Chapter 5: Risk Assessment

5 Chapter Overview

5.1 Federal Requirements for Risk Assessment

This chapter of the Plan addresses the Risk Assessment requirements of 44 CFR Section 201.6 (c)(2), as follows:

“201.6 (c)(2) 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. The risk assessment shall include:

(i) A description of the type, 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.

(ii) 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. All 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)(i)(A) of this section and a description of the methodology used to prepare the estimate;

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.

(iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction’s risks where they vary from the risks facing the entire planning area.”

5.2 Summary of Plan Updates

Table 5-1: Updates to the Hazard Identification and Risk Assessment Section of the Plan

Summary of Changes to the Risk Assessment Section		
Section		**Change**
5.3	Identification of Hazards Affecting Each Jurisdiction	Adds table summarizing hazards that pose a risk to each jurisdiction
5.4	Description of Hazards and Hazard Profiles	Adds additional natural hazards not included in the previous plan; Improves descriptions of hazards; Improves descriptions of locations, extent, and probabilities; updates past occurrences; adds maps
5.5	Summary of Hazards and Community Impacts	Adds summary of the impacts of hazards to the respective communities
5.6	Vulnerability of Structures and Dollar Estimate of Losses	Updates data regarding vulnerable structures and estimated loss values; adds information regarding residential structures and values
5.7	General Description of Population and Development Trends	Updates information regarding population and development trends
5.8	NFIP Insured Structures	Addresses new plan requirement
5.9	NFIP Participation	Addresses new plan requirement

5.3 Identification of Hazards Affecting the Jurisdiction

The types of natural hazards affecting the City of Alpharetta are listed in Table 5-2. Table 5-2 also notes other natural hazards that could be considered interconnected with or caused by the primary hazard event. The 2010 Atlanta-Fulton County Hazard Mitigation Plan lists hazards from which the Fulton County Hazard Mitigation Planning Committee considered the County to be vulnerable. The Alpharetta Mitigation Advisory Committee reviewed these identified hazards and determined that several of the hazards threatening Fulton County also threatened the City of Alpharetta. In addition, the Mitigation Advisory Committee determined there were a few hazards which needed to be addressed in further detail. The hazards which needed to be detailed are highlighted in the Table 5-2. Also, the other identified hazards are listed in this table.

Table 5-2: Hazards Considered for the 2011 Plan

Types of Hazards Considered for the Plan	
Hazards	Associated Hazards
Flooding	Landslide, Erosion
Dam Failure	Flooding, Landslides
Winter Storms	Snow Storms, Ice Storms, Extreme Cold, High Winds
Tornadoes	High Winds, Severe Storms
Tropical Systems	Severe Storms, High Winds, Floods
Severe Storms	Thunderstorms, Hail, Lightning, High Winds, Floods Tornadoes
Droughts	Extreme Heat, Wildfire, Sinkholes
Heat Wave	None
Landslides	None
Earthquakes	Landslides
Sinkholes	None
Wildfire/Urban Interface	None

Sources for Identifying Hazards
The Mitigation Advisory Committee used the following sources for identifying hazards in the City of Alpharetta:

Atlanta – Fulton Multi-Jurisdictional Hazard Mitigation Plan. The 2010 update of the County's plan provided information regarding possible hazards. The County's plan cross referenced information with the State of Georgia's 2008 plan therefore addressing both County and State vulnerabilities. Hazards identified in both the County and State plan were compared to local and historical event information to determine impacts on the City of Alpharetta. No additional hazards were profiled that were not included in the State or County Hazard Mitigation Plans. Hazard Descriptions were obtained from the County's plan in an effort to seamlessly merge the City of Alpharetta's updated information into the countywide plan.

Risk Assessment Matrix. A matrix was discussed with the Mitigation Advisory Committee members to determine which hazards posed a risk, the likelihood of a hazard event, and the severity and magnitude of damage that would occur. This information is included in Section 5.5.

Various Internet Sources. Many sources gathered off the internet were referenced such as the USGS, NCDC and FEMA amongst others. Sources are cited as appropriate throughout the Plan.

5.4 Description of Hazards and Hazard Profiles

5.4.1 Flood

5.4.1.1 Description of Hazard

A flood is a natural event for rivers and streams. Excess water from snowmelt, rainfall, or storm surge accumulates and overflows onto the banks and adjacent floodplains. Floodplains are lowlands, adjacent to rivers, lakes, and oceans that are subject to recurring floods. Hundreds of floods occur each year, making it one of the most common hazards in all 50 states and U.S. territories. Floods kill an average of 150 people a year nationwide. They can occur at any time of the year, in any part of the country, and at any time of day or night. Floodplains in the U.S. are home to over nine million households. Most injuries and deaths occur when people are swept away by flood currents, and most property damage results from inundation by sediment-filled water.

Several factors determine the severity of floods, including rainfall intensity (or other water source) and duration. A large amount of rainfall over a short time span can result in flash flood conditions. A small amount of rain can also result in floods in locations where the soil is saturated from a previous wet period or if the rain is concentrated in an area of impermeable surfaces such as large parking lots, paved roadways, or other impervious developed areas. Topography and ground cover are also contributing factors for floods. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. Frequency of inundation depends on the climate, soil, and channel slope. In regions where substantial precipitation occurs in a particular season each year, or in regions where annual flooding is derived principally from snowmelt, the floodplains may be inundated nearly every year. In regions without extended periods of below-freezing temperatures, floods usually occur in the season of highest precipitation. In areas where flooding is caused by melting snow, and occasionally compounded by rainfall, the flood season is spring or early summer.

Fortunately, most of the known floodplains in the United States have been mapped by FEMA, which administers the NFIP (National Flood Insurance Program). When a flood study is completed for the NFIP, the information and maps are assembled into a Flood Insurance Study (FIS). An FIS is a compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community and includes causes of flooding. The FIS report and associated maps delineate Special Flood Hazard Areas (SFHAs), designate flood risk zones, and establish base flood elevations (BFEs), based on the flood that has a 1% chance of occurring annually, or the 100-year flood. Paper FIRMs and FIS reports are gradually being replaced by DFIRMs (digital FIRMs).

The 100-year flood designation applies to the area that has a 1 percent chance, on average, of flooding in any given year. However, a 100-year flood could occur two years in a row, or once every 10 years. The 100-year flood is also referred to as the base flood. The base flood is the standard that has been adopted for the NFIP. It is a national standard that represents a compromise between minor floods and the greatest flood likely to occur in a given area and provides a useful benchmark.

Base Flood Elevation (BFE), as shown on the FIRM, is the elevation of the water surface resulting from a flood that has a 1% chance of occurring in any given year. The BFE is the height of the base flood, usually in feet, in relation to the National Geodetic Vertical Datum (NGVD) of 1929, the North American Vertical Datum (NAVD) of 1988, or other datum referenced in the FIS report.

Special Flood Hazard Area (SFHA) is the shaded A-Zone or V-Zone area on a FIRM that identifies an area that has a 1% chance of being flooded in any given year or the 100-year floodplain. FIRMs show different floodplains with different zone designations, as shown on Table 5-4 “Flood Zone Designations.” These are used for insurance rating purposes, but are also necessary for flood permitting and flood hazard mitigation planning purposes. The 500-Year Floodplain is the shaded X-Zone area shown on a FIRM that has a 0.2% chance of being flooded in any given year.

Floodway is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood without substantial increases in flood heights. The Flood Fringe is the remainder of the 100-year floodplain. Figure 5-3 illustrates the components of a floodplain along a stream.

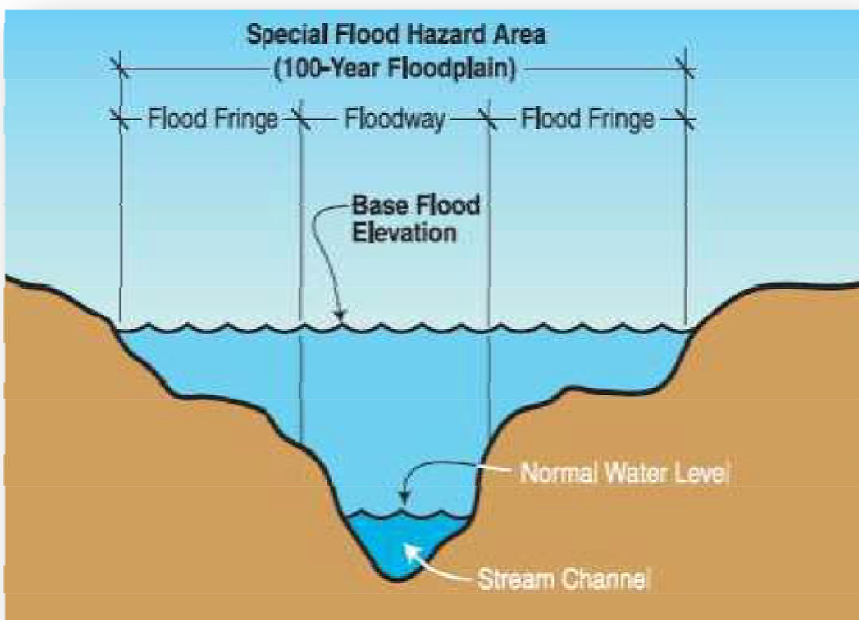
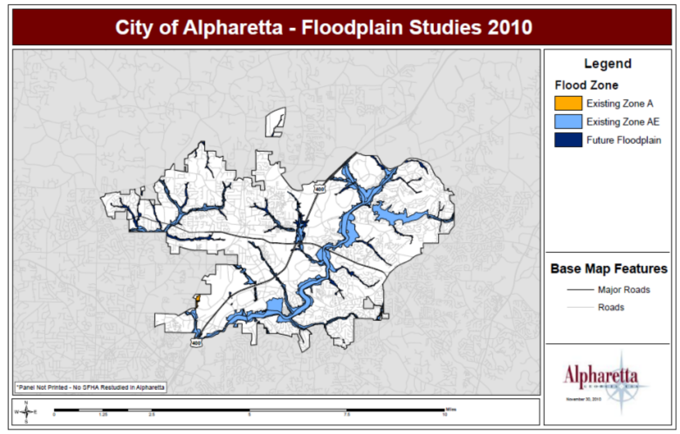


Figure 5-1: Floodplain Cross Section

Table 5-3: Flood Zone Designations

A Zones	100-year Riverine and inland floodplain areas of high risk	
	A	The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This often called an unnumbered A zone or an approximate A zone.
	AE	The base floodplain where base flood elevations are provided.
	AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	AH	Shallow flooding base floodplain. BFEs are provided.
	A99	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
	AR	The base floodplain that results from the de-certification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection.
V Zones	100-year Coastal floodplain areas of high risk	
	V	The coastal area subject to a velocity hazard (wave action) where BFEs are not determined on the FIRM.
	VE	The coastal area subject to a velocity hazard (wave action) where BFEs are provided on the FIRM.
X Zones	Areas of minimal to moderate risk outside the 100-year floodplain	
	Shaded	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. Also includes areas protected by levees from the 100-year flood and shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square miles.
	Unshaded	Area of minimal flood hazard determined to be outside the 500-year floodplain.
D Zone	Area of undetermined but possible flood hazards	

5.4.1.2 Hazard Profile



Nationally, flooding is one of the most common disasters to occur. In fact, 75% of presidential disaster declarations are due to flooding. Similarly, flooding is one of the most common disasters to occur in the City of Alpharetta. The City of Alpharetta anticipates increased damages from flooding due to increases in development within the City and also downstream and upstream of the City. An increase in impervious land uses (i.e. roads, parking lots, etc.) decreases the ability of the land to absorb rainfall as opposed to fields or woodlands. Urbanization causes runoff amounts to be increased by 2 to 6 times over what would occur on terrain such as an open field. The main areas of flooding within the City of Alpharetta are areas near Foe Killer Creek and also Big Creek and its tributaries. In an attempt to help reduce the risk of future damages, the City of Alpharetta has completed an anticipated future floodplain assessment. From this study the City can regulate and guide development away from anticipated high risk flood areas. Currently, the City does not participate in the Community Rating Service (CRS) program which rewards communities that take actions to reducing flood risk by reducing premiums on flood insurance policies.

Past Occurrences of Flood Events

Fulton County has reported approximately 60 flood events since 1991 according to the National Climatic Data Center (NCDC). Approximately ten of those incidents were specifically reported in Alpharetta or referenced a nearby town. The record setting floods that occurred in the fall of 2009 set new records for most streams in the area. A description of the flooding events that affected Alpharetta are provided below:

July 3, 2001 – Localized street flooding was observed in the vincity of Georgia Highway 9 and Hembree Road.

June 17, 2003 – Approximately 4 – 5 miles south of Alpharetta flooding was reported that caused many people to evacuate their homes as water rose to approximately the level of their mailboxes.

September, 2004. The flooding that occurred during the month of September 2004 is the most recent notable events. Big Creek suffered massive flooding after Hurricane Frances was followed by Hurricane Ivan in September 2004. Big Creek tied a record high crest of 11.3 feet which was more than four feet above flood stage.

January 2, 2006 – Flash Flood. The river gage on Crooked Creek indicated the river had exceeded flood stage approximately 5 miles south of Alpharetta. This lasted for approximately three hours before returning below flood stage. No damage was reported.

March 21, 2006 – The river gage on Big Creek near Alpharetta reported a cresting of 8.2 feet which is 1.2 feet above flood stage. Minor flooding was observed in parks and the Alpharetta Greenway had to be shut down. Fortunately only minor debris cleanup was necessary.

August 28, 2009 – An upper level low pressure system was slowly making its way through the region bringing with it heavy showers and thunderstorms. Some flash flooding was observed and Big Creek briefly exceeded flood stage in Alpharetta.

September 17, 2009 – The USGS stream gage on Big Creek at Kimball Bridge Road near Alpharetta reached flood stage. This was the first indication of massive flooding which would occur in the following week in Alpharetta as a deep tropical moisture pattern was developing and preparing to stall over the area.

Source: The Big Creek Greenway

September 21, 2009 – Over 10 inches of rain caused Big Creek to reach record stage. It rose to approximately 12 feet which is five feet over flood stage. Kimball Bridge Road was shut down according to an online news report written on September 22 about the event on www.bigcreekgreenway.com *Trailnews*. In total 40 roads had to be closed in the City of Alpharetta. Several of the storm drains backed up and a few of the roads were impacted. Some roads, such as the intersection of Webb Bridge and Big Creek had almost two feet of moving water over it. The City had to respond to approximately 40 incidents from this event alone.


Photo by Alan Cressler, USGS.

The flooding was so significant that a section of Interstate twenty, which is several miles south of Alpharetta, was shut down for several days as flooding exceeded the 500 year event.

October 12, 2009 – Several areas in north Georgia experience yet another significant rainfall event in the previous few months. Approximately five miles to the east of Alpharetta flooding was reported.

April 15, 2011 – The USGS stream gage on Big Creek River in Alpharetta reached flood stage and remained there for approximately 2 days. Significant damage was reported in the area but mostly due to other related hazards.

Location of Potential Flooding

A map of Alpharetta's future and existing floodplains are provided in the Additional Hazard Research appendix. Not all areas of Alpharetta have updated floodplains as some areas are currently being studied. Big Creek is one of the most commonly affected areas. Flood stage is 7 feet depth, and due to the heavy urbanization in the area, it often reaches above this mark during heavy storms. Flash flooding is one of the most common hazard events along this creek.

Flash Floods are caused by a sudden increase in the amount of water traveling through a river bed within a short amount of time. Examples include during heavy rains or if a dam or levee has failed. The Georgia Water Information Network (GWIN) lists real-time information for Big Creek and can be accessed at:
http://nwis.waterdata.usgs.gov/ga/nwis/uv/?site_no=02335700&PARAmeter_cd=00065,00060

Extent and Intensity of Potential Floods
Flood events have ranged from localized flooding to widespread flooding. According to the data listed on the National Climatic Data Center, the following types of events have been recorded since 1998 which have affected the City of Alpharetta:

- Flash Flooding - 8 times in the past 14 years
- Major Flooding - 4 times, and indicated isolated small flooding occurred once

The data from the NCDC does not always indicate if Alpharetta was directly included, therefore some events might be affecting the regional area around the City of Alpharetta.

Probability of Future Floods
The City of Alpharetta has taken proactive steps to mitigate flooding but implementation of these actions will be a long-term process. During this time, the probability of future flooding events remains high. Based on past experience the City of Alpharetta can expect to experience a flooding event along one of its rivers every 12 – 15 months. Regulations, insurance and education are actions which the City can undertake to help reduce the risk to stakeholders whom are vulnerable to these future events. Maps of the current and future 100-year floodplain flood zones are included in the Additional Hazard Research appendix.

5.4.2 Drought

5.4.2.1 Description of Hazard

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It occurs in virtually all climatic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate.

It is generally defined as a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector. Drought should be considered relative to some long-term average condition of balance between precipitation and evapotranspiration (i.e., evaporation + transpiration) in a particular area, a condition often perceived as “normal”. It is also related to the timing (i.e., principal season of occurrence, delays in the start of the rainy season, occurrence of rains in relation to principal crop growth stages) and the effectiveness (i.e., rainfall intensity, number of rainfall events) of the rains. Other climatic factors such as high temperature, high wind, and low relative humidity are often associated with it in many regions of the world and can significantly aggravate its severity.

A few examples of direct impacts of drought are: reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitats. Social impacts include public safety; health issues; conflicts between water users; reduced quality of life; and inequities in the distribution of impacts and disaster relief. Income loss is another indicator used in assessing the impacts of drought; reduced income for farmers has a ripple effect throughout the region's economy (National Drought Mitigation Center, 1998).[1]

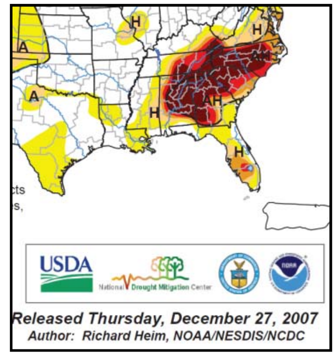
According to the National Drought Mitigation Center (NDMC), there are four ways of measuring drought. First is a **meteorological drought**, which is a decrease in precipitation in some period of time. These are usually region-specific, and based on a thorough understanding of regional climatology. Meteorological measurements are the first sign of drought. An **agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought occurs after a meteorological drought, but before hydrological drought. **Hydrological drought** is deficiencies in surface and subsurface water supplies. It is measured as stream flow and at lake, reservoir and groundwater levels. There is a time lag between lack of rain and less water in rivers, streams, reservoirs and lakes. When precipitation is deficient over time, it will show in these water levels. The last type of drought defined by NDMC is a **socioeconomic drought**, which occurs when water shortages begin to affect people. In addition to the impacts discussed above, water level decline due to drought can also cause sinkholes to form. Drought can be measured through a variety of drought indices. The various scientific methodologies can be found in detail, along with the advantages and disadvantages for each at the NDMC's website at:
http://www.drought.unl.edu/whatis/indices.htm.

5.4.2.2 Hazard Profile

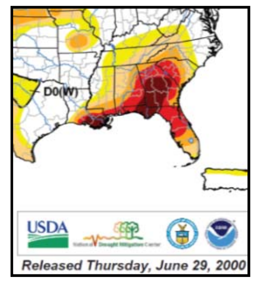
The City of Alpharetta is mostly within the Upper Chattahoochee River Watershed (03130001). Much of the water which enters the City eventually ends up in the Chattahoochee River. A major water reservoir within the City limits is called Lake Windward. According to the Metropolitan North Georgia Water Planning District 1 which services the Fulton County and the City of Alpharetta, groundwater makes up less than 1% of the public water supplies for the Metro Water District. It is expected that this will remain constant through 2035. A drought within the City of Alpharetta or neighboring areas would have significant impacts on both the surface water capacity, such as Lake Windward, and put an increased reliance on groundwater supplies.

Figure 5-2: Watershed Boundaries

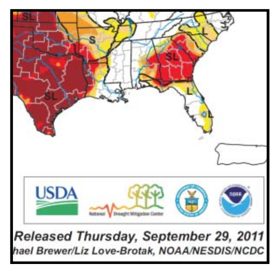
Past Occurrences of Drought Events



According to data from the National Climatic Data Center, there have been approximately 20 drought, very dry, or abnormally dry events since 1997. This has resulted in $670.7 million dollars in crop losses for the affected zones (which included counties in addition to Fulton). A recent extreme drought event was extended from September 2007 and ended in December of 2007. As a result of this drought, Lake Lanier in northeast Georgia and the main water supply for the Atlanta metropolitan area, dropped to its lowest level in history on December 28, 2007 with a reading of 1050.75 feet. New records were set nearly every day after November 20th, when the previous record low-level of 1052.63 feet was reached. This event resulted in $344 million dollars in crop damage for the affected areas. Other notable events which affected the Alpharetta or the local region included:

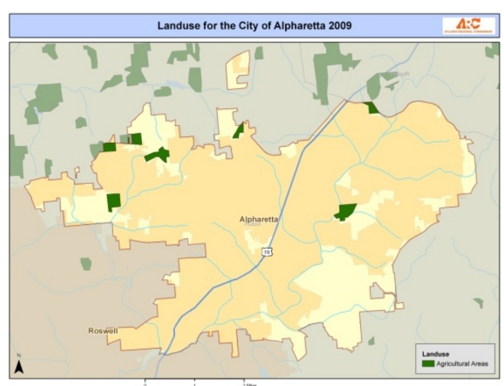


April 1998 – June 2000 – Extemely dry conditions persisted over North and Central Georgia. This pattern has been observed for about two years. Observation centers were indicating yearly rainfall totals of approximately 10 – 15 inches below normal. The total two year deficit was more than a twenty inches below normal through much of the same region. Streamflows were at or below the lowest 10th percentile of the historical distribution during the month of June 2000.



September 2011 - The northern part of Georgia was experiencing minor drought which began in April of the same year. Agriculture losses in the northern region were negligible but the southern part of the State was experiencing a significant drought with crop loss at 30% greater than expected in ordinary years. The southern deficits caused strain on upstream water resources, including major water supplies such as Lake Lanier.

Location of Potential Droughts



Since all locations and geographic areas of the City of Alpharetta are dependent on adequate water supply, droughts affect all areas. Less than 1% of the population within the City of Alpharetta works in a farming industry. Therefore, a drought would mostly affect public lands, golf courses, agricultural areas and any other open spaces that need to be maintained.

Extent and Intensity of Potential Droughts

Due to the recent drought events that have affected the state, and in anticipation of continued growth that will affect the demand for water, the State of Georgia has recognized the need for

drought awareness and water conservations actions. On June 2, 2010, the Governor signed into effect the "Water Stewardship Act" which is designed to help secure water supplies by preparing for future growth, protecting water-sensitive industries, and equipping the State to navigate future droughts. The intensity of future droughts can be mitigated through education. The Metropolitan North Georgia Water Planning District (MNGWPD) has created a website which allows users to quickly and easily find rebate offers, free water usage audits and much more. The MNGWPD has been working towards securing additional water supplies and also encouraging water conservation. For more information see:
http://www.northgeorgiawater.com/

Probability of Future Droughts

The City of Alpharetta will continue to be susceptible to droughts. There is not a great deal of historical information regarding droughts. The oldest drought record with the NCDC only dates back to 1997. The MNGWPD has created a plan that includes the construction of three new reservoirs and the investigation of an additional three reservoirs. Along with conservation and additional storage capacity the commission encourages reuse opportunities. All measures combined will help lower the impacts and frequency of future droughts, but based on historical data and current water supplies the City of Alpharetta can expect to experience a drought once every 2 years.

5.4.3 Earthquakes

5.4.3.1 Description of Hazard

An earthquake is the shaking and vibration at the surface of the earth resulting from underground movement along a fault plane. Earthquakes are caused by the release of built-up stress within rocks along geologic faults or by the movement of magma in volcanic areas. They usually occur without warning and are usually followed by aftershocks.

Earthquakes can affect hundreds of thousands of square miles and cause tens of billions of dollars of damage to property. An earthquake event can cause injury and loss of life to hundreds of thousands of persons and can greatly disrupt the social and economic functioning of the affected area. Secondary hazards during an earthquake may occur, such as surface faulting, sinkholes, and landslides.

Earthquakes are caused by the rupture or sudden movement of a fault where stresses have accumulated along opposing fault planes of the earth's outer crust. These fault planes are usually found along the borders of the earth's tectonic plates which generally follow the outlines of the continents. However, fault planes may occur at the interior of the plates. The plates range from 50 to 60 miles in thickness and move slowly and continuously over the earth's interior. Where the plates move past each other, they continually bump, slide, catch, and hold. When the stress exceeds the elastic limit of the rock, an earthquake occurs. Generally, the larger the earthquake, the greater the potential for surface fault rupture.

Most property damage and earthquake-related deaths result from the failure and collapse of structures caused by ground shaking or ground motion. Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by an earthquake. The strength of the ground shaking is determined by the magnitude of the earthquake, the surface distance from the earthquake's epicenter and type of fault, and by the site and regional geology.

Ground shaking causes waves in the earth's interior, known as seismic waves, and along the earth's surface, known as surface waves. There are two types of seismic waves: primary waves which are longitudinal that cause back-and-forth oscillation along the direction of travel (vertical motion); and secondary waves or shear waves which are slower than primary waves and cause structures to vibrate from side-to-side (horizontal motion). Surface waves travel more slowly than and are usually significantly less damaging than seismic waves.

Seismic activity is described in terms of magnitude and intensity. Magnitude describes the total energy released and intensity describes the effects at a particular location. Magnitude is defined as the measure of the amplitude of the seismic wave and is expressed by the Richter scale. The Richter scale is a logarithmic measurement where an increase in the scale by one whole number represents a tenfold increase in the measured amplitude of the earthquake. Figure 5-3 illustrates the increasing magnitude and associated affects of earthquake energy.

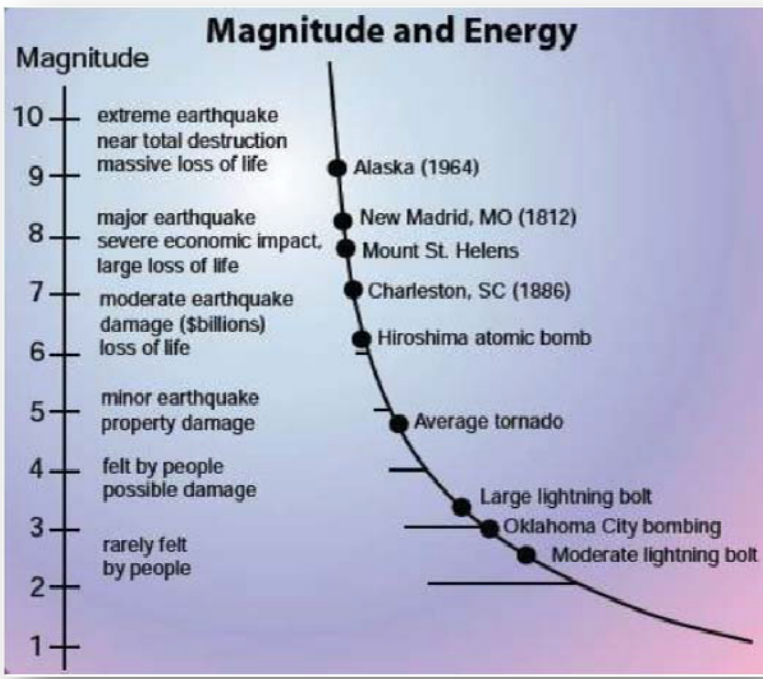


Figure 5-3: Earthquake Scales

Source: USGS

Figure 5-4 depicts the seismic hazard map for the State of Georgia with the Atlanta area indicated.

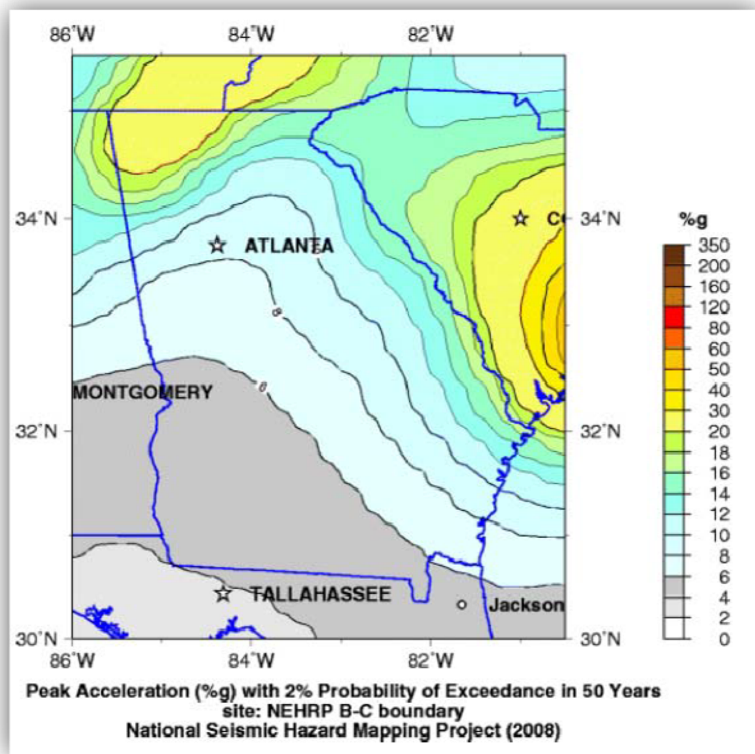
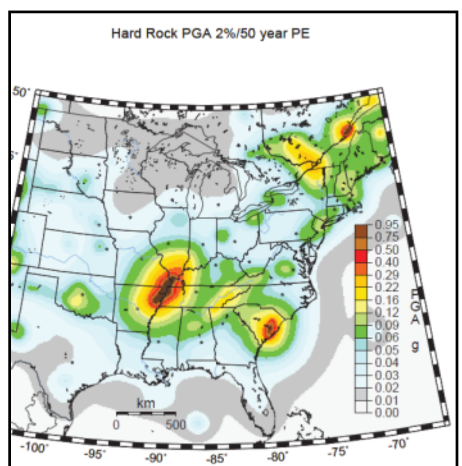


Figure 5-4: Seismic Hazard Map for Georgia

Source: USGS

5.4.3.2 Hazard Profile

Earthquakes may be felt in any area of Georgia. No area in Georgia is immune from the earthquake threat, but northern Georgia has experienced more earthquakes in recent history than any other part of the state. When a damaging earthquake occurs, it will affect an area covering many surrounding counties. Based on the historical seismicity three levels of seismic activity are apparent in Georgia. The northern half of Georgia has experienced moderate seismicity, with a magnitude 4 earthquake about every 10 years. When the details of the seismicity contained in the more frequent smaller earthquakes are included in a hazard assessment, two areas of northern Georgia stand out as being unusually active. These are the Central Georgia Seismic Zone and the extension of the Southeastern Tennessee Seismic Zone across northwest Georgia. The maximum damage from an earthquake will occur in the epicentral area and thus the counties located in these two zones have the greatest earthquake



Source: USGS

hazard in Georgia. There are two minor faults in northwest Georgia, the Cartersville and Rome faults; one that runs more or less along the Chattahoochee River; and two more in Central Georgia.

Past Occurrences of Earthquake Events

There have been approximately 61 earthquakes within 100 miles of the City of Alpharetta since 1973 which have ranged from 1.8 to 4.9 on the Richter Scale according to the USGS. The most recent occurrence was November 9, 2011, which was a magnitude of 2.7 and approximately 100 miles east of the City of Alpharetta.

Figure 5.5 shows the location of earthquakes within 100 miles since 1973 of the City. Table 5-4 lists the large earthquake events that have occurred within 100 miles of the City in the same time period.

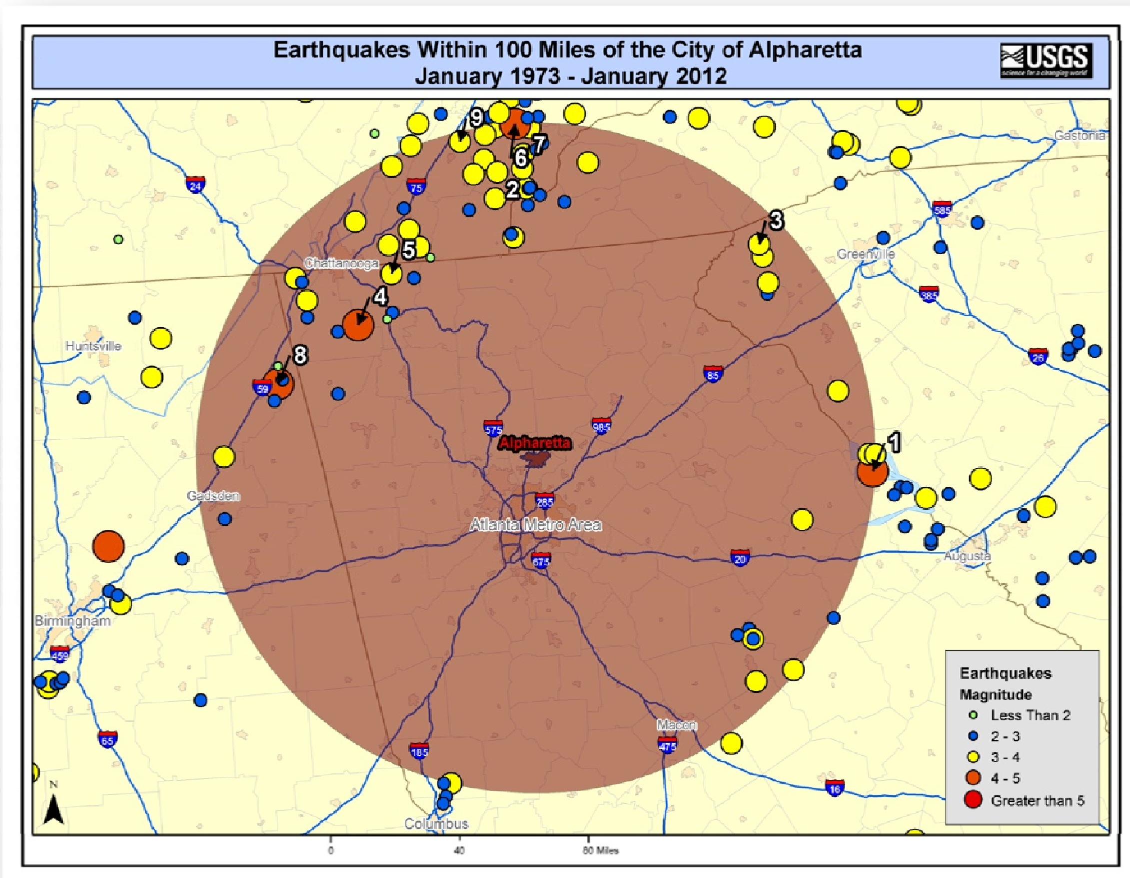


Figure 5-5: Historic Earthquakes Near Alpharetta

Table 5-4: Description of Earthquakes Near Alpharetta

Earthquakes within 100 Miles of the City 1973 - 2012		
ID	Date	Magnitude
1	1974 Aug 2,	4.9
2	1979 Aug 13	3.7
3	1979 Aug 26	3.7
4	1984 Oct 9,	4.2
5	1986 Jul 11	3.8
6	1987 Mar 27	4.2
7	1995 Jul 5,	3.7
8	2003 Apr 29	4.6
9	2005 Oct 12	3.6

Location of Potential Earthquake Events

Since all locations and geographic areas of Alpharetta are within a potential seismic area, earthquakes affect all areas of the City. Some areas such as high density, urban areas may be more vulnerable to the affects of earthquakes, particularly any buildings that were not constructed to withstand seismic activity.

Extent and Intensity of Potential Earthquakes

According to Dr. Tim Long of Georgia Tech, earthquakes in this area are typically deeper focus, meaning they are down 20 to 30 kilometers in the Earth's crust. This means they are felt over a wider area, but not as strongly as some other types of earthquakes.[3]

Probability

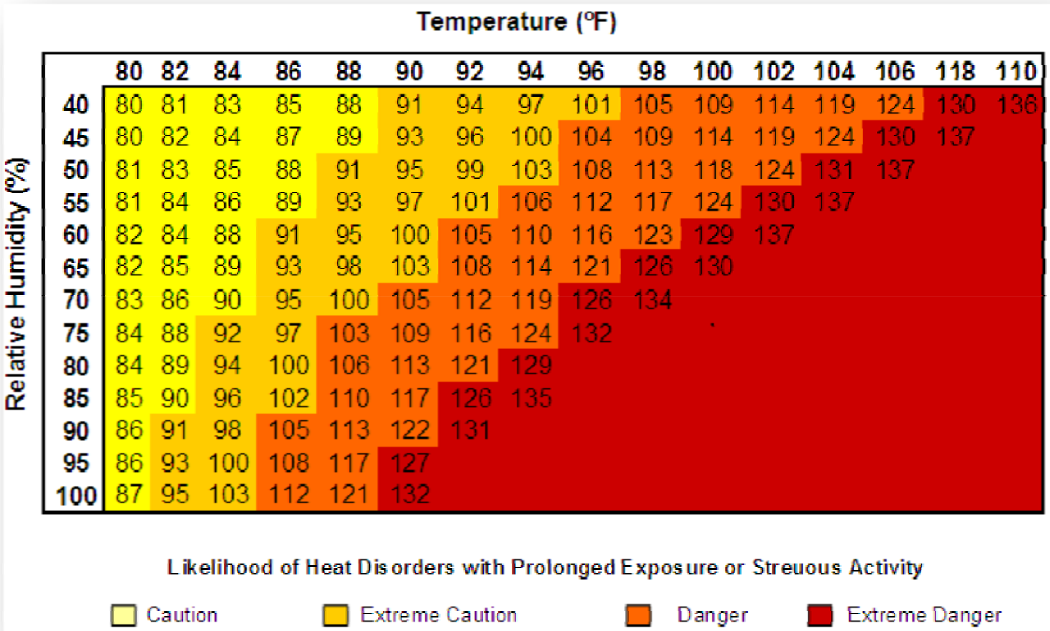
Earthquakes are a very frequent occurrence within 100 miles of the City. The fortunate part has been that the earthquakes are generally very minimal is the Magnitude of a 4 or less on the Richter Scale. The City can expect based on past occurrences to have an earthquake of this strength every year. The City has also had an earthquake with a magnitude greater than 4.0 four times since 1973. Using this as a benchmark, the City can expect to experience a magnitude 4 earthquake or higher within 100 miles once every decade. It should also be noted that there has not been an earthquake event above a 5 magnitude on the Richter Scale within 100 miles of the City since 1973.

5.4.4 Heat Wave

5.4.4.1 Description of Hazard

According to the National Weather Service, heat is the number one weather-related killer in the United States. The National Weather Service statistical data shows that heat causes more fatalities per year than floods, lightning, tornadoes, and hurricanes combined. Based on the 10-year average from 1994 to 2003, excessive heat claimed 237 lives each year. By contrast, floods killed 84; tornadoes, 58; lightning, 63; and hurricanes, 18.

NOAA's heat alert procedures are based mainly on Heat Index Values. The "Heat Index", sometimes referred to as the "apparent temperature" and given in degrees Fahrenheit, is a measure of how hot it really feels when relative humidity is added to the actual air temperature. Figure 5-6 is the NOAA Heat Index Chart.



Temperature (ºF)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution · Extreme Caution · Danger · Extreme Danger

Figure 5-6: National Weather Service Heat Index Chart

Each National Weather Service (NWS) Weather Forecast Office (WFO) can issue the following heat-related products as conditions warrant:

Excessive Heat Outlook: This is issued when the potential exists for an excessive heat event in the next 3 to 7 days. An outlook is used to indicate that a heat event may develop. It is intended to provide information to those who need considerable lead time to prepare for the event, such as public utilities, emergency management and public health officials.

Excessive Heat Watch: This is issued when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A watch is used when the risk of a heat wave has increased, but its occurrence and timing is still uncertain. It is intended to provide enough lead time so those who need to set their plans in motion can do so, such as established individual city excessive heat event mitigation plans.

Excessive Heat Warning/Advisory: This is issued when an excessive heat event is expected in the next 36 hours. These products are issued when an excessive heat event is occurring, is imminent, or has a very high probability of occurrence. The warning is used for conditions posing a threat to life or property. An advisory is for less serious conditions that cause significant discomfort or inconvenience and, if caution is not taken, could lead to a threat to life and/or property.

5.4.4.2 Hazard Profile

Extreme heat is no stranger to residents of Alpharetta and because of this can often be overlooked as a serious risk to populations such as elderly and low-income residents. Most of the illnesses related to extreme heat are not fatal but can result in public health problems and deplete the public safety and emergency care systems of the community. The extent of a heat wave usually is described as affecting a significant amount of land area such as the southeast region but sometimes can be exasperated by large urban areas contributing to what is known as the 'Urban Heat Island' effect. The City of Alpharetta is not considered a large contributor to the 'Urban Heat Island' effect. Although the City does not contribute much to the Urban Heat Island effect, isolated micro climates can be extremely hazardous. During a heat wave children, adults and pets are extremely vulnerable if left in high risk areas, such as cars, for extended periods of time. On a day when the temperature is approximately 80° Fahrenheit outside, the inside temperature of a car can reach over 120° Fahrenheit within an hour if it is parked in direct sunlight.

Past Occurrences of Heat Waves

Extreme heat is not confined to political boundaries therefore, the county experience with excessive heat relates very well with the City of Alpharetta's past occurrences. The region around Alpharetta, including different areas within Fulton County, has experienced 89 heat waves since 1952. The most recent heat wave was August 2007 which was the warmest month on record. Other notable years were 1980 and 1993 in which 11 and 13 heat waves were recorded, respectively. The heat wave in 1995 resulted in two deaths related, as did the extreme heat event in 2007. Typically, the months of June, July and August are the hottest during the year as evidenced by 42 years of historic records available at the following location: http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/max90temp.html

Location of Potential Heat Waves

Since all locations and geographic areas of the City of Alpharetta are subject to temperature extremes, heat waves affect all areas of the City. However, micro climates within the City will pose the highest risk to residents. More information on precautionary measure to be taken during heat waves is provided at: http://www.noaawatch.gov/themes/heat.php

Extent and Intensity of Heat Waves

August 2007 proved to be one of the hottest months on record for much of north and central Georgia. This was the result of a large ridge of high pressure combined with abnormally dry conditions from several preceding months of below normal rainfall. Numerous daily record high temperatures were broken, especially during the mid part of the month. Furthermore, some record high minimum values were recorded during this period. It was also the warmest month ever for Atlanta and tied the record for the most number of days that 100° was reached or exceeded in one summer for Atlanta. While most of the month was above normal, the core of the intense heat was during the period from August 7th to August 22nd. Similar situations were observed at the other reporting stations. Two heat related deaths were reported, one of which was in Atlanta. The excessive heat combined with continued below normal rainfall to exacerbate the drought conditions across the region.

Probability of Future Heat Waves

The City of Alpharetta is highly likely to experience heat waves and other extreme heat events, with the Urban Heat Island effect having minimal effects in the City. Based on past experience the City will experience approximately one heat wave each year.

5.4.5 Landslide

5.4.5.1 Description of Hazard

Landslides occur and can cause damage in all 50 states, at an annual cost of about $3.5 billion per year (2005). Between 25 and 50 deaths per year in the U.S. are attributable to landslides. Landslides cause damage to the natural environment and economic losses, due to reduced real estate values, decreased agricultural and forestry productivity, among other adverse economic effects.

A landslide is a downward and outward movement of slope-forming soil, rock, and vegetation under the influence of gravity, which includes a wide range of ground movement. Numerous types of events, including natural and man-made changes within the environment, can trigger landslides. Examples of these changes that cause weaknesses in the composition or structures of the rock or soil include heavy rain, changes in ground water level, seismic activity, or construction activity. Man-made landslides may result from activities such as terracing, cut and fill construction, building construction, mining operations, and changes in irrigation or surface runoff.

There are different types of landslides. **Rock falls** are rapid movement of bedrock characterized by free-fall, bouncing and rolling. **Slides** are movements of soil or rock along a distinct surface of rupture that separates the slide material from the more stable underlying material. There are two major types of slides: rotational and translational slides.

In a **rotational slide** the surface of rupture is curved concavely upward and the slide block rotates around an axis parallel to the slope contours. A **translational slide** is a mass that moves down and outward along a relatively planar surface with little rotational movement or backward tilting.

Flows are mass movements of water-saturated material. The movement of flows can be extremely rapid (debris avalanche), very rapid (debris flow) or very slow (earth flow).

The following are some significant landslide facts from the USGS:

• Landslides often accompany earthquakes, floods, storm surges, hurricanes, wildfires, or volcanic activity. They are often more damaging and deadly than the trigging event.

• Human activities and population expansion are major factors in increasing landslide damage and costs.

• Although the National Flood Insurance Act covers certain damage from “mudflows,” insurance against landslides is generally unavailable in most areas of the United States. As a result, many victims of landslides resort to litigation in order to recover damages.

5.4.5.2 Hazard Profile

Northern Fulton County has a potentially high susceptibility due to slopes, but only a low incident rate, of landslides due to the enactment of slope ordinances by many jurisdictions.

Landslides that have occurred have been minor and localized in nature and not significantly affected homes, businesses, infrastructure, or other valuable property. No jurisdiction rated landslides as a significant hazard event in their risk assessments and hazard vulnerability analysis.

Location of Potential Landslides Events

The City of Alpharetta has several areas of steep slopes. These areas are not classified as hazardous but pose the highest risk to the City of Alpharetta. The areas of steep slopes are highlighted in the location map below:

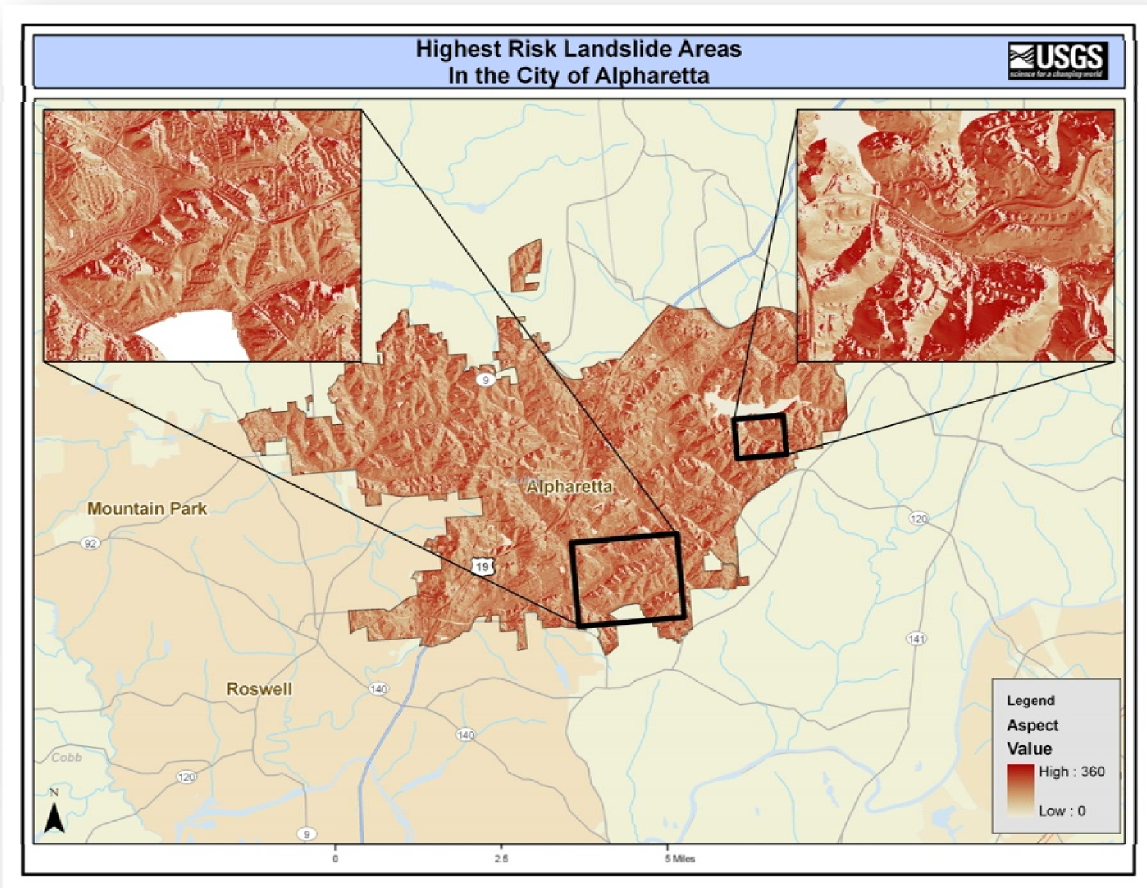


Figure 5-7: Map of Landslide Potential near Alpharetta, GA

Probability of Landslide Events

Landslides are generally a secondary cause of a primary event such as the result of an earthquake, or heavy rains. There have been no reported landslides in Alpharetta but that does not mean future events will not happen.

5.4.6 Severe Weather

5.4.6.1 Description of Hazard

A severe thunderstorm is defined as a thunderstorm containing one or more of the following phenomena: hail 3/4" or greater, winds gusting in excess of 57.5 mph, and/or a tornado. Severe weather can include lightning, tornadoes, damaging straight-line winds, and large hail. Most individual thunderstorms only last several minutes, however some can last several hours. Long-lived thunderstorms are called supercell thunderstorms. A supercell is a thunderstorm that has a persistent rotating updraft. This rotation maintains the energy release of the thunderstorm over a much longer time than typical, pulse-type thunderstorms which occur in the summer months. Supercell thunderstorms are responsible for producing the majority of severe weather, such as large hail and tornadoes (National Oceanic and Atmospheric Administration).

Downbursts are also occasionally associated with severe thunderstorms. A downburst is a strong downdraft resulting in an outward burst of damaging winds on or near the ground. Downburst winds can produce damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can even occur with showers too weak to produce thunder (National Oceanic and Atmospheric Administration). Strong squall lines can also produce widespread severe weather, primarily very strong winds and/or microbursts.

When a severe thunderstorm approaches, the National Weather Service will issue alerts. Two possible alerts are:

• Severe Thunderstorm Watch - Conditions are favorable for the development of severe thunderstorms.

• Severe Thunderstorm Warning - Severe weather is occurring in the area.

Perhaps the most dangerous and costly effect of thunderstorms is lightning. As a thunderstorm grows, electrical charges build up within the cloud. Oppositely charged particles gather at the ground below. The attraction between positive and negative charges quickly grows strong enough to overcome the air's resistance to electrical flow. Racing toward each other, they connect and complete the electrical circuit. Charges from the ground then surge upward at nearly one-third the speed of light and produce a bright flash of lightning (Cappella, 1997).

On average, more people are killed by lightning than any other weather event. From 1993 to 2003, Georgia ranked 9th in the nation for deaths caused by lightning. Nationwide, lightning related economic losses to over $5 billion dollars per year, and the airline industry alone loses approximately $2 billion a year in operating costs and passenger delays from lightning. Approximately 30% of all power outages are lightning-related with total costs approaching $1 billion.

5.4.6.2 Hazard Profile

Storm data from the National Climatic Data Center reveal that severe weather events are one of the most common threats to the City of Alpharetta and surrounding area. And recently, new evidence suggests severe storms may be enhanced by urban areas.[9] These areas produce heat and lift which are two important factors for thunderstorm formation. Results from a recent

10 year investigation of lightning and thunderstorm activity surrounding the Atlanta area identified increases in thunderstorm intensity, rainfall, and lightning over and downwind of the city center during the summer months of June, July, and August. Researched hypothesized several possible causes.

Urban Heat Island (UHI): A UHI occurs when the city registers higher temperatures than the surrounding rural area. This also includes the lack of cooling during late afternoon and evening after temperatures normally reach their highest.

"Canyon" Winds: Wind also plays a vital role in the intensification of urban heat. Warmer air over the city reduces atmospheric pressure and promotes lift. As these winds encounter the urban canyons created by tall buildings, the winds tend to slow, converge and rise over the city. The UHI and converging winds cause air to ascent over the city center and sink along its periphery. The lifting of warm, humid air over the city often creates clouds that can develop into thunderstorms if the air remains unstable and continues to rise. Furthermore, thunderstorms that are already formed and moving over a city can also be enhanced by the urban area.

Pollution: Pollution injects billions of small particles into the atmosphere. These particulates can be caught in the updrafts produced by the UHI and lifted into the developing thunderstorms. Pollution keeps droplets smaller and allows more water to be transported higher where temperatures are lower. Evidence suggests that their presence can alter how a thunderstorm forms. These particles are some of the best cloud embryos, as water readily condenses on to them, forming cloud droplets. Lightning may also be enhanced by pollution as the cloud droplets take on different electrical charges. This in turn can lead to greater cloud electrification.

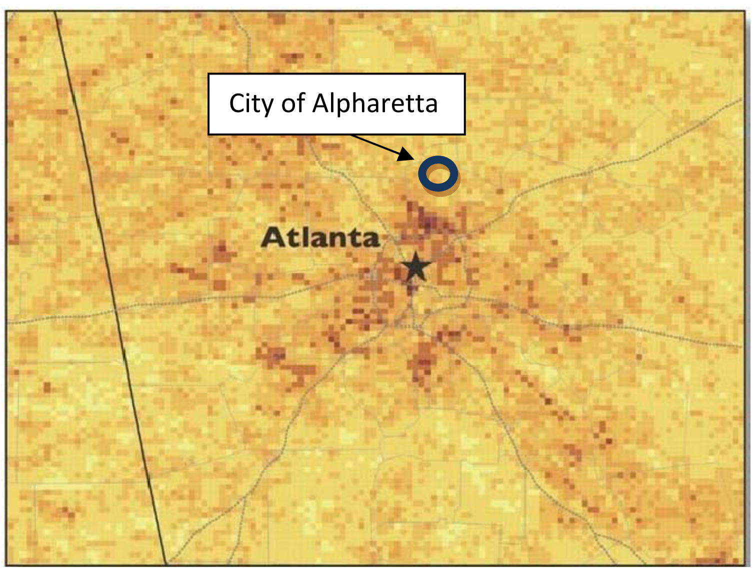


Figure 5-8: Radar Climatology

Radar climatology illustrating the clustering of strong thunderstorm days directly over and immediately surrounding Atlanta.[10]

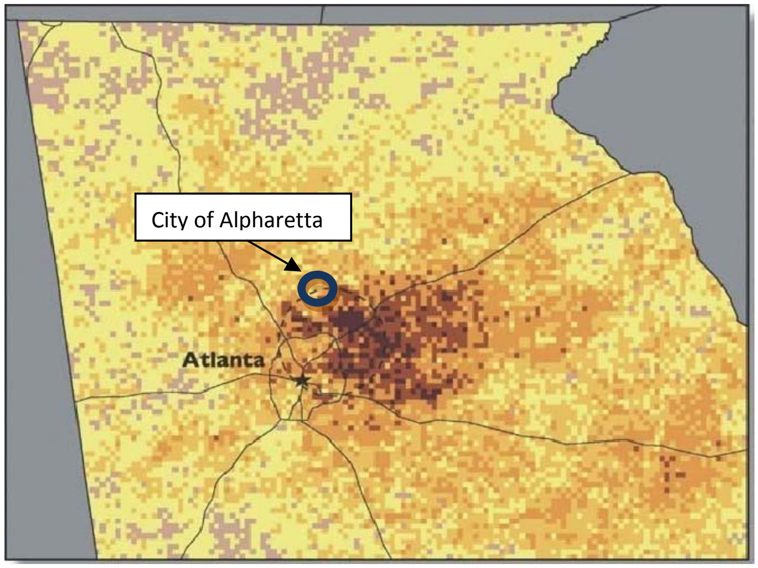


Figure 5-9: Lightning Occurrences Near Alpharetta

Figure 5-9 shows a plot of lightning events during periods of westerly flow illustrating downwind enhancement east of Atlanta.

Past Occurrences of Severe Weather Events

Many of the severe weather events documented and described in the 2010 Fulton County Hazard Mitigation Plan had an effect on the City of Alpharetta. In addition to these events the City has experienced approximately 30 additional severe weather events in or around the area since that update. For the purposes of this plan, these are defined as documented events by the National Climatic Data Center that produced hail, thunderstorms, severe lightning, strong wind events and/or heavy rain. These events have resulted in approximately $6.2 million dollars in property damage. Seven of these events resulted in property damage $100,000 or more. A few of the more significant events are described below.

July 26, 2010 - Quarter to Half – Dollar sized hail fell just east of Alpharetta. The storm also produced damaging winds that blew down trees.

March 26, 2010 - A slow moving front moved across the region producing 4 inch hail in western Georgia, a tornado in the central part of the state and in Alpharetta approximately quarter size hail along with intense cloud to ground lightning.

April 15, 2011 – High winds, tornadoes and isolated server thunderstorms moved through the region producing golf ball sized hail and causing over $4.3 million worth of property damage.

February 22, 2010 – A strong line of thunderstorms moved into Georgia bringing with it considerable lightning, small hail and heavy rain in some areas. Approximately 4-5 miles east of Alpharetta lightning struck a gas line adjacent to a residential structure. Fortunately, no one was reported injured.

June 15, 2010 – Two commercial building were set on first as the result of lightning strikes. One of those buildings was located in Alpharetta. This was the result of a day which had temperatures ranging in the mid to upper 90s and high humidity causing for an extremely unstable atmosphere.

October 25, 2010 – A slow moving system resulted in three days of heavy thunderstorms. This was unusual for the month of October. This event ended up being one of the most significant weather outbreaks of the year for this area. Small tornadoes were confirmed as part of this system in different parts of the State.

June 14, 2010 - A strong thunderstorm system caused trees to fall down and caused road closures in nearby towns. A downburst was indicated near the City of Alpharetta and appeared to cause the trees to fall.

April 4, 2011 – A southwest oriented squall line of thunderstorms created two brief small tornadoes and down trees on homes and vehicles. The event caused seven fatalities which is the most deaths in a single natural disaster event since the 2009 September flooding event.

Extent and Intensity of Potential Severe Weather Events

The extent of each storm event markedly varies according to storm severity and duration. Storm severity can be measured by the storm characteristics, which may include heavy precipitation, large hail, intense lightning, and high winds. The exact extent of severe storms is not predictable. Severe storms can also result in flooding due to heavy precipitation and wildfires due to lightning and will accompany hurricanes and tornadoes.

Large hail, though very rare, can cause injury or loss of life and major property damages. Normally, however, hail damage is limited to automobiles and minor building damage. Both lightning and high winds have the potential to cause loss of life and considerable property damage. The power of lightning's electrical charge and intense heat can electrocute on contact, split trees, and ignite fires. High winds are often the cause of power outages and can cause severe damages to buildings and infrastructure by fallen trees and direct wind gusts.

Recent studies indicate that urbanization may interact and possibly increase the number and intensity of severe weather effects such as thunderstorms, lighting, and heavy rainfall.

Location of Potential Severe Weather Events

Most areas of the City of Alpharetta have experienced a high frequency of severe storms, including thunderstorms, high winds, heavy precipitation, hail, and lightning and share equal risks for all types of severe storms. Hail and wind storm locations were collected from NOAA and are shown in Figures 5-10 and 5-11.

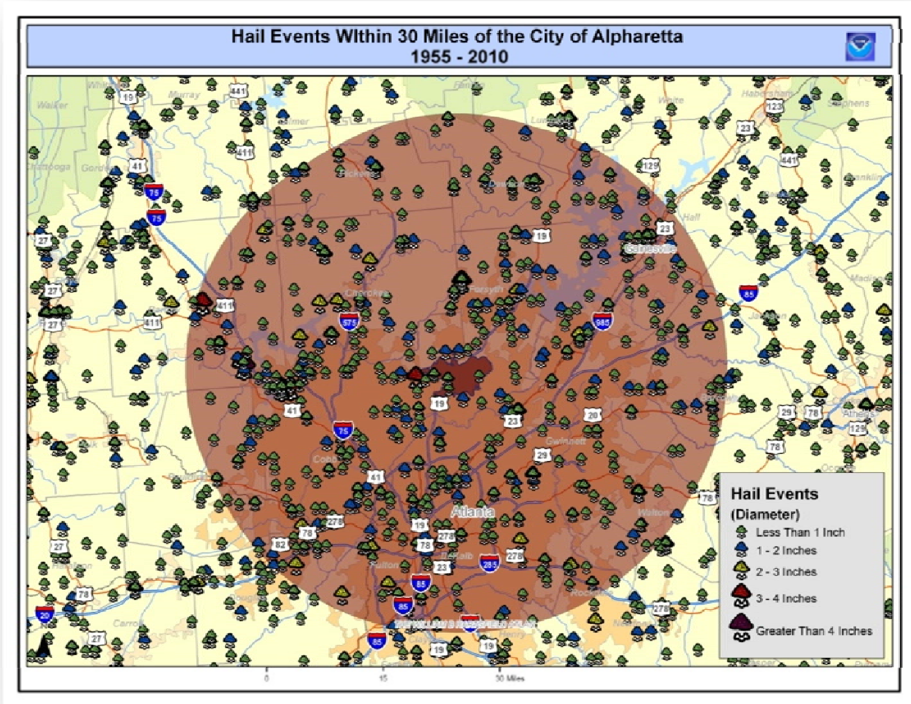


Figure 5-10: Hail Events near Alpharetta

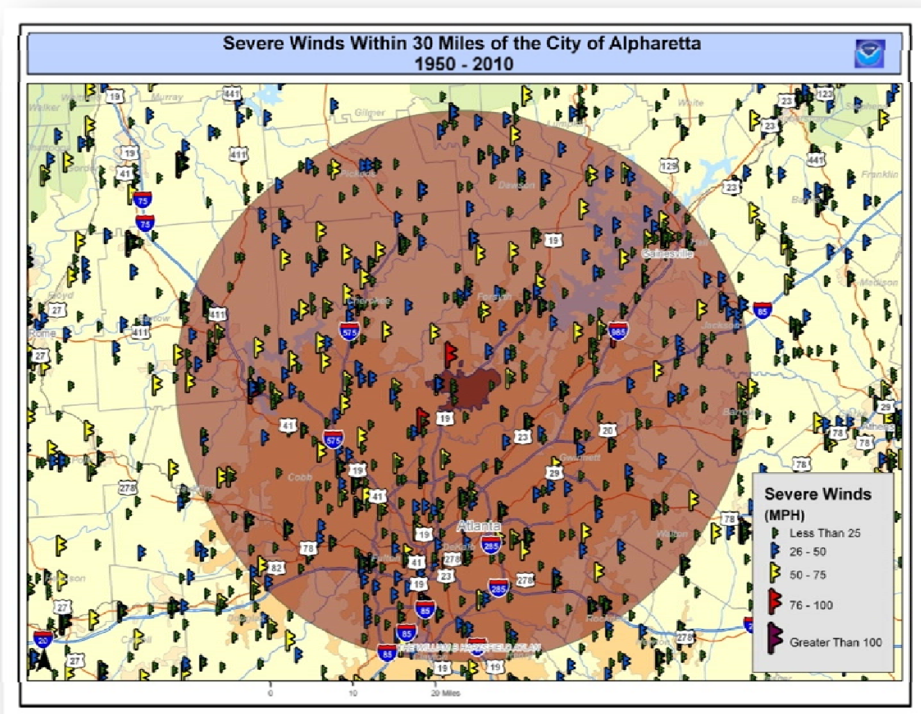


Figure 5-11: Severe Events near Alpharetta

Probability of Future Severe Weather Events

Past climate patterns indicate that the City of Alpharetta will continue to be subject to the effects of severe weather. The City can expect to experience a severe thunderstorm which causes minor to moderate damages each year.

5.4.7 Winter Storms

5.4.7.1 Hazard Profile

Severe winter storms and blizzards are extra-tropical cyclones that originate as mid-latitude depressions. Snowstorms, blizzards, and ice storms are the most common examples. These storms can bring heavy snowfall, high winds, ice, and extreme cold with them. Although infrequent, historically, winter storms in Georgia have produced significant snowfall, sleet, and freezing rain. Ice storms are the most common winter storm disaster in DeKalb County.

During the winter, cold arctic and polar air masses intrude farther and farther south into the United States. An air mass is a large (1,000-5,000 km in diameter) region above the Earth that has a fairly uniform temperature and moisture level. Given just the right dynamics, disturbances forming along the boundary between the cold polar air and the relatively warm, tropical air sometimes turn into winter storms. There are several requirements for a winter storm to occur. First, the jet stream must be positioned properly. This should cause a sufficient amount of cold polar air to flow down from the north. The air must be cold enough in the clouds and near the ground to drop temperatures so that frozen or freezing precipitation will fall. Also, the proximity of a relatively warm air mass accompanied by plenty of moisture flowing up from the south is important. The moisture is needed to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean, is an excellent source of moisture. The last requirement is lift: something to raise the moist air to form the clouds and cause precipitation. Lift occurs when warm air collides with cold air and is forced to rise over the cold dome, or when air flows up the side of a mountain.

The boundary between the warm and cold air masses is called a front. If cold air is advancing and pushing away the warm air, the front is called a cold front. If the warm air is advancing, it rides up over the cold air mass (since warm air is less dense than cold air), and the front is called a warm front. If neither air mass is advancing, the front is called a stationary front. It is along a stationary front that a winter storm will typically begin. An area of lower pressure will develop along the front as the atmosphere tries to even out the pressure difference. This creates wind, which always blows from high pressure towards low pressure, in an attempt to move enough air to even out the pressure difference. As the air moves toward the center of the low-pressure area, it has nowhere to go but up into the colder regions of the upper atmosphere. This causes the water vapor in the air to condense. To the north of the storm, where the temperatures are colder, this condensed water falls as snow. To the south, if the temperatures are warm enough, it can fall as heavy rain in thunderstorms.

Over North America, strong winds blowing from west to east usually move a winter storm quickly across the continent. That's why a winter storm rarely lasts more than a day in one area. In Georgia, winter storms can range from moderate snow over a few hours to dangerously low temperatures, strong winds, freezing rain and sleet that can impact an area for several days.

Heavy snow can immobilize a region, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow or ice can collapse buildings and knock down trees and power lines.

Extreme cold from a winter storm is most harmful to infants and elderly people. Prolonged exposure to the cold can cause frostbite or hypothermia and become life-threatening. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat.

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

There are also indirect hazards associated with winter storms. In fact, winter storms can be deceptive in their seriousness, as most deaths that they cause are only indirectly related to the storm. The leading cause of death during winter storms is from automobile and other transportation accidents. Exhaustion and heart attacks, especially among the elderly, are common during winter storms, and the elderly are also the most likely to be victims of hypothermia. House fires occur more frequently during winter storms due to lack of property safety precautions while using alternate heating sources (such as wood fires or space heaters). Improper use of some alternate heating sources can and has caused asphyxiation, such as using charcoal briquettes indoors, which produces carbon monoxide.

Disaster History

Winter weather affects vast areas and can cause havoc if the communities are not prepared for it. The State of Georgia has received Presidential Disaster Declarations for extreme winter storms twice since 1990. In March of 1993, 93 Georgia counties including Fulton County were declared disaster areas by the President due to the severe snowfall that occurred in the area. Again in January of 2000, the President declared disaster areas in 48 counties including Fulton County, this time due to severe ice storms, freezing rain, damaging wind, and severely cold temperatures.

Although winter storms in Georgia can wreak havoc on people and the economy, they are not especially common occurrences. The area may go several years without experiencing a single winter storm. However, that infrequency could help exacerbate the hazard, as motorists caught in winter storms are unaccustomed to handling their vehicles in slippery conditions or in lowered visibility. Homes and other structures are not necessarily equipped to deal with extreme cold, and may be un-insulated or without heat. Municipalities that rarely receive snow and ice may not have budgeted for clean-up efforts required during and after a major winter storm, as they happen too infrequently for this kind of budget to be economically justifiable.

Between the years of 1996 and 2011 the NCDC database reported approximately 25 winter storm events resulting in roughly $60 million dollars in damages. Summaries of several NCDC events for which data were available are listed below.

January 2002 - A strong upper-level system rotated through the southeastern United States to bring a burst of heavy snow to north and central Georgia. Snowfall amounts of three to five inches occurred in a period of approximately six to eight hours. Total snowfall amounts for the two-day storm ranged from four to six inches. Automobile and airplane travel was severely disrupted during the event. At least two fatalities were reported in the Atlanta area because of traffic accidents on ice covered roadways.

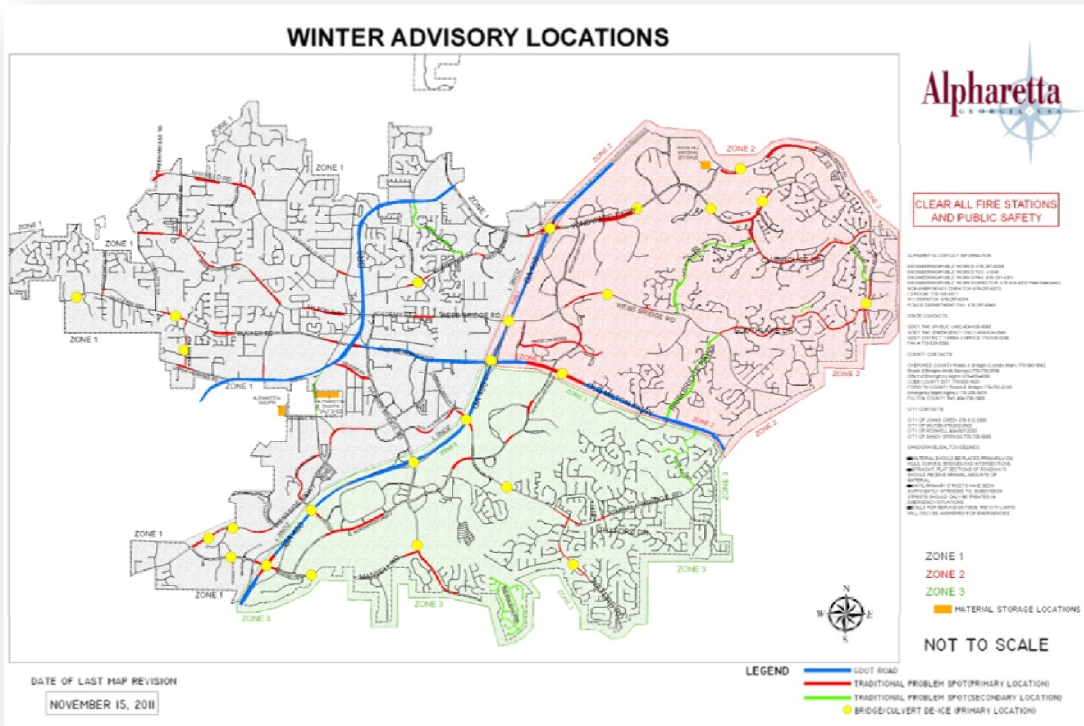
March 2009 - A rare late season heavy snow storm occurred in parts of north and central Georgia. The water content of the snow was high, which resulted in extensive downed trees, power lines, and telephone cables. Widespread power outages to thousands of people were observed in areas of northeast Georgia. Many residents were left without power for two to three days.

February 2010 – In mid-February, very cold air aloft and cold Arctic surface air mass combined with the overrunning Gulf moisture and upper dynamics to produce the most widespread snow observed across north and central Georgia in several years. All 96 counties within the NWS Peachtree City forecast area observed measurable snow.

January 2011 – Snowfall accumulations of 6 inches and ice accumulations up to 2 inches were reported throughout the region. Immediately following the snowstorm, temperatures fell below freezing for an entire week. There was an extensive amount of ice remaining on roadways throughout the week as the ice would melt during the day and refreeze during the night. To make matter worse the communities didn't have enough equipment to clear the roads quickly; therefore, the snow was compacted into dense ice sheets on the roadways by passing motorist. The initial accumulations happened so rapidly that commuters were stranded on highways and forced to abandon their vehicles. Several days after the event, those who did venture out to travel the roads found conditions to be very treacherous. Traffic on many interstates was held to either a standstill or had limited lanes open for approximately a week before the temperatures climbed above freezing for an extended period of time. The total cost of this event is not yet determined but could be in the hundreds of millions based on transportation delays and infrastructure damages.

Location and Extent/Probability of Occurrence and Magnitude

All of the City of Alpharetta is vulnerable to winter storms. During the period of historical record obtained from the NCDC; there were 25 events in a 16 year period, indicating a one or more severe winter storms is likely to occur in any given year. The City of Alpharetta provided a map which shows the roadway locations which generally have issues during severe winter weather.



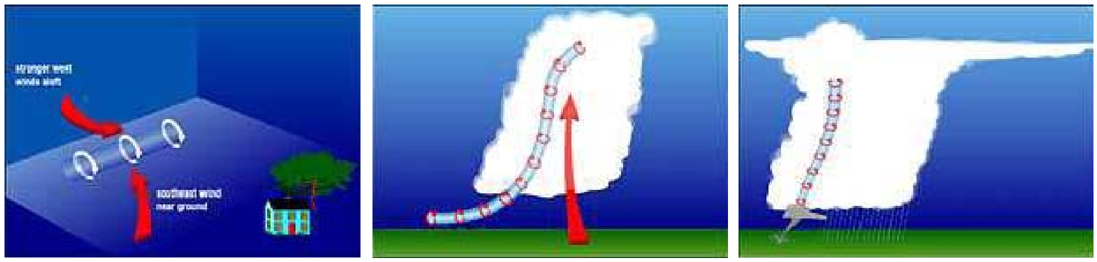
5.4.8 Tornadoes

5.4.8.1 Description of Hazard

Tornadoes are one of nature's most violent storms, which are characterized by a rapidly rotating column of air extending from the base of a thunderstorm to the ground. In an average year, approximately 1,000 tornadoes are reported across the United States, resulting in over 1,500 injuries and 80 deaths and tremendous destruction. Damage paths can be more than one mile wide and 50 miles long. Tornadoes can occur anywhere and come in all shapes and sizes.

Tornadoes can occur in thunderstorms that develop in warm, moist air masses in advance of eastward-moving cold fronts. These thunderstorms often produce large hail and strong winds, in addition to tornadoes. Thunderstorms spawn tornadoes when cold air overrides a layer of warm air, causing the warm air to rise rapidly. Tornadoes occasionally accompany tropical storms and hurricanes that move over land. They are most common to the right and ahead of the path of the storm center as it comes onshore. The winds produced from wildfires have also been known to produce tornadoes.

Figure 5-12: How a Tornado Forms



Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height create an invisible, horizontal spinning effect in the lower atmosphere

Rising air within the thunderstorm updraft tilts the rotating air from horizontal to vertical.

An area of rotation, 2-6 miles wide, now extends through much of the storm. Most strong and violent tornadoes form within this area of strong rotation.

Meteorologists rely on weather radar to provide information on developing storms. The National Weather Service is strategically locating Doppler radars across the country which can detect air movement toward or away from the radar. Early detection of increasing rotation aloft within a thunderstorm can allow life-saving warnings to be issued before the tornado forms.

When conditions are favorable for severe weather to develop, a severe thunderstorm or tornado WATCH is issued. Weather Service personnel use information from weather radar, spotters, and other sources to issue severe thunderstorm and tornado WARNINGS for areas where severe weather is imminent. Severe thunderstorm warnings are passed to local radio and television stations and are broadcast over local NOAA Weather Radio stations serving the warned areas. These warnings are also relayed to local emergency management and public safety officials who can activate local warning systems to alert communities.

In 1971, Dr. T. Theodore Fujita of the University of Chicago developed the original F-scale for wind damages, including tornadoes. The original F-scale, however, was recently replaced by an enhanced version effective February 1, 2007. The Enhanced F-scale is a more precise method of tornado damage assessment that classifies damage according to calibrations developed by engineers and meteorologists across 28 different types of damage indicators. The underlying premise is that a tornado scale needs to take into account the varying strengths and weaknesses of different types of construction. As with the original Fscale, the enhanced version rates the tornado as a whole based on most intense damage within the path. Historical tornadoes before February 1, 2007, will not be re-evaluated using the Enhanced F-scale.

Table 5-5: Description of the Enhanced Fujita Scale

Enhanced Fujita Scale for Tornado Damage		
EF Number	3 second gusts	Damage Description
F-0	65 - 85 mph	Light Damage: Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.
F-1	86 - 110 mph	Moderate Damage: Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored manufactured homes are overturned, and attached garages may be destroyed.
F-2	111 - 135 mph	Considerable Damage: Roof structures are damaged, manufactured homes are destroyed, debris becomes airborne, large trees are snapped or uprooted.
F-3	136 - 165 mph	Severe Damage: Roofs and some walls are torn from structures, some small buildings are destroyed, non-reinforced masonry buildings are destroyed, most trees in forest are uprooted.
F-4	166 - 200 mph	Devastating Damage: Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne.
F-5	Over 200 mph	Incredible Damage: Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized debris becomes airborne, trees are completely debarked.

5.4.8.2 Hazard Profile

Recent research conducted by Michael Frates of the University of Akron found that there are other regions of tornadic activity, other than the traditional “Tornado Alley.” His research revealed four regions, one of which is termed “Dixie Alley” of which Georgia is part. In his study of the spatial distribution of dangerous tornadoes (ranked F3, F4, or F5), he discovered that such tornadoes occur most often in Dixie Alley which spans from eastern Texas across parts of Missouri, Arkansas, Louisiana, Mississippi, Tennessee, and Alabama into northeast Georgia (Figure 5-8). Dixie Alley has the highest frequency of long-track F3 to F5 tornadoes making it the most active region in the United States.

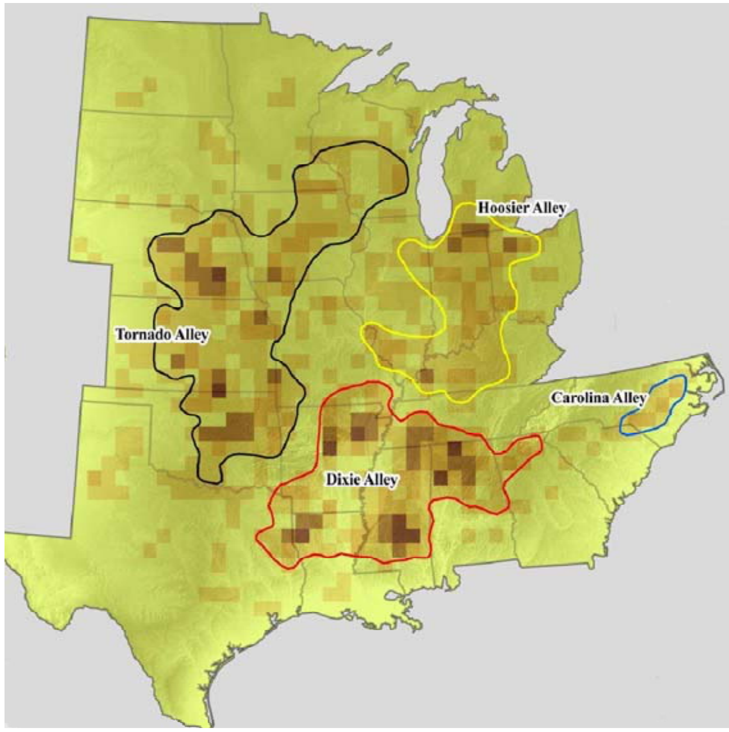


Figure 5-13: The Four Tornado Alleys Identified by Major Spatial Pattern

According to research in 2007 by Dr. Walker Ashley, Northern Illinois University meteorologist, a number of factors explained the higher number of tornado fatalities in the Dixie Alley area. Dr. Ashley stated that the south is more susceptible to nighttime killer tornadoes, that it has the highest percentage of manufactured homes in the US (where 63% of the overall fatalities occur), that there are more heavily forested areas, that there is a lack of a focused tornado season which can lead to complacency indicating that it has tornadoes much earlier than the national peak (May and June). Complicating matters is that tornadoes are rarely visible in this area as they are more likely to be embedded in shafts of heavy rain, and that the hilly topography makes them difficult to see.[12]

Past Occurrences of Tornadoes

The City of Alpharetta is located in an area which is frequented by tornadoes. Between the years 1950 – and 2010 77 tornadoes either touched down or passed within approximately 30 miles of the City according to the NOAA tornado database. Most of those tornadoes were an F2 rating class or lower but occasionally much larger and more destructive tornadoes occurred. There have been 13 occasions when an F3 or F4 rated tornado passed within 30 miles of the City. The most recent was in 2008 when an F3 tornado passed by about 30 miles to the west of the City. The City was directly struck by an F1 tornado in 1975 in which two injuries were reported and less than $50,000 was caused. Figure 5-14 shows the touchdown locations and the path of the tornadoes, while table 5-6 describes the more significant events. For a complete table and full map please see the Additional Hazard Research appendix. There was an additional outbreak of tornadoes in April of 2011 which were not yet included in the NOAA database but those tornadoes were several miles away from the city limits.

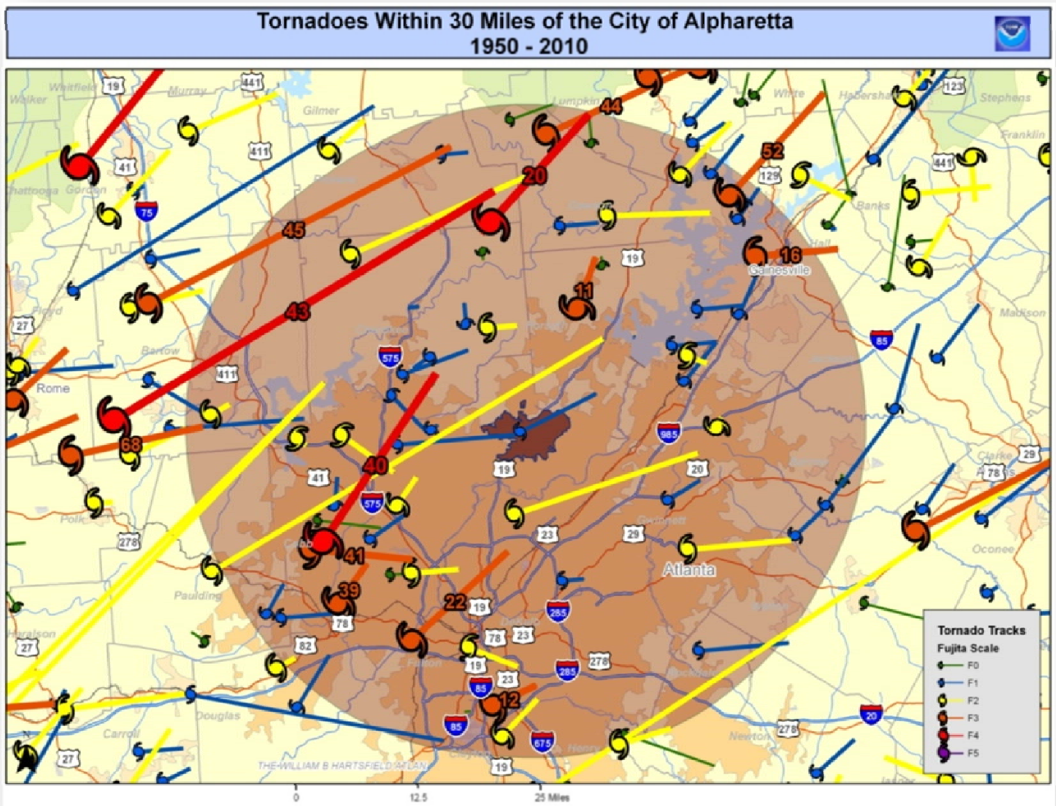


Figure 5-14: Tornadoes near Alpharetta

Table 5-6: Tornadoes near Alpharetta

F3/ F4 Tornadoes within 30 Miles of the City of Alpharetta 1950 - 2010						
Date	Time	F-Scale	Fatalities	Loss ($1,000)	Length (Miles)	Width (Feet)
4/2/1970	4:00am	3	0	$5 - $50	6.5	50
1/10/1972	10:25am	3	1	$50 - $500	6.3	200
12/13/1973	11:20am	3	0	$500 - $5,000	9.5	200
4/3/1974	6:30pm	4	6	$500 - $5,000	17.7	200
3/24/1975	5:30am	3	3	$50,000 - $500,000	14.8	500
3/29/1991	6:30am	3	0	$5,000 - $50,000	5.0	1320
11/22/1992	9:45am	4	0	$5,000 - $50,000	20.0	867
2/21/1993	7:15pm	3	0	$5,000 - $50,000	8.0	880
3/27/1994	11:15am	4	3	$5,000 - $50,000	49.0	1760
3/27/1994	12:15pm	3	3	$5,000 - $50,000	44.0	2613
3/27/1994	1:00pm	3	9	$5,000 - $50,000	40.0	2613
3/20/1998	5:25am	3	12	Unknown	4.0	100
3/15/2008	10:25am	3	2	$5,000 - $50,000	16.9	880

Location of Potential Tornadoes
All portions of the City of Alpharetta are equally at risk for tornadoes.

Extent and Intensity of Potential Tornados
Historic data indicates that the intensity of tornadoes near the City of Alpharetta is generally between F0 and F2. However, seven F3 and three F4 tornadoes have been recorded within 30 miles of the City since 1950. These tornadoes are extremely powerful and diverse in nature. Some of them travel for only 4 miles on the ground while others travel almost 50 miles in length before quitting. The widths of these tornadoes are usually around 500 – 1,000 feet but occasionally they can expand to almost ½ mile wide or larger. The destructiveness of these events can be summarized by the injuries, fatalities and damage left behind. Please see the Additional Hazard Research appendix for full details.

Probability of Future Tornadoes
Meteorologists are quick to point out that tornado frequency, intensities, and locations are totally unpredictable. Past records are no guarantee of the probability of future events. If however, past trends would continue, the City of Alpharetta can anticipate approximately one tornado every year within 30 miles of the City. Furthermore, the City can anticipate an F3 or greater tornado event approximately every 5 years within 30 miles of the City.

5.4.9 Tropical Systems

5.4.9.1 Description of Hazard

Tropical systems include several types of tropical cyclones: Hurricanes, tropical storms, and tropical depressions. A tropical cyclone is a rotating weather system that develops in the tropics. A tropical depression is an organized system of persistent clouds and thunderstorms with low level closed circulation and maximum sustained winds of 38 mph or less. A tropical storm is an organized system of strong thunderstorms with a well defined circulation and maximum sustained winds of 39 to 73 mph. All of these tropical cyclones begin as a disturbance. A disturbance may result from a number of different weather events including Easterly Waves, West African Disturbance Line, Tropical Upper Tropospheric Trough or an Old Frontal Boundary. In order for a tropical disturbance to develop into a hurricane, three things must occur.

First, the disturbance must gather energy and heat through contact with warm ocean waters. Next, added moisture evaporated from the sea surface then provides power to the tropical storm. And last, the seedling storm forms a wind pattern near the ocean surface that spirals inward. Warm water is the most important of the three, as it provides the fuel for a disturbance to eventually develop into a hurricane. A hurricane is a tropical weather system with a well defined circulation and sustained winds of 74 mph or higher. Even inland areas, well away from the coastline, can experience destructive winds, tornadoes and floods from tropical storms and hurricanes.

The Atlantic hurricane season begins on June 1 and lasts through November. Within the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico annually there are an average of 11 tropical storms, 6 of which become hurricanes. In a typical three-year span, the US coastline is struck an average five times, two that are major hurricanes (category 3 or higher.) Hurricanes pose the greatest threat to life and property, but tropical depressions and storms can also cause extensive damage and loss of life.

5.4.9.2 Hazard Profile

The City of Alpharetta is situated approximately 250 miles from the Georgia coastline. While the City may not likely be affected by hurricane force events, it can still be affected by tropical systems. Furthermore, hurricane winds which can extend inland for hundreds of miles and spawn tornadoes. They can also trigger inland floods and landslides.

Past Occurrences of Tropical Systems

The City of Alpharetta has been exposed to the effects of tropical systems within 100 miles of the City approximately 20 times since 1959. Since 2002, 6 tropical systems categorized as a Tropical Depression have been within 100 miles of the City. Generally, these system cause more flood damage then wind related damages with the most notable being Tropical Storm Fay in 2008. Estimated combined damages for the five days that tropical storm Fay affected the north and central Georgia area was $1.89 million. Tropical Storm Fay's track passed about 100 miles to the northwest of the City of Alpharetta, which meant most of the southeastern rainfall bands directly impacted the City. Figure 5-15 shows the tropical depressions that have passed within 100 miles since 1959. In the Additional Hazard Research appendix a figure is provided which shows every recorded system since 1852 to pass within 100 miles.

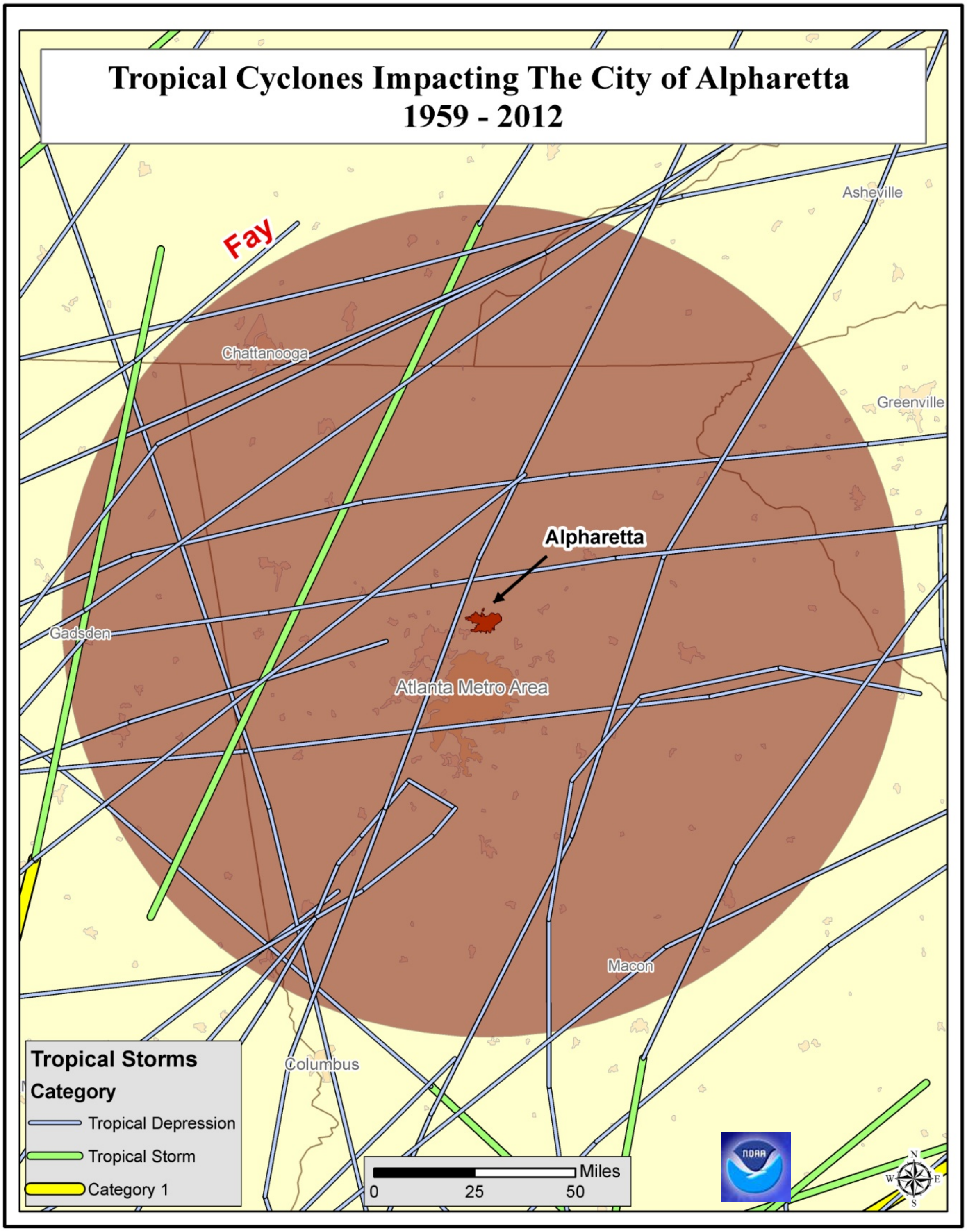


Figure 5-15: Tropical Storms near Alpharetta

Location of Potential Tropical Systems
All locations and geographic areas of the City of Alpharetta are subject to the effects of tropical systems, particularly areas that are located in flood prone areas.

Extent and Intensity of Potential Tropical Systems
Landfalling hurricanes will lose their wind intensity by the time they reach the City of Alpharetta. Should the path pass through or very near the City, the tropical system would be downgraded to a tropical storm or depression with thunderstorms, tornadoes and flooding. Aside from the tornadoes, some of these storms can produced wind gusts up to 74 mph.

Tropical storms and depressions often bring torrential rains and flooding, which may last for days after the storm has passed. The dissipated strength of the inland storm does not necessarily affect the amount of rainfall and resultant flood levels. A weak tropical storm or depression moving slowly or lingering can cause more damage due to flooding than a fast moving hurricane. Historical storm data from events in the City indicate that heavy rainfall is likely to be a greater threat due to the risk of flooding.

Tornadoes may also occur but not always - some hurricanes produce none, while others spawn numerous ones. According to hurricane records, half produce one or more tornadoes with capabilities to compound wind damages. A tornado can occur within 12 hours of landfall. This timeframe is within reach of the City of Alpharetta. Normally, a tornado watch will usually follow the projected inland path of a hurricane with resulting tornado watches being issued in the right-front quadrant which is in advance of the track the storm is heading. www.weather.com

Probability of Future Tropical Systems
As is the case with most natural hazards, past records are no guarantee of the probability of future tropical system events affecting the City of Alpharetta. Given its inland location however, the City can continue to expect the remnants of frequent Gulf and Atlantic Coast hurricanes and occasional direct impacts of tropical depressions. The City's inland location would cause the hurricanes to dissipate to tropical depression status. The probable impacts of tropical depressions directly passing through or near the City would be damages resulting from high wind gusts around 50 to 65 mph, heavy rainfall causing localized flooding of streams and drainage ways, and possible tornadoes. Based on recent events, Alpharetta residents can expect to be impacted by a tropical system within 100 miles of the City once every two years.

5.4.10 Sinkholes

5.4.10.1 Description of Hazard

Sinkholes are a common, naturally occurring geologic feature that is hazardous to property and the environment. Although many new sinkholes develop naturally, their increasing frequency corresponds to the accelerated development of ground-water and land resources. Usually little more than a nuisance, new sinkholes can sometimes cause substantial property damage and structural problems for buildings and roads.

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. Sinkholes are dramatic because the land usually stays intact for a while until the underground spaces get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. These collapses can be small or they can be huge and can occur where a house or road is on top.

A change in the local environment affecting the soil mass initiates sinkhole collapses and areas of subsidence. This change is called the "triggering mechanism." Water, either surface or ground water, is generally the most important agent effecting environmental changes that cause subsidence. Triggering mechanisms for subsidence include water level decline, changes in ground-water flow, increased loading, and deterioration (relates to abandoned coal mines).

New sinkholes have been correlated to land-use practices, especially from ground-water pumping and from construction and development practices. Sinkholes can also form when natural water-drainage patterns are changed and new water-diversion systems are developed. Some sinkholes form when the land surface is changed, such as when industrial and runoff storage ponds are created. The substantial weight of the new material can trigger an underground collapse of supporting material, thus causing a sinkhole.

Increased numbers of sinkholes can generally be attributed to changing or loading of the earth’s surface with development such as retention ponds, buildings, changes in drainage patterns, heavy traffic, drilling vibrations or a sudden or gradual decline in groundwater levels. In urban areas, all these impacts may occur at the same time, accelerating any sinkhole tendencies. Urban construction, coupled with limestone depths of less than 200 feet, contributes to the development of many of the modern sinkholes.

The built-up sediments that cover buried cavities in the aquifer systems are delicately balanced by ground-water fluid pressure. The water below ground is actually helping to keep the surface soil in place. Ground-water pumping for urban water supply and for irrigation can produce new sinkholes in sinkhole-prone areas. If pumping results in a lowering of ground-water levels, then underground structural failure, and thus, sinkholes, can occur.

Lowering water levels is one of the most significant triggering mechanisms for subsidence in a karst terrain. Water-level decline may occur naturally or be induced by man. Factors leading to a decline in water levels include the pumping of water from wells, localized drainage from construction, dewatering from mining, and periods of drought.

Sinkholes also threaten water and environmental resources by draining streams, lakes, and wetlands, and creating pathways for transmitting surface waters directly into underlying aquifers. Where these pathways are developed, movement of surface contaminants into the underlying aquifer systems can persistently degrade ground-water resources. In some areas, sinkholes are used as storm drains, and because they are a direct link with the underlying aquifer systems it is important that their drainage areas be kept free of contaminants.

Conversely, when sinkholes become plugged, they can cause flooding by capturing surface-water flow and can create new wetlands, ponds, and lakes.

5.4.10.2 Hazard Profile

Groundwater accounts for only 1% of the water source for the City of Alpharetta. Additionally, according to the USGS, the underlying rock types that make the ground prone to catastrophic sinkholes does not exist widely in this area (see Figure 5-16). In these areas the formation of underground cavities can form and catastrophic sinkholes can happen. These rock types are evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). Evaporite rocks underlie about 35 to 40 percent of the United States, though in many areas they are buried at great depths. However, sinkholes have occurred in the county due such as failure of underground water and sewer infrastructure, land use and development practices, or combinations of these variables. Shown below is a map of areas of the United States where certain rock types that are susceptible to dissolution in water occur.

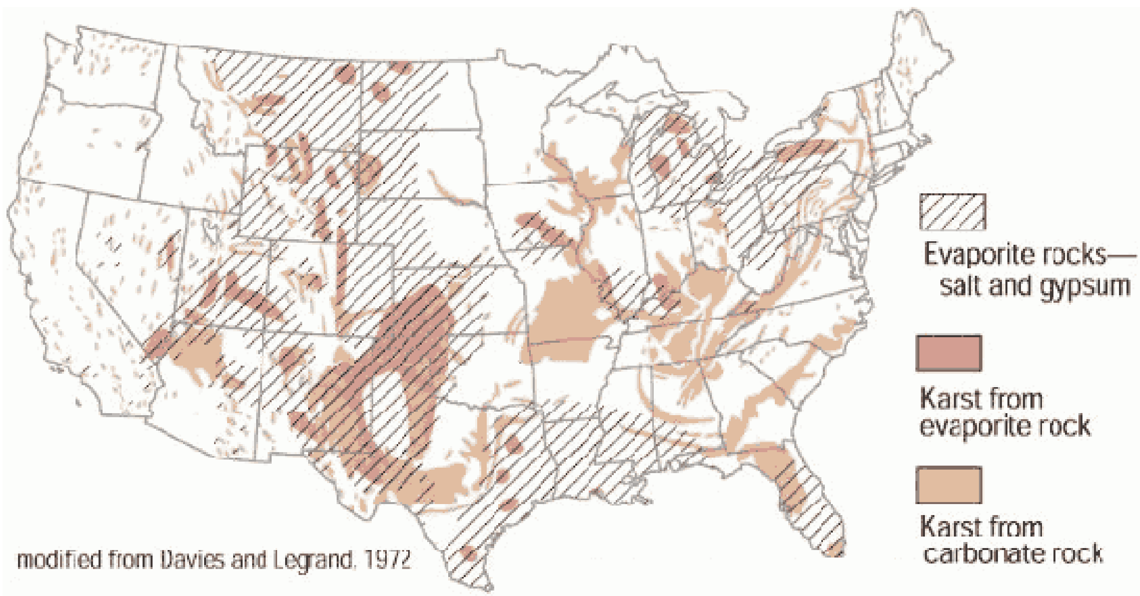


Figure 5-16: Underlying Rock Types

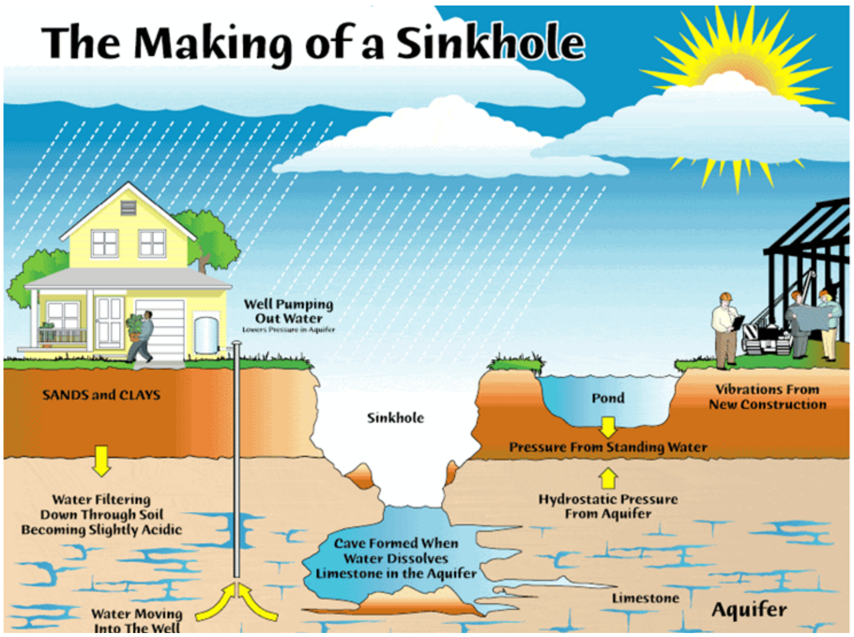
Past Occurrences of Sinkhole Events

Although the City may not be at risk for sinkholes due to geologic causes, there have been several recent documented cases of smaller sinkhole occurrences that are as a result of man-made actions. Recent significant sinkholes in the City include:

10/8/2007 – A sinkhole destroyed a piece of the sidewalk costing approximately $3,000 to repair.
2/15/2008 – A sinkhole on Village Green Way cost over $11,000 to repair

10/9/2009 – A sinkhole between two residences was caused by a separation of a pipe. Cost was over $6,000 to repair.
10/14/2009 – A sinkhole at the leading edge of a pipe caused a sidewalk to crumbled costing $13,000 to fix.
9/1/2011 – A sink hold had fallen in due to a storm drain which broke. Total cost to fix was approximately $1,000.

Location of Potential Sinkholes
Based on the occurrence of recent sinkholes, it appears that the areas that are vulnerable to future sinkhole events will involve areas that involve infrastructure and development decisions, rather than natural processes.



http://www.swfwmd.state.fl.us/hydrology/sinkholes/SinkholePoster.gif

Extent and Intensity of Potential Sinkholes
Based on the underlying geological composition in the City, it does not appear that the City is at risk for very large or catastrophic sinkholes due to the lack of salt and gypsum evaporate rock, karst from evaporate rock, or karst from carbonate rock. However, the location and size of the sinkholes that have occurred have posed local public safety risks (i.e. neighborhood residents, motorists) and have disrupted delivery of basic utility services such as drinking water.

Probability of Future Sinkholes
Due to the existence of underground infrastructure such as water systems, there is an inherent risk of failure of these systems which can cause instability in the ground above it, thus causing sinkholes. Additionally, development decisions that may seem safe and appropriate at the time may later prove to cause unforeseen instability result in sinkholes. So although the probability of a catastrophic sinkhole may be low, it is likely that developed areas will continue to experience occasional sinkholes for the reasons discussed in this section.

5.4.11 Wildfire/Urban Interface Zone

5.4.11.1 Description of Hazard

The Wildfire/Urban Interface is defined as the area where structures and other human development meet with undeveloped wildland or vegetative fuels (Federal Emergency Management Agency, 1996). As residential areas expand into relatively untouched wildlands, people living in these communities are increasingly threatened by wild fires.

There are three different classes of wildland fires. A surface fire is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire is usually started by lightning and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually identified by dense smoke that fills the area for miles around.

Rural and large tracts of unimproved lands are susceptible to brush and forest fires capable of threatening life, safety and property loss in adjacent developed areas if not effectively controlled. Wildfires are caused by numerous sources including arson, carelessness by smokers, individuals burning debris, operating equipment which throws sparks, and children playing with matches. However, the largest number of fires is caused by lightning strikes which coincide with the height of the thunderstorm season. A major wildland fire can leave a large amount of scorched and barren land, and these areas may not return to pre-fire conditions for decades. If the wildland fire destroys the ground cover, other potential hazards, such as erosion, may develop (Federal Emergency Management Agency, 1998).

Structures in the wildfire/urban interface zone are vulnerable to ignition in three different ways: radiation, convection, and firebrands (National Wildfire/Urban Interface Fire Protection Program). Radiating heat from a wildfire can cause ignition by exposure to the structure. The chances of ignition increase as the size of the flames increases, surface area exposed to flames increases, length of exposure time increases, and distance between the structure and the flames decreases. Another source of ignition by wildfire is convection. Ignition of a structure by convection requires the flame to come in contact with the structure. Contact with the convection column is generally not hot enough to ignite a structure. Clearing to prevent flame contact with the structure must include any materials capable of producing even small flames. Wind and steep slopes will tilt the flame and the convection column uphill increasing the chance of igniting a structure. Structures extending out over a slope have the greatest likelihood of ignition from convection.

Firebrands also pose a threat to structures in the wildland/urban interface. A firebrand is a piece of burning material that detaches from a fire due to strong convection drafts in the burning zone. They can be carried a long distance (approximately 1 mile) by fire drafts and winds. The chance of these firebrands igniting a structure depends on the size of the firebrand, how long it burns after contact, and the materials, design, and construction of the structure.

Past Occurrences of Wildfire/Urban Interface Fires

Wildfires have become a common annual occurrence in wooded areas during Georgia's dry season. Exposure to wildfire varies greatly across the City of Alpharetta. While exposure is relatively low along in the City's urbanized areas, it is quite high in the areas bordered by national parks and other heavily wooded areas. The US Fire Service provided historical wildfire source locations since 2001 which are mapped in figure 5-17.

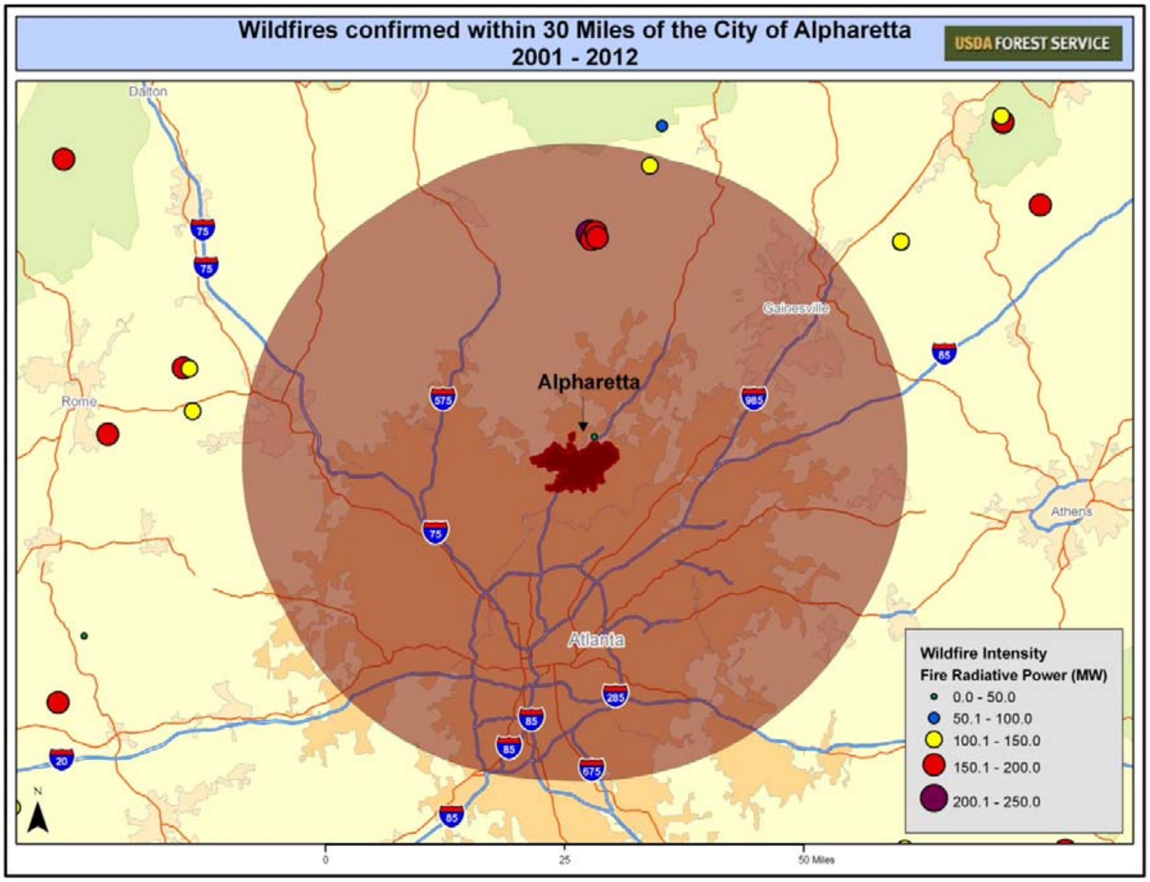


Figure 5-17: Wildfires near Alpharetta

Location of Potential Wildfire/Urban Interface Fires

Over the past few years wildfire monitoring has increased significantly. Daily, monthly and seasonal forecast can be investigated the at the USDA Forest Service's site for detecting wildfires (http://activefiremaps.fs.fed.us/activefiremaps.php?sensor=modis&extent=conus) The US Fire Service also provides data which can spatially depict relative relationship of wildfire risk within a given area. Figure 5-18 shows that relative risk for area around the City of Alpharetta.

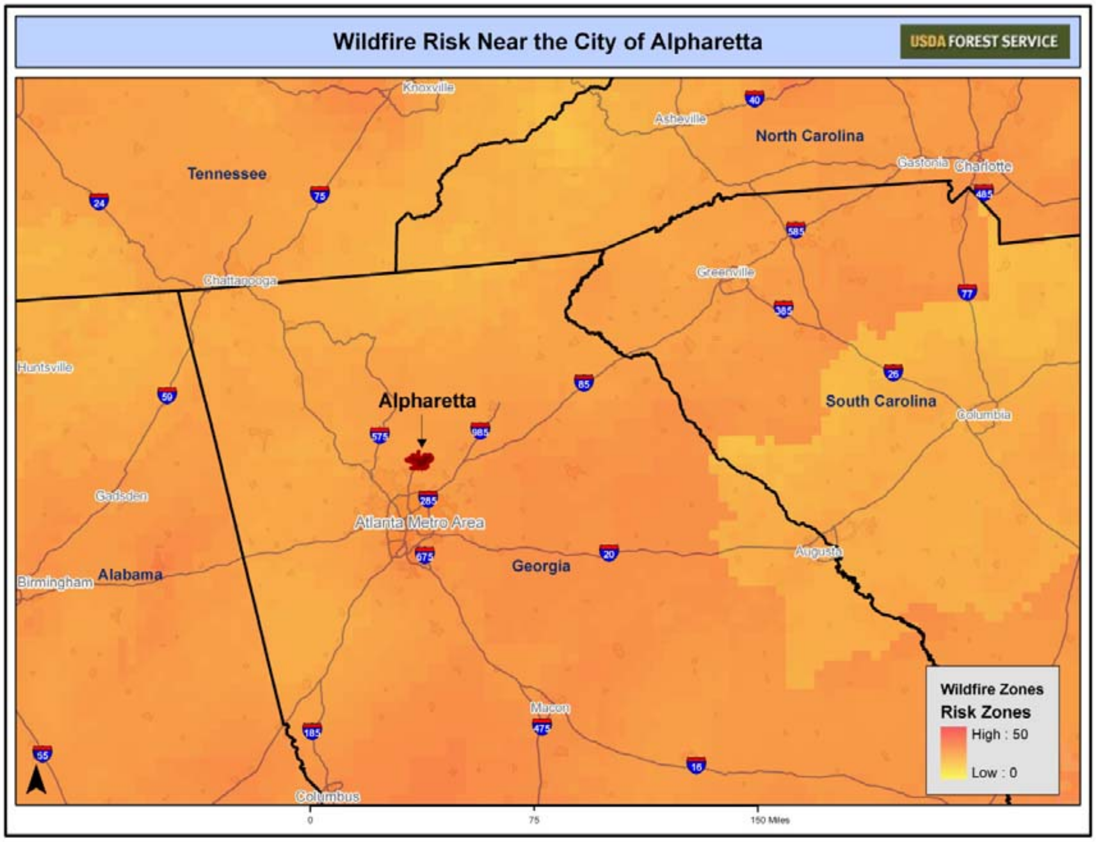


Figure 5-18: Wildfire Risk Zones near Alpharetta

Extent and Intensity of Wildfire/Urban Interface Fires

The City of Alpharetta has multiple fuel sources and is prone to drought and thunderstorms which increase the potential severity of wildfires significantly. The City has abundant fuel sources in various locations. Weather conditions, given the high frequency of severe storms with lightning and periodic severe drought conditions, can exacerbate wildfires.

Another factor that has direct impact on wildfire formation and increase the risk for wildfires in the City is topography. Topography can have a powerful influence on wildfire behavior. Slope, gulches, and hollows can greatly increase the rate of spread and hamper access. These slopes lend themselves to rapid spreading fires due to their angle. The greater the slope, the faster the flames move and the longer the flames. Wildfires can reach into overhanging canopies, allowing spread not only through the lower areas of the forest, but the ability to jump to other trees.

The degree of exposure of properties at the wild land-urban interface also affects the extent of wildfires in the City, especially at the edge of developed areas of the City. High risk properties located within these interface areas have the greatest potential for property damages and threats to life.

Finally, firefighting resources can affect the severity of wildfires. Rural fire departments are almost exclusively made up of volunteers and usually have limited resources that are stretched during periods when numerous fires occur. These limited firefighting resources can compound the risk and extent of wildfire damages.

Probability of Wildland/Urban Interface Fires
Although wildfires can occur at any time, certain times of the year are more prone to risk of this hazard, early spring poses the greatest risk for occurrence. However, many jurisdictions have taken steps to reduce this risk by enacting ordinances that restrict or prohibit open burning. The US Fire Service also provides prediction models based on dead fuels and other data. The data simply shows which areas have an increasing, consistent or decreasing risk for wildfire events and is show in figure 5-19.

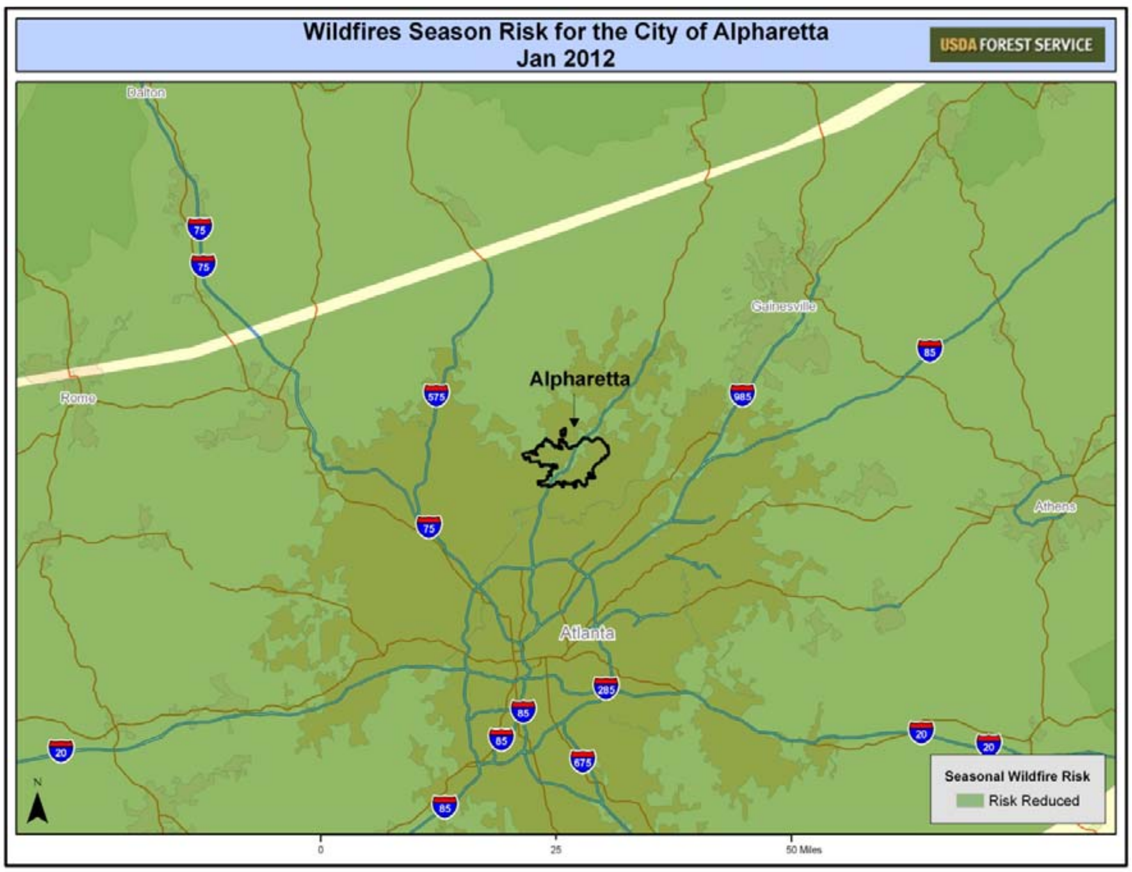


Figure 5-19: Seasonal Wildfire Risk

5.4.12 Dam Failure

5.4.12.1 Hazard Description

A dam is a constructed barrier across flowing water that obstructs, directs, or slows the velocity of the water, creating a reservoir, lake, or impoundment. Generally, the structure's purpose is to simply retain water for a variety of purposes such as generating power, providing water for irrigation or water supply, or controlling flooding.

The threat of dam failures is triggered by carelessness of design, construction, and maintenance. The integrity of older dams, often affected by weathering, mechanical changes, and the influence of chemical agents, is deteriorating. Not only is dam failure risk increasing (with aging infrastructure) but the population vulnerable to this hazard is also increasing due to downstream development.

Even structures outside of the known 100 year floodplain may prove affected by dam failures because of the water's often sudden release and velocity. Dam failures are generally grouped into three classifications: hydraulic, seepage, and structural. Generally, the three types of failure compound upon one another to create complex and interrelated hazard events. Hydraulic failures are a result of the uncontrolled flow of water over and around the dam structure as well as the erosive action on the dam and its foundation. The uncontrolled flow causing the failure is often classified as wave action, toe erosion, or gullying. Earthen dams are particularly susceptible to hydraulic failure because earthen materials erode at relatively slow velocities. This type of failure constitutes approximately 40% of all dam failures.

While all dams exhibit some seepage, the velocity and amount of water are controlled to prevent failure. Seepage occurs through the structure and its foundation and erodes the structure from within. Seepage accounts for approximately 4% of all dam failures. Structural failure involves the rupture of the dam or the foundation by water movement, earthquake, or sabotage. Large earthen dams and dams constructed with weak materials (such as silt) are especially susceptible to structural failure. This type of failure accounts for approximately 30% of all dam failures.

Because of the high velocity of the water, flooding can strike beyond known floodplains. Dam failures often have a rapid rate of onset, leaving little time for evacuation. The first signs of the failure may go unnoticed upon visual inspection of the dam structure. However, continual maintenance and inspection of dams often provides knowledge on the possibility of failure with certain precipitation amounts. The duration of the flooding event caused by the failure also depends on the amount of water and downstream topography. Given smaller volumes of water and a topography suited for transporting the water rapidly downstream, the event may only last hours.

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Because of the lack of seasonality and other predictive factors, the frequency of dam failures cannot be determined. In terms of magnitude and intensity of the flooding event caused by dam failures, no measures actually exist. However, the National Dam Safety Program (NDSP) produces rankings and definitions of dam structures based on potential impact. Table 5-6 lists the dam categories and potential impact of dam failure.

Table 5-7: Description of Dam Risk Categories

Dam Categories and Potential Impact		
Classification	Loss of Human Life	Economic, Environmental, of Lifeline Loss
High (Cat 1)	Probable, >1	Yes (not necessary for classification)
Significant (Cat 2)	None expected	Yes
Low (Cat 3)	None expected	Low & generally limited to owner

5.4.12.2 Hazard Profile

Past Occurrences of Dam Failures

There have been no past occurrences within the City of Alpharetta of a dam failure. Although no catastrophic dam failures have occurred in the City, Georgia has experienced a catastrophic and deadly dam failure. On November 6, 1977, the Kelly Barnes Dam near Toccoa, Georgia failed. The dam was an earthen embankment, originally constructed in 1887, and was holding back 176 million gallons of water at the time of its failure. When the dam broke, a wall of water traveled through a nearby college campus at 120 miles per hour, killing 39 people. This event caused the formation of the Georgia Safe Dams Program.

Location of Potential Dam Failures

The City of Alpharetta has six dams within the City limits. None of the dams are classified as a category 1 dam. However, there are several category ones dams just outside the City limits. In addition there are several other lower category dams located near the City limits. None of the dams in the City limits were reported to be in a distressed condition.

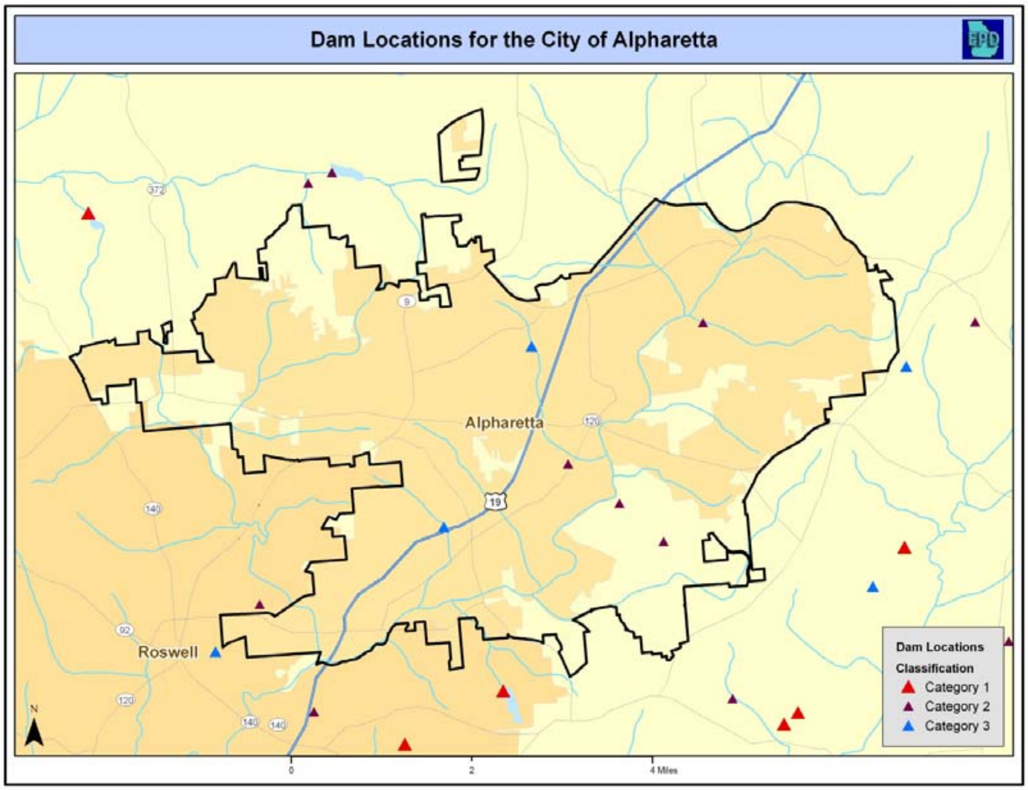

Figure 5-20: Dam Locations near Alpharetta

5.5 Summary of Hazards and Community Impacts

The participating jurisdiction completed a Risk Assessment Matrix that was derived from the NFPA 1600 methodology. This methodology measured level of magnitude or severity as:

- Level I – Catastrophic
    - Personnel: Death or fatal injury.
    - Public: Death or fatality or fatalities due to direct exposure.
    - Environment: A major hazardous chemical spill that is uncontained. Regional or total species/subspecies loss.
    - Economic Impact: Total loss of financial base, incapacitating the City. Funding not available within one week to initiate urgent recovery procedures.
    - Facilities: Complete shutdown of facilities and critical services for more than a month.
    - Property: More than 50 percent of the property located in the proximity of the City is severely damaged.
- Level II – Critical
    - Personnel: Permanent disability, severe injury or illness.
    - Public: Permanent disability, severe injury or illness.
    - Environment: A minor hazardous chemical spill that is uncontained. Local or species/subspecies damage.

  - Economic Impact: Partial loss of financial base, temporarily incapacitating the City. Funding not available within four days to initiate recovery procedures.
  - Facilities: Complete shutdown of facilities and critical services for more than two weeks.
  - Property: More than 25 percent of the property located in the proximity of the City is severely damaged.
- Level III – Marginal
  - Personnel: Injury or illnesses not resulting in disability, major quality of life loss, or perceived illness.
  - Public: Injury or illnesses not resulting in disability, major quality of life loss, or perceived illness.
  - Environmental: A major hazardous chemical spill that is contained. Portion of local organisms negatively impacted.
  - Economic Impact: Minor loss of financial base, temporarily incapacitating the City. Funding not available within 24 hours to initiate recovery procedures.
  - Facilities: Complete shutdown of facilities and critical services for more than a week.
  - Property: More than 10 percent of the property located in the proximity of the City is severely damaged.
- Level IV: Negligible
  - Personnel: Treatable first aid injury.
  - Public: Minor quality of life loss.
  - Environment: A minor hazardous chemical spill that is contained. No measurable impact to environs.
  - Economic Impact: Minor loss of financial base, which does not incapacitate the City. Funding not available within 12 hours to initiate recovery procedures.
  - Facilities: Complete shutdown of facilities and critical services for more than 24 hours.
  - Property: No more than 1 percent of property located in the proximity of the City is severely damaged.

In addition, the probability or likelihood of the hazard occurring at each particular magnitude above was categorized as:

- Highly Likely – A hazard whose potential impact is very probable (100%) within the next year.
- Likely – A hazard whose potential impact is probable (10% - 100%) within the next year, or one whose impact has a chance of occurring within the next ten years.
- Possible – A hazard whose potential impact is possible (1% - 10%) or has one chance of occurrence in a hundred years.
- Unlikely – A hazard whose potential impact is likely to occur less than once in a hundred years (<1%). This category can be compared to the 100-year flood exposures used in design.

This qualitative categorization was performed by MAC members for each natural hazard identified as a potential threat. A meeting was conducted with the participating jurisdiction to complete the assessment exercise. The Planning Process appendix contains the online survey that was used as the assessment instrument and included descriptions for the levels of measurement. After an assessment was completed for the participating jurisdiction, the respective scores were combined to determine an overall county risk assessment. The individual jurisdiction risk assessments are on the following pages followed by the overall county risk assessment matrix.

This assessment also served to assist the City in determining which threats posed the highest or greatest threat. Once this was determined, this assessment was used to guide the development of hazard mitigation actions that were in the best interest of protecting the community from the most likely and/or the most severe hazards facing the jurisdiction.

Table 5-8: Assessment of Vulnerability Per the Mitigation Advisory Committee

Alpharetta Risk Assessment Matrix					
Hazard Type	**Level I Catastrophic**	**Level II Critical**	**Level III Marginal**	**Level IV Negligible**	**Score**
Tornadoes	L	L	L	H	13
Winter Storm	P	L	L	H	12
Severe Weather	P	L	L	L	11
Drought	P	P	L	L	10
Flood	P	P	L	L	10
Heat Wave	P	P	P	P	8
Wildfire/Urban Interface	P	P	P	P	8
Dam Failure	U	P	P	P	7
Tropical System	U	P	P	P	7
Earthquake	U	U	P	P	6
Sinkhole	U	U	U	P	5
Average Risk by Level	1.73	2.09	2.36	2.64	

H = Highly Likely (4 points)
L = Likely (3 points)
P = Possible (2 points)
U = Unlikely (1 point)

Table 5-9: Countywide Assessment of Vulnerability to Hazards

Overall County Combined Jurisdiction Risk Assessment Averages					
Hazard Type	**Level I Catastrophic**	**Level II Critical**	**Level III Marginal**	**Level IV Negligible**	**Score**
Tornadoes	1.71	2.21	2.93	3.79	10.64
Severe Weather	1.36	2.00	3.21	3.86	10.43
Winter Storms	1.21	1.79	2.86	3.86	9.71
Flood	1.29	1.86	2.64	3.57	9.36
Drought	1.36	1.50	1.93	3.29	8.07
Heat Wave	1.14	1.43	2.00	3.36	7.93
Tropical System	1.07	1.29	2.14	2.86	7.36
Wildfire	1.14	1.21	1.93	3.07	7.36
Dam Failure	1.14	1.36	1.57	2.21	6.29
Sinkhole	1.00	1.00	1.00	2.14	5.14
Earthquake	1.00	1.07	1.14	1.71	4.93
Landslide	1.00	1.00	1.25	1.67	4.92
Average by Risk	**1.20**	**1.48**	**2.05**	**2.95**	

NOTE: This table is a revision of table 5-20 from the countywide document to include the City of Alpharetta's scores.

5.6 Vulnerability of Structures and Dollar Estimate of Losses

This section provides data on the vulnerability of existing and future buildings, critical facilities, and infrastructure located within identified hazard areas and jurisdiction. For the purposes of this risk assessment, vulnerability refers to the exposure of buildings, critical facilities, infrastructure and property to a particular hazard and their susceptibility to the resultant damages that could be incurred by such hazard exposure. The property inventory in this section provides the basis for the loss estimates presented in Summary of Exposure Tables by jurisdiction. The information in these tables is prioritized based on the City of Alpharetta's risk assessment matrix found in Section 5.5 – Summary of Hazards and Community Impacts. Certain analyzes were based on FEMA's HAZUS MH MR 5 software while others were computed outside of the software.

Most of the identified Alpharetta hazards are countywide, where exposure is generally uniform among all jurisdictions. Countywide hazards include tornadoes, severe weather, tropical systems, winter storms, droughts, heat waves, and earthquakes. Location-specific hazards, where exposure may vary among jurisdictions include flooding, dam failure, landslides, and sinkholes. The HAZUS model was used to estimate losses from flood, wind, and earthquake. Landslides and sinkholes were not considered priority hazards for the City and thus were not studied in greater detail for loss. Dam Failure is a hazard that the committee has decided to put greater emphasis on during this update, however it is still considered a lower-priority hazard. Detailed information is not readily available for the dams and a risk assessment model has not been decided upon by the City. Section 5.6 will highlight the community's vulnerability and estimated losses from the high-priority, geographically-specific hazards of flooding, high winds, and earthquake.

5.6.1 Vulnerability of Structures (including Critical Facilities) to Flood Hazards

Vulnerability describes how exposed or susceptible to damage an asset is, and depends on an asset's construction, contents, and the economic value of its functions. Depth and velocity of flooding are also directly correlated with the amount of building and content damage for a given structure. The vulnerability analysis predicts the extent of damage to residential, commercial, industrial, religious, educational and governmental properties as well as other critical facilities that may result from a flood event of a given intensity in a given area on the existing built environment. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. Indirect effects can be much more widespread and damaging than direct effects.

Flooding that occurs in the City can impact residential, commercial and industrial properties as well as critical facilities. A critical facility is defined as a facility in either the public or private sector that provides essential products and services to the general public, is otherwise necessary to preserve the welfare and quality of life in the City, or fulfills important public safety, emergency response, and/or disaster recovery functions. Figure 5-21 shows critical facilities within the City Limits. Some of the facilities are considered highly sensitive and are monitored by the Department of Homeland Security and FEMA. Other facilities are crucial to the day to day operations of the community such as the city hall, jail and schools but are not necessarily monitored by the Department of Homeland Security. Although the map might indicate that critical facilities are in the floodplain, this is not the case. Within the City of Alpharetta, no critical facilities identified are within the special flood hazard area.

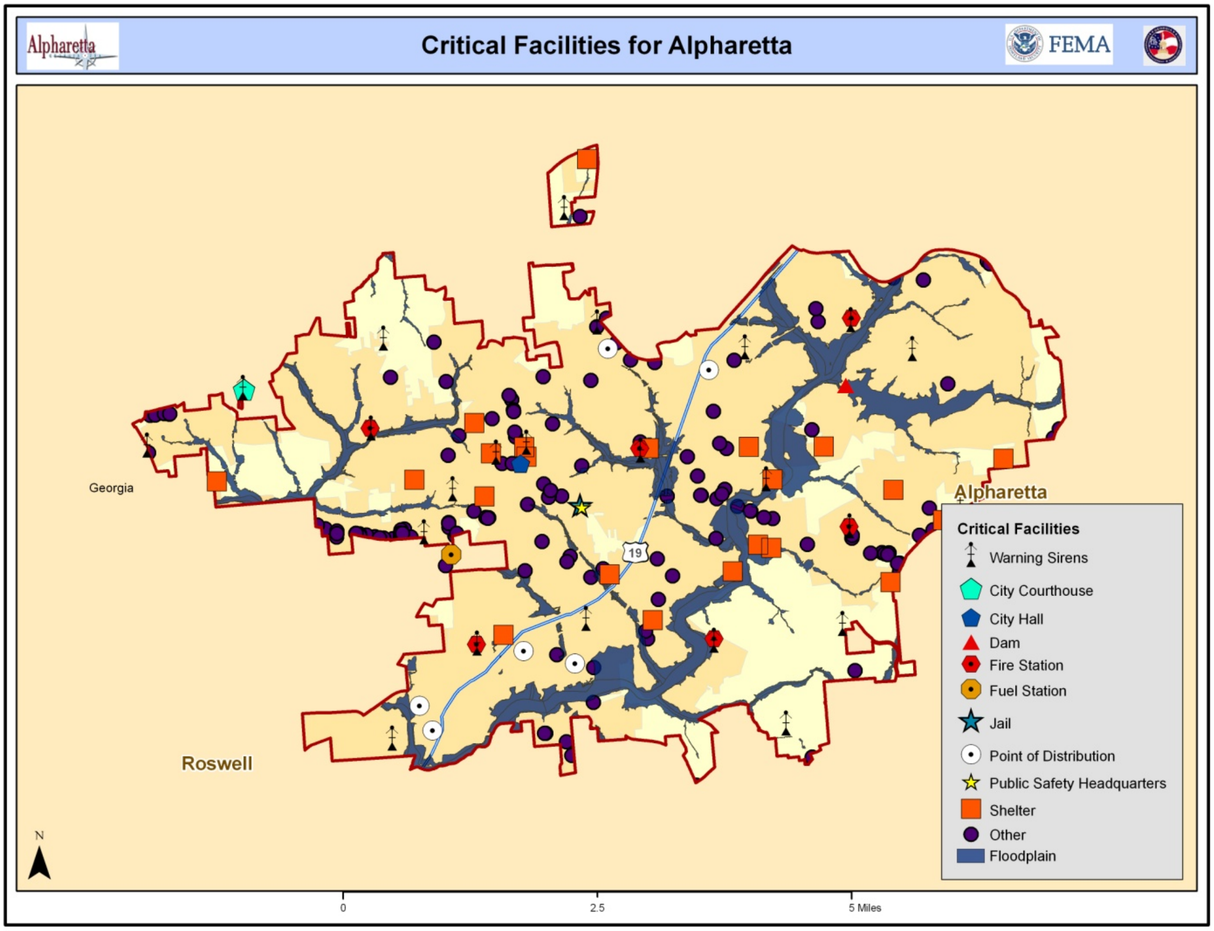

Figure 5-21: Location of Critical Facilities for Alpharetta

The critical facilities database was created from a combination of data sources such as locations specified by the Mitigation Advisory Committee, data from the Atlanta Regional Commission, data from GEMA and data from the GEMA Critical Facility Inventory website were considered in assessing inventories of critical facilities and other structures in the jurisdictions. The tables in later sections of this plan provide inventories of population and landuse in high risk areas and describe the methodologies used in their identification.

Exposure

Exposure characterizes the value of structures within the hazard zone, and is shown as estimated exposure based on the overlay of the hazard on the critical facilities, infrastructure, and other structures, which are given an assumed cost of replacement for each type of structure exposed. These replacement costs are estimated using the building square footage inventory from HAZUS-MH along with information from the Bureau of Census, Standard Industrial Classification and the Department of Energy[1]. These data sources combine to develop the

[1] HAZUS-MH MR5 Technical Manual – Flood Model Chapter 3 page 5

General Building Stock (GBS) inventory. The loss or exposure value is then determined with the assumption that the given structure is totally destroyed (worst case scenario), which is not always the case in hazard events. This assumption was valuable in the planning process, because the maximum potential damage value was identified and used to determine capabilities and mitigation measures for the City. According to the HAZUS-MH MR 5 data the total value of exposed assets within the City s estimated at over $5 billion dollars. The following table displays the distribution of exposed assets within the county.

Table 5-10: Exposure of Alpharetta's General Building Stock

The City of Alpharetta General Building Stock Exposure	
Category	Exposure ($1,000)
Residential	2,611,437
Commercial	1,851,642
Industrial	448,842
Agriculture	15,334
Religious	116,419
Government	12,186
Education	40,517
Total	5,096,377

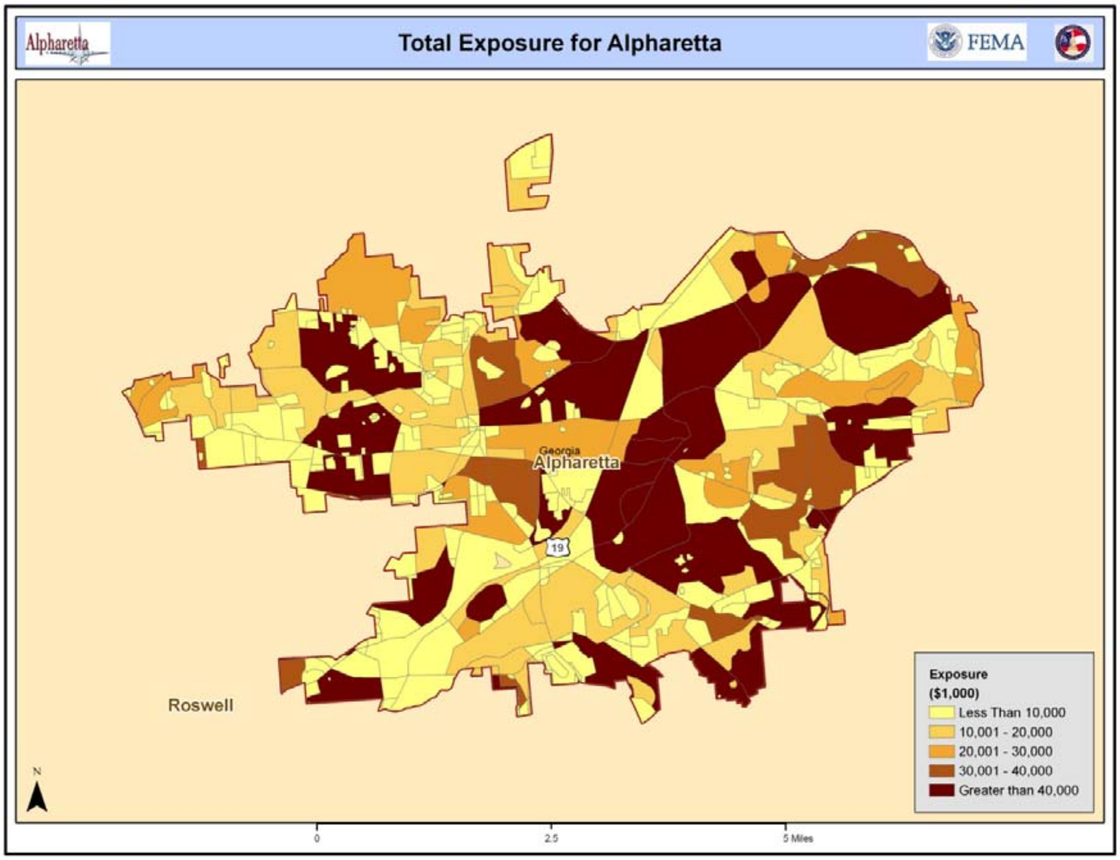

Figure 5-22: Map of Building Exposure

Loss Estimation

In addition to exposure, loss was estimated for flood hazards in the City. Loss estimation includes the portion of the exposure that is expected to be lost to a certain hazard scenario, and is estimated by referencing frequency and severity of previous hazards. Information from HAZUS used in the analysis included economic and structural data on infrastructure and critical facilities. It provided estimates for the potential impact by using a common, systematic framework for evaluation. Loss estimates used available data, and the methodologies applied resulted in an approximation of risk.

These estimates should be used to understand relative risk from flooding and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis such as incomplete inventories, broad value estimation, demographics, or economic parameters.

Using data from HAZUS, potential impacts on residential and commercial structures in the event of a 100-year flood (considered high risk area for this plan) were estimated using average potential 100-year flood depth from the FEMA flood maps and utilizing the Federal Insurance Administration's (FIA) previously determined depth damage functions to anticipate damage to buildings and contents. These functions estimate the damages to a structure as a percentage of the building value, and are differentiated by building type and jurisdiction. An average estimated damage per structure was calculated and then applied to all the structures in the floodplain of the same use for the City.

Complete parcel data, linkable to county tax assessments, was available for this planning exercise but was not used due to extraordinary circumstances. For that reason, the total number of structures in the floodplain for each jurisdiction was developed by overlaying FEMA effective flood data on census block data extracted from HAZUS. The percentage of each particular census block overlain by floodplain was then calculated assuming equal distribution of buildings values. Using this method, the relative total exposure values of structures in the floodplain was estimated for all structures combined in the HAZUS database and the distribution is shown in figure 5-23.

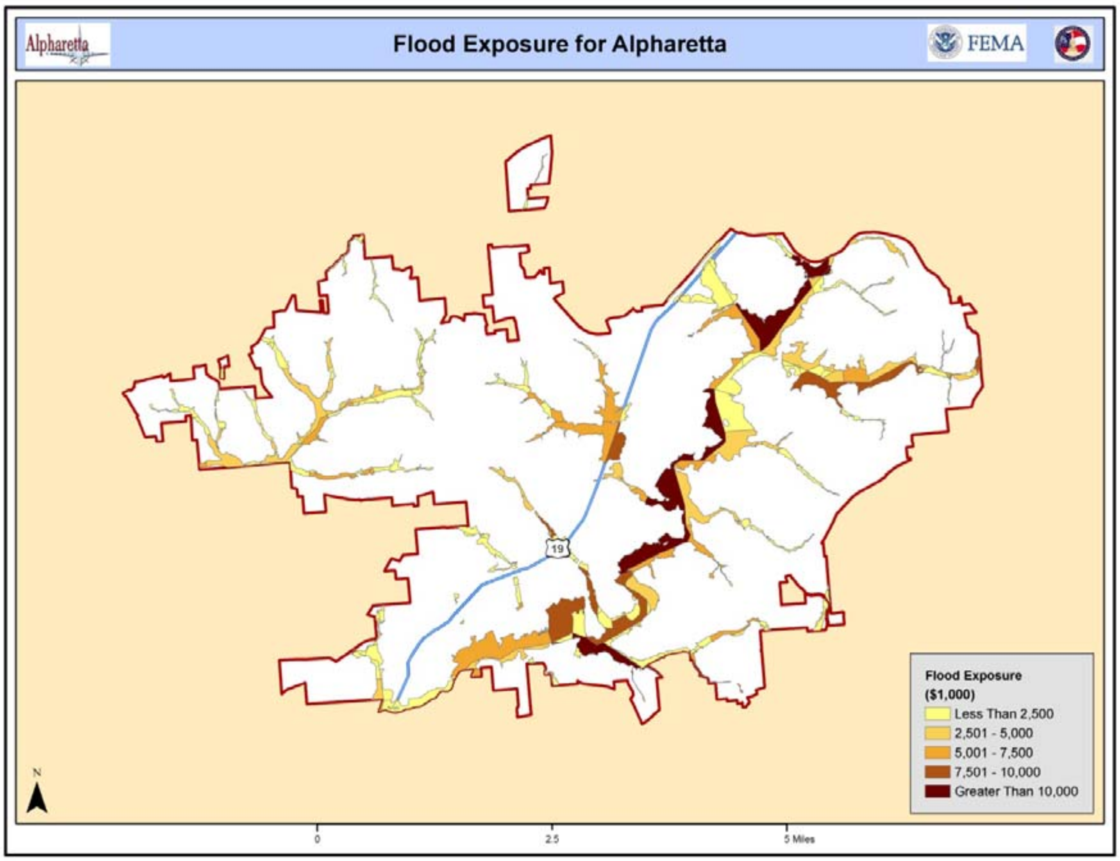

Figure 5-23: Flood Exposure for the City

Table 5-11: Dollar Value of Flood Exposure by Land Use Type

The City of Alpharetta Assets Exposed in Floodplain	
Category	Exposure ($1,000)
Residential	$282,949
Commercial	$147,482
Industrial	$34,959
Agriculture	$1,282
Religious	$5,856
Government	$723
Education	$2,369
Total	$475,622

An average flood depth for the county was determined by evaluating the FEMA determined flood elevations in comparison to local topography data and profiles from the Fulton County FEMA Flood Insurance Study. An average 100-year flood depth was then used to determine the appropriate level of damage utilizing FEMA's Federal Insurance Administration depth damage functions for both building and content damage. Utilizing these values the total damage for both buildings and contents was determined for each jurisdiction and for each use type. The complete flood loss estimation table, including all formulas and assumptions is included in the Additional Hazard Research appendix.

Tables 4.3-4 and 4.3-5 provide a breakdown of potential losses to residential, commercial, religious, educational and government property. Approximately one billion dollars in property damage could occur in the 100 year flood event.

Table 5-12: Estimated Riverine Losses

Estimated Losses for 100 - Year Riverine Flood Event - City of Alpharetta, GA										
City	Structure Type	Total Exposure	Average Riverine Depth Above Grade	% Building Damage	Estimated Building Total Damage	Contents Value as Percent of Building Value	Total Contents Value	Contents Damaged	Estimated Contents Damage	Total Buildings and Content Damage
Alpharetta	Residential	$282,949	4.5	21.0%	$59,419	30%	$84,885	31.5%	$26,739	$192,686
	Commercial	$147,482	4.5	29.5%	$43,507	50%	$73,741	44.3%	$32,667	
	Industrial	$34,959	4.5	29.5%	$10,313	100%	$34,959	44.3%	$15,487	
	Agriculture	$1,282	4.5	21.0%	$269	40%	$513	31.5%	$162	
	Religious	$5,856	4.5	21.0%	$1,230	75%	$4,392	31.5%	$1,383	
	Government	$723	4.5	21.0%	$152	50%	$362	31.5%	$114	
	Education	$2,369	4.5	21.0%	$497	100%	$2,369	31.5%	$746	
					$115,388				$77,298	

5.6.2 Vulnerability of Structures (including Critical Facilities) to Wind and Earthquake Hazards

Exposure

FEMA HAZUS MH MR 5 software was used to conduct the vulnerability analysis and risk assessment for both earthquake and severe wind scenarios using HAZUS default data at census track level. HAZUS has uncertainties that are inherent in any loss estimation technique and claims that there may be differences between the actual event and the actual social and economic losses following a specific event. Flood vulnerability was assessed using different methods as described in the flood vulnerability section. For the earthquake and Wind analysis the total area studied was approximately 85 square miles and included 9 census tracks. This area had over 38,000 households in the region with a population in excess of 100,000. There are approximately 34,000 buildings in this region with a total exposure of over $11 billion dollars. Most of these buildings are considered residential and made of a wood frame design. The total exposure of transportation assets is $665 million and the total exposure of utility systems is $193 million. These exposure values include over 50 miles of highways, 1,000 miles of pipe and 60 bridges. A breakdown of the total building exposure by occupancy type is shown in Table 5-12.

Table 5-13 Building Exposure by Occupancy

Occupancy	Exposure ($1000)	Percent of Tot
Residential	7,863,262	71.4%
Commercial	2,444,305	22.2%
Industrial	465,693	4.2%
Agricultural	25,828	0.2%
Religious	143,479	1.3%
Government	15,047	0.1%
Education	53,727	0.5%
Total	**11,011,341**	**100.0%**

Earthquake Loss Estimation

Using FEMA's HAZUS MH MR 5 software a magnitude 5 earthquake event was placed within 10 miles of the City of Alpharetta. This building construction type model was assumed to be for more economical types in comparison to Alpharetta's. This magnitude has been recorded in within 100 miles of the City therefore it was decided that the event was possible but not probable. The following is an estimate of the expected building damage by occupancy class:

Table 5-14: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	136	0.39	1	1.04	0	1.08	0	1.12	0	0.68
Commercial	2,291	6.63	24	19.51	6	23.43	1	24.88	0	19.24
Education	78	0.23	1	0.60	0	0.70	0	0.72	0	0.69
Government	17	0.05	0	0.12	0	0.13	0	0.13	0	0.08
Industrial	701	2.03	7	5.58	2	6.59	0	6.60	0	4.23
Other Residential	2,685	7.77	16	13.08	4	16.17	0	16.80	0	16.88
Religion	169	0.49	2	1.38	1	1.92	0	2.20	0	2.33
Single Family	28,465	82.41	72	58.68	13	49.97	1	47.54	0	55.86
Total	**34,543**		**123**		**26**		**3**		**0**	

HAZUS also considers the construction type of buildings in the area affected. HAZUS analyzes buildings which are built with materials such as wood frames, steel, concrete, precast and other materials. The area affected was mostly wood framed buildings (83%). These buildings were mostly single family residential designs. An analysis of damage caused by structure type is shown in table 5-14.

Table 5-15: Expected Building Damage by Building Type (All design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	28,792	83.35	44	35.85	3	11.01	0	0.00	0	0.00
Steel	1,618	4.68	13	10.62	3	10.38	0	8.20	0	0.00
Concrete	312	0.90	2	1.75	0	1.34	0	0.52	0	0.00
Precast	101	0.29	2	1.24	1	2.65	0	3.40	0	0.00
RM	501	1.45	4	3.01	1	4.82	0	5.23	0	0.00
URM	3,176	9.19	58	46.88	18	69.06	2	82.53	0	100.00
MH	42	0.12	1	0.66	0	0.74	0	0.12	0	0.00
Total	**34,543**		**123**		**26**		**3**		**0**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

The model also estimates essential facility damage. Essential facilities include hospitals or other emergency care facilities, police stations, fire stations and facilities that are necessary for the day to day function of the City. A total of 40 essential facilities were located within the affected area. None of these facilities had major loss of functionality associated with the event.

Table 5-16: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	1
Schools	37	0	0	37
EOCs	0	0	0	0
PoliceStations	1	0	0	1
FireStations	1	0	0	1

HAZUS also conducts a transportation analysis. In the transportation analysis highways, railways, bus, ferry, port and airport infrastructure are analyzed. The assumed level of design for these infrastructure types is assumed to be low in this area. The highway segments are assumed to be damaged by ground failure only. HAZUS only calculates damages to these structure types if there are any ground-failure maps provided. Since there were no ground-failure maps provided HAZUS was not able to calculate the damage to the infrastructure. The total exposure of utility lines is broken down by category.

Table 5-17: Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	913	0	0
Waste Water	548	0	0
Natural Gas	365	0	0
Oil	0	0	0

After an earthquake secondary effects such as fires can occur and burn out of control. HAZUS uses a Monte Carlo simulation to estimate the number of ignitions and the amount of burnt area. The model did not indicate any results in this event but it should be noted that the potential for these fires exists. The total debris produced from this earthquake would require approximately 80 truckloads (@25 tons/truck) to remove all the debris generated from the earthquake. HAZUS also calculated that sheltering requirements would be minimal and there would be very little loss of life.

Building related losses for this event are broken into two categories, direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building related losses were approximately $3 million. Almost fifty percent of those losses were related to the business interruption of the region. The residential occupancy class made up over 35% of the total loss. This could be not only from the losses to the building but also from loss in rent or other income associated with the structure.

Table 5-18: Building-Related Economic Loss Estimate ($ Millions)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.02	0.28	0.01	0.01	0.31
	Capital-Related	0.00	0.01	0.25	0.00	0.00	0.27
	Rental	0.02	0.05	0.23	0.01	0.00	0.31
	Relocation	0.09	0.03	0.26	0.02	0.03	0.43
	Subtotal	**0.11**	**0.11**	**1.02**	**0.04**	**0.04**	**1.32**
Capital Stock Losses							
	Structural	0.19	0.06	0.30	0.05	0.03	0.63
	Non_Structural	0.42	0.13	0.33	0.04	0.03	0.94
	Content	0.04	0.01	0.06	0.01	0.01	0.13
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.65**	**0.20**	**0.68**	**0.10**	**0.07**	**1.70**
	Total	**0.77**	**0.30**	**1.70**	**0.14**	**0.11**	**3.02**

Severe Wind Losses

HAZUS MH MR 5 was used to develop a severe wind loss scenario. The scenario included sustained winds at 75mph over any census tract that intersected the City of Alpharetta's political boundary. Not all census tracks were completely contained within the City limits but there was no way using the current software to isolate or eliminate the exposure of a census track which was outside of the City limits. The analysis was conducted by analyzing the different occupancy class within the hazard area and applying loss estimation methods. The occupancy classes which were analyzed were agriculture, commercial, education, government, industrial religious and residential.   The expected building damage by occupancy class due to the sustained 75mph winds is shown in table 5-19.

Table 5-19: Expected Building Damage by Occupancy (100-Yr Event)

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	138	99.68	0	0.31	0	0.01	0	0.00	0	0.00
Commercial	2,311	99.54	10	0.45	0	0.01	0	0.00	0	0.00
Education	79	99.64	0	0.36	0	0.00	0	0.00	0	0.00
Government	17	99.63	0	0.37	0	0.00	0	0.00	0	0.00
Industrial	707	99.62	3	0.38	0	0.00	0	0.00	0	0.00
Religion	170	99.70	1	0.30	0	0.00	0	0.00	0	0.00
Residential	31,222	99.88	35	0.11	1	0.00	0	0.00	0	0.00
Total	**34,644**		**50**		**1**		**0**		**0**	

HAZUS also conducted on a loss analysis based on the building type. HAZUS review five different building types during this analysis which were concrete, masonry, mobile homes, steel and wood framed buildings. The majority of the area was assumed to be made up of wood framed buildings. Table 5-19 shows the expected building damage by building type during the defined scenario.

Table 5-20: Expected Damage by Building Type (100-Yr Event)

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	418	99.43	2	0.57	0	0.00	0	0.00	0	0.00
Masonry	3,740	99.48	19	0.51	1	0.01	0	0.00	0	0.00
MH	42	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	1,628	99.48	8	0.51	0	0.01	0	0.00	0	0.00
Wood	28,824	99.95	14	0.05	0	0.00	0	0.00	0	0.00

There were approximately 40 critical facilities affected in the scenario. These facilities expect to see minor disruptions that should not take more than a day to remedy. Table 5-21 shows the critical facilities results from HAZUS.

Table 5-21: Expected Damage to Essential Facilities (Wind)

		# Facilities		
Classification	Total	Probability of at Least Moderate	Probability of Complete Damage > 50%	Expected Loss of Use < 1 day
Fire Stations	1	0	0	1
Hospitals	1	0	0	1
Police Stations	1	0	0	1
Schools	37	0	0	37

HAZUS estimates approximately 4,000 tons of debris will be generated from the defined scenario. Most of this would come from downed trees and a small portion will come from damage to buildings. The conditions of the trees will greatly determine the susceptibility to wind. A dying or dead tree will likely be uprooted and cause transportation issues and other injuries. Although uncommon, trees occasionally fall on cars injuring or killing the motorist. It would be advisable for heavily congested roadways in the City limits to be monitor for trees in weak condition in order to prevent this from happening. As uncommon as it is, generally heavily traveled roadways are clogged during rainstorms at certain times of the day, therefore, any tree failing on this roadway has a high potential to impact a motorist stuck in traffic. Figure 5-24 shows highly traveled roadways based on average daily traffic counts.

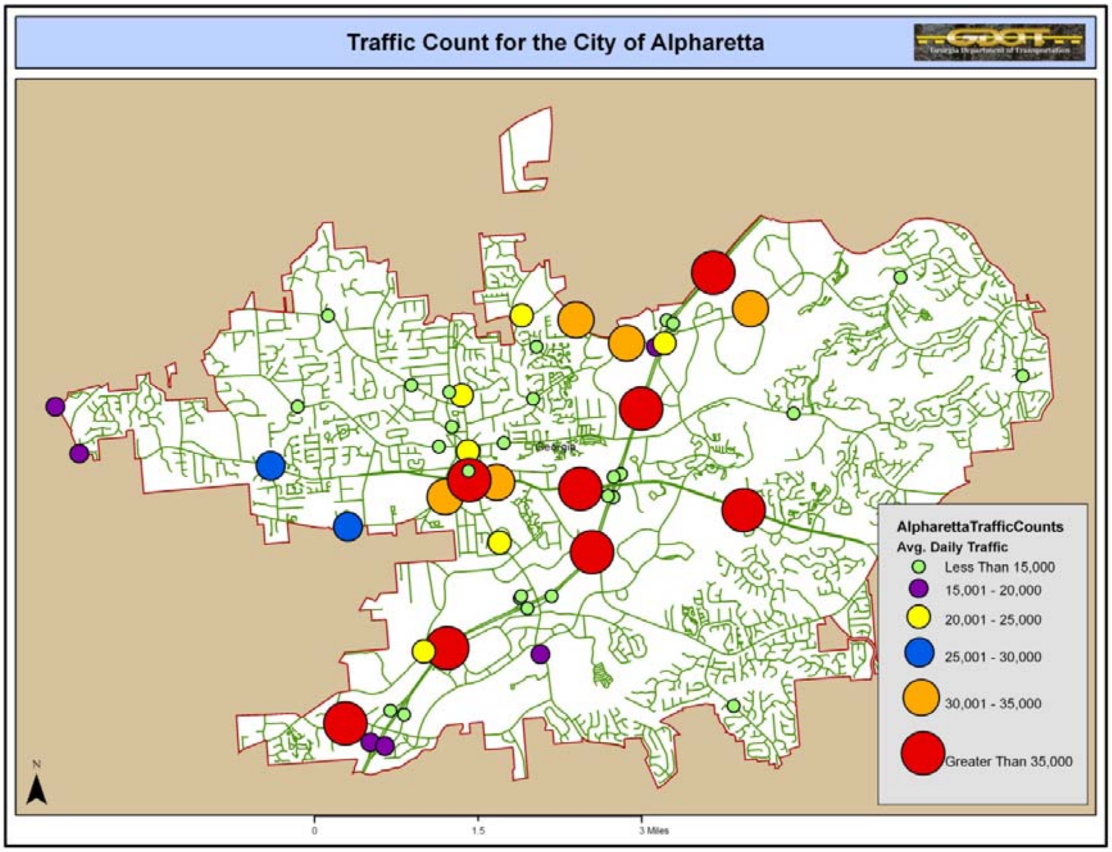

Figure 5-24: Traffic Counts within Alpharetta

HAZUS estimates the total building – related economic loss to be approximately $3.3 million. The losses are a calculation of property damages and business interruption loss estimates. Most of the property damage would occur to residential buildings and most likely be very minor. These estimates are based on consistent wind but winds change rapidly during an event and isolated areas very high straight-line winds or tornadoes are potential during severe weather events. HAZUS does not have a module yet to specifically look at those hazards. Therefore, in an event of extreme wind event certain areas can be expected to be impacted at a much different than those listed in table 5-22.

Table 5-22: Building-Related Economic Loss Estimates ($1000's)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	3,069.09	244.43	46.57	21.56	3,381.64
	Content	0.00	0.00	0.00	0.00	0.00
	Inventory	0.00	0.00	0.00	0.00	0.00
	Subtotal	**3,069.09**	**244.43**	**46.57**	**21.56**	**3,381.64**
Business Interruption Loss						
	Income	0.00	0.00	0.00	0.00	0.00
	Relocation	1.69	1.63	0.00	0.05	3.36
	Rental	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.00	0.00	0.00	0.00
	Subtotal	**1.69**	**1.63**	**0.00**	**0.05**	**3.36**
Total						
	Total	**3,070.78**	**246.06**	**46.57**	**21.61**	**3,385.01**

In addition to the assessments above, the City also has some additional information from the comprehensive plan relative to property within jurisdictional boundaries. It is important to note, that while HAZUS provides a base assessment of the community, the national data (general building stock, essential facilities, etc) used in the analysis is typically not as up to date as what the jurisdiction may have collected on its own.

Table 5-23: Breakdown of the Count of Property by Class

Countywide Property Inventory by Property Class		
Occupancy	Count	Percentage
Agriculture	6	.002%
Commercial	20,217	5.882%
Education	993	.287%
Public Property	5,713	1.662%
Industrial	3,133	.912%
Religious	1,922	.559%
Hospitals/Medical	94	.027%
Charitable	613	.178%
Historic	365	.106%
Conservation & Environmental	517	.150%
Utilities	870	.253%
Single Family Residence	308,961	89.905%
Other	249	.072%
Total Property	**343,653**	**100.00%**

Table 5-24: Breakdown of the Value of Property by Class

Countywide Property Values by Property Class		
Occupancy	Value	Percentage
Agriculture	$11,235,120	.008%
Commercial	$47,273,285,632	32.70%
Education	$2,466,779,000	1.71%
Public Property	$8,165,125,200	5.65%
Industrial	$4,230,265,829	2.92%
Religious	$1,768,829,300	1.22%
Hospitals/Medical	$1,050,616,600	.727%
Charitable	$1,050,523,800	.727%
Historic	$165,309,900	.114%
Conservation & Environmental	$253,069,172	.175%
Utilities	$241,891,000	.167%
Single Family Residence	$76,899,533,652	53.20%
Other	$980,285,500	.678%
Total Property	**$144,556,749,705**	**100.00%**

Table 5-25: Jurisdictional Exposure for Countywide Hazards

Summary of Exposure by Jurisdiction for Countywide Hazards (Drought, Earthquakes, Heat Waves, Severe Weather, Tornadoes, and Tropical Systems)					
Jurisdiction	Population[1]	Number of Properties[2]		Value of Properties[2]	
		Residential	Non-Residential	Residential	Non-Residential
Alpharetta	67,575	16,960	2,166	$5,129,366,231	$6,105,778,810
Atlanta	445,709	130,001	18,231	$31,656,624,557	$38,525,329,664
Chattahoochee Hills	3,000[3]	1,661	237	$355,013,340	$132,651,020
College Park	15,527	2,447	1,517	$334,003,920	$1,325,277,152
East Point	37,465	2,535	1,666	$1,341,678,140	$1,291,064,804
Fairburn	5,464[4]	5,655	479	$626,321,699	$395,179,461
Hapeville	6,180[4]	2,069	479	$237,562,658	$542,460,400
Johns Creek	70,050[5]	24,194	718	$8,223,527,193	$2,154,321,610
Milton	30,180[6]	11,695	521	$4,410,128,607	$1,106,974,072
Mountain Park	5064	764	93	$52,688,200	$2,599,800
Palmetto	3,400[4]	1,712	242	$168,338,646	$178,221,710
Roswell	103,711	27,165	2,487	$8,018,867,289	$3,764,533,514
Sandy Springs	98,941	25,997	1,626	$10,245,416,584	$7,559,094,574
Union City	11,621[4]	6,993	638	$660,106,590	$694,069,765
Unincorporated Fulton County	245,180	40,331	2,288	$5,793,882,938	$3,811,589,997
Totals	**1,144,509**	**300,209**	**33,388**	**$77,253,527,592**	**$67,589,106,353**

[1] *Includes both property with and without physical structures*
[2] *2006-2008 US Census American Community Survey estimates, unless otherwise noted*
[3] *http://www.chatthillcountry.org/*
[4] *2000 US Census*
[5] *http://www.johnscreekga.gov/about/demographics.asp*
[6] *http://www.cityofmiltonga.us/index.asp?Type=B_LIST&SEC={328767DC-FDC7-4184-A65EC372B73538EE}#{7A96E367-8C29-472B-8701-22632A828D6A}*

Table 5-26: Hazards with Impacts to the City

Summary of Exposure by Hazard – City of Alpharetta				
Hazard	Number of Properties		Value of Properties	
	Residential	Non-Residential	Residential	Non-Residential
Dam Failure	N/A	N/A	N/A	N/A
Drought*	16,960	2,166	$5,129,366,231	$6,105,778,810
Earthquake*	16,960	2,166	$5,129,366,231	$6,105,778,810
Flood	N/A	N/A	N/A	N/A
Heat Wave*	16,960	2,166	$5,129,366,231	$6,105,778,810
Severe Weather*	16,960	2,166	$5,129,366,231	$6,105,778,810
Sinkhole	N/A	N/A	N/A	N/A
Tornadoes*	16,960	2,166	$5,129,366,231	$6,105,778,810
Tropical System*	16,960	2,166	$5,129,366,231	$6,105,778,810
Wildfire/Urban Interface	N/A	N/A	N/A	N/A
Winter Storm*	16,960	2,166	$5,129,366,231	$6,105,778,810

* This hazard is broad in potential geographic extent and may impact anywhere within the City of Alpharetta (or all of the City) depending on the magnitude of the event

5.7 General Description of Population and Development Trends

5.7.1 Population Trends

The City of Alpharetta had an estimated population of over 40,000 residents in 2012. This compares to other areas such as Fulton County which has an estimated 2005 population of 904,796 and the 10 county Atlanta Region has a population of 3,923,462. The 28 county Atlanta Metropolitan Statistical Area (MSA) contains 4.9 million people, which is more than half of Georgia's population of 9.1 million people. Almost all of the population growth in the MSA from 1980 to 2005 has been in the Atlanta suburbs. The population of the Atlanta Region has been increasing as a percentage of the State of Georgia; from approximately 12% in 1900 to almost 42% in 2000. The suburban portion of the Atlanta Region grew by nearly 2 million people between 1980 and 2000. The population in counties to the north and east seemed to be generally higher than those in the south and west.

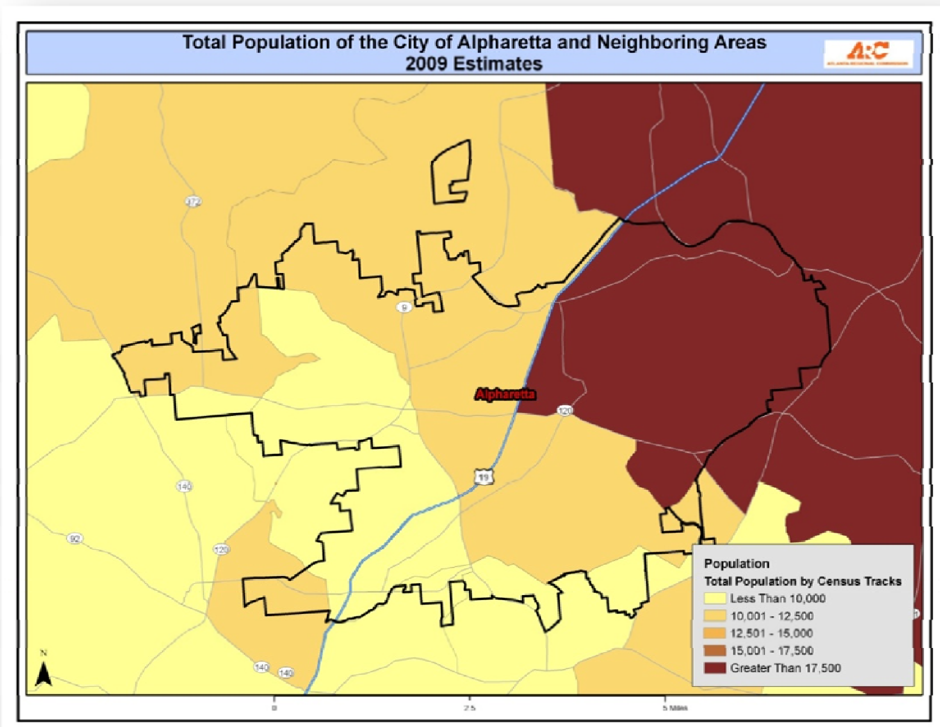

Figure 5-25: 2009 Population Estimates

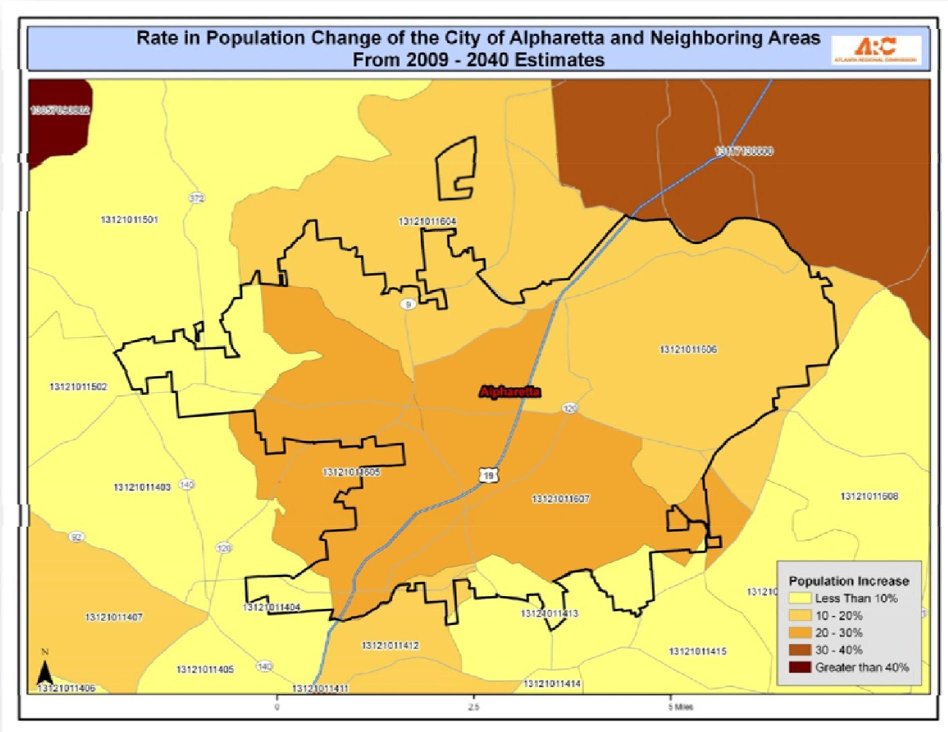

Figure 5-26: Rate of Population Change

Table 5-27: Census Tracts for Alpharetta

Census Tracks intersecting the City of Alpharetta*			
Census Track ID	Population 2009	Population 2040	% Increase From 2009
13117130600	52,813	84,459	37%
13121011403	9,111	10,100	10%
13121011404	11,131	11,510	3%
13121011412	8,619	10,153	15%
13121011413	9,874	10,380	5%
13121011415	10,928	11,888	8%
13121011501	18,834	20,132	6%
13121011502	10,164	10,297	1%
13121011604	19,040	21,397	11%
13121011605	10,573	14,585	28%
13121011606	20,607	23,155	11%
13121011607	14,050	19,911	29%
*Not all Census Tracks are completely contained within the City limits			

Total populations for the past twelve years and beyond for the City were estimated as such:

City of Alpharetta's Population Projections				
Year	Population	Housing Units	Avg. Persons Per Units	Growth Rate
2000	34,854	13,911	2.505	N/A
2001	35,738	14,246	2.509	2.5%
2002	36,385	14,504	2.509	1.8%
2003	37,026	14,760	2.509	1.7%
2004	37,611	14,993	2.509	1.6%
2005	39,021	15,568	2.506	3.6%
2006	39,518	15,794	2.502	1.3%
2007	40,423	16,292	2.481	2.2%
2008	41,521	16,905	2.456	2.6%
2009	41,941	17,096	2.453	1.0%
2010	42,360	17,286	2.451	1.0%
2011	43,479	17,724	2.453	2.6%
2012	44,265	18,081	2.448	1.8%
2013	45,051	18,439	2.443	1.7%
2014	45,837	18,797	2.439	1.7%
2015	46,623	19,154	2.434	1.7%
2016	47,409	19,512	2.430	1.7%
2017	48,194	19,870	2.426	1.6%
2018	48,980	20,227	2.421	1.6%
2019	49,766	20,585	2.418	1.6%
2020	50,552	20,943	2.414	1.6%
2021	50,960	21,110	2.414	0.8%
2022	51,318	21,257	2.414	0.7%
2023	51,628	21,384	2.414	0.6%
2024	52,011	21,541	2.414	0.7%
2025	52,370	21,688	2.415	0.7%
2026	52,728	21,835	2.415	0.7%
2027	53,087	21,982	2.415	0.7%
2028	53,446	22,130	2.415	0.7%
2029	53,805	22,277	2.415	0.7%
2030	54,164	22,424	2.415	0.7%

*Source – Estimates from 2009 referenced on City Website http://www.alpharetta.ga.us/

For purposes of assessing risk, population data was gathered from the City's 2009 estimates and the US Census based on census tracks. It is important to note that this data has already been superseded due to the City's extraordinary growth. According to the 2030 Comprehensive Plan's Housing element, primary issues and opportunities will be higher density residential, infill housing, retirement and elderly housing, and retention of its "Baby Boom" population.

The City of Alpharetta is located in the Atlanta-Sandy Springs-Marietta Metropolitan Statistical Area (MSA) and is one of the fastest-growing cities in the State of Georgia. Based on the City's *Comprehensive Plan 2030 – Community Agenda*, the total population for the City of Alpharetta has been estimated to grow to a total of 69,395 by 2030. From 2000 to 2009, the City of Alpharetta's population growth rate was 72% from 30,511 in 2000 to 52,415 in 2009. The average annual growth rate for the City is 6.2% while the county's is 2.7%.

According to more recent population projections obtained from Community Development in 2011, growth since annexation is no longer possible. Alpharetta experienced a 54% increase in housing units growing from 13,894 in 2000 to 20,894 in 2009 as a direct consequence. Some of this increase is a result of recent annexations. This rate of growth is not expected to continue.

COMMUNITY SNAPSHOT

POPULATION TRENDS

Year	City of Alpharetta	Fulton County	Atlanta Region
1990	13,002	648,951	2,513,612
2000	30,511	816,006	3,429379
2009	52,415	1,033,757	4,124300

Source: U.S. Census Bureau

GROWTH RATES

2000-2009	City of Alpharetta	Fulton County	Atlanta Region
% Change	71.8%	26.7%	20.3%
Ave. Annual	6.2%	2.7%	2.1%

POPULATION PROJECTIONS

Year	City of Alpharetta
2015	56,494
2020	60,800
2025	65,434
2030	69,395

Source: City of Alpharetta Community Development Department

5.7.2 Land Use and Development Trends

The City of Alpharetta is generally a residential city. However, there are major areas of commercial activity near State Highway 400. Many people commute into the City from other nearby cities or unincorporated areas of North Georgia. This is the reason the City population can double or almost triple during a typical work day. Most of these commuters will stay within the commercial corridor. This City does not have many areas designed for Industrial. The map below shows the distribution of major land use categories within the City limits.

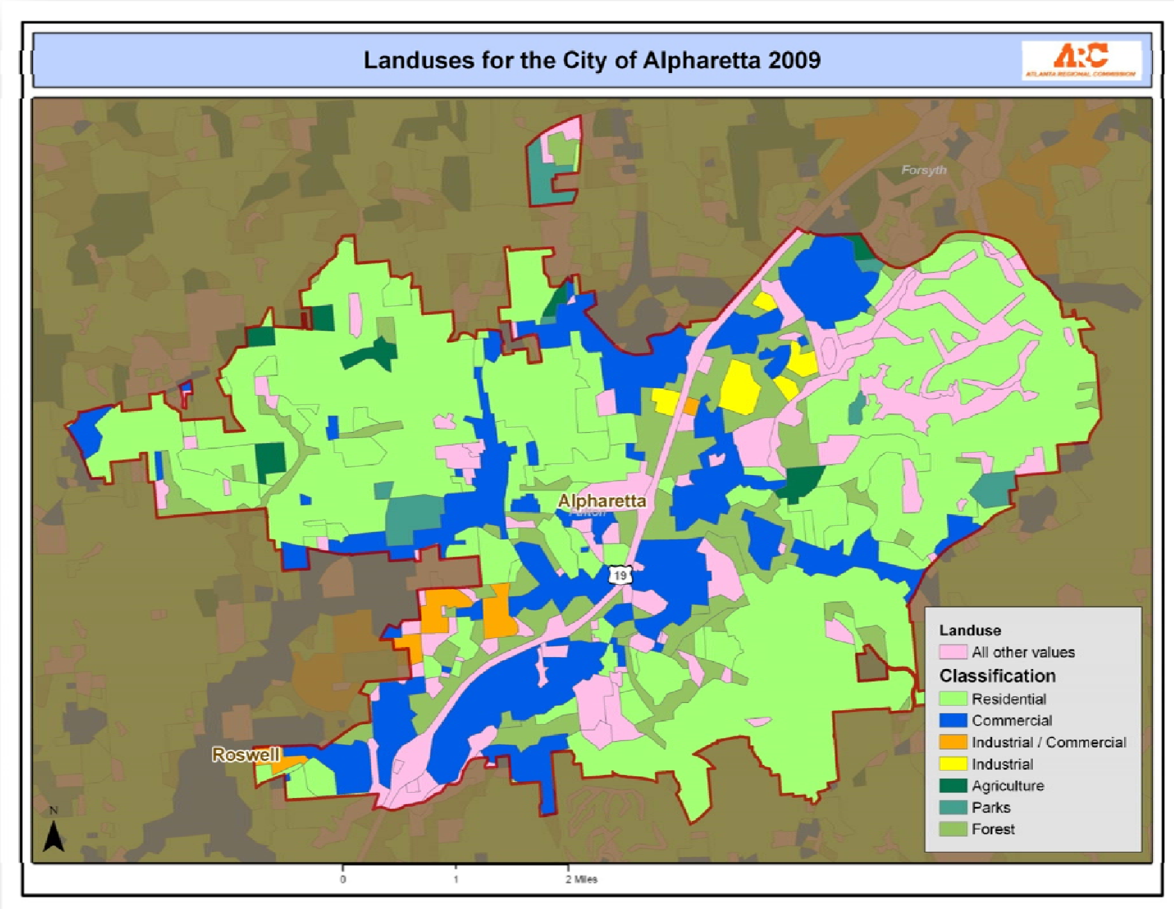

Figure 5-27: 2009 Land Use Map

Table 5-28: Alpharetta Land Use by Area and Percent of Total

Alpharetta Land Use		
Category	Area (Sq. Miles)	Percent of Total
Forest	2.49	21.68%
Commercial	2.46	21.37%
Residential - Multi	1.35	11.72%
Residential - Low	0.84	7.31%
Transitional	0.68	5.95%
Other	0.60	5.23%
Wetlands	0.54	4.71%
Golf Courses	0.54	4.66%
Residential - Med	0.44	3.83%
Reservoirs	0.34	2.95%
Industrial	0.28	2.43%
Parks	0.26	2.23%
Ind/Com	0.24	2.06%
Agriculture	0.23	2.02%
Urban/Other	0.08	0.73%
Residential - High	0.08	0.71%
TCU	0.05	0.40%
Cemeteries	0.03	0.22%
Total	11.49	100.00%

The City of Alpharetta has a substantial amount of forested areas. It can be expected that much of this area will be developed by the year 2040 unless ordinances are enacted to protect this open space. Also the City of Alpharetta should consider that much of this area will be within FEMAs designated 1% annual chance floodplain meaning it is at high risk of flooding.

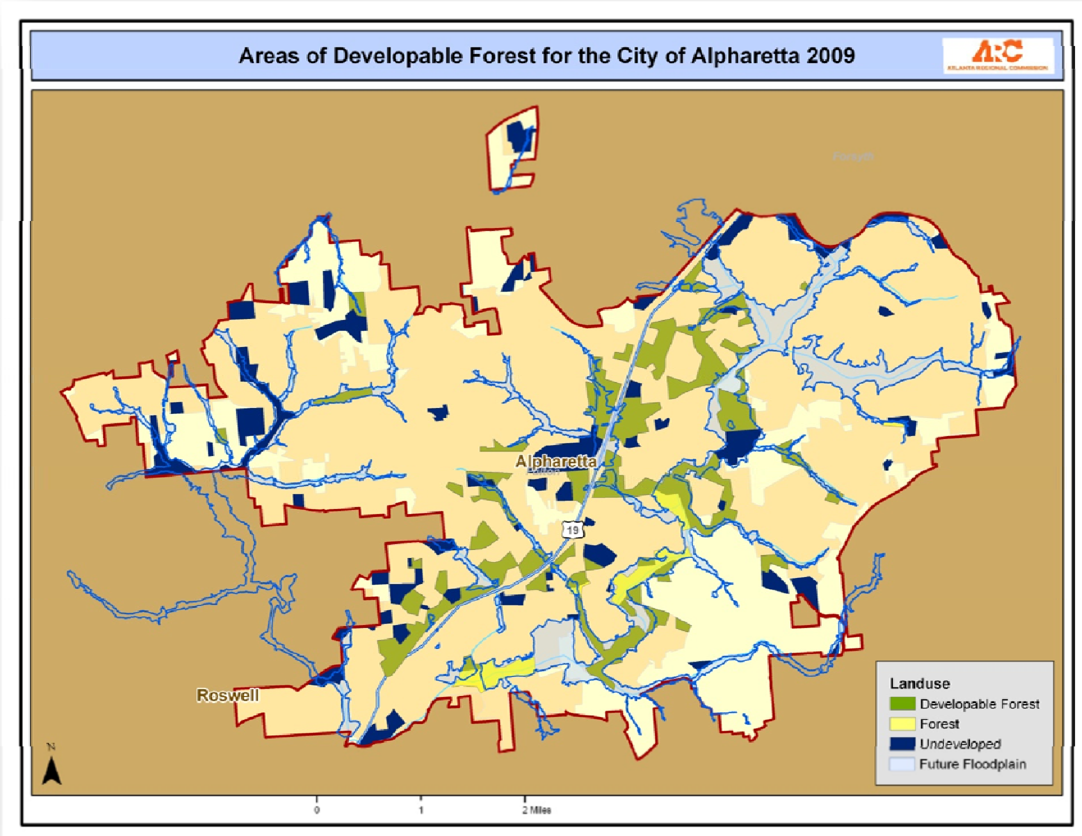

Figure 5-28: Map of Developable Forest Areas

Areas of rapid growth in the City can be tracked by monitoring water demand, sewer flows, the increase in number of new accounts added to the system, zonings, increases in population and households as well as population and household forecasts. The City has been identified as one of the highest growth areas in the county. Another way of tracking development and increased development is by comparing the increase in impervious surface over the past few decades.

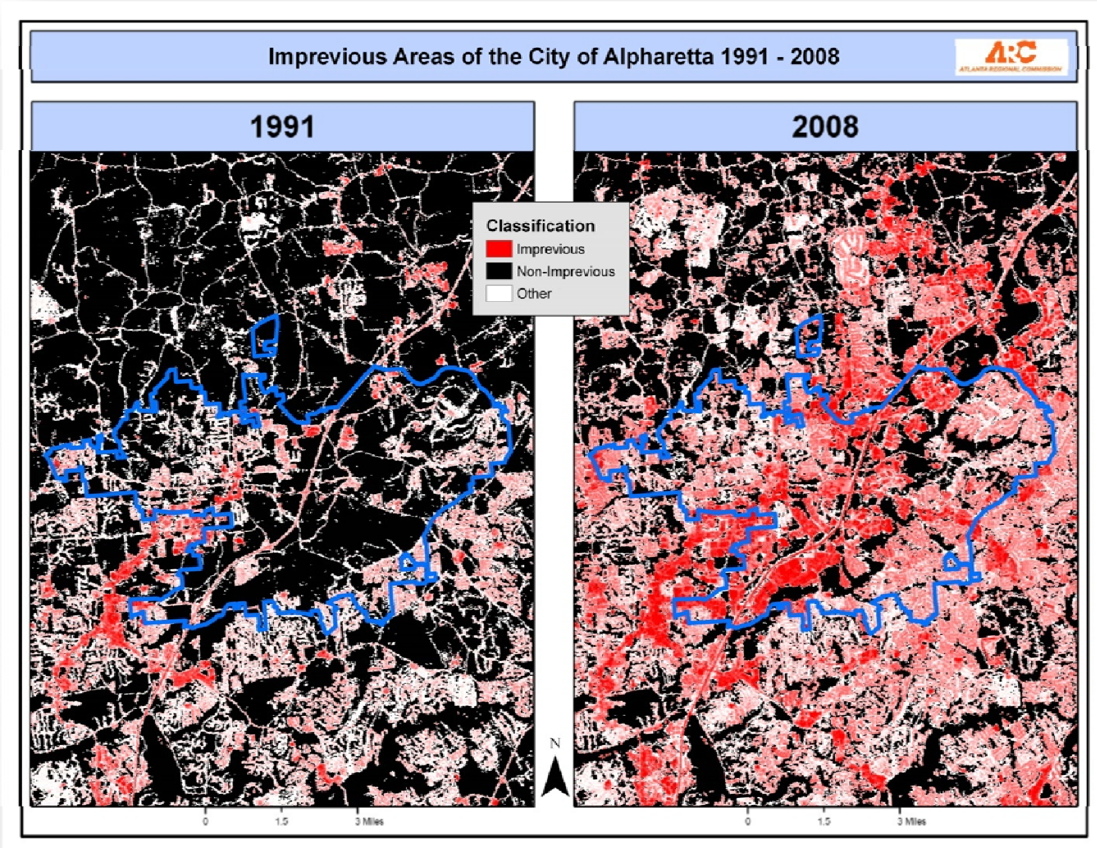

Figure 5-29: Map of Changes to Impervious Area from 1991-2008

Conversion of undeveloped land to impervious surfaces has increased storm water runoff, which directly impacts the quality and flow of the City and, subsequently, County's streams. In fact, nonpoint source pollution (runoff from parking lots, city streets, roofs, and lawns) is now responsible for 75% of the pollution in 3,400 stream miles in Georgia that do not meet water quality standards.

The Northwest portion of Fulton County is an emerging area of development. Once an area with primarily rural agricultural land, it is now a mix of rural/agricultural uses, residential subdivisions, golf courses and small commercial nodes. Regional employment corridors have formed along Georgia 400 in the City of Alpharetta. The coverage is characterized by medium density residential areas in the east and central part and by retail/office corridors. In the Alpharetta area employment is expected to rise in the future with additional jobs in many different sectors. Table 5-29 provides details on these estimates.

Table 5-29: Employment Forecast near Alpharetta

Total Employment Forecasted by Year							
Census Track	2016	2020	2024	2025	2030	2040	Total % Increase
13117130600	34,166	36,458	38,093	38,521	41,143	46,650	26.8%
13121011403	6,355	6,565	6,736	6,774	7,027	7,609	16.5%
13121011404	8,593	9,083	9,420	9,509	10,047	11,150	22.9%
13121011412	11,170	12,340	13,190	13,421	14,879	17,933	37.7%
13121011413	2,006	2,103	2,192	2,210	2,324	2,599	22.8%
13121011415	2,390	2,641	2,829	2,877	3,137	3,734	36.0%
13121011501	3,564	3,888	4,174	4,233	4,579	5,375	33.7%
13121011502	1,230	1,260	1,293	1,299	1,327	1,398	12.0%
13121011604	15,686	16,550	17,056	17,189	18,150	20,032	21.7%
13121011605	26,823	28,151	29,171	29,441	31,059	34,585	22.4%
13121011606	21,949	22,624	23,177	23,304	24,034	25,592	14.2%
13121011607	26,177	28,751	30,634	31,127	34,081	39,872	34.3%
Average Increase for the Census Blocks within and around Alpharetta							25.1%

Residential land use makes up the majority of standard land use types in the City of Alpharetta - at 46.2%, according to the 2030 *Comprehensive Plan*. Of the residential uses, there are three subclasses. The subclass known as low density residential land use makes up about 35.6% for the entire land use inventory. According to 2009 land use data from the Atlanta Regional Commission, however, low density residential appeared to be less. Considering the data is from 2009 and has already been exceeded and that the 2030 Comprehensive Plan has been recently developed approved and adopted, land use data from any other source may not suffice for risk assessment analysis in the future.

5.8 NFIP Insured Structures

The Federal Emergency Management Agency maintains a Community Information System to track information and statistics about communities participating in the National Flood Insurance Program (NFIP). The latest report pulled in April of 2012 indicates that the City is not a participant in the Community Rating System and lists the important statistics shown in the table below.

Table 5-30: National Flood Information Program for Alpharetta

NFIP Item of Note	Date/Number
NFIP Entry Date – Emergency Program	03/05/1974
NFIP Entry Date- Regular Program	02/15/1978
NFIP Flood Insurance Studies – Including Effective Dates	06/22/1998 – Countywide Study 06/18/2010 – Chattahoochee River Corridor Study
Repetitive Loss Properties	2
Flood Insurance Policies	106
Flood Insurance Premiums	$53,613
Insurance in Force	$28,456,500
Flood Loss Events	5
Number of Closed Paid Losses	9 (in the amount of $210,070)
Substantial Damage Paid Losses	0
CRS Class	10