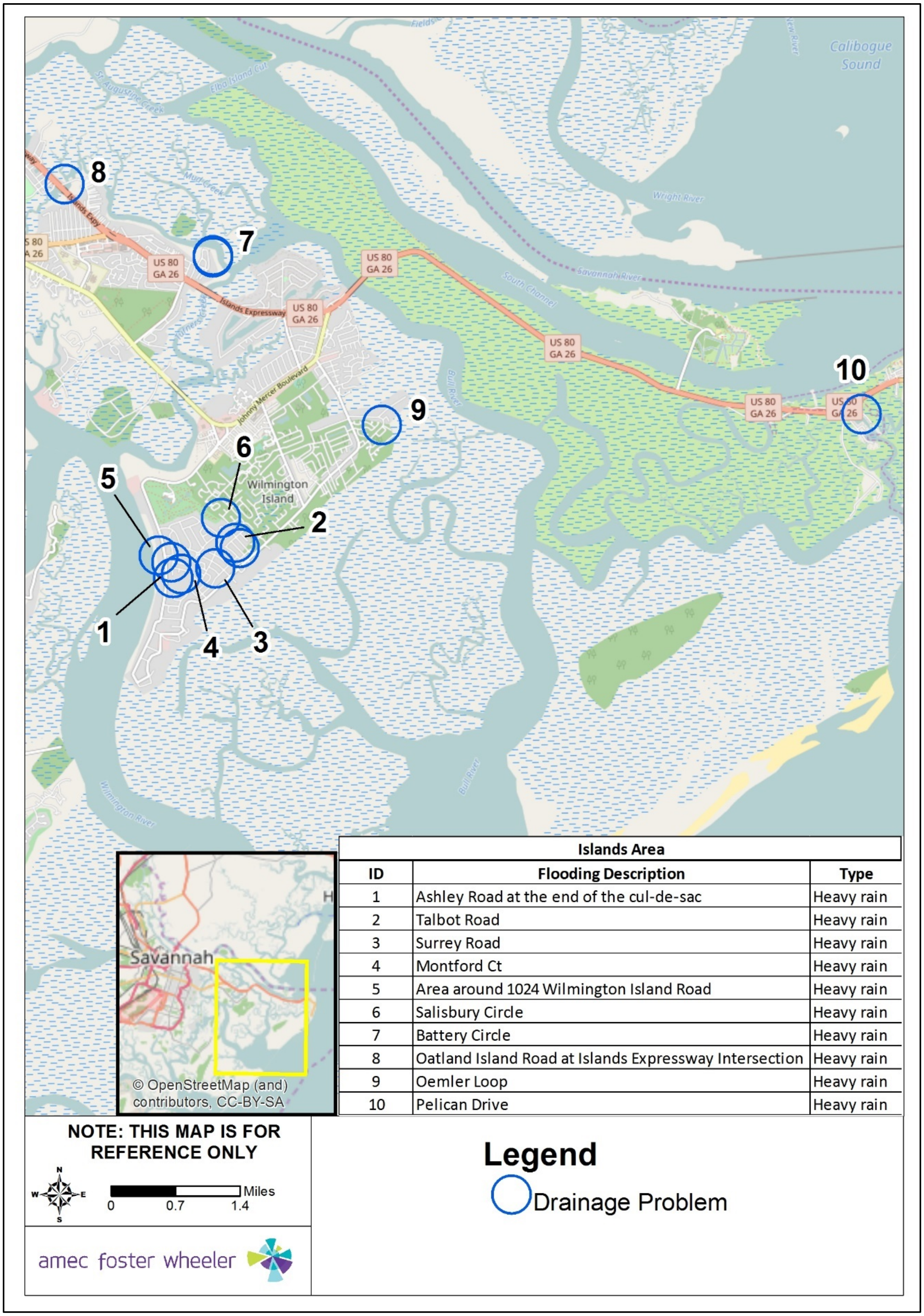


Eastside Area

ID	Flooding Description	Type
1	Leghorn Street	Heavy rain
2	Jacquelyn Drive at LaRoche Avenue	Heavy rain
3	Garland Drive	Heavy rain
4	Area around 227 Ferguson Avenue	Heavy rain
5	Aquatic Center parking lot	Heavy rain
6	Marian Circle	Heavy rain

Source: Chatham County Public Works Department, 2017

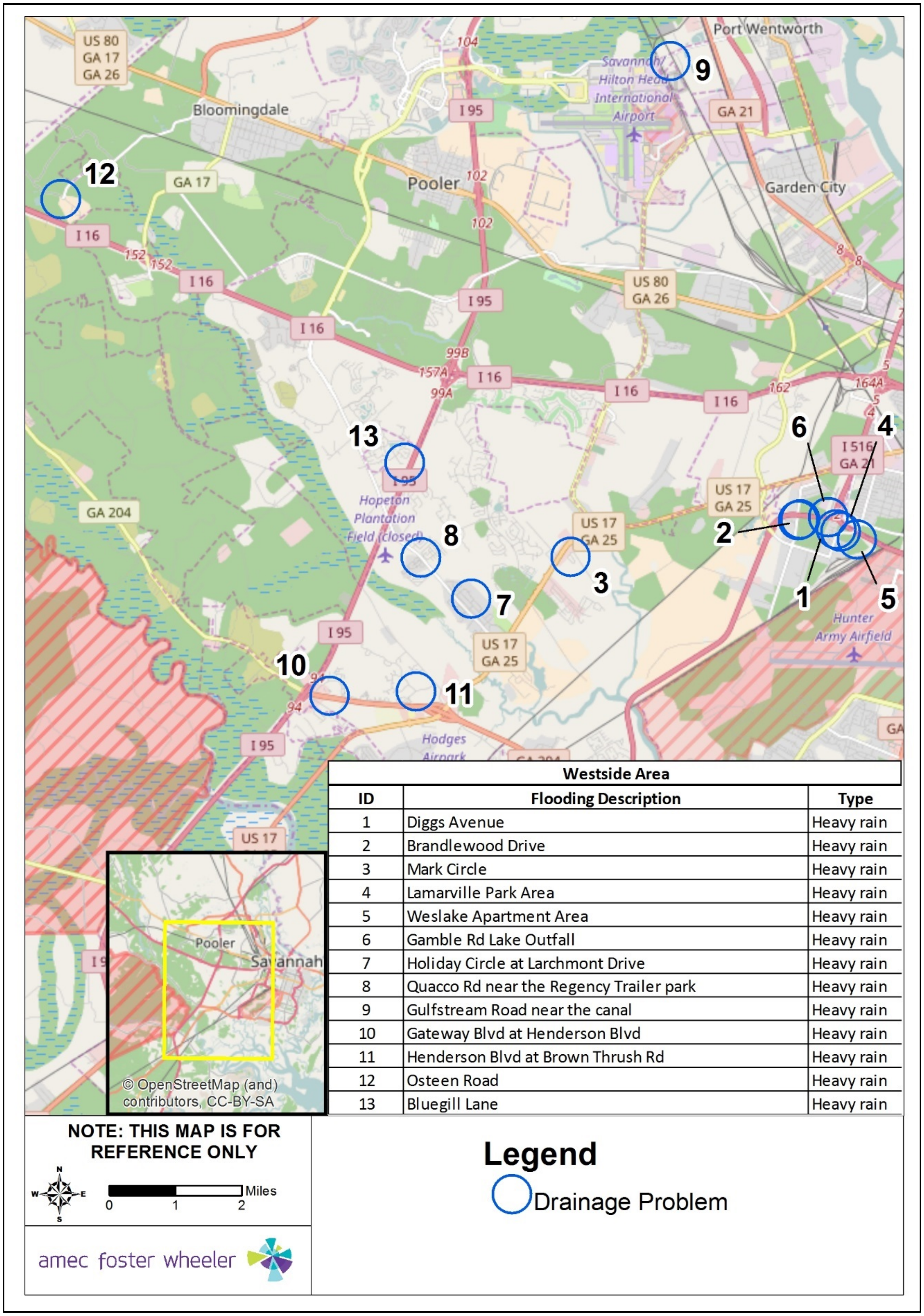
Figure 5.12 – Localized Flooding, Eastside Area



Islands Area		
ID	**Flooding Description**	**Type**
1	Ashley Road at the end of the cul-de-sac	Heavy rain
2	Talbot Road	Heavy rain
3	Surrey Road	Heavy rain
4	Montford Ct	Heavy rain
5	Area around 1024 Wilmington Island Road	Heavy rain
6	Salisbury Circle	Heavy rain
7	Battery Circle	Heavy rain
8	Oatland Island Road at Islands Expressway Intersection	Heavy rain
9	Oemler Loop	Heavy rain
10	Pelican Drive	Heavy rain

Source: Chatham County Public Works Department, 2017

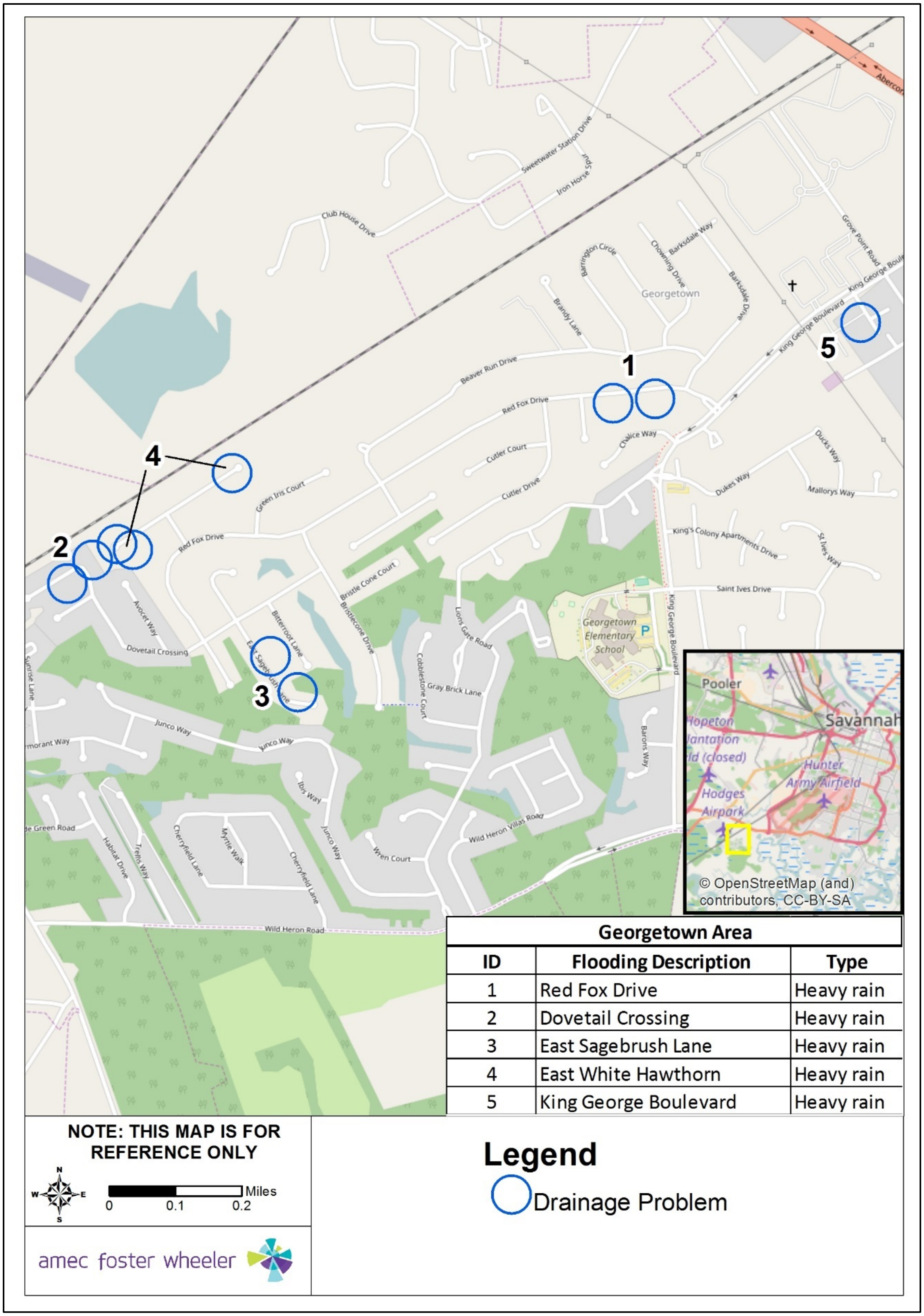
Figure 5.13 – Localized Flooding, Islands Area



Westside Area		
ID	Flooding Description	Type
1	Diggs Avenue	Heavy rain
2	Brandlewood Drive	Heavy rain
3	Mark Circle	Heavy rain
4	Lamarville Park Area	Heavy rain
5	Weslake Apartment Area	Heavy rain
6	Gamble Rd Lake Outfall	Heavy rain
7	Holiday Circle at Larchmont Drive	Heavy rain
8	Quacco Rd near the Regency Trailer park	Heavy rain
9	Gulfstream Road near the canal	Heavy rain
10	Gateway Blvd at Henderson Blvd	Heavy rain
11	Henderson Blvd at Brown Thrush Rd	Heavy rain
12	Osteen Road	Heavy rain
13	Bluegill Lane	Heavy rain

Source: Chatham County Public Works Department, 2017

Figure 5.14 – Localized Flooding, Westside Area



Georgetown Area		
ID	**Flooding Description**	**Type**
1	Red Fox Drive	Heavy rain
2	Dovetail Crossing	Heavy rain
3	East Sagebrush Lane	Heavy rain
4	East White Hawthorn	Heavy rain
5	King George Boulevard	Heavy rain

Source: Chatham County Public Works Department, 2017

Figure 5.15 – Localized Flooding, Georgetown Area

Past Occurrences

Table 5.7 shows detail for flash flood events reported by the NCEI since 1996 for Chatham County.

Table 5.8 – NCEI Flash Flooding in Chatham County – January 1996 to March 2017

Location	Date	Event Type	Injuries /Deaths	Property Damage	Crop Damage
SAVANNAH	7/5/1996	Flash Flood	0/2	1,000,000	$0
SAVANNAH	8/7/1996	Flash Flood	0/0	75,000	$0
EAST PORTION	1/23/1998	Flash Flood	0/0	$0	$0
EAST PORTION	6/29/1999	Flash Flood	0/0	7,000,000	$0
SAVANNAH	10/11/2002	Flash Flood	0/0	$0	$0
SAVANNAH	4/7/2003	Flash Flood	0/0	$0	$0
SAVANNAH	4/8/2003	Flash Flood	0/0	$0	$0
SAVANNAH	4/8/2003	Flash Flood	0/0	$0	$0
SAVANNAH	7/24/2003	Flash Flood	0/0	$0	$0
SAVANNAH	8/12/2004	Flash Flood	0/0	$0	$0
SAVANNAH	10/5/2005	Flash Flood	0/0	$0	$0
SAVANNAH	7/6/2006	Flash Flood	0/0	10,000	$0
SAVANNAH	7/30/2007	Flash Flood	0/0	8,000	$0
SAVANNAH	9/1/2007	Flash Flood	0/0	$0	$0
CENTRAL JCT	9/13/2007	Flash Flood	0/0	$0	$0
CENTRAL JCT	9/21/2007	Flash Flood	0/0	$0	$0
SAVANNAH	12/21/2007	Flash Flood	0/0	$11,000	$0
CENTRAL JCT	7/27/2008	Flash Flood	0/0	$0	$0
MEINHARD	10/24/2008	Flash Flood	0/0	$0	$0
SAVANNAH	7/27/2009	Flash Flood	0/0	10,000	$0
CENTRAL JCT	8/3/2009	Flash Flood	0/0	5,000	$0
GARDEN CITY	8/3/2009	Flash Flood	0/0	150,000	$0
SAVANNAH	8/12/2009	Flash Flood	0/0	$0	$0
SAVANNAH	6/27/2010	Flash Flood	0/0	$0	$0
VERNONBURG	8/20/2010	Flash Flood	0/0	$0	$0
CENTRAL JCT	6/29/2011	Flash Flood	0/0	$0	$0
THUNDERBOLT	7/14/2011	Flash Flood	0/0	10,000	$0
SAVANNAH	8/6/2011	Flash Flood	0/0	$0	$0
SAVANNAH	7/12/2013	Flash Flood	0/0	11,000	$0
OLEARY	7/13/2013	Flash Flood	0/0	$30,000	$0
SAVANNAH	7/31/2013	Flash Flood	0/0	$30,000	$0
CENTRAL JCT	8/16/2013	Flash Flood	0/0	20,000	$0
BONA BELLA	6/23/2014	Flash Flood	0/0	15,000	$0
CENTRAL JCT	8/10/2014	Flash Flood	0/0	$0	$0
LIBERTY CITY	7/17/2016	Flash Flood	0/0	$20,000	$0
WILLIAMS	10/7/2016	Flash Flood	0/0	$0	$0
		Total	**0/2**	**$8,405,000**	**$0**

Source: NCEI, July 2017

The following provides details on select flood events recorded in the NCEI database. These scenarios represent the types of flood events that can be expected in the future in the Chatham County.

July 5, 1996 – Eight to ten inches of rain fell in 3-4 hours in and around Savannah. As a result, 50 streets and 100 homes were flooded to various degrees. Numerous businesses had water several inches deep.

There were 31,000 residents without power for several hours. This event also occurred close to high tide. Some streets had water up to headlights on cars while some homes had water almost knee deep.

June 29, 1999 – Slow moving showers and thunderstorms developed repeatedly across Chatham County and Effingham County during the day. Twenty-four-hour rainfall amounts ranged from about 7 inches to over 13 inches. As a result of the flooding, over 500 homes and businesses were damaged to varying degrees and almost 600 automobiles were damaged. Water was as deep as 6 ft in some places. Numerous roads were washed out and/or closed during the flooding. Estimated dollar damage for public property was 4.5 million dollars and at least another 2.5 million dollars for private property.

October 11, 2002 – Tropical Storm Kyle dumped 3 to 5 inches of rain in the Savannah area within a 12-hour period. This very heavy rainfall caused flooding of roads, low lying areas and places with poor drainage. Numerous cars stalled and roads were closed as the flooding began to endanger lives.

July 24, 2003 – Thunderstorms dumped an estimated 4 to 6 inches of rain around high tide causing flooding in downtown Savannah. Numerous streets and underpasses were closed due to flooding. Four people were rescued from their cars after driving into water that caused cars to stall.

July 30, 2007 – Numerous road closures were reported in Downtown Savannah as a result of heavy rain from showers and thunderstorms across the region. High water was reported entering some apartments. Cars were floating down the roadway at 65th and Abercorn Street.

August 3, 2009 – Showers and thunderstorms brought heavy rainfall to southeast Georgia. The Chatham County Emergency Management Agency reported flooding of the following roadways or intersections in Savannah, Georgia, East Broad and Gwinnett, the 500 Block of River, 37th Street and Burroughs, Gwinnett and West Boundary, Legrand and 33rd Street, Drayton and 35th-36th Streets, Abercorn and Duffy, East Broad and Anderson, the 700 Block of East Henry, Bay and East Broad, Randolph and General McIntosh, President and General McIntosh, Martin Luther King Jr. and Hall, the 800 Block of Anderson, and East Broad and Henry.

June 23, 2014 – A line of stationary thunderstorms produced between 4-10 inches of rain across Chatham County, which resulted in flash flooding. KSAV observed the wettest June day on record since observations began in 1871. A trained spotter measured 4.75 inches of rainfall in under two hours. The Savannah Airport ASOS measured 6.65 inches of rainfall for the day. Flood waters also washed out a section of the CSX rail line near Highway 307 and Gulf Stream Road. Total costs were generally estimated to be around 15.0K.

Probability of Future Occurrence

Highly Likely – Given the 36 flash flood events recorded in NCEI over a 20-year period, there is a 100 percent chance of occurrence within the next year. Precipitation resulting from heavy rainstorms, including tropical storms and hurricanes, makes it highly likely that unmitigated properties will continue to experience localized flooding.

5.5 HURRICANE AND TROPICAL STORM

Hazard Description

A hurricane is a type of tropical cyclone or severe tropical storm that forms in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and in the eastern Pacific Ocean. All Atlantic and Gulf of Mexico coastal areas are subject to hurricanes. The Atlantic hurricane season lasts from June to November, with the peak season from mid-August to late October.

While hurricanes pose the greatest threat to life and property, tropical storms and depressions also can be devastating. A tropical disturbance can grow to a more intense stage through an increase in sustained wind speeds. The progression of a tropical disturbance is described below.

- **Tropical Depression:** A tropical cyclone with maximum sustained winds of 38 mph (33 knots) or less.
- **Tropical Storm:** A tropical cyclone with maximum sustained winds of 39 to 73 mph (34 to 63 knots).
- **Hurricane:** A tropical cyclone with maximum sustained winds of 74 mph (64 knots) or higher. In the western North Pacific, hurricanes are called typhoons; similar storms in the Indian Ocean and South Pacific Ocean are called cyclones.
- **Major Hurricane:** A tropical cyclone with maximum sustained winds of 111 mph (96 knots) or higher, corresponding to a Category 3, 4 or 5 on the Saffir-Simpson Hurricane Wind Scale.

The Saffir-Simpson Hurricane Wind Scale classifies hurricanes by intensity into one of five categories as shown in Table 5.9. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures.

Table 5.9 – Saffir-Simpson Hurricane Wind Scale, 2012

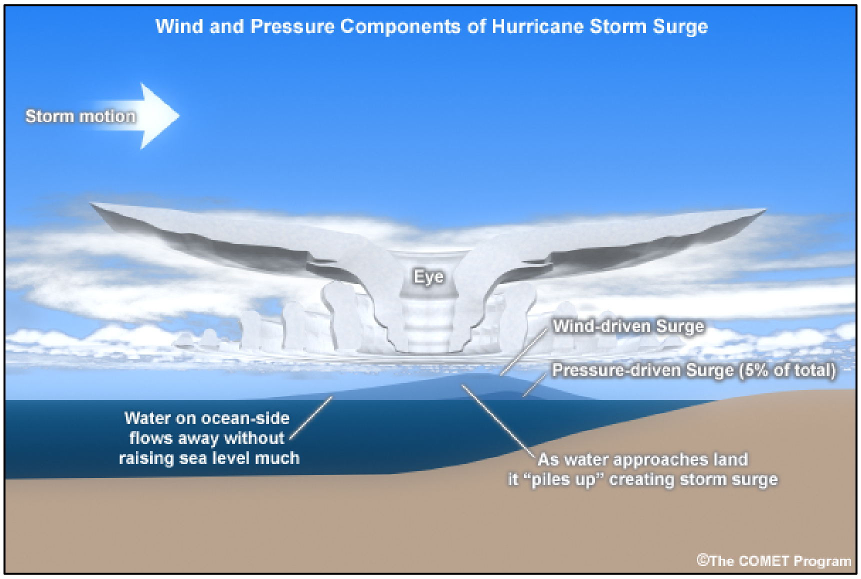
Category	Wind Speed (mph)	Potential Damage
1	74-95	**Very dangerous winds will produce some damage**: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-129	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	$\geq$ 157	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center/NOAA

Storm Surge

The greatest potential for loss of life related to a hurricane is from the storm surge. Storm surge is water that is pushed toward the shore by the force of the winds swirling around the storm as shown in Figure 5.16. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level to heights impacting roads, homes and other critical infrastructure. In addition, wind driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides.

The maximum potential storm surge for a location depends on several different factors. Storm surge is a very complex phenomenon because it is sensitive to the slightest changes in storm intensity, forward speed, size (radius of maximum winds-RMW), angle of approach to the coast, central pressure (minimal contribution in comparison to the wind), and the shape and characteristics of coastal features such as bays and estuaries. Other factors which can impact storm surge are the width and slope of the continental shelf. A shallow slope, as is found off the coast of Chatham County, will produce a greater storm surge than a steep shelf.



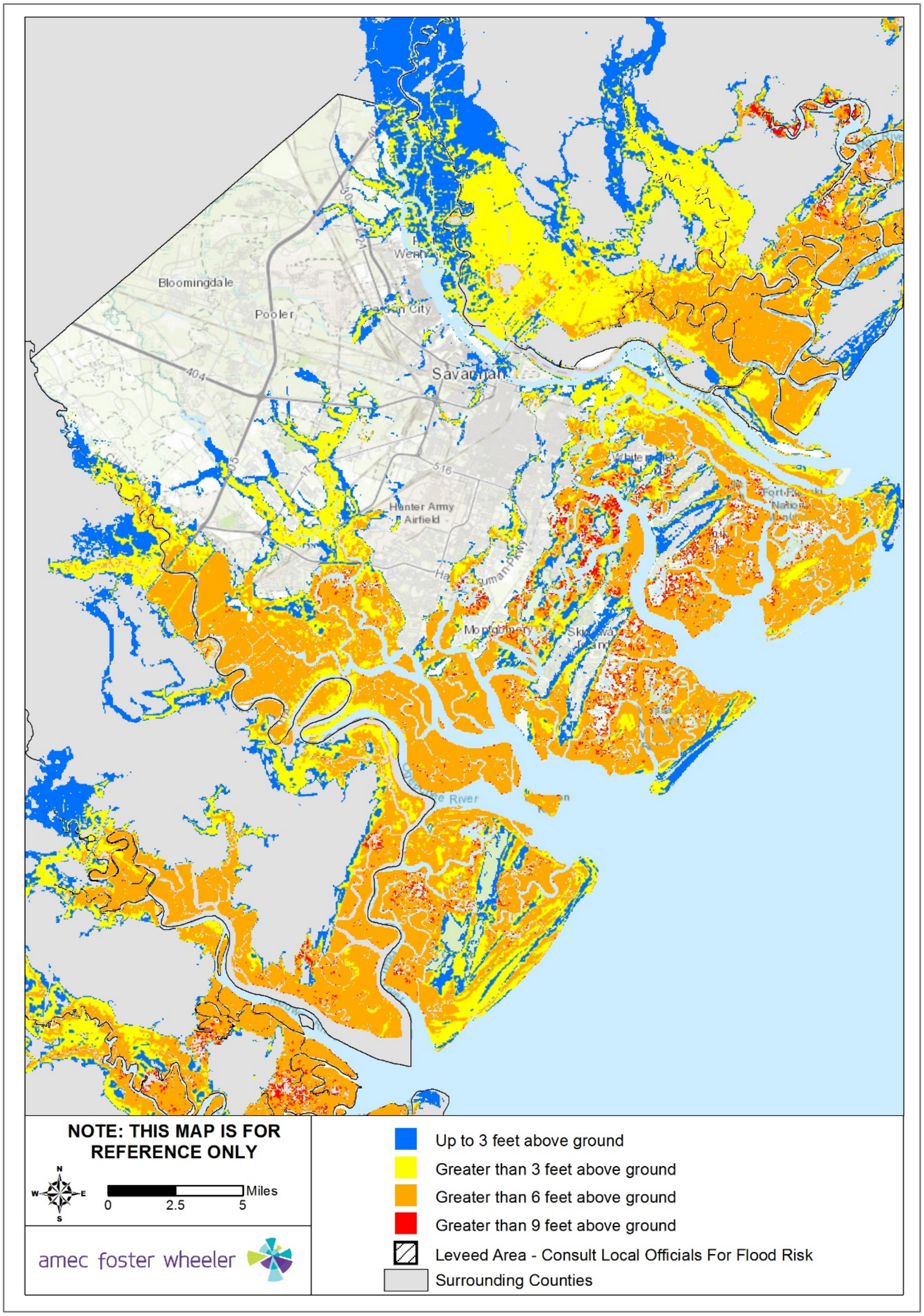
Source: NOAA/The COMET Program

Figure 5.16 – Components of Hurricane Storm Surge

Storm Surge Mapping

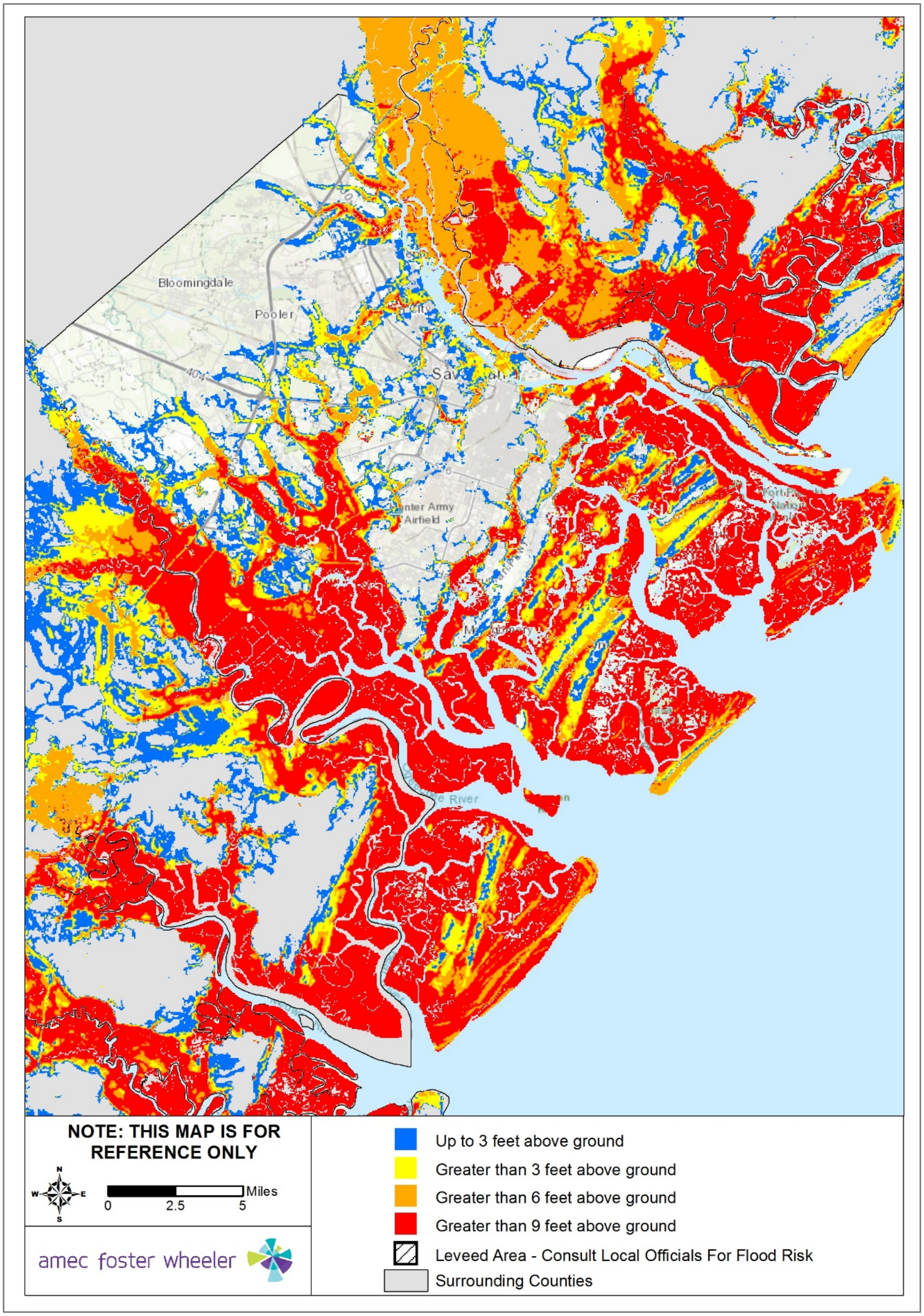
The Sea, Lake and Overland Surges from Hurricanes (SLOSH) model is a computerized numerical model developed by the National Weather Service to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees and other physical features. The model creates outputs for all different storm simulations from all points of the compass. Each direction has a MEOW (maximum envelope of water) for each category of storm (1-5), and all directions combined result in a MOMs (maximum of maximums) set of data.

Anticipated SLOSH model surge elevations for Category 1 – Category 5 hurricanes are shown for Chatham County in Figure 5.17 through Figure 5.21 on the following pages. Given Chatham County's coastal location and low elevation, it is extremely vulnerable to storm surge flooding. Even a Category 1 storm surge has the potential to cause significant damage to the County.



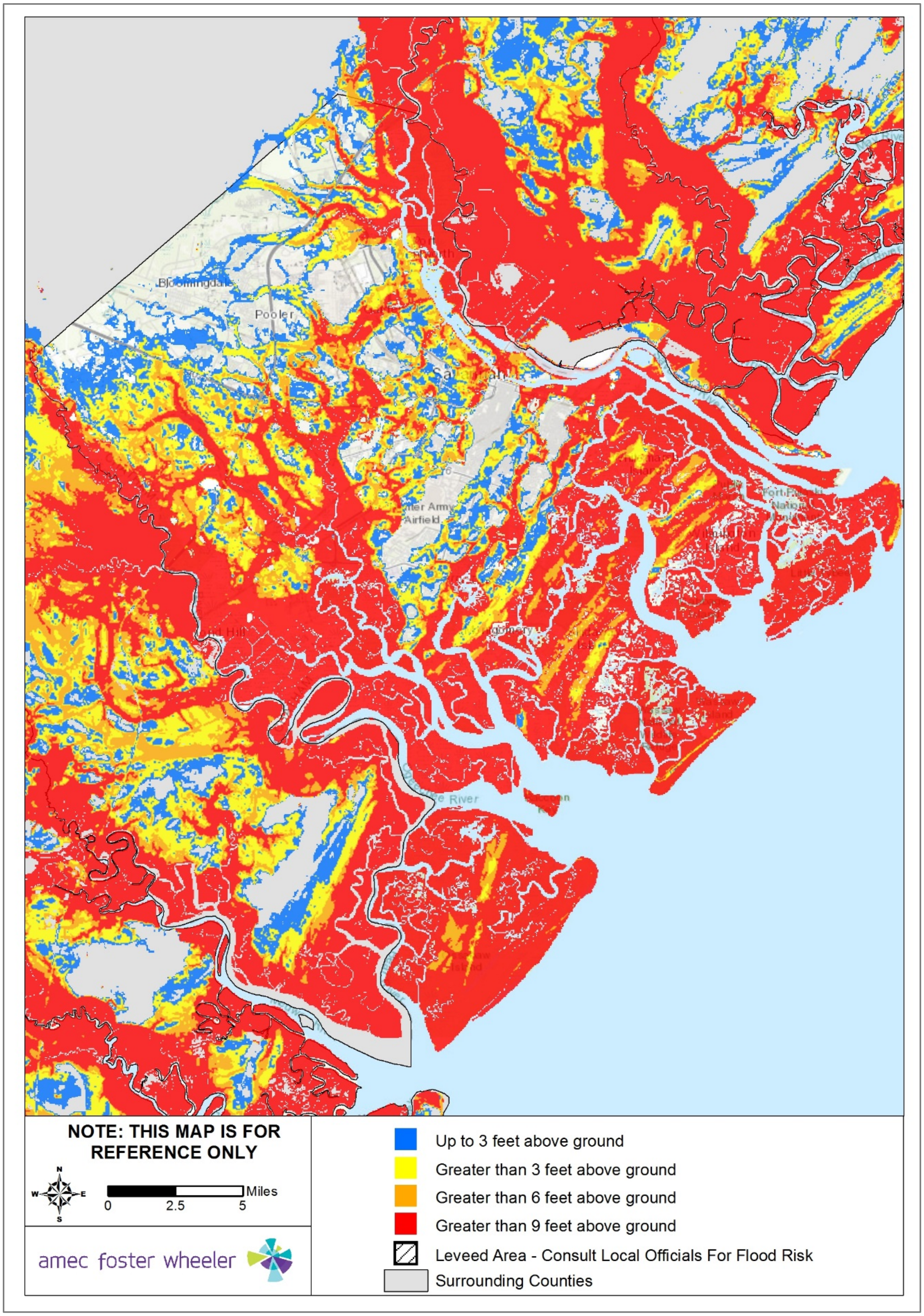
Source: NOAA/NWS/NHC Storm Surge Unit

Figure 5.17 – SLOSH Storm Surge Model for a Category 1 Storm



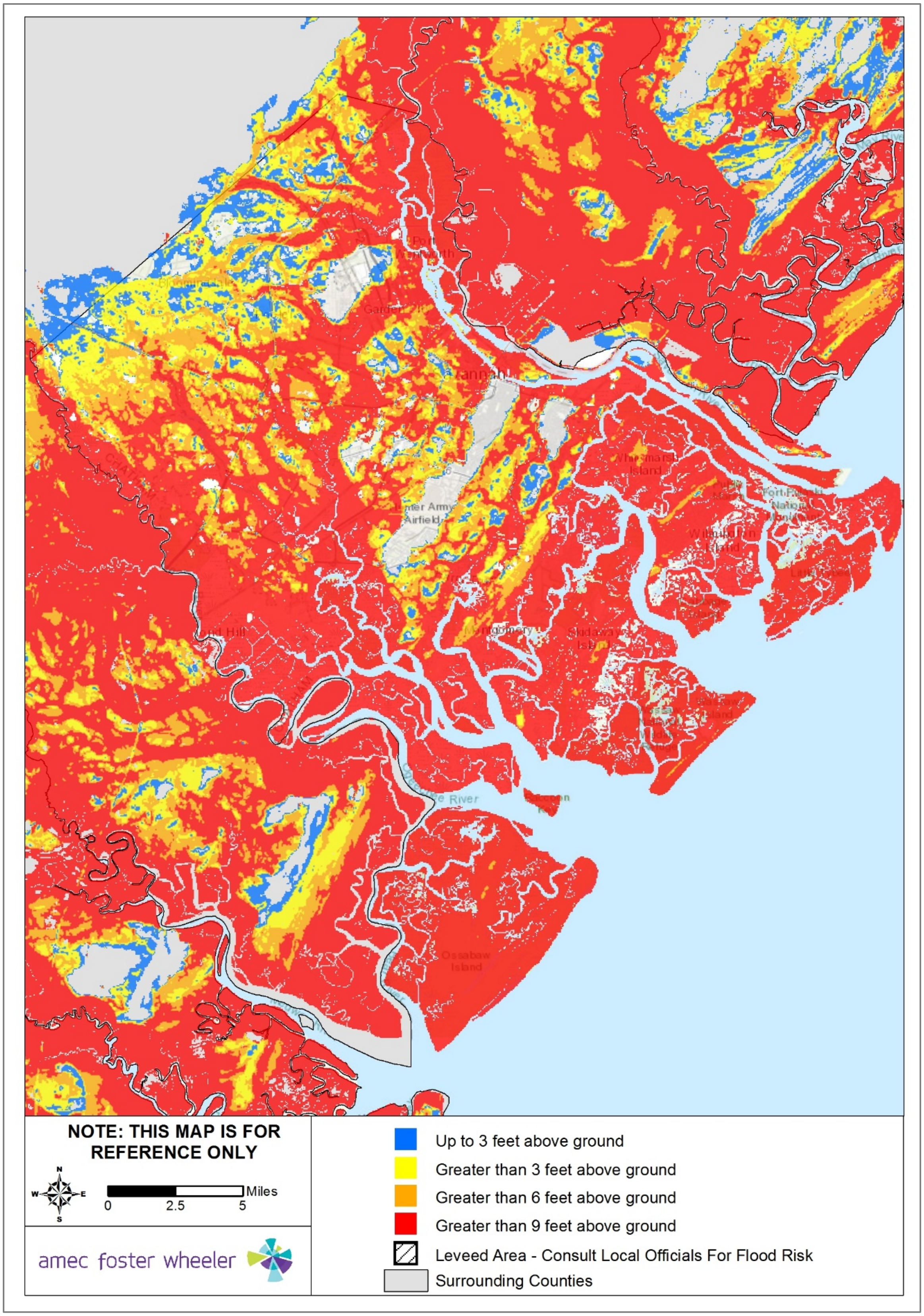
Source: NOAA/NWS/NHC Storm Surge Unit

Figure 5.18 – SLOSH Storm Surge Model for a Category 2 Storm



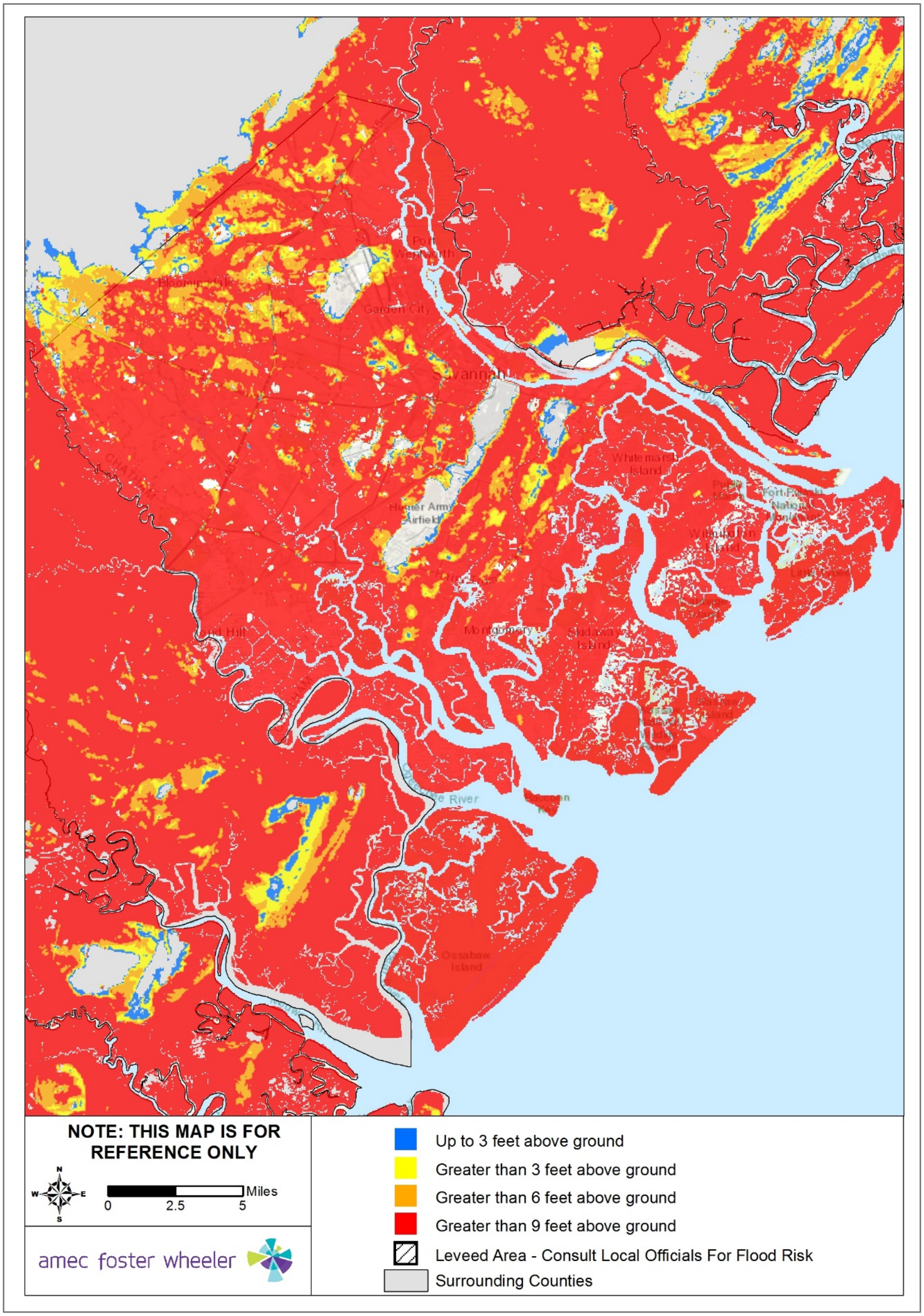
Source: NOAA/NWS/NHC Storm Surge Unit

Figure 5.19 – SLOSH Storm Surge Model for a Category 3 Storm



Source: NOAA/NWS/NHC Storm Surge Unit

Figure 5.20 – SLOSH Storm Surge Model for a Category 4 Storm



Source: NOAA/NWS/NHC Storm Surge Unit

Figure 5.21 – SLOSH Storm Surge Model for a Category 5 Storm

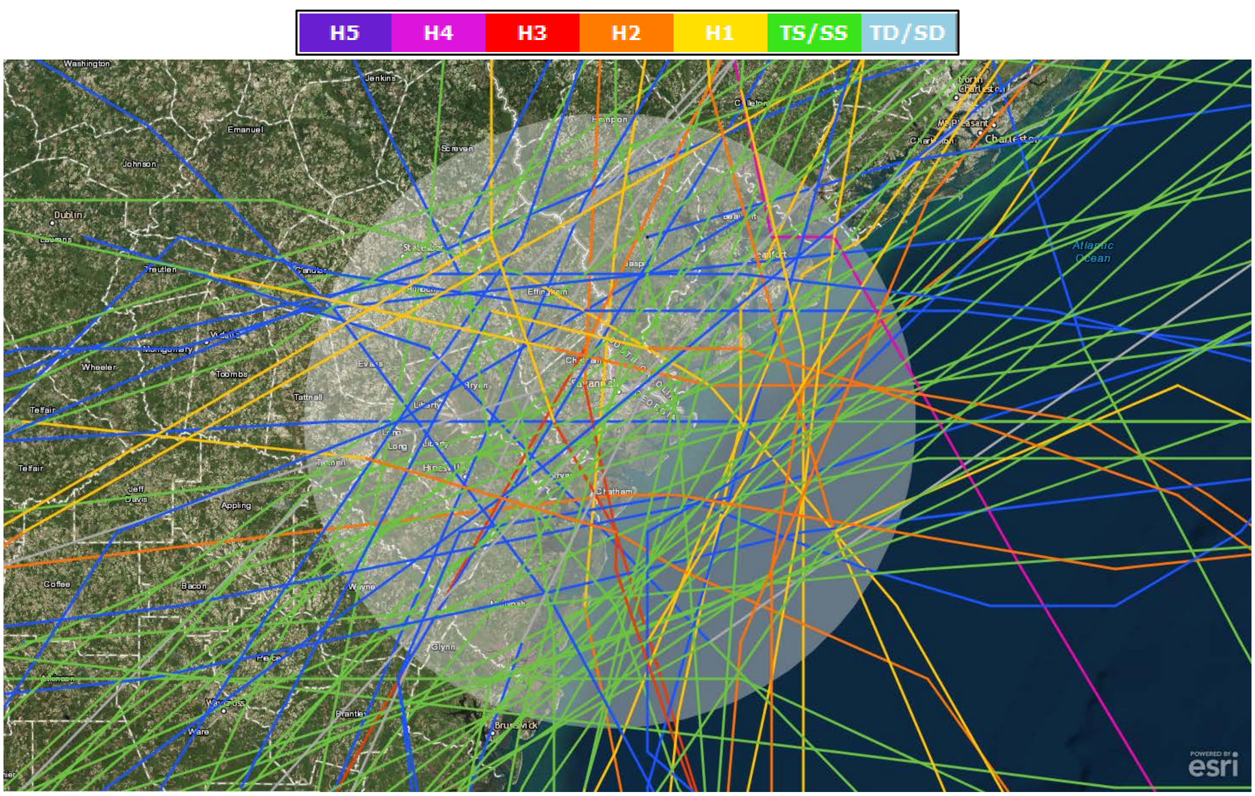
Past Occurrences

Chatham County is vulnerable to flood damage from hurricane rains and storm surge. Based on a search of the NOAA's National Hurricane Center Historical Hurricane Tracks for all hurricanes that have passed within 50 nautical miles of the County, the County has been exposed to 83 hurricanes and tropical storms including 3 tropical depressions since 1851. Type and frequency are as follows in Table 5.9. A listing of all hurricanes and tropical storms that passed within 50 nautical miles of Chatham County since 1851 is provided on the following pages in Table 5.10.

Table 5.10 – Hurricane Type & Frequency

Storm Intensity	Number of Occurrences	Rate of Occurrence
Tropical Storm/Depression	34	1 in 4.9 years
CAT I Hurricane	18	1 in 9.2 years
CAT II Hurricane	8	1 in 20.8 years
CAT III Hurricane	13	1 in 12.8 years
CAT IV Hurricane	7	1 in 23.7 years
CAT V Hurricane	3	1 in 55.3 years
TOTAL	83	1 in 2 years

Figure 5.22 on the following page illustrates past hurricane strike data for land falling major hurricanes over Chatham County as provided by the National Hurricane Center.



Source: NOAA/National Hurricane Center (http://coast.noaa.gov/hurricanes/#)

Figure 5.22 – Historical Hurricane Tracks (1851-2016)

Table 5.11 – Historical Hurricane Tracks Near Chatham County, GA

Storm Name	Max Saffir-Simpson	Date
Unnamed 1854	H3	09/07/1854 – 09/12/1854
Unnamed 1860	H3	08/08/1860 – 08/16/1860
Unnamed 1868	TS	10/01/1868 – 10/07/1868
Unnamed 1871	H3	08/14/1871 – 08/23/1871
Unnamed 1871	H3	08/17/1871 – 08/30/1871
Unnamed 1871	H1	09/30/1871 – 10/07/1871
Unnamed 1873	H1	09/18/1873 – 09/20/1873
Unnamed 1874	H1	09/25/1874 – 10/01/1874
Unnamed 1878	H2	09/01/1878 – 09/13/1878
Unnamed 1878	H1	10/09/1878 – 10/15/1878
Unnamed 1880	H1	09/06/1880 – 09/11/1880
Unnamed 1881	H2	08/21/1881 – 08/29/1881
Unnamed 1882	H4	10/05/1882 – 10/15/1882
Unnamed 1884	H1	09/10/1884 – 09/20/1884
Unnamed 1885	H2	08/21/1885 – 08/28/1885
Unnamed 1885	TS	08/29/1885 – 08/31/1885
Unnamed 1888	TS	09/06/1888 – 09/13/1888
Unnamed 1893	H1	06/12/1893 – 06/20/1893
Unnamed 1893	H3	08/15/1893 – 09/02/1893
Unnamed 1894	H3	09/18/1894 – 10/01/1984
Unnamed 1894	H3	10/01/1894 – 10/12/1894
Unnamed 1896	H3	09/22/1896 – 09/30/1896
Unnamed 1898	H1	08/30/1898 – 09/01/1898
Unnamed 1904	TS	10/31/1904 – 11/06/1904
Unnamed 1906	H3	10/08/1906 – 10/23/1906
Unnamed 1907	TS	06/24/1907 – 06/30/1907
Unnamed 1907	TS	09/27/1907 – 09/30/1907
Unnamed 1909	TS	06/26/1909 – 07/04/1909
Unnamed 1910	H4	10/09/1910 – 10/23/1910
Unnamed 1911	TS	08/04/1911 – 08/12/1911
Unnamed 1911	H2	08/23/1911 – 08/31/1911
Unnamed 1912	TS	09/02/1912 – 09/06/1912
Unnamed 1912	TS	07/12/1912 – 07/17/1912
Unnamed 1916	TS	10/02/1916 – 10/05/1916
Unnamed 1916	TS	05/13/1916 – 05/18/1916
Unnamed 1923	TS	06/22/1923 – 06/29/1923
Unnamed 1924	H1	09/13/1924 – 09/19/1924
Unnamed 1924	TS	09/27/1924 – 10/01/1924
Unnamed 1928	H5	09/06/1928 – 09/21/1928
Unnamed 1932	TS	09/09/1932 – 09/18/1932
Unnamed 1940	H2	08/05/1940 – 08/14/1940
Unnamed 1941	H3	10/03/1941 – 10/13/1941
Unnamed 1944	H4	10/12/1944 – 10/24/1944
Unnamed 1945	H4	09/12/1945 – 09/20/1945
Unnamed 1946	H2	10/05/1946 – 10/14/1946
Unnamed 1947	TS	09/20/1947 – 09/26/1947
Unnamed 1947	H2	10/08/1947 – 10/16/1947
Love 1950	H1	10/18/1950 – 10/16/1950

Storm Name	Max Saffir-Simpson	Date
Able 1952	H2	08/18/1952 – 09/03/1952
Unnamed 1953	TS	08/29/1953 – 09/01/1953
Florence 1953	H3	09/23/1953 – 09/27/1953
Unnamed 1954	TS	07/10/1954 – 07/14/1954
Unnamed 1957	TS	06/08/1957 – 06/15/1957
Gracie 1959	H4	09/20/1959 – 10/02/1959
Brenda 1960	TS	07/271960 – 08/07/1960
Cleo 1964	H4	08/20/1964 – 09/05/1964
Dora 1964	H4	08/28/1964 – 09/16/1964
Alma 1966	H3	06/04/1966 – 06/14/1966
Alma 1970	H1	05/17/1970 – 05/27/1970
Unnamed 1971	TD	09/08/1971 – 09/11/1971
Dawn 1972	H1	09/05/1972 – 09/14/1972
Unnamed 1976	TS	05/21/1976 – 05/25/1976
Unnamed 1976	TS	09/13/1976 – 09/17/1976
David 1979	H5	08/25/1979 – 09/08/1979
Unnamed 1981	TD	07/02/1981 – 07/04/1981
Bob 1985	H1	07/21/1985 – 07/26/1985
Isabel 1985	TS	10/07/1985 – 10/15/1985
Kate 1985	H3	11/15/1985 – 11/23/1985
Charley 1986	H1	08/13/1986 – 08/30/1986
Chris 1988	TS	08/21/1988 – 08/30/1988
Gordon 1994	H1	11/08/1994 – 11/21/1994
Josephine 1996	TS	10/04/1996 – 10/16/1996
Gordon 2000	H1	09/17/2000 – 09/21/2000
Kyle 2002	H1	09/20/2002 – 10/12/2002
Unnamed 2003	TD	07/25/2003 – 07/27/2003
Bonnie 2004	TS	08/03/2004 – 08/14/2004
Barry 2007	TS	05/31/2007 – 06/05/2007
Beryl 2012	TS	05/25/2012 – 06/02/2015
Andrea 2013	TS	06/05/2013 – 06/08/2013
Colin 2016	TS	06/05/2016 – 06/08/2016
Hermine 2016	H1	08/28/2016 – 09/08/2016
Julia 2016	TS	09/13/2016 – 09/21/2016
Matthew 2016	H5	09/28/2016 – 10/10/2016

Source: NOAA Historical Hurricane Tracks, 2017

The following is a description of past occurrences of hurricanes and tropical storms recorded by NCEI:

July 7, 1996 – Hurricane Watch for Bertha and later a Warning for the Georgia Coast caused about 20,000 people to evacuate, primarily Chatham County. Bertha was far enough offshore that it did not cause significant damage. Estimated loss revenue and down time for local plants and factories was $2,000,000.

October 10, 2005 – Tropical Storm Tammy moved ashore in northeast Florida but the strongest effects were felt well north of the actual center. Tropical Storm force wind gusts as high as 50 mph affected the Georgia coast for many hours. Numerous trees were blown down, a few of which fell on houses and cars. Coastal flooding and high surf also occurred due to Tammy. Significant beach erosion occurred at Tybee Island.

August 21, 2008 – Tropical Storm Fay moved eastward into northeast Florida, resulting in Tropical Storm force conditions across southeast Georgia. Law Enforcement reported power lines blown down near the intersection of Johnny Mercer and Pennwaller roads. Traffic lights were also reported down at the intersection of Dereene and Montgomery roads. Several roads were flooded, including portions of Abercorne Street, 40th Street, Bull Street and Montgomery Street.

May 27, 2012 – Beryl developed as a Subtropical Storm over the Atlantic Ocean well east of the North Coastal Georgia area. The cyclone eventually became a Tropical Storm and slowly moved to the southwest and finally made landfall along the northeast Florida coast. The system then weakened to a Tropical Depression and meandered about before slowly moving back to the northeast across coastal portions of Georgia and South Carolina. The system produced tropical storm force winds, rip currents, and areas of heavy rainfall across the region.

October 7, 2016 – Across southeast Georgia and southeast South Carolina, the main impacts from Matthew included heavy rain, wind damage in the form of scattered to widespread trees and power lines blown down and storm surge, specifically along coastal locations from Tybee Island, GA north to Edisto Beach, SC. Storm total rainfall amounts generally ranged from 4.5 to 7 inches across western areas of Southeast Georgia and extreme western locations of Southeast South Carolina to 8 to 17 inches closer to the coast, highest in coastal counties of Southeast Georgia and the lower Southeast South Carolina coast. A peak storm total rainfall of 17.49 inches was recorded at Hunter Army Airfield in Georgia. Daily record rainfall totals of were also set on October 7th and October 8th at the Savannah International Airport (KSAV), 4.36 inches and 3.84 inches, respectively. Heavy rains also led to several instances of flash flooding with damage to roads and homes. The most extensive damage came with storm surge during Matthew. The entire Southeast Georgia and Southeast South Carolina coast was impacted by storm surge generally ranging between 2 to 5 feet with some locations as high as 6 to 8 feet. A peak surge of 7.69 feet occurred at the Fort Pulaski tide gauge at 248 AM October 8th. Damage from surge was most notable on the northern ends of Tybee Island in Georgia.

Table 5.11 shows hurricane, tropical storm, and storm surge data reported by NCEI since 1996 for Chatham County. Duplicate records have been condensed where possible into one line per event.

Table 5.12 – NCEI Hurricane/Tropical Storm Data for Chatham County

Date	Event Type	Deaths/ Injuries	Property Damage	Crop Damage
7/11/1996	Hurricane	0/0	$0	$0
9/15/1999	Hurricane	0/0	$0	$0
7/10/2005	Hurricane	0/0	$0	$0
8/29/2005	Hurricane	0/0	$0	$0
9/14/2002	Tropical Storm	0/0	$0	$0
7/1/2003	Tropical Storm	0/0	$0	$0
9/6/2004	Tropical Storm	0/0	$0	$0
9/16/2004	Tropical Storm	0/0	$0	$0
9/26/2004	Tropical Storm	0/0	$0	$0
9/27/2004	Tropical Storm	0/0	$0	$0
6/12/2005	Tropical Storm	0/0	$0	$0
7/6/2005	Tropical Storm	0/0	$0	$0
10/5/2005	Tropical Storm	0/0	$0	$0
6/12/2006	Tropical Storm	0/0	$0	$0
8/30/2006	Tropical Storm	0/0	$0	$0
8/21/2008	Tropical Storm	0/0	$3000	$0
8/22/2008	Tropical Storm	0/0	$1500	$0
11/10/2009	Tropical Storm	0/0	$0	$0
9/4/2011	Tropical Storm	0/0	$0	$0

Date	Event Type	Deaths/ Injuries	Property Damage	Crop Damage
5/27/2012	Tropical Storm	0/0	$2500	$0
6/6/2013	Tropical Storm	0/0	$7500	$0
9/2/2016	Tropical Storm	0/0	$0	$0
10/7/2016	Tropical Storm	0/0	$0	$0
9/2/2016	Storm Surge/Tide	0/0	$0	$0
10/7/2016	Storm Surge/Tide	0/0	$0	$0
	Total	**0/0**	**$14,500**	**$0**

Source: NCEI, November 2016

Probability of Future Occurrence

Likely – Given the 25 hurricane, tropical storm, and storm surge occurrences recorded by NCEI over a period of 20 years (1996-2016), and the 83 historical hurricane tracks recorded by NOAA and the National Hurricane Center, hurricane-related flooding in Chatham County is likely in the future. A hurricane or tropical storm affects Chatham County on average once every 2 years.

Climate Change and Hurricane and Tropical Storms

One of the primary factors contributing to the origin and growth of tropical storm and hurricanes systems is water temperature. Sea surface temperature may increase significantly in the main hurricane development region of the North Atlantic during the next century as well as in the Gulf of Mexico. According to the 2014 National Climate Assessment, studies suggest that there will be an increase in the number of Category 4 and 5 storms as well as an increase in rainfall rates from these storms.

5.6 COASTAL/STREAM BANK EROSION

Hazard Description

Coastal Erosion

Coastal erosion is a process whereby large storms, flooding, strong wave action, sea level rise, and human activities, such as inappropriate land use, alterations, and shore protection structures, wears away the beaches and bluffs along the coast. Erosion undermines and often destroys homes, businesses, and public infrastructure and can have long-term economic and social consequences. According to NOAA, coastal erosion is responsible for approximately $500 million per year in coastal property loss in the United States, including damage to structures and loss of land. To mitigate coastal erosion, the federal government spends an average of $150 million every year on beach nourishment and other shoreline erosion control measures.

Coastal erosion has both natural causes and causes related to human activities. Gradual coastal erosion/replenishment results naturally from the impacts of tidal longshore currents. Severe coastal erosion can occur over a very short period of time when the state is impacted by hurricanes, tropical storms and other weather systems. Sand is continually removed by longshore currents in some areas but it is also continually replaced by sand carried in by the same type of currents. Structures such as piers or sea walls, jetties, and navigational inlets may interrupt the movement of sand. Sand can become “trapped” in one place by these types of structures. The currents will, of course, continue to flow, though depleted of sand trapped elsewhere. With significant amounts of sand trapped in the system, the continuing motion of currents (now deficient in sand) results in erosion. In this way, human construction activities that result in the unnatural trapping of sand have the potential to result in significant coastal erosion.

Erosion rates and potential impacts are highly localized. Severe storms can remove wide beaches, along with substantial dunes, in a single event. In undeveloped areas, these high recession rates are not likely to cause significant concern, but in some heavily populated locations, one or two feet of erosion may be considered catastrophic (NOAA, 2014).

Stream Bank Erosion

Stream banks erode by a combination of direct stream processes, like down cutting and lateral erosion, and indirect processes, like mass-wasting accompanied by transportation. When the channel bends, water on the outside of the bend (the cut-bank) flows faster and water on the inside of the bend (the point) flows slower as shown in Figure 5.23. This distribution of velocity results in erosion occurring on the outside of the bend and deposition occurring on the inside of the bend.

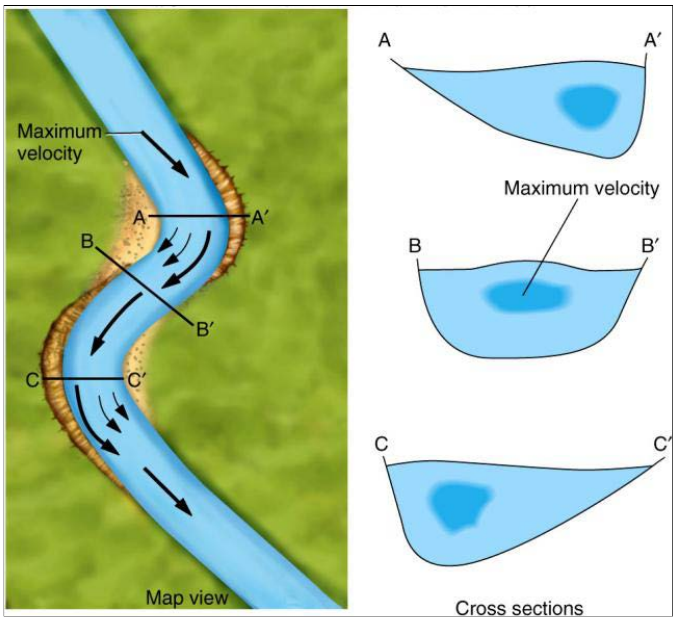


Figure 5.23 – Stream Meanders

Stream bank erosion is a natural process, but acceleration of this natural process leads to a disproportionate sediment supply, stream channel instability, land loss, habitat loss and other adverse effects. Stream bank erosion processes, although complex, are driven by two major components: stream bank characteristics (erodibility) and hydraulic/gravitational forces. Many land use activities can affect both of these components and lead to accelerated bank erosion. The vegetation rooting characteristics can protect banks from fluvial entrainment and collapse, and also provide internal bank strength. When riparian vegetation is changed from woody species to annual grasses and/or forbs, the internal strength is weakened, causing acceleration of mass wasting processes. Stream bank aggradation or degradation is often a response to stream channel instability. Since bank erosion is often a symptom of a larger, more complex problem, the long-term solutions often involve much more than just bank stabilization. Numerous studies have demonstrated that stream bank erosion contributes a large portion of the annual sediment yield.

Determining the cause of accelerated streambank erosion is the first step in solving the problem. When a stream is straightened or widened, streambank erosion increases. Accelerated streambank erosion is part of the process as the stream seeks to re-establish a stable size and pattern. Damaging or removing streamside vegetation to the point where it no longer provides for bank stability can cause a dramatic increase in bank erosion. A degrading streambed results in higher and often unstable, eroding banks. When land use changes occur in a watershed, such as clearing land for agriculture or development, runoff increases. With this increase in runoff the stream channel will adjust to accommodate the additional flow, increasing streambank erosion. Addressing the problem of streambank erosion requires an understanding of both stream dynamics and the management of streamside vegetation.

Past Occurrences

The Chatham County Hazard Mitigation Plan notes that soils along the coast, which are primarily fine-grained sands, have a high erosion hazard. Erosion in the County is typically caused by coastal tides, ocean currents, and storm events. Areas near the coast, like Tybee Island, where natural erosion processes are limited by development are most susceptible to erosion.

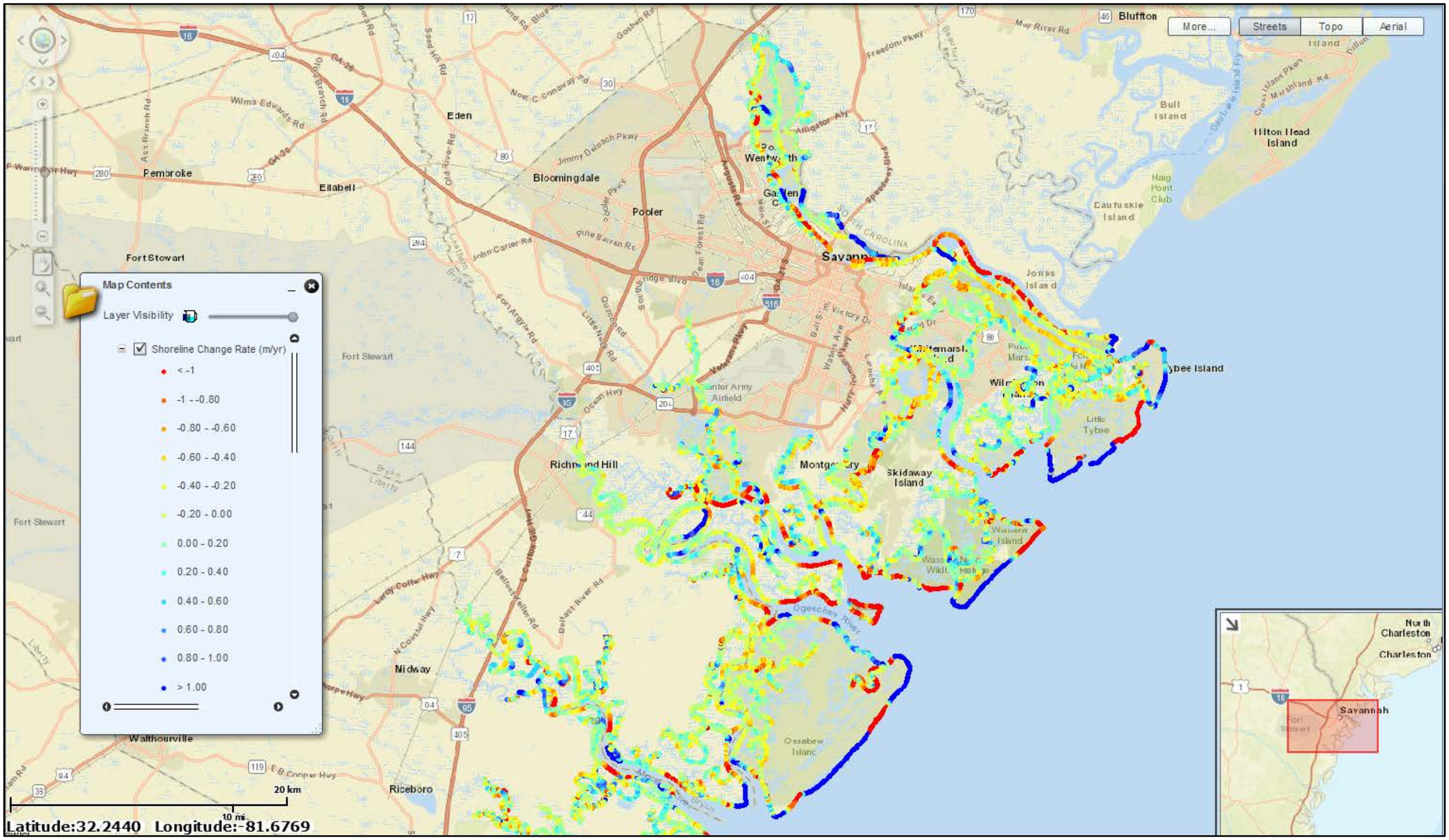
Erosion is generally an ongoing process rather than an episodic hazard, and its impacts are easier to see and understand over time.

The Georgia Coastal Hazards Portal shows long-term shoreline change rates along the Georgia coast. Shoreline change rates in Chatham County from 1930 to 2000 are shown in Figure 5.24 on the following page. The Chatham County coast has experienced erosion along portions of the coast and accretion in others. The Georgia Coastal Hazard Portal also provides locations for erosional hotspots in Georgia, based on research from the Applied Coastal Research Laboratory at Georgia Southern University, shown in Figure 5.25.

Though shoreline erosion is typically an ongoing process, it can intensify during storm events, particularly with hurricane storm tides. The following instances of major erosion are noted in flood-related events recorded by NCEI for Chatham County:

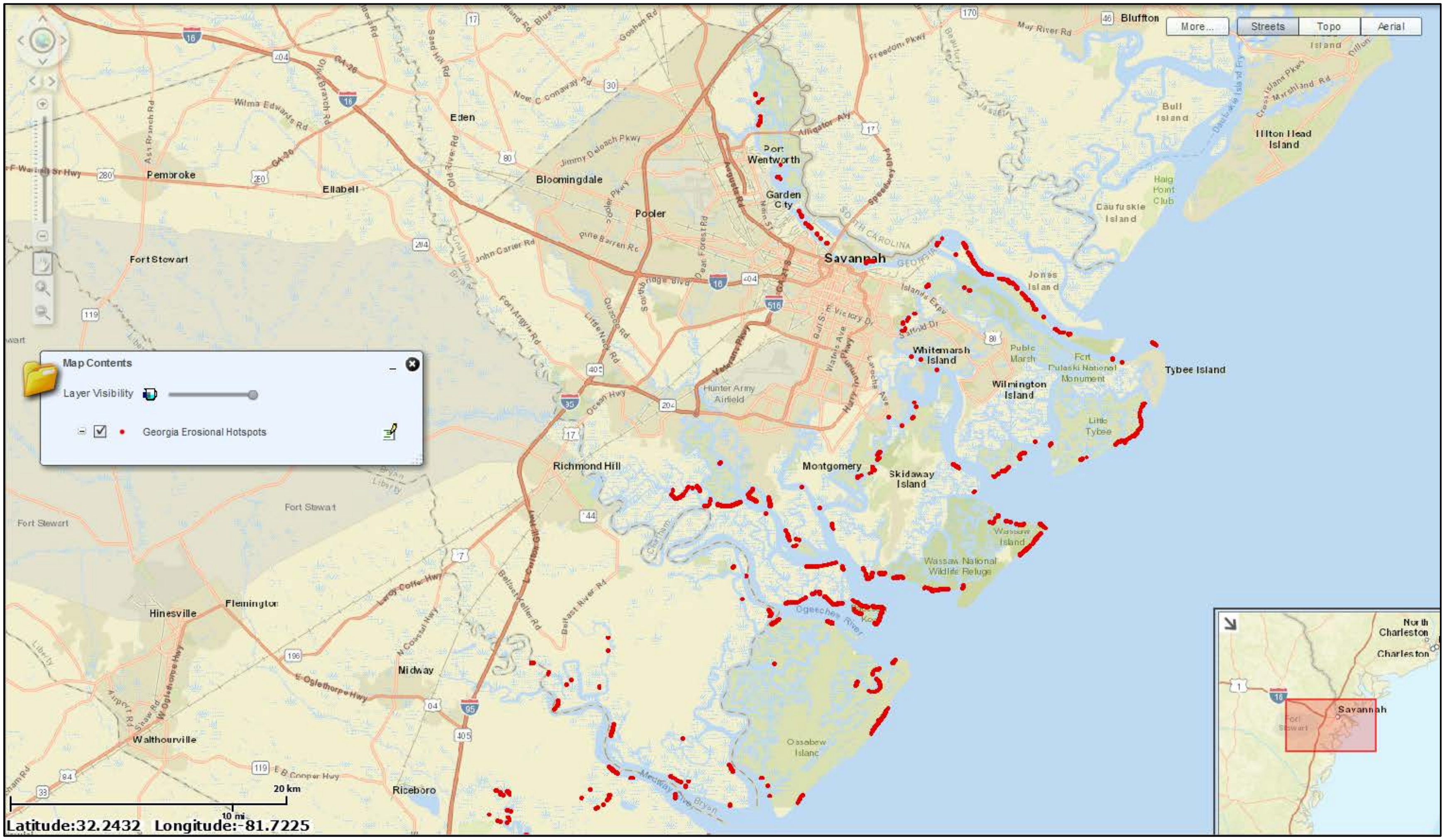
October 10, 2005 – Tropical Storm Tammy moved ashore in northeast Florida but the strongest effects were felt well north of the actual center. Tropical Storm force wind gusts as high as 50 mph affected the Georgia coast for many hours. Numerous trees were blown down, a few of which fell on houses and cars. Coastal flooding and high surf also occurred due to Tammy. Significant beach erosion occurred at Tybee Island.

September 30, 2017 – Severe Beach Erosion took place along area beaches as High Astronomical Tides combined with strong Northeast winds across the coastal waters. Severe Beach Erosion was reported at Tybee Island. Lifeguard towers were undermined or destroyed. Several homes were damaged due to high surf and coastal flooding. The beach was completely washed away in several areas.



Source: Georgia Coastal Hazards Portal, 2017

Figure 5.24 – Short-Term Shoreline Change Rates



Source: Georgia Coastal Hazards Portal, 2017

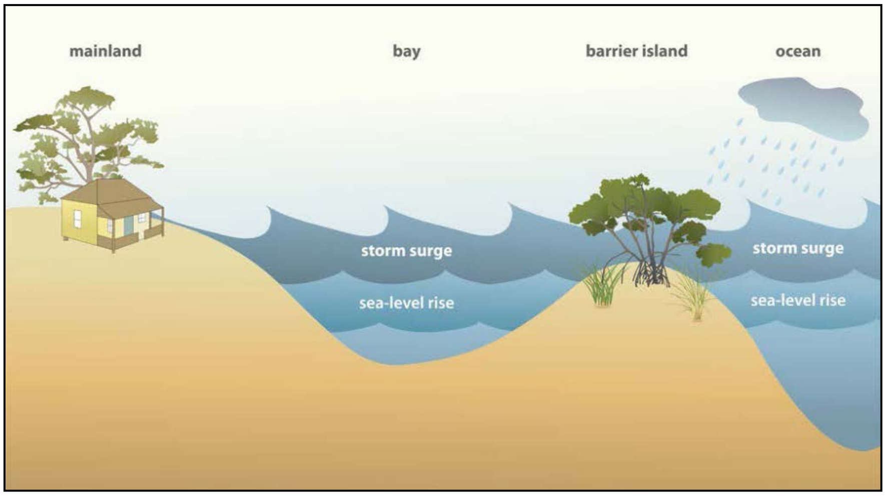
Figure 5.25 – Long-Term Shoreline Change Rates

Probability of Future Occurrence

Likely – Erosion is a natural, dynamic, and continuous process that can be expected to occur in the future. Erosion of coastal and estuarine shorelines is an ongoing and natural process along the Chatham County coast. Erosion rates are extremely variable, but given Chatham County's coastal setting, soils, and topography, as well as the likelihood of hurricane and tropical storm events that may exacerbate erosion, the probability of occurrence for coastal/estuarine erosion is "likely."

Climate Change and Erosion

Sea-level rise will raise all tide levels, from low tide to storm surge (see Figure 5.22). Wave action at higher tide levels may increase erosion of sandy beaches. The combined effects of wind and waves could damage dunes, leaving the beachfront more vulnerable (UF/IFAS Extension, 2013).



Source: Jane Hawkey, IAN Image Library (ian.umces.edu/imagelibrary/)

Figure 5.26 – Sea Level Rise and Coastal Erosion of Dunes

5.7 ASSESSMENT OF AREAS LIKELY TO FLOOD

The following targeted areas are identified by the FMPC as areas likely to flood in the future.

Identified Area #1: 100-year SFHAs

According to the Effective DFIRM, approximately 76% of Chatham County's unincorporated areas fall within the 100-year floodplain in the effective FIRMs. Changes in the floodplain and development within the watershed could increase base flood elevation in SFHAs and expand SFHA boundaries if these changes and development bring an increase in impervious surface or infringe upon natural floodplains and drainage features. Given that the population is projected to increase by 45% by 2050, development and changes in the floodplain are likely.

Identified Area #2: Areas of Localized Stormwater Flooding

Due to the low elevation and flat topography, frequent tidal flooding, and heavy precipitation resulting from thunderstorms, tropical storms, and hurricanes, it is highly likely that unmitigated properties will continue to experience localized flooding. An increase in impervious area due to future development could exacerbate localizing flooding issues, particularly if growth expands into currently undeveloped areas, unless measures are taken to limit the volume of runoff allowed post-development. Furthermore, the intensity of individual rainfall events is likely to increase in the future due to climate change which may further overwhelm stormwater drainage systems and increase flooding. Tidal impacts on stormwater systems must also be considered. As sea level rise continues, the capacity of stormwater infrastructure may decline.

Identified Area #3: Repetitive Loss Areas

Repetitive loss properties have a greater need for flood protection. Repetitive loss can be attributed to development within the 100-year floodplain as well as localized stormwater flooding. As mentioned above, both types of flooding could increase in the future if measures are not taken to mitigate the effects of development. Therefore, it is very likely that unmitigated repetitive loss properties will continue to flood in the future. Repetitive loss areas identified by the FMPC are shown in Figure 5.27.

Impact of Future Flooding

Changes in the watersheds (particularly an increase in impervious area) could make these identified areas even more likely to flood in the future. Chatham County is located within the Ogeechee Coastal Sub-basin, with additional areas in the Lower Savannah River Sub-basin and the Lower Ogeechee Sub-basin.

The SFHA extends throughout the entire County, with VE Zone along the Atlantic coast, the Savannah River, the Ogeechee River, and throughout the coastal marshes. AE Zone covers much of the land along the Savannah and Ogeechee Rivers as well as along smaller creeks throughout the County and lands around Skidaway Island, Isle of Hope, and Wilmington Island. Areas of localized stormwater flooding are located throughout the County, primarily in the Ogeechee Coastal basin.

Repetitive loss properties are scattered throughout the southeastern portions of the County, and located primarily within the Ogeechee Coastal drainage basin. Repetitive loss property locations align with areas of tidal flooding and localized stormwater flooding, both of which may be vulnerable to increased risk in the future. Localized stormwater flooding can increase as a result of increased development, therefore properties downstream of West Chatham and other areas planned for development may be at risk of increased flooding. Similarly, as sea levels continue to rise, repetitive loss properties in areas affected by tidal flooding may experience increased flooding in the future.

The future land use component of the comprehensive plan (discussed in greater detail in Section 3.8), recommends mixed use development, town centers, cluster and conservation design, and New Urban development options and it encourages open space preservation. However, these development forms are not fully supported by the policy framework needed for their implementation. Additionally, the plan recognizes that past development forms pose a challenge to smart development and growth management, as large lot sizes, strip malls, grayfields, and suburban development have created a sprawling form difficult to reverse.

According to the U.S. Census Bureau's Building Permits Survey data, shown in Table 5.13, residential building permit issuance rose from 2010 to 2014 but has since begun to slow. Despite the recent drop in permits issued, there were still more permits issued in 2016 than in 2010 or 2011. The majority of building permits issued in all years since 2010 have been for single family homes. Single family detached homes are also the most common housing type in the County, making up 63.8% of the housing supply as of 2014. Single family homes typically produce the most impervious surface per unit, which means the development trends in Chatham County have been greatly increasing impervious surface coverage.

Table 5.13 – Building Permits Issued in Chatham County since 2010

Year	1-unit		2-units		3-4 units			5+ units		
	Bldgs	Value	Bldgs	Value	Bldgs	Units	Value	Bldgs	Units	Value
2010	676	$87,335,207	1	$140,000	2	8	$258,888	21	271	$13,946,583
2011	655	$84,463,420	3	$437,850	5	20	$2,294,000	20	376	$22,141,746
2012	811	$122,205,698	1	$197,500	1	4	$175,000	13	198	$11,142,608
2013	901	$156,331,898	9	$1,803,902	1	4	$200,000	19	127	$6,486,958
2014	1,048	$205,885,088	3	$657,120	0	0	$ -	42	263	$45,184,142
2015	933	$200,307,059	1	$210,000	0	0	$ -	1	24	$2,000,000
2016	780	$194,149,166	4	$713,744	0	0	$ -	10	170	$12,915,000
Total	**5,804**	**$1,050,677,536**	**22**	**$4,160,116**	**9**	**36**	**$2,927,888**	**126**	**1,429**	**$113,817,037**

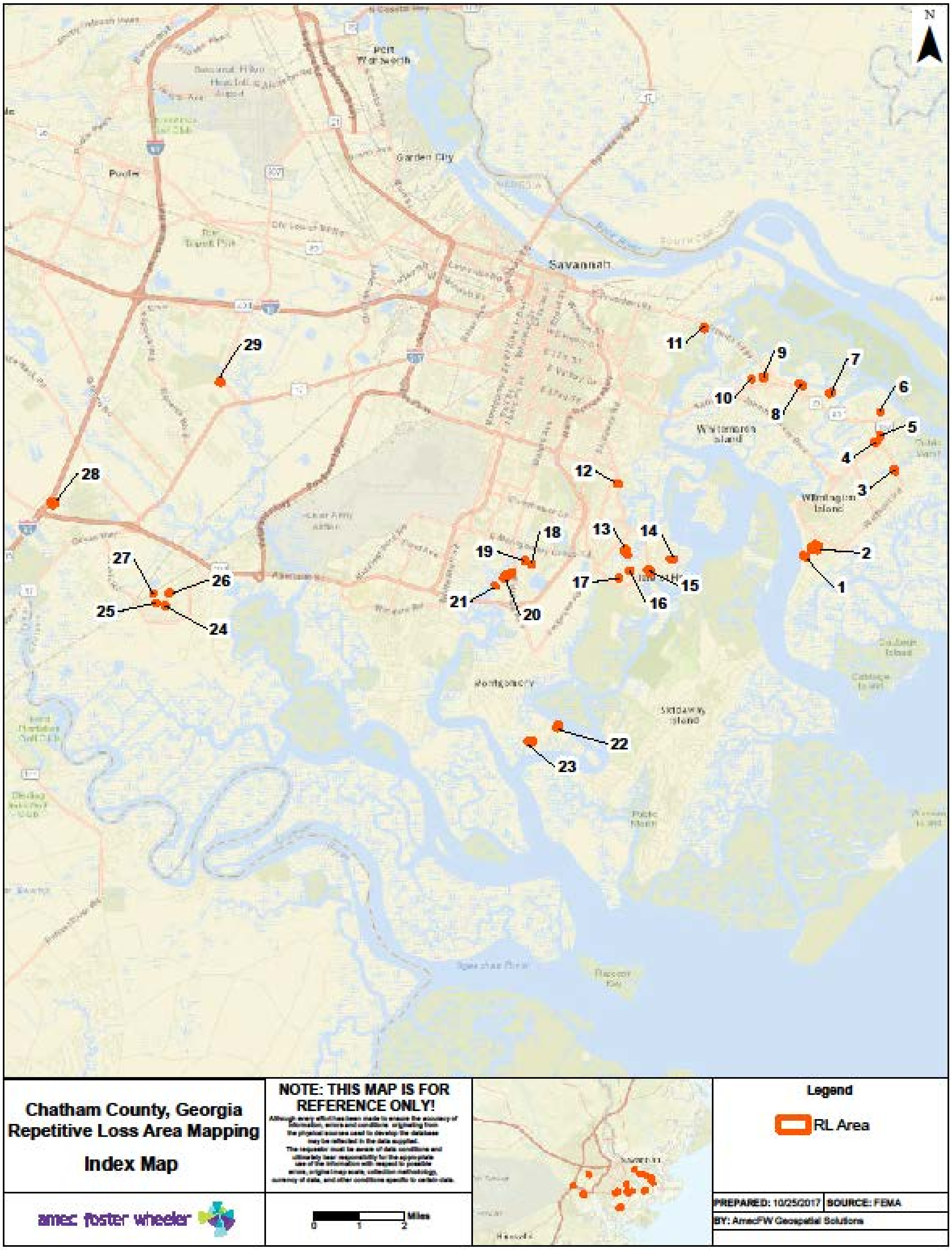


Figure 5.27 – Repetitive Loss Areas in Chatham County

5.8 FLOOD HAZARDS PROFILE SUMMARY

Table 5.12 summarizes the results of the hazard profile for Chatham County based on hazard identification data and input from the FMPC. For each hazard profiled within Chapter 5, this table includes the likelihood of future occurrence and whether or not the hazard has been included in Chapter 6 Vulnerability Assessment.

Table 5.14 – Summary of Flood Hazard Profile Results

Hazard	Likelihood of Future Occurrence	Vulnerability Assessment
Climate Change & Sea Level Rise	Highly Likely	Yes
Dam/Levee Failure	Unlikely	Yes
Flood: 100-/500-year	Possible	Yes
Flood: Stormwater/Localized Flooding	Highly Likely	Yes
Hurricane/Tropical Storm	Likely	Yes
Coastal/Stream Bank Erosion	Possible	Yes

6 VULNERABILITY ASSESSMENT

44 CFR Subsection D §201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. Plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:

A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B): An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; and

(C): Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

Chapter 6 quantifies the vulnerability of Chatham County to the priority hazards identified in Table 5.12. It consists of the following subsections:

- 6.1 Methodology
- 6.2 Asset Inventory
- 6.3 Land Use
- 6.4 Vulnerability Assessment Results
- 6.5 Priority Risk Index Results

The FMPC conducted a vulnerability assessment of the hazards identified as a priority in order to assess the impact that each hazard would have on the County. The vulnerability assessment quantifies, to the extent feasible using best available data, assets at risk to natural hazards and estimates potential losses.

The vulnerability assessments followed the methodology described in the FEMA publication Understanding Your Risks—Identifying Hazards and Estimating Losses (August 2001). The vulnerability assessment first describes the total vulnerability and values at risk and then discusses vulnerability by hazard. Data used to support this assessment included the following:

- Geographic Information System (GIS) datasets, including building footprints, topography, aerial photography, and transportation layers;
- Hazard layer GIS datasets from state and federal agencies;
- Written descriptions of inventory and risks provided by the State Hazard Mitigation Plan; and
- Written descriptions of inventory and risks provided by the Regional Hazard Mitigation Plan.

6.1 METHODOLOGY

Two distinct risk assessment methodologies were used in the formation of this vulnerability assessment. The first consists of a ***quantitative*** analysis that relies upon best available data and technology, while the second approach consists of a ***qualitative*** analysis that relies on local knowledge and rational decision making. The quantitative analysis involved the use of FEMA's Hazus-MH, a nationally applicable standardized set of models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters—such as wind speed and building type—were modeled using the Hazus software to determine the impact on the built environment. Chatham County's GIS-based flood risk assessment was completed using data collected from local, regional and national sources that included Chatham County, GEMA/HS, and FEMA.

6.2 ASSET INVENTORY

An inventory of assets within Chatham County was compiled to identify those structures potentially at risk to the identified hazards. Assets include elements such as buildings, property, business/industry goods, and civil infrastructure. Building footprint, foundation type, and building value data were provided by the County. Critical infrastructure and key resources, as defined by FEMA, were the focus of the non-building data collection. By understanding the type and number of assets that exist and where they are in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed.

6.2.1 Properties at Risk

The properties identified to be at risk include all improved properties in Chatham County according to building footprint data provided by Chatham County. The information is provided in Table 6.1. This risk information is further detailed by flood zone in Table 6.5 in Section 6.4.3.

Table 6.1 – Chatham County Properties at Risk

Occupancy Type	Total Number of Buildings	Total Building Value	Estimated Content Value	Total Value
Agricultural	172	$37,867,482	$37,867,482	$75,734,964
Commercial	3,773	$1,010,684,961	$1,010,684,961	$2,021,369,922
Education	84	$50,100,420	$50,100,420	$100,200,840
Government	4	$0	$0	$0
Industrial	2,170	$1,433,689,017	$2,150,533,525	$3,584,222,542
Religious	18	$41,041,700	$41,041,700	$82,083,400
Residential	31,227	$5,215,897,502	$2,607,948,751	$7,823,846,253
Total	**37,448**	**7,789,281,082**	**5,898,176,839**	**$13,687,457,921**

Source: Chatham County, FEMA 2014 Effective DFIRM

Note: Content value estimations are generally based on the FEMA Hazus methodology of estimating value as a percent of improved structure values by property type. The residential property type assumes a content replacement value equal to 50% of the building value. Agricultural, commercial, education, government, and religious property types assume a content replacement value equal to 100% of the building value. The industrial property type assumes a content replacement value equal to 150% of the building value.

6.2.2 Critical Facilities and Infrastructure at Risk

Of significant concern with respect to any disaster event is the location of critical facilities and infrastructure in the planning area. Critical facilities are often defined as those essential services and facilities in a major emergency which, if damaged, would result in severe consequences to public health and safety or a facility which, if unusable or unreachable because of a major emergency, would seriously and adversely affect the health, safety, and welfare of the public. Critical facilities and infrastructure in Chatham County are listed by type in Table 6.2 and shown Figure 6.1. Structure values by type are estimated using County parcel data; values were not available for all critical facilities.

Table 6.2 – Critical Facilities and Infrastructure at Risk in Chatham County

Facility Name	Count	Structure Value
Civic	1	$ 8,897,000
Cultural	64	$ 188,167,997
EMS	1	$ -
Fire	43	$ 96,524,672

Facility Name	Count	Structure Value
Government	75	$ 235,304,518
Hazmat	4	$ 4,343,500
Health	14	$ 267,988,346
Police	20	$ 63,556,740
School	58	$ 256,093,593
Transportation	4	$ 36,230,950
Utility	19	$ 25,325,531
Water	376	$ 655,781,716
Total	679	$ 1,838,214,563

Planning for Critical Facility and Infrastructure Protection

Chatham County has several options to consider in planning to reduce the vulnerability of these critical facilities and infrastructure. Per FEMA guidance, of primary concern is the protection of essential systems and equipment in order to maintain the function of these critical facilities for community resilience during and after hazard events. One way to protect critical facilities is to ensure that electrical systems, mechanical systems, and other essential equipment is sufficiently elevated above the base flood elevation. Another option is to install dry floodproofing in order to protect these critical components from floodwaters, flood forces, and leakage. Among the components that should be considered for protection are electrical service and distribution systems; data systems; heating, ventilation, and air conditioning systems; water and wastewater systems; emergency power systems, and elevators.

Alternatively, the County can consider relocating some vulnerable critical facilities to new locations outside the floodplain. However, additional protection may still be required because areas outside the 1%-annual-chance and 0.2%-annual-chance floodplain are still at low risk to flooding. According to FEMA, properties outside of high-risk flood areas account for over 20 percent of NFIP claims and one-third of disaster assistance for flooding.

The Chatham County FMPC considered these concerns in developing their mitigation strategies.

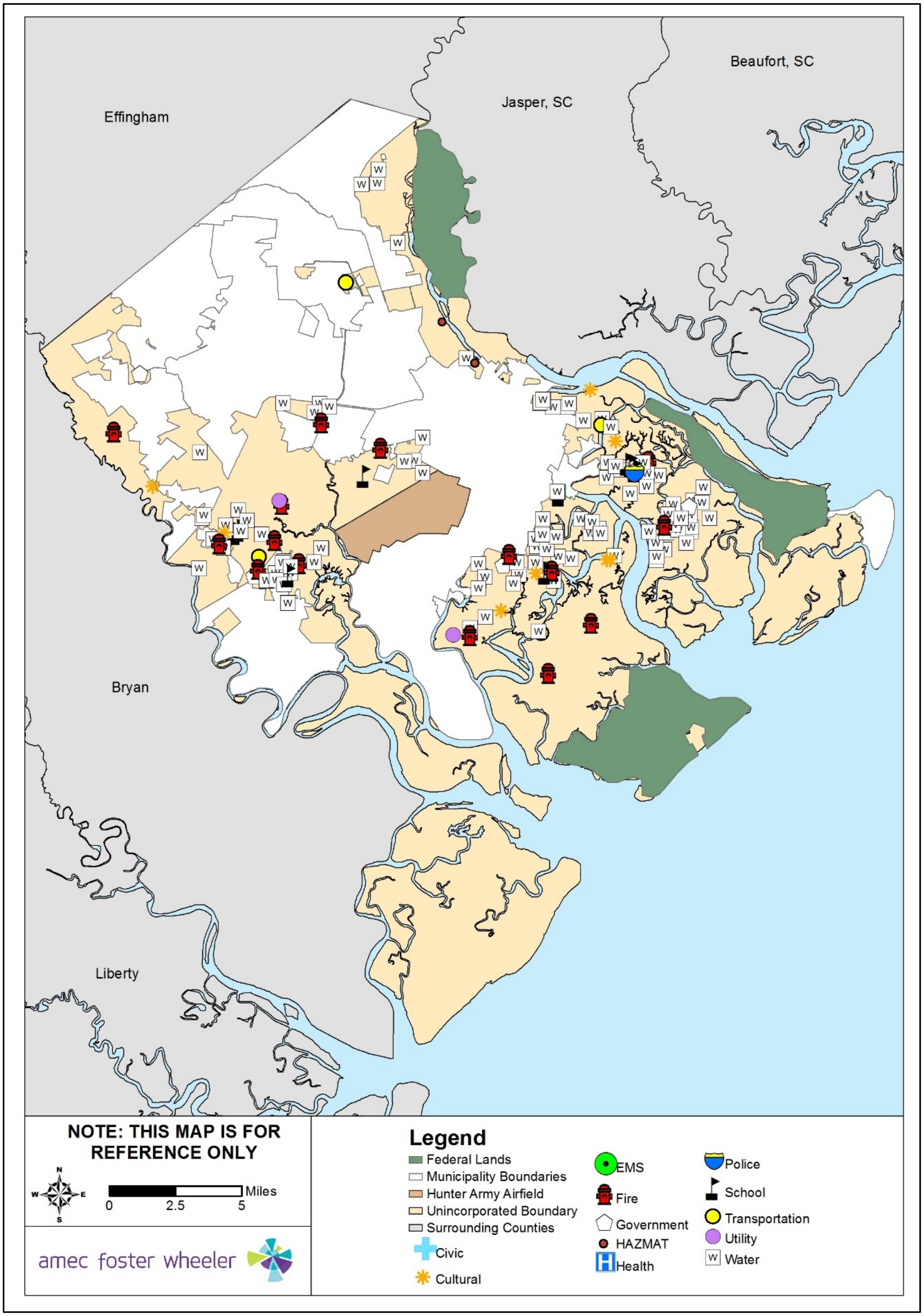


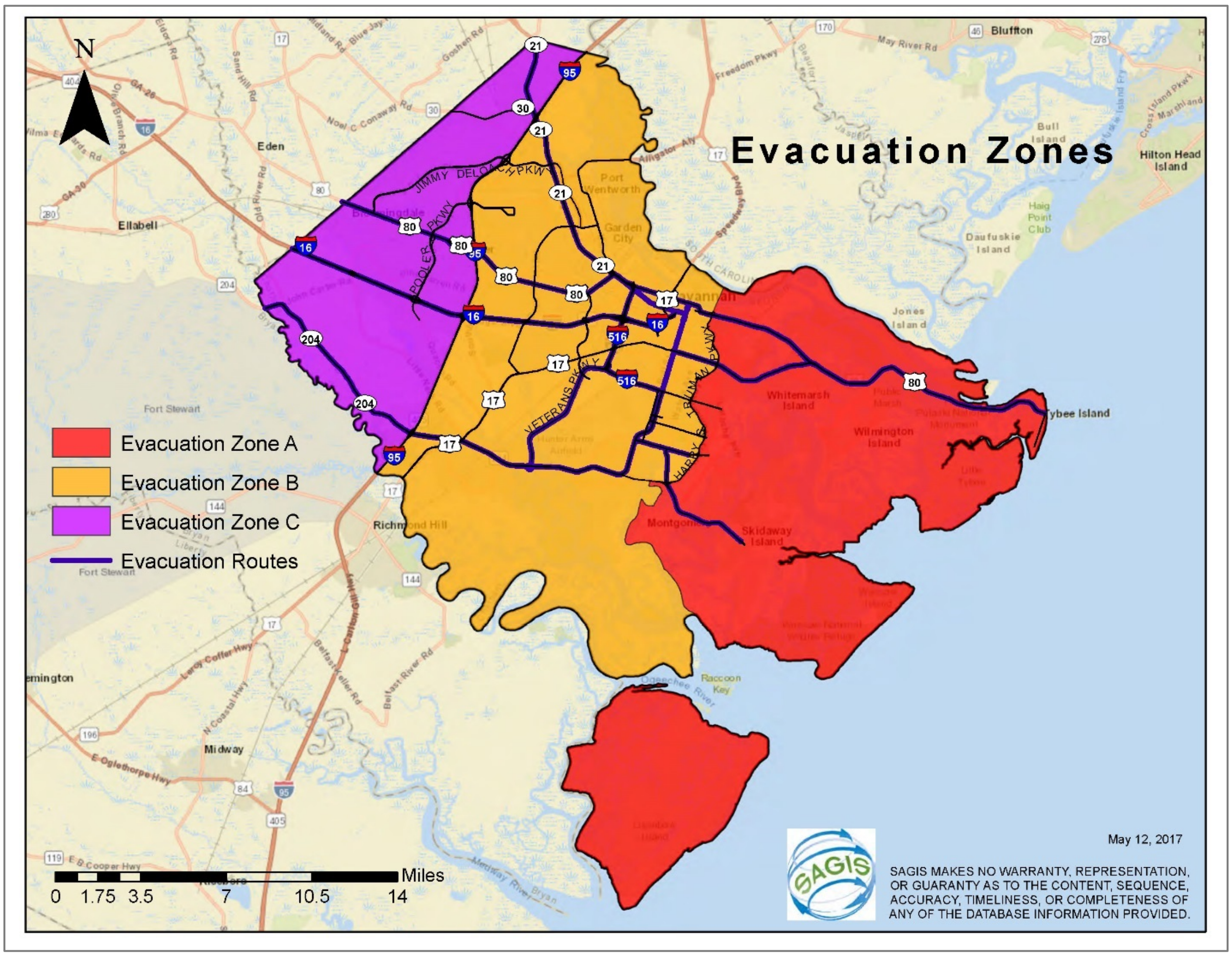
Figure 6.1 – Chatham County Critical Facilities

6.3 HEALTH & SAFETY

6.3.1 Life, Safety, Warning, and Evacuation

Hurricane storm surge models, shown in Section 5.5 Hurricane/Tropical Storm indicate areas likely to experience flooding and require evacuation in the event of a hurricane. Based on these models, a category 1 or category 2 storm would require minimal evacuation. A category 3 storm or stronger is likely to require more substantial evacuation or sheltering of County residents and visitors due to storm surge flooding.

It should be noted that these models do not predict storm surge, and actual storm surge heights may exceed the estimates shown. Additionally, these storm surge models do not incorporate other hurricane impacts that may exacerbate flooding and necessitate evacuation, including hurricane strength winds and rain. Therefore, these models should be interpreted as a minimum impact scenario. Actual evacuation advisories are issued by emergency management in the event of a storm.



Source: Chatham County Emergency Management

Figure 6.2 – Chatham County Evacuation Zones

6.3.2 Public Health

Certain health hazards are common to flood events. While such problems are often not reported, three general types of health hazards accompany floods. The first comes from the water itself. Floodwaters carry anything that was on the ground that the upstream runoff picked up, including dirt, oil, animal waste, and lawn, farm and industrial chemicals. Pastures and areas where farm animals are kept or their wastes are stored can contribute polluted waters to the receiving streams.

Floodwaters also saturate the ground, which leads to infiltration into sanitary sewer lines. When wastewater treatment plants are flooded, there is nowhere for the sewage to flow. Infiltration and lack of treatment can lead to overloaded sewer lines that can back up into low-lying areas and homes. Even when it is diluted by flood waters, raw sewage can be a breeding ground for bacteria such as e.coli and other disease causing agents. Residents with private wells will need to have their water quality tested to ensure it is safe for use.

The second type of health problem arises after most of the water has gone. Stagnant pools can become breeding grounds for mosquitoes, and wet areas of a building that have not been properly cleaned breed mold and mildew. A building that is not thoroughly cleaned becomes a health hazard, especially for small children and the elderly.

Another health hazard occurs when heating ducts in a forced air system are not properly cleaned after inundation. When the furnace or air conditioner is turned on, the sediments left in the ducts are circulated throughout the building and breathed in by the occupants. Flooding can also cause extensive mold growth in building walls and floors, which also poses a respiratory health hazard.

If the County's water systems lose pressure, a boil order may be issued to protect people and animals from contaminated water.

The third problem is the long-term psychological impact of having been through a flood and seeing one's home damaged and personal belongings destroyed. The cost and labor needed to repair a flood-damaged home puts a severe strain on people, especially the unprepared and uninsured. There is also a long-term problem for those who know that their homes can be flooded again. The resulting stress on floodplain residents takes its toll in the form of aggravated physical and mental health problems.

6.4 VULNERABILITY ASSESSMENT RESULTS

The Disaster Mitigation Act regulations require that the FMPC evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies the County's vulnerability to each of the hazards identified as a priority hazard in Table 5.12. The hazards evaluated as part of this vulnerability assessment are:

- Climate Change and Sea Level Rise
- Dam Failure
- Flood: 100-/500-year
- Flood: Stormwater/Localized Flooding
- Hurricane & Tropical Storm

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to the identified hazard can be counted and their values tabulated. Other information can be collected in regard to the hazard area, such as the location of critical facilities, historic structures, and valued natural resources (e.g., an identified wetland or endangered species habitat). Together, this information conveys the impact, or vulnerability, of that area to that hazard.

The conclusions drawn from the hazard profiling and vulnerability assessment process can be used to prioritize all potential hazards to the Chatham County planning area. The Priority Risk Index (PRI) is a good practice to use when prioritizing hazards because it provides a standardized numerical value so that hazards can be compared against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk has been assigned a value (1 to 4) and a weighting factor as summarized below in Table 6.4.

Table 6.3 – Priority Risk Index

RISK ASSESSMENT CATEGORY	LEVEL	DEGREE OF RISK CRITERIA	INDEX	WEIGHT
PROBABILITY What is the likelihood of a hazard event occurring in a given year?	**UNLIKELY**	LESS THAN 1% ANNUAL PROBABILITY	**1**	**30%**
	POSSIBLE	BETWEEN 1 & 10% ANNUAL PROBABILITY	**2**	
	LIKELY	BETWEEN 10 &100% ANNUAL PROBABILITY	**3**	
	HIGHLY LIKELY	100% ANNUAL PROBABILTY	**4**	
IMPACT In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?	**MINOR**	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	**1**	**30%**
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR > 1 DAY	**2**	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR > 1 WEEK.	**3**	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES > 30 DAYS.	**4**	
SPATIAL EXTENT How large of an area could be impacted by a hazard event? Are impacts localized or regional?	**NEGLIGIBLE**	LESS THAN 1% OF AREA AFFECTED	**1**	**20%**
	SMALL	BETWEEN 1 & 10% OF AREA AFFECTED	**2**	
	MODERATE	BETWEEN 10 & 50% OF AREA AFFECTED	**3**	
	LARGE	BETWEEN 50 & 100% OF AREA AFFECTED	**4**	
WARNING TIME Is there usually some lead time associated with the hazard event? Have warning measures been implemented?	**MORE THAN 24 HRS**	SELF DEFINED	**1**	**10%**
	12 TO 24 HRS	SELF DEFINED	**2**	
	6 TO 12 HRS	SELF DEFINED	**3**	
	LESS THAN 6 HRS	SELF DEFINED	**4**	
DURATION How long does the hazard event usually last?	**LESS THAN 6 HRS**	SELF DEFINED	**1**	**10%**
	LESS THAN 24 HRS	SELF DEFINED	**2**	
	LESS THAN 1 WEEK	SELF DEFINED	**3**	
	MORE THAN 1 WEEK	SELF DEFINED	**4**	

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). The sum of all five risk assessment categories equals the final PRI value, demonstrated in the equation below (the highest possible PRI value is 4.0).

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

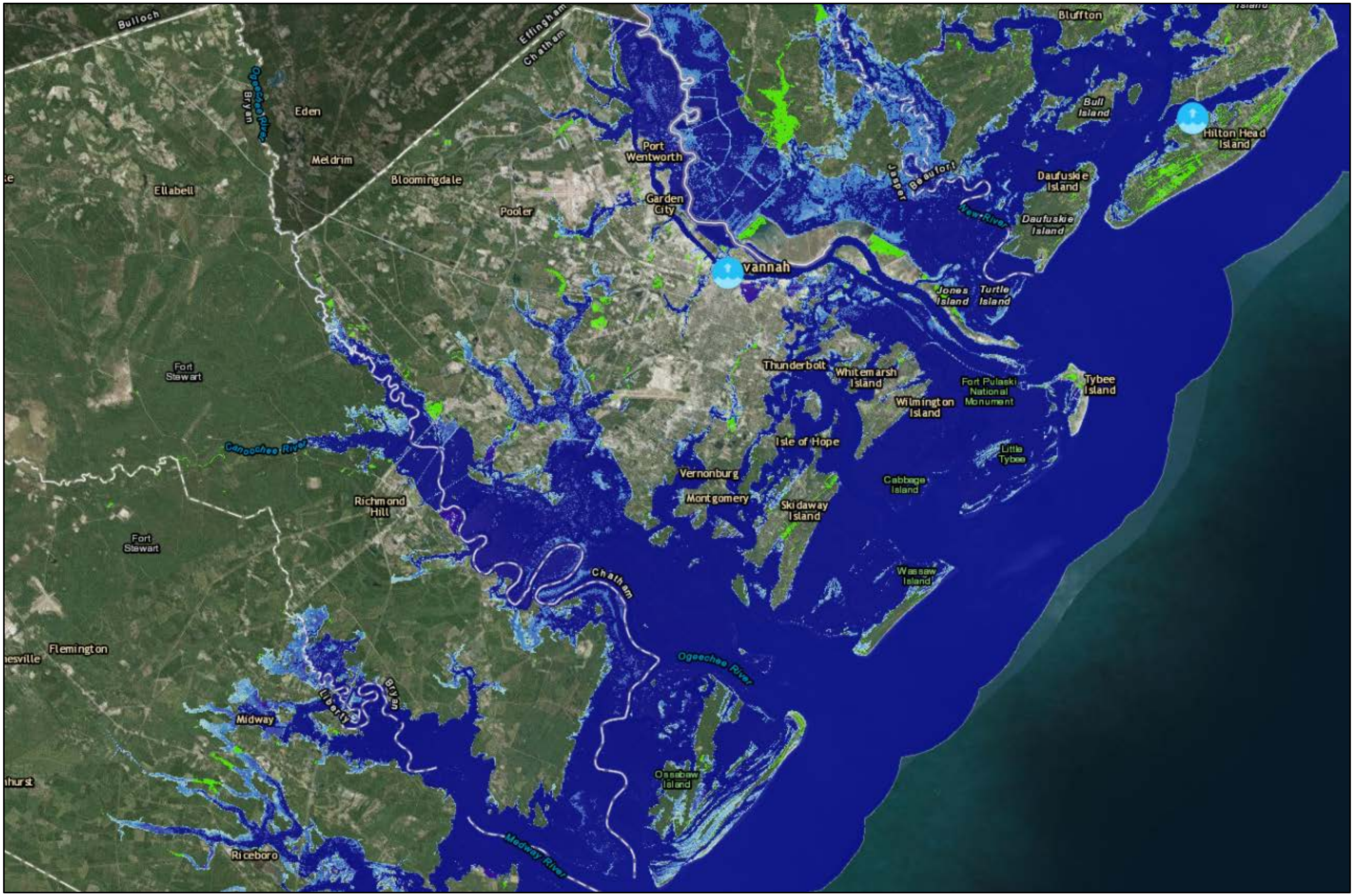
The purpose of the PRI is to categorize and prioritize all potential hazards for the Chatham County planning area as high, moderate, or low risk. The summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes.

6.4.1 Climate Change and Sea Level Rise

Probability	Impact	Spatial Extent	Warning Time	Duration
Highly Likely	Minor	Small	> 24 hours	> 1 week

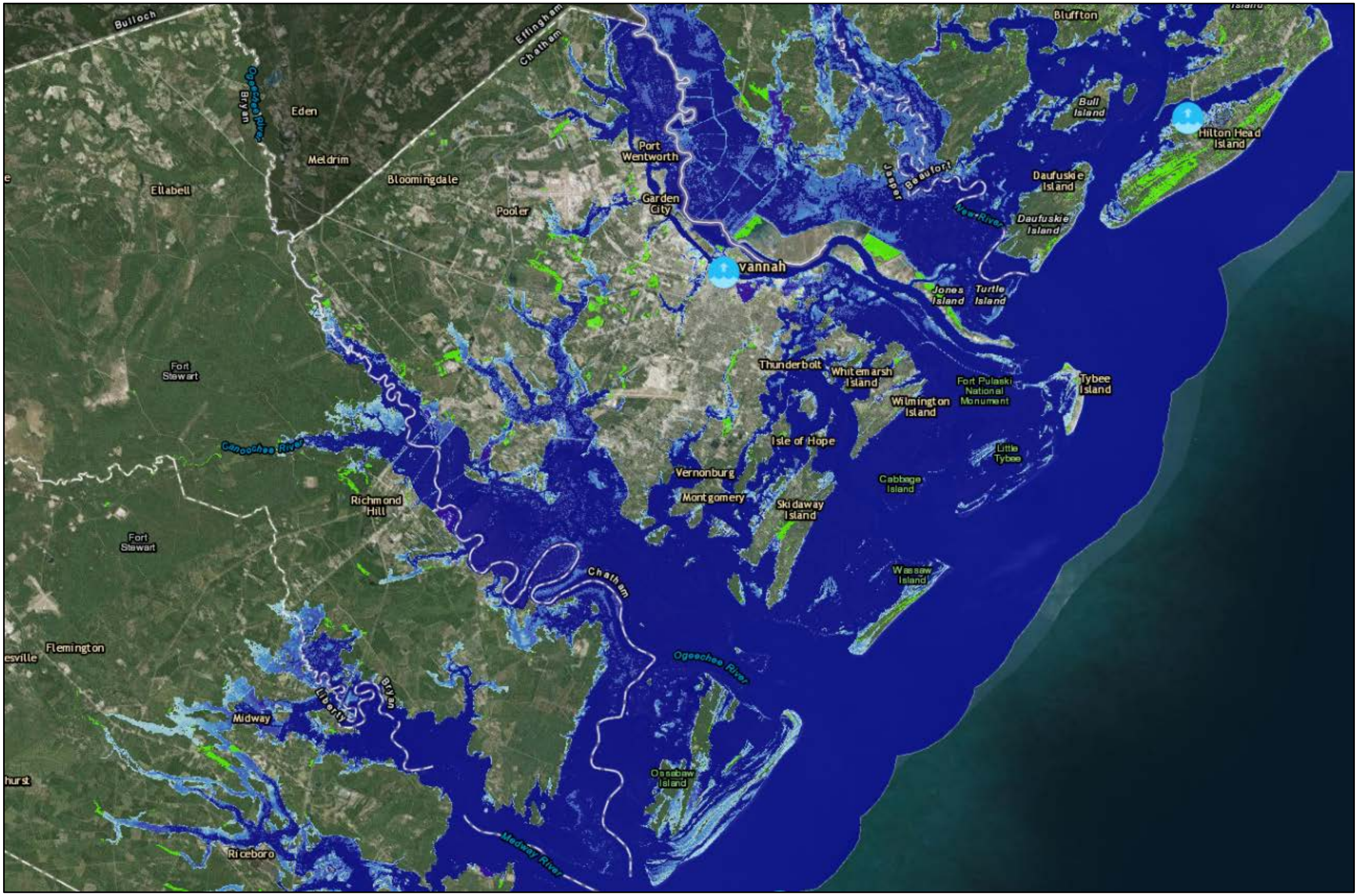
Chatham County is vulnerable to the potential impacts of climate change and sea level rise. The climate change hazard profile in Section 5.1 discusses how climate-driven hazards such as hurricanes and flooding are likely to increase in intensity, and possibly frequency, in the future. Thus the 25-year flood of today may become the 10-year event in the future. The reader should refer to the vulnerability assessment discussions on Flood, Erosion, and Hurricane for the current exposure and risk to these hazards with the perspective that climate change has the potential to exacerbate the existing risk and vulnerabilities. The potential impacts of climate change include increased flooding frequency, potential damage to critical infrastructure, and increasing public costs associated with flood insurance claims, infrastructure repair and maintenance, environmental impacts, and emergency management efforts.

Estimates of the impact of 2-foot, 3-foot, and 4-foot Sea Level Rise (SLR) are shown in Figure 6.3, Figure 6.4, and Figure 6.5, respectively. These maps show SLR above mean higher high water (the high tide line). SLR will likely affect coastal marsh lands as well as land along the Ogeechee and Savannah rivers and their tributaries. Additionally, SLR will likely increase future risk of flooding from the other flood hazards discussed in this chapter, as more land will have a lower elevation relative to sea level. For example, with much of the barrier islands and marsh land inundated, inland areas will lose their natural protection and may become susceptible to coastal flooding with velocity wave action.



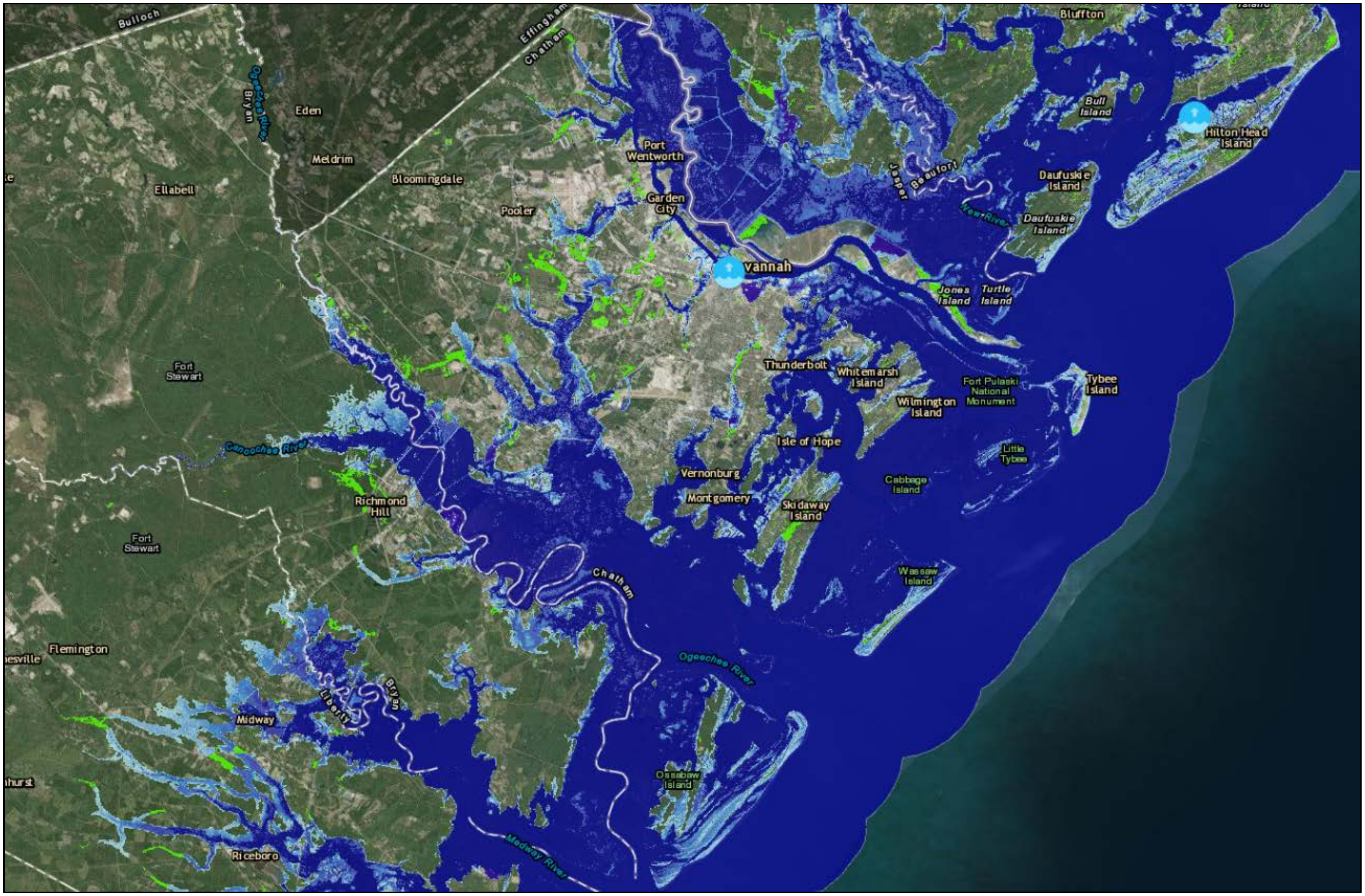
Source: NOAA Office for Coastal Management Sea Level Rise Viewer, July 2017

Figure 6.3 – Estimated Impact of 2 Foot SLR on Chatham County



Source: NOAA Office for Coastal Management Sea Level Rise Viewer, July 2017

Figure 6.4 – Estimated Impact of 3 Feet SLR on Chatham County



Source: NOAA Office for Coastal Management Sea Level Rise Viewer, July 2017

Figure 6.5 – Estimated Impact of 4 Feet SLR on Chatham County

6.4.2 Dam Failure

Probability	Impact	Spatial Extent	Warning Time	Duration
Unlikely	Minor	Negligible	< 6 hours	< 6 hours

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, regular monitoring is still necessary to prevent these events from occurring.

The 2014 Georgia Infrastructure Report Card prepared by ASCE, gave Georgia dams a grade of D- for a low level of staff and funding as well as an increase in regulated dams and a high percentage of high-hazard dams considered deficient. This report indicates a high level of vulnerability in the State to dam failure. However, given the location and size of dams in Chatham County and its nearby upstream areas, the County’s vulnerability to flooding from dam failure or overtopping is very low.

6.4.3 Flood: 100-/500-year

Probability	Impact	Spatial Extent	Warning Time	Duration
Possible	Limited	Moderate	6 to 12 hours	< 1 week

Flood damage is directly related to the depth of flooding by the application of a depth damage curve. In applying the curve, a specific depth of water translates to a specific percent damage to the structure, which translates to the same percentage of the structure's replacement value. Figure 6.6 depicts the depth of flooding that can be expected within the County during the 100-year flood event based on the July 7, 2014 Effective DFIRM.

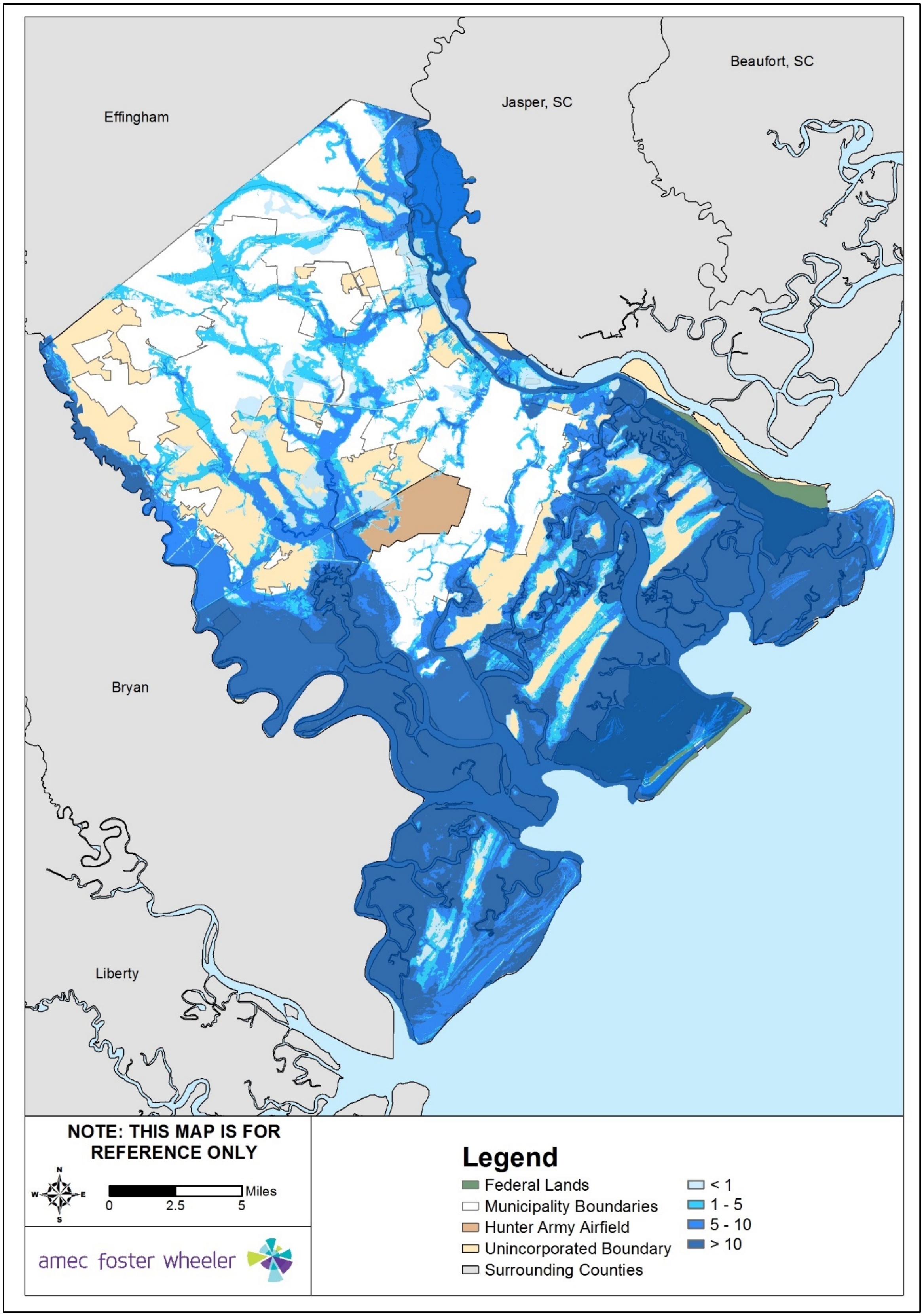
A flood risk assessment for Chatham County was performed using FEMA's Hazus tool. Building counts by FEMA flood zone were determined using a spatial intersection of the Effective FEMA flood zones and building footprints provided by the Chatham County GIS Department. The land use codes provided in the Chatham County tax parcel data were translated into the following occupancy types which are specific to FEMA's Hazus software: Agricultural, Commercial, Education, Government, Industrial, Religious and Residential. The occupancy types were standardized to ensure the correct depth damage factor was applied to each building based on its occupancy class, producing a more accurate damage assessment of the building.

Content value estimations are based on FEMA Hazus methodologies of estimating value as a percent of improved structure values by property type. Table 6.5 shows the breakdown of the different property types and their estimated content replacement value percentages.

Table 6.4 – Content Replacement Factors

Property Type	Content Replacement Values
Residential	50%
Commercial	100%
Education	100%
Government	100%
Religious	100%
Industrial	150%

Source: Hazus 2.1



Source: Depths derived from FEMA 2014 Effective DFIRM

Figure 6.6 – 100-yr Effective Flood Depths for Chatham County

Property at Risk

The loss estimate for flood is based on the total of improved building value and contents value. Land value is not included in any of the loss estimates as generally the land is not subject to loss from floods. Once the potential value of affected parcels was calculated, damage factors were applied to obtain loss estimates by flood zone.

Properties at risk are detailed by flood zone in Table 6.5, below. Building footprint data was used to provide an accurate assessment of how many buildings are located in hazard areas.

Table 6.5 – Properties at Risk by Flood Zone

Occupancy Type	Total Number of Buildings	Total Building Value	Estimated Content Value	Total Value
Zone A				
Agricultural	0	$0	$0	$0
Commercial	0	$0	$0	$0
Education	0	$0	$0	$0
Government	0	$0	$0	$0
Industrial	0	$0	$0	$0
Religious	0	$0	$0	$0
Residential	4	$1,020,366	$510,183	$1,530,549
Total	4	$1,020,366	$510,183	$1,530,549
Zone AE				
Agricultural	97	$27,615,982	$27,615,982	$55,231,964
Commercial	1,005	$184,618,041	$184,618,041	$369,236,082
Education	63	$43,699,270	$43,699,270	$87,398,540
Government	0	$0	$0	$0
Industrial	1,128	$309,721,728	$464,582,592	$774,304,320
Religious	0	$0	$0	$0
Residential	11,734	$2,420,100,851	$1,210,050,425	$3,630,151,276
Total	**14,027**	**$2,985,755,872**	**$1,930,566,310**	**$4,916,322,182**
Zone VE				
Agricultural	26	$3,089,000	$3,089,000	$6,178,000
Commercial	1	$5,656	$5,656	$11,313
Education	0	$0	$0	$0
Government	0	$0	$0	$0
Industrial	14	$471,315	$706,973	$1,178,288
Religious	0	$0	$0	$0
Residential	413	$82,143,258	$41,071,629	$123,214,887
Total	**454**	**$85,709,230**	**$44,873,258**	**$130,582,488**
Zone X (500-year)				
Agricultural	19	$2,928,616	$2,928,616	$5,857,232
Commercial	329	$113,714,304	$113,714,304	$227,428,608
Education	12	$5,303,850	$5,303,850	$10,607,700
Government	2	$0	$0	$0
Industrial	631	$148,335,477	$222,503,216	$370,838,693
Religious	1	$4,256,625	$4,256,625	$8,513,250
Residential	7302	$1,321,526,269	$660,763,134	$1,982,289,403
Total	**8,296**	**$1,596,065,141**	**$1,009,469,745**	**$2,605,534,886**
Zone X (Unshaded)				
Agricultural	30	$4,233,883	$4,233,883	$8,467,766

Commercial	2,438	$712,346,959	$712,346,959	$1,424,693,918
Education	9	$1,097,300.00	$1,097,300	$2,194,600
Government	2	$0	$0	$0
Industrial	397	$975,160,495	$1,462,740,743	$2,437,901,238
Religious	17	$36,785,075	$36,785,075	$73,570,150
Residential	11,774	$1,391,106,756	$695,553,378	$2,086,660,134
Total	**14,667**	**$3,120,730,468**	**$2,912,757,338**	**$6,033,487,806.00**

Table 6.5 shows the building count, total value, estimated damages and loss ratio for buildings that fall within the 100-year floodplain of the Effective FIRM, detailed by land use type.

The loss ratio is the loss estimate divided by the total potential exposure (i.e., total of improved and contents value for all buildings located within the 100-year floodplain) and displayed as a percentage of loss. FEMA considers loss ratios greater than 10% to be significant and an indicator a community may have more difficulties recovering from a flood. Loss ratios for all occupancy types with identified structures in Chatham County are well above 10%, meaning that in the event of a flood with a magnitude of the 1%-annual-chance event or greater, the County would face extreme difficulty in recovery. Even smaller, more probabilistic floods may also result in the County having difficulty recovering.

Table 6.6 – Estimated Building Damage and Content Loss

Occupancy Type	Total Number of Buildings with Loss	Total Value (Building & Contents)	Estimated Building Damage	Estimated Content Loss	Estimated Total Damage	Loss Ratio
Agricultural	73	$37,832,008	$2,937,363	$8,298,888	$11,236,251	29.7%
Commercial	542	$232,663,013	$8,284,789	$25,826,279	$34,111,068	14.7%
Education	56	$58,941,192	$2,401,055	$15,177,131	$17,578,186	29.8%
Government	0	--	--	--	--	--
Industrial	715	$626,046,635	$27,695,636	$55,716,850	$83,412,486	13.3%
Religious	0	--	--	--	--	--
Residential	7078	$2,338,943,317	$400,112,028	$218,105,946	$618,217,974.00	26.4%
Total	**8464**	**$3,294,426,165**	**$441,430,871**	**$323,125,094**	**$764,555,965**	**23.2%**

Source: Hazus v.2, FEMA 2014 Effective DFIRM

Population at Risk

A separate analysis was performed to determine the population at risk in each FEMA flood zone. Using GIS, the DFIRM flood zones were intersected with the building footprint layer. Those residential buildings that intersected the flood zones were counted and multiplied by a household factor for Chatham County of 2.55. This household factor was derived from a weighted average of the 2011-2015 American Community Survey's average household size for owner- and renter-occupied housing. The resulting estimates of population at risk are shown in Table 6.7.

Table 6.7 – Chatham County Population at Risk to Flood

Flood Zone	Residential Property Count	Population at Risk
Zone VE	413	1,053
Zone AE	11,734	29,922
Zone A	4	10
Zone X (500-yr)	7,302	18,620
Zone X (unshaded)	11,744	29,947
Total	**31,225**	**79,552**

Source: FEMA, U.S. Census Bureau 5-year Community Survey (2011-2015)

Critical Facilities at Risk

A separate analysis was performed to determine critical facilities located in the 100- and 500-year floodplains. Using GIS, the DFIRM flood zones were overlaid on the critical facility location data. Critical facilities are detailed by facility type and flood zone in Table 6.8. Figure 6.7 depicts the location of these critical facilities relative to flood zones for the Effective FIRM.

Table 6.8 – Critical Facilities by Flood Zone

Facility Name	Location	Facility Type	Estimated 100-yr Flood Depth (Ft)
Zone AE			
Booster Station	Lathrop Ave	Water	1.96
COLONIAL OIL GROUP	101 N LATHROP	Hazmat	4.93
County Causton Mechanical Bri	Hwy 80 East	Transportation	17.18
County Lift Station	Rice Mill	Water	2.13
County Lift Station	3 Paxton	Water	4.88
County Lift Station	Central	Water	2.25
County Lift Station	Galebreak	Water	2.36
County Lift Station	Hopecrest	Water	1.91
County Lift Station	Modena Island	Water	1.39
County Lift Station	Salcedo	Water	-0.92
County Lift Station	Wylly Island	Water	3.47
County Skidaway Isl Draw Brid	Diamond Causeway	Transportation	15.31
County Water Well	Diamond Causweay	Water	-11.46
County Water Well	Kings Ferry	Water	4.10
Crawford Landing Airport	Crawford Landing	Transportation	3.30
Generator - Kayton Canal Water	Kayton Street Statio	Water	3.31
Oatland Island Education Cent	711 Sandtown Road	Cultural	7.02
Old Fort Jackson	1 Fort Jackson Rd.	Cultural	6.06
President St. WPCP	1400 President St.	Water	1.50
Pump Station #2	Coldstream Road	Water	0.47
Sav Lift Stations #012	Halcyon Bluff / Lavon Ave. & 8815 Whitfield Ave.	Water	6.12
Sav Lift Stations #037	Battery Point / 212 Stonebridge Ln. & Bobstay Ct.	Water	5.15
Sav Lift Stations #039	Wilmington Park / 1121 Wilmington Island Rd. & Devonshire Rd.	Water	3.95
Sav Lift Stations #043	Manchester / 110 Manchester Ct. & Wellington Ct.	Water	1.31
Sav Lift Stations #048	Piggly Wiggly / 100 Johnny Mercer Blvd. @ Wilm Townhouses	Water	6.11
Sav Lift Stations #058	Woodridge / 803Woodridge Dr. & Walthour Rd.	Water	1.73
Sav Lift Stations #070	Betz Creek / 2 Teakwood Dr. & Point Cove Rd.	Water	2.94
Sav Lift Stations #081	Ford's Point / Ford's Pointe @ Basin Rd.	Water	1.18

Facility Name	Location	Facility Type	Estimated 100-yr Flood Depth (Ft)
Sav Lift Stations #102	Bull River Shoals / Johnny Mercer @ 100 River Walk Dr.	Water	-2.33
Sav Lift Stations #103	Sheftall Landings / 2 Bradford Ct. @ Penn Waller	Water	5.97
Sav Lift Stations #105	Old Town / 101-L Brompton Rd. & Dorsey Ct.	Water	0.41
Sav Lift Stations #108	Village Green Lift Station - 599 King George Blvd. behind 210 Westminister	Water	0.87
Sav Lift Stations #109	Forest Cove / 105 Sea Ln. south of Mariner's Way	Water	0.40
Sav Lift Stations #110	Westwing Landing / 450 Johnny Mercer Blvd.	Water	9.09
Sav Lift Stations #117	Whitemarsh #2 / Johnny Mercer Blvd. behind 141 Summer Winds	Water	0.14
Sav Lift Stations #118	Long Point #1 / 205 Lyman Hall Rd. @ Grays Creek Dr.	Water	5.64
Sav Lift Stations #121	Dutch Island #1 / Behind 263 Meriweather Dr.	Water	7.33
Sav Lift Stations #126	Grove Point / Hwy. 204 @ 1499 Grove Point Rd.	Water	3.91
Sav Lift Stations #129	Windfield / 5707 LaRoche Ave. @ Windfield Dr.	Water	-7.60
Sav Lift Stations #134	Southbridge #1 / Wedgefield Crossing @ 415 Southbridge	Water	0.88
Sav Lift Stations #144	Marsh Harbor / 105 Marsh Harbor Dr.	Water	-0.15
Sav Lift Stations #146	Long Point #2 / Lyman Hall Rd. & Johnny Mercer	Water	-0.18
Sav Lift Stations #161	Wilmington Golf Course / 501 Wilmington Isl Rd.	Water	-2.21
Sav Lift Stations #162	Southbridge #2 / 105 Greenview Drive @ Southbridge Blvd.	Water	0.17
Sav Lift Stations #175	Village of Vallambrosa /	Water	3.61
Sav Lift Stations #180	Northport #2 / International Trade Pkwy. Georgia Ports	Water	-1.00
Sav Lift Stations #197	Rice Mill / 183 Rice Mill Rd.	Water	2.25
Sav Lift Stations #198	Wild Heron Villas / 240 Wild Heron Rd.	Water	1.06
Sav Well #20	Sapelo Rd. @ Pennwaller	Water	2.84
Sav Well #21	Wellington Cir. @ Millward Rd. 31410	Water	3.97
Sav Well #22	Wilmington Island Rd. @ Cromwell	Water	3.68
Sav Well #28	Bryan Wood Rd. @ Hwy 80	Water	-0.02
Sav Well #30	King George Blvd.14 Beaver Run Dr.	Water	2.17
Sav Well #32	Johnny Mercer Blvd. & Hwy 80	Water	0.28
Sav Well #33	401 Herb River Dr.	Water	2.37
Sav Well #39	Same as Site #28	Water	5.08
Savannah-Ogeechee Canal Society	681 Fort Argyle Rd.	Cultural	2.47
Skidaway Institute of Oceanography Library	10 Ocean Science Cir	Cultural	2.44
Southside Fire Dept Sta # 02	1831 East Montgomery Crossroads	Fire	-1.93
Southside Fire Dept Sta # 05	553 McWhorter Dr	Fire	-0.36
Southside Fire Dept Sta # 07	1440 Grove Point Rd	Fire	3.25

Facility Name	Location	Facility Type	Estimated 100-yr Flood Depth (Ft)
Southside Fire Dept Sta # 08	4800 US Hwy 80 East	Fire	-0.70
Storm Water Pump Station	President St	Water	3.55
Storm Water Pump Station	Fell St/Georgia Port	Water	14.06
University of Georgia - Skidaway Aquarium	20 & 30 Ocean Science Cir	Cultural	1.46
VOPAK Terminal	Brampton Rd	Hazmat	-0.30
Waste Water Mgmt Bldg	Agonic Road	Water	1.63
Water Tank	Sapelo Road - 500,000 Gallons	Water	4.49
Wormsloe State Historic Site	7601 Skidaway Rd.	Cultural	3.03
Zone A			
N/A	N/A	N/A	N/A
Zone A			
N/A	N/A	N/A	N/A
Zone VE			
County Water Well	Island Expressway	Water	9.88
Zone X Shaded (500-yr)			
Bethesda Museum	9520 Ferguson Ave.	Cultural	0
Islands Branch Library	125 Wilmington Island Rd.	Cultural	0
Southside Fire Dept Sta # 09	59 Log Landing Rd	Fire	0
Fire Station #15	740 Chevis Road	Fire	0
Isle of Hope Fire Station	409 Parkersburg Rd (Isle of Hope)	Fire	0
Southside Fire Dept Sta # 04	155 Wilmington Island Road	Fire	0
Southside Fire Dept Sta # 10	4501 Ogeechee Road	Fire	0
Wilmington Land Fill	Wilmington Island Road	Government	0
Frank G Murray Center	160 Whitemarsh Rd	Government	0
Police Precinct #5 (County)	54 Johnny Mercer Blvd	Police	0
Isle of Hope Elementary	100 Parkersburg Rd.	School	0
Howard Elementary	115 Wil. Island Rd.	School	0
Islands High	170 Whitmarsh Is. Rd	School	0
Marshpoint Elementary	135 Whitemarsh Isl R	School	0
Coastal Middle	4595 US 80 East	School	0
Sav Lift Stations #132	Mistwoode / 9312 Whitfield Ave. @ Mistwoode Lane	Water	0
County Lift Station	The Colony	Water	0
Sav Lift Stations #199	Habitat / 210 Habitat Dr.	Water	0
County Lift Station	21 Nancy Place	Water	0
County Lift Station	Marian Circle	Water	0
Sav Lift Stations #153	Lexington / Walthour Rd. @ Penn Waller 8 Ballastone	Water	0

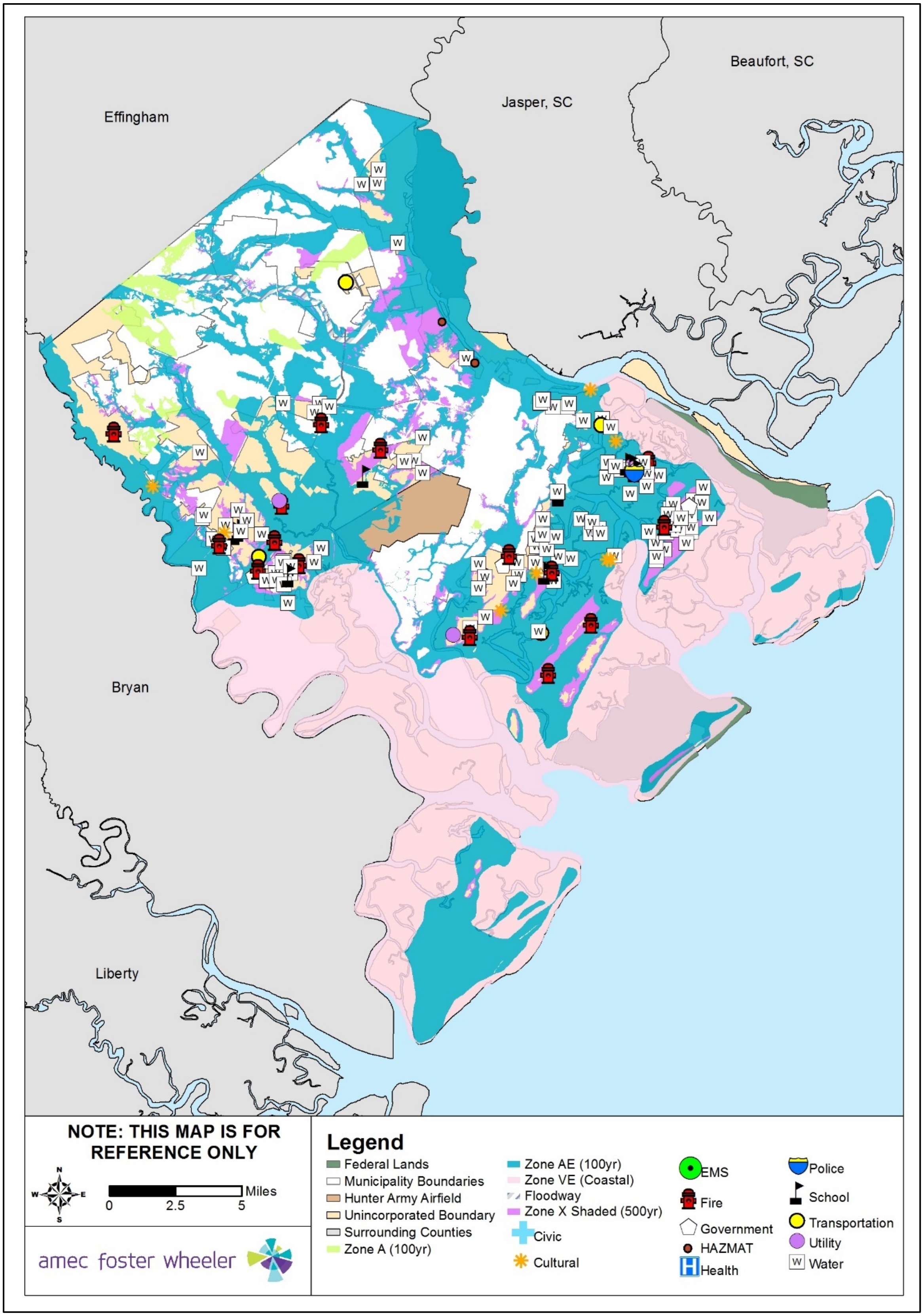
Facility Name	Location	Facility Type	Estimated 100-yr Flood Depth (Ft)
Sav Well #34	840 Kolb Dr.	Water	0
Sav Lift Stations #130	Dutch Island #2 / 153 Dutch Island Dr. @ Meriweather Dr.	Water	0
Sav Lift Stations #157	Henderson Lake / Hwy. 17 @ Hwy 204 on Brown Thrush Rd	Water	0
Sav Lift Stations #069	Deerwood Lift Station / Can Station Deerwood Rd. & Cromwell Place	Water	0
Sav Well #38	Dutch Island Dr.@ Verdell Dr.	Water	0
Sav Well #24	Off Leaning Oaks Dr. (Cobb Rd. @ Pennwaller)	Water	0
Sav Lift Stations #124	Shell House Restaurant / 8 Gateway Blvd. & Hwy. 204	Water	0
Sav Lift Stations #112	Buccaneer Trace / 1 Lantern Lane @ Cromwell Rd.	Water	0
Sav Lift Stations #079	Brown Thrush / 300-P Brown Thrush Rd. @ Vahalla Dr.	Water	0
Sav Lift Stations #104	Oemler Loop / 604 Walthour Rd. @ Palmetto Cove Rd.	Water	0
Sav Lift Stations #038	Wilmington Park Islandwood / 29 Sapelo Rd. & Port Royal Dr.	Water	0
Sav Lift Stations #142	Crows Nest / 3-L Wilmington Island Rd. & Burns Lane	Water	0
County Well	Charlie Brooks Park	Water	0
Sav Well #25	Gamble Rd. @ Hwy 17	Water	0
Sav Lift Stations #119	Marshes / East US Hwy. 80 @ Johnny Mercer Blvd	Water	0
Sav Lift Stations #131	Whitemarsh #1 / 4777 East US Hwy 80 @ Johnny Mercer Dr.	Water	0
Sav Lift Stations #120	Sam's / 3609 Ogeechee Rd.	Water	0
County Lift Station	Runaway Point	Water	0
Sav Lift Stations #067	Southeastern Shipyard / Walstrom @ 42 Forbes	Water	0

Source: Chatham County, FEMA 2014 Effective DFIRM

Critical facilities located in the Unshaded Zone X are summarize in Table below. No cultural, HAZMAT, or Police critical facilities are located in these areas.

Table 6.9 – Critical Facilities in Zone X Unshaded

Facility Type	Count
Fire	6
Government	3
School	6
Transportation	1
Utility	2
Water	33



Source: Chatham County, FEMA 2014 Effective DFIRM

Figure 6.7 – Critical Facilities and FEMA Flood Zones, Effective FIRM

Flood Insurance Analysis

One valuable source of information on flood hazards is current flood insurance data for active policies and past claims. Flood insurance is required as a condition of federal aid or a mortgage or loan that is federally insured for a building located in a FEMA flood zone.

Chatham County has been a Regular participant in the NFIP since August 1980 and a participant in the CRS program since October 2009. Participation in the NFIP's Community Rating System at a Class 9 or better rewards all policyholders in the County with percent reduction in their flood insurance premiums. Chatham County is currently a Class 6 community, which provides a 20% discount to policyholders in the SFHA. Table 6.9 through Table 6.12 reflect NFIP policy and claims data for the County categorized by structure type, flood zone, Pre-FIRM and Post-FIRM.

Table 6.10 – NFIP Policy and Claims Data by Occupancy Type – Chatham County

Occupancy	Policies in Force	Total Premium	Insurance in Force	Number of Closed Paid Losses	Total of Closed Paid Losses
Single Family	15,402	$11,078,385	$4,545,986,800	757	$9,398,374.52
2-4 Family	169	$78,305	$34,836,100	17	$105,998.89
All Other Residential	1,115	$388,635	$192,432,200	13	$428,844.33
Non Residential	401	$657,619	$174,532,400	40	$1,322,462.17
Total	17,087	$12,202,944	$4,947,787,500	827	$11,255,678.00

Source: FEMA Community Information System as of 05/31/2017

Table 6.11 – NFIP Policy and Claims Data by Flood Zone – Chatham County

Flood Zone	Policies in Force	Total Premium	Total Coverage	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	11,391	$9,249,167	$3,133,347,700	502	$7,158,535.05
A Zones	15	$17,752	$3,991,800	20	$312,398.47
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	159	$607,952	$42,551,400	5	$89,477.97
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					
Standard	239	$323,848	$65,088,400	61	$767,912.29
Preferred	5,279	$2,001,825	$1,702,675,000	224	$2,880,651.62
Total	17,083	$12,200,544	$4,947,654,300	812	$11,208,973.00

Source: FEMA Community Information System as of 05/31/2017

Table 6.12 – NFIP Policy and Claims Data Pre-FIRM – Chatham County

Flood Zone	Policies in Force	Total Premium	Total Coverage	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	2,607	$3,392,837	$677,711,400	332	$5,208,141.58
A Zones	5	$8,568	$1,374,200	20	$312,398.47
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00

Flood Zone	Policies in Force	Total Premium	Total Coverage	Number of Closed Paid Losses	Total of Closed Paid Losses
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	46	$171,542	$10,543,200	2	$78,332.83
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					
Standard	80	$116,291	$22,993,600	40	$431,698.13
Preferred	1,417	$535,995	$444,036,000	138	$1,814,444.95
Total	4,155	$4,225,233	$1,156,658,400	532	$7,845,014.00

Source: FEMA Community Information System as of 05/31/2017

Table 6.13 – NFIP Policy and Claims Data Post-FIRM – Chatham County

Flood Zone	Policies in Force	Total Premium	Total Coverage	Number of Closed Paid Losses	Total of Closed Paid Losses
A01-30 & AE Zones	8,784	$5,856,330	$2,455,636,300	170	$1,950,393.47
A Zones	10	$9,184	$2,617,600	0	$0.00
AO Zones	0	$0	$0	0	$0.00
AH Zones	0	$0	$0	0	$0.00
AR Zones	0	$0	$0	0	$0.00
A99 Zones	0	$0	$0	0	$0.00
V01-30 & VE Zones	113	$436,410	$32,008,200	3	$11,145.14
V Zones	0	$0	$0	0	$0.00
D Zones	0	$0	$0	0	$0.00
B, C & X Zone					
Standard	159	$207,557	$42,094,800	21	$336,214.16
Preferred	3,862	$1,465,830	$1,258,639,000	86	$1,066,206.67
Total	12,928	$7,975,311	$3,790,995,900	280	$3,363,958.00

Source: FEMA Community Information System as of 05/31/2017

Repetitive Loss Analysis

A repetitive loss property is a property for which two or more flood insurance claims of more than $1,000 have been paid by the NFIP within any 10-year period since 1978. An analysis of repetitive loss was completed by the County to examine repetitive loss properties against FEMA flood zones.

According to 2017 NFIP records, there are a total of 4 mitigated and 40 unmitigated repetitive loss properties within Chatham County. Table 6.15 details repetitive loss building counts, FEMA flood zones and total payment for the unmitigated properties.

Table 6.14 – Unmitigated Repetitive Loss Summary

Flood Zone[1]	Building Type		Building Count		Total Building Payment	Total Content Payment	Total Paid
	Commercial	Residential	Insured	Uninsured			
AE		X	X		$54,769.83	$25,675.37	$80,445.20
X		X	X		$21,044.41	$2,329.35	$23,373.76
AE		X	X		$83,644.40	$14,600.00	$98,244.40
AE		X	X		$10,974.67	$0.00	$10,974.67
AE		X	X		$6,107.46	$0.00	$6,107.46
AE		X	X		$27,935.85	$3,168.32	$31,104.17
A15		X		X	$6,395.41	$0.00	$6,395.41
AE		X	X		$70,012.83	$14,392.36	$84,405.19
X		X		X	$6,988.22	$316.41	$7,304.63
X		X		X	$32,340.39	$3,193.56	$35,533.95
X		X		X	$12,381.13	$0.00	$12,381.13
AE		X	X		$2,519.49	$0.00	$2,519.49
X		X		X	$21,603.84	$2,239.14	$23,842.98
AE		X	X		$59,345.87	$0.00	$59,345.87
AE		X	X		$10,070.78	$3,112.25	$13,183.03
A15		X	X		$18,730.44	$8,004.69	$26,735.13
B		X	X		$55,549.85	$41,126.54	$96,676.39
AE		X	X		$9,775.16	$0.00	$9,775.16
X		X		X	$17,976.84	$5,630.53	$23,607.37
AE		X	X		$39,681.71	$21,752.56	$61,434.27
X		X	X		$11,994.51	$0.00	$11,994.51
X		X		X	$4,849.47	$0.00	$4,849.47
X		X		X	$24,744.95	$15,304.17	$40,049.12
AE		X	X		$18,098.63	$10,642.68	$28,741.31
AE		X	X		$25,366.78	$5,900.00	$31,266.78
X		X		X	$9,390.65	$2,307.35	$11,698.00
AE		X	X		$28,438.95	$5,182.07	$33,621.02
AE		X	X		$96,295.54	$0.00	$96,295.54
AE		X	X		$51,419.58	$4,708.25	$56,127.83
X		X		X	$18,480.53	$2,914.08	$21,394.61
AE		X	X		$51,213.54	$38,638.26	$89,851.80
AE		X	X		$8,112.97	$0.00	$8,112.97
A15		X	X		$62,287.60	$0.00	$62,287.60
AE		X	X		$24,523.91	$11,740.90	$36,264.81
A15		X		X	$7,201.74	$0.00	$7,201.74
AE		X	X		$5,086.73	$0.00	$5,086.73
AE		X	X		$25,929.43	$0.00	$25,929.43
X	X			X	$11,524.26	$0.00	$11,524.26
AE		X	X		$50,163.44	$0.00	$50,163.44
AE		X	X		$4,635.66	$0.00	$4,635.66
	1	**39**	**28**	**12**	**$1,107,607.45**	**$242,878.84**	**$1,350,486.29**

Source: NFIP Repetitive Loss Data, 1/31/2017

[1]Flood Zone is based on historical FIRM when first loss occurred. These zones do not reflect the current Effective FIRM zone for each property.

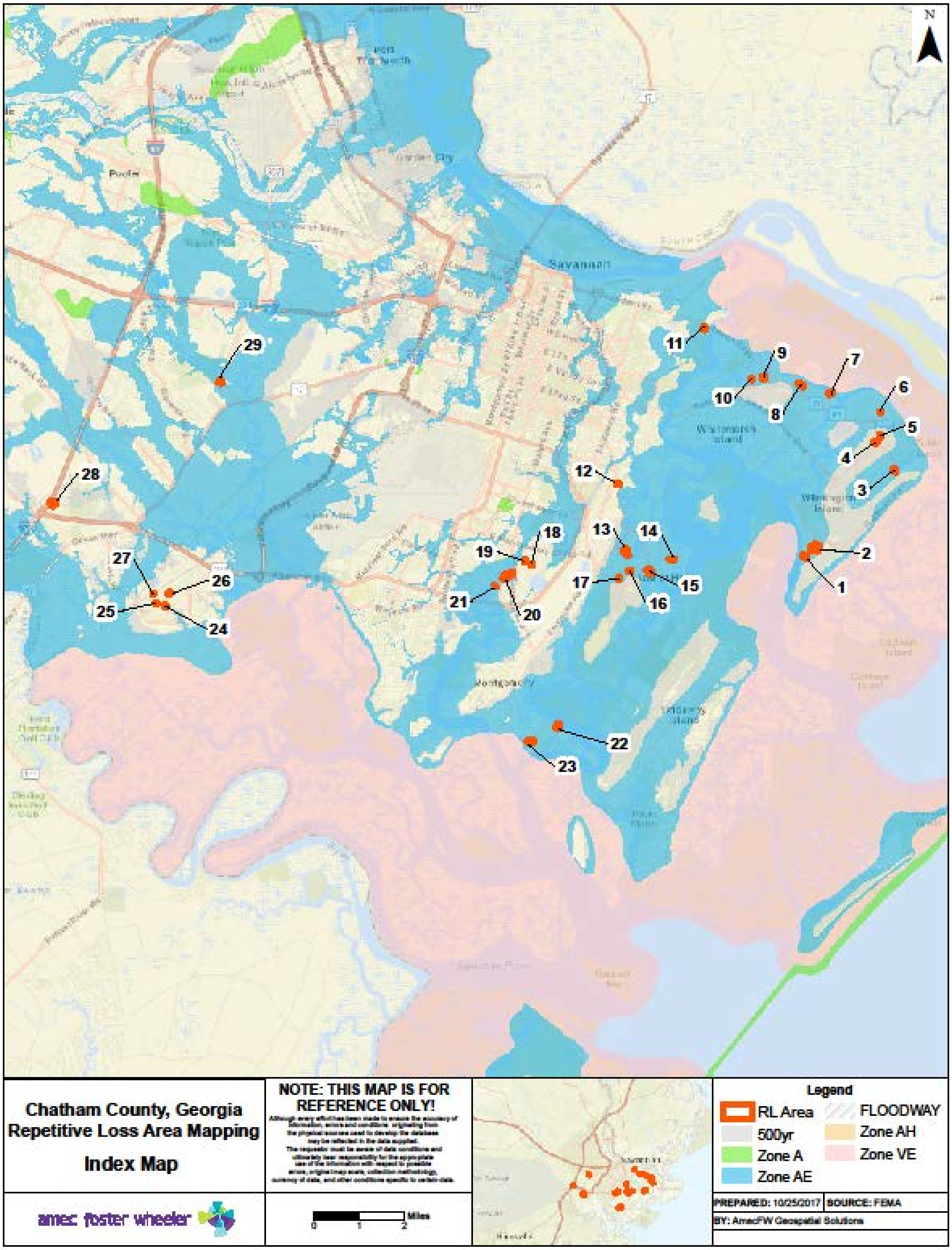
Figure 6.11 illustrates repetitive loss areas within Chatham County. The repetitive loss areas were created by identifying the unmitigated repetitive loss properties, surrounding historic loss properties and additional properties that are likely to experience the same or similar flood conditions but not have had any claims paid against the NFIP.

Repetitive Loss Area Mapping

The above list of unmitigated repetitive loss properties is not a complete list of properties at risk to repeat flood events. Additional properties with only one past flood claim or with similar flood conditions may also be at risk of becoming repetitive loss properties. In accordance with the principles outlined in the CRS guidance titled Mapping Repetitive Loss Areas dated August 15, 2008, 29 repetitive loss areas were identified in Chatham County. To classify these repetitive loss areas, the FMPC and consulting team mapped the above list of FEMA-identified repetitive loss properties along with historical claim properties (those with one claim paid against the NFIP) and identified additional surrounding properties with similar flood conditions. All of these properties should be assessed for mitigation. The resulting 29 repetitive loss areas are indexed in Figure 6.12 in relation to the FEMA flood zones and shown in detail in Figure 6.9 through Figure 6.37. The structure count within each repetitive loss area is detailed in Table 6.15 below.

Table 6.15 – Structures in Repetitive Loss Areas

Repetitive Loss Area	Number of Repetitive Loss Properties	Number of Additional Structures	Total Number of Properties
1	2	4	6
2	7	22	29
3	1	2	3
4	1	7	8
5	1	4	5
6	1	2	3
7	1	2	3
8	1	8	9
9	2	13	15
10	1	2	3
11	1	3	4
12	1	3	4
13	2	3	5
14	1	4	5
15	1	2	3
16	1	4	5
17	1	3	4
18	1	5	6
19	1	4	5
20	3	29	32
21	1	3	4
22	1	6	7
23	1	2	3
24	1	5	6
25	1	2	3
26	1	5	6
27	1	2	3
28	1	1	2
29	1	2	3
Total	**40**	**154**	**194**



Source: NFIP Repetitive Loss Data, 1/31/2017

Figure 6.8 – Chatham County Repetitive Loss Areas and FEMA Flood Zones

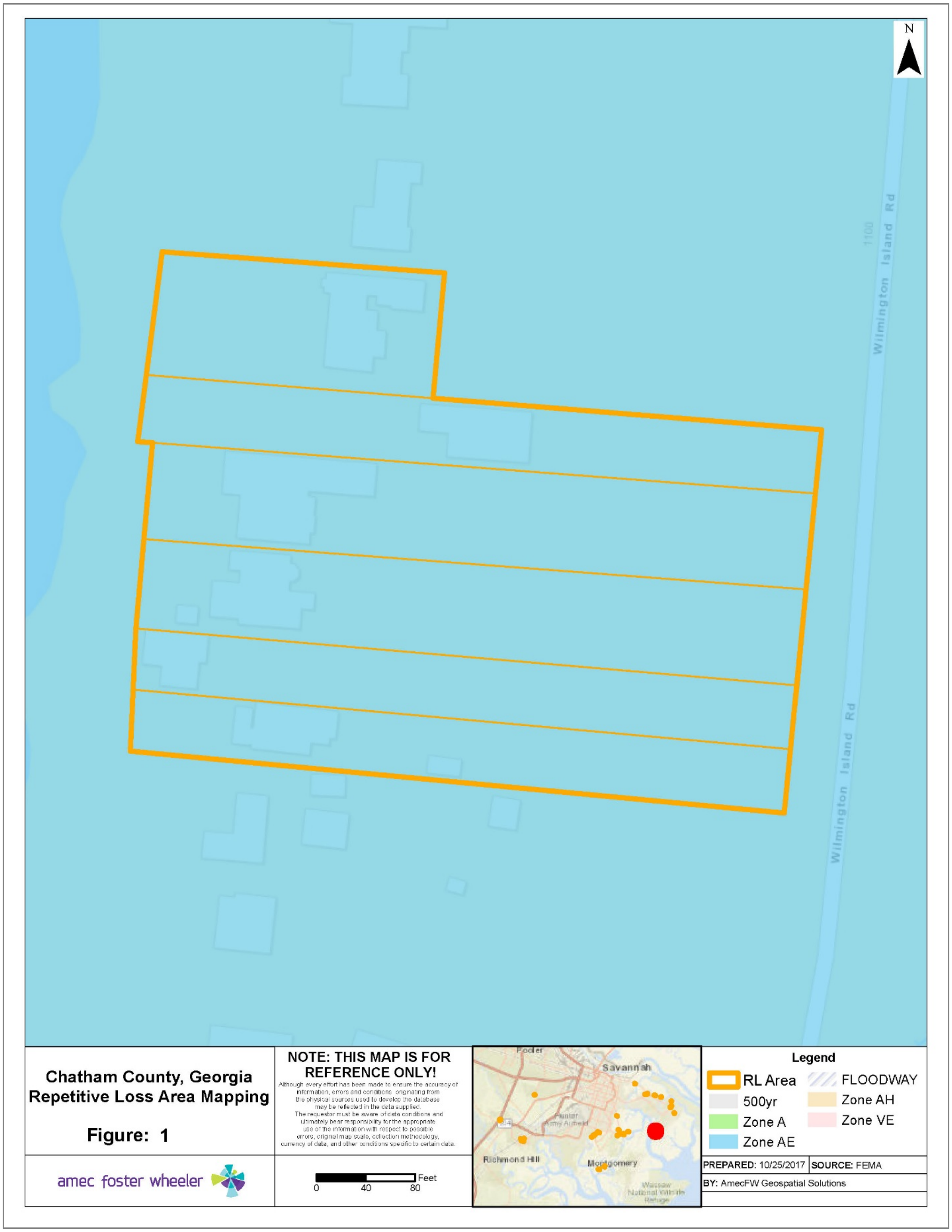


Figure 6.9 – Repetitive Loss Area Mapping, Area 1

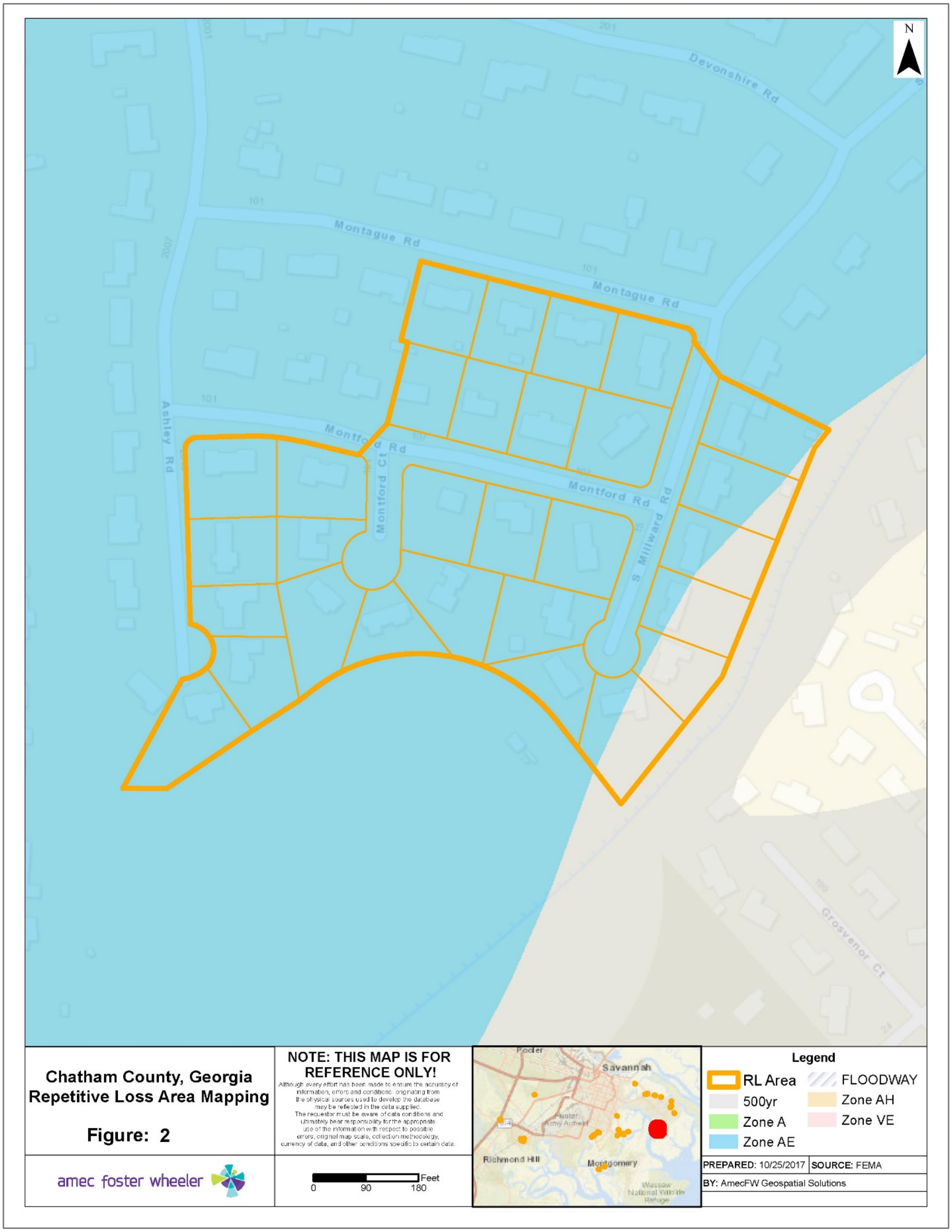


Figure 6.10 – Repetitive Loss Area Mapping, Area 2

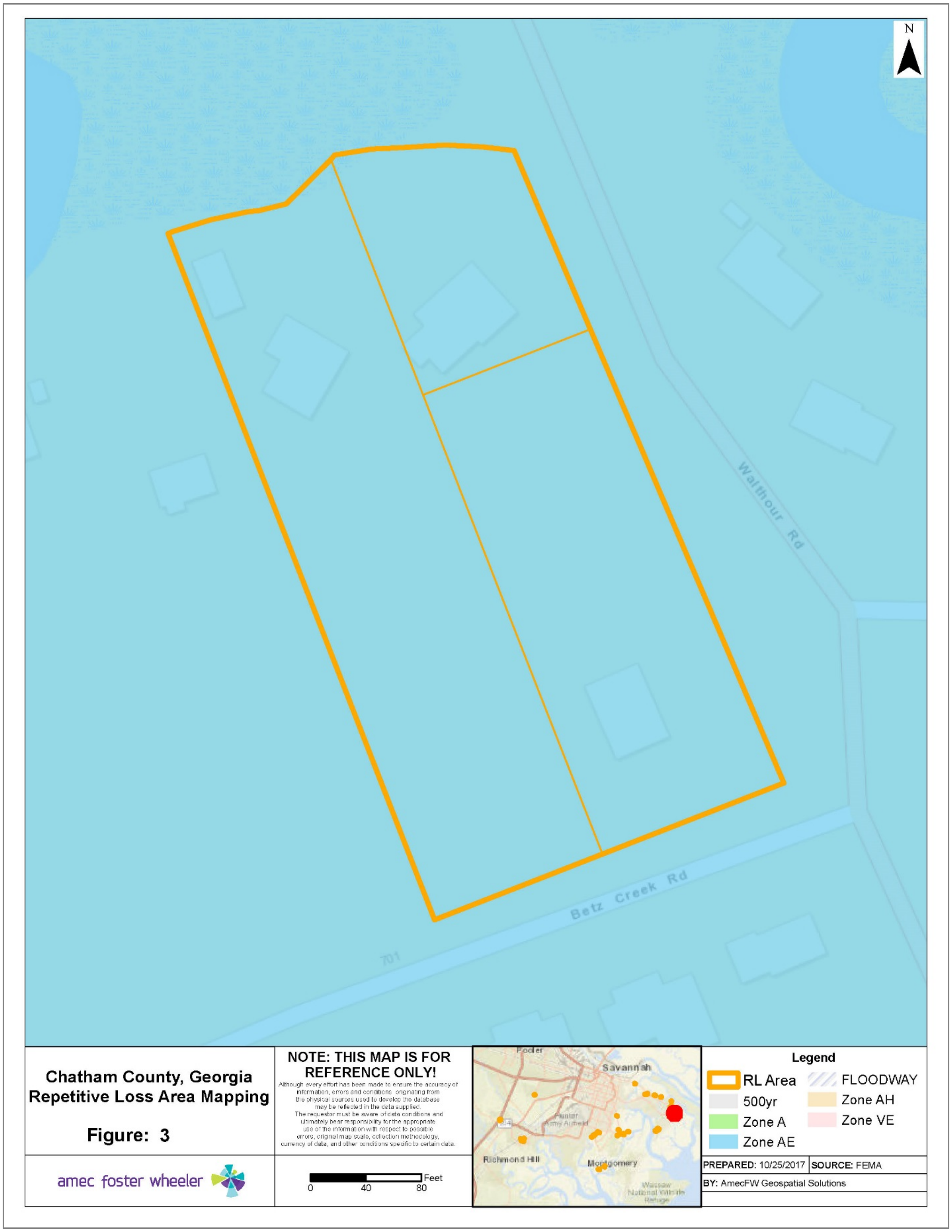


Figure 6.11 – Repetitive Loss Area Mapping, Area 3

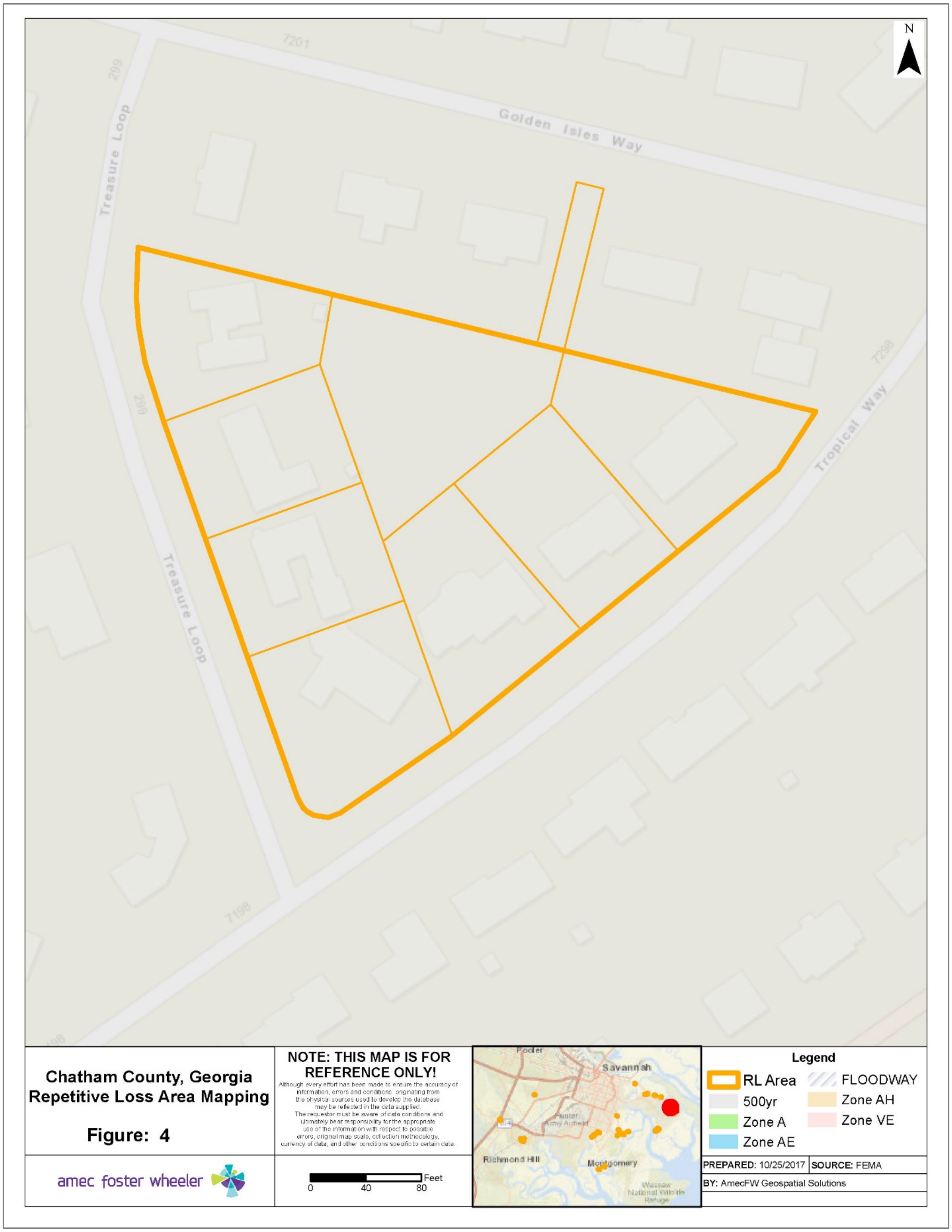


Figure 6.12 – Repetitive Loss Area Mapping, Area 4

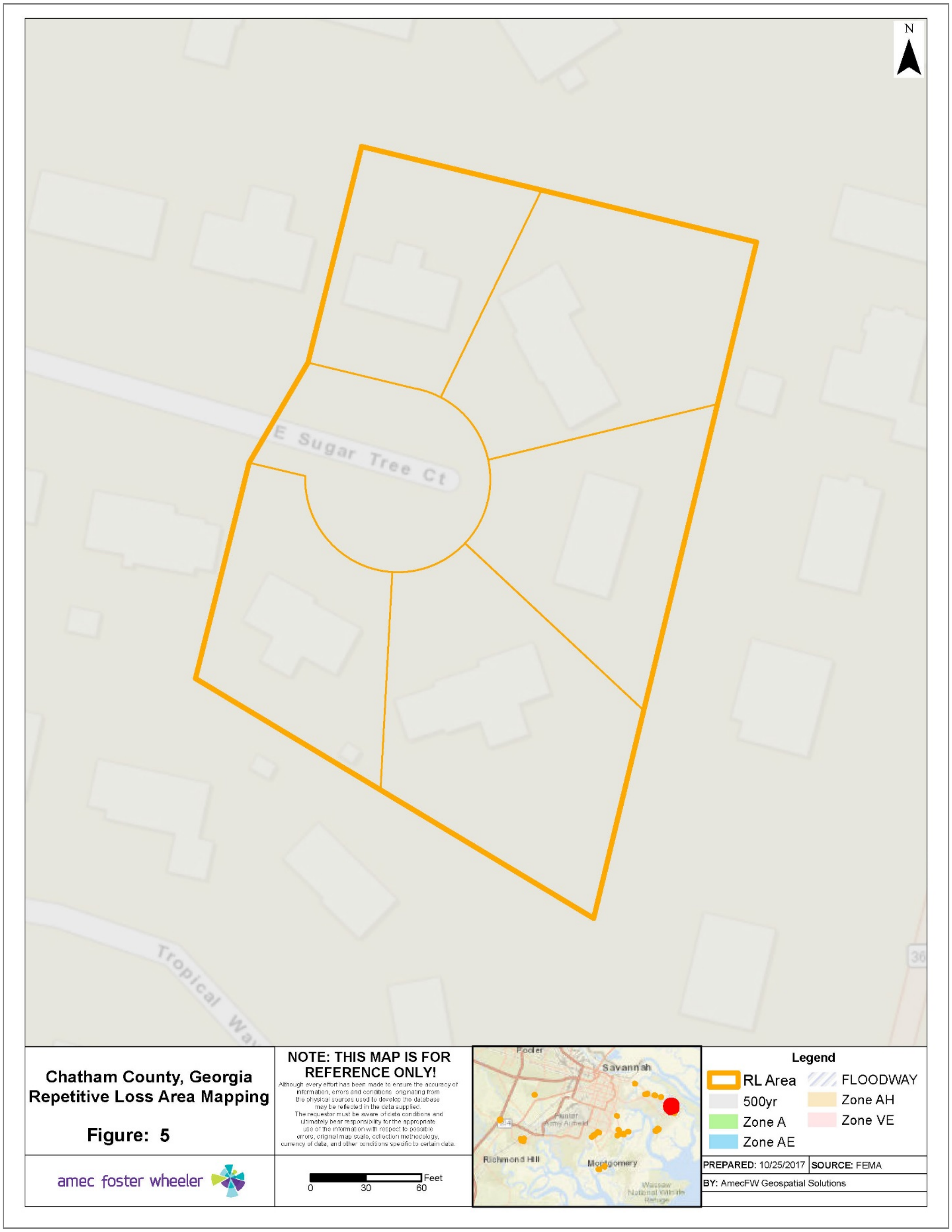


Figure 6.13 – Repetitive Loss Area Mapping, Area 5

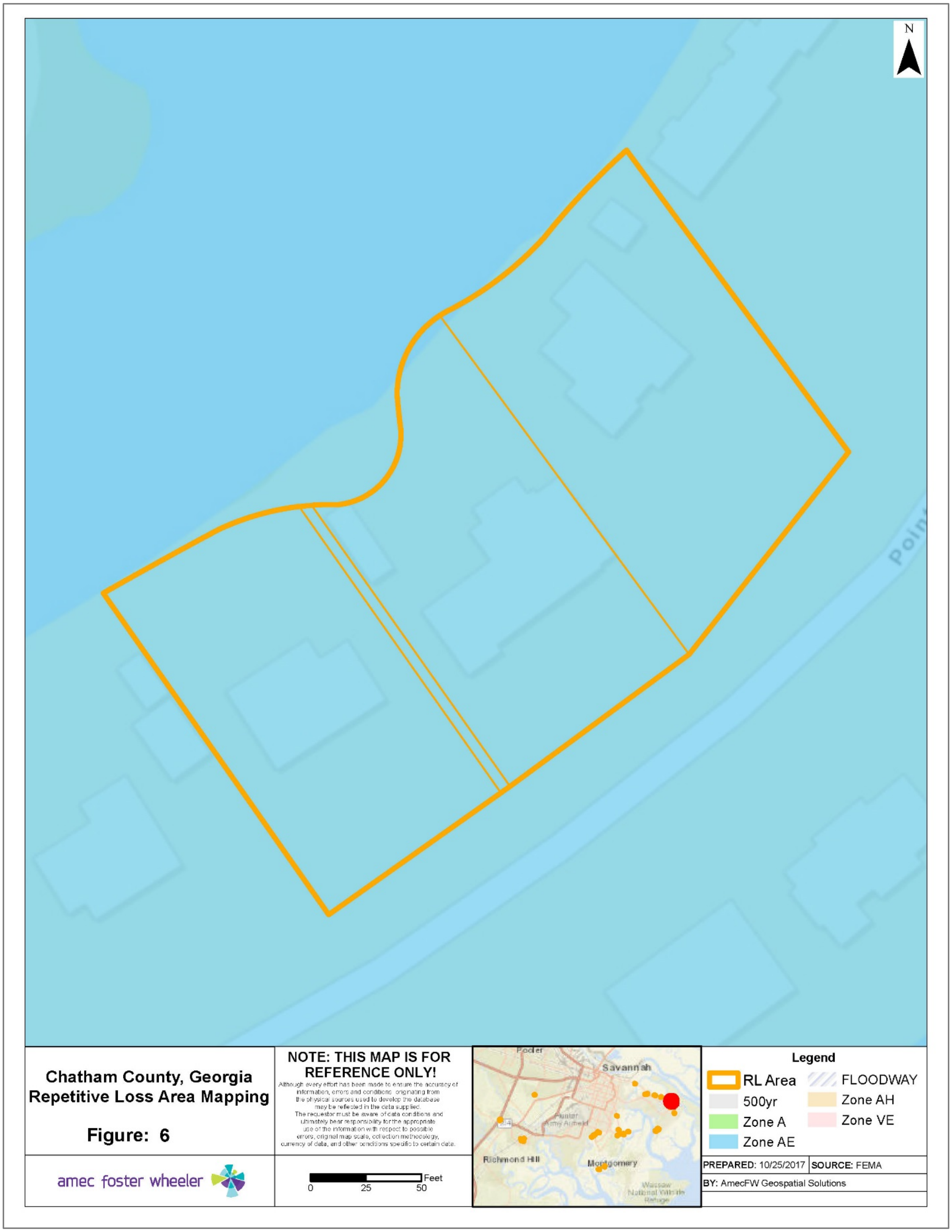


Figure 6.14 – Repetitive Loss Area Mapping, Area 6

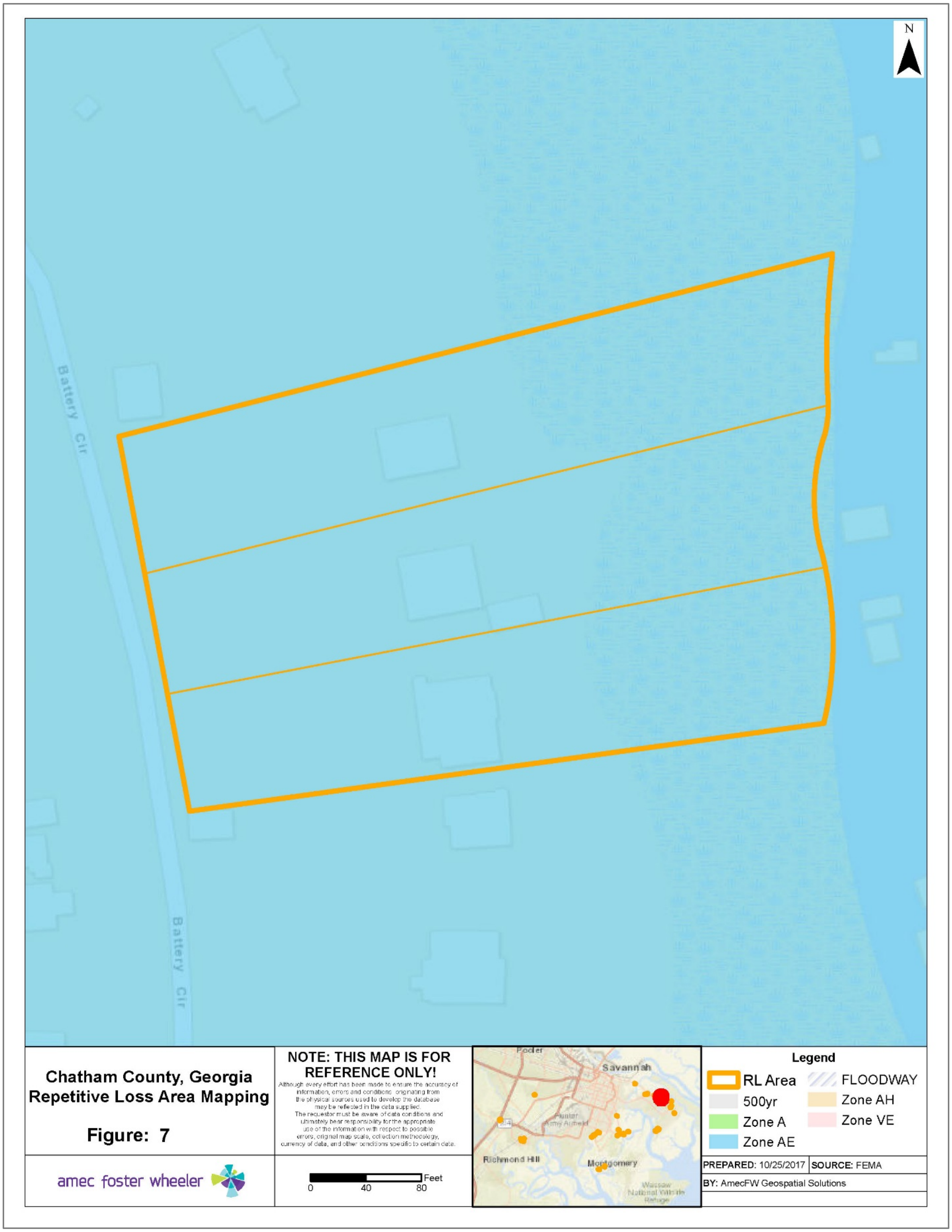


Figure 6.15 – Repetitive Loss Area Mapping, Area 7

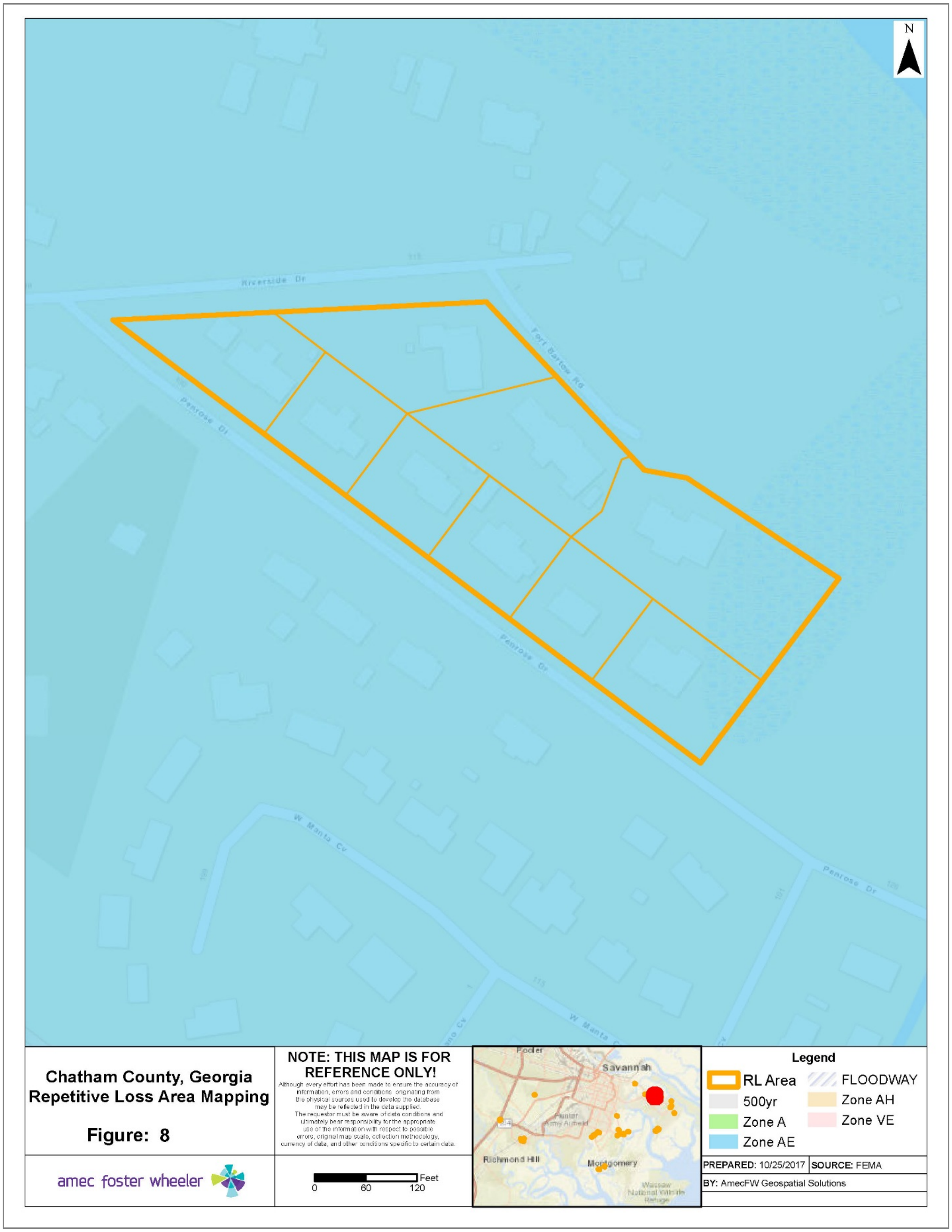


Figure 6.16 – Repetitive Loss Area Mapping, Area 8

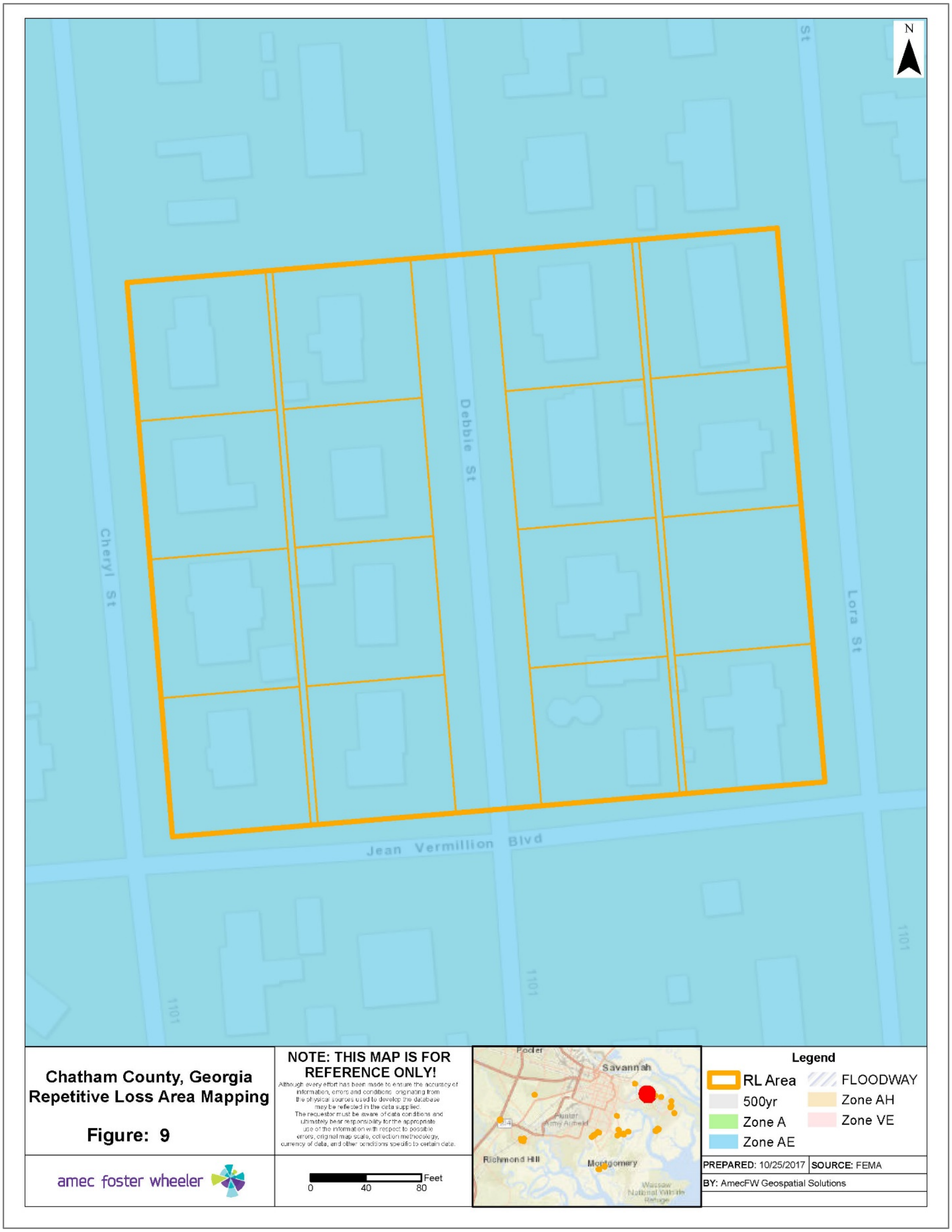


Figure 6.17 – Repetitive Loss Area Mapping, Area 9

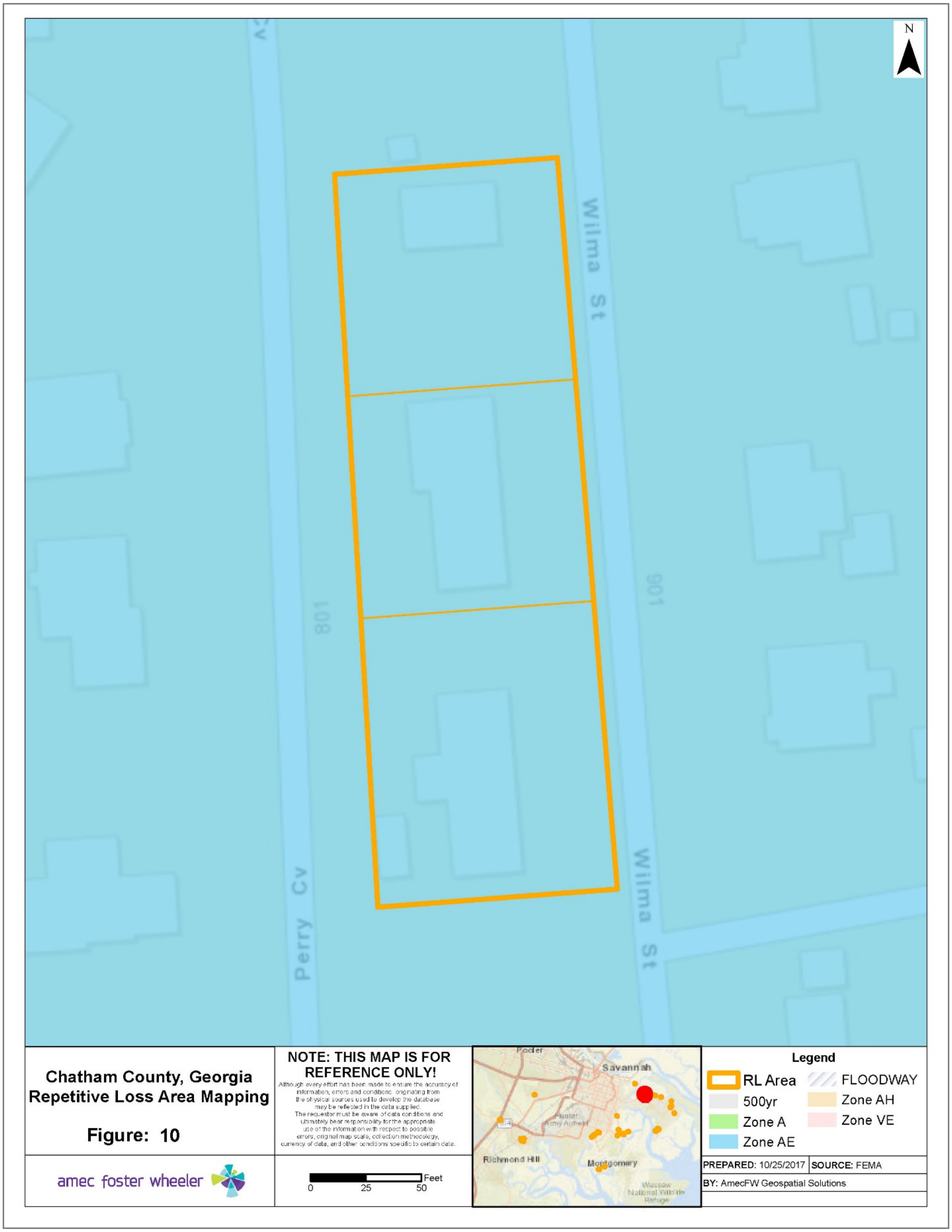


Figure 6.18 – Repetitive Loss Area Mapping, Area 10

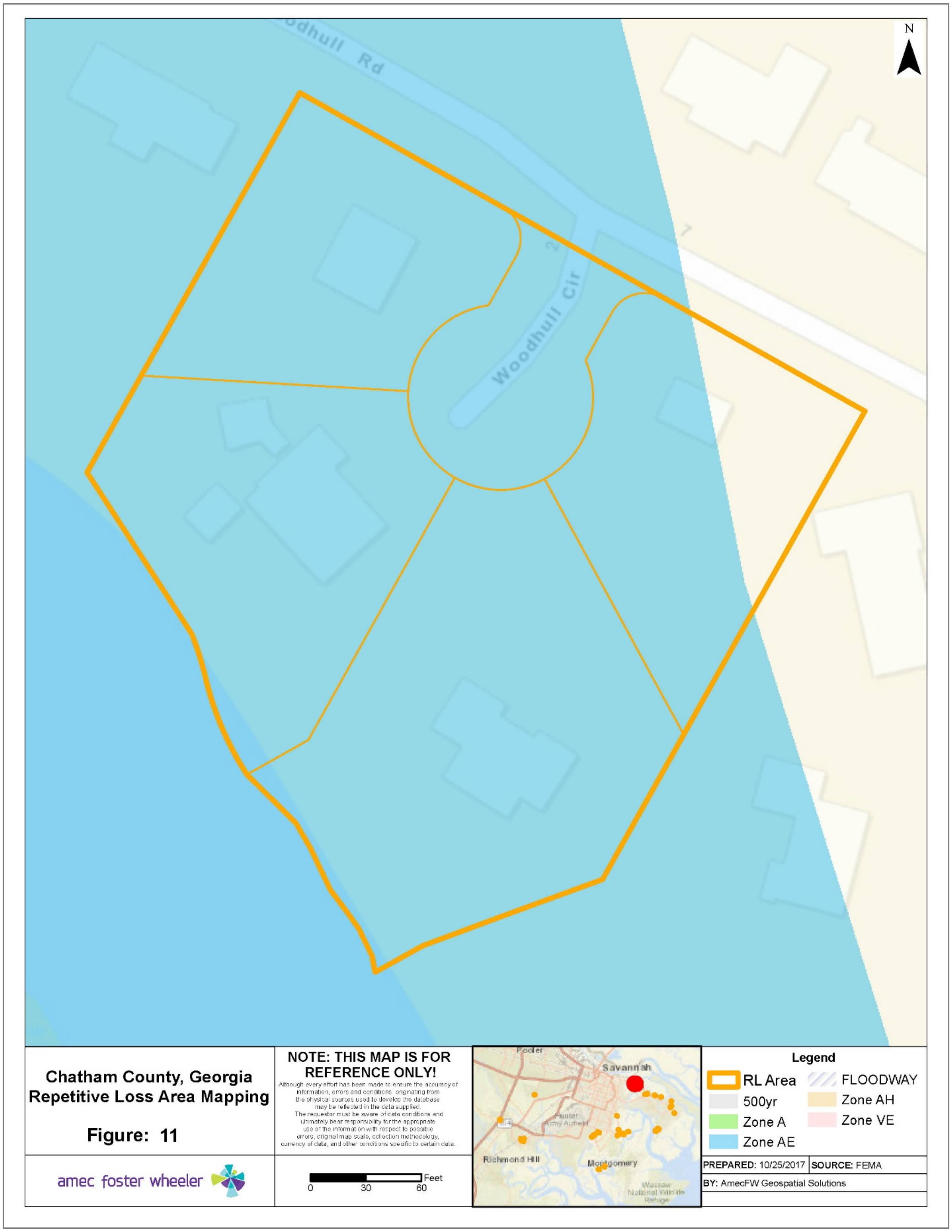


Figure 6.19 – Repetitive Loss Area Mapping, Area 11

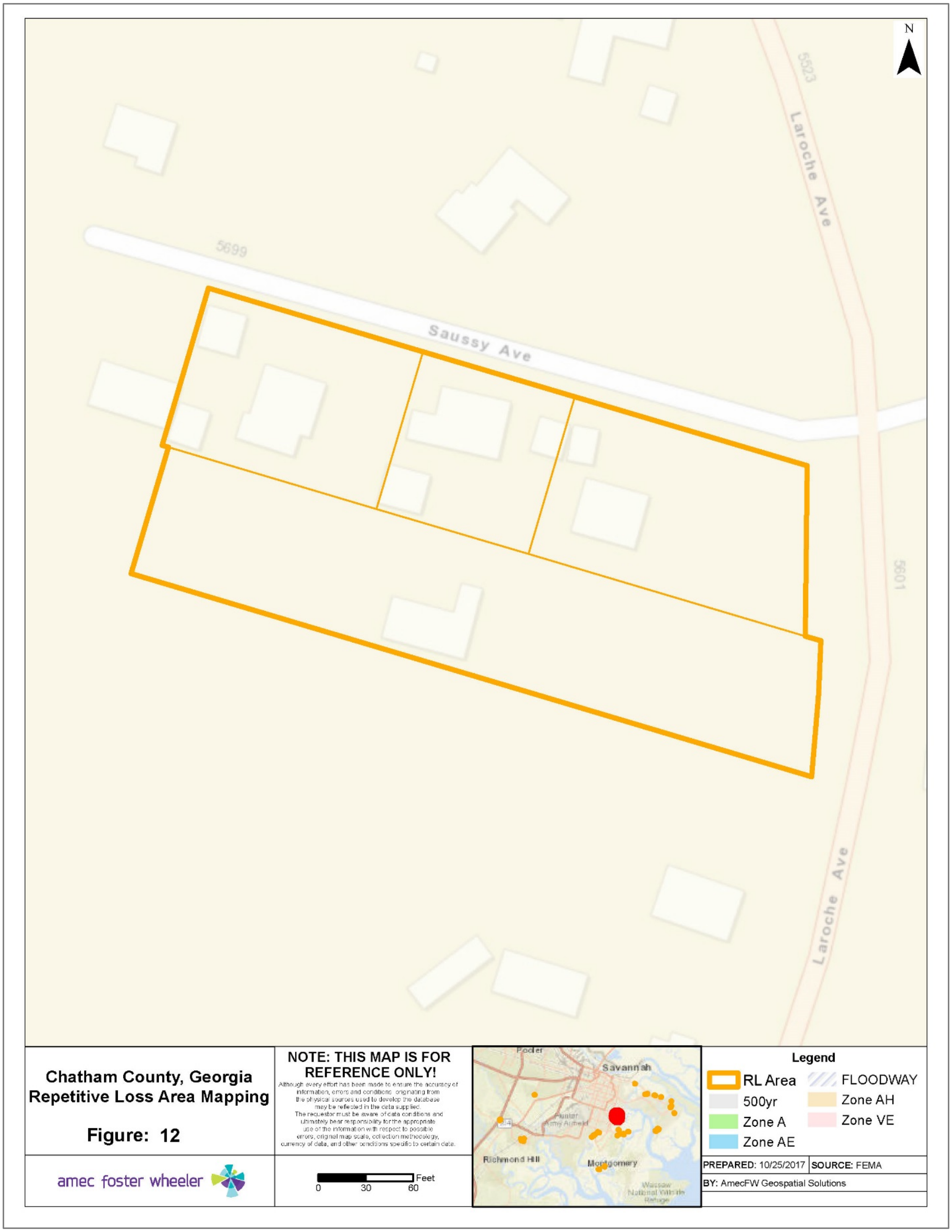


Figure 6.20 – Repetitive Loss Area Mapping, Area 12

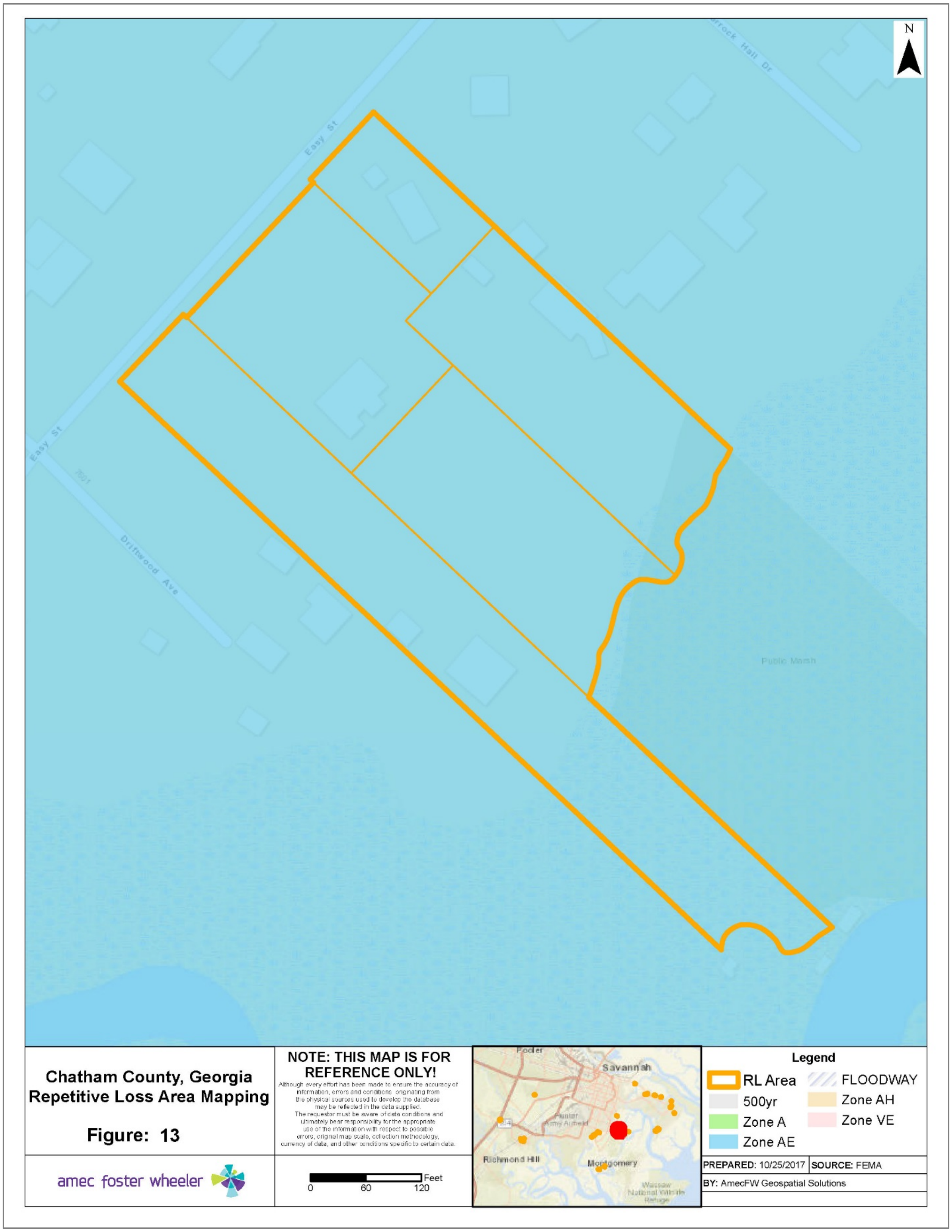


Figure 6.21 – Repetitive Loss Area Mapping, Area 13

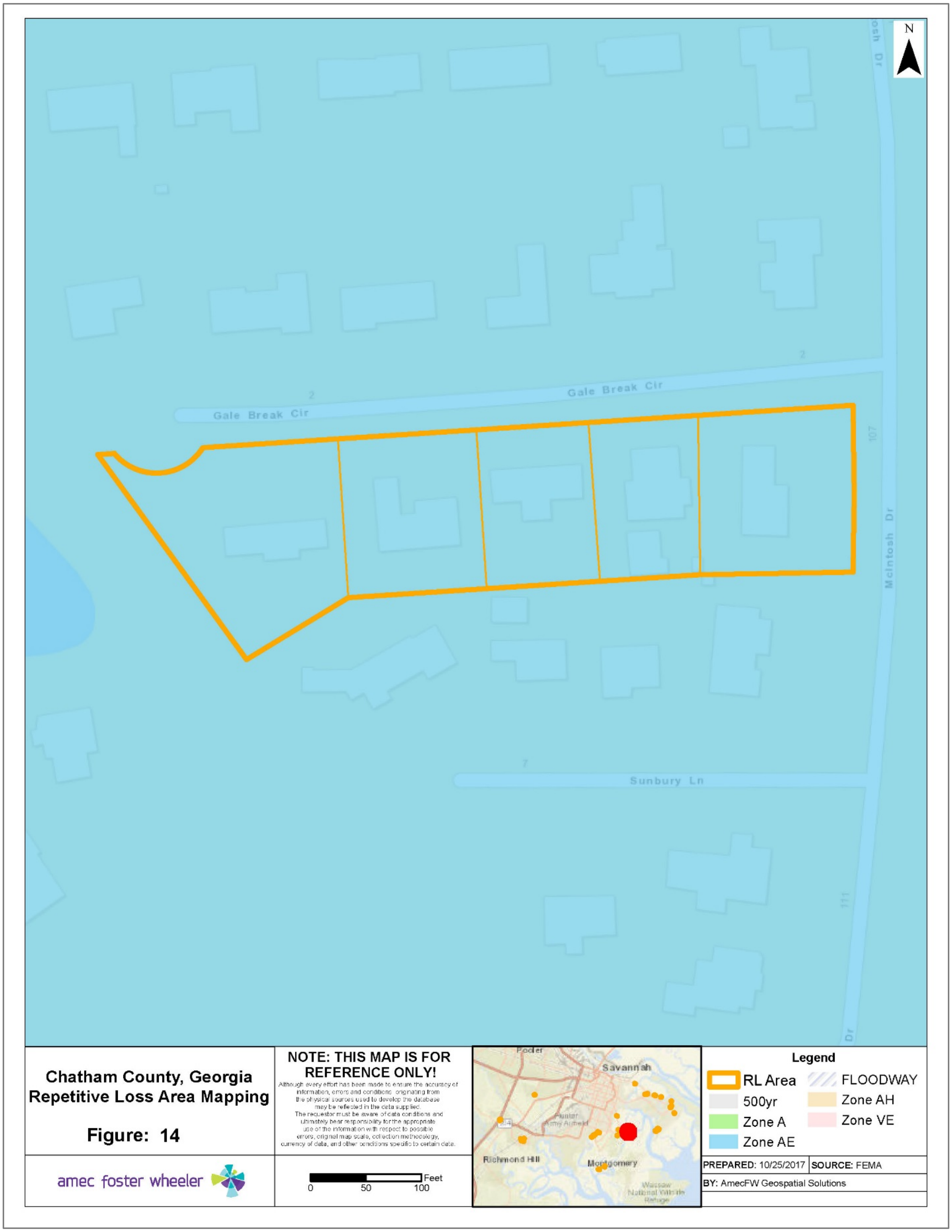


Figure 6.22 – Repetitive Loss Area Mapping, Area 14

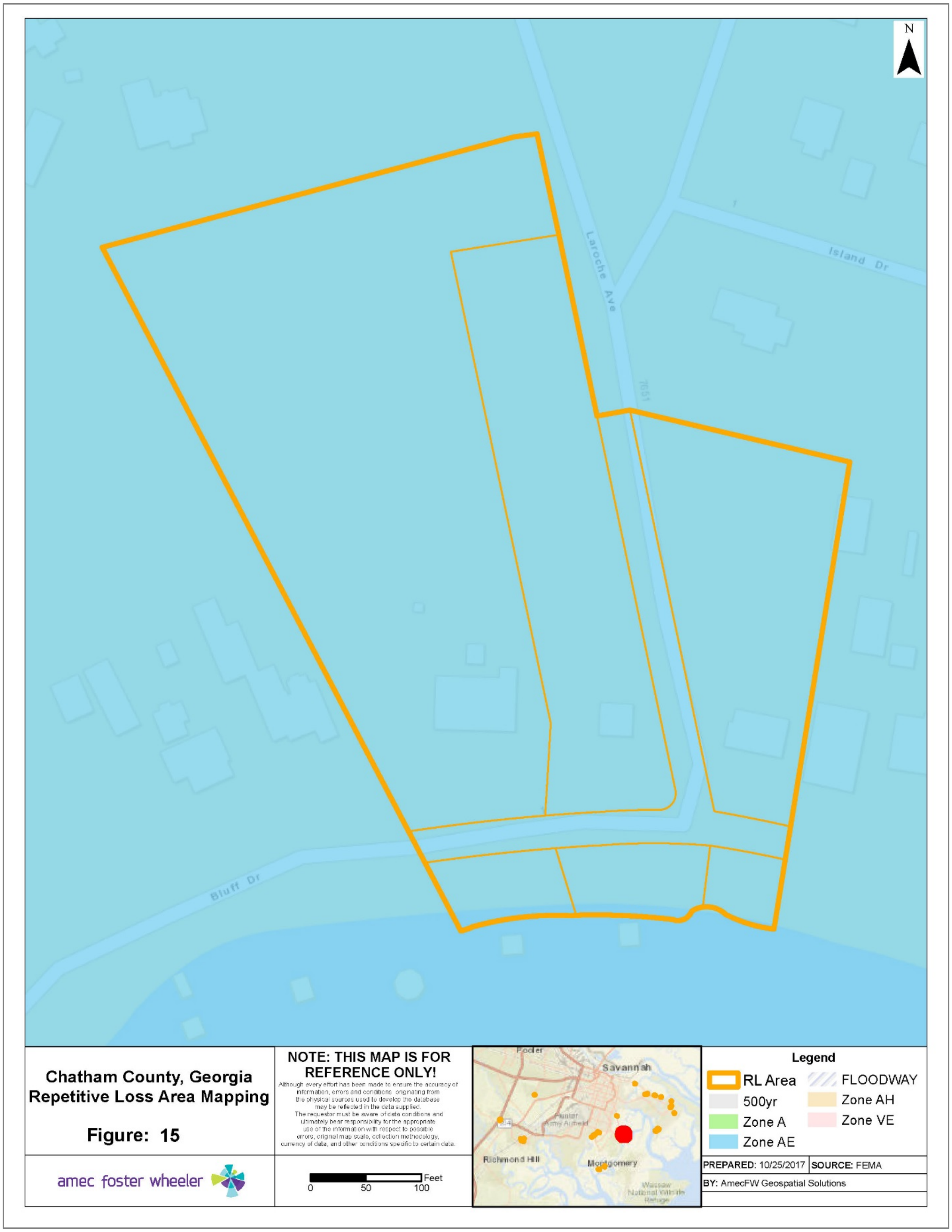


Figure 6.23 – Repetitive Loss Area Mapping, Area 15

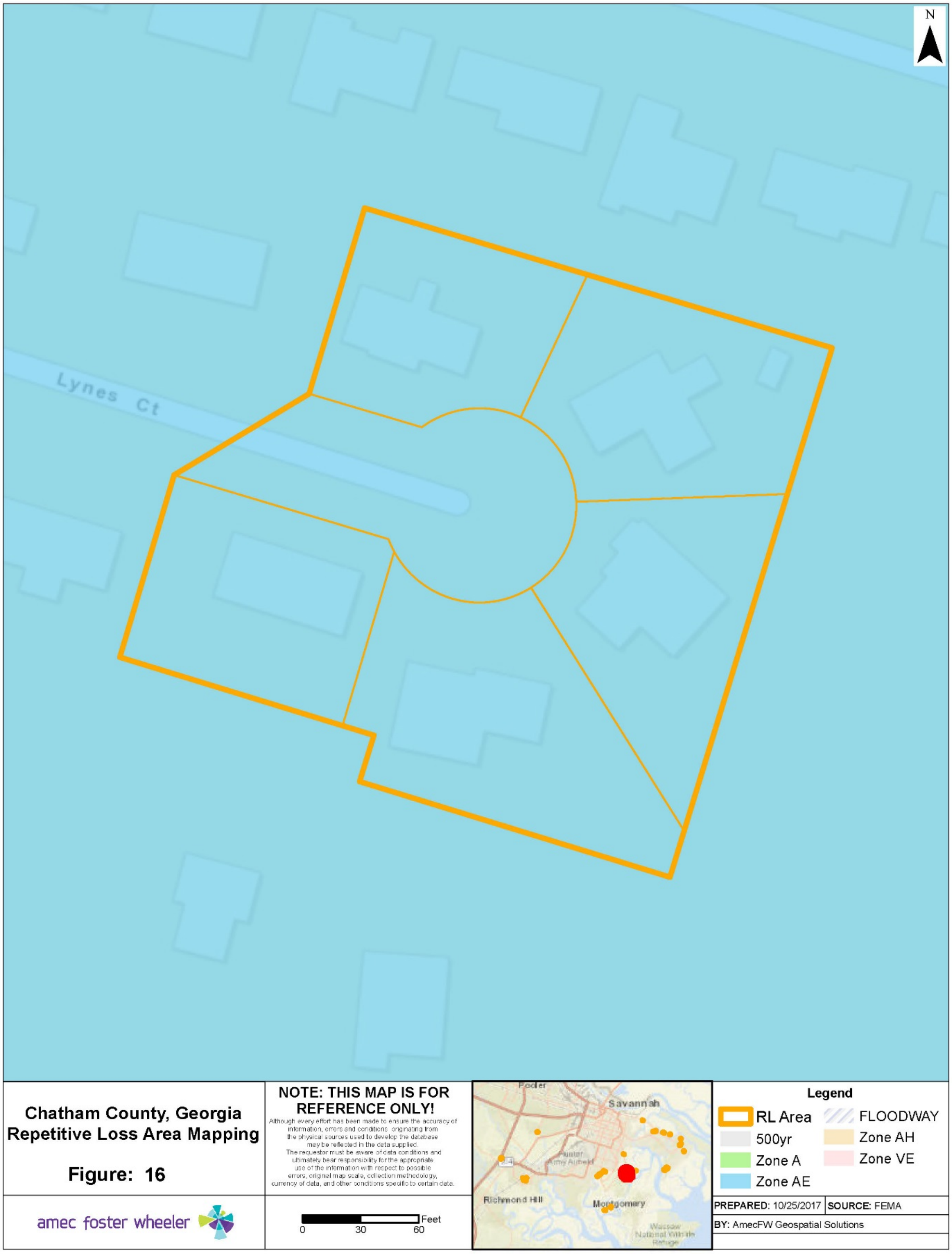


Figure 6.24 – Repetitive Loss Area Mapping, Area 16

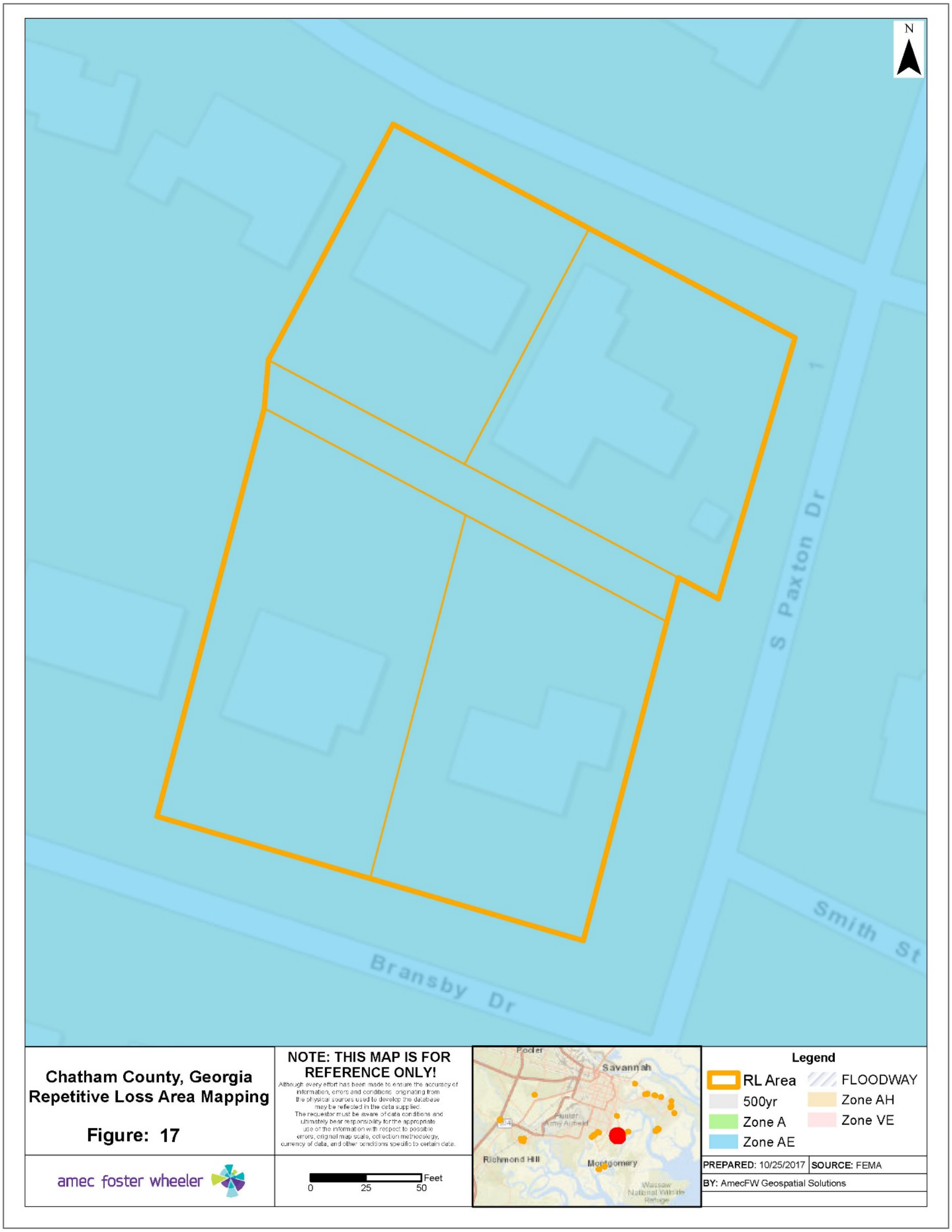


Figure 6.25 – Repetitive Loss Area Mapping, Area 17

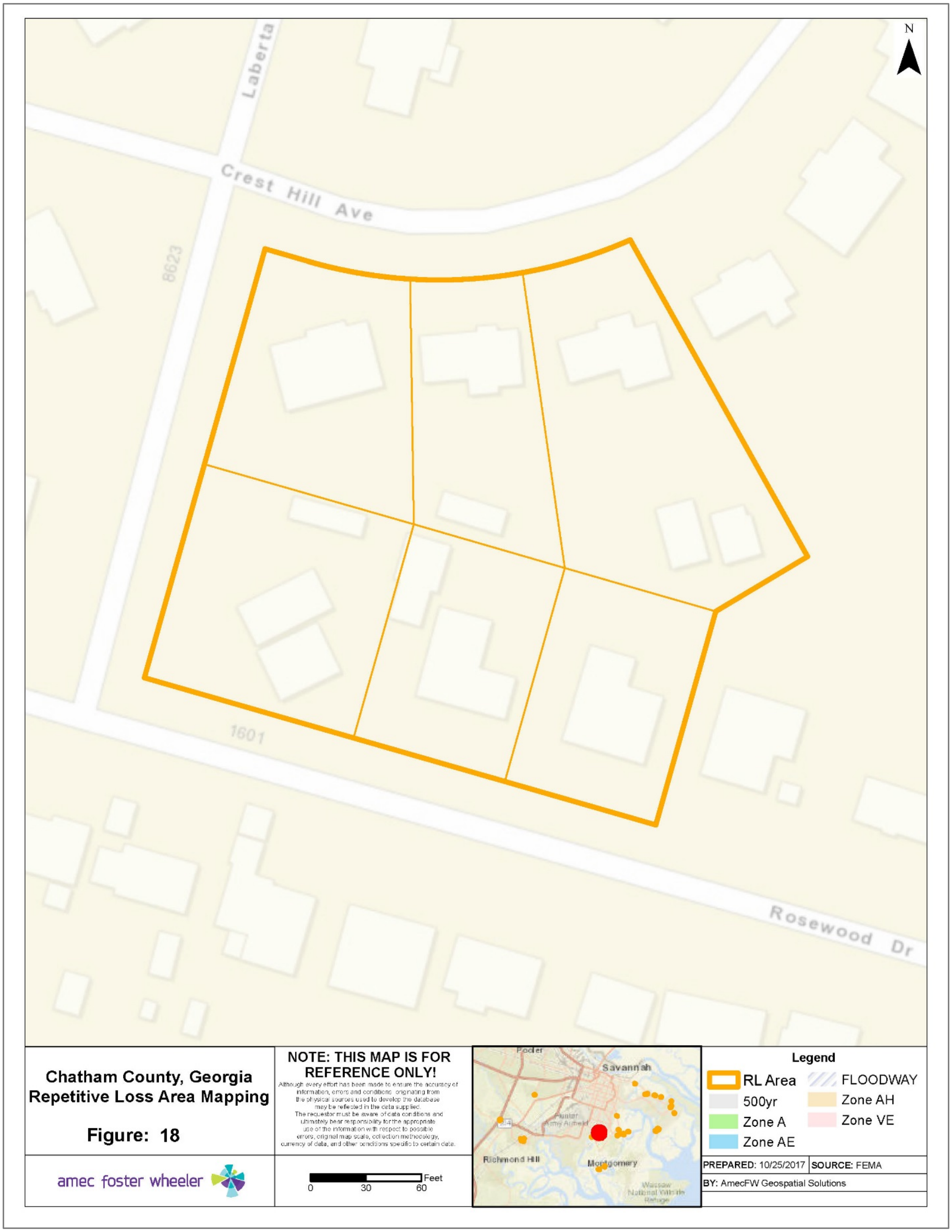


Figure 6.26 – Repetitive Loss Area Mapping, Area 18

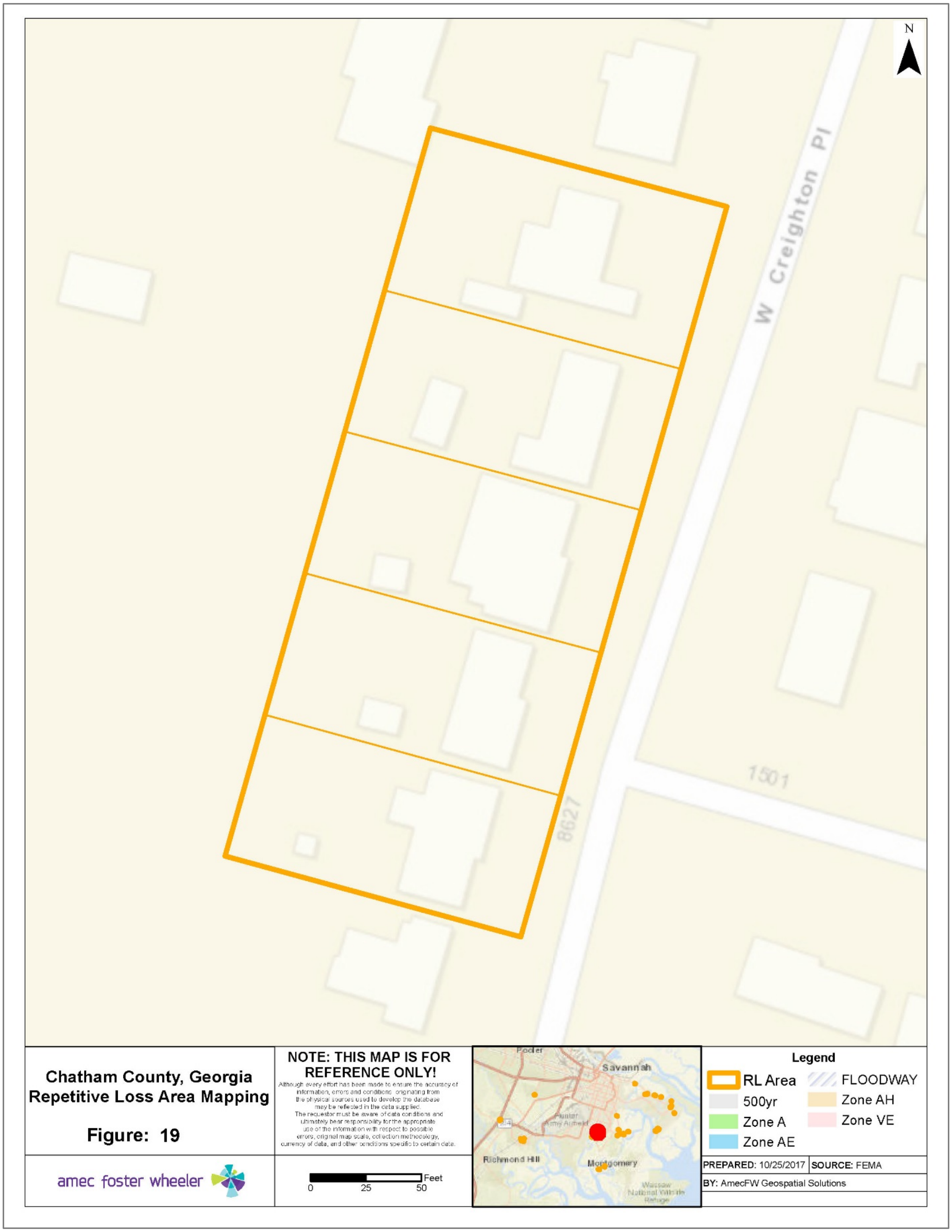


Figure 6.27 – Repetitive Loss Area Mapping, Area 19

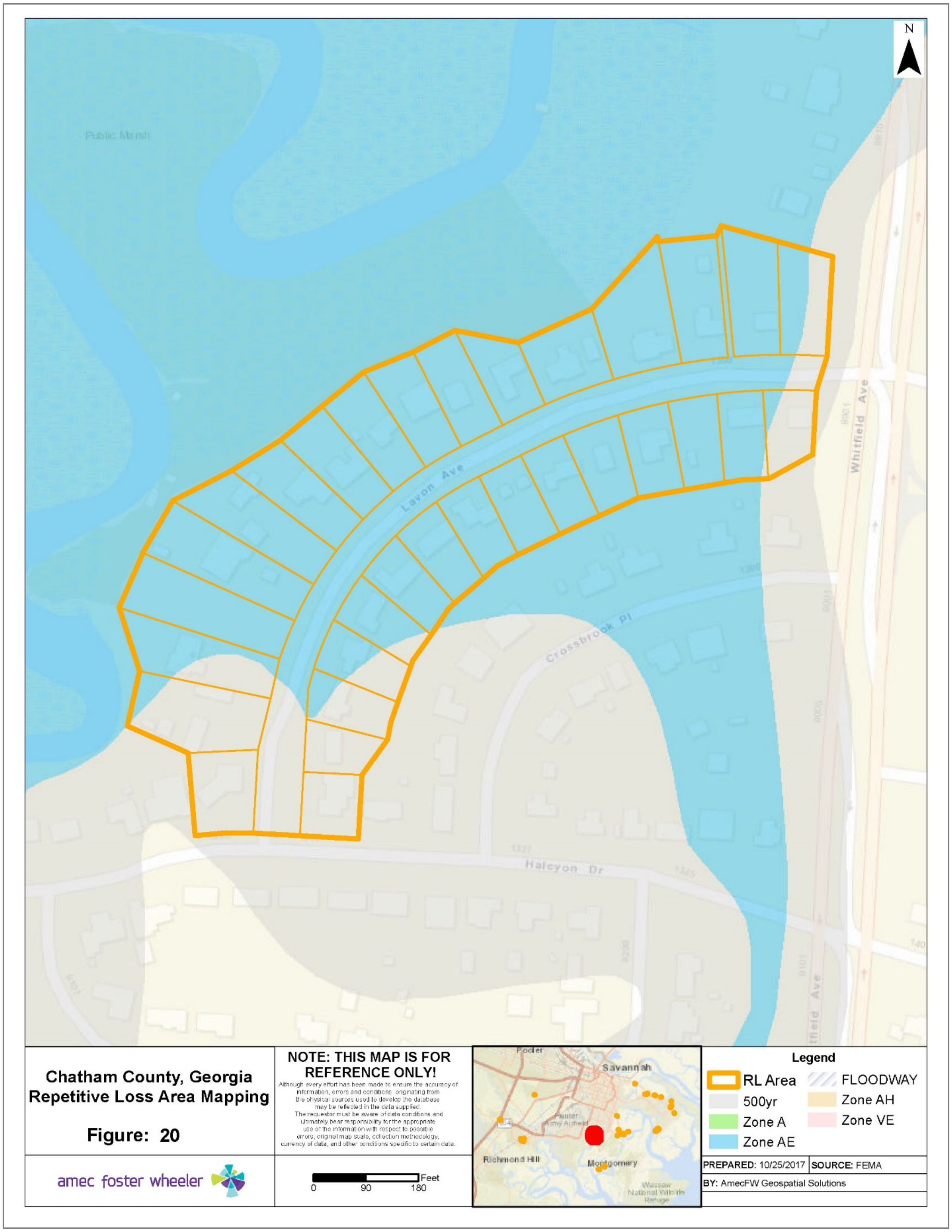


Figure 6.28 – Repetitive Loss Area Mapping, Area 20

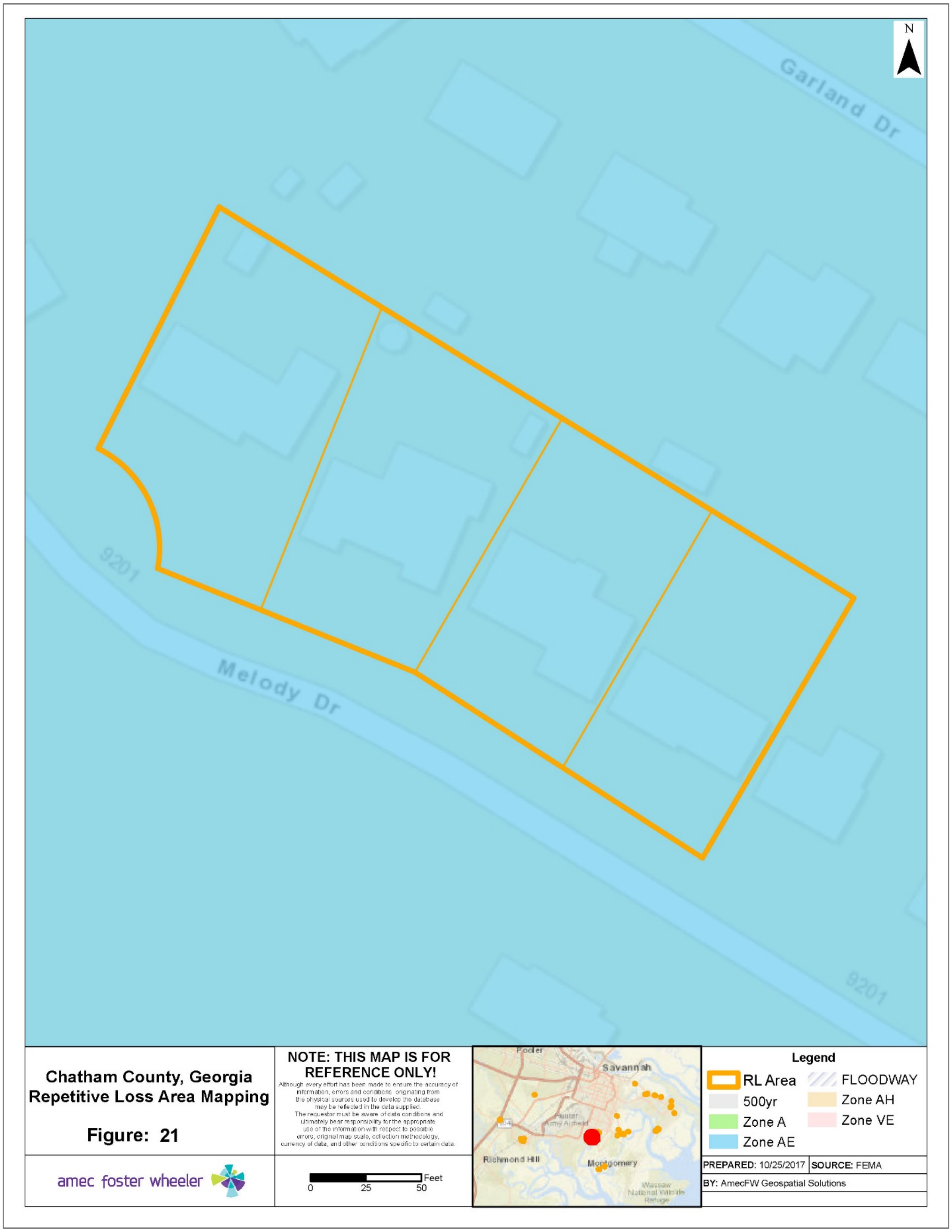


Figure 6.29 – Repetitive Loss Area Mapping, Area 21

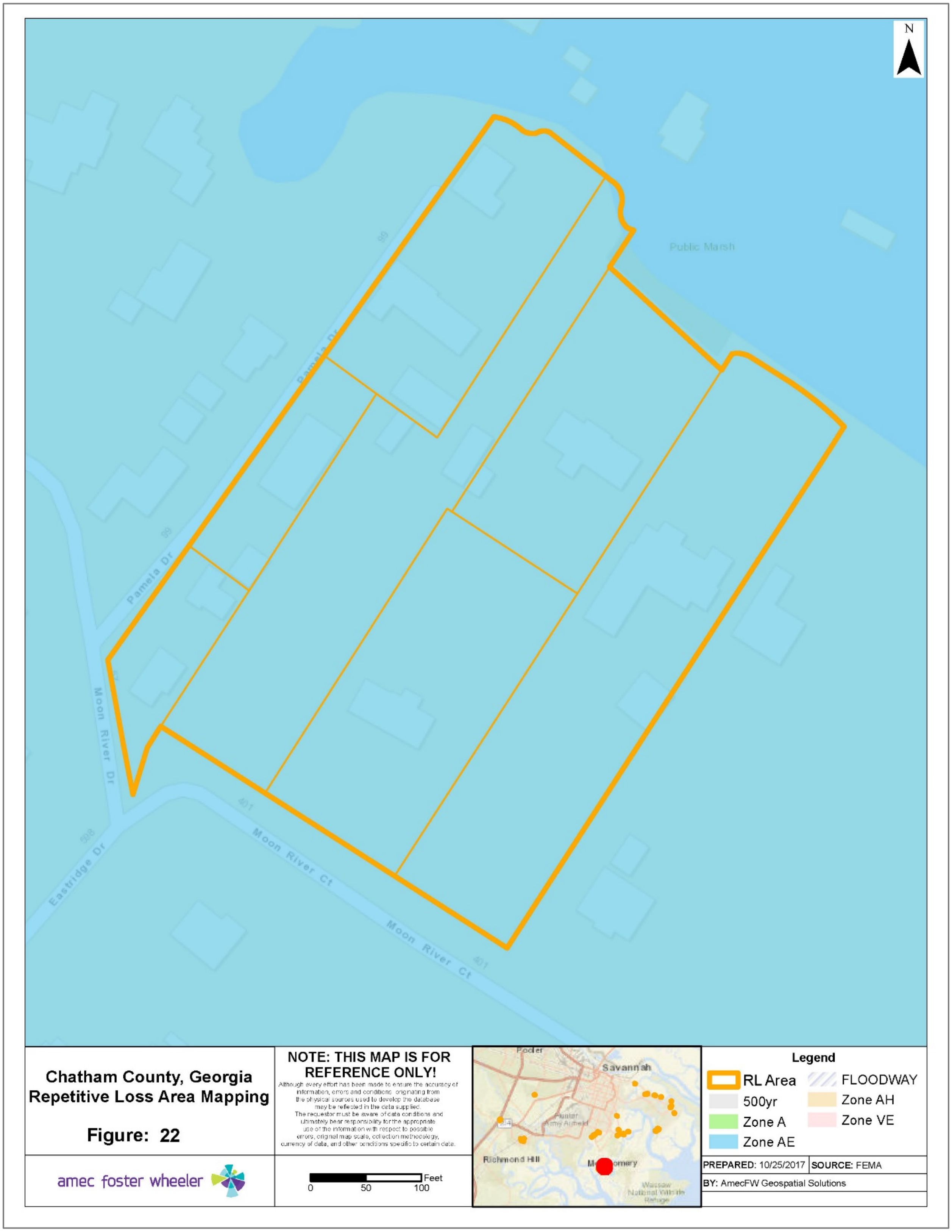


Figure 6.30 – Repetitive Loss Area Mapping, Area 22

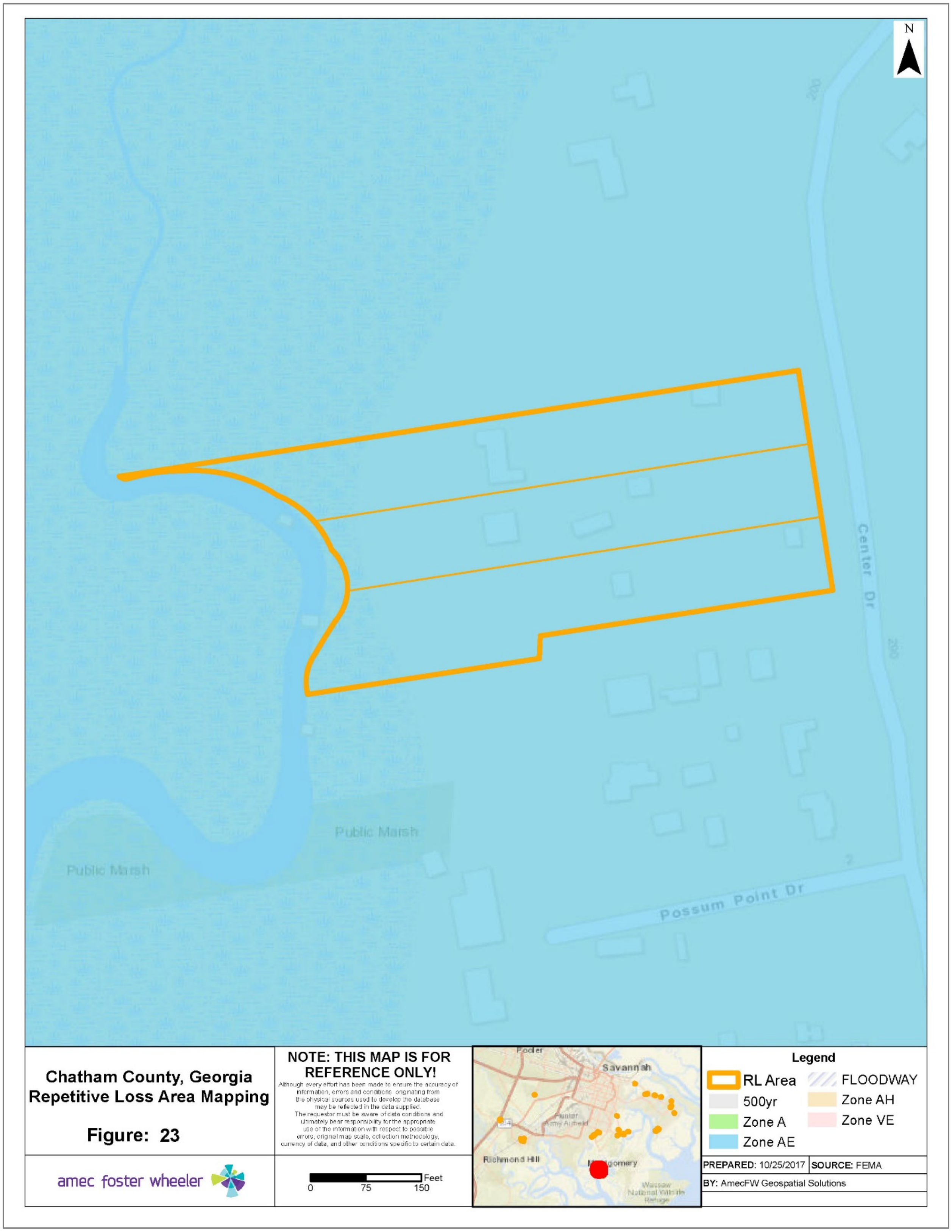


Figure 6.31 – Repetitive Loss Area Mapping, Area 23

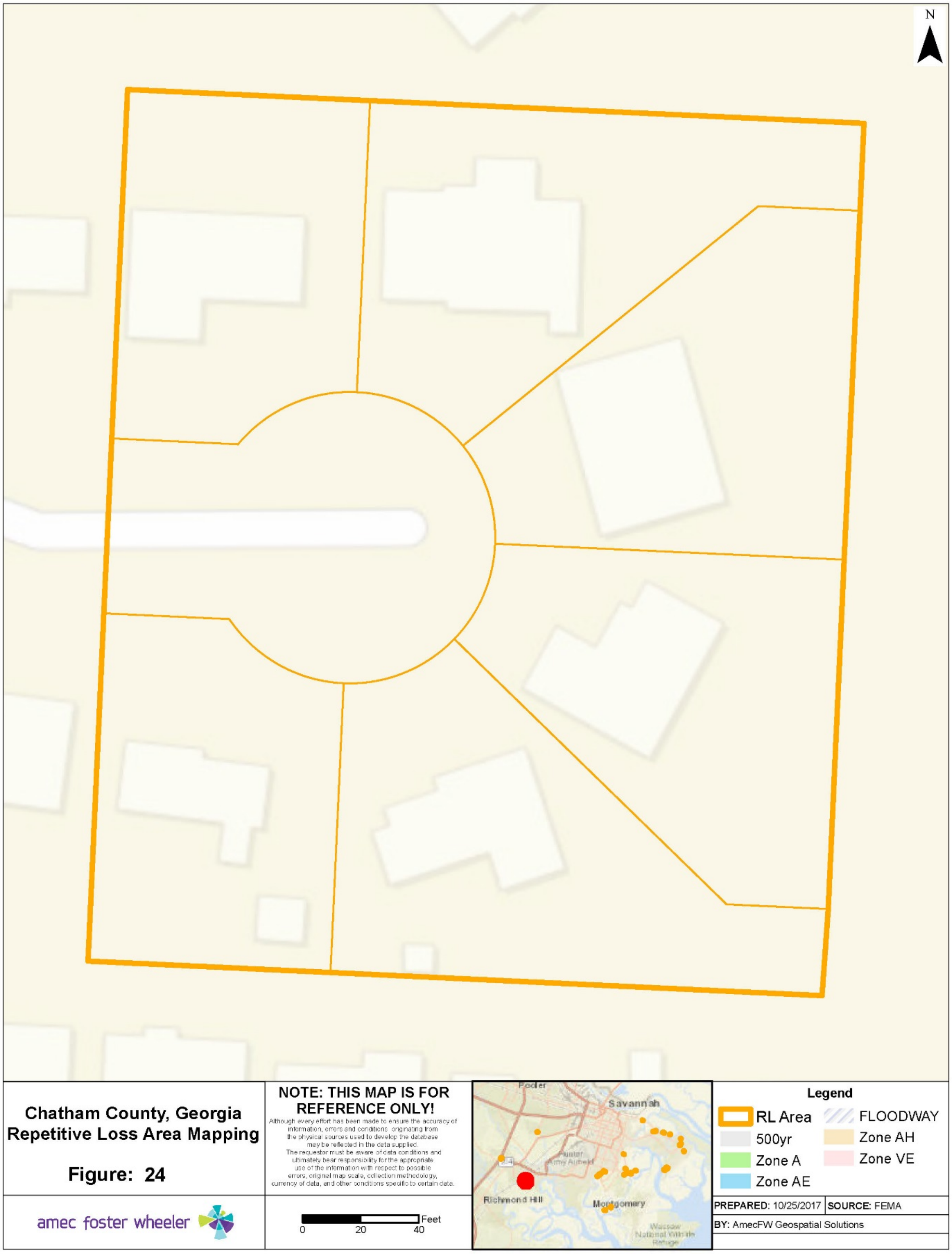


Figure 6.32 – Repetitive Loss Area Mapping, Area 24

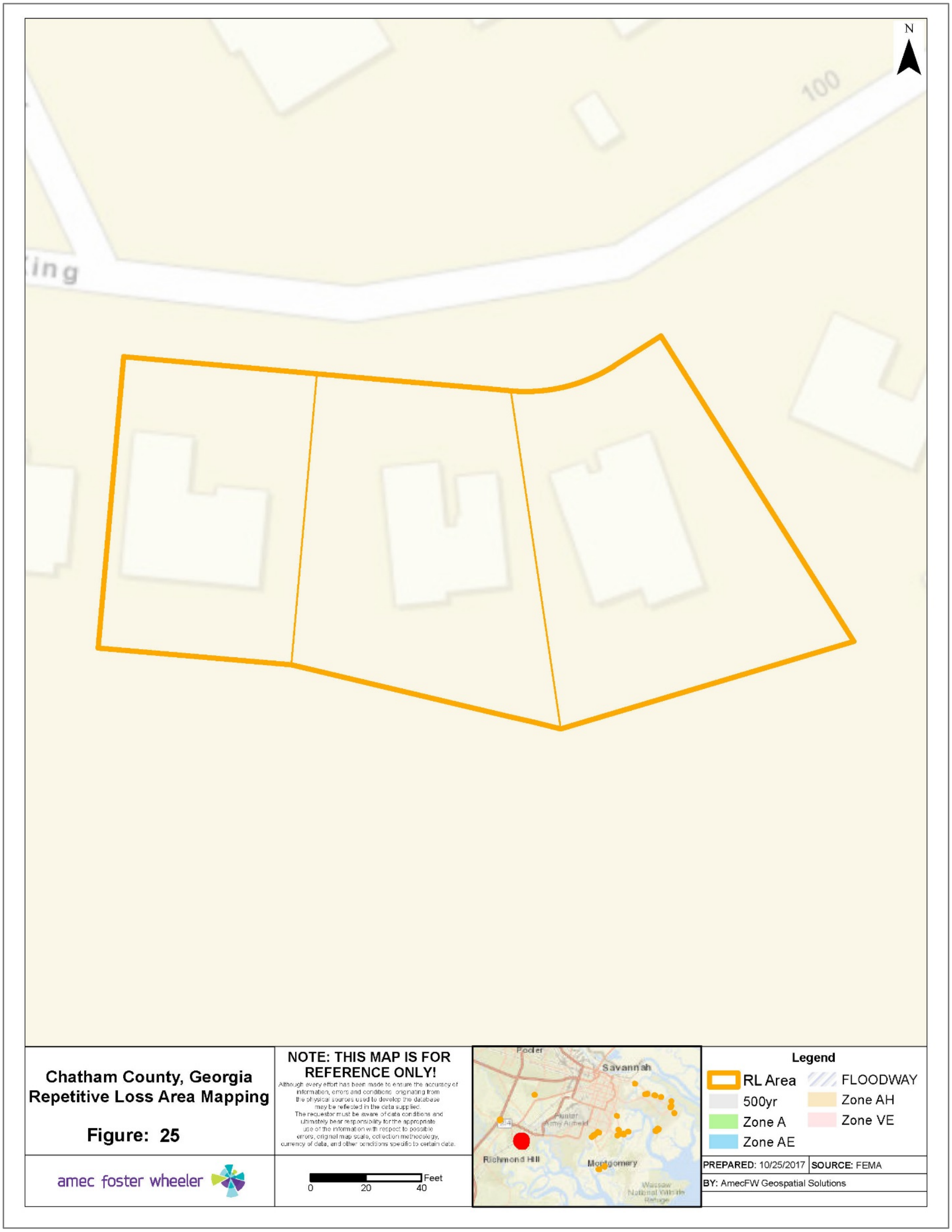


Figure 6.33 – Repetitive Loss Area Mapping, Area 25

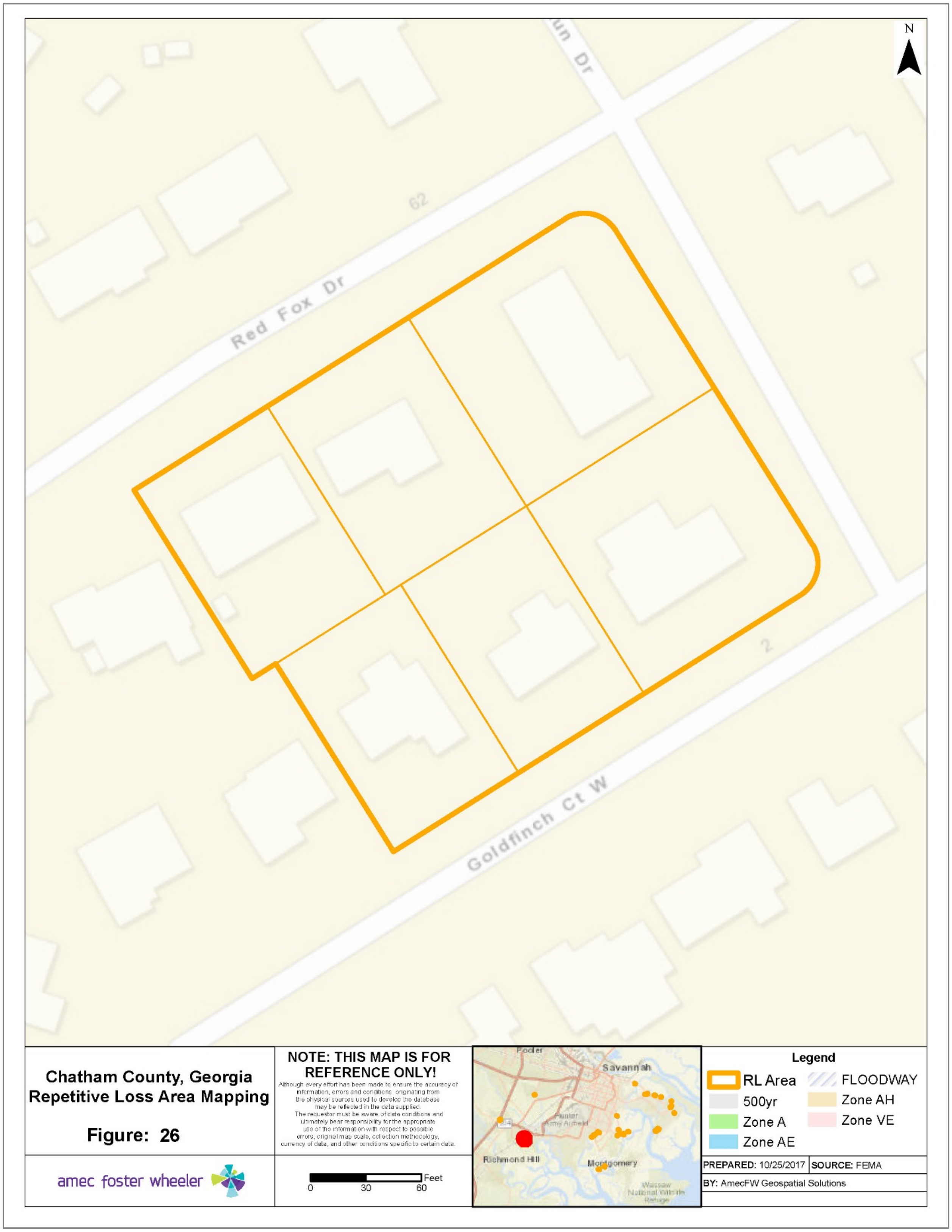


Figure 6.34 – Repetitive Loss Area Mapping, Area 26

Figure 6.35 – Repetitive Loss Area Mapping, Area 27

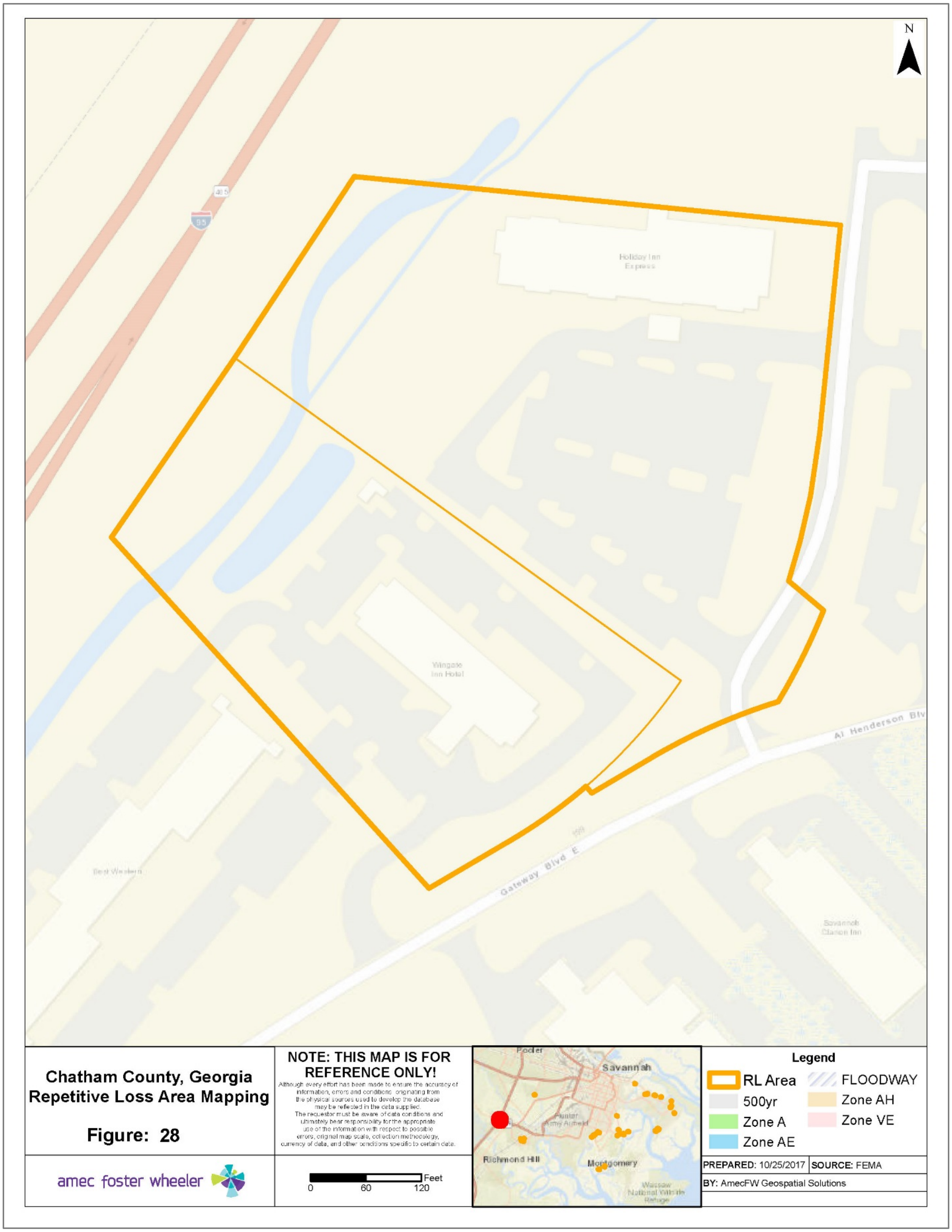


Figure 6.36 – Repetitive Loss Area Mapping, Area 28

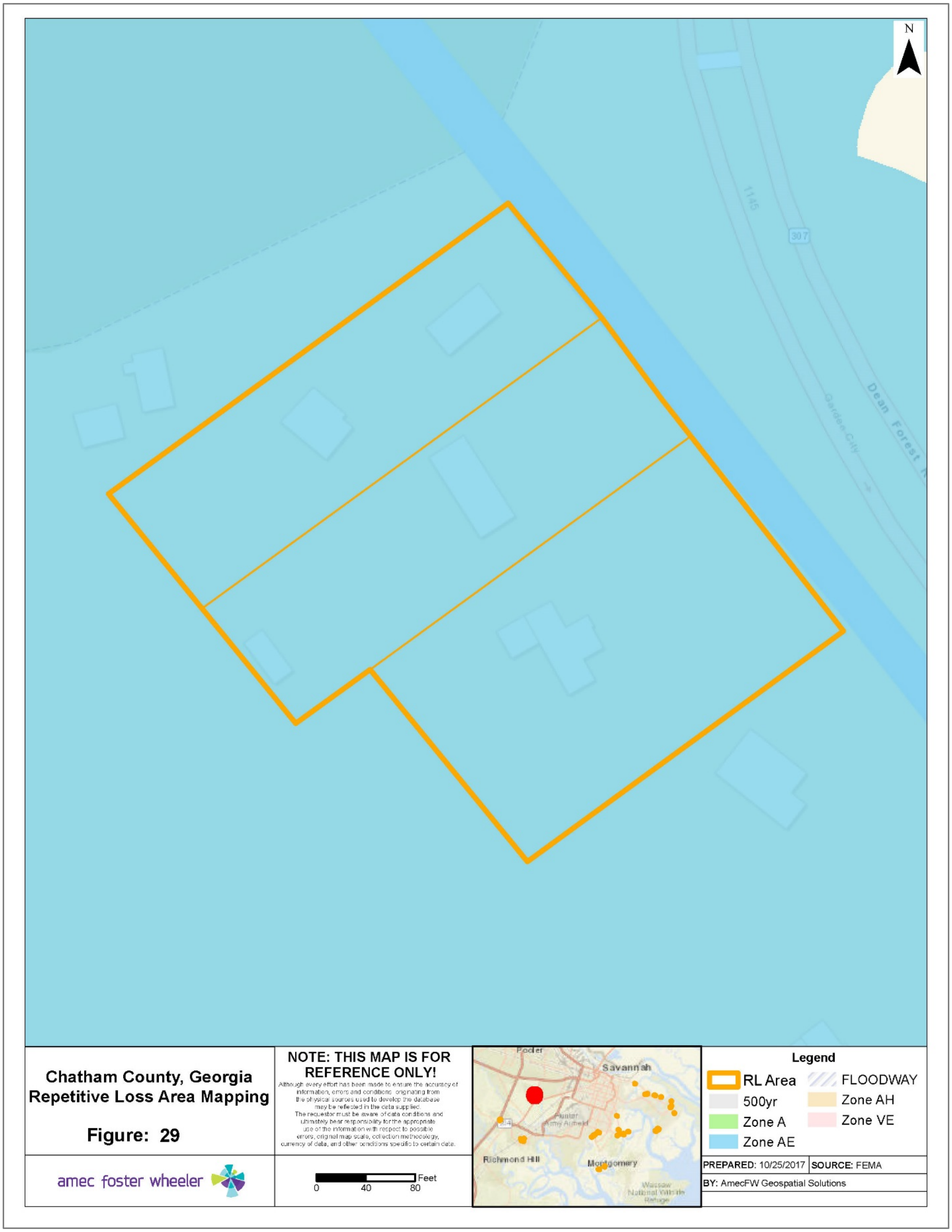


Figure 6.37 – Repetitive Loss Area Mapping, Area 29

6.4.4 Flood: Stormwater/Localized Flooding

Probability	Impact	Spatial Extent	Warning Time	Duration
Highly Likely	Minor	Small	6 to 12 hours	< 24 hours

Future Development

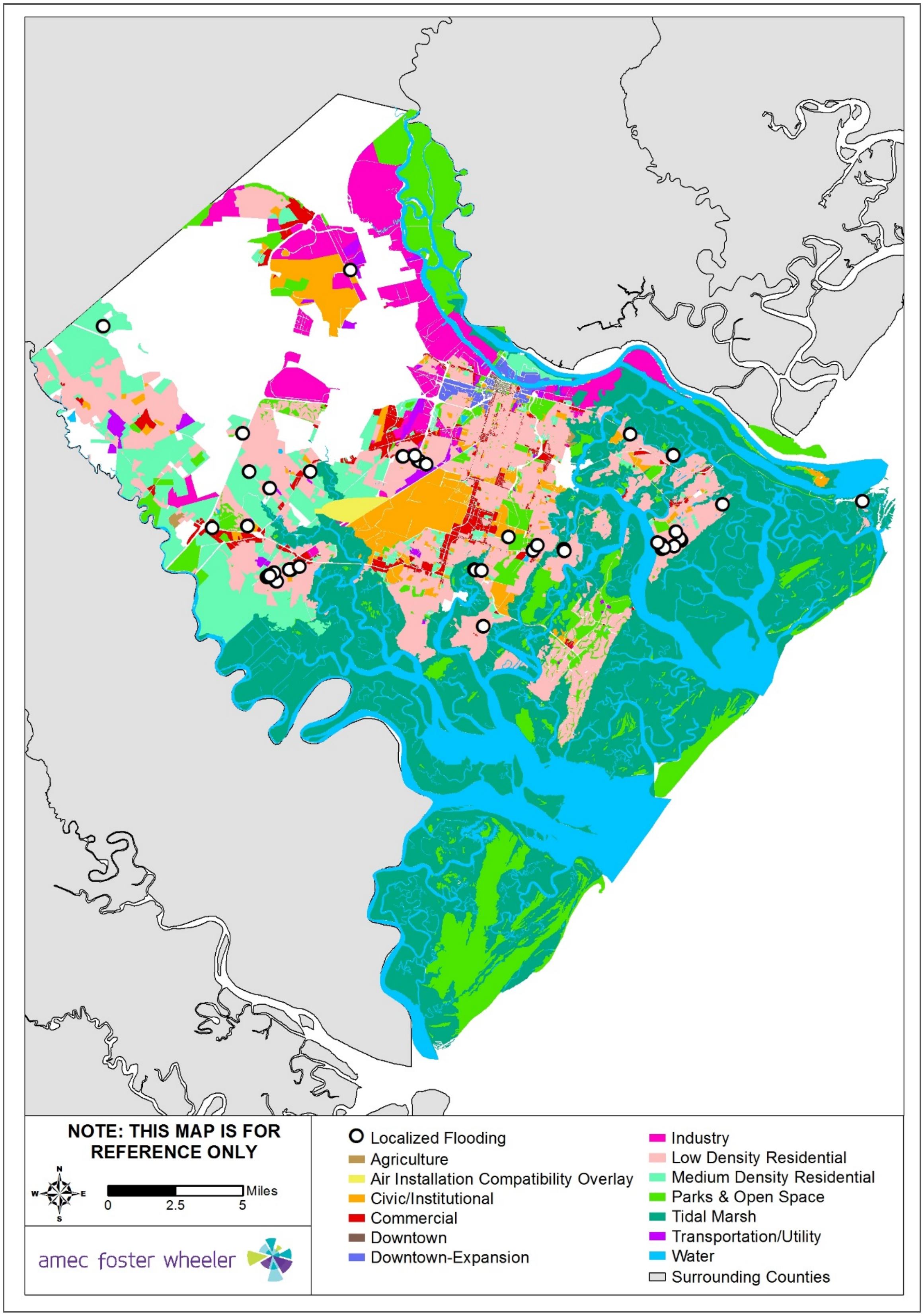
The risk of localized flooding to future development can be minimized by accurate recordkeeping of repetitive localized storm activity and by identifying and evaluating regional drainage issues. Mitigating the root causes of localized flooding or choosing not to develop in areas that often are subject to localized flooding will reduce future risk of losses due to this hazard. Figure 6.30 shows localized stormwater flooding in relation to future land use for Chatham County and the City of Savannah.

An analysis of future land use along with current known flooding locations indicates that most localized flooding occurs in areas slated for low density residential development near tidal marshes. Additionally, an increase in future flooding can likely be expected in and around the Westside and Georgetown hotspots in West Chatham County. As most of the developable land in the Islands and Southeast Chatham is built out, development pressure has shifted to West Chatham County, reflected in the planned low and medium density residential land uses in areas currently under agricultural and forestry use.

Evaluated on a watershed level, impervious surface and thus stormwater-related flooding is likely to increase in the Ogeechee Coastal and Lower Ogeechee basins, especially around areas of rapid development. Based on the land use and development mapped for these areas, not only will more property be exposed due to new construction, but the associated increase in impervious surface and reduction in flood storage areas will increase the vulnerability of existing property within these watersheds, particularly in West Chatham County and downstream areas.

Property at Risk

Localized flooding occurs at various times throughout the year with several areas of primary concern to the County. Localized flooding and ponding affect streets and property.



Source: Chatham County Public Works; Metropolitan Planning Commission; NFIP Repetitive Loss Data, 11/30/2016

Figure 6.38 – Localized Flooding Locations in Relation to Future Land Use

6.4.5 Hurricane/Tropical Storm

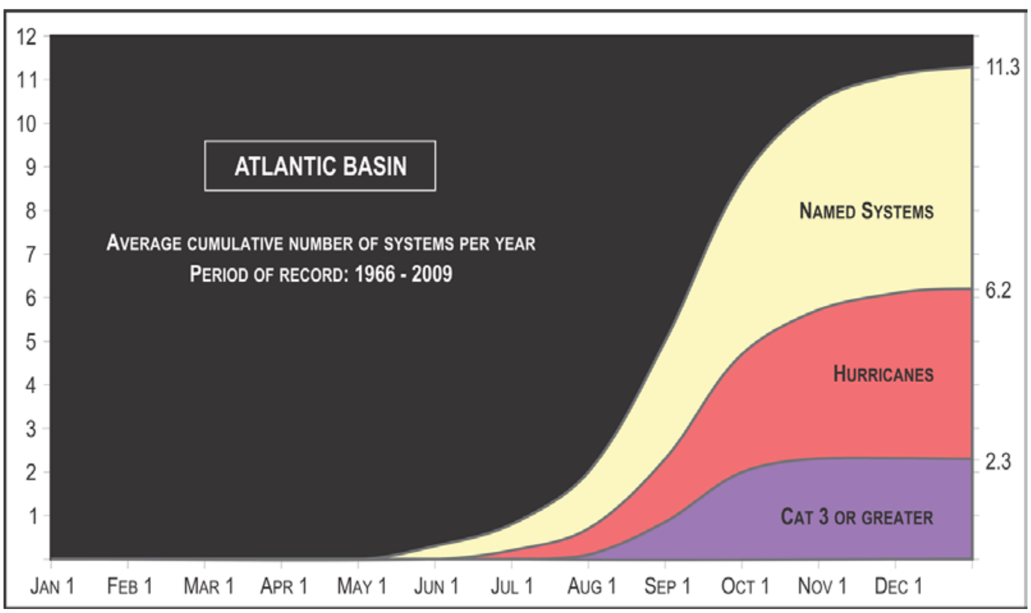
Probability	Impact	Spatial Extent	Warning Time	Duration
Likely	Critical	Large	> 24 hours	< 1 week

The heavy rains associated with tropical weather systems are not only responsible for major flooding in areas where the storm initially strikes, but can also affect areas hundreds of miles inland. Torrential rains from hurricanes and tropical storms can produce extensive urban and riverine flooding, especially if the storm systems are large and slow moving. Winds from these storms located offshore can drive ocean water up the mouth of a river or canal, compounding the severity of inland overbank flooding.

In addition to the combined destructive forces of wind, rain, and lightning, hurricanes can cause a surge in the ocean, which can raise the sea level as high as 25 feet or more in the strongest hurricanes. As a hurricane approaches the coast, its winds drive water toward the shore. Once the edge of the storm reaches the shallow waters of the continental shelf, the water begins to pile up. Winds of hurricane strength eventually force the water onto the shore. At first, the water level climbs slowly, but as the eye of the storm approaches, water rises rapidly. Furthermore, storm surge can also cause extensive damage on the backside of a hurricane as storm surge waters are sucked back out to sea.

Natural resources, particularly beaches, are devastated by hurricanes. The erosion of the coastline is considerable due to the impact of wind, waves, and debris in a hurricane event. Storm surge and subsequent erosion of the shoreline often leads to the loss of property

The Atlantic basin hurricane season runs from June 1st to November 30th. The Atlantic basin includes the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Figure 6.37 shows the progress of a typical hurricane season in terms of the total number of tropical systems and hurricanes produced throughout the year in the Atlantic basin. The curves represent the average cumulative production of all named tropical systems, all hurricanes, and those hurricanes which were Category 3 or stronger in those basins.



Source: NOAA/National Hurricane Center

Figure 6.39 – Average Number of Tropical Storms per Year (Atlantic Basin)

Properties at Risk

Table 6.17 through 6.20 provide a summary of assets at risk to hurricane surge based on each hurricane category. The buildings vulnerable to each hurricane category are mapped in Figure 6.32 through Figure 6.36 on the following pages. Building are shown as at risk to hurricane storm surge if they fall within any portion of the SLOSH model storm surge extent, regardless of flood depth. Therefore, some structures are more vulnerable than others depending on the actual depth of flooding that could occur at each location.

The estimate of assets at risk for each hurricane category is based on the total of improved and contents value. These values are not damage estimates, but rather reflect the total building and contents value for all structures that could be exposed to any depth of hurricane storm surge flooding for each category of storm based on NOAA SLOSH models.

Note: Due to data limitations, 17 structures located on Ossabaw Island were not included in this analysis. However, NOAA SLOSH models indicate that all of Ossabaw Island would be inundated by a Category 2 hurricane storm surge.

Table 6.16 – Properties at Risk to Category 1 Storm Surge

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agricultural	50	$10,586,733	$10,586,733	$21,173,466
Commercial	113	$24,831,126	$24,831,126	$49,662,252
Education	46	$38,535,639	$38,535,639	$77,071,278
Government	0	$0	$0	$0
Industrial	216	$49,873,928	$74,810,892	$124,684,820
Religious	0	$0	$0	$0
Residential	3,423	$877,350,177	$438,675,088	$1,316,025,265
Total	**3,848**	**$1,001,177,603**	**$587,439,479**	**$1,588,617,082**

Source: Chatham County building data, NOAA SLOSH model

Table 6.17 – Properties at Risk to Category 2 Storm Surge

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agricultural	112	$28,486,882	$28,486,882	$56,973,764
Commercial	923	$187,622,321	$187,622,321	$375,244,642
Education	74	$48,851,755	$48,851,755	$97,703,510
Government	0	$0	$0	$0
Industrial	893	$293,958,703	$440,938,055	$734,896,758
Religious	0	$0	$0	$0
Residential	15,313	$3,394,784,750	$1,697,392,375	$5,092,177,125
Total	**17,315**	**$3,953,704,411**	**$2,403,291,388**	**$6,356,995,799**

Source: Chatham County building data, NOAA SLOSH model

Table 6.18 – Properties at Risk to Category 3 Storm Surge

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agricultural	170	$36,666,582	$36,666,582	$73,333,164
Commercial	3,226	$824,586,879	$824,586,879	$1,649,173,758
Education	76	$49,573,520	$49,573,520	$99,147,040
Government	4	$0	$0	$0
Industrial	1,573	$539,260,002	$808,890,003	$1,348,150,005
Religious	15	$39,473,966	$39,473,966	$78,947,932
Residential	26,462	$4,699,351,772	$2,349,675,886	$7,049,027,658
Total	**31,526**	**$6,188,912,721**	**$4,108,866,836**	**$10,297,779,557**

Source: Chatham County building data, NOAA SLOSH model

Table 6.19 – Properties at Risk to Category 4 Storm Surge

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agricultural	172	$37,867,482	$37,867,482	$75,734,964
Commercial	3,541	$940,064,885	$940,064,885	$1,880,129,770
Education	82	$49,968,695	$49,968,695	$99,937,390
Government	4	$0	$0	$0
Industrial	2,070	$825,001,560	$1,237,502,340	$2,072,062,685
Religious	18	$41,041,700	$41,041,700	$82,083,400
Residential	29,816	$5,056,792,044	$2,528,396,022	$7,585,188,066
Total	**35,703**	**$7,099,400,368**	**$4,922,109,763**	**$11,785,577,490**

Source: Chatham County building data, NOAA SLOSH model

Table 6.20 – Properties at Risk to Category 5 Storm Surge

Occupancy Type	Building Count	Total Building Value	Estimated Content Value	Total Value (Building and Contents)
Agricultural	172	$37,867,482	$37,867,482	$75,734,964
Commercial	3,607	$958,159,408	$958,159,408	$1,916,318,816
Education	84	$50,100,420	$50,100,420	$100,200,840
Government	4	$0	$0	$0
Industrial	2,117	$828,825,074	$1,243,237,611	$2,072,062,685
Religious	18	$41,041,700	$41,041,700	$82,083,400
Residential	30,559	$5,183,406,284	$2,591,703,142	$7,775,109,426
Total	**36,561**	**$7,099,400,368**	**$4,922,109,763**	**$12,021,510,131**

Source: Chatham County building data, NOAA SLOSH model

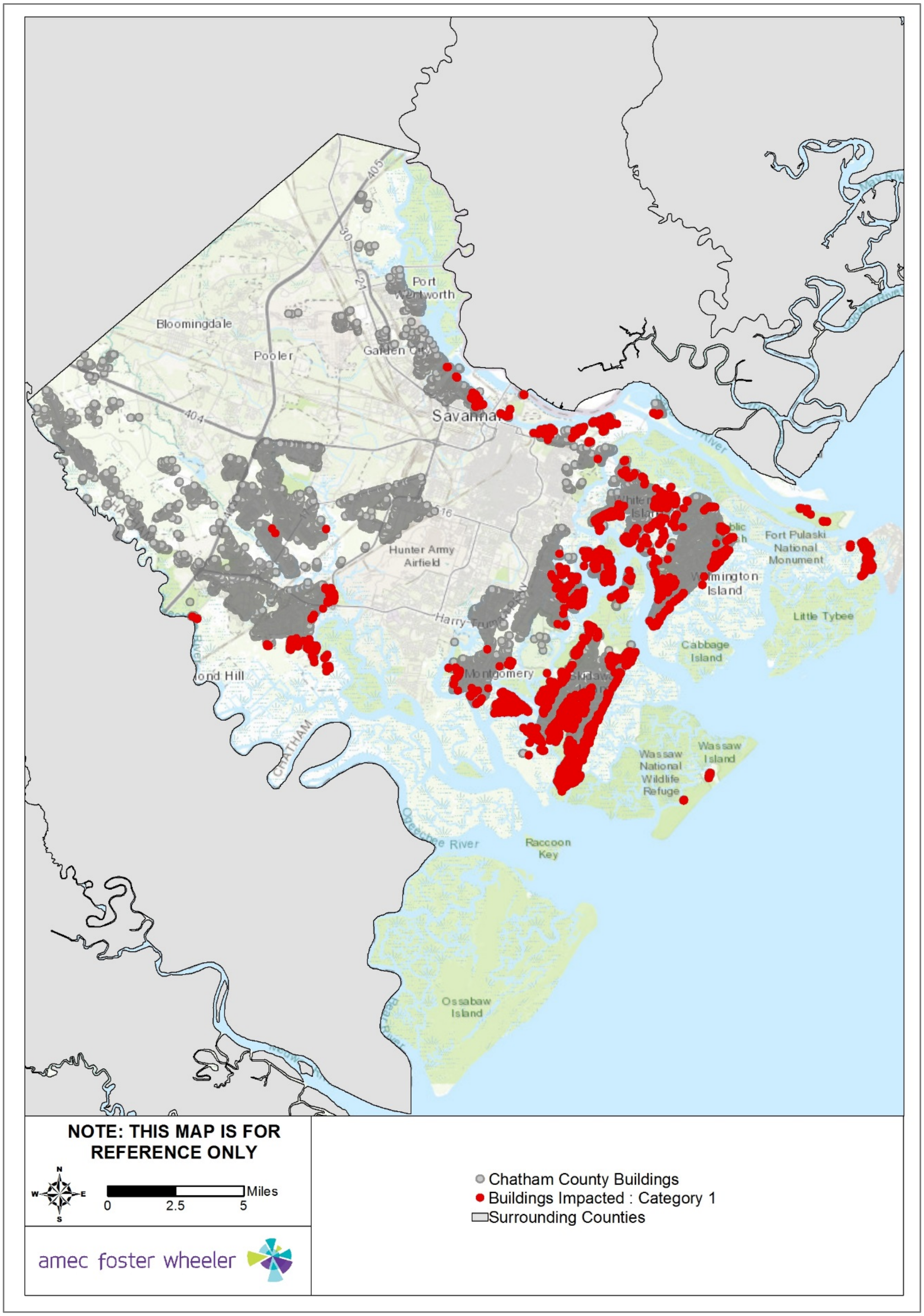


Figure 6.40 – Buildings Vulnerable to Modeled Category 1 Storm Surge

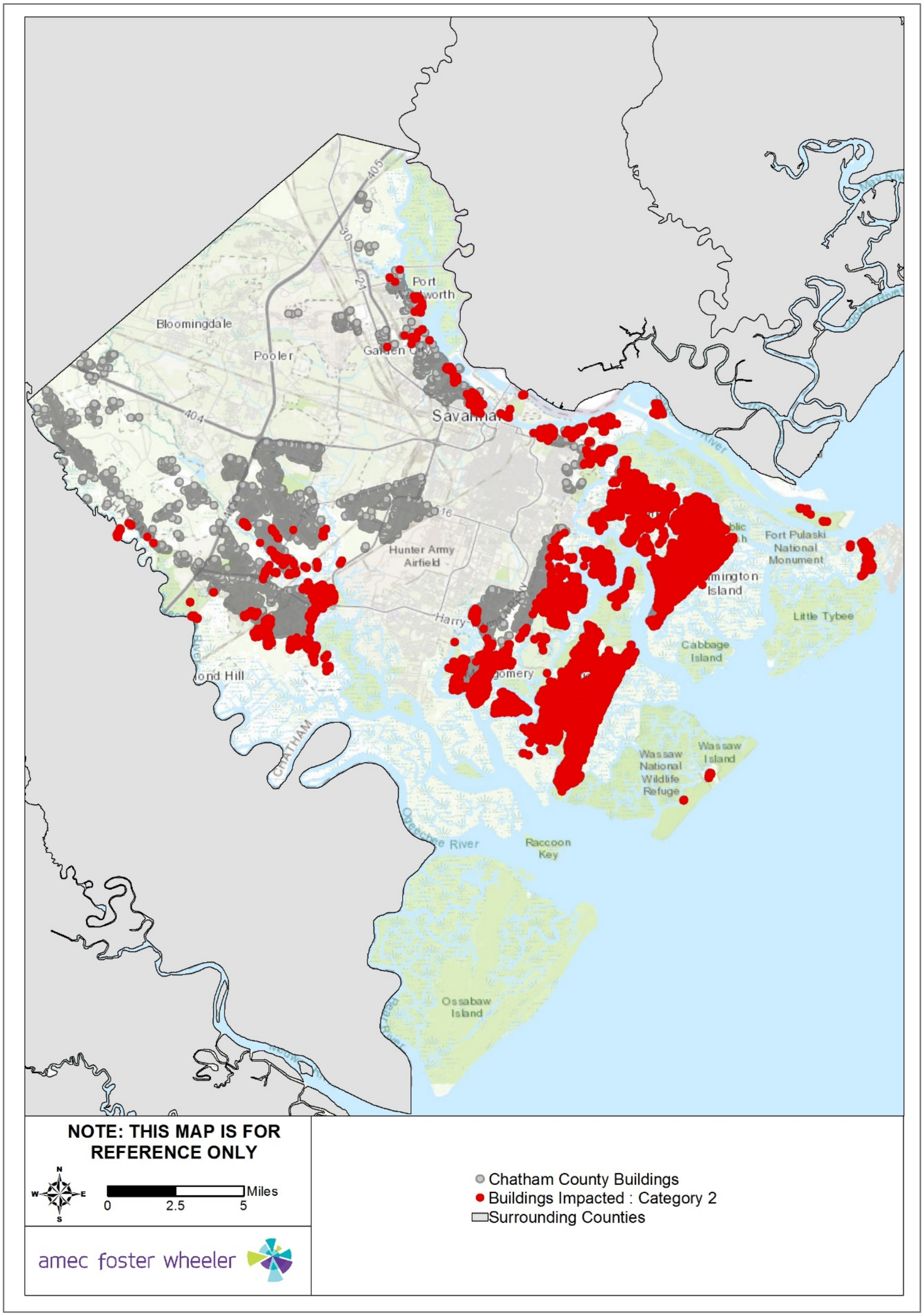


Figure 6.41 – Buildings Vulnerable to Modeled Category 2 Storm Surge

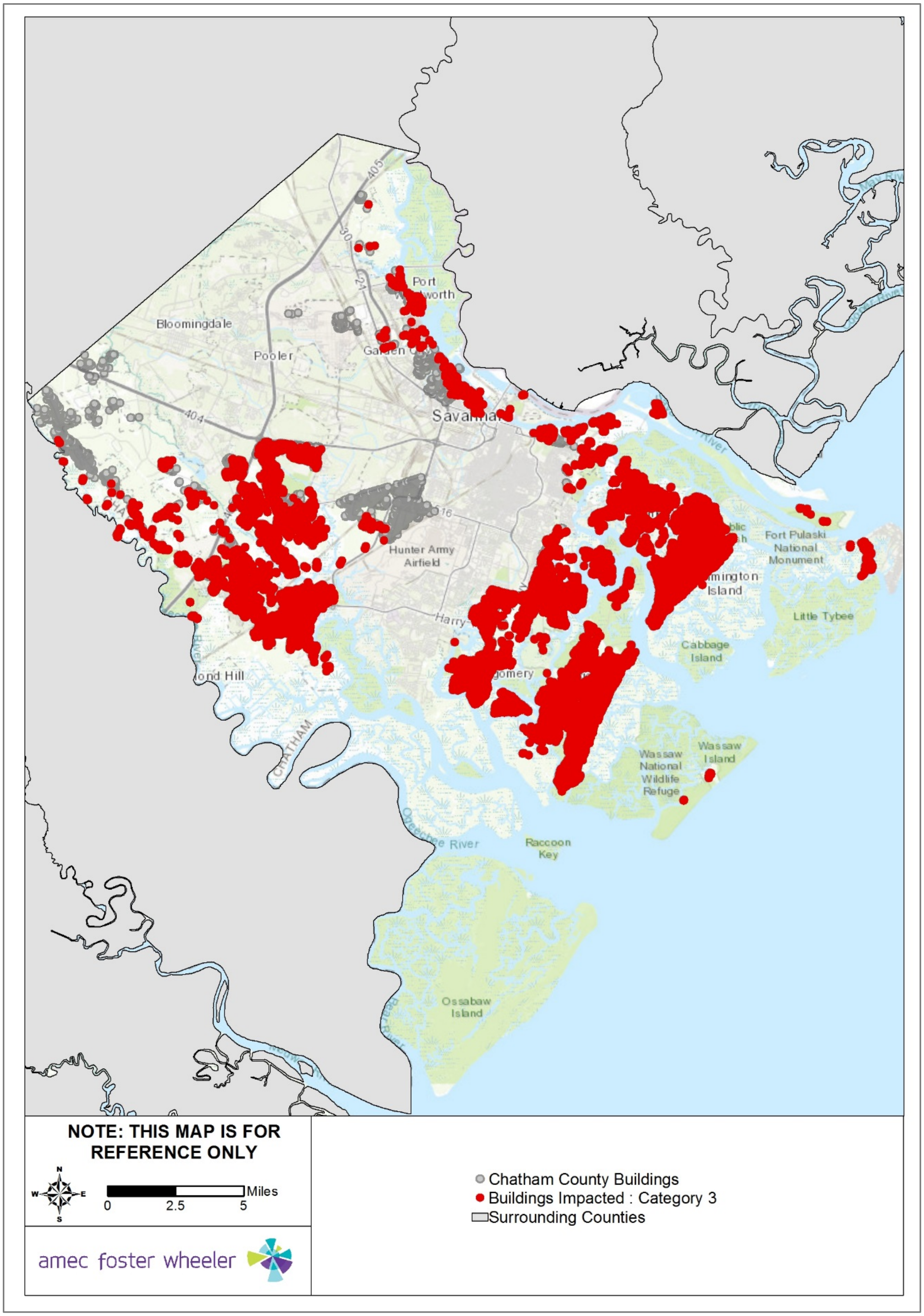


Figure 6.42 – Buildings Vulnerable to Modeled Category 3 Storm Surge

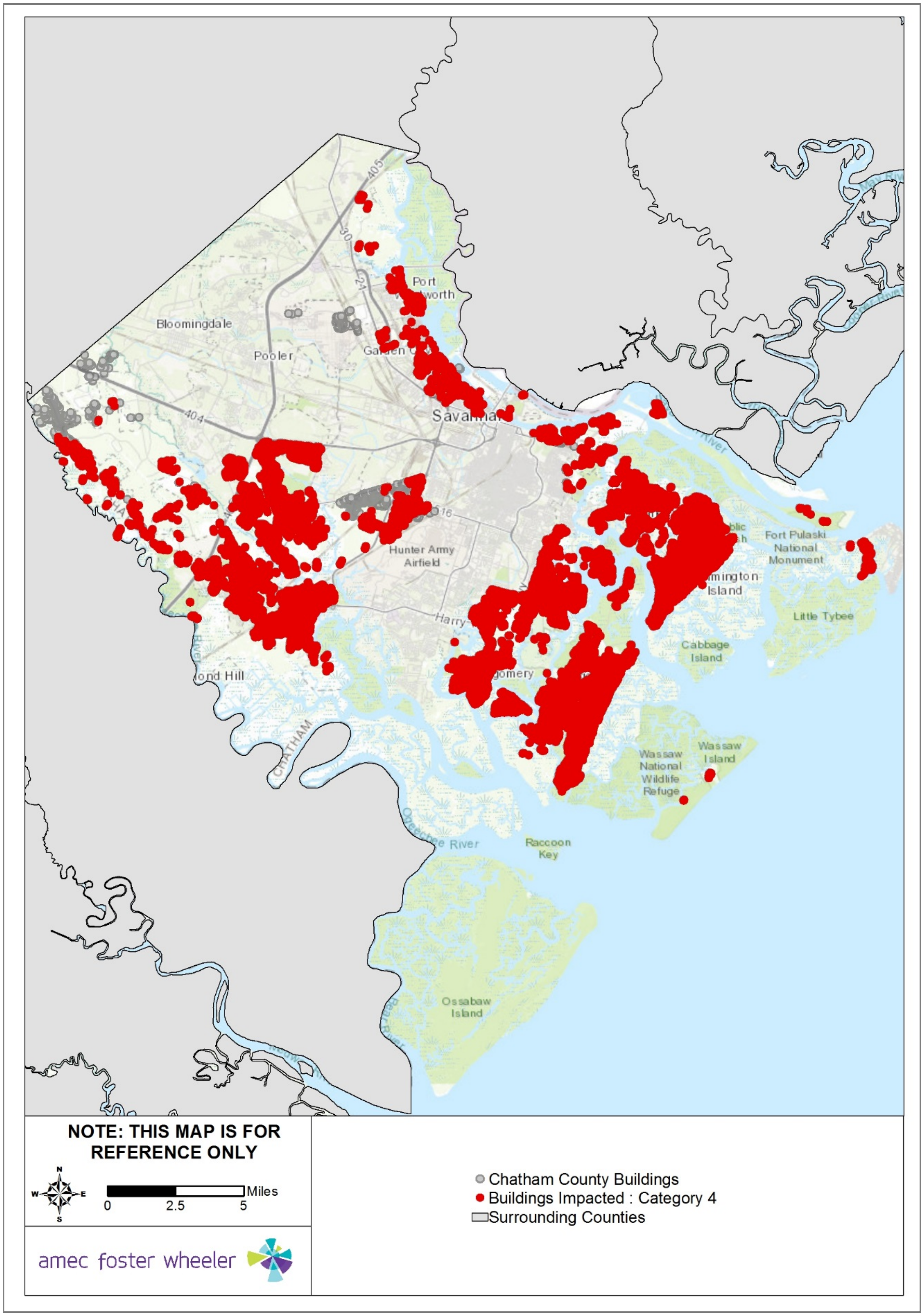


Figure 6.43 – Buildings Vulnerable to Modeled Category 4 Storm Surge

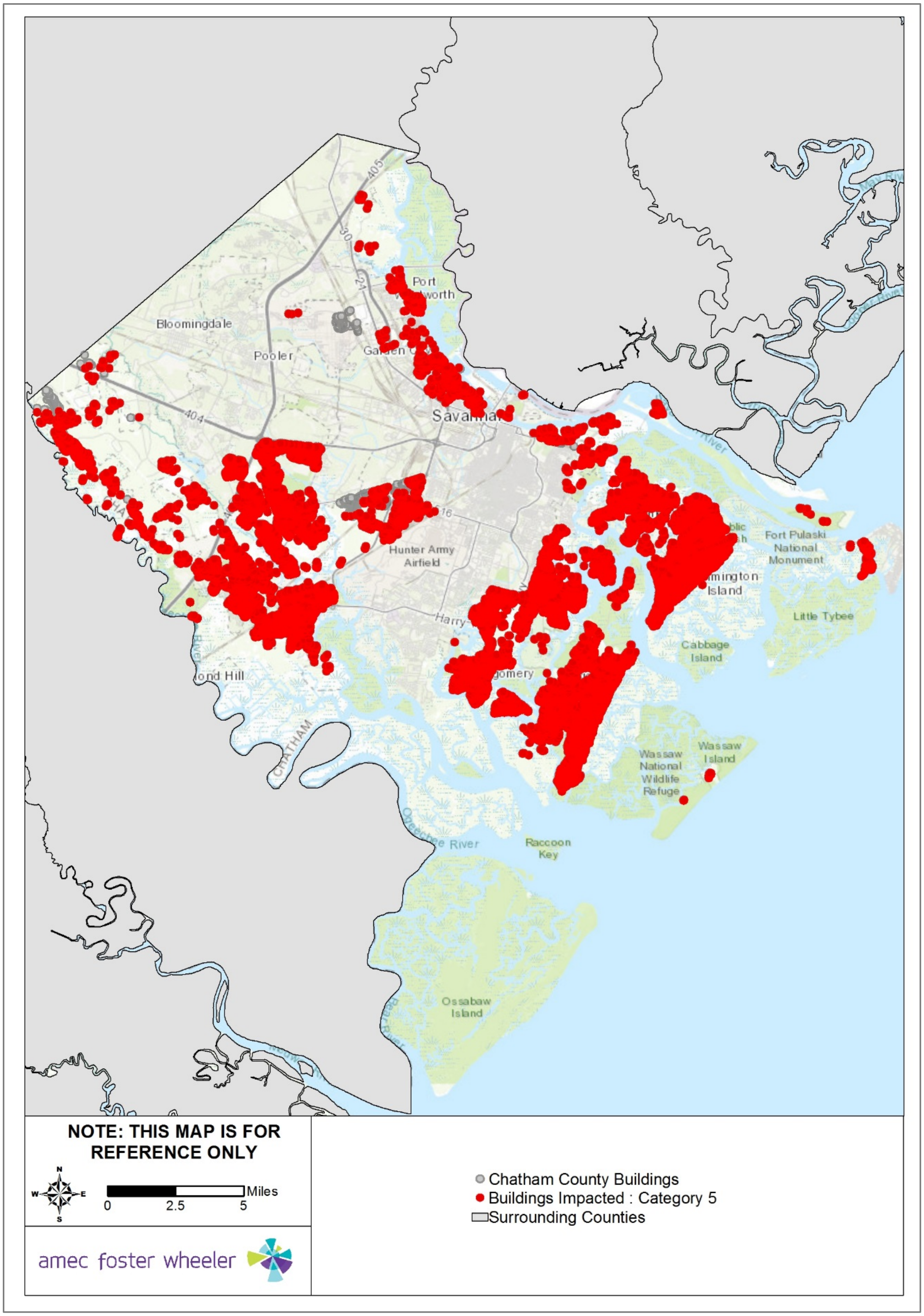


Figure 6.44 – Buildings Vulnerable to Modeled Category 5 Storm Surge

6.4.6 Coastal Erosion

Probability	Impact	Spatial Extent	Warning Time	Duration
Likely	Minor	Small	> 24 hours	> 1 week

Given past erosion rates and locations mapped by the Georgia Coastal Hazards Portal, it can be reasonably assumed that coastal erosion will continue to affect Chatham County's shorelines. Properties most at risk to erosion are those located in and along the tidal marshes and islands in southeastern Chatham County. Properties built directly on coastlines face a higher level of risk for erosion-related damage. However, if a streambank collapses and blocks the normal streamflow, this may cause properties further upstream to experience flooding as a result of the poor drainage downstream.

6.5 PRIORITY RISK INDEX RESULTS

Table 6.21 summarizes the degree of risk assigned to each identified hazard using the PRI method.

Table 6.21 – Summary of PRI Results

Hazard	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Climate Change/Sea Level Rise	Highly Likely	Minor	Small	> 24 hours	> 1 week	2.4
Dam Failure	Unlikely	Minor	Negligible	< 6 hours	< 6 hours	1.3
100-/500-year Flood	Possible	Limited	Moderate	6 to 12 hours	< 1 week	2.4
Stormwater/Localized Flooding	Highly Likely	Minor	Small	6 to 12 hours	< 24 hours	2.3
Hurricane/Tropical Storm	Likely	Critical	Large	> 24 hours	< 1 week	3.0
Coastal Erosion	Likely	Minor	Small	> 24 hours	> 1 week	2.1

The results from the PRI have been classified into three categories based on the assigned risk value which are summarized in Table 6.22 below:

- **Low Risk** – Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium Risk** – Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **High Risk** – Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread.

Table 6.22 – Summary of Hazard Risk Classification

High Risk (2.5 – 3.0)	Hurricane/Tropical Storm
Moderate Risk (2.0 – 2.4)	Climate Change/Sea Level Rise 100-/500-year Flood Stormwater/Localized Flooding Coastal Erosion
Low Risk (< 2.0)	Dam Failure