

# CITY OF WAGONER, OKLAHOMA



## **Multi-Hazard Mitigation Plan - 2020**

CITY OF WAGONER, OKLAHOMA  
AND  
WAGONER SCHOOL DISTRICT

December 2020

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# **Chapter 1: Introduction**

## **1.1 About the Plan**

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This document is the multi-hazard mitigation plan for the City of Wagoner and the Wagoner School District, located in Wagoner, Wagoner County, Oklahoma. The term “Planning Area” used in this document shall mean both the City of Wagoner and the Wagoner School District jurisdictions. It is a strategic planning guide developed in fulfillment of the Hazard Mitigation Grant Program requirements of the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act. This act provides federal assistance to state and local governments to alleviate suffering and damage from disasters. It broadens existing relief programs to encourage disaster preparedness plans and programs, coordination and responsiveness, insurance coverage, and hazard mitigation measures.

This plan fulfills requirements for the Hazard Mitigation Grant Program (HMGP). The plan addresses natural hazards and hazardous materials events.

### **1.1.1 Purpose**

The purpose of this plan is to:

1. Assess the ongoing hazard mitigation activities in the Planning Area, located in City of Wagoner, Wagoner County, Oklahoma. (Chapter 1)
2. Outline the Planning Process used by the City of Wagoner and the Wagoner School District in completing a Multi- Hazard Mitigation Plan (Chapter 2)
3. Identify and assess the hazards that may pose a threat to citizens and property (Chapter 3)
4. Evaluate mitigation measures that should be undertaken to protect citizens and property (Chapter 4)
5. Outline a strategy for implementation of mitigation projects (Chapter 5)
6. Provide methodology for the plan maintenance and adoption (Chapter 6)

The objective of this plan is to provide guidance for city-wide hazard mitigation actions for the next five years. It will ensure that the City of Wagoner and the Wagoner School District implement actions that are most effective and appropriate for mitigating natural hazards and hazardous materials incidents.

### **1.1.2 Scope**

The scope of the City of Wagoner Multi-Hazard Mitigation Plan is city-wide and throughout the school district. It addresses natural hazards deemed to be a threat to the citizens of the City of Wagoner, as well as hazardous-material events. Both short-term and long-term hazard mitigation opportunities are addressed beyond existing federal, state, and local funding programs. The jurisdictions participating in this plan:

<b>Community</b>	<b>Street Address</b>	<b>City</b>
City of Wagoner	317 E Lee St	Wagoner
Wagoner School District	308 Northeast 2nd Street	Wagoner

### **1.1.3 Authority**

Section 409 of the *Robert T. Stafford Disaster Relief and Emergency Assistance Act*, (Public Law 93-288, as amended), Title 44 CFR, as amended by Section 102 of the *Disaster Mitigation Act of 2000*, provides the framework for state and local governments to evaluate and mitigate all hazards as a condition of receiving federal disaster assistance.

### **1.1.4 Funding**

Funding for the City of Wagoner Multi-Hazard Mitigation Plan was provided by the City of Wagoner, as approved by the City Council on April 18, 2016.

### **1.1.5 Goals**

The goals for the City of Wagoner Multi-Hazard Mitigation Plan were developed by City of Wagoner staff, City of Wagoner Floodplain Administrator, the Wagoner School District Board, and the City of Wagoner Emergency Manager, with input from local agencies, and interested citizens. The local goals were developed taking into account the hazard mitigation strategies and goals of the Federal and State governments.

#### ***National Mitigation Strategy and Goal***

FEMA has developed ten fundamental principles for the nation's mitigation strategy:

1. Risk reduction measures ensure long-term economic success for the community as a whole, rather than short-term benefits for special interests.
2. Risk reduction measures for one natural hazard must be compatible with risk reduction measures for other natural hazards.
3. Risk reduction measures must be evaluated to achieve the best mix for a given location.
4. Risk reduction measures for natural hazards must be compatible with risk reduction measures for technological hazards, and vice versa.
5. All mitigation is local.
6. Emphasizing proactive mitigation before emergency response can reduce disaster costs and the impacts of natural hazards. Both pre-disaster (preventive) and post-disaster (corrective) mitigation is needed.
7. Hazard identification and risk assessment are the cornerstones of mitigation.
8. Building new federal-state-local partnerships and public-private partnerships is the most effective means of implementing measures to reduce the impacts of natural hazards.
9. Those who knowingly choose to assume greater risk must accept responsibility for that choice.
10. Risk reduction measures for natural hazards must be compatible with the protection of natural and cultural resources.

FEMA's goal is to:

1. Substantially increase public awareness of natural hazard risk so that the public insists on having safer communities in which to live and work; and
2. Significantly reduce the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from natural hazards.

#### *State of Oklahoma Mitigation Strategy and Goals*

The State of Oklahoma has developed a Strategic Mitigation Plan to guide all levels of government, business, and the public to reduce or eliminate the effects of natural, technological, and man-made disasters. The goals and objectives are:

1. Improve government recovery capability.
2. Provide pre- and post-disaster recovery guidance.
3. Protect public health and safety.
4. Reduce losses and damage to property and infrastructure.
5. Preserve natural and cultural resources in vulnerable areas.
6. Preserve the environment.
7. Focus only on those mitigation measures that are cost-effective and provide the best benefit to communities.

The key measures to implement these goals include:

1. Enhance communication between state and federal agencies and local governments to facilitate post-disaster recovery and pre- and post-disaster mitigation.
2. Coordinate federal, state, local, and private resources to enhance the preparedness and mitigation process.
3. Ensure consistency between federal and state regulations.
4. Protect critical facilities from hazards.
5. Support legislation that protects hazardous areas from being developed.

#### *City of Wagoner's Goal*

To improve the safety and well-being of the citizens residing and working in City of Wagoner by reducing the potential of death, injury, property damage, environmental and other losses from natural and technological hazards

Specific goals for mitigation of each of the hazards are presented in Chapter 4.



### **1.1.6 Point of Contact**

The primary point of contact for information regarding this plan is:

Kelly Grooms, Fire Chief  
The City of Wagoner Emergency Management Director  
231 Church Street  
Wagoner, OK 74467  
Telephone: (918) 485-2554 Ext 221  
Fax: (918) 485-4748  
e-mail: [chiefgrooms@wagonerok.org](mailto:chiefgrooms@wagonerok.org)

The secondary point of contact is:

W. B. Smith, P.E. CFM  
Floodplain Administrator  
28508 W. 41<sup>st</sup> Street South  
Mannford, Oklahoma 74044  
Telephone: (918) 625-2449  
Cell: (918) 625-2449  
[e-mail: wbsmith@hisinc.us](mailto:wbsmith@hisinc.us)

The third point of contact is:

Albert Jones, Mayor  
The City of Wagoner  
231 Church Street  
Wagoner, OK 74467  
Telephone: (918) 485-2554  
Cell: (918) 729-0479  
[e-mail: mayor@wagonerok.org](mailto:mayor@wagonerok.org)

The fourth point of contact is:

Randy Harris, Superintendent of Schools  
Wagoner School District  
707 N. Story Ave  
Wagoner, OK 74467  
Telephone: (918) 485-4046  
Cell: (580) 483-3686  
[e-mail: rharris@wagonerps.org](mailto:rharris@wagonerps.org)

## **1.2 Community Description**

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Like most cities in the region, the City of Wagoner is faced with a variety of hazards, both natural and man-made. In recent history, winter storms, lightning, floods, and tornados have made the national headlines. Any part of the city may be impacted by high winds, drought, hail, fire, hazardous materials events, and other catastrophes. In some cases such as flooding and levee break, the areas most at risk have been mapped and delineated.

The City of Wagoner is located in Wagoner County west of Fort Gibson Lake in the eastern part of the State of Oklahoma.

### **1.2.1 Geography**

Latitude: 35.86N  
Longitude: 95.38W

The City of Wagoner is located in northeast Oklahoma and is accessed primarily from I-44 to either US-69 (south to Wagoner), or State Highway 51 (east to Wagoner). Wagoner is the county seat of Wagoner County and is 46 miles southeast of Tulsa, 30 miles north of Muskogee, and 37 miles west of Tahlequah, Oklahoma. The City of Wagoner encompasses approximately 7 square miles. Map Number 1 in Appendix 1 is a location map of the City of Wagoner.

### **1.2.2 Climate**

The City of Wagoner, the county seat of Wagoner County, lies at an elevation of generally about Elev. 580 feet above sea level. The City of Wagoner is far enough south to miss the extreme cold of winter. The climate is essentially continental characterized by rapid changes in temperature. The winter months are usually mild, with temperatures occasionally falling below zero, but only for a very short time. Temperatures of 100 degrees or higher are often experienced from late July to early September. January's average temperature is 40 degrees Fahrenheit and August's average high temperature is 78 degrees Fahrenheit. The average annual rainfall in the City of Wagoner is 39.85 inches.

### **1.2.3 History**

The town of Wagoner began as a small community at the intersection of the Missouri-Kansas-Texas (MKT) Railway and the Kansas and Arkansas Valley Railway (a branch of the Missouri Pacific Railway), when William McAnally, a foreman for the MKT built a small hotel at this isolated location in June 1887. By the next summer others had built two more hotels and two general stores. The town was named for railroad dispatcher Henry "Big Foot" Wagoner, who had reported the need for a railroad switch nearby to accommodate the shipment of logs and hay. The switch had been previously named "Wagoner's Switch." The switch soon relocated to the town and caused the development of a major cattle shipping business.

By 1894, the community had 642 names in a local census. A local newspaper began promoting the town in 1895, encouraging more people to move to there. By 1896, there were approximately 1,500 residents. In the fall of 1895, the community formed a commission that circulated a petition requesting incorporation under the statutes of Arkansas. Incorporation was granted by the U. S. District Court on January 4, 1896, making Wagoner the first city incorporated in Indian Territory.

A privately funded courthouse was built in 1897, which housed a newly created U. S. Western District Court. The Dawes Commission turned Indian Territory land from tribal to individual ownership by members of each tribe. The individuals were allowed to sell their land to non-Indians, causing a real estate boom in farmland around the area. By statehood in 1907, the city had 2,950 residents and was named as the county seat of Wagoner County.

The boom continued through 1910, when the population reached 4,018. The MKT had located a division headquarters in the city, which then had three railroad trunk lines and twenty passenger trains a day. Industries included three grain elevators, a cotton gin, cotton oil mill, iron foundry, hardwood company, cement plant, and roller mill. However, the boom ended in 1913, when the MKT moved its division headquarters to Muskogee. The oil boom farther west and later, the Great Depression, caused a further decline in the city's economy and population.

World War II started a revival of Wagoner's fortunes. The city lay between two war-related Federal Government projects: Camp Gruber to the south and the Oklahoma Ordnance Works to the north. After the war, several small manufacturing industries took root. Completion of the nearby Fort Gibson Lake in 1950 stimulated the economy and turned Wagoner into a sports and retirement center. The McLellan-Kerr navigational channel made the agricultural area accessible by barges, stimulating farm-related businesses. Highway improvements made Wagoner a bedroom community for Tulsa and Muskogee.

## 1.2.4 Population and Demographics

According to the 2014 American Community Survey 5-year estimates, US Census (ACS), the 2014 City of Wagoner population was 8,499. In 2000, the City population was 7,552, thus an increase of 11.14% over the fifteen years; making an annual growth rate of 0.79%. The median age of the City of Wagoner population is 36.6, with 15.8% of the population being 65 or greater, according to the 2014 ACS. Older populations are more vulnerable to certain hazards, such as extreme heat and cold. A map, showing the age 65 and older areas, is shown in Map Number 2 in Appendix 1. Low-income populations are also more vulnerable to extreme temperatures; low-income areas are shown in Map Number 3 in Appendix 1. The City of Wagoner demographic data is shown in Table 1-1.

**Table 1-1: The City of Wagoner Demographic Data**

**Source: 2013-2017 American Community Survey 5-year Estimates Census**

SUBJECT	NUMBER
Total Population	8,688
65 years and older	1,498
Poverty Status in 2017 (individuals)	2,077

According to the Wagoner County Assessor's Office 2016 records, there are 4,575 parcels in the City, and 3,261 parcels with improvements, with an assessed improvement value of \$375,933,758. Numbers of parcels with improvements (buildings, garages, pools, storage, etc.) and improvement values, by type are shown in the table below.

**Table 1-2: The City of Wagoner Housing Property Types by Assessed Values**  
Source: The Wagoner County Assessor's Office

Category	Number of Structures	Structure Value (\$\$)
Residential	2,735	202,359,252
Commercial	317	66,018,881
Agricultural	66	6,949,058
Exempt/Unknown	143	100,606,567
Total	3,261	375,933,758

### **1.2.5 Local Utilities--Lifelines**

Lifelines are defined as those infrastructure facilities that are essential to the function of the community and the well-being of its residents. They generally include transportation and utility systems. Transportation systems include interstate, US, and state highways, rail, waterways, ports and harbors, and airports. Utility systems include electric power, gas and liquid fuels, telecommunications, water, and wastewater. The following table shows utilities and the companies or sources that supply the City of Wagoner.

**Table 1-3: Utility Suppliers for the City of Wagoner**

UTILITY	SUPPLIER
Electric	GRDA sells energy to City of Wagoner Electric Dept
Water	City of Wagoner
Sewage Treatment	City of Wagoner
Natural Gas	Oklahoma Natural Gas
Telephone, including cellular and internet providers	Southwestern Bell, Verizon, T-Mobile, AT&T, Sprint, Windstream, Valornet
Railroad	Union Pacific Railroad
Environmental Quality	Oklahoma Department of Environmental Quality

### **1.2.6 Economy**

According to the 2014 ACS, the City of Wagoner's population age 16 and over was 6,570. In 2014, there were 3,518 people in the City of Wagoner labor force and a 13% City unemployment rate. Of the people employed, 79.5% are salary and private-wage workers, 13.9% are government workers, and 6.1% are self-employed in unincorporated businesses. The median household income in 2014 was \$34,450.

### **1.2.7 Industry**

Principle employment occupations in the City of Wagoner are managerial, professional, sales, office work, production, transportation, service occupations, construction and maintenance.

### **1.2.8 Future Growth and Growth Trends**

The Oklahoma Department of Commerce reports the Wagoner County annual growth rate is 1.51%. The City of Wagoner Planning Department estimates growth in the City to continue at this same pace. Primary growth areas include the areas near US Hwy 69 and State Hwy 51 and west of US Hwy 69 on State Hwy 51. There is also infill development ongoing.

### **1.2.9 Schools**

Wagoner School District participated in the development of the City of Wagoner hazard mitigation plan.

- The Wagoner Public Schools have six schools; one public high school, one middle school, one central intermediate school, two elementary schools and a kindergarten school. There is one private high school. Enrollment in the public schools for FY 2016-17 is 2457. It has a 242 square mile district area and uses 19 buses.

## **1.3 Regulatory Framework**

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This section contains a summary of the current ordinances for land use zoning, subdivision, floodplain in The City of Wagoner that was reviewed by the City of Wagoner Emergency Management Advisory Committee. It also lists the current building codes and fire insurance rating.

### ***1.3.1 Land Development Planning and Zoning***

The City of Wagoner has a land use zoning code, and subdivision regulations. The Wagoner Metropolitan Area Planning Commission oversees the planning and zoning in the City of Wagoner and Wagoner County, on as an advisory basis to the Wagoner County Board of County Commissioners.

The following shows which jurisdictions administer zoning codes and subdivision regulations.

The City of Wagoner Zoning Code, originally adopted July 1, 1981, and amended on April 1, 2019, is administered by City Staff.

The City of Wagoner Subdivision Regulations, adopted January 12, 2004, is administered by the Wagoner Metropolitan Area Planning Commission pursuant to the powers vested through Title 19, Oklahoma Statutes, Chapter 19.a, Sections 12 and 13, as amended to review, approve and disapprove plats for the subdivision of land within the City of Wagoner.

The City of Wagoner last adopted a Comprehensive Planning and Zoning Ordinance in July 2018 which is administered by the City of Wagoner Planner.

### ***1.3.2 Floodplain Management***

The City of Wagoner participates in the National Flood Insurance Program (NFIP), adopting the flood damage prevention ordinance and enforcing the floodplain management regulations beyond the national minimum criteria. The City's floodplain management regulations and mapping were utilized as a resource and reference in the development of this Hazard Mitigation Plan.

The original Floodplain Ordinance was adopted on October 19, 1982 and was last amended on February 6, 2012.

### ***1.3.3 Stormwater Management***

The City of Wagoner adopted a stormwater management ordinance in 2016. The City's stormwater ordinance was utilized as a resource and reference in the development of this Hazard Mitigation Plan.

### ***1.3.4 Building Codes***

The City of Wagoner utilizes the 2015 International Building Code, published by International Code Council (ICC).

### ***1.3.5 Fire Protection***

The City of Wagoner Fire Department is staffed by city personnel and augmented by volunteers. The ISO rating for the City of Wagoner fire department is as follows: 4

## **1.4 Existing Plans Incorporating Hazard Mitigation**

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The City of Wagoner has existing plans that incorporate the goals, objectives and actions of hazard mitigation. The review of existing plans is important in the preparation of this hazard mitigation plan.

### **1.4.1 Emergency Operations Plans**

The City of Wagoner adopted an Emergency Operations Plan (EOP) in 2011. The City revisits and re-adopts it annually. The EOP was a reference in preparing this Hazard Mitigation Plan. As part of the EOP, critical facilities were identified. These facilities include shelters, police and fire stations, schools, childcare centers, senior citizen centers, hospital, disability centers, vehicle and equipment storage facilities, emergency operations center, and City Hall. The City of Wagoner's EOP critical facilities were used and added to, as listed in Section 3.3. The vulnerability of Critical Facilities to various hazards is addressed in this study.

The participating The City of Wagoner community has an EOP, and the adoption date was reported as follows.

Wagoner has adopted an Emergency Operations Plan, last adopted in 2007.  
Wagoner has adopted an Emergency Operations Plan, originally adopted in 2003.

The Wagoner Public Schools have an EOP, last adopted in 2011.

The City of Wagoner Fire Department has a Response Plan for Hazardous Materials

### **1.4.2 Capital Improvement Plan**

The Capital Improvement Plan (CIP) is the principle method of scheduling and financing future capital needs, and the CIP can include projects that address hazard mitigation actions. Major updates to the CIP should occur periodically and the plan should receive a minor review during the annual budgeting process. The City of Wagoner does have a formal CIP.

The City of Wagoner last updated their CIP in 2004. Their capital projects included:

- Upgrade and Repair Red Bud Park SW9th & Johnson
- Street Improvements
- Sewer Line and Pump Station Improvements
- Water Line Improvements
- Acquire a skid steer
- New Fire Station
- Replace Policed Patrol Vehicles
- Renovate/Replace Police Building
- Additional Storm Sirens - Proposed outside CIP
- Remodel Police Station
- Street Repairs in multiple locations
- Update Airport Building & Runway
- Update Public Library
- Update City Maintenance Shed and New Buildings
- Update EMSA Building

The City of Wagoner School District also has a capital improvement plan, entitled Goal Area #4 Operations and Resources in a similar manner and purposes as the community of Wagoner, as summarized below.

The Wagoner Public Schools Goal Area #4 Operations and Resources was last updated in 2017 and is reviewed each year as part of the 5-Year planning process. Their capital projects include:

Objective 1:

- Facility Improvements - Reconfigure building entrances in 4 buildings for security purposes and provide safe rooms for 3 out of 5 buildings with access by all buildings.
- Security Equipment - Purchase new DVR systems to enable current cameras to function properly; install new security panels where needed; and provide a monitoring company for alarm system.

Objective 2:

- New Schools - to house Central Intermediate School (CIS) and Ellington Early Childhood Center
- Develop a plan to sell CIS to Wagoner County



# ***Chapter 2: The Planning Process***

## **2.1 Documentation of the Planning Process**

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The City of Wagoner Multi-Hazard Mitigation Plan is a city-wide effort to coordinate the City of Wagoner's multi-hazard planning, development, and mitigation actions. The City of Wagoner's Floodplain Administrator was responsible for overall coordination and management of the study, aided by The City of Wagoner staff and representatives of the Wagoner School District and Wagoner County staff.

A mitigation plan is the product of a rational thought process that reviews the hazards, quantifies their impacts on the county, identifies alternative mitigation actions, and selects those actions that will work best for the county.

This plan addresses the following hazards

1. Floods
2. Tornados
3. High Winds
4. Lightning
5. Hailstorms
6. Severe Winter Storms
7. Extreme Heat
8. Drought
9. Expansive Soils
10. Wildfires
11. Earthquakes
12. Hazardous Materials Events
13. Dam/Dike/Levee Breaks

The approach for the City of Wagoner multi-hazard mitigation plan update followed a ten-step process, based on the guidance and requirements of FEMA. The ten steps are described below.

### **2.1.1 Step One: Organize to Prepare the Plan**

An open public process was established to give all individuals and agencies in the Planning Area interested in hazard mitigation issues an opportunity to become involved in the planning process and make their views known. Citizens and community leaders; city, county, regional, state, and federal staff; and professionals active in hazard mitigation planning provided or were requested to provide important input in the development of the plan.

The planning process was conducted by the City of Wagoner Floodplain Administrator, with representatives of the various City Departments and public citizens participating.

The Planning Committee was supported by the City and County staff. City staff worked with the committee for development of this hazard mitigation plan. The City and County staff met several times during the planning process; attended meetings of the Planning Committee and meetings with elected officials. All of the Planning Committee meetings were posted at the City and

County and in other public places, including the City Emergency Management Office, and open to the public.

The Planning Committee met at the City of Wagoner City Hall Council Chambers during the planning process to review progress, identify issues, receive task assignments, and advise the City staff dedicated to updating the plan. Neighboring jurisdictions, Federal and State agencies, businesses, universities, non-profit organizations and the public were invited to participate. Local research and input was provided by committee members and the City staff provided a regional hazard mitigation perspective and direct access to state and federal hazard information resources and led the preparation of draft planning documents. City staff outlined the plan and prepared a draft. Committee members selected the hazards to investigate, provided specific city information, conducted the public hazard awareness survey, ranked mitigation actions, and selected the action plan projects. City staff then prepared the final plan update for review. A list of Planning Committee members is shown in Table 2-1 and meetings in Table 2-2. The agendas, minutes, and sign-in sheets for these meetings are included in Appendix 2.

**Table 2–1:  
The City of Wagoner Emergency Management Advisory  
Committee (CWEMAC)**

NAME	AFFILIATION	TITLE	CONTRIBUTIONS
Kelly Grooms	City of Wagoner	City Emergency Mgmt.	Participated in the planning meetings Contributed data on past hazards Contributed information on past mitigation efforts Reviewed draft plan Contributed to plan revisions Coordinated survey within community Provided information on the area
Robyn Murray Taylor Tannehill	City of Wagoner	City Planner	Provided information on County plans Reviewed draft plan Contributed to plan revisions Provided information on the area Provided information on current and future development trends
Kelly Grooms	City of Wagoner	Fire Dept Chief	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner
Albert Jones, PLS, CFM	City of Wagoner	Mayor	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner
W.B. Smith, P.E., CFM	City of Wagoner	Floodplain Administrator - Stormwater Coordinator	Prepared draft plan Contributed to plan Provided information on Wagoner Wrote the plan draft updates Contributed data on past hazards Reduced and processed the data Coordinated the planning meetings Chaired and Made presentations at the planning meetings Reviewed draft plan Made the plan revisions Coordinate grant requirements
Bob Haley	City of Wagoner	Police Dept Chief	Reviewed draft plan Contributed to plan revisions Provided information on Kiefer
Rhonda Hash	City of Wagoner	City Clerk	Reviewed draft plan Contributed to plan revisions Provided information on Oilton
Randy Harris	Wagoner Public Schools	Superintendent	Reviewed draft plan Contributed to plan revisions Provided information on School System Wagoner
Dwayne Elam	City of Wagoner	Public Works Director	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner Schools
Thomas Applegate	City of Wagoner	Superintendent (Effective Jan 2020)	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner Schools
Dwayne Elam	City of Wagoner	Superintendent (Effective Sept 2017)	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner
Jeff Jacobson	S&J Homes	Developer	Reviewed draft plan Contributed to plan revisions Provided information on Wagoner
Doc Pruitt	Private Developer	Private Developer	Reviewed draft plan #1 Contributed to plan revisions
Daryl Nieto	Private Developer	Private Developer	Reviewed draft plan #2 Contributed to plan revisions

**Table 2-2**  
**Committee Meetings and Activities**

<i><b>Date</b></i>	<i><b>Activity</b></i>
First meeting 10/18/16	CWEMAC meeting at The City of Wagoner Council Chamber in City Hall to discuss the overall need for a plan, the planning process and plan outline, discuss hazard identification and assessment issues and begin review of Draft Plan. Developed a hazard awareness survey.
Second meeting 11/7/17	CWEMAC meeting at The City of Wagoner Council Chamber in City Hall to send out the hazard awareness survey, review the draft Hazard Mitigation Plan, discuss the Wagoner School System participation, and review mitigation actions and the ranking process. Over the past 9 months informal working sessions have occurred with the Mayor, City Planner, and City staff relating to details for the Hazard Mitigation Plan. Plan is submitted to Council and private developers for final review and comment on November 10, 2017.
Third meeting/ Public Hearing 12/4/17	CWEMAC meeting at The City of Wagoner Council Chamber in City Hall is scheduled to be held to conduct a public hearing on final draft, receive comments from citizens and agencies, and Committee recommendation to approve plan. Before and following the public hearing the CWEMAC will meet and review and discuss the public survey comments and the public meeting comments.
December 4, 2017	The City of Wagoner City Council Meeting. The Council takes action to adopt the updated City of Wagoner multi-hazard mitigation plan by resolution.
Fourth meeting 11/19/2020	CWEMAC meeting at The City of Wagoner Council Chamber in City Hall to discuss the updated plan based on FEMA and OEM comments to the original adopted plan submitted in December 2017. Comments included in Final Draft for Public Meeting.
Fifth meeting/ Public Hearing 12/10/20	CWEMAC meeting at The City of Wagoner Council Chamber in City Hall is scheduled to be held to conduct a public hearing on final draft, receive comments from citizens and agencies, and Committee recommendation to approve plan. Before and following the public hearing the CWEMAC will meet and review and discuss the public survey comments and the public meeting comments.
	<b>The City of Wagoner City Council Meeting. The Council takes action to adopt the updated City of Wagoner multi-hazard mitigation plan by resolution.</b>

## 2.1.2 Step Two: Involve the Public

An open to the public planning process was utilized by the City in this plan development process. In addition to the CWEMAC, the staff team undertook activities to inform the public in the Planning Area of this effort and to solicit their input. All meetings of the CWEMAC were publicly posted. A hazard awareness survey was developed (hard copy and electronic survey monkey) and circulated by CWEMAC members and by the citizens of the City of Wagoner to solicit community input on hazard awareness and assessment of their level of concern. Feedback from these surveys was important to the development of the plan. 294 responses were received. A copy of the survey and summary of the responses are included in Appendix 4. The survey responses were discussed by the committee at the Third committee meeting so the citizen's

comments were considered in the subsequent identification of proposed mitigation activities. Public comments were also invited through a public hearing. A public hearing was held on December 4, 2017 to solicit public comments before initial plan approval. A copy of the December 4, 2017 Public Hearing meeting notice is included in Appendix 2. A second public hearing was held on December 10, 2020, to solicit any additional public comments before final plan approval. A copy of the Second Public Hearing meeting notice is included in Appendix 2.

### **2.1.3 Step Three: Coordinate with Other Agencies and Organizations**

As part of the plan update process and to collect data on the hazards that impact the City of Wagoner staff reviewed information sources: public agencies, private organizations, academia and businesses that contend with natural hazards. These sources included printed documents and internet web sites. The agencies and organizations included FEMA, the Corps of Engineers, the US Geological Survey, INCOG, the City of Wagoner, Wagoner County, the Wagoner School District, the State Department of Environmental Quality, the National Climatic Data Center, the National Oceanic and Atmospheric Administration, and the Natural Resource Conservation Service. FEMA mapping, when combined with aerial data and historic data from the National Climatic Data Center, proved to be crucial to hazard identification and impact. The following list of federal, state, national non-profit, and regional agencies were invited to comment on a draft of the plan prior to approval. A sample letter requesting such comments and the list of the agencies and organizations with the person's title of those sent letters is included in Appendix 3. The City of Wagoner, and the business and local non-profit organizations that were already participating in the planning meetings did not receive letters.

#### ***Federal***

US Army Corps of Engineers  
Natural Resource Conservation Service (NRCS) US  
Fish and Wildlife Service

#### ***National Non-Profit***

American Red Cross

#### ***State***

Oklahoma Water Resources Board  
Oklahoma Conservation Commission Oklahoma  
Department of Wildlife Conservation  
Oklahoma Department of Environmental Quality

#### ***Regional***

Indian Nation Council of Governments (INCOG)

#### ***The City of Wagoner***

City Departments

#### ***Business***

S&J Homes, Doc Pruitt, Daryl Nieto - Private Developers

#### ***Academia***

Wagoner Public Schools

#### ***Local Non-Profit***

Wagoner County Health Department

Coordination with other city planning efforts is critical to the success of the Multi-Hazard Mitigation Plan updates. The CWEMAC used information included in the most current

version of the City of Wagoner Comprehensive Plan, Emergency Operations Plan, FIRM Maps, Building Codes and City Ordinances as part of the update process. The City Staff provided information in regard to the utilization of the initial Multi-Hazard Mitigation Plan as a resource for integrating Action Plan Activities and other plan information into other City planning activities. Through participation in the CWEMAC, participating entities in the CWEAC provided valuable information to the plan.

## 2.1.4 Step Four: Assess the Hazard

The staff team collected data on the hazards from available sources. Hazard assessment is included in Chapter 3, with the discussion of each hazard.

Table 2-3 lists the various hazards that affects the Planning Area, describes how they were identified, and why they were identified.

**Table 2–3:  
How and Why Hazards Were Identified**

<i><b>Hazard</b></i>	<i><b>How Identified</b></i>	<i><b>Why Identified</b></i>
<b>Floods</b>	<ul style="list-style-type: none"> <li>Review of FEMA and City and County floodplain maps</li> <li>Structures in the floodplains</li> <li>Historical floods and damages</li> </ul>	<ul style="list-style-type: none"> <li>175 improved parcels in The City of Wagoner are located in the floodplain</li> <li>Over \$ 4.5 million of property at risk</li> </ul>
<b>Tornados</b>	<ul style="list-style-type: none"> <li>Review of recent disaster declarations</li> <li>Input from Emergency Manager</li> <li>Consensus of Emergency Management Advisory Committee</li> <li>Review of data from the NCDC</li> </ul>	<ul style="list-style-type: none"> <li>The City of Wagoner is located in “Tornado Alley”</li> <li>An average of one tornado strikes the City of Wagoner roughly every 10 years since 1950.</li> <li>All of Wagoner County is a risk from tornadoes</li> </ul>
<b>High Winds</b>	<ul style="list-style-type: none"> <li>National Weather Service data</li> <li>Loss information provided by national insurance companies</li> </ul>	<ul style="list-style-type: none"> <li>High wind-related events in occur in the City of Wagoner.</li> </ul>
<b>Lightning</b>	<ul style="list-style-type: none"> <li>NCDC information and statistics</li> </ul>	<ul style="list-style-type: none"> <li>The lightning hazard occurs regularly throughout the City and County.</li> </ul>
<b>Hailstorms</b>	<ul style="list-style-type: none"> <li>National Climatic Data Center</li> </ul>	<ul style="list-style-type: none"> <li>Anecdotal evidence suggests hail damage accounts for the highest residential insurance claims in the County.</li> </ul>
<b>Severe Winter Storms</b>	<ul style="list-style-type: none"> <li>Review of past Disaster Declarations</li> <li>Input from State Emergency Management Agency and the City of Wagoner Emergency Management</li> </ul>	<ul style="list-style-type: none"> <li>The City experienced a severe snow and ice event in 2011, bringing the City to a halt.</li> <li>Severe snow and ice events seem to occur annually.</li> </ul>
<b>Extreme Heat</b>	<ul style="list-style-type: none"> <li>Review of number of heat-related deaths and injuries during hot Oklahoma summers</li> <li>Review of data from NCDC</li> </ul>	<ul style="list-style-type: none"> <li>Local community service organizations have made heat- related deaths a high priority.</li> <li>Extreme heat is extremely dangerous to the elderly and infirm.</li> </ul>
<b>Drought</b>	<ul style="list-style-type: none"> <li>Historical vulnerability to drought, the “Dust Bowl” era</li> <li>Drought and water shortages in adjacent communities in recent years</li> </ul>	<ul style="list-style-type: none"> <li>Need to ensure adequate long- term water resources for the City</li> </ul>
<b>Expansive Soils</b>	<ul style="list-style-type: none"> <li>Review of NRCS data</li> </ul>	<ul style="list-style-type: none"> <li>The shrink-swell characteristic of expansive soils damages a building’s foundation and above ground structure can be mitigated with building code provisions.</li> </ul>

**Table 2–3: How and Why Hazards Were Identified (continued)**

<i><b>Hazard</b></i>	<i><b>How Identified</b></i>	<i><b>Why Identified</b></i>
<b>Wildfires</b>	<ul style="list-style-type: none"> <li>• Input from the City of Wagoner Fire Department</li> <li>• Input from State Fire Marshal</li> </ul>	<ul style="list-style-type: none"> <li>• Continuing loss of life and property due to fires</li> <li>• Numerous areas of the City of Wagoner are exposed and vulnerable to wildfires</li> </ul>
<b>Earthquakes</b>	<ul style="list-style-type: none"> <li>• Historic records of area earthquakes</li> <li>• Input from Oklahoma Geological Survey</li> <li>• Input from USGS</li> </ul>	<ul style="list-style-type: none"> <li>• The City of Wagoner has had mild earthquakes</li> </ul>
<b>Dam/Dike/Levee Break</b>	<ul style="list-style-type: none"> <li>• USACE Dam Safety Program</li> <li>• Review of USGS maps</li> <li>• Review of FIRM maps</li> </ul>	<ul style="list-style-type: none"> <li>• 3 dams in the county are identified as significant or high hazard dams on the Grand River.</li> <li>• A dam/Dike 10/ levee break on Fort Gibson Lake would flood buildings and facilities adjacent to the Dike 10 on the west</li> </ul>
<b>Hazardous Materials Events</b>	<ul style="list-style-type: none"> <li>• Input from ODEQ</li> <li>• Input from the State Fire Marshal</li> </ul>	<ul style="list-style-type: none"> <li>• Several hazardous materials sites are scattered throughout the county</li> <li>• Major traffic ways expose the City of Wagoner to potential traffic way hazardous materials incidents, including railroads</li> </ul>

## 2.1.5 Step Five: Assess the Problem

The hazard data was analyzed in light of what it means to public safety, health, buildings, transportation, infrastructure, critical facilities, and the economy within the Planning Area. City and County staff prepared several analyses using geographic information system (GIS). The discussion of the problem assessment is addressed for each hazard in Chapter 3.

### DAMAGE ESTIMATION METHODOLOGY

The following methodologies were used in the development of damage cost estimated for buildings and contents for flooding and tornado/high wind damage, used in the City of Wagoner's Multi-Hazard Mitigation Plan.

**Structure Value:** The value of the buildings within the Planning Area was obtained from the Wagoner County Assessor's office.

**Contents Value:** Value of contents for all buildings was estimated using FEMA 386-2 *Understanding Your Risks*. Table, page 3-11, "Contents Value as Percentage of Building Replacement Value".

## 2.1.6 Step Six: Set Goals

Hazard mitigation goals and objectives for the Planning Area were developed by the CWEMAC to guide the development of the plan. The hazard mitigation goals and objectives for the Planning Area are listed in Chapter 4.

## 2.1.7 Step Seven: Review Possible Activities

A wide variety of measures that can affect hazards or the damage from hazards were examined

in the Planning Area. The mitigation activities were organized under the following five (5) categories. A more detailed description of each category is located in “Chapter 4: Mitigation Strategies.”

1. **Preventive activities**—Zoning, building codes, City ordinances
2. **Structural Projects**—Dike 10 Improvements, Stormwater Detention Facilities, channel improvements, Storm Drainage System Improvements
3. **Property protection**—Acquisition, retrofitting, insurance
4. **Emergency service**—Warning, sandbagging, evacuation
5. **Public information and education**—Outreach projects and technical assistance

### **2.1.8 Step Eight: Draft an Action Plan**

The City of Wagoner and the CWEMAC were unable to review the list of recommended actions in the previous Wagoner County Multi-Hazard Mitigation Plan due to the inability to locate a copy. The City reported to the committee the projects that have been completed over the past 5 years with the new administration and staff. Potential future hazard mitigation activities were reviewed and discussed by the committee and are the focus of moving the City forward in mitigation activities. The City then selected mitigation projects and activities for the City to include in this plan; for each project or activity identified for this plan, it identified the party responsible for implementing the task, estimated the cost of the project, identified potential funding sources, and determined the target completion date for each activity. The School District participating jurisdiction did the same for their own jurisdiction. Once the School District’s action plans were drafted, they were inserted into the final draft of the City multi-hazard mitigation plan.

### **2.1.9 Step Nine: Adopt the Plan**

The CWEMAC reviewed the final draft, approved the final plan, and submitted it to the City Council, and the Wagoner City School District’s governing board, for adoption.

### **2.1.10 Step Ten: Implement, Evaluate, and Revise**

Adoption of the Multi-Hazard Mitigation Plan is only the beginning of this effort. The City of Wagoner and the City of Wagoner School District, other agencies, and private partners will proceed with implementation. The City of Wagoner Emergency Management Director and the City of Wagoner Floodplain Administrator will monitor progress, evaluate the activities, and annually recommend any needed revisions to the action items. This process will monitor progress on the Action Plan, and review other mitigation actions for inclusion in the Action Plan for Years 2 through 5. This monitoring and review process will also be coordinated so as to provide input into other appropriate City and School District planning efforts and the City’s Annual Budget.



# ***Chapter 3: Risk Assessment and Vulnerability Analysis For the City of Wagoner and Wagoner Schools***

This chapter is the risk and vulnerability analysis for all of the City Wagoner and the participating school district.

## **3.1 Identifying Hazards**

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There were 13 hazards investigated by the CWEMAC. These were considered to all be relevant to the City of Wagoner, following the committee's hazard information search. Hazard identification was discussed at the initial hazard mitigation planning meetings, held on October 18, 2016. The City buildings, and the participating Wagoner School Districts' buildings, are all located within the City of Wagoner. Therefore, their risk and vulnerability from the hazards are included in the City of Wagoner wide risk and vulnerability analysis.

Each school building is located at the address shown in Section 1.1.2. A map showing the location of the school district boundary is shown on Map Number 1A in Appendix 1.

As is discussed in Section 3.2.1, Flood Hazard, the flood hazard does extend onto the school properties thus it does pose a risk to the school district properties.

The hazards are listed in Table 2.3. The table lists each hazard, the items that were considered in how the hazard was identified, and why each hazard was identified. Hazard information was obtained from the City Emergency Management, Community Officials, review of FEMA FIRM panels, and public input.

## **3.2 Profiling Hazard Events**

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This section provides a profile of each hazard. In this section, the letter "X", when included in a subsection identification label, refers to a specific hazard's subsection, as follows:

X=1 Flood Hazard	X=8 Drought Hazard
X=2 Tornado Hazard	X=9 Expansive Soils Hazard
X=3 High Winds Hazard	X=10 Wildfire Hazard
X=4 Lightning Hazard	X=11 Earthquake Hazard
X=5 Hail Storm Hazard	X=12 Hazardous Material Hazard
X=6 Winter Storm Hazard	X=13 Dam/Dike/Levee Break
X=7 Heat Hazard	

Subsection 3.2.X.1 describes each hazard, subsection 3.2.X.2 identifies the location of the hazard, subsection 3.2.X.3 identifies the extent (such as severity or magnitude) of the hazard, subsection 3.2.X.4 provides information on previous occurrences, subsection 3.2.X.5 discusses the probability of future occurrences, and subsection 3.2.X.6 discusses vulnerability and impact. Each hazard affects the ~~county~~ Planning Area as a whole, except floods, expansive soils, wildfires, and dam/dike/levee breaks which are location specific.

## **3.2.1 Flood Hazard**

### **3.2.1.1 Type**

Flooding is defined as the accumulation of water within a water body and the overflow of the excess water onto adjacent lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding.

Flooding can take many forms including river floods (riverine) and the Planning Area's flash floods, and local storm drainage system being undersized causing local flooding outside the SFHA. The most likely event for serious flooding would be flash flooding due to storm water drainage backup caused by a large amount of rain from a thunderstorm. Flash floods occur with little or no warning and can reach peak flow within a few minutes. Waters from flash floods move with great force and velocity and can roll boulders, tear out trees, destroy buildings, and sweep away bridges. These walls of water can reach heights of 2 to 5 feet and generally carry large amounts of debris. Most flood deaths are due to flash floods.

### **3.2.1.2 Location**

The location of the flood hazard in the Planning Area is its regulatory floodplain, as defined by the FEMA Flood Insurance Rate Maps (FIRMs). The regulatory floodplain lies in several watersheds within the Planning Area. The flood hazard for the City of Wagoner is shown on Map Number 6 in Appendix 1.

The Planning Area has specific flood hazard infrastructure concerns at the area near the Ft. Gibson Dike No. 10, SH 51 culvert on the Un-named North Tributary, areas adjacent to Coal Creek at SH 51 and in various subdivisions throughout the Un-named North and South Tributaries.

None of the City of Wagoner school districts' school sites are in the regulatory floodplain. However, the City of Wagoner Bus Barn is located in the Special Flood Hazard Area. One school building is located in an area protected by a levee (Dike No. 10), but is subject to Interior Drainage localized flooding issues. The location of Dike 10 is show on Map Number 12. All the maps are in Appendix 1.

Throughout the City of Wagoner there are a significant number of locations where the local culverts under City streets and bar ditches or storm drain systems are based on a 10-Yr or less frequency storm when they were originally construction at the time of origination of the City of Wagoner. There is a culvert upsizing and bar ditch cleaning and improvement program within the City of Wagoner since early 2019 and continues.

### **3.2.1.3 Extent**

The severity of a flood is determined by several factors; including, rainfall intensity, duration, and location, and ground cover imperviousness and degree of saturation. The magnitude of the flood hazard is the regulatory floodplain. The regulatory floodplain is defined as the area inundated by the runoff from the rainfall having a one-percent chance of occurring in any given year. Although flooding is an identified hazard, the effects have been minimal except for a few

instances and locations in the City. The regulatory floodplain is identified in the City's Flood Insurance Rate Maps (FIRMs) as Zone A and Zone AE. The following table describes the FIRM's flood zones.

Table 3-1

<b>FLOOD ZONES</b>		
<b>Zone A</b>	The 1% (100-year) or Base Floodplain. There are seven types of A zones:	
	<b>A</b>	The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This is often called an unnumbered A zone or an approximate A zone.
	<b>A1-30</b>	These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the firm shows a BFE (old format).
	<b>AE</b>	The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
	<b>AO</b>	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	<b>AH</b>	Shallow flooding base floodplain. BFE's are provided.
	<b>A99</b>	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
<b>Zone V and VE</b>	<b>AR</b>	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
	<b>V</b>	The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM.
<b>Zone B and Zone X (shaded)</b>	<b>VE</b>	The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM.
	Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.	
<b>Zone C and Zone X (unshaded)</b>	Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood.	
<b>Zone D</b>	Area of undetermined but possible flood hazards.	

#### 3.2.1.4 Previous Occurrences

Historically, the City of Wagoner has recognized flooding as a hazard. The City of Wagoner joined the National Flood Insurance Program (NFIP) in 1982, adopting a Flood Damage Prevention Resolution, and requiring that all future development be built one foot above the 100-year base flood elevation. According to the National Climatic Data Center, from 1950 through 2015, the City of Wagoner has had 79 flood events, causing an estimated \$12,000,000 in total damages.

FEMA data shows there is one (1) Severe Repetitive Loss property in The City of Wagoner. There are other known residential structures in the Dike 10 Area that have been flooded several times since 2016 due to the Interior Drainage issues when the USACE closes the valve on the outlet pipe due to flooding of Ft. Gibson Lake. A new Interior Drainage Study is underway.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.1.5 Future Occurrences

The probability of future flooding from the regulatory floodplain is statistically a one-percent chance of occurring in any given year, the 1 % (100-year) floodplain. The City of Wagoner requires all new development to develop in compliance with their flood damage prevention ordinance and stormwater ordinance. Therefore, new development will not cause an increase in the flood hazard by not increasing the hazard on to adjacent property and building new structures above the regulatory flood elevation; both provisions of the ordinances. The probability of future flood damage should not increase with future development. According to the likelihood rating from Appendix 6, the likelihood of a flood hazard in the City is “highly likely” because there were 79 flood events from 1950 through 2015.

#### 3.2.1.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City of Wagoner and the participating schools is discussed as follows.

The low-lying areas in the floodplains would be more susceptible to flooding than areas on higher ground. This is especially true for the Interior Drainage to Dike 10. This area historically floods due to the closure of the discharge valve by the USACE when Ft. Gibson Lake rises above Elev.

561.5. Continued rainfall and stormwater runoff "ponds" behind Dike 10 and floods the low-lying areas with the USACE Flowage Easement (See Map 13) and areas adjacent within the City of Wagoner through the storm drainage ditches and culverts. Roadways in the area are vulnerable and have a history of having to be closed during flooding events. This can cause temporary interruptions to the highway and road system and has the potential to isolate a community for a period of time.

Table 3-2

CONTRIBUTING FACTORS TO THE FLOOD HAZARD	
Factor	Effect
<b>Precipitation Rate</b>	As the rate of precipitation increases, the ground's infiltration rate is exceeded. This is the dominant factor in flash flooding events, and can overwhelm any or all of the following factors.
<b>Training Echoes</b>	Storm cells that follow each other (much like box cars on a train) can repeatedly deposit large amounts of water on the same watershed, overwhelming its ability to handle runoff.

<b>Slope of Watershed</b>	Steeper topography (hills, canyons, etc.) will move runoff into waterways more quickly, resulting in a quicker, flashier response to precipitation.
<b>Shape of Watershed</b>	Longer, narrower watersheds will tend to “meter out” runoff so that water arrives from down shed (nearer to the mouth of the stream) areas faster than from up shed areas. In watersheds that are more square or circular than elongated, runoff tends to arrive in the main stem at the same time, intensifying the response. This factor becomes more significant with larger watersheds.
<b>Saturation of Soils</b>	Saturated or near-saturated soils can greatly reduce the rate at which water can soak into the ground. This can increase runoff dramatically.
<b>Hardened Soils</b>	Extremely dry soils can develop a pavement or “crust” that can be resistant to infiltration. This is especially true in areas of recent wildfire, where plant oils or resins may cause the soil to be even more water-resistant.
<b>Urbanization</b>	The urban environment usually intensifies the response to heavy precipitation. The two dominant urban factors are: 1) increased pavement coverage, which prevents infiltration and dramatically increases runoff; and 2) Urban systems are designed to remove water from streets and byways as quickly as possible. This accelerates the natural response to precipitation by placing runoff in waterways much more quickly.
<b>Low-water crossings</b>	The vast majority of flash flood related deaths occur in vehicles. Many of these deaths occur at low-water crossings where the driver is unaware of the depth of the water or the consequences of driving into it.

It is estimated that 5.5% of the improved property (3,261 parcels) in the City are located in the 1% (100 year) floodplain. It is unknown the number of people that reside in these residences; these structures are valued at 4.5 million dollars.

A typical flood hazard would be an event where rainfall causes runoff to exceed the creek channel capacity spilling runoff into the floodplain fringe, the area between the creek channel and the edge of the regulatory floodplain. This area of inundation would still be regulated by the City of Wagoner’s Flood Damage Prevention Ordinance and new Stormwater Ordinance where new buildings are protected under the ordinance and older structures are addressed below in section 3.2.1.4.

The City of Wagoner considers water that stays within the creek beds or does not rise above curbs and causes no damage to be a minor severity. And the City of Wagoner considers water that fills the floodplain, blocks streets and enters homes and businesses to be a major severity. The school district considers this minor and major severity appropriate to their district.

The City of Wagoner has several specific areas of concern of the flood hazard, proposing a mitigation action to enhance the drainage channels tributary to East Coal Creek which flows from the north and south Un-named Tributaries through the middle of the community with improvements to the channels and regional stormwater detention facilities. The North Un-Named Tributary runs northeast to southwest in the northeast part of the community between NW 3rd to NW 7th from N. Wagoner Ave to Union Pacific Railroad and then between NW 5th to SW 6th from the Union Pacific Railroad to SH 69. The South Un-Named Tributary runs east to west in the areas between SW 6th to SW 12th from the Union Pacific Railroad to SH 69. The third area is behind Dike 10 and the Interior Drainage Flooding that occurs each time Fort Gibson Lake level rises and the USACE closes the drain valve that discharges stormwater runoff from behind Dike 10 into the lake. Repetitive flooding has occurred in this area due to stormwater runoff flowing from the city drainage system into the Interior Dike area and being held for extensive time periods and over multiple storm events, causing localized flooding. This area is under current study with the new LIDAR topography available and will be re-assessed and added to the SFHA as applicable with the FEMA Letter of Map Revision.

As described in the flood hazard location section, 3.2.1.2, none of the participating school district school sites are in the regulatory floodplain so none of the school sites are impacted by the flood hazard; however, the School District’s Bus Barn is located in the Interior Drainage Dike 10 Area and has historically been flooded.

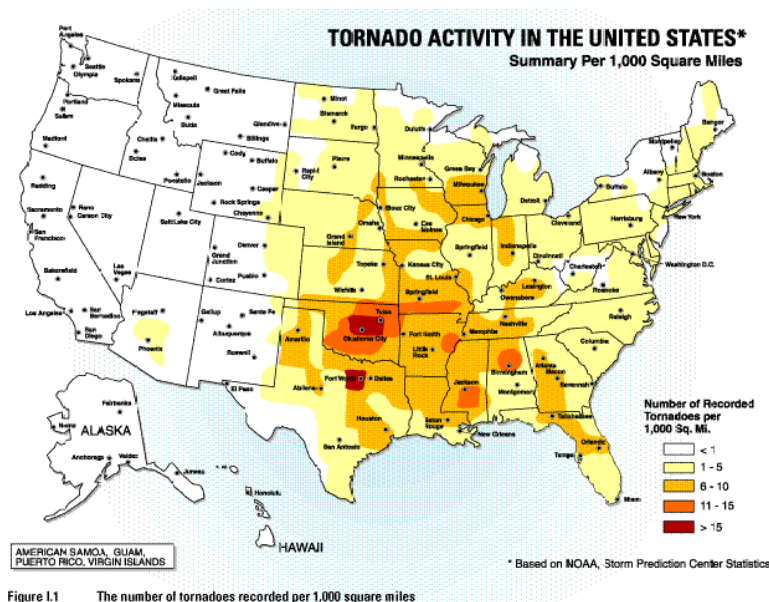
## 3.2.2 Tornado Hazard

### 3.2.2.1 Type

A tornado is a rapidly rotating vortex or funnel of air extending to the ground from a cumulonimbus cloud. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. The path width of a tornado is generally less than a half-mile, but the path length can vary from a few hundred yards to dozens of miles. A tornado moves at speeds from 30 to 125 mph, but can generate winds exceeding 300 mph.

### 3.2.2.2 Location

The Planning Area is located south southeast of Tulsa, Oklahoma in Wagoner County. The following figure obtained from the FEMA web site shows central Oklahoma, along with the area around Fort Worth Texas, to be the area of highest number of recorded tornados per area in the country. Within the City of Wagoner, is not any more or less at risk from the tornado hazard.



### 3.2.2.3 Extent

The severity of tornados is measured on the Fujita Tornado Scale (see table below). Almost 70% of all tornados are measured F0 and F1 on the Fujita Tornado Scale, causing light to moderate damage, with wind speeds between 40 and 112 miles per hour. F4 and F5 tornados are considerably less frequent, but are the big killers. 67 percent of all tornado deaths were caused by F4 and F5 storms, which represent only 1% of all tornados. From 1950 through 2015, the immediate area within or adjacent to the City of Wagoner Planning Area experienced two tornados with a Fujita Scale magnitude greater than F3.

**Table 3-3: Fujita Tornado Scale**

Category	Wind Speed (mph)	Damage
F0	Gale tornado (40-72)	<b>Light:</b> Damage to chimneys, tree branches, shallow-root trees, sign boards
F1	Moderate tornado (73-112)	<b>Moderate:</b> Lower limit is beginning of hurricane wind speed—surfaces peeled off roofs, mobile homes pushed off foundations or overturned, cars pushed off roads

F2	Significant tornado (113-157)	<b>Considerable:</b> Roofs torn off frame houses, mobile homes demolished, boxcars pushed over, large trees snapped or uprooted, light-object missiles generated
F3	Severe tornado (158-206)	<b>Severe:</b> Roofs and some walls torn off well-constructed houses, trains overturned, most trees in forest uprooted, cars lifted off the ground and thrown
F4	Devastating tornado (207-260)	<b>Devastating:</b> Well-constructed houses leveled, structures with weak foundations blown off some distance, cars thrown and large missiles generated
F5	Incredible tornado (261-318)	<b>Incredible:</b> Strong frame houses lifted off foundations and carried considerable distance to disintegrate, automobile-sized missiles fly through the air in excess of 100 yards, trees debarked

On February 1, 2007, the Fujita scale was decommissioned in favor of the more accurate Enhanced Fujita Scale, described in the following table. None of the tornados recorded on or before January 31, 2007 will be re-categorized. Therefore maintaining the Fujita scale will be necessary when referring to previous events.

**Table 3-4: Enhanced Fujita Tornado Scale**

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
<b>EF0</b>	65-85	<b>Light damage:</b> Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
<b>EF1</b>	86-110	<b>Moderate damage:</b> Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
<b>EF2</b>	111-135	<b>Considerable damage:</b> Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
<b>EF3</b>	136-165	<b>Severe damage:</b> Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
<b>EF4</b>	166-200	<b>Devastating damage:</b> Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
<b>EF5</b>	>200	<b>Incredible damage:</b> Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

source: [http://en.wikipedia.org/wiki/Enhanced\\_Fujita\\_Scale](http://en.wikipedia.org/wiki/Enhanced_Fujita_Scale)

The City of Wagoner and the participating school district consider a tornado event measuring EF0 on the Enhanced Fujita Tornado Scale to be of minor severity. And they consider tornado events measuring EF1 through EF5 on the Enhanced Fujita Tornado Scale to be of major severity.

#### 3.2.2.4 Previous Occurrences

According to the National Climatic Data Center, from 1950 through 2015, Wagoner County has experienced 12 tornados, causing an estimated \$29.675 million in property damage. The City of Wagoner was hit by an F-4 tornado in 1973, causing 5 deaths, 25 injuries, with \$50,000 to \$500,000 in damages. The City of Wagoner was hit by an F-5 tornado in 1960, causing 5 deaths, 81 injuries, with \$500,000 to \$5,000,000 in damages. Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.2.5 Future Occurrences

Meteorological conditions have not changed, so future tornado events should occur at the same probability as previous events. No area of the County is any more or less at risk from the tornado hazard. According to the likelihood rating from Appendix 6, the likelihood of a tornado hazard in the City is “highly likely” because there were 2 reported tornado events from 1950 through 2015.

#### 3.2.2.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

The City of Wagoner is located in what is considered an active part of tornado alley. Every structure in the City of Wagoner is vulnerable to tornados. Structures, automobiles, persons, agriculture, and utilities can sustain damage from tornados. Utility service outages can affect large segments of the population for long periods of time.

Utility infrastructures, such as power lines, substations, water towers and water wells are vulnerable and can be severely damage or destroyed from a tornado. Emergency vehicles responding to the devastated areas can have trouble responding due to down power lines and debris in roadways. Livestock are vulnerable during tornado events and are often killed since there is little protection for the animals on the open range. People caught in the path of a tornado who don't take shelter have the potential of being injured or killed. Residents most vulnerable to tornados are those living in mobile homes.

Historically the tornado will move in a southwest to northeast direction, but can move in any direction. Consequently, vulnerability of humans and property is difficult to evaluate since the tornados form at different strengths, in random locations, and create narrow paths of destruction.

Advances in meteorology and the use of Doppler radar allow efficient prediction of tornado formation. A network of storm watchers attempt to identify funnel clouds and report to various networks to alert the population. Even though these advances have significantly improved the available response time, tornados can still occur unexpectedly and without warning.

Utilizing storm spotters and early warning systems, City residents can take appropriate precautions during these events. As a result, casualty rates are low. The popularity of mobile/manufactured housing has increased susceptibility of existing structures to tornados. The use of better building techniques, tie-down systems and the availability of storm shelters all help



mitigate losses in the county.

A typical tornado hazard for the City of Wagoner and the participating schools would be an EF0 event, as defined in Table 3-4 above, the Enhanced Fujita Tornado Scale. The worst case tornado hazard would be an EF5 event, as defined in Table 3-4 above.

### 3.2.3 High Wind Hazard

#### 3.2.3.1 Type

Wind is defined as the motion of air relative to the earth's surface. Extreme windstorm events are associated with cyclones, severe thunderstorms, and accompanying phenomena such as tornados and downbursts. Winds vary from zero at ground level to 200 mph in the upper atmospheric jet stream at 6 to 8 miles above the earth's surface. The mean annual wind speed in the mainland United States is reported by FEMA to be 8 to 12 mph, with frequent speeds of 50 mph and occasional wind speeds of greater than 70 mph. Oklahoma wind speeds average 10 miles per hour.

#### 3.2.3.2 Location

The location of this hazard is uniform over the entire Planning Area. No area of the Planning Area is more or less at risk from a high wind hazard than another.

#### 3.2.3.3 Extent

The magnitude of the high wind hazard is categorized on various wind scales, such as the Beaufort, Saffir-Simpson, and the Fujita measurement scales. The tables below containing the Beaufort and Saffir-Simpson scales show that there is little consensus of opinion as to what wind speeds produce various damages. (The Fujita Scale and Enhanced Fujita Scale are shown in section 3.2.2, "Tornado Hazard"). The National Weather Service (NWS) issues Severe Thunderstorm Warnings whenever a thunderstorm is forecast to produce wind gusts to 58 miles per hour (50 knots) or greater and/or hail one inch in diameter or larger. Hail size increased from ¾ inch to one inch on January 5, 2010, for warning issues. The hail hazard will be addressed in Section 3.2.5.

**Table 3-5**  
**Saffir-Simpson Scale**

Category	Wind Speed (mph)	Storm Surge (feet)	Damages
1	74-95	4- 5	<b>Minimal:</b> Trees, shrubbery, unanchored mobile homes, and some signs damaged, no real damage to structures
2	96-110	6-8	<b>Moderate:</b> Some trees toppled, some roof coverings damaged, major damage to mobile homes
3	111-130	9-12	<b>Extensive:</b> Large trees are toppled, some structural damage to roofs, mobile homes destroyed, structural damage to small homes and utility buildings
4	131-155	13-18	<b>Extreme:</b> Extensive damage to roofs, windows, and doors, roof systems on small buildings completely fail, some curtain walls fall
5	155+	18+	<b>Catastrophic:</b> Roof damage is considerable and widespread, window and door damage is severe, extensive glass failure, entire buildings could fall

**Table 3-6  
Beaufort  
Scale**

<b>Force</b>	<b>Wind Speed (knots)</b>	<b>Description</b>	<b>Damages</b>
0	Less than 1	Calm	Smoke rises vertically.
1	1-3	Light air	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	4-6	Light breeze	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	7-10	Gentle breeze	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate breeze	Dust and loose paper are blown about. Small branches begin to move
5	17-21	Fresh breeze	Branches of a moderate size move. Small trees in leaf begin to sway.
6	22-27	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
7	28-33	High wind, near gale	Whole trees in motion. Effort needed to walk against the wind.
8	34-40	Gale	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	41-47	Strong gale	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	48-55	Whole gale, storm	Trees are broken off or uprooted, structural damage likely.
11	56-63	Violent storm	Widespread vegetation and structural damage likely.
12	64+	Hurricane	Severe widespread damage to vegetation and structures. Debris and unsecured objects are hurled about

A typical high wind hazard would be a Beaufort Scale Force 4 event, as defined in Table 3-6 above. The worst case high wind hazard would be Beaufort Scale Force 10 and greater event, as defined in Table 3-6 above,

#### 3.2.3.4 Previous Occurrences

According to the National Climatic Data Center, there have been 9 recorded high winds events in the City of Wagoner during the period of 1950 through 2015, causing an estimated \$41,500 in property damage.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.3.5 Future Occurrences

The majority of the United States is at some risk of high wind hazards, including the City of Wagoner. Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a high wind hazard in the Planning Area is “highly likely”.

### 3.2.3.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

Property damage and loss of life from windstorms are increasing due to the increasing use of manufacturing housing and mobile homes in the City of Wagoner. This type of structure provides less resistance to wind than conventional construction. With older building aging, and the increased use of aluminum-clad mobile homes, the impacts of wind hazards will likely continue to increase.

In addition to structural issues, high winds can affect electrical and other utilities with service outages. Power lines can ground out or be knocked down causing loss of electrical service. There could also be loss of water, sewer, and communications abilities.

A typical high wind hazard in the City of Wagoner would be a Beaufort Scale Force 4 event, as defined in Table 3-6 above, the Beaufort Scale. The worst-case high wind hazard would be Beaufort Scale Force 10 and greater event, as defined in Table 3-6 above.

## 3.2.4 Lightning Hazard

### 3.2.4.1 Type

Lightning is a discharge of atmospheric electricity, accompanied by a vivid flash of light, frequently from one cloud to another, sometimes from a cloud to the earth. The accompanying thunder sound is produced by the electricity passing rapidly through the atmosphere.

Within the thunderstorm clouds, rising and falling air causes turbulence which results in a buildup of a static charge. The negative charges concentrate in the base of the cloud. Since like charges repel, some of the negative charges on the ground are pushed down away from the surface, leaving a net positive charge on the surface. Opposite charges attract, so the positive and negative charges are pulled toward each other. This first, invisible stroke is called a stepped leader. As soon as the negative and positive parts of the stepped leader connect there is a conductive path from the cloud to the ground and the negative charges rush down it causing the visible stroke. Thunder is caused by extreme heat associated with the lightning flash. In less than a second, the air is heated from 15,000 to 60,000 degrees. When the air is heated to this temperature, it rapidly expands. When lightning strikes very close by, the sound will be a loud bang, crack or snap. Thunder can typically be heard up to 10 miles away. During heavy rain and wind this distance will be less, but on quiet nights, when the storm is many miles away, thunder can be heard at longer distances.

### 3.2.4.2 Location

The location of this hazard is uniform over the entire ~~City area~~ Planning Area. No area of the Planning Area is more or less at risk from a lightning hazard than another.

### 3.2.4.3 Extent

The type of lightning is a measure of the severity of the lightning hazard. Cloud-to-ground is the more severe type in terms of potential cause of damage. The table below from the National Climatic Data Center shows the types and frequency categories of lightning. The more severe type of lightning; coupled with an increased frequency, pose a greater lightning hazard.

**Table 3-7: Type of Lightning**

Type	Contraction	Definition
Cloud to Ground	CG	Lightning occurring between cloud and ground.
In Cloud	IC	Lightning occurring within the cloud.
Cloud to Cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud to Air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.

**Table 3-8: Frequency of Lightning**

Frequency	Contraction	Definition
Occasional	OCNL	Less than 1 flash per minute.
Frequent	FRQ	About 1 to 6 flashes per minute
Continuous	CONS	More than 6 flashes per minute.

The City of Wagoner and the participating schools consider any lightning event of less than 1 flash per minute as minor, and any event of greater than 1 flash per minute as major.

#### 3.2.4.4 Previous Occurrences

For the City of Wagoner, the National Climatic Data Center (NCDC) reports two lightning events during the 66 year period from 1950 through 2015, with no reported property damage. With the frequent wind and thunderstorm activity the county experiences, it is certain that lightning strikes occurred more often, but were just not all reported.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.4.5 Future Occurrences

Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a lightning hazard in the City of Wagoner is “unlikely” because there were two reported events from 1950 through 2015.

#### 3.2.4.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

Lightning strikes can also cause high-voltage power surges that have the ability to seriously damage equipment. Property damage from power surges and resulting fires can destroy not only the electronics in private homes, but the structure itself.

The largest vulnerability to lightning is the potential loss of human life. Property damage can also occur to structures and electrical equipment. People outdoors during a thunderstorm is exposed and at risk of injury from lightning. Most people are injured or killed by lightning will participating in some form of recreation.

A typical lightning hazard would be lightning that stays in the air, not touching the ground. The worst-case lightning event would be a cloud to ground lightning type where the lightning strikes a large public gathering location, which could result in mass casualties.

## 3.2.5 Hail Storm Hazard

### 3.2.5.1 Type

Hail is frozen water droplets formed inside a thunderstorm cloud. They are formed during the strong updrafts of warm air and downdrafts of cold air, when the water droplets are carried well above the freezing level to temperatures below 32 deg F, and then the frozen droplet begins to fall, carried by cold downdrafts, and may begin to thaw as it moves into warmer air toward the bottom of the thunderstorm. This movement up and down inside the cloud, through cold then warmer temperatures, causes the droplet to add layers of ice and can become quite large, sometimes round or oval shaped and sometimes irregularly shaped, before it finally falls to the ground as hail.

### 3.2.5.2 Location

The location of this hazard is uniform over the entire Planning Area. No area of the Planning Area is more or less at risk from the hail storm hazard than another.

### 3.2.5.3 Extent

The severity of the hail hazard depends on the hailstone size. The magnitude of a hail storm is as follows;

**Table 3-9  
HAILSTONE SIZES**

<b>Diameter</b>	<b>Example</b>		<b>Diameter</b>	<b>Example</b>
1/4 inch	Pea		1 ¾ inches	Golf Ball
1/2 inch	Marble		2 ½ inches	Tennis Ball
3/4 inch	Penny		2 ¾ inches	Baseball
7/8 inch	Nickel		3 inches	Tea Cup
1 inch	Quarter		4 inches	Grapefruit
1 ½ inches	Ping Pong Ball		4 ½ inches	Softball

The National Weather Service (NWS) issues Severe Thunderstorm Warnings whenever a thunderstorm is forecast to produce wind gusts of 58 miles per hour (50 knots) or greater and/or hail size one inch in diameter or larger. Prior to January 5, 2010 the criteria for hail was ¾ inch or larger.

The City of Wagoner and the participating schools measure the extent of the hail hazard by the size of the hail.

The City of Wagoner and the participating schools consider any hail event that causes major property damage or death to be a major severity, generally hail stone diameters one-inch and greater, and minor severity events are hail events that cause little property damage and no injuries, generally hail stones of less than one-inch in diameter.

### 3.2.5.4 Previous Occurrences

According to the National Climatic Data Center, the City of Wagoner experienced 34 hail hazard events of hail diameter 3/4-inch and greater during the period from 1950 through 2015, causing no reported property damage.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.5.5 Future Occurrences

Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a future hail hazard in the City of Wagoner is “highly likely” because there were 34 reported hail events of 3/4-inch or greater from 1950 through 2015.

#### 3.2.5.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

The impact of the hazard can range from damage through destruction of structures and personal property to bodily injury, depending on the diameter. The National Climatic Data Center has reported hail in the City up to 2 ¾ -inches in diameter.

A typical hail storm hazard would be hailstones that are noticeable but cause no damage, ¼ inch to ½ inch. The worst case hail storm event would be a hail storm event where the hailstones exceed the maximum diameter reported by a recording agency such as the National Climatic Data Center, causing wide-spread structure damage and at a time of a large public outdoor gathering causing injuries to persons not under cover of a substantial structure.

Hail is capable of causing considerable damage to crops, buildings, and vehicles. Hail can also strip leaves and small limbs from non-evergreen trees. While large hail poses a threat to people caught outside in a storm, it seldom causes loss of human life.

Past storms in the City of Wagoner have shown crops losses in the agricultural areas within the City from slight damage of less than 10% production loss to total devastation of the crop with 100% loss. Damage to vehicles can range from several hundred dollars to total loss of the vehicle.



## 3.2.6 Winter Storm Hazard

### 3.2.6.1 Type

All winter storms are accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A severe winter storm is one that drops 4 or more inches of snow during a 12 –hour period, or 6 or more inches during a 24- hour span. An ice storm occurs when freezing rain falls and freezes immediately on impact. All winter storms make driving and walking extremely hazardous. The aftermath of a winter storm can impact a community or region for days, weeks, and even months. People can become stranded on the road or trapped at home, without utilities or other services. Residents, travelers and livestock may become isolated or stranded without adequate food, water and fuel supplies. The conditions may overwhelm the capabilities of a local jurisdiction. Winter storms are considered deceptive killers as they indirectly cause transportation accidents, and injury and death resulting from exhaustion/overexertion, hypothermia and frostbite from wind chill, and asphyxiation; house fires occur more frequently in the winter due to the lack of proper safety precautions while using home heating equipment.

### 3.2.6.2 Location

The location of this hazard is uniform over the entire Planning Area. No area of the Planning Area is more or less at risk from the winter storm hazard than another.

### 3.2.6.3 Extent

A winter storm can range from moderate snow (2 to 4 inches over 12 to 24 hours) to blizzard conditions (4 to 6 inches over 12 to 24 hours) with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that last several days. Some winter storms may be large enough to affect several states while others may affect only a single community. All winter storms are accompanied by cold temperatures and blowing snow, which increases the severity of the winter storm.

The Balthrop Ice Scale attempts to quantify the severity of the winter storm hazard. The scale is shown in Table 3-10.

**Table 3-10**  
**The Balthrop Ice Scale**

Level	Cause	Effect
Level 1; Nuisance Event, No Major Impact	Freezing rain and sleet, but little ice accumulation. Roads not hazardous. Ice forming on grass.	Little to no effect on the State of Oklahoma.
Level 2; Minor Event, Caution Advised	No measurable ice. Black ice on roads and bridges. Winter Weather Advisory.	Untreated roadways and bridges may become hazardous and slick. Livestock may need additional supplemental feed.
Level 3; Major Event, Isolated Emergency Conditions in the State of Oklahoma	Ice accumulations of ¼ to ½ inches. Reduced visibility. Winter Storm Warning.	Widespread hazardous road conditions. Travel discouraged. Isolated power outages because of down power lines from ice accumulations. Tree damage. Livestock loss potential increases. Supplemental feed necessary.

Level 4; Extreme Event, The State of Oklahoma Under Full State of Emergency	Crippling event. Winds over 35 mph. Little to no visibility. Ice accumulations of more than ½ inch. Blizzard Warning.	Road conditions hazardous to impassable. People and livestock isolated. Widespread power and utility outages. Infrastructure damage. High potential for loss of livestock. Structures threatened from accumulating ice. Communications infrastructure lost from ice accumulation. May be a long lasting event.
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#### 3.2.6.4 Previous Occurrences

According to the National Climatic Data Center, 16 snow and ice events were reported in the City of Wagoner from 1950 through 2015, causing an estimated \$1,700,000 of property damage.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.6.5 Future Occurrences

Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a winter storm hazard in the Planning Area is “highly likely”.

#### 3.2.6.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

A typical winter storm hazard would be a Level 1 event, as defined by the Balthrop Ice Scale, a nuisance event. The worst case winter storm hazard would be a Level 4 event, where transportation is stopped, widespread power outages occur, livestock loss is likely, and the duration may be long.

The Planning Area is affected periodically by heavy snow and ice that cause damage. Trees and power lines fall due to the weight of ice and snow causing damage to their surroundings as well as blocking streets and roads. Icy roads cause accident rates to increase and impair the ability for emergency vehicles to respond which can result in more injuries and a higher loss of life.

Winter storms can range from accumulating snow and/or ice over just a few hours to blizzard conditions with blinding wind-driven snow that can last several days. The aftermath from a damaging winter storm can continue to impact a region for weeks and even months. Economic losses can occur to livestock producers and any business in the affected areas. Carbon monoxide poisoning is always a possibility as homeowners and businesses use alternative heat sources to keep warm. Personal health can be affected in a variety of ways including mental and physical stress, frostbite or related injuries and inability to travel for care.

## 3.2.7 Heat Hazard

### 3.2.7.1 Type

A heat hazard is defined as when the temperature exceeds the body's ability to cool itself. Humid conditions can worsen the hazard by limiting the body to cool itself. The National Weather Service issues an excessive heat warning when the heat index (a measure of the temperature combined with the relative humidity) is at least 105°F for more than 3 hours per day for 2 consecutive days, or if the heat index is greater than 115°F for any period of time.

### 3.2.7.2 Location

The location of this hazard is uniform over the entire Planning Area. No area of the Planning Area is more or less at risk from the heat hazard than another.

### 3.2.7.3 Extent

The severity of the extreme heat is dependent on a combination of temperature and humidity. High temperatures, when combined with high humidity can put an area in the "Extreme Danger" category on the National Weather Service Heat Index scale. When extreme heat is combined with drought, excessively dry hot conditions that contribute to a high risk of life-threatening heat-related illnesses may result. The heat index is a measure of the severity of a heat hazard. The heat index can be related to a range of specific heat disorders. The City of Wagoner can experience heat index reading into the heat stroke range.

**Table 3-11**  
**Heat Index**

Temperature (F) versus Relative Humidity (%)						
°F	90%	80%	70%	60%	50%	40%
80	85	84	82	81	80	79
85	101	96	92	90	86	84
90	121	113	105	99	94	90
95		133	122	113	105	98
100			142	129	118	109
105				148	133	121
110						135

HI	Possible Heat Disorder:
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	Heat stroke highly likely with continued exposure.

### 3.2.7.4 Previous Occurrences

According to the National Climatic Data Center, from 1950 through 2015, the City of Wagoner experienced five extreme heat events. No structural damage was recorded for the heat hazard for the City.

Appendix 6 summarizes previous occurrences of this hazard.

### 3.2.7.5 Future Occurrences

Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a heat hazard in the City of Wagoner is “occasional”.

### 3.2.7.6 Impact and Vulnerability

The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

A typical heat hazard would be to persons experiencing temperatures reaching 90 degrees, as described in Table 3-11 above. The elderly population is most at risk from this high heat hazard. The worst case heat hazard event would be to persons exposed to temperatures exceeding 130 degrees where heat stroke is likely.

Heat kills by pushing the human body beyond its limits. Under normal conditions, the body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.

Most heat disorders occur because the victim has been overexposed to heat or has over exercised for his or her age and physical condition. Other conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality.

Extreme heat can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, damage to food supplies may occur as the heat damages agricultural crops and livestock are susceptible to heat related injuries or death.

Young children, elderly people, and those who are sick or overweight are more likely to become victims to extreme heat. Other conditions that can limit the ability to regulate temperature include fever, dehydration, heart disease, mental illness, poor circulation, sunburn, prescription drug use, and alcohol use. Another segment of the population at risk is those whose jobs consist of strenuous labor outside. When temperatures reach 90 degrees and above, people and animals are more likely to suffer sunstroke, heat cramps, and heat exhaustion.

Another extreme heat hazard is air pollution. During summer months, consistent high temperatures and stagnant airflow patterns cause a build-up of hydrocarbons to form a dome-like ceiling over large cities. The abundance of factories, automobiles, lawn equipment, and other internal combustion machines emit high particulate matter that builds and worsens with the increase in temperature. The resulting stagnant, dirty, and toxic air does not move away until a weather front arrives to disperse it. When the particulate matter reaches a pre-determined level, an ozone alert is issued for the Tulsa area and implementation measures are undertaken to reduce the use of cars and the output of the offending chemicals. Ozone alerts usually include advisories for the elderly and those with breathing difficulties to stay indoors in air-conditioned environments.

Extreme heat can have a structural impact. Roads can buckle during times of extreme heat. Tar becomes soft and can allow concrete to settle, creating gaps and uneven surfaces. Extreme heat leads to rapid evaporation of ponds and lakes, depleting water sources used by both farmers and the community. Often times, residents use additional water during extreme heat to counter the drying of soils and prevent vegetation from dying. This additional strain on water systems can

lead to low water pressure, and can cause water shortages when firefighters are trying to save property and brush land dried out by the extreme heat.

## 3.2.8 Drought Hazard

### 3.2.8.1 Type

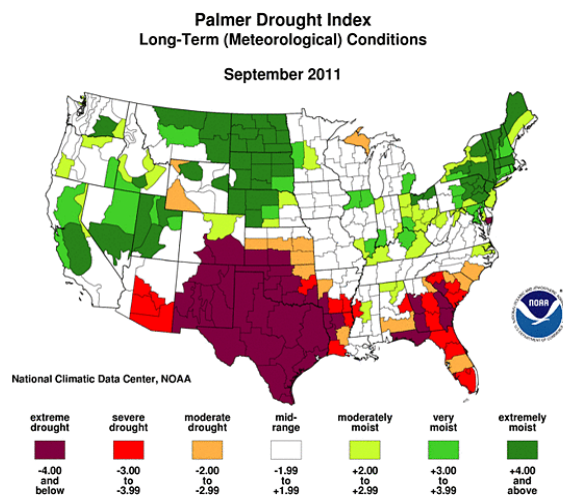
A drought is a period of drier-than-normal conditions that results in water-related problems. Precipitation (rain or snow) falls in uneven patterns across the country. When no rain or only a small amount of rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells decreases. If dry weather persists and water supply problems develop, the dry period can become a drought. The first evidence of drought usually is seen in records of decreased rainfall. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and rivers or on water levels in lakes and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after the drought begins. A period of below-normal rainfall does not necessarily result in drought conditions. Some areas of the United States are more likely to have droughts than other areas. In humid, or wet, regions, a drought of a few weeks is quickly reflected in a decrease in soil moisture and in declining flow in streams. In arid, or dry, regions, such as Oklahoma, people rely on ground water and water in reservoirs to supply their needs. They are protected from short-term droughts, but may have severe problems during long dry periods because they may have no other water source if wells or reservoirs go dry.

### 3.2.8.2 Location

The location of this hazard is uniform over the entire Planning Area. No area of the Planning Area is more or less at risk from the drought hazard than another.

### 3.2.8.3 Extent

The Palmer Drought Index was developed in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought severity index. The Palmer Index is most effective in determining long term drought; a matter of several months. It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. NOAA has used this index to classify the drought hazard through the continental United States. As of September, 2011, the City of Wagoner was in the severe to extreme severity range of the Palmer Drought Index. The national map showing the September 2011 Palmer Drought Index is shown below.



The Palmer Drought Index does not extend down to a sub-City level. So the City is in a Minus 3 drought index, all jurisdictions within the City are considered at a Minus 3 drought index.

#### 3.2.8.4 Previous Occurrences

One of the greatest natural disasters in U.S. history and the most severe and devastating to Oklahoma was the decade-long drought in the 1930s that has become known as the Dust Bowl. Reaching its peak from 1935 through 1938, high temperatures and low rainfall combined to destroy crops and livestock. High winds literally blew the land away, causing massive soil erosion. Hundreds of small rural communities were ruined and about 800,000 people were displaced. The total expenditure by the American Red Cross for drought relief in Oklahoma in 1930-1931 was the third largest ever in the nation.

According to the National Climatic Data Center, there have been 25 drought events in the City of Wagoner from 1950 through 2015.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.8.5 Future Occurrences

Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a heat hazard in the City of Wagoner is “occasional”.

#### 3.2.8.6 Impact and Vulnerability

The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

A typical drought hazard would be a mid-range to moderate Palmer Drought Index, where some form of voluntary water rationing would be encouraged but not required, and the only damage would be to under watered lawns. The worst case drought hazard event would be a Palmer Drought index of negative 4.00 and below, an extreme drought, where it lasts for months to years.

Droughts increase the wildfire hazard and reduce the water supply. Lack of fresh water is damaging to livestock and crops. Another problem associated with drought is stale water. Areas of stale water are known to produce deadly bacteria.

Drought impacts in a number of ways, spanning all regions, and is capable of affecting the economy as well as the environment. Specific impacts can include

- reduced crop, rangeland;
- increased livestock and wildlife mortality rates;
- reduced income for farmers and agribusiness;
- increased fire hazard;
- reduced water supplies for municipal/industrial, agricultural and power uses;
- damage to fish and wildlife habitat;
- increased consumer prices for food;
- reduced tourism and recreational activities;
- unemployment;
- reduced tax revenues because of reduced expenditures; and
- foreclosures on bank loans to farmers and businesses.

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. While drought impacts in the City of Wagoner are numerous and often dependent upon the timing and length of individual drought episodes, the greatest impacts of drought are usually experienced in the agricultural community. In addition to the obvious direct losses of both crop and livestock production due to a lack of surface and subsurface water, drought is frequently associated with increases in insect infestations, plant disease, and wind erosion.

One of the most significant potential impacts of drought relates to public water supply. Reduced flows in rivers, reduced lake and reservoir levels, and reduced levels in aquifers, have a significant effect on the amount of water available for municipal use. There may be a need to stop washing cars, cease watering the grass and take other water conservation steps.

Water shortages can also affect firefighting capabilities in both urban and rural settings through reduced water flows and pressures. Most droughts dramatically increase the danger of wildfires. Although droughts are most associated with summer and high temperatures, droughts can impact the City during winter months.



## 3.2.9 Expansive Soils Hazard

### 3.2.9.1 Type

Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets. The effect of expansive soils are most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. Expansive soils can be recognized either by visual inspection in the field or by conducting laboratory analysis. Shales, clay shales, and residual soils containing smectite often have a characteristic "popcorn" texture, especially in semiarid areas.

### 3.2.9.2 Location

The Natural Resources Conservation Service (NRCS) has identified the soils in the City of Wagoner. The expansive tendency of a soil is a function of its shrink-swell potential. The locations of these types of soils are shown on Map Number 7 in Appendix 1.

The soil data for The City of Wagoner is from the State Soil Geographic (STATSGO) data base. The STATSGO data base is designed for multi-City resource planning, and is not detailed enough for interpretations at the City level. The soil maps for STATSGO are compiled by generalizing the more detailed SSURGO soil maps, Soil Survey Geographic (SSURGO) data base. The STATSGO data base is raster GIS data; each map unit is assigned an attribute value by sampling areas on more detailed maps and expanding the data statistically to characterize all map units. Raster type data cannot be used for spatial analysis; however, it is shown in Map Number 7 for a general location of expansive soils throughout the City.

Overlaying each one of the school sites locations, as listed in Chapter 1, over the soils map shows none of the school sites are on soils with high or very high shrink-swell potential. However, because of the generalized soils information, all the jurisdictions should continue to take this expansive soils hazard risk into consideration in future development.

### 3.2.9.3 Extent

The NRCS sorts this shrink-swell potential soil property in the City of Wagoner into five categories; very low, low, moderate, high, and very high. This is the range of magnitude of an expansive soils hazard. Shrink-swell potential categories are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The categories are very low, a change of less than 1%; low, 1 to 3%; moderate, 3 to 6%; high, 6 to 9%; and very high, greater than 9%. Map Number 7 in Appendix 1 illustrates the majority of the City falls into the low shrink-swell potential category.

### 3.2.9.4 Previous Occurrences

No information is available for the City of Wagoner area on how expansive soils have damaged structures. This hazard develops gradually and thus not usually reported, largely because a catastrophic expansive soils hazard event has not occurred.

#### 3.2.9.5 Future Occurrences

The soils properties have not changed so future occurrences of soils expansion and contraction will continue. An estimate of future occurrences is rated as “unlikely”, shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6, because no data is reported for this hazard.

#### 3.2.9.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4.

The impact of expansive soils is to foundations of structures, and occurs slowly over time, compared to a tornado. Structure foundations such as in homes and commercial buildings, concrete slabs in driveways and sidewalks, and parking lots, are at risk to this hazard. Asphalt surfaces such as highways and runways could be affected. These structures are affected because expansive soils cause uneven settlement of the soil under the structures’ foundations. Excessive or uneven settlement can cause cracks in the foundation and damage to the structure above the foundation.

A typical expansive soils hazard would be to structures built in areas of high shrink-swell potential that were not built with any foundation displacement protection, such as post-tension reinforcing in foundations. The worst case expansive soils hazard event would be to structures as described above, but during extreme and extended drought conditions where the soils dry out to such a depth causing voids to occur which would increase the circumstances for foundations to deflect causing foundation and structure damage.

Due to the generalized soils information, specific site analyses cannot be made for certain to determine if the City and school sites may have high and very high shrink-swell potential soils to be impacted by. Therefore, mitigation actions will be recommended to better quantify this hazard for each site.

## **3.2.10 Wildfire Hazard**

### **3.2.10.1 Type**

Wildfires are defined as the uncontrolled burning of highly vegetated areas, usually in forests and wooded areas.

Wildfires are often referred to as grass fires in the Planning Area. The amount of control the fire departments have on the burning vegetated area is a factor in calling the fire a wildfire. Also, the size of the burning vegetated area is a factor; a small area of burning vegetation is often referred to as a grass fire while a large area of burning vegetation is called a wildfire. Both size and control are factors in how this hazard is named, but specific criteria as when to refer to burning vegetation as a wildfire have not been established.

### **3.2.10.2 Location**

According to City of Wagoner Emergency Management, fire locations are more frequent around the more populated areas. This area is referred to as the wildland-urban interface. The amount of risk to this hazard can vary by location. The wildland-urban interface is where the main risk and vulnerability is to this wildfire hazard. This interface is defined as the area ½ mile either side of a community's corporate limits. Locations in a community within the ½ mile wildland-urban interface are at less risk primarily due to the reduction of vegetated area because of the community's homes, structures, and infrastructure. Areas in the unincorporated areas of the City outside the wildland-urban interface have a lower risk from the hazard because they are away from the populated areas.

Map Number 8 in Appendix 1 shows the wildland-urban interface for the City of Wagoner. When applying the ½ mile buffer to the City of Wagoner, only Wagoner County has an area inside its wildland-urban interface. This is shown on Map Number 8A for Wagoner.

All Wagoner Public Schools buildings are located inside the City of Wagoner. All of the buildings are within the community's wildland-urban interface. This is shown on Map Number 9.

While the wildland-urban interface areas are at a higher risk from the hazard than the areas inside the wildland-urban interface and outside the wildland-urban interface, these two other areas are still susceptible to the hazard so still at risk from the hazard. Therefore, The City of Wagoner considers all locations of the Planning Area at risk from this wildfire hazard, and the schools at risk from this hazard.

### **3.2.10.3 Extent**

The extent of a hazard is the strength or magnitude of the hazard; a scale or way to quantify the magnitude of the hazard. The Keetch-Byram Drought Index (KBDI), created by John Keetch and George Byram in 1968 for the United States Department of Agriculture's Forest Service, quantifies the probability of a wildfire based on soil moisture and other conditions related to drought. Designed as an index for fire potential assessment. It is a continuous index, relating to the flammability of organic material in the ground. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. It is a closed system ranging from 0 to 800 units. Zero is the point of no moisture deficiency and 800 is the maximum drought that is possible. At any point along the scale, the index number indicates the amount of net rainfall that is required to reduce the index to zero, or saturation.

KBDI levels and its relationship to expected fire potential are reflected as follows:

- KBDI = 0 – 200: Soil moisture and large class fuel moistures are high and do not contribute much to fire intensity. This is typical of spring dormant season following winter precipitation.
- KBDI = 200 – 400: Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity
- KBDI = 400 – 600: Typical of late summer, early fall. Lower litter and duff layers contribute to fire intensity and will burn actively.
- KBDI = 600 – 800: Often associated with more severe drought with increased wildfire occurrence. Intense, deep-burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels.

The City of Wagoner and the participating Public Schools consider the wildfire hazard with a KBDI level of 0-400 to be of minor severity. And The City of Wagoner and the participating Public School consider the wildfire hazard with a KBDI level of 400-800 to be of major severity.

#### 3.2.10.4 Previous Occurrences

In The City of Wagoner, municipal and rural volunteer fire departments respond to numerous grass fires every year, but that number could not be determined. However, the City of Wagoner responded to 34 grass fire events in 2015 and in 2016 combined. The City of Wagoner Emergency Management Director reports this as representative of the grass fires occurrences throughout the City.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.10.5 Future Occurrences

The City of Wagoner Fire Departments are continuing campaigns to educate the public on the causes and effects of fires. However, all fires cannot be prevented so this hazard will continue. The likelihood rating for wildfires in the City is “highly likely”. This estimate of future occurrences is taken from the Likelihood Rating scale in the Hazard Summary Table in Appendix 6.

#### 3.2.10.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

A typical wildfire hazard would be a grass fire, in which a Fire Department is dispatched to put out the fire before it causes any damage to crops, structures, or persons. The worst case wildfire scenario would be an event that could not be controlled before it overwhelms a community, causing damage to crops, structures, and persons.

The number of structures within each community’s wildland-urban interface, the area more vulnerable to a wildfire than the interior of the community, is shown in section 3.3.11 and the damage estimate for those structures is shown in section 3.4.6.

Periods of drought, dry conditions, high temperatures, and low humidity set the stage for wildfires. People start more than four out of every five wildfires, usually as debris burns, arson, or carelessness. This is why the City Emergency Management considers the wildland-urban interface at higher risk from wildfires; where the rural setting meets the populated areas.

Lightning strikes are another leading cause of wildfires, a non-man-made occurrence. Wildfires that do not encounter a human population are difficult to calculate damages. Homes and businesses that are burned in naturally occurring fires are usually privately owned.

When wild lands are destroyed by fire, the resulting erosion can cause heavy silting of streams, rivers, and reservoirs. Serious damage to aquatic life, irrigation, and power production then occurs.

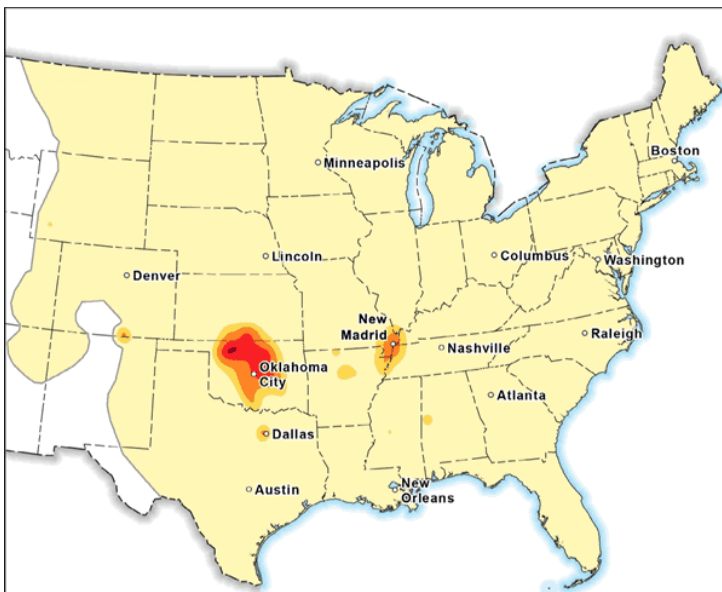
### 3.2.11 Earthquake Hazard

#### 3.2.11.1 Type

An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates. Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70 to 75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach \$200 billion. There are 45 states and territories in the United States at moderate to very high risk from earthquakes, and they are located in every region of the country. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes—most located in uninhabited areas. The largest earthquakes felt in the United States were along the New Madrid Fault in Missouri, where a three-month long series of quakes from 1811 to 1812 included three quakes larger than a magnitude of 8 on the Richter scale. These earthquakes were felt over the entire Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking.

#### 3.2.11.2 Location

The faults most likely to affect Oklahoma are the New Madrid Fault, centered in the Missouri Bootheel region, and the Meers Fault, located in southwestern Oklahoma near Lawton. The distance from the Missouri Bootheel region to Wagoner, OK, (in the center of The City of Wagoner) is approximately 400 miles, and the distance from the Meers fault region to Wagoner is approximately 245 miles. Recently the Oklahoma Geological Survey identified a new earthquake zone in Oklahoma primarily due to the fracking practice for oil and gas production. The new map is shown below.



### 3.2.11.3 Extent

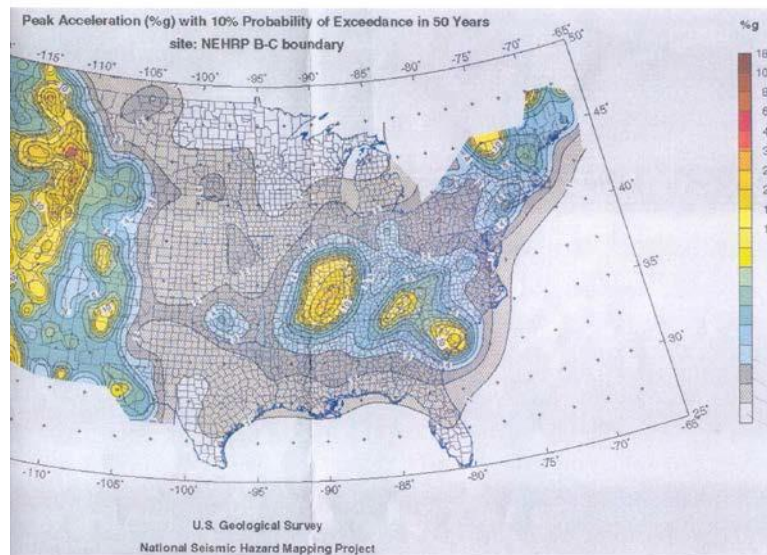
The severity of an earthquake can be expressed in several ways. The magnitude of an earthquake, usually expressed by the Richter Scale, is a measure of the amplitude of the seismic waves. The Richter Scale, named after Dr. Charles F. Richter of the California Institute of Technology, is the best-known scale for measuring the magnitude of earthquakes. The scale is logarithmic. An earthquake of magnitude 2 is the smallest earthquake normally felt by people. Earthquakes with a Richter value of 6 or more are commonly considered major; great earthquakes have magnitude of 8 or more on the Richter scale.

**Table 3-12**  
**The Richter Scale**

Magnitude	Description
1 to 3	Recorded on local seismographs, but generally not felt.
3 to 4	Often felt, with little to no damage reported.
5	Felt widely, slight damage near epicenter.
6	Damage to poorly constructed buildings and other structures within 10 kms.
7	"Major" earthquake. Causes serious damage up to 100 km (recent Taiwan, Turkey, Kobe, Japan, Iran and California earthquakes).
8	"Great" earthquake, great destruction, loss of life over several 100 km (1906 San Francisco, 1949 Queen Charlotte Islands).
9	Rare great earthquake, major damage over a large region over 1000 km (Chile 1960, Alaska 1964, and west coast of British Columbia, Washington, Oregon, 1700)

The City of Wagoner considers an earthquake of magnitude 4 and below on the Richter Scale to be a minor severity earthquake, and an earthquake greater than a magnitude 4 on the Richter Scale to be of major severity.

The USGS National Seismic Hazard Mapping, shown below, shows The City of Wagoner in the 2%g (peak acceleration), 10% probability of exceedance in 50 years area. According to the FEMA 386-2, "Understanding Your Risks", Step 1; areas with 2%g peak acceleration or less have a relatively low seismic risk, and an earthquake risk assessment is not warranted.



### 3.2.11.4 Previous Occurrences

According to the National Climatic Data Center, there have been no earthquake events in the City of Wagoner from 1950 through 2010. On September 3, 2016, the state experienced an earthquake that tied the largest in state history. A 5.6 magnitude earthquake occurred in Pawnee at about 7:02 am. On January 7, 2016 a 4.8 magnitude earthquake occurred near Prague at about

2:12 am followed by a 4.7 magnitude earthquake, preceded by a 5.6 magnitude earthquake occurred near Sparks in 2011. Both earthquakes were centered in Lincoln City, a City west of the Planning Area in central Oklahoma. The Sept 2016 earthquake surpassed the then largest earthquake in state history, a 5.5 magnitude earthquake near El Reno on April 9, 1952.

#### 3.2.11.5 Future Occurrences

However, most earthquakes in the state are not felt. According to the National Climatic Data Center, there have been no earthquake events in The City of Wagoner from 1950 through 2010; a likelihood rating of “unlikely”. This estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

#### 3.2.11.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

A typical earthquake event would be a magnitude 1 to 4 on the Richter Scale, which would be largely unfelt and no damage. The worst-case earthquake hazard would be a magnitude 9 on the Richter Scale, causing a large amount of structure damage and personal injury over a large area.

All structures, homes, businesses and transportation infrastructure are vulnerable to an earthquake. Earthquakes occurring near the Planning can still impact the City and School District structures and public facilities. Timely notification of events can allow residents to take precautions in the event of aftershocks.



## 3.2.12 Hazardous Material Hazard

### 3.2.12.1 Type

Hazardous materials are chemical substances that, if released or misused, can pose a threat to the environment or human health. These chemicals are used in industry, agriculture, medicine, research, and consumer goods. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or chemical accidents at plant sites. In the State of Oklahoma, communities are required to list facilities that either use or store Extremely Hazardous Substances (EHS) in their Emergency Operations Plans (EOP). EHS facilities are a subset of the Tier 2 facilities; and like the Tier 2 facilities, EHS facilities are reported annually to the Oklahoma Department of Environmental Quality by the users and the following list is from the DEQ website. The EHS facilities are incorporated into the City of Wagoner plan update.

### RESPONSE TO A HAZMAT INCIDENT

- The fire service will be tasked with identification, rescue and emergency decontamination.
- Dispatch is responsible for a chemical library, contacting Poison Control
- Law enforcement will manage initial area isolation, extended evacuation and egress control.
- Medical facilities will have a jump on secondary decontamination facilities, patient care and antidotal treatments.
- Private companies and local organizations may play a role in technical mitigation assistance, housing and meals for displaced civilians, as well as final clean-up and disposal.

### Hazardous materials response to railroad or other hazardous materials incidents

First responder goals are to act safely, limit potential exposure to all persons and provide timely information to the proper authorities.

#### Recognition and identification

- recognize the presence of hazardous materials;
- identify the materials, if possible and; gather information.

#### Notification

- Notify the proper authorities;
- Call for assistance; and provide updates

#### Isolation

- Set parameters/zones;
- Denied entry; and evacuate if needed

#### Protection

- Initiate the incident command system (ICS);
- Protect responders/public;
- Initiate contamination; and initiate defensive actions only (no intentional contact)

### 3.2.12.2 Location

The locations of the Planning Area EHS facilities are listed in the following table, and shown in Map Number 9 in Appendix 1.

**Table 3-13**  
**The City of Wagoner**  
**EHS Sites**

<b>Facility Name</b>	<b>Street Address</b>	<b>City</b>
Ametek Prestolite Motors	1211 W Cherokee	Wagoner
Ametek Prestolite Motors	305 S. McQuarrie Ave	Wagoner
Calvary Plastics	Hwy 16 S	Wagoner
Cellxion Lightweight Division	300 SE 15th Suite A	Wagoner
Elastomer Specialties Polymer	2210 S. Hwy 69	Wagoner
Former McJunkin Red Man Corp	1300 N. Labarge Ave	Wagoner
Kevin Grover GMC Inc	1440 S. Dewey	Wagoner
O'Reilly Auto Parts Store 159	510 West Cherokee	Wagoner
Open Molded Plastics Inc.	902 S. Adams	Wagoner
Stacys Motor Company	705 W Cherokee	Wagoner
Sustainable Solutions Inc.	300 SE 15th Street Ste B	Wagoner
Tracys Body Shop	407 W Cherokee	Wagoner
Unarco Industries LLC	400 SE 15th	Wagoner
Union Pacific Railroad	302 S Main Street	Wagoner
Wagoner City Maintenance Shop	300 SE 3rd St	Wagoner
Wagoner Wastewater Plant	N4270 Rd (South of E760 Rd)	Wagoner
Wagoner Water Plant	Recreation Road (North of Whitehorn Cove Rd)	Wagoner
Wagoner Ford Line Merc	1510 W 51 Hwy	Wagoner
Wagoner Transmission	310 SE 2nd Street	Wagoner

#### 3.2.12.3 Extent

The extent of the hazardous material hazard in the City of Wagoner is the EHS fixed location sites. The sites include buildings or property where EHS materials are manufactured or stored, and are regulated nationally under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) by the U.S. Environmental Protection Agency (EPA), and in Oklahoma by the Department of Environmental Quality.

#### 3.2.12.4 Previous Occurrences

For the evaluation of previous occurrences of hazardous material events, traffic accidents with gasoline spills were included in the number of hazardous material events experienced by the City, in addition to responding to incidents at EHS facilities. Throughout the City, the committee members report their municipal fire departments respond to more than one vehicle accidents with gasoline spills per year. The City of Wagoner quantified vehicle accident runs in 2011, responding to 24 events. The City of Wagoner Emergency Management Director reports this is representative of the vehicle accident occurrences throughout the City.

Appendix 6 summarizes previous occurrences of this hazard.

#### 3.2.12.5 Future Occurrences

The impact of the hazard in terms of the capabilities or activities is the same for each

participating community as well as the City and the participating school, and is discussed as follows.

Chemicals and hazardous materials are used throughout our society today, and will continue to be used in the future. And The City of Wagoner will continue to be exposed to this hazard. The likelihood rating for hazardous material events in the City is “highly likely”. This estimate of future occurrences is taken from the Likelihood Rating scale in the Hazard Summary Table in Appendix 6 because the committee members report numerous vehicle accidents with gasoline spills every year.

### 3.2.12.6 Impact and Vulnerability

Many parts of the City are susceptible to hazardous materials events due to the high number of highly traveled roads and highways. Potential impacts include disruptions in transportation if highways are shut-down. Local businesses and residences can be affected by the roads being closed. Soils and waterways could become contaminated by spills. The City and the Communities will follow their emergency operations plans in the event of any hazardous material events.

A typical hazardous material hazard scenario would be an automobile accident where gasoline (which is not an EHS) is spilled and the local fire department responds. The worst case scenario would be responding to facility that contains a hazardous material that has not been properly documented so the responders may not be properly prepared for the hazardous material they would be encountering. The quantity of a hazardous substance is not the sole factor in the severity of a hazardous material event. Location, weather, population, topography, vegetation all could be factors in the event’s severity. But one gallon of gasoline spilled on a flat, impervious surface on a calm dry day in an unpopulated area would constitute an event of minor severity, where a tanker truck carrying a hazardous substance rupturing near a waterway on a hill in a populated area would constitute an event of major severity.

Be prepared to provide the following information:

1. Incident location
2. Number and type of injuries if any
3. Name of carrier for transportation accidents and any placarding information
4. Type of radioactive material present if available (From shipping papers, package labels or employees.)

### Emergency Contact Phone Numbers:

Union Pacific Railroad Emergency Contact	1-888-877-7267
Oklahoma Emergency State Emergency Operations Center	1-800-800-2481
Wagoner County Emergency Management	918-485-3124
Oklahoma Natural Gas	1-800-664-5463
Department of Environmental Quality	1-800-522-0206

### 3.2.13 Dam/Dike/Levee Break Hazard

#### 3.2.13.1 Type

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams typically are constructed of earth, rock, concrete, or mine tailings. A levee, dike, embankment, flood bank, or stop bank is defined as an elongated naturally occurring ridge or artificially constructed fill or wall, which regulates water levels. It is usually earthen and often parallel to the course of a river in its floodplain or along low-lying coastlines. A dam break is the collapse, breach, or other failure resulting in downstream flooding. Levee breaks are primarily caused by hydrologic or structural deficiencies. A hydrologic deficiency is inadequate spillway capacity, caused by excessive runoff from a large amount of precipitation. Structural deficiencies include seepage, erosion, cracking, sliding, and overturning, mainly caused by the age of a dam and lack of maintenance.

A dam break is the collapse, breach, or other failure resulting in downstream flooding. Levee breaks are primarily caused by hydrologic or structural deficiencies. A hydrologic deficiency is inadequate spillway capacity, caused by excessive runoff from a large amount of precipitation. Structural deficiencies include seepage, erosion, cracking, sliding, and overturning, mainly caused by the age of a dam and lack of maintenance. Rodents are also able to cause a dam or levee break due to boring through the embankments and creating a pathway for piping of material to cause a failure.

The Oklahoma Water Resources Board coordinates the Oklahoma Dam Safety Program to ensure the safety of dams in the state. The program requires inspections every five years for low hazard structures and every three years for significant hazard structures. The program requires annual inspections for high hazard dams. Dams are designated as high hazard dams due to the presence of occupied dwellings immediately downstream. The following table lists the 13 dams in the program categorized as significant hazard or high hazard that affect the Planning Area.

**Table 3-14**

**The Dams in the Oklahoma Dam Safety Program – Affecting the Planning Area**

(Source: OWRB – 2011)

NAME	WAGONER	CITY	HAZARD CATEGORY
USACE Dike No. 10	Ft. Gibson Lake	Wagoner	Not Classified
Markham Ferry Dam	Grand River	Locust Grove	Significant
Pensacola Dam	Grand River	Disney	Significant
Ft Gibson Dam	Grand River	Wagoner	Significant

#### 3.2.13.2 Location

The dams listed in Table 3-14 above pose a high or significant risk, per the OWRB, to occupied dwellings in Planning Area. Their locations are shown in Map Number 11 in Appendix 1. An emergency action plan (EAP) is required by the OWRB, USACE and FERC for all high hazard category dams. An element of the EAP is an inundation map showing the area inundated in the event of its dam or dike break. For any high hazard category dams, the OWRB has EAPs for the dam.

For these unclassified or significant hazard category dams/dikes/levees, Wagoner and the

surrounding area that would be inundated is as follows. For the USACE Dike No. 10 there is a low lying area to the west of the existing dike that floods when stormwater runoff accumulates behind the dike due to high water levels in Fort Gibson Lake. There are residential and non-residential structures that are subject to flooding. In the event of a dam breach at either Markham Ferry Dam or Pensacola Dam (GRDA) the inundation flood wave that would be created could impact the Dike No. 10 with resulting flooding of the same or more residential or non-residential structures.

The specific area of inundation from a break of any of these three structures would be in the respective dam's emergency action plan (EAP). For the two significant hazard category dams, the OWRB and FERC have EAPs for the two dams. For the Dike No. 10 on Fort Gibson Lake dam, its EAP would be at the office of the Tulsa District, U.S. Army Corps of Engineers.

Each one of the school sites are outside of the regulatory floodplain so probably outside an inundation area of any dam break. But due to the incomplete nature of the EAP's, the location of this hazard at each school site cannot be located with certainty; the data is deficient.

Further due to the incomplete nature of the available data, the location of this hazard in The Planning Area cannot be quantified; the data is deficient. So the hazard is kept in the plan because it cannot be determined if a jurisdiction is not affected by the hazard. A mitigation action will be recommended to be included in the City of Wagoner action plan to accurately document the location of the hazard throughout the Planning Area, the location of the entire hazard, and the number of structures affected.

#### 3.2.13.3 Extent

The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,500 dams in the state that falls within its jurisdiction. The dam safety program categorizes dams into three hazard categories; high, significant, and low. The OWRB defines these categories as follows. Low hazard dams are those where a break would result in no probable loss of human life and low economic losses. Significant hazard dams are those dams where a break would result in no probable loss of human life but can cause economic or disruption of lifeline facilities. High hazard dams are those dams where a break will probably cause loss of human life.

#### 3.2.13.4 Previous Occurrences

According to the National Climatic Data Center, there have been no dam break events in the City of Wagoner from 1950 through 2010. Its impact on the City would be similar to the flood hazard. Nationally, the most famous dam break event occurred at Johnstown, PA. The South Fork Dam was built across Little Conemaugh River 14 miles upstream of Johnstown. In 1889, South Fork Dam failed, and the resulting flood on the Little Conemaugh River caused over 2200 fatalities.

#### 3.2.13.5 Future Occurrences

Continued dam/dike/levee inspection and proper maintenance should continue to keep these dams from failing. The City of Wagoner contracts with private engineering firms to annually inspect the dike; though the U.S. Army Corps of Engineers is required to inspect and report to the Department of the Army. According to the City Emergency Management Department, there have been no dam/dike/levee breaks in the City of Wagoner from 1950 through 2010; a likelihood rating of "unlikely". The likelihood of future hazard event occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6.

#### 3.2.13.6 Impact and Vulnerability

The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the City and the participating schools is discussed as follows.

The worst case scenario of this hazard would be an unexpected break of a high hazard dam, so the emergency personnel could not enough advanced warning time to notify people in the area of inundation of the impending event.

The emergency action plans (EAP) for these significant hazard categorized dams are not available to the City of Wagoner, thus a data deficiency, as discussed in section 3.2.13.2. Therefore, the consequences of these dams breaking were not quantified. A mitigation action will be recommended to be included in the City of Wagoner action plan to accurately document the location of the hazard throughout the City, the location affected, and the number of structures affected.

As long as dams exist so does the chance for failure. The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,500 dams in the state that falls within its jurisdiction. Dams falling within the OWRB's jurisdiction are non-Federally constructed and maintained dams which are: 1) greater than 6 feet in height with storage capacities of 50 acre-feet or more; and/or 25 feet or greater in height with storage capacities of 15 acre-feet or more. The program requires inspections every five and three years for low and significant hazard structures, respectively. It requires annual inspection of the State's high-hazard dams, so designated due to the presence of one or more habitable structures downstream with loss of life and flooding likely to occur if a dam were to fail.

The City of Wagoner has no high hazard dams and no significant hazard dams that could possibly put people and structures at risk, but there is no recorded history of any dam/dike/levee break in the City since 1950. Flooding potential exists if dam break should occur at these high hazard dams. Obviously the impact of this would be devastating and many people would have to relocate to carry on normal lives. Disruption to businesses and schools would occur.

The hazard classifications are based upon current conditions, including population and land-use patterns below the dams. Such conditions can shift over time, such that a structure that is not considered high-hazard may receive such designation in the future, should, for example, dwellings built within the floodplain below the dam. Other high-hazard dams may have such designation lowered should land-use patterns change, reducing the threat of loss to life or property. Mitigation aspects, such as relocations of vulnerable properties, can reduce the number and magnitude of high-hazard dams. To protect vulnerable populations the State of Oklahoma and The City of Wagoner, the following law is in place:

***State Law 785:25-7. Warning and evacuation plans.***

- Owners of existing or proposed dams classified as high hazard, regardless of the size of such dams, and any other dam as determined by the Board, shall provide an adequate warning system and written evacuation plan to protect downstream lives and property, with a written description of said system and written evacuation plan to be approved by and filed with the local Civil Defense authorities.
- Additionally, the written description of the warning system and approved evacuation plan shall be filed with the Board.

### 3.3 Assessing Vulnerability: Identifying Assets

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This section describes vulnerability in terms of the type and number of existing buildings and critical facilities in the hazard location. The vulnerability analysis utilized FEMA publication 386-2, “Understanding Your Risks,” Step 3, in order to determine the building value and contents value to determine a total value per building at risk from the hazard.

Wagoner County Assessor classifies properties into three (3) types; residential, commercial, and agricultural. A value for each property with a structure was determined by the assessor. The contents value was determined as a percentage of the building value, based on the Contents Value table in FEMA 386-2, Step 3.

The following table shows this information for all buildings in The City of Wagoner. This table will be referred to for all hazards that do not vary by location throughout the City.

**Table 3-15  
TOTAL IMPROVED PARCELS IN CITY**

Category	Number of Structures	Structure Value (\$\$)
Residential	2,7356	202,359,252
Commercial	317	66,018,881
Agricultural	143	6,949,058
Exempt/Unknown	143	100,606,567
Total	3,261	375,933,758

Flood hazards, dam/dike/levee break hazards, wildfire hazards, and hazards from expansive soils are the only four hazards that vary in magnitude in a pre-determined location. A hypothetical tornado was analyzed in the tornado hazard section. For these hazards, GIS models were used to determine the buildings in a hazard location.

For each hazard, the assets (buildings) at risk from that hazard are tabularized in each hazard’s section, or referred to the above table. The total number of buildings at risk, the building type, the building value, its contents value, and the total value is shown. These tables follow the format in FEMA 386-2, worksheets 3a “Inventory Assets”.

This assessment also analyses the critical facilities at risk from each hazard. Information on mobile homes is not tracked by the Wagoner County Assessor; therefore, it is not included in the City of Wagoner vulnerability assessment.

Facilities that are classified to be critical by The City of Wagoner are listed in the following table, Table 3-16, and shown on Map Number 4 in Appendix 1. These facilities are critical to the City in they provide public safety and emergency response services to the public in the event of a hazard occurrence or they are necessary to preserve welfare and quality of life to the community.

**Table 3-16  
CITY CRITICAL FACILITIES**

TYPE	NAME	ADDRESS	CITY
City Government	City of Wagoner City Hall	231 W. Church St.	Wagoner
City Govt	Civic Center	301 S. Grant Ave.	Wagoner
City Govt	Library	302 N. Main St.	Wagoner
City Govt	WPWA	100 S. Gertrude Ave.	Wagoner
City Govt	City of Wagoner Emergency Mgmt.	300 SE 3 <sup>rd</sup> St.	Wagoner
Fire Department	City of Wagoner Fire Department	807 W. Cherokee St.	Wagoner
Police Department	Wagoner Police Department	105 S. Casaver Ave.	Wagoner
Water Treatment Facility	Wagoner Water	68645 S. 320 Rd.	Wagoner
Wastewater Facility	Wagoner Wastewater		Wagoner
County Govt	Wagoner County Courthouse	307 E. Cherokee St.	Wagoner
County Govt	County Barn	908 SW. 15 <sup>th</sup> St.	Wagoner
Schools	Wagoner Schools, 5 sites	Various	Wagoner
Substations	Electrical, 4 sites	Various	Wagoner
Lift Stations	Sanitary Sewer Lift, 8 sites	Various	Wagoner
Airport	1 Site		Wagoner
Hospitals	Wagoner Community Hospital	1200 W. Cherokee	Wagoner
Elderly Care	Nursing Home	205 N. Lincoln Ave.	Wagoner

Some facilities are private and are included for reference.



### 3.3.1 Flood Hazard

FEMA data shows there is one Severe Repetitive Loss property within The City of Wagoner corporate boundary. Damaged structures are rebuilt in conformance with the City's flood damage prevention ordinance. As grants funds become available, the regulating jurisdiction works with the property owner to remove the structure from the floodplain. For all structures at risk from a flood hazard, those buildings on property intersecting the regulatory floodplain are summarized below.

**Table 3-17**  
**TOTAL BUILDINGS IN REGULATORY FLOODPLAIN**

	<b>Number of Buildings</b>	<b>Building Value (\$\$)</b>	<b>Contents Value (\$\$(EST)</b>	<b>Total Value (\$\$)</b>
Residential	155	21,320,000	10,660,413	31,980,493
Commercial	11	1,209,000	1,119,208	2,319,208
Agricultural	14	1,541,162	1,541,162	3,082,324
Exempt/Unknown	5	950,000	950,000	1,900,000
Total	185	25,011,242	14,270,783	39,282,025

Any future building in a flood hazard will be built in conformance with the City's Flood Damage Prevention Ordinance as part of the City's membership in the NFIP; therefore, future buildings will not be considered at risk from the regulatory floodplain. The same will be for each The City of Wagoner community participating in the plan update that participates in the NFIP, as they will also enforce their flood damage prevention ordinance. The City's Stormwater Ordinance will also help reduce flooding risk.

### 3.3.2 Tornado Hazard

The City of Wagoner has been hit by a series of F-2 and F-3 tornados since recordings beginning in 1960. F-2 Tornados caused damage on May 5, 1960, September 16, 1980, August 27, 1982, September 26, 1986, April 17, 1995, and May 13, 2010. F-3 Tornados have also caused damage on June 8, 1974, June 5, 1975, May 30, 1976, and April 11, 1986. The path of some of the tornados is shown on Map Number 7 in Appendix 1. It was reported by committee members to have done substantial damage to all structures in a quarter-mile width along its path. To illustrate the structures at risk if this tornado occurred today, the current buildings within the general paths of the historic tornado's paths of destruction were determined and their building, contents, and total value were estimated. This estimate is shown in the following table.

**Table 3-18**  
**BUILDINGS IN TORNADO SCENARIO**

<b>Type</b>	<b>Number of Buildings</b>	<b>Building Value (\$\$)</b>	<b>Contents Value (\$\$)</b>	<b>Total Value (\$\$)</b>
Residential	140	8,149,708	1,074,854	12,224,562
Commercial	8	2,271,425	2,271,425	4,542,850
Agricultural	1	27,092	40,638	67,730
Total	149	10,448,225	6,386,917	16,835,142

### **3.3.3 Dam/Dike/Levee Break Hazard**

The OWRB Dam Safety Program requires all high hazard category dams to prepare an emergency action plan (EAP) which would make a determination on the number of structures and infrastructure in each dam's dam break inundation area. As discussed in section 3.2.13, only the GRDA dams have EAPs that contain the number of structures in their respective dam break inundation area. The EAP made an estimate of the values of these structures, nor any other improvements that may be affected by its dam break.

### **3.3.4 High Wind Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.5 Lightning Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.6 Hail Storm Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.7 Winter Storm Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.8 Heat Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.9 Drought Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section.

### **3.3.10 Expansive Soils Hazard**

The properties at risk from this hazard are properties located on high and very high shrink-swell potential soil types. The locations of expansive soils are shown in Map Number 7 in Appendix 1. As discussed in the profile of the expansive soil hazard in The City of Wagoner, due to the generalized raster soils information, site specific analyses cannot be made with certainty to determine if the communities and school sites may have high and very high shrink-swell potential soils for be impacted by. Therefore, mitigation actions will be recommended to better quantify this hazard for each site.

Structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots are vulnerable to this hazard because expansive soils cause the ground under the foundations to settle unevenly. Asphalt surfaces such as highways and runways could be affected. This causes cracking and damage to the foundation and structure above the foundation, such as buildings wall and a road's pavement.

### 3.3.11 Wildfire Hazard

The wildland-urban interface is where the City is most vulnerability to this wildfire hazard. Because the City of Wagoner community is not very large in area, only the Cities of Wagoner and Wagoner County have an area inside its wildland-urban interface

Table 3-19 shows the numbers of structures within each community's wildland-urban interface. Structures in the ½ mile areas outside each community's corporate limits are included in this table for The City of Wagoner.

**Table 3-19  
STRUCTURES IN THE  
WILDLAND-URBAN INTERFACE**

<b>Community</b>	<b>Type</b>	<b># of Structures</b>
Wagoner	Residential	172
Wagoner	Commercial	28
Wagoner	Agricultural	70
Wagoner	Exempt/Unknown	7

Fires can also destroy nonstructural assets such as agriculture, vegetation, and vehicles. Vulnerability of these non-structural assets, both in identifying these assets and estimating their damage potential was not quantified.

### 3.3.12 Earthquake Hazard

All areas, and all buildings, in the City are at equal risk from this hazard. The total number of buildings, and value, in the City is shown in the table at the beginning of this section. Vulnerabilities include all structures, homes, businesses and transportation infrastructure.

### 3.3.13 Hazardous Material Hazard

The public is most at risk from hazardous materials when they are being transported. The City has defined the major transportation routes and is shown in Map Number 4 in Appendix 1.

## 3.4 Assessing Vulnerability: Estimating Potential Losses

For each hazard, an analysis was done to determine the potential dollar losses to vulnerable buildings identified in Section 3.3. The analysis followed the methodology discussed in FEMA 386-2, step 4, and the format of FEMA 386-2 worksheet #4 “Estimate Losses” where applicable.

Only the flood hazard and the hypothetical tornado analyses identified structures with varying amounts of damage. The wildfire hazard section totaled structures and damages within the wildland-urban interface.

### 3.4.1 Flood Hazard

For the flood hazard, for this planning exercise, all structures on property intersecting the regulatory floodplain are evaluated at one foot below the base flood elevation. (Actual first floor elevations were not surveyed and the best available topography has 10 foot contour intervals making windshield surveys plus and minus five feet.) Using FEMA 386-2, part 4, building damage with one foot of flood depth is estimated to be 14 percent of the building value, and content damage is estimated to be 21 percent of the building value.

**Table 3-20**  
**DAMAGE ESTIMATE WITH ONE-FOOT FLOOD DEPTH**

Type	Number of Buildings	Building Value (\$)	Building Damage Value (\$)	Contents Damage Value (\$)	Total Damage Value (\$)
Residential	155	21,320,000	2,984,800	4,477,200	7,462,000
Commercial	11	1,209,000	169,260	253,890	423,150
Agricultural	14	1,541,162	215,762	323,644	539,406
Exempt/Unknown	5	950,000	133,000	199,500	332,500
Total	185	25,011,242	3,502,822	5,254,234	8,757,056

### 3.4.2 Tornado Hazard

For the tornado hazard analysis, the path and impact area of the F-3 tornado to hit the City of Wagoner in 1974 is depicted in Map Number 7 in Appendix 1. As discussed in Section 3.3.2, the current buildings at risk from this tornado were determined. The FEMA 386-2 literature states there are no standard loss estimation models and tables for tornadoes. Therefore, all buildings within this tornado’s impact area were estimated to be completely destroyed. The potential loss from this tornado today is shown in the following table.

**Table 3-21**  
**TOTAL BUILDINGS IN TORNADO SCENARIO**

<b>Type</b>	<b>Number of Buildings</b>	<b>Building Value (\$\$)</b>	<b>Contents Value (\$\$)</b>	<b>Total Value (\$\$)</b>
Residential	140	8,149,708	1,074,854	12,224,562
Commercial	8	2,271,425	2,271,425	4,542,850
Agricultural	1	27,092	40,638	67,730
Total	149	10,448,225	6,386,917	16,835,142

### **3.4.3 Dam/Dike/Levee Break Hazard**

As stated in section 3.3.3, only the Markham Ferry Dam EAP and the Pensacola Dam EAP state the number of houses and related structures in their respective dam break inundation area. No damage values were made in either EAP. The other dam's EAPs do not contain an estimate of the number of structures and infrastructure affected by their respective dam break so no damage estimates are available.

### **3.4.4 Hazardous Material Hazard**

The locations of the EHS locations and the major transportation routes are shown on Map Number 9 in Appendix 1.

### **3.4.5 Expansive Soils**

The potential damage to structures and infrastructure located on high and very high shrink-swell potential soils is dependent on the design of its foundation and quality of the construction of the foundation. Both factors were beyond the scope of this multi-hazard mitigation plan. Set damage estimates based on a percentage of the structure value were not used because of the wide variation of the factors involved in a foundation's stability. Structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots, are vulnerable to this hazard because expansive soils causes the ground under foundations to settle unevenly. Asphalt surfaces such as highways and runways could be affected. This causes cracking and damage to the foundation and structure above the foundation, such as a building's wall and a road's pavement.

### **3.4.6 Wildfires**

For this vulnerability analysis of wildfires, the structures within each community's wildland-urban interface and the City's WUI were inventoried and value estimated from the City Assessor database; shown in Table 3-22. The contents of the structure were estimated based on the structure value and total value is the sum of the structure's value and its contents value. For this planning process, the structure is considered a total loss if burned by the wildfire and the estimated value of the loss due to the wildfire is the total value, and also shown in Table 3-22.

**Table 3-22**  
**WILDLAND-URBAN INTERFACE DAMAGE ESTIMATE**

<b>Community</b>	<b>Type</b>	<b># of Structures</b>	<b>Value of Structures \$\$</b>	<b>Value of Contents \$\$</b>	<b>Total Value \$\$</b>
Wagoner	Residential	172	16,163,120	15,000,000	31,163,120
Wagoner	Commercial	28	11,245,019	14,000,000	25,245,019
Wagoner	Agriculture	70	6,303,143	400,000	6,703,143
Wagoner	Exempt/Unknown	7	19,356,810		19,356,810
Total		277	53,068,092	29,400,000	82,468,092

### **3.4.7 All Other Hazards**

The magnitude of the damage to structures from all the other hazards does not vary by location. The total building and content value for all structures in City is totaled and shown in the table in the beginning of Section 3.3.

## 3.5 Assessing Vulnerability: Analyzing Development Trends

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This section discusses the community's vulnerability in terms of a general description of land use and development trends so that mitigation options can be considered in future land use decisions. Three areas were analyzed. These are the types of existing and proposed land uses, development densities in the hazard areas, and anticipated changes in land use

3.5.1 The Wagoner County Assessor assigns three land use categories for the City. These are residential, commercial, and agricultural. Land use changes can occur, and are initiated by the property owner, usually to accommodate a new development. The City's Planning Commission reviews each change request, and takes into account hazards and hazard prone areas in ruling on any land use change request.

3.5.2 There are 4,575 parcels of property in the City. Of these, 1,314 parcels are undeveloped, as shown on Map Number 5 in Appendix 1. And of these 1,314 undeveloped parcels, 185 are in the regulatory floodplain; 265 residential, 12 commercial, 15 agricultural, and 60 are exempt or unknown. It must be noted that no new building development will be added to the flood hazard because any new building will conform to the City's Flood Damage Prevention Ordinance and Stormwater Ordinance, which the City will continue to vigorously enforce. It will be recommended for all new construction to investigate the shrink-swell potential of its soils, and design and construct the foundation with the soils' properties as a consideration.

3.5.3 Anticipated changes in land use, i.e., new subdivision development, are expected to occur in and around Wagoner. It is not anticipated the smaller communities will have significant development in the short term, however infill development will continue; utilizing existing infrastructure within the community. No changes in development impacted the City's overall vulnerability.

# **Chapter 4:**

## **Mitigation Strategies**

This chapter identifies the hazard mitigation goals set by The City of Wagoner and the participating jurisdiction (Wagoner School District), and discusses the mitigation projects or measures to be taken to achieve those goals.

### **4.1 Hazard Mitigation Goals**

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#### **4.1.1 Mission Statement**

To create a disaster-resistant community and improve the safety and well-being of the citizens of The Planning Area by reducing deaths, injuries, property damage, environmental losses, and other losses from natural and technological hazards in a manner that advances community goals, quality of life, and results in a more livable, viable, and sustainable community.

The mission statement and goals were determined by the committee at their initial meetings. Specific objectives were developed during the risk assessment phase and evaluated again as potential action steps were considered.

#### **4.1.2 Specific Goals and Objectives**

**Goal 1** General: To protect vulnerable populations and critical facilities from hazards.

**Objectives:**

1. Minimize the loss of life and damage to property and infrastructure from natural and man-made disasters through education, maintenance of culverts and ditches and floodplain channels.
2. Increase public awareness of risks from hazards and implement measures that can be taken to protect families and property from disasters through distribution of educational flyers, newspaper articles, meetings with developers and the public.
3. Reduce the risk and effects of hazards and minimize disruption in the City, through working with the Emergency Manager and City officials on remediation projects.
4. Identify and protect vulnerable populations from natural and man-made hazards, through updated 2020 census information and other demographic updates.
5. Identify and protect critical City, School District, and community facilities from hazards so that they can continue their missions in the event of a disaster.

**Goal 2** Flood Hazard: To reduce the risk of flood hazard in the Planning Area.

**Objectives:**

1. Identify City and School District buildings and residential structures at risk from the 1% (100-year) regulatory flood, or Interior Drainage flooding behind Dike No. 10. A new study behind Dike 10 for Interior Drainage flooding is in process and will provide design data for a proposed permanent pump station for removal of stormwater runoff when the USACE has closed the valve on the Dike 10 drainage system.
2. Ensure that development does not increase flooding downstream or have off-site adverse impacts, through evaluation of every proposed development under the Stormwater Ordinance and requirements for on-site stormwater detention when there is an impact.
3. Identify and maximize the natural and beneficial uses of the floodplain, through review of stormwater and floodplain development permits.
4. Implement the best flood control measures to reduce vulnerability of flood-prone



- properties.
5. Construct Regional Stormwater Detention facilities to mitigate past development practices and provide stormwater storage for future development. There are currently three (3) regional stormwater detention facilities that have been designed and are pending funding for construction.
  6. Improve existing channel & conveyance system structures (drainage pipes, culverts, bridges) to reduce the backwater effects of in-flow structures, and inadequate channels. This issue is reviewed with every Stormwater Development Permit since 2016.
  7. Restudy the Approximate Zone A areas within the Planning Area to update the current FEMA FIRM Panels. The North Un-Named Tributary has been completed and the FEMA FIRM panels have been updated. The South Un-Named Tributary is currently in process and will be updated.
  8. Restudy the Dike No. 10 Interior Drainage Flood Hazard Delineation with assistance from the USACE on Flowage Easement Delineations and Final Design requirements for a permanent pump station. This study is currently in place and funding will be requested once the HMP is approved by FEMA.

**Goal 3** Tornado Hazard: To reduce the risk of personal injury from tornados in the Planning Area.

**Objectives:**

1. Encourage building of individual safe rooms and storm shelters. Many storm shelters have been submitted for construction in 2019 and 2020 under the Stormwater Ordinance and are all located outside the SFHA.

**Goal 4** Hailstorm Hazard: To reduce the risk of property damage from hailstorms in the Planning Area

**Objectives:**

1. Promote construction of hail resistant roofs. This will be an Outreach program for the City.

**Goal 5** Lightning Hazard: To reduce the risk of personal injury from lightning in the Planning Area.

**Objectives:**

1. Reduce loss of life and property, and injury due to lightning by increased public awareness of measures to prevent and reduce damage, including warnings. This will be an Outreach program for the City.

**Goal 6** Winter Storm Hazard: To reduce the hazards from winter storms in the Planning Area.

**Objectives:**

1. Reduce property loss and community disruption due to severe winter cold and ice storms. This will be an Outreach program for the City. This could include underground electrical service.

**Goal 7** High Winds Hazard: To reduce the risk from high winds in the Planning Area.

**Objectives:**

- 1 Educate and encourage the building trades industry about construction standards that are adequate to withstand frequent high winds. This will be an Outreach program for the City.

**Goal 8** Drought Hazard: Reduce the economic impact of drought hazards to the Planning Area.

**Objectives:**

1. Reduce damage to property and building foundations due to drought by improving building codes. This will be an Outreach program for the City.

**Goal 9** Wildfire Hazard: To reduce the threat of wildfire hazards and their financial impact in the Planning Area.

**Objectives:**

1. Develop a City-wide fire response and support group to facilitate the provisioning of water to fires during large fires. This will be an Outreach program for the City through our Fire Department.
2. Notification Signage for high-risk, no-burn periods.

**Goal 10** Expansive Soil Hazard: Reduce structure's susceptibility to soil movement in the Planning Area.

**Objectives:**

1. Reduce damage to property and building foundations due to expansive soils by improving building codes. This will be an Outreach program for the City along with development of an improved building code.

**Goal 11** Earthquake Hazard: To reduce the risk from earthquakes in the Planning Area.

**Objectives:**

1. Educate and encourage the building trades industry about earthquake resistant construction. This will be an Outreach program for the City.

**Goal 12** Hazardous Materials Hazard: To reduce the risk from hazardous material storage facilities around the Planning Area.

**Objectives:**

1. Protect the public from exposure from hazardous materials events from sites within the community. This will be an Outreach program for the City after identification of local hazardous properties and more importantly working with the railroads for the transit of hazardous materials on all of the railroad lines through the middle of the City of Wagoner.

**Goal 13** Dam/Dike/Levee Break Hazard: To reduce the risk of flooding hazard in the Planning Area-

**Objectives:**

1. Identify and coordinate with Owners of dams or levees for safety notifications that could impact the Planning Area.
2. Identify areas at risk.

**Goal 14** Extreme Heat: To reduce the risk from extreme heat in the Planning Area.

**Objectives:**

- Lessen injury and potential loss of life to citizens during periods of extreme heat through public outreach and education. A/C window units for vulnerable population. Periodic Check-in. This will be an Outreach program for the City.

## 4.2 Mitigation Categories

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There are several types of measures that communities and individuals can use to protect themselves from, or mitigate the impacts of, natural and man-made hazards. Mitigation measures, for purposes of this study, fall into the following categories:

- Preventive Measures
- Structural Projects
- Property Protection
- Emergency Services
- Public Information and Education

## **4.2.1 Preventive Measures**

Preventive measures are designed to keep certain conditions from occurring or getting worse. The objective is to ensure that **new** development does not increase damage and that new construction is protected from hazards. Preventive measures are usually administered by building, zoning, planning, and code enforcement offices. They typically include planning, zoning, building codes, and floodplain development regulations and storm water management.

Planning and zoning, work to keep development out of the hazardous or sensitive areas. Zoning ordinances regulate development by dividing the City into zones or districts and setting development criteria for each zone or district. A zoning ordinance is considered the primary tool to implement land development.

The City of Wagoner, participates in the National Flood Insurance Program (NFIP). The NFIP sets minimum requirements for subdivision regulations and building codes. Stormwater management regulations require developers to mitigate any increase in runoff due to their development. Building codes require a level of new construction standards for new building construction.

### **4.2.1.1 Example Preventative Measure Activities**

- Planning and zoning help the City of Wagoner develop proactively so that the resulting development is laid out in a coherent and safe manner.
- Building codes for foundations, sprinkler systems, masonry, and structural elements such as roofs and the exterior building envelope are prime mitigation measures for occurrences of floods, tornados, high winds, extreme heat and cold, and earthquakes.
- Participation in the NFIP and using floodplain ordinances and subdivision regulations to regulate floodplain development is beneficial for the Planning Area, with consideration for Low Impact Development.
- Tree trimming adjacent to overhead power lines and placing new lines underground would help in preventing power outages during winter ice storms.
- Better information about hazardous materials in the Planning Area being transported through the Planning Area is desired for safety and contingency planning.

## **4.2.2 Structural Projects**

Structural projects are usually designed by engineers or architects, constructed by both the public and private sector, and maintained and managed by governmental entities. Structural projects traditionally include on-site and regional stormwater detention facilities, dikes, levees and floodwalls, channel modifications, and drainage and storm sewer improvements.

### **4.2.2.1 Example Structural Projects Activities**

- Crossing and roadway drainage improvements must take into account additional stormwater detention or run-off reduction.
- Drainage and storm sewer improvements carry runoff from smaller, more frequent storms. Development of a city-wide hydrologic model for sizing of culverts and bar ditches or storm sewer systems.
- Drainage system maintenance is an ongoing project of removing debris that decreases the effectiveness of detention ponds, channels, ditches, and culverts.
- Require past unauthorized fills in the SFHA to be removed or mitigated
- Design and construction of a major pump station for the Dike No. 10 Interior Drainage.

## 4.2.3 Property Protection Measures

Property protection measures are used to modify **existing** buildings or property subject to damage from various hazardous events. Property protection measures are normally implemented by the property owner. However, in some cases, technical and financial assistance can be provided by a governmental agency. Property protection measures from flooding typically include acquisition and relocation, flood-proofing, building elevation, and barriers. Property protection measures from other natural hazards include retrofitting, reinforced foundations, enhanced building codes with emphasis on the exterior building envelope, anchoring of roof and foundation, installation of safe rooms, hail resistant roofing, and insurance.

### 4.2.3.1 Examples of Property Protection Measure Activities

#### *Floods*

- Dry flood proofing (making walls watertight so floodwaters cannot get inside) - non-residential structures only
- Wet flood proofing (letting the water in and removing everything that could be damaged by a flood) - non-residential structures only
- Installing drain plugs, standpipes or backflow valves to stop sewer backup

#### *Tornado*

- Constructing an underground shelter or in-building “safe room”
- Securing roofs, walls and foundations with adequate fasteners or tie downs
- Strengthening garage doors and other large openings

#### *High Winds*

- Installing storm shutters and storm windows
- Burying utility lines
- Installing/incorporating backup power supplies

#### *Hailstorms*

- Installing hail resistant roofing materials

#### *Lightning*

- Installing lightning rods and lightning surge interrupters
- Burying utility lines
- Installing/incorporating backup power supplies

#### *Winter Storms*

- Adding insulation
- Relocating water lines from outside walls to interior spaces
- Sealing windows
- Burying utility lines
- Installing/incorporating backup power supplies

#### *Extreme Heat and Drought*

- Adding insulation
- Installing water saver appliances, such as shower heads and toilets

#### *Wild Fires*

- Replacing wood shingles with fire resistant roofing
- Adding spark arrestors on chimneys
- Landscaping to keep bushes and trees away from structures
- Installing sprinkler systems
- Installing smoke alarms
- Notification Signage of High Risk Periods

### *General Measures*

From the above lists, it can be seen that certain approaches can help protect from more than one hazard. These include:

- Strengthening roofs and walls to protect from wind and earthquake forces
- Bolting or tying walls to the foundation protect from wind and earthquake forces
- and the effects of buoyancy during a flood
- Adding insulation to protect for extreme heat and cold
- Anchoring water heaters and tanks to protect from ground shaking and flotation
- Burying utility lines to protect from wind, ice and snow
- Installing backup power systems for power losses during storms
- Installing roofing that is hail resistant and fireproof

Insurance has the advantage that, as long as the policy is in force, the property is protected and no human intervention is needed for the measure to work. Although most homeowner's insurance policies do not cover a property for flood damage, an owner can insure a building for damage by surface flooding through the National Flood Insurance Program (NFIP).

## **4.2.4 Emergency Service Measures**

Emergency services measures protect people during and after a hazard event. Locally, these measures are coordinated by the emergency management agencies of the individual communities. Measures include preparedness, threat recognition, warning, response, critical facilities protection, and post-disaster recovery and mitigation.

Threat recognition is the key. The first step in responding to a flood, tornado, storm or other natural hazard is knowing that one is coming. Without a proper and timely threat recognition system, adequate warnings cannot be disseminated.

After the threat recognition system tells municipal police departments and/or The City of Wagoner Emergency Management Agency and/or Wagoner School District that a hazard is coming, the next step is to notify, **or warn**, the public and staff of other agencies and critical facilities. The following are the more common warning media:

- Outdoor warning sirens
- Sirens on public safety vehicles
- NOAA Weather Radio
- Commercial or public radio or TV stations
- Cable TV emergency news inserts
- Telephone trees
- Door-to-door contact
- Mobile public address systems

Just as important as issuing a warning is telling people what to do. A warning program should have a public information aspect. People need to know the difference between a tornado warning (when they should seek shelter in a basement) and a flood warning (when they should stay out of basements).

### **4.2.4.1 Example Emergency Service Measures Activities**

The protection of life and property is the foremost important task of emergency responders. Concurrent with threat recognition and issuing warnings, a community should respond with actions that can prevent or reduce damage and injuries. Typical actions and responding parties include the following:

#### *Response Activities*

- Activating the emergency operations room (Emergency Management)
- Closing streets or bridges (Sheriff/Police/City or Public Works)
- Shutting off power to threatened areas (OG&E/AEP/City and Rural Co-ops)
- Holding children at school/releasing children from school (School District)
- Passing out sand and sandbags (City or Public Works)
- Ordering an evacuation (Commission Chairman or Mayor)
- Opening evacuation shelters (Red Cross)
- Monitoring water levels (City or Public Works)
- Security and other protection measures (Sheriff or Police)

After a disaster, communities should undertake activities to protect public health and safety, facilitate recovery, and prepare people and property for the next disaster. This is commonly referred to as Post-Disaster Recovery and Mitigation.

#### *Recovery Activities*

- Patrolling evacuated areas to prevent looting
- Providing safe drinking water
- Monitoring for diseases
- Vaccinating residents for tetanus
- Clearing streets
- Cleaning up debris and garbage
- Regulating reconstruction to ensure that it meets all code requirements, including the NFIP's substantial damage regulations

#### *Mitigation Activities*

- Conducting a public information effort to advise residents about mitigation measures they can incorporate into their reconstruction work or pre-disaster outreach
- Evaluating damaged public facilities to identify mitigation measures that can be included during repairs or opportunities for pre-disaster mitigation
- Acquiring substantially or repeatedly damaged properties from willing sellers
- Planning for long term mitigation activities
- Applying for post-disaster mitigation funds

#### *Overall Emergency Service Activities*

- Using solid, dependable threat recognition systems is first and foremost in emergency services.
- Following a threat recognition, multiple or redundant warning systems and instructions for action are most effective in protecting citizens.
- Good emergency response plans that are updated yearly ensure that well-trained and experienced people can quickly take the appropriate measures to protect citizens and property.
- To ensure effective emergency response, critical facilities protection must be part of the plan.
- Post-disaster recovery activities include providing neighborhood security, safe drinking water, appropriate vaccinations, and cleanup and regulated reconstruction.

### **4.2.5 Public Information and Education Measures**

Successful public information and education measures involve both public and private sectors. Public information and education activities advise and educate citizens, property owners, renters, businesses, and local officials about hazards and ways to protect people and property from the hazards. Public information activities are among the least expensive mitigation measures, and at the same time are often the most effective thing a community can do to save lives and property.

All mitigation activities begin with public information and education.

Many benefits stem from providing map information to inquirers. Residents and businesses that are aware of the potential hazards can take steps to avoid problems and reduce their exposure to flooding, dam break or releases, hazardous materials events, and other hazards that have a geographical distribution. These mapped hazards are included in this Hazard Mitigation study, and are discussed below. Flood Insurance Rate Maps (FIRMS) and Flood Hazard Boundary maps are available to show the flood zones for each property. Flood insurance is always recommended for those properties subject to flooding, especially for those in Flood Zone A.

Hazardous materials sites, listed in the Oklahoma Department of Environmental Quality's EHS list, are shown on Map Number 9 in Appendix 1, and are listed in Section 3.2.12. Transportation routes frequently used in the transport of hazardous materials include US Highway 60, State Highway (SH) 10, SH 11, SH 18, SH 20, SH 97, SH 99 and SH 123. There are no railroads currently within the City. High-pressure pipeline locations have been suppressed by the Federal government since 9/11.

Public Libraries located in the City are a place for residents to seek information on hazards, hazard protection, and protecting natural resources. Interested property owners can read or check out handbooks or other publications that cover their situation. The libraries also have their own public information campaigns with displays, lectures, and other projects, which can augment the activities of the local government.

The Wagoner School District can distribute information and flyers to the students to share with their parents, guardians, or other responsible parties. The Emergency Manager and Floodplain Administrator can go into the classrooms and share information to the students about the various hazards that affect the City of Wagoner and how they can help educate others, or participate in City and School District outreach projects.

#### **4.2.5.1 Example Public Information and Education Measure Activities**

- There are many ways that public information programs can be used so that people and businesses will be more aware of the hazards they face and how they can protect themselves.
- Most public information activities can be used to advise people about all hazards, not just floods.
- Other public information activities require coordination with other organizations, such as Wagoner schools and real estate agents.
- There are several area organizations that can provide support for public information and educational programs.

## 4.3 Research, Review, and Prioritization

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A wide range of literature searches and other sources were researched to identify mitigation measures for each hazard. Measures were identified to ascertain those that were most appropriate for the Planning Area. The public involvement process included a citizen hazard mitigation questionnaire. 104 responses were received. The survey and summary of the responses are included in Appendix 4. The public involvement process also included holding open meetings for all committee meetings; and a public hearing at the March 29, 2012 committee meeting. A list of potential mitigation measures was prepared by staff and presented to the committee to stimulate debate and discussion.

The committee reviewed the mitigation activities. The committee incorporated the criteria and principles of the STAPLE+E project evaluation method in their consideration of the mitigation activities. While not referred to by name at the time of the mitigation activity review, the intent of the method was used. An explanation of each STAPLE+E criteria item is as follows:

- |                   |  |
|-------------------|--|
| S: Social         | Mitigation actions are acceptable to the City and School District if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the City and School District's social and cultural values. |
| T: Technical      | Mitigation actions are technically most effective if they provide long-term reduction of losses and have minimal secondary adverse impacts.  |
| A: Administrative | Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.   |
| P: Political      | Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.  |
| L: Legal          | It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.   |
| E: Economic       | Budget constraints can significantly deter the implementation of mitigation actions. It is important to evaluate whether an action is cost-effective before an action is implemented.  |
| E: Environmental  | Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with environmental regulations, and that are consistent with the City and School District's environmental goals, have mitigation benefits while being environmentally sound.       |

Among the factors discussed for each activity was its economic impact on the Planning Area. A cost-benefit analysis was not done for each activity under consideration, but the committee decided to have a formal cost-benefit evaluation done for any selected activity that would follow the requirements of the funding source when funds are being sought and the CWEMAC would look for actions with a benefit greater than its cost.

While the committee did not select projects for each jurisdiction, it did offer recommendations. The City of Wagoner, and the Wagoner School District, selected their own mitigation actions, with the criteria as outlined in this section. The potential social impact, implementation capabilities (City work force), and potential funding availability for each activity, and the other STAPLE+E criteria principles were considered in prioritizing the activities. All participating jurisdictions took



into account the above factors in selecting their action plan and specific mitigation actions. The City and School District's action plans, and the participating jurisdictions' action plans, include at least two (2) mitigation actions for each hazard, as shown in Tables 5-2 and 5-3.

# Chapter 5: Action Plan

The City of Wagoner and the Wagoner School District have reviewed and analyzed the risk assessment studies for the natural hazards and hazardous material events that may impact their jurisdiction. The City and School District also reviewed the list of recommended actions or projects the City and School District included in the previous plan to identify actions that had been completed, and what other actions should be continued, deferred, or cancelled. The results of this review are included in table 5-1 below.

**Table 5-1  
Status of Mitigation Measures from Previous  
Plan**

<b>Action Plan #</b>	<b>Action Description</b>	<b>Progress on Action</b>	<b>Recommendation for the Action</b>
1	Complete 911 addressing for all of the Planning Area	100%	Update as needed
2	Develop specific ideas for educating the public and businesses about hazards that can affect them, and methods of preparing for and minimizing the hazard event.	25%	Public Outreach
3	Identify and plan for hazardous materials and incidents on major transportation routes through the-Planning Area.	25%	Develop Hazard Mitigation Plan
4	Develop a Planning Area fire response and support group to facilitate the provisioning of water to fire departments during large fires.	10%	Develop Fire Response Plan
5	Build community partnerships involving local government leaders, civic, business and volunteer groups to work together.	25%	Continue Process
6	Acquire accurate or verify accuracy of existing floodplain maps and develop land use regulations to avoid construction in flood-prone locations.	65%	Update Existing Models & Maps
7	Inspect the Planning Area schools for tornado and high wind vulnerability.	10%	Add Storm Shelters
8	Construct adequate bridges to pass 100-year regulatory flood without overtopping.	5%	Evaluate Models and Bridges
9	Investigate voluntary pilot demonstration projects for mobile home communities providing a shelter and/or safe rooms for residents.	0%	Review and Discuss Options
10	Acquire and remove Repetitive Loss Properties and repeatedly flooded properties where acquisition is the most cost effective and desirable mitigation measure.	2%	In Process with HMGP

Since this is the initial hazard mitigation plan there are no mitigation actions identified in the previous plan have been completed or continued into this update.

As part of the plan process, this chapter identifies at least two (2) specific mitigation actions per hazard to achieve the mitigation goals. For each action, the hazard type it would be targeting

is identified, the type of action is shown, the lead agency is identified, an anticipated time schedule and estimated cost is shown, identification of the possible funding sources are made, and the type of work product and expected outcome is discussed. Once funding is sought, a detailed benefit/cost analysis will be done and will follow the requirements of the funding source.

The City and School District identified at least two (2) specific mitigation actions per hazard to achieve the mitigation goals within its jurisdiction that it could undertake in the next five years to mitigate specific hazards. Each mitigation action included information on the same eight points as discussed in the previous paragraph.

Tables 5-2 and 5-3 shows which mitigation action item is associated with each hazard for the City, and the School District.

### **Mitigation Actions and Activities for each of the participating jurisdictions.**

The following pages show the mitigations actions as selected by the City of Wagoner and the School District. Table 5.2 shows the mitigation actions selected by the City of Wagoner and the School District at least two mitigation actions per hazard. And Table 5.3 shows the mitigation actions selected by the school district, at least two mitigation actions per hazard. The City and the School District selected non-mitigation actions to be in their action plan, but only the mitigation actions are included in the Tables 5.2 and 5.3.

All the hazards (floods, tornados, high winds, lightning, hail, severe winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, hazardous material events, dam breaks) affect the City, and the School Districts' school building properties; except, floods. Floods do not affect the School Districts' school building properties, except the bus barn. Therefore, no flood hazard mitigation actions are included for the School District. The location of the flood hazard was profiled in Section 3.2.1.2.

**Table 5.2**  
**City and Communities Mitigation Actions**

	The City of Wagoner
Flood	1-2-10-15- 19
Tornado	1-2-5-13- 19-24
High winds	1-2-5-24
Lightning	1-2-16
Hail	1-2-24
Winter storm	1-2-5-19
Extreme heat	1-2-23-24
Expansive soils	2-4
Drought	1-2-3
Wildfires	1-2-5-25
Earthquake	1-2-5-19
Haz Mat Events	1-2-17
Dam Break	1-2-19-29

**Table 5.3**  
**School Districts Mitigation Actions**

	Wagoner School District
Flood	2-5-7
Tornado	2-5-7
High winds	2-7
Lightning	1-2
Hail	1-2-8
Winter storm	1-2-8
Extreme heat	1-2
Expansive soils	2-4
Drought	1-2-3
Wildfires	1-2-8
Earthquake	1-2-8
Haz Mat Events	1-2-8
Dam Break	1-2

**The City of Wagoner** has reviewed and analyzed the risk assessment studies for the natural hazards and hazardous material events that may impact their jurisdiction. They reviewed the mitigations activities listed in Chapter 4, incorporated the criteria and principles of the STAPLE+E project evaluation method in their consideration of the mitigation activities, and prioritized the activities as was detailed in Section 4.3. Once funding is sought, a detailed benefit/cost analysis will be done and will follow the requirements of the funding source.

#### **Action Item #1**

Title	Installation of NOAA weather radios in City facilities
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY21-22
Estimated Cost	\$100 per radio
Funding source	Local and/or grants
Work product	Purchase and install NOAA weather radios in City facilities
Expected outcome	To provide an increased awareness and improved warning for approaching hazard events and hazard notification at City facilities

#### **Action Item #2**

Title	Develop an “all media program” to educate the City residents about mitigating the risk of life and property associated with the occurrence of hazards
Hazard(s) Targeted Title	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY21
Estimated Cost	\$25,000
Funding source	Local and/or grants
Work product	Dissemination of information about mitigating the risk associated with hazards
Expected outcome	City residents become less at risk and less vulnerable from hazards

#### **Action Item #3**

Title	Installation of water saving fixtures in all City facilities
Hazard(s) Targeted	Drought
Project Type	Mitigation
Lead and participating agencies	City building operations
Time schedule	FY21-22
Estimated Cost	\$50-\$500 per fixture, depending on the fixture mitigated
Funding source	Local and/or grants
Work product	Installation of water saving fixtures
Expected outcome	Reduction in the amount of water used at each fixture

**Action Item #4**

Title	Map expansive soils risk area
Hazard(s) Targeted	Expansive soils
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY20-21
Estimated Cost	\$200,000
Funding source	Local and/or grants
Work product	Develop detailed soils maps
Expected outcome	Identification of the soils' construction properties, including shrink-swell potential, to insure proper foundation design and construction of future improvements and buildings

**Action Item #5**

NOTE: this action is included in the event the City can partner with the utility company.

Title	Bury overhead power lines to make them more hazard resistant
Hazard(s) Targeted	Earthquakes, tornados, high winds, winter storms, wildfire
Project Type	Mitigation
Lead and participating agencies	City emergency management, Private Utility Companies
Time schedule	FY20-25
Estimated Cost	Not determined
Funding source	Grants
Work product	Bury overhead power lines
Expected outcome	Minimize power outages because hazards can bring down overhead power lines and poles

**Action Item #6**

Title	Complete 911 addressing for all of The City of Wagoner.
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Preparation
Lead and participating agencies	Sheriff's Office and City IT Dept
Time schedule	FY20-21
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Establish and implement a system for the assignment of street names and numbering on houses in The City of Wagoner.
Expected outcome	The system will retain a uniform systematic house numbering system throughout the City, which will promote continuity, avoid duplications, and eliminate house renumbering. This will also include 911 cell phone locations for E-911.

**Action Item #7**

Title	Identify and plan for hazardous materials and incidents on major transportation routes through the City of Wagoner.
Hazard(s) Targeted	Hazard material events
Project Type	Preparation
Lead and participating agencies	City emergency management, Sherriff's Dept
Time schedule	FY20-21
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Identify hazardous materials and the transportation systems used in their transport within the City
Expected outcome	Inventory vulnerable populations in those areas and accessible fire and law enforcement resources useful for responding to hazardous material incidents.

**Action Item #8**

Title	Develop a Citywide fire response and support group to facilitate the provisioning of water to fire departments during large fires.
Hazard(s) Targeted	Wildfire
Project Type	Preparation
Lead and participating agencies	City emergency management, Community Fire Depts.
Time schedule	FY20
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Establish partnerships to aid in fire response coverage
Expected outcome	Efficient and effective mutual aid procedures

**Action Item #9**

Title	Build community partnerships involving local government leaders, civic, business and volunteer groups to work together.
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Preparation
Lead and participating agencies	City emergency management
Time schedule	FY20-22
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Active contacts in government, business and volunteer services
Expected outcome	A City with active contacts in government, business and volunteer services to aid in all areas of emergency response assistance and hazard preparedness.



**Action Item #10**

Title	Update the accuracy of existing floodplain maps. And also modify land use ordinances to avoid construction in flood-prone locations.
Hazard(s) Targeted	Flood
Project Type	Mitigation
Lead and participating agencies	City emergency management, City floodplain administrator
Time schedule	FY20-23
Estimated Cost	\$250,000
Funding source	Local/Grants
Work product	Update existing floodplain maps with best available data
Expected outcome	Better floodplain maps and ordinances that reflect more than the minimum standards of floodplain development.

**Action Item #11**

Title	Inspect The City of Wagoner buildings and facilities for tornado and high wind vulnerability.
Hazard(s) Targeted	Tornados, high winds
Project Type	Preparation
Lead and participating agencies	City emergency management
Time schedule	FY20-21
Estimated Cost	\$50,000
Funding source	Local/Grants
Work product	Inventory buildings for areas susceptible to high winds and tornados
Expected outcome	Identify vulnerable structures and develop plan for their upgrade

**Action Item #12**

Title	Inventory and inspection of City bridges/culverts to determine their adequacy to convey the 100-year regulatory flood.
Hazard(s) Targeted	Flood
Project Type	Preparation
Lead and participating agencies	City emergency management
Time schedule	FY20-21
Estimated Cost	\$200,000
Funding source	Local/Grants
Work product	Inspect bridges/culverts for flood capacity
Expected outcome	Inventory and prioritize City bridges in need of capacity increases

**Action Item #13**

Title	Build shelters and/or safe rooms in mobile home communities for residents.
Hazard(s) Targeted	Tornado
Project Type	Mitigation
Lead and participating agencies	City emergency management, Mobile home community
Time schedule	FY21-23
Estimated Cost	\$500,000
Funding source	Local/Grants
Work product	Install a tornado safe room with a capacity to hold all residents of the selected mobile home park.
Expected outcome	Find creative sources of funding and materials such as abandoned railroad cars that are suitable for such a shelter.

**Action Item #14** Reserved for future use

Title	
Hazard(s) Targeted	
Project Type	
Lead and participating agencies	
Time schedule	
Estimated Cost	
Funding source	
Work product	
Expected outcome	

**Action Item #15**

Title	Acquire and remove Repetitive Loss Properties and repeatedly flooded properties where acquisition is the most cost effective and desirable mitigation measure.
Hazard(s) Targeted	Flood
Project Type	Mitigation
Lead and participating agencies	City emergency management, City floodplain administrator
Time schedule	FY20-24
Estimated Cost	\$500,000
Funding source	Local/Grants/HMGP
Work product	Acquisition and removal of all buildings from the floodplain.
Expected outcome	Reduction of repetitive loss structures

**Action Item #16**

Title	Provide surge protection and uninterruptible power sources for electronic-reliant City facilities, such as the Sheriff Department, City Offices, and Emergency Operations Center.
Hazard(s) Targeted	Lightning
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY20-22
Estimated Cost	\$500 per unit and \$40,000 for generator per facility
Funding source	Local/Grants
Work product	The work product will be electronic protection units to protect the electronic equipment in City facilities.
Expected outcome	The expected outcome will be uninterrupted data retrieval from City facilities. With so much data and municipal records stored electronically, access to that data is vital to the continuous operation of government.

**Action Item #17**

Title	Educate the Sheriff Department and City's Fire Department personnel to expand their knowledge and capabilities relative to hazardous materials and events, including meth labs. Also include public education on Meth Labs.
Hazard(s) Targeted	Hazard material events
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY20-22
Estimated Cost	\$100,000
Funding source	Local/Grants
Work product	First responders to most effectively mitigate the impact of hazardous material events
Expected outcome	So scene can be stabilized awaiting hazmat personnel. Also include a public information campaign to educate the general public on how to identify Meth Labs.

**Action Item #18**

Title	Upgrade the emergency communications network for fire, police, sheriff, 911, ambulance and other emergency operations.
Hazard(s) Targeted	Flood, Tornado, Winter Storm, Earthquake, Dam Break
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY20-23
Estimated Cost	\$100,000
Funding source	Local/Grants/HMGP
Work product	Upgrade in communication equipment and expand personnel dispatching coverage.
Expected outcome	The outcome will be the ability to better disseminate information to response personnel and the public.

**Action Item #19**

Title	Evaluate, Design, Construction of Permanent Pump Station at Dike No. 10
Hazard(s) Targeted	Flood, Dam/Dike/Levee Break
Project Type	Preparation
Lead and participating agencies	Floodplain Management
Time schedule	FY20-22
Estimated Cost	\$2,000,000.00
Funding source	Local/Grants/HMGP
Work product	Final Design and Construction of Permanent Pump Station on City side of existing Dike No. 10 at Ft. Gibson Lake Outlet.
Expected outcome	The outcome will be to provide permanent pumping of the storage area when the outlet gate is closed during intense rainstorms and Ft Gibson lake is higher than low area. Eliminate need for emergency generators and temporary pumps.

**Action Item #20**

Title	Update City equipment and vehicles for combating ice storm damage/adverse conditions to public infrastructure.
Hazard(s) Targeted	Severe Winter Storm
Project Type	Preparation
Lead and participating agencies	City maintenance/Public Works
Time schedule	FY20-21
Estimated Cost	\$25,000.00 (will utilize existing City vehicles)
Funding source	Local/Grants
Work product	Acquisition of additional winter snow and ice equipment (plows and spreaders) for its existing vehicles to combat ice and winter storms.
Expected outcome	Returning the infrastructure back to normal operations as quickly as possible after winter storms, ice and snow hazards, and all adverse conditions, is essential to hazard recovery, and is the expected outcome.

**Action Item #21**

Title	Install window air conditioners for elderly shut-ins for whom extreme heat can be a life threatening hazard.
Hazard(s) Targeted	Extreme Heat
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY20-22
Estimated Cost	\$1,000 per unit
Funding source	Local/Grants
Work product	Installation of AC units
Expected outcome	The expected outcome is to reduce the number of persons who are exposed to heat as a life threatening hazard.

**Action Item #22**

Title	Window Laminates
Hazard(s) Targeted	Hail, Heat, High Winds, Tornadoes
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY21-23
Estimated Cost	\$500 per unit
Funding source	Local/Grants
Work product	The work product would be installing laminates to all City buildings' windows.
Expected outcome	The expected outcome will be a layer of protection from the hazards to prevent or lessen injuries to occupants of the buildings.

**Action Item #23**

Title	Establish fire breaks in the Wildfire urban interface.
Hazard(s) Targeted	Wildfires
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY21-23
Estimated Cost	\$2,500,000
Funding source	Local/Grants
Work product	The work product would be a fire resistant buffer around the incorporated parts of the City.
Expected outcome	The expected outcome will be to minimize the area where wildfires can easily enter the urban areas of the City.

**Action Item #24**

Title	Engineering for a new City Maintenance Building and Emergency Operations Center
Hazard(s) Targeted	Floods, tornadoes, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Preparation
Lead and participating agencies	City emergency management, City Administration
Time schedule	FY22-24
Estimated Cost	\$31,000.00 for the engineering
Funding source	Local/Grants
Work product	Prepare the site for the new City maintenance building for construction
Expected outcome	Preparation of the necessary documents for the floodplain development application and building permits.

**Action Item #25**

Title	New Radio Repeater Towers
Hazard(s) Targeted	Floods, Tornadoes, High Winds, Lightning, Hail, Severe Winter Storms, Extreme Heat, Wildfires, Earthquakes, Hazardous Material Events, and Levee Breaks
Project Type	Communication
Lead and participating agencies	City emergency management
Time schedule	FY21-23
Estimated Cost	\$250,000
Funding source	Local/Grants
Work product	Construct new repeater towers throughout the City.
Expected outcome	This will provide communication to CB radio operators, schools, and link City districts.

**Action Item #26**

Title	New Hand Held Narrow Band Radios
Hazard(s) Targeted	Floods, Tornadoes, High Winds, Lightning, Hail, Severe Winter Storms, Extreme Heat, Wildfires, Earthquakes, Hazardous Material Events, and Dam/Dike/Levee Breaks
Project Type	Communication
Lead and participating agencies	City emergency management
Time schedule	FY20-22
Estimated Cost	\$35,000
Funding source	Local/Grants
Work product	Acquisition and distribution of hand held narrow band radios.
Expected outcome	This will meet new federal regulations for governmental and private groups on narrow band radios.

**Action Item #27**

Title	Citywide Dike No. 10 break inundation plan
Hazard(s) Targeted	Dam/Dike/Levee Break.
Project Type	Preparation
Lead and participating agencies	City emergency management, OWRB/Floodplain Manager
Time schedule	FY20-22
Estimated Cost	\$150,000
Funding source	Local and/or grants
Work product	Determine the inundation area from a Dike No. 10 breach in the City. And the number of structured inundated.
Expected outcome	This comprehensive plan will properly quantify the dam/dike/levee break hazard in the City of Wagoner.

**Action Item #28**

Title	Build a Community Safe Room, located on existing acreage owned by the Town or on acreage to be obtained by donation.
Hazard(s) Targeted	Tornado, High Winds
Project Type	Mitigation
Lead and participating agencies	Community Administration
Time schedule	FY22-23
Estimated Cost	\$500,000
Funding source	Local/Grants
Work product	Construction of a community safe room (approximately 750 SF) to temporarily shelter 100 people
Expected outcome	A structure dedicated to serve as a storm shelter for the citizens of the City of Wagoner

**Action Item #29**

Title	Stationary mounted 35 KW emergency generators to qualify Safe Room and City Hall as emergency shelters.
Hazard(s) Targeted	Severe Winter Storms
Project Type	Mitigation
Lead and participating agencies	Fire Department and Mayor
Time schedule	FY22
Estimated Cost	\$80,000 (2 at \$40,000)
Funding source	Local/Grants
Work product	Purchase and Installation of two stationary mounted 35 KW emergency generators, one for the new safe room and one for City Hall.
Expected outcome	To make the new Safe Room and the Town Hall building as Red Cross compliant emergency shelters

**Action Item #30**

Title	Removal of Debris and Re-shaping of Coal Creek Floodplain and Floodway and the enhancement of two Un-named tributaries to Coal Creek
Hazard(s) Targeted	Flood
Project Type	Mitigation
Lead and participating agencies	Public Works Department
Time schedule	FY22-25
Estimated Cost	\$500,000
Funding source	Local/Grants
Work product	Clearing the existing floodway of accumulated debris and re-shaping/enlarging the existing channel through the Town to provide additional hydraulic capacity, thus reducing the effective floodplain width.

Expected outcome	The City of Wagoner does have limited heavy equipment to maintain the large channel of Coal Creek and remove the existing accumulated debris (trees, trash, plant overgrowth, illegally dumped material, etc.) This project would not only clean out the existing channel, but the enhanced channel re-shaping will increase the hydraulic capacity and reduce the current effective Zone AE floodplain limits for approximately 8 commercial properties and approximately 15 residential properties.
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### Action Item #31

Title	LID Improvement of East Coal Creek Wagoner Floodplain and Floodway and North and South Un-named Tributaries
Hazard(s) Targeted	Flood
Project Type	Mitigation
Lead and participating agencies	Public Works Department/Floodplain Administrator
Time schedule	FY22-25
Estimated Cost	\$4,500,000
Funding source	Local/Grants
Work product	Re-channelization of Coal Creek from the Hwy 69 through the City using Low Impact Development techniques to provide additional hydraulic capacity and creation of water features to improve storm water quality and reducing the effective floodplain width to be contained within the Coal Creek LID channel and develop a new regional stormwater detention facility on the North Un-named Tributary to Coal Creek in Dunbar Park Area
Expected outcome	The City of Wagoner desires to improve Coal Creek and the North and South Un-named Tributaries, add regional stormwater detention facilities, and remove some of the meander of the existing Wagoner alignment through the City to contain the regulatory floodway and floodplain using Low Impact Development techniques. This project would not only re-align the existing channels to provide additional lands for park/recreation area, but also provide a trail area and possible installation of a pedestrian walkway across the newly enhanced channel in Dunbar Park to create a recreational walkway along the top of the bank of the Wagoner area. The LID improved channel would be much easier for the City to maintain with its current staff and equipment since the banks would be grass-lined, rather than relying on the existing property owners or City to maintain the existing channel on their individual tracts. This would require either land acquisition or permanent drainage easements to be granted by the landowners to the City.



**Action Item #32**

Title	Enhance the City floodplain ordinance to expand enforcement to the Police Department and the Fire Chief.
Hazard(s) Targeted	Flood
Project Type	Mitigation
Lead and participating agencies	Town Police Chief, Community Administration
Time schedule	FY21-22
Estimated Cost	\$10,000
Funding source	Local/Grants
Work product	A stricter ordinance to enforce the floodplain regulations
Expected outcome	People have stored unwanted material within the 1% (100-Year) floodplain for years. In the event of a sudden and heavy rainfall event that continued for some time, the floodplain could be inundated. The presence of material and debris in the floodplain could cause more serious flooding issues downstream and floating items carried by storm water cause property damage or injury to persons. Enforcement of floodplain regulations will minimize or eliminate this threat.

**Action Item #33**

Title	Local drainage channel improvements
Hazard(s) Targeted	Flood
Project Type	Preparation
Lead and participating agencies	Community Administration/Floodplain Manager
Time schedule	FY20-25
Estimated Cost	\$100,000 to \$150,000
Funding source	Local/Grants
Work product	An organized plan to enhance the local drainage channels that are tributary to Coal Creek
Expected outcome	There are several local drainage channels that are undersized and cause street and property flooding within the City of Wagoner. The goal of this project is to acquire additional right-of-way and create improved drainage channels to minimize or eliminate street flooding that is causing erosion and damage to approximately 23 streets. This project would also improve about 20 culverts under the cross streets to convey storm water.

**Action Item #34**

Title	Develop and implement a water conservation methods
Hazard(s) Targeted	Drought, Hazardous Materials (Water Source Contamination and Mechanical Failure)
Project Type	Mitigation
Lead and participating agencies	Community Administration
Time schedule	FY21-22
Estimated Cost	Plan \$10,000. \$50-\$500 per fixture
Funding source	Local/Grants

Work product	Methods to deal with severe water shortages or curtailment of supply of potable water due to severe drought, water source contamination or the physical ability to meet the demand that would be implemented in stages as the problem becomes more severe.
Expected outcome	Reduce water usage during water shortages.

#### **Action Item #35**

Title	Develop a routine Storm Siren Testing Procedure
Hazard(s) Targeted	Tornados and High Winds
Project Type	Preparation
Lead and participating agencies	Community Administration
Time schedule	FY22
Estimated Cost	\$500
Funding source	Local/Grants
Work product	A regular and routine testing of sirens on a scheduled basis that can be communicated to the public so they are not alarmed when they hear the sirens.
Expected outcome	An assurance that the sirens do work when needed and confidence in early warning system by the citizens.

#### **Action Item #36**

Title	Develop an “all media program” to educate the City residents about mitigating the risk of life and property associated with the occurrence of hazards
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Mitigation
Lead and participating agencies	Community Administration
Time schedule	FY21-22
Estimated Cost	\$25,000
Funding source	Local and/or grants
Work product	Dissemination of information about mitigating the risk associated with hazards
Expected outcome	City residents become less at risk and less vulnerable from hazards

#### **Action Item #37**

Title	Installation of water saving fixtures in all City facilities
Hazard(s) Targeted	Drought
Project Type	Mitigation
Lead and participating agencies	Community Administration
Time schedule	FY21-22
Estimated Cost	\$50-\$500 per fixture, depending on the fixture mitigated
Funding source	Local and/or grants
Work product	Installation of water saving fixtures
Expected outcome	Reduction in the amount of water used at each fixture

**Action Item #38**

Title	Rescue trailer for emergency situations
Hazard(s) Targeted	Tornados, Floods, Earthquakes, Wildfires
Project Type	Preparation
Lead and participating agencies	Community Administration
Time schedule	FY21
Estimated Cost	\$50,000
Funding source	Local/Grants
Work product	A trailer equipped with rescue and emergency response equipment, specifically equipped with jacks, chain saws, lights, and winches for extraction.
Expected outcome	The expected outcome is to have rescue equipment ready to go and able to transported to an emergency situation.

**Action Item #39**

Title	Large capacity community safe room and emergency responder shelter
Hazard(s) Targeted	Tornados, high winds
Project Type	Mitigation
Lead and participating agencies	Community Administration
Time schedule	FY22-23
Estimated Cost	\$2,500,000
Funding source	Local/Grants
Work product	The work product will be the installation of a shelter for emergency responders and high capacity safe room.
Expected outcome	The expected outcome will be to provide a safe, secure location for emergency responders and area residents during storm events.

**Action Item #40**

Title	Response to an impending hazard with an evacuation order
Hazard(s) Targeted	Flood, tornado, high winds, wildfire, , hazardous material, dam break
Project Type	Response
Lead and participating agencies	Fire Department and Town Administration
Time schedule	FY21-22
Estimated Cost	\$10,000
Funding source	Local/Grants
Work product	The work product would be an organized procedure to announce and implement an evacuation.
Expected outcome	To safely and efficiently move people out of harm's way.

**The School District** has reviewed and analyzed the risk assessment studies for the natural hazards and hazardous material events that may impact their jurisdiction. They reviewed the mitigations activities listed in Chapter 4, incorporated the criteria and principles of the STAPLE+E project evaluation method in their consideration of the mitigation activities, and prioritized the activities as was detailed in Section 4.3. Once funding is sought, a detailed benefit/cost analysis will be done and will follow the requirements of the funding source.

#### **Action Item #1**

Title	Installation of NOAA weather radios in School facilities
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY22
Estimated Cost	\$100 per radio
Funding source	Local and/or grants
Work product	Purchase and install NOAA weather radios in School facilities
Expected outcome	To provide an increased awareness and improved warning for approaching hazard events and hazard notification at School facilities

#### **Action Item #2**

Title	Develop an “all media program” to educate the principals, teachers, students and parents of students about mitigating the risk of life and property associated with the occurrence of hazards
Hazard(s) Targeted	Floods, tornados, high winds, lightning, hail, winter storms, extreme heat, drought, expansive soils, wildfires, earthquakes, dam breaks, hazard material events
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY22
Estimated Cost	\$25,000
Funding source	Local and/or grants
Work product	Dissemination of information about mitigating the risk associated with hazards
Expected outcome	Principals, Teachers, Students and parents of students become less at risk and less vulnerable from hazards

#### **Action Item #3**

Title	Installation of water saving fixtures in all School facilities
Hazard(s) Targeted	Drought
Project Type	Mitigation
Lead and participating agencies	School District building operations
Time schedule	FY22
Estimated Cost	\$50-\$500 per fixture, depending on the fixture mitigated
Funding source	Local and/or grants

Work product	Installation of water saving fixtures
Expected outcome	Reduction in the amount of water used at each fixture

#### **Action Item #4**

Title	Map expansive soils risk area
Hazard(s) Targeted	Expansive soils
Project Type	Mitigation
Lead and participating agencies	City emergency management
Time schedule	FY21-22
Estimated Cost	\$200,000
Funding source	Local and/or grants
Work product	Develop detailed soils maps
Expected outcome	Identification of the soils' construction properties, including shrink-swell potential, to insure proper foundation design and construction of future improvements and school buildings

#### **Action Item #5**

NOTE: this action is included in the event the School District can partner with the utility company.

Title	Bury overhead power lines on school properties to make them more hazard resistant
Hazard(s) Targeted	Earthquakes, tornados, high winds, winter storms, wildfire
Project Type	Mitigation
Lead and participating agencies	City emergency management, Private Utility Companies
Time schedule	FY21-25
Estimated Cost	Not determined
Funding source	Grants
Work product	Bury overhead power lines on School properties
Expected outcome	Minimize power outages because hazards can bring down overhead power lines and poles

#### **Action Item #7**

Title	Identify and plan for hazardous materials and incidents on major school transportation routes through the City of Wagoner.
Hazard(s) Targeted	Hazard material events
Project Type	Preparation
Lead and participating agencies	City emergency management, Sherriff's Dept, School Transportation Department
Time schedule	FY22-23
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Identify hazardous materials and the transportation systems used in the transport of students within the City

Expected outcome	Inventory vulnerable populations in those areas and accessible fire and law enforcement resources useful for responding to hazardous material incidents.
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#### **Action Item #8**

Title	Develop a fire response program and support group to assist the City in the provisioning of water to fire departments during large fires.
Hazard(s) Targeted	Wildfire
Project Type	Preparation
Lead and participating agencies	City emergency management, Community Fire Depts.
Time schedule	FY22
Estimated Cost	\$25,000
Funding source	Local/Grants
Work product	Establish partnerships to aid in fire response coverage
Expected outcome	Efficient and effective mutual aid procedures

#### **Action Item #9**

Title	Build School District Safe Rooms, located in existing and future schools owned by the School District.
Hazard(s) Targeted	Tornado, High Winds
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY22-23
Estimated Cost	\$500,000
Funding source	Local/Grants
Work product	Construction of safe room (approximately 750 SF) for each school to temporarily shelter the number of students within each school.
Expected outcome	Structures dedicated to serve as a storm shelters for the students and teachers of the City of Wagoner School District

#### **Action Item #10**

Title	Installation of water saving fixtures in all School facilities
Hazard(s) Targeted	Drought
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY18-19
Estimated Cost	\$50-\$500 per fixture, depending on the fixture mitigated
Funding source	Local and/or grants
Work product	Installation of water saving fixtures
Expected outcome	Reduction in the amount of water used at each fixture

**Action Item #11**

Title	Install 2-way radios on school buses and at schools.
Hazard(s) Targeted	Tornados, High Winds, Lightning, Hail, Winter Storms, Wildfires, Earthquakes, Hazardous Material Events.
Project Type	Communication
Lead and participating agencies	School Administration
Time schedule	FY17-18
Estimated Cost	\$500 per unit
Funding source	Local/Grants
Work product	The work product will be to equip all buses and schools with 2-way radios.
Expected outcome	The expected outcome will be the ability of transportation supervisors to communicate with buses in the event of hazardous and/or emergency situations. And for any bus to communicate to the transportation supervisors of hazardous and/or emergency situations.

**Action Item #12**

Title	School Safe Room for each school for school students/teachers/administration, and community. School Safe Rooms would be available to community during no-school hours.
Hazard(s) Targeted	Tornado, High Winds
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY18-20
Estimated Cost	\$15,250,000
Funding source	Local/Grants
Work product	The work product will be the construction of a safe room in each school building.
Expected outcome	A safe secure location for our students and staff during storms, and community during non-school hours.

**Action Item #13**

Title	Install LED Lighting in all schools
Hazard(s) Targeted	Tornado, High Winds
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY18-20
Estimated Cost	\$200,000.00
Funding source	Local/Grants
Work product	The work product will be the conservation of energy.
Expected outcome	To reduce the electrical bill for the School System and to conserve energy for other uses in the community.

**Action Item #14**

Title	Install Lightning Rods and Surge Protectors at all School Buildings
Hazard(s) Targeted	Lightning
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY18-19
Estimated Cost	\$100,000
Funding source	Local/Grants
Work product	To install lightning rods and surge protection devices at all school buildings.
Expected outcome	The expected outcome is to protect students, buildings and electrical equipment from lightning strikes.

**Action Item #15**

Title	Upgrade Intercom Systems and Installing Security Cameras at the District's five school sites.
Hazard(s) Targeted	Tornado, High Winds, Hail, Lightning, Hazardous Material Events
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY22-23
Estimated Cost	\$430,000
Funding source	Local/Grants
Work product	The work product would be to upgrade all indoor/outdoor intercom systems at all schools in our school district and to add Security Cameras at all schools.
Expected outcome	The expected outcome would be to better inform the students and staff in the event of hazardous / dangerous events.

**Action Item #16**

Title	Communications equipment
Hazard(s) Targeted	Tornados, High Winds, Lightning, Hail, Severe Winter Storms, Wildfires, Earthquakes, Hazardous Materials Events. (Hazards with short notification time).
Project Type	Communications
Lead and participating agencies	School Administration
Time schedule	FY21
Estimated Cost	\$20,000
Funding source	Local/Grants
Work product	To provide hand held radios to all sites in the school district
Expected outcome	With the purchase of these new radios, we will be able to communicate with local agencies as well as all of our school sites in case of emergency situations.



**Action Item #17**

Title	Response to an evacuation order
Hazard(s) Targeted	Tornado, high winds, hail, winter storm, wildfire, earthquake, hazardous material
Project Type	Mitigation
Lead and participating agencies	School Administration
Time schedule	FY 21-22
Estimated Cost	\$10,000
Funding source	Local/Grants
Work product	The work product will be an organized procedure to announce and implement an evacuation to a safe location
Expected outcome	To safely and efficiently move people out of harm's way

# ***Chapter 6:***

## ***Plan Maintenance and Adoption***

This chapter includes a discussion of the plan maintenance process and plan adoption process.

### **6.1 Monitoring, Evaluating, Updating the Plan**

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The Mayor, Public Works Director, and the Emergency Management Director will oversee the general implementation of the plan. Monitoring will include getting quarterly reports from the agencies and departments involved in the mitigation actions as to their progress in implementing the projects included the Action Plan that fall within that agency's or department's scope of responsibility.

The Mayor, Public Works Director, Emergency Management Director and the Floodplain Administrator will also evaluate the mitigation plan on an as needed day-by-day basis and on an annual planning basis. The evaluation shall include reviewing the goals and objectives of the mitigation plan for any changes. The evaluation will also include a review of the hazards in the plan to determine if the risks or hazard locations have changed. The Emergency Management Director and Floodplain Administrator will complete and provide an annual evaluation to the City Council summarizing the accomplishments of the mitigation actions. In the action plan, the Director will review the action plan's items identified to be implemented for their appropriateness, and report issues to the City Council. These reviews will include the responsible agency to oversee the mitigation activity, the time schedule, and the funding source.

The City of Wagoner Emergency Management Advisory Committee will make a comprehensive update to the Multi-Hazard Mitigation Plan within five years, from the approval date, as per FEMA requirements, and will be re-submitted to ODEM and FEMA for approval as required.

### **6.2 Incorporating the Multi-Hazard Mitigation Plan**

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The City of Wagoner Multi-Hazard Mitigation Plan has been adopted by the City of Wagoner City Council as a guide to City-wide mitigation actions. Appropriate Action Plan actions will be incorporated into the planning process, and in the annual City budget. As stated in section 6.1, the Mayor, Public Works Director, and the Emergency Management Director will oversee the general implementation of the plan.

They will work with the CWEMAC to monitor how mitigation actions are incorporated into other City plans. Members of the CWEMAC are also City program managers, charged with the responsibility of updating and enforcing key plans and policies of the City. The City of Wagoner's codes, ordinances, and plans guide development and future improvements. These plans have mitigation strategy components in them, and the City will incorporate any approved the mitigation plan strategies into those plans when the particular plan is updated. All plans are updated as needed by the City. The planning department enforces the zoning codes and subdivision regulations in The City of Wagoner. After adoption of the mitigation plan, the planning department will continue to enforce the codes on new construction and development. Selection of future projects will include consideration of the goals and objectives of the mitigation plan.

The communities and school districts with capital improvement plans are listed in section 1.4.2. These jurisdictions will incorporate their approved mitigation plan actions into their CIPs when

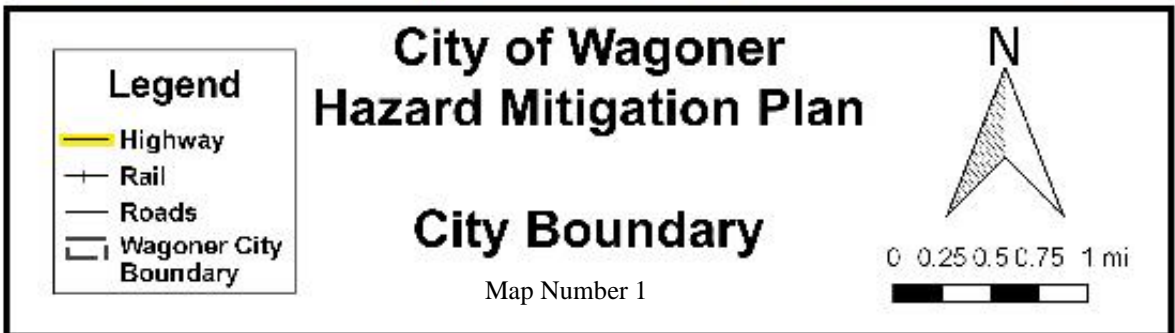
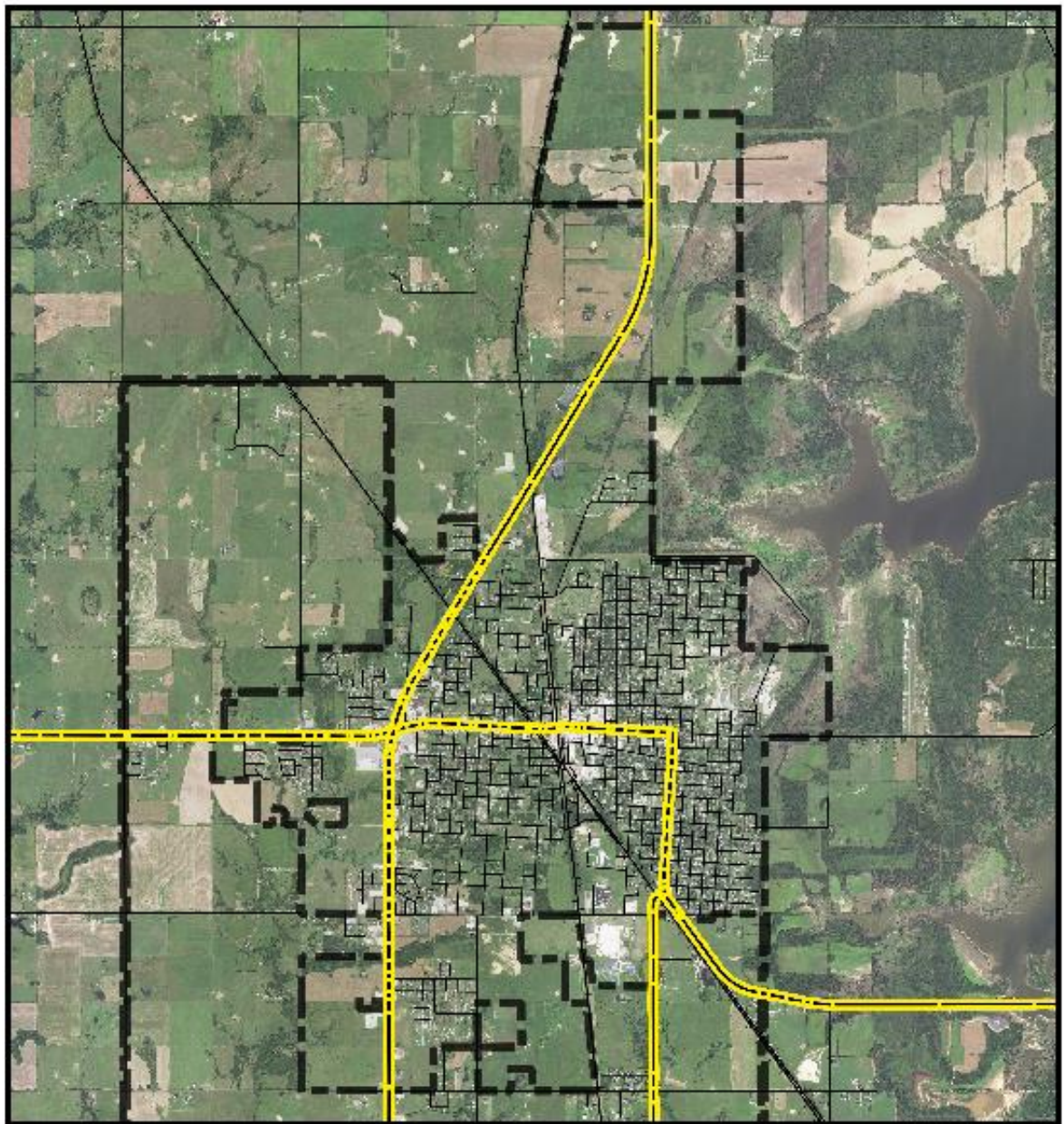
they are updated. And selection of future CIP projects will include consideration of the goals and objectives of the mitigation plan. For the school district without a CIP, they do not have planning documents that their mitigation plan actions can be incorporated into.

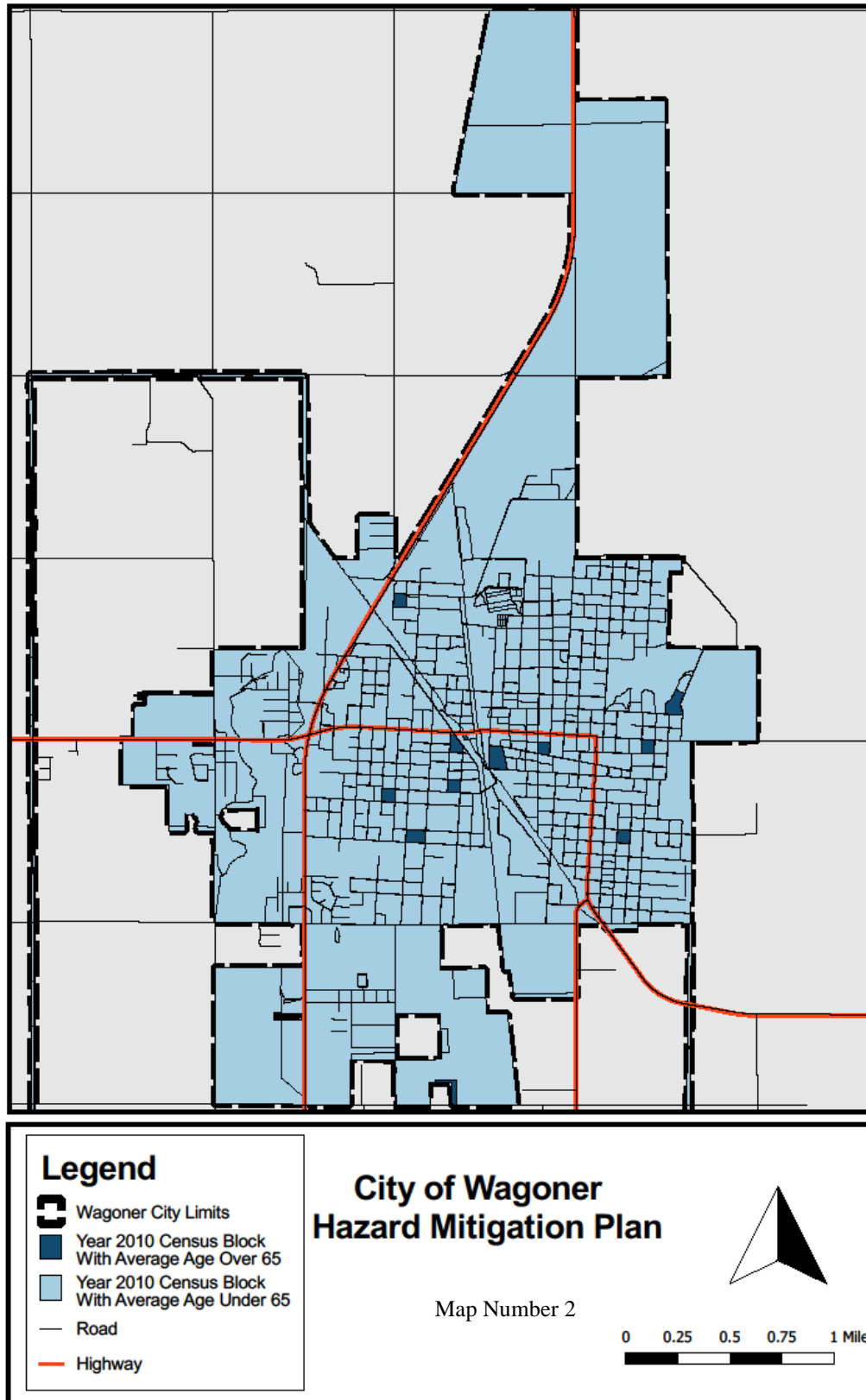
## **6.3 Public Involvement**

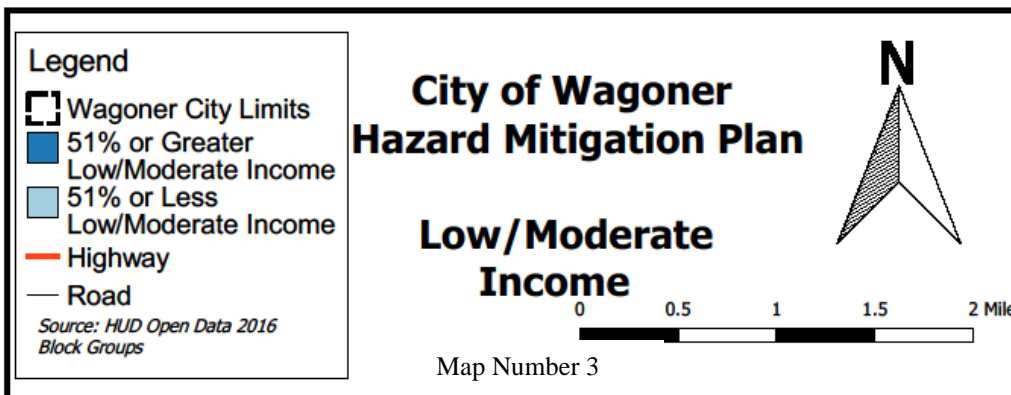
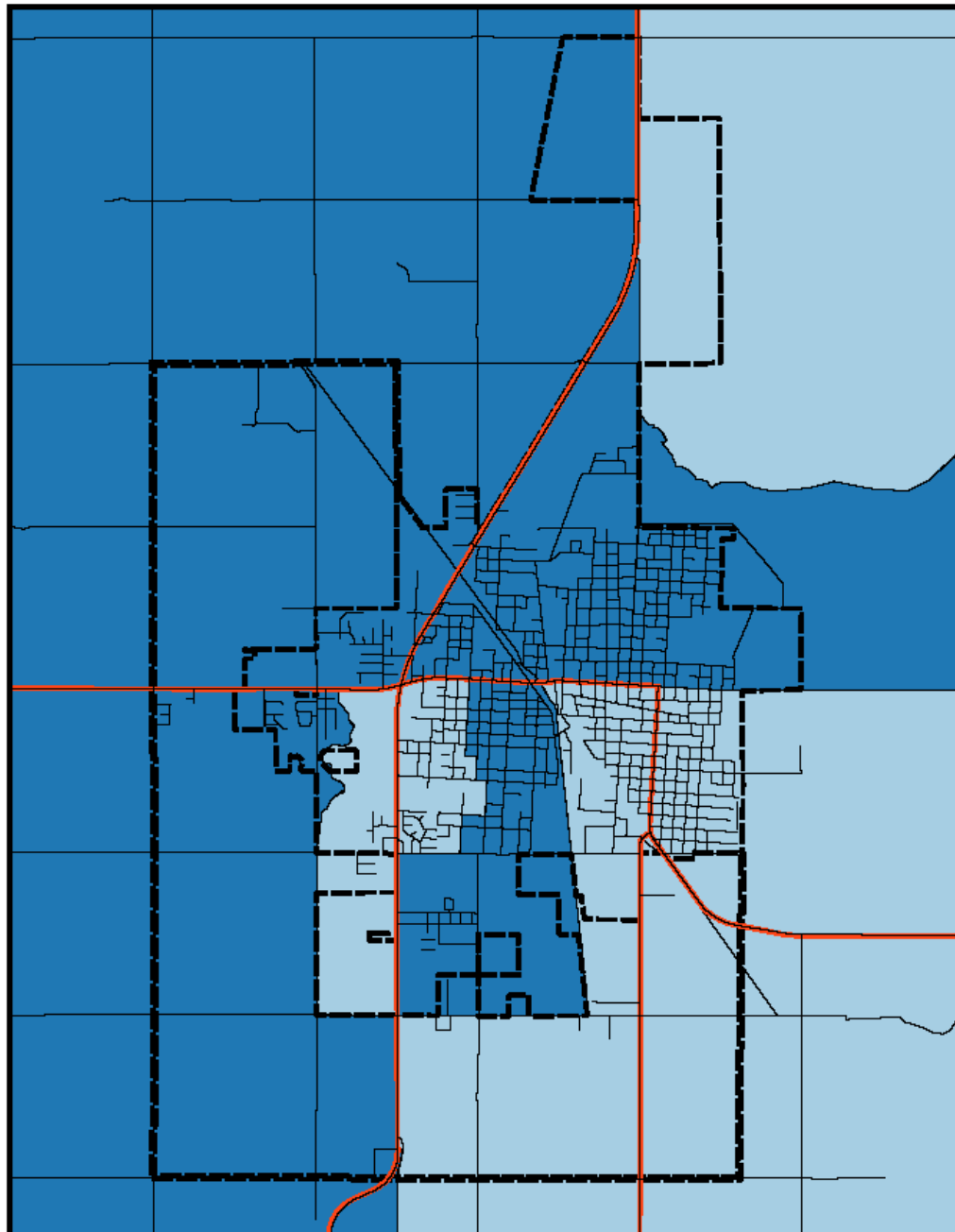
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The City of Wagoner and the Wagoner School District are committed to involving the public directly in updating and maintaining the Hazard Mitigation Plan. A City-wide "monkey survey" was issued in 2017 and responses from 294 individuals to the survey and additional comments were received. Copies of the final Hazard Mitigation Plan will be available at the City of Wagoner Emergency Management Office and at the City Hall Office. Input from citizens will be encouraged, particularly at the annual evaluation to the City of Wagoner Council meetings and their agendas are posted and open to the public where the public can comment on this or any agenda item. At any time of the year, comments can be made directly to the Mayor, Public Works Director, Floodplain Manager, and the Emergency Management Director.

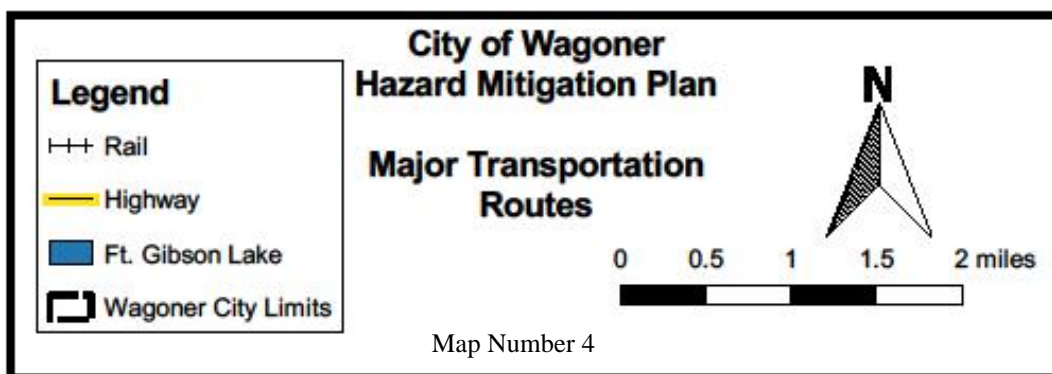
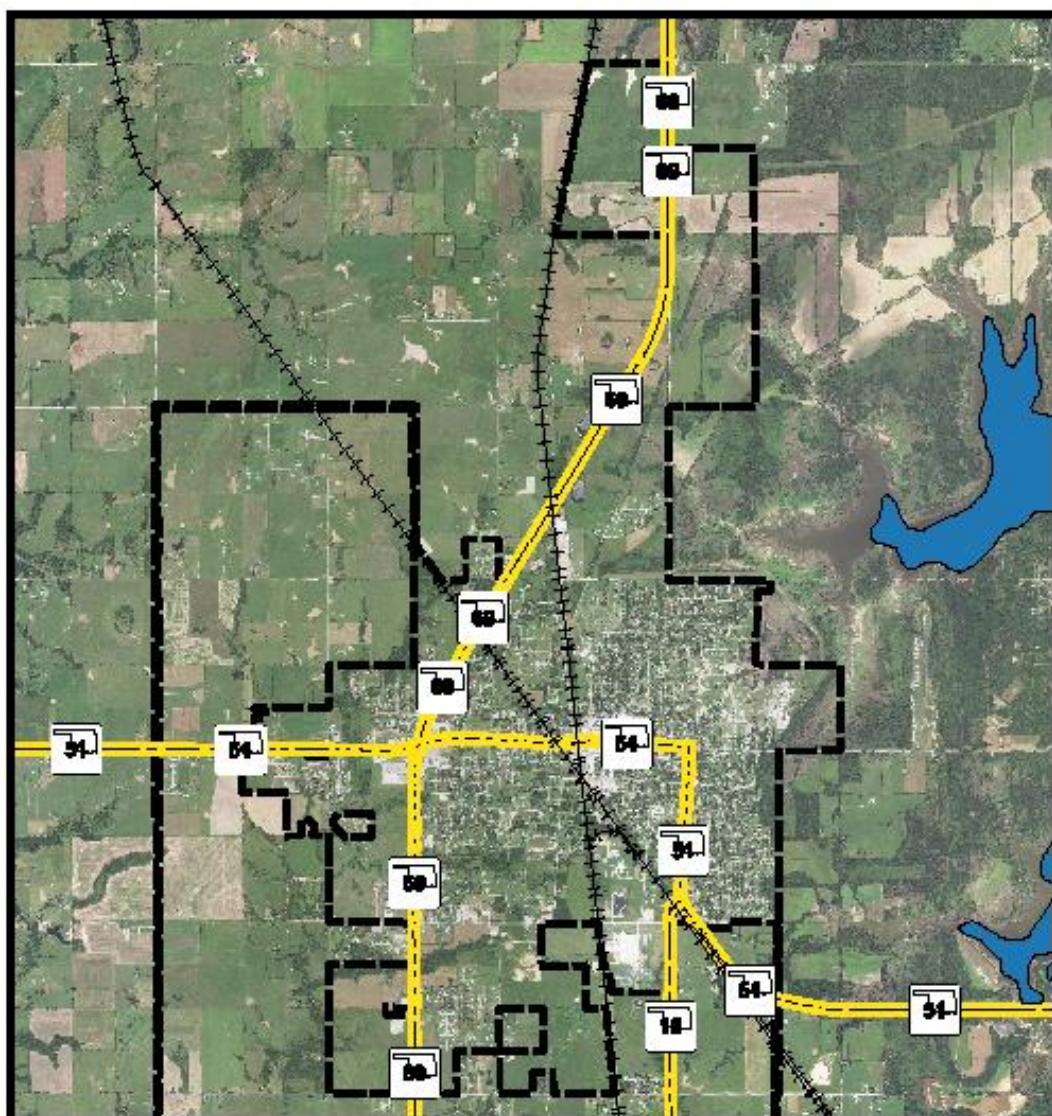
# ***Appendix 1: Mapping***



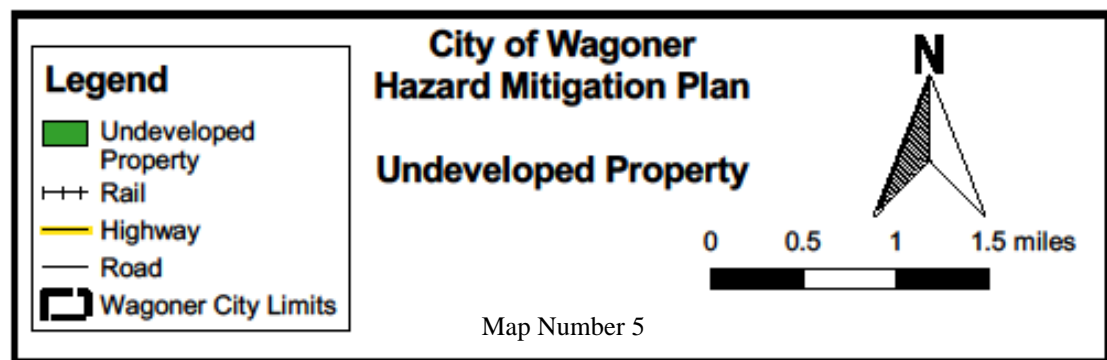
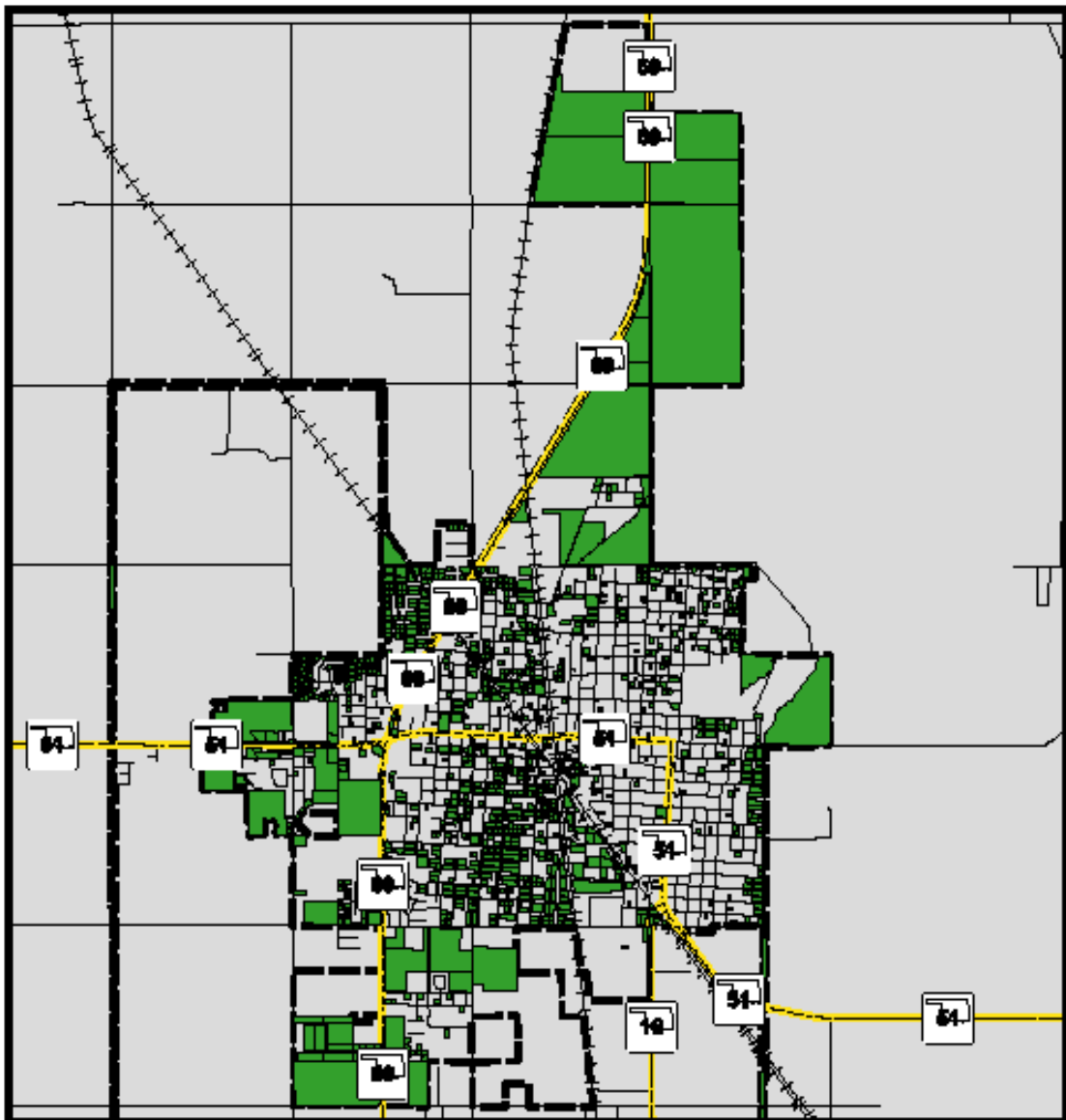


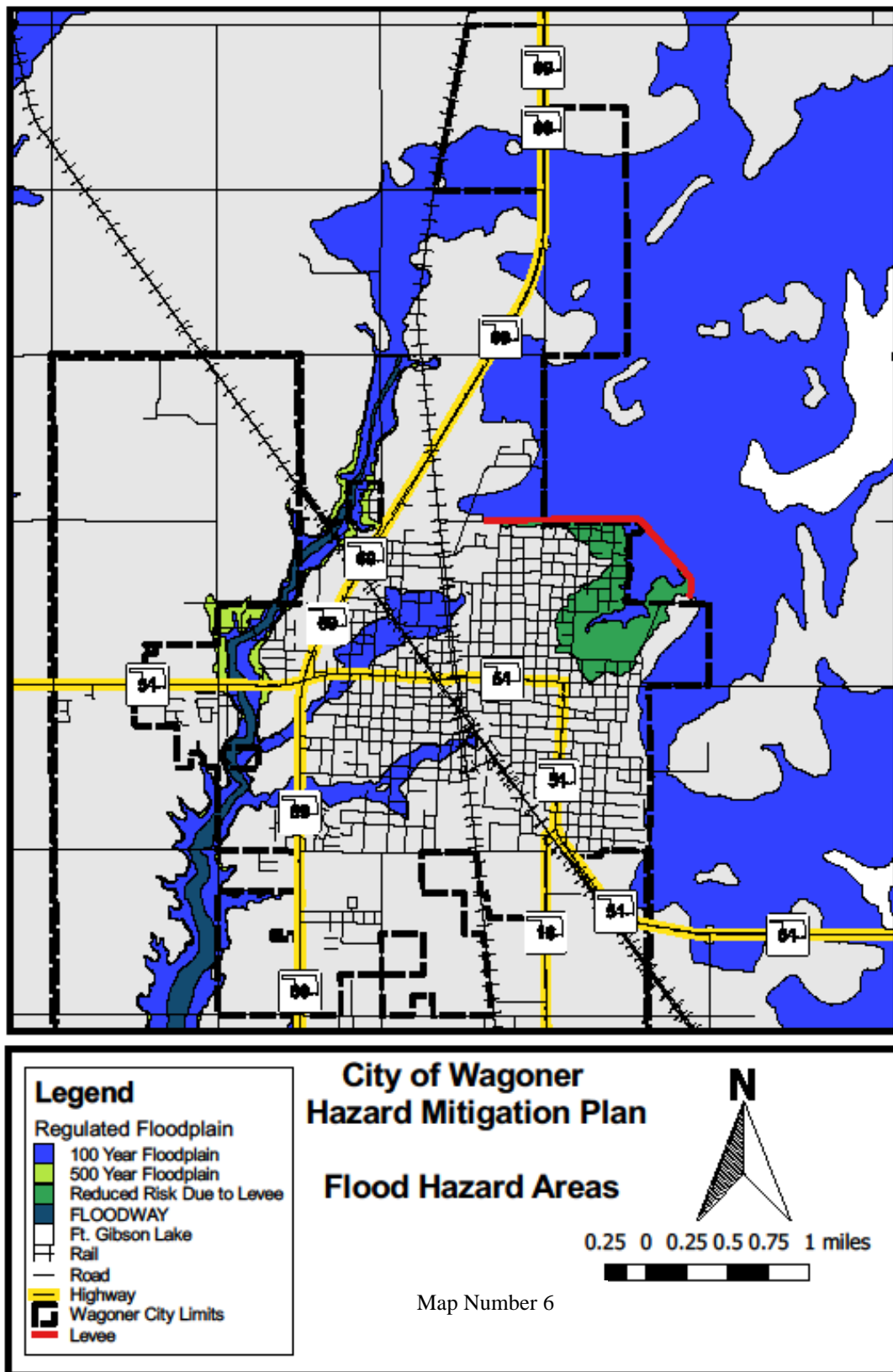


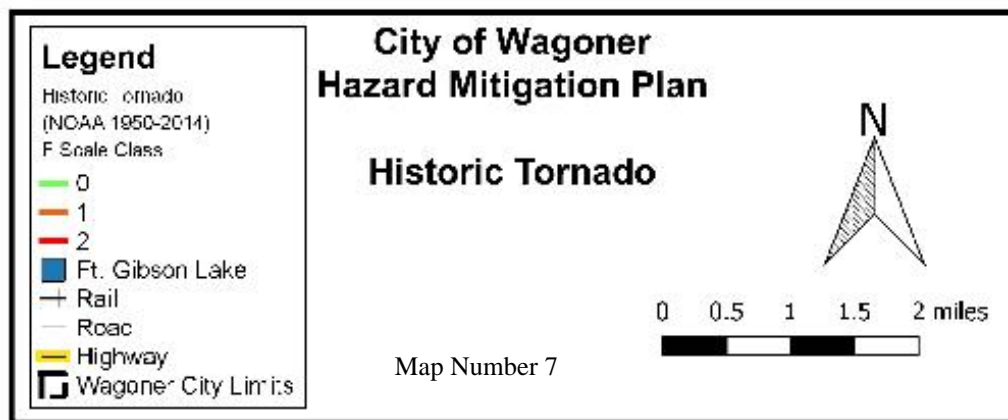
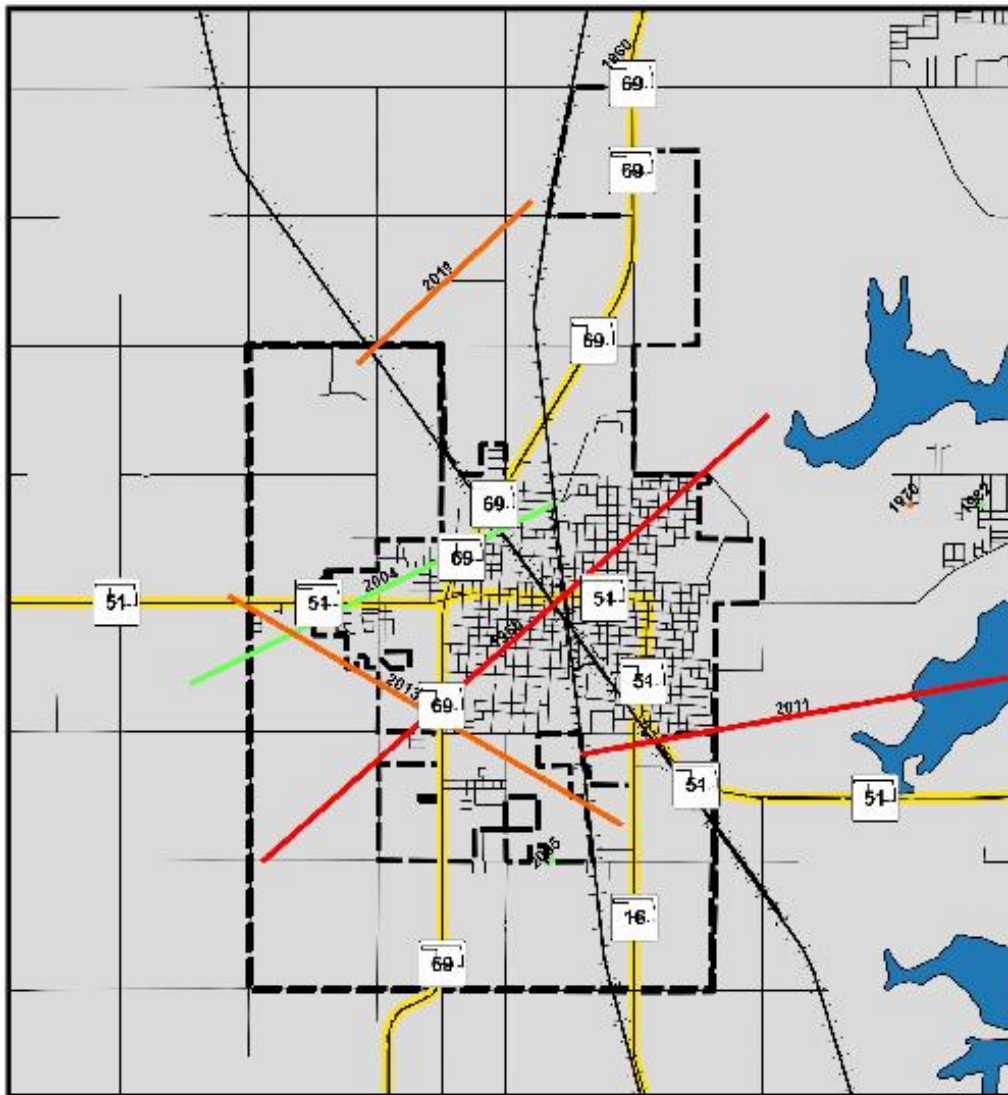


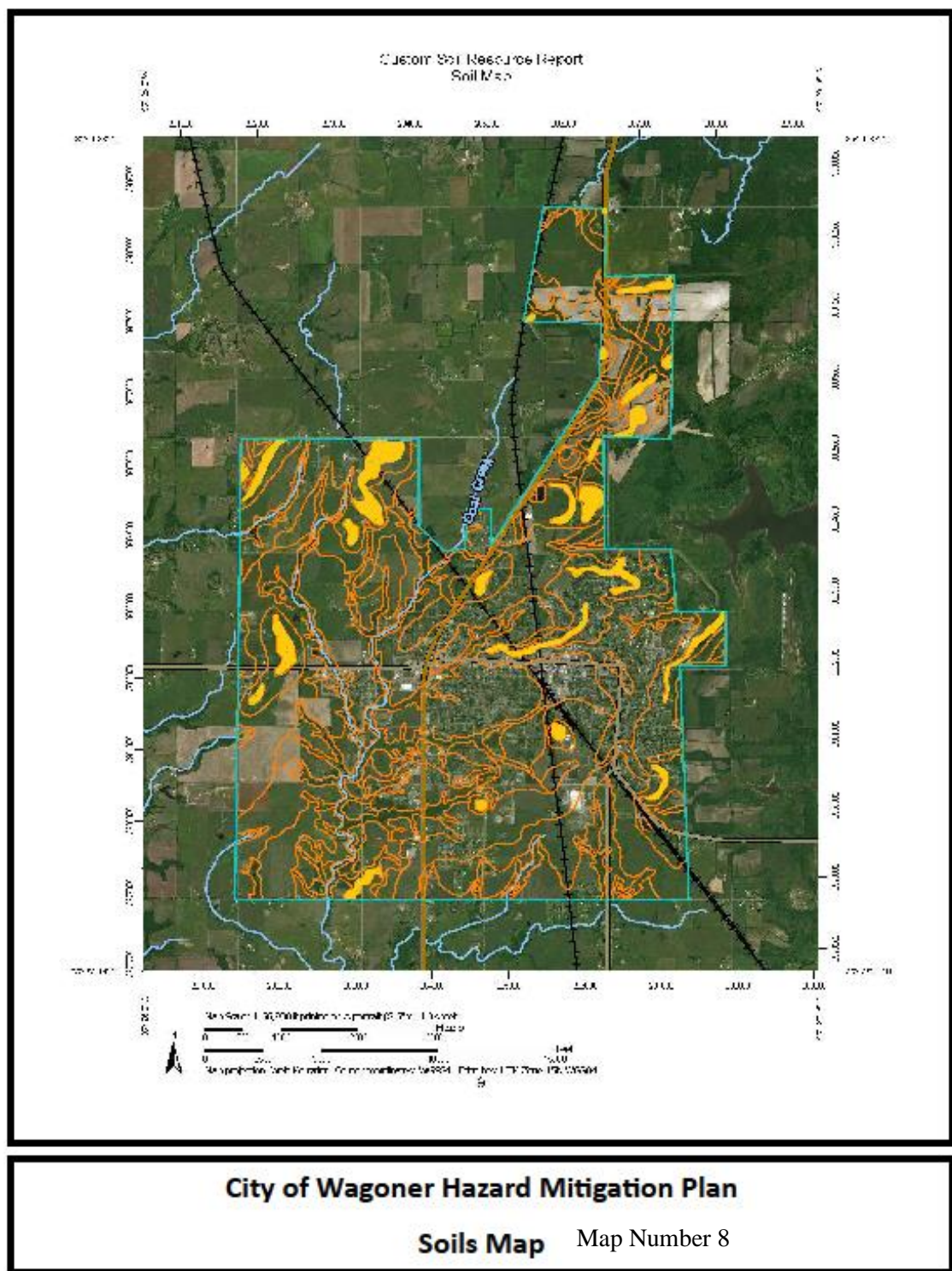




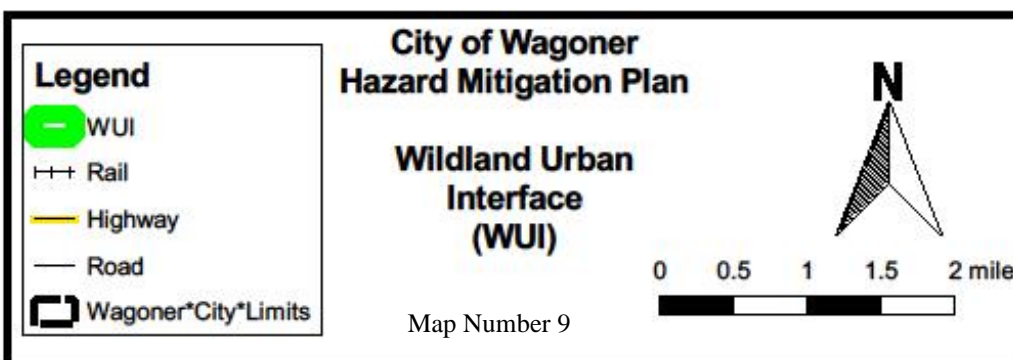
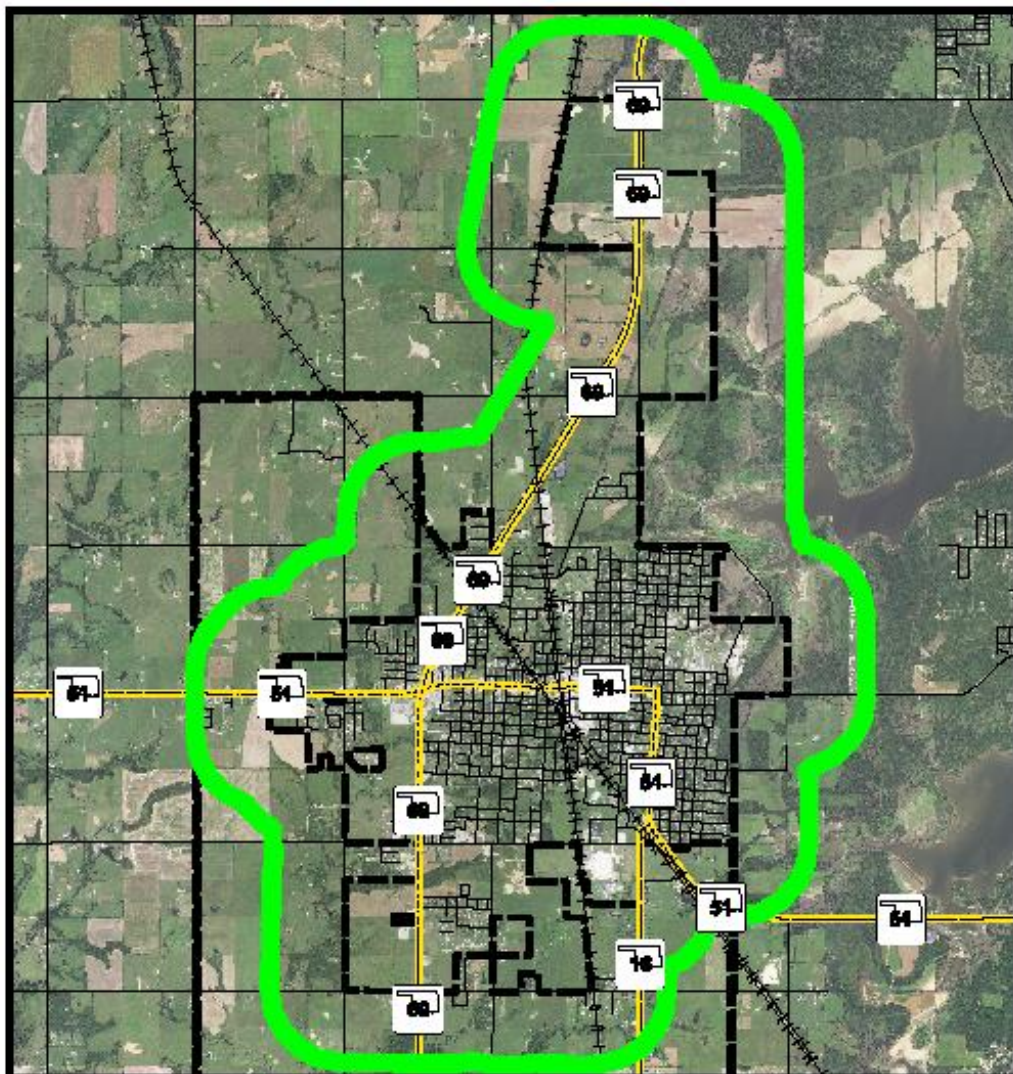




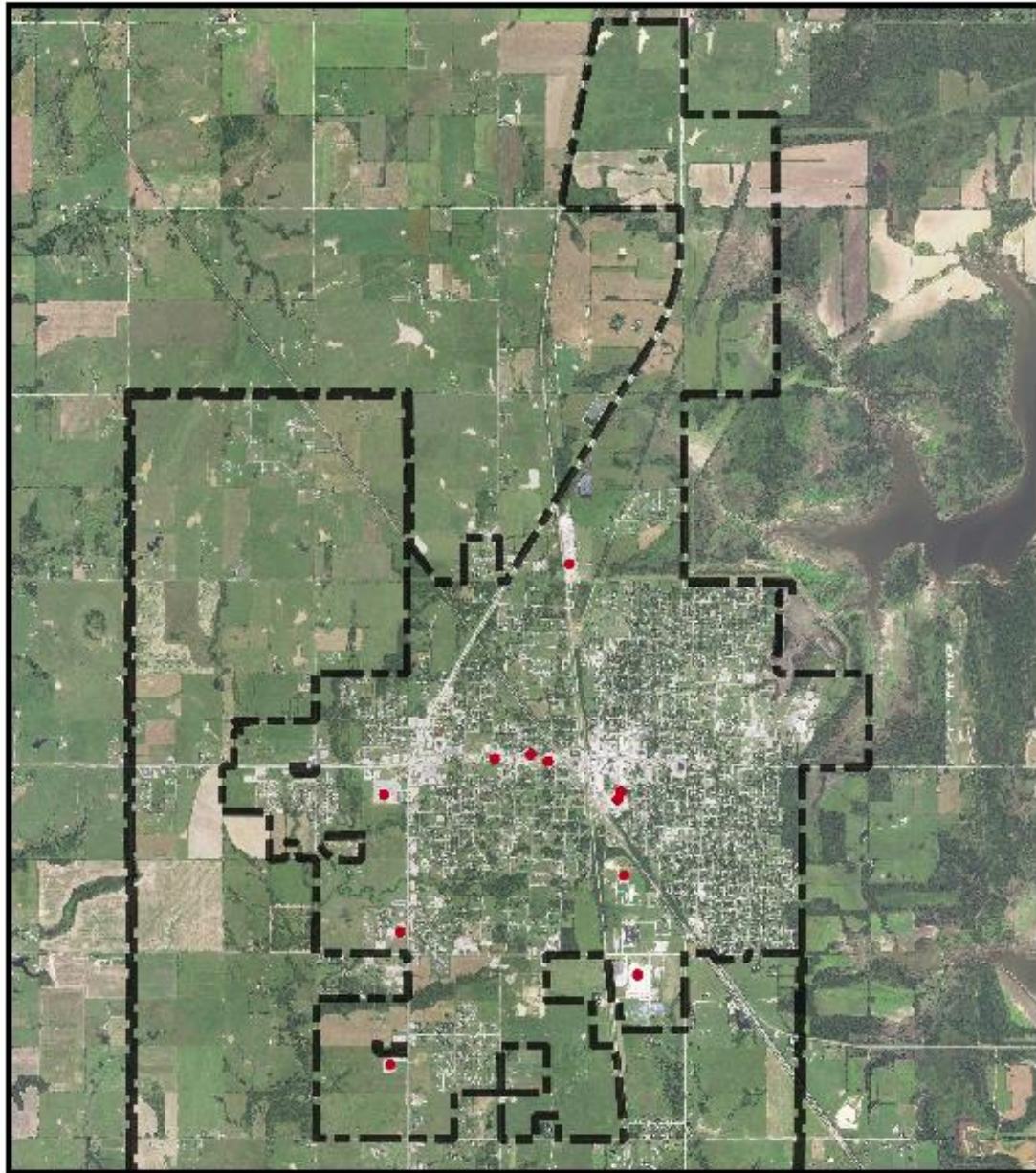












**Legend**

-  Wagoner City Limits
-  Hazardous Materials Facilities


**City of Wagoner  
Hazard Mitigation Plan**

**Hazardous Materials  
Storage Facilities**

Map Number 10

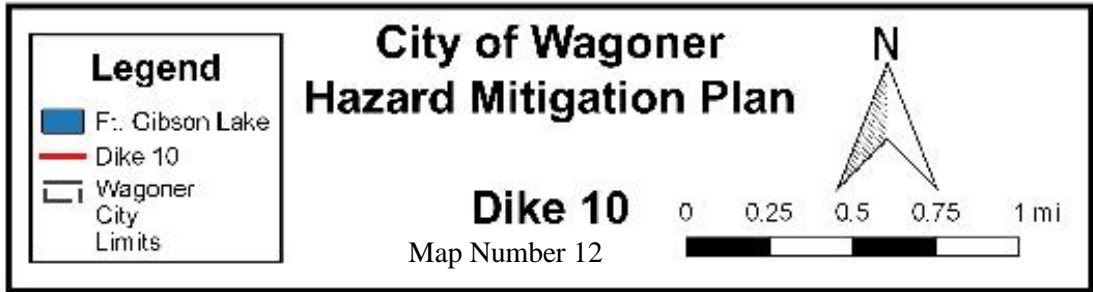
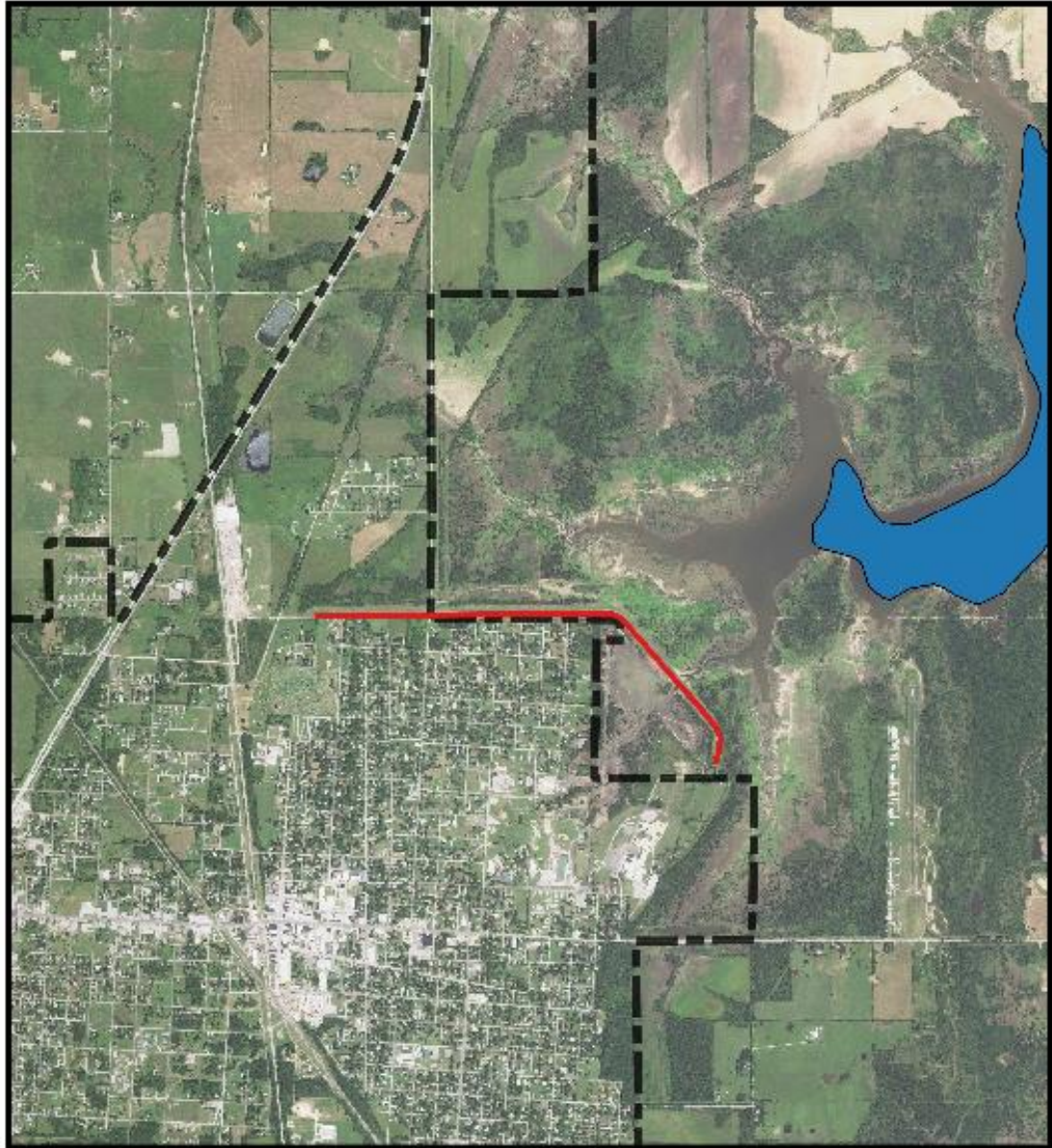


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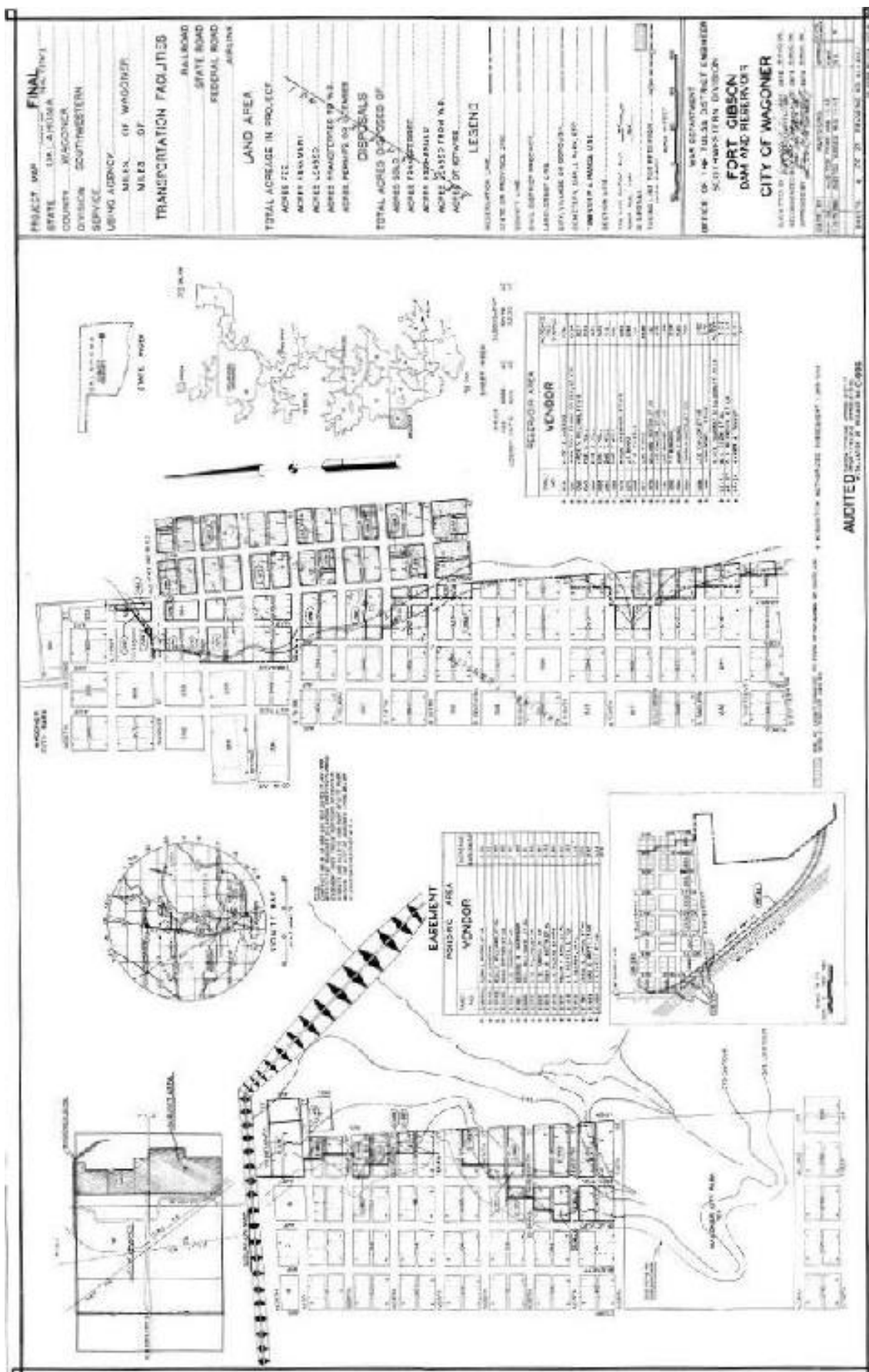


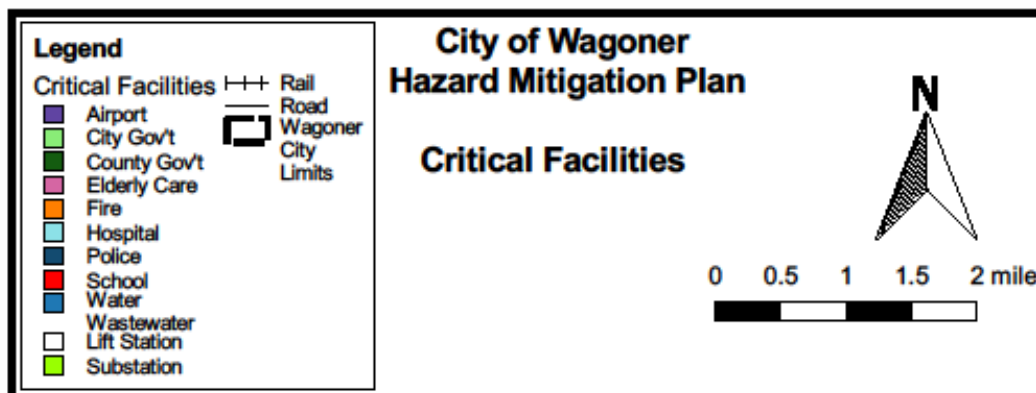
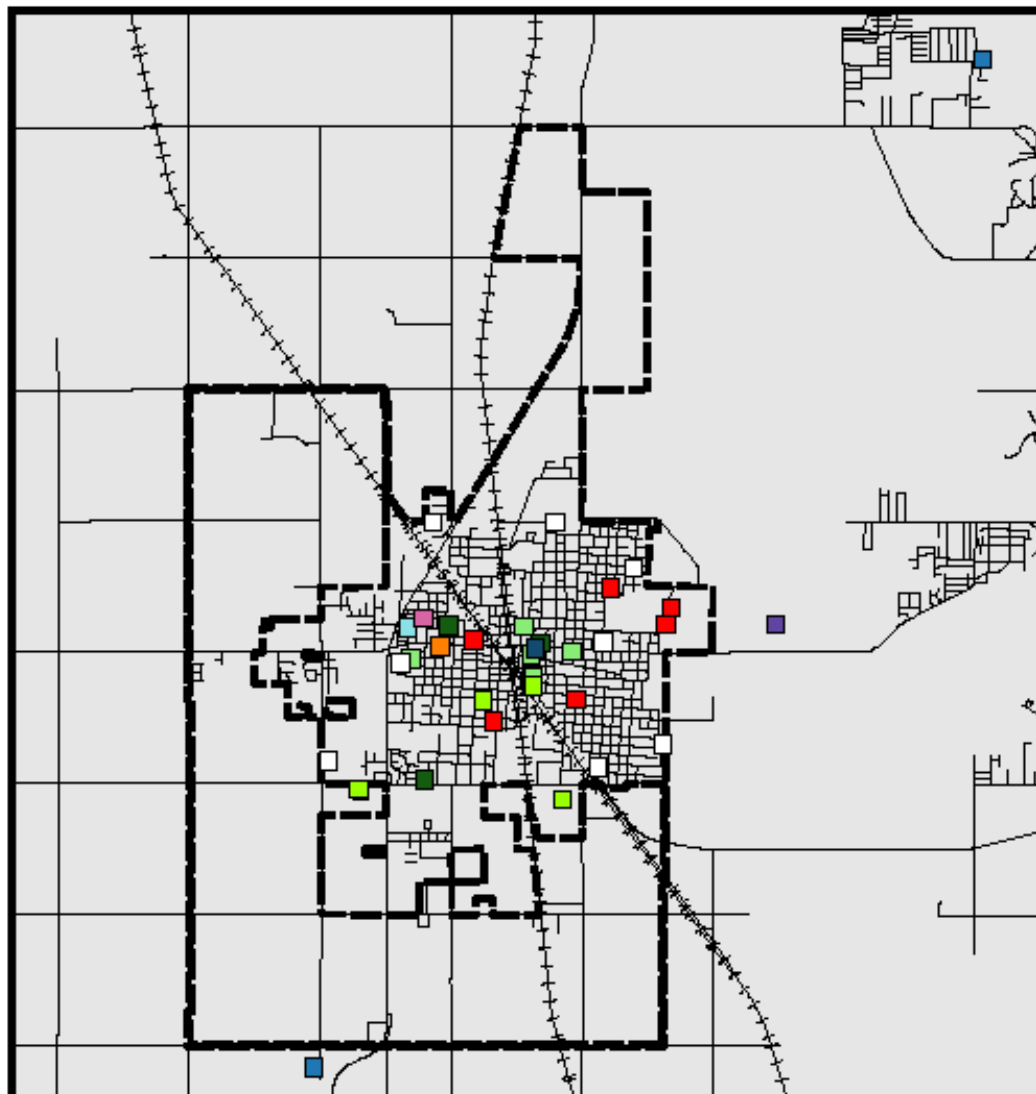












Map Number 14



**City of Wagoner**

**Gas Transmission Pipe Line**

Map Number 15



**City of Wagoner**  
**Railroad Line Map**

Map Number 16

Map Number 17 reserved for future use

## ***Appendix 2: Committee Meetings***

## Meeting #1 Agenda

# **The City of Wagoner Hazard Mitigation Plan Update Meeting**

City Hall  
The City of Wagoner Building  
231 E. Church Street  
Wagoner, OK

October 18, 2016  
8:30 am

### Meeting Agenda

1. Call to order.
2. Introductions.
3. Discussion on the need for this multi-hazard mitigation plan.
4. Discussion on the involvement of the jurisdictions; The City of Wagoner, and the Wagoner School District.
5. Establishment of a committee to facilitate the creation of the City of Wagoner Hazard Mitigation Plan, and appoint the Floodplain Administrator to work with the City Planner.
6. Review draft of entire Hazard Mitigation Plan developed by the Floodplain Administrator and discuss items to remove and to add to initial draft.
7. Set date for initial review comments from participants.
8. Adjourn.

### Meeting #1 Attendance

Name	Jurisdiction
Albert Jones	Mayor, City of Wagoner
Larry Morgan	Emergency Manager, Superintendent, City of Wagoner
Dwayne Elam	Director of Public Works, City of Wagoner
W. B. Smith	Floodplain Administrator, City of Wagoner
Chief Bob Haley	Police Chief
Chief Kelly Grooms	Fire Chief
Taylor Tannehill	City Planner
Tony Ponds	Wagoner Police - Deputy Chief
Charity Muehlenweg	Publicity - City of Wagoner

## Meeting #1 Minutes



FLOODPLAIN ADMINISTRATOR

October 18, 2016  
City of Wagoner Hazard Mitigation Plan Update Meeting No. 1  
City Council Chambers, City Hall  
231 E. Church Street  
Wagoner, Oklahoma

### Minutes of Meeting No. 1

1. The Meeting was called to order at 8:30 AM
2. General Introductions were made around the room since Mr. Smith is "new" to the community
3. Bill Smith discussed the need for the City of Wagoner to have a Multi-Hazard Mitigation Plan.
4. The basic format of this plan has been in development for almost a year to create a basis for a) potential funding opportunities, b) to be eligible for disaster assistance, and c) to separate the City from the original Wagoner County Multi-Jurisdictional Hazard Mitigation Plan that was allowed to expire. The Floodplain Administrator and the Mayor and Public Works Director have been identifying issues that need resolution and to prepare a plan for implementation.
5. Each person was to take a copy of the initial draft back to their respective departments/agencies and review and provide comments.
6. Each of the proposed Action Items was reviewed. #1 was deleted; #6 was deleted; #7 was discussed concerning Hazardous Waste being transported by rail through downtown Wagoner; #13 was discussed about additional locations for safe rooms; #16 was deleted; #21 - the police chief was preparing a list of elderly for A/C units (in progress); #23 was discussed and deleted as there is already a fire break at the refuge and agricultural area surrounding the City of Wagoner; #25 was discussed - there are two existing repeater towers and three are being replaced by the City so there will be 5 for police use; #35 was requested to add three more - there are currently 14 sirens; #39 was deleted.
7. New action items included generators at sewage lift stations (3 permanent) and floodproofing the wastewater treatment plant.
8. It was agreed that review comments would be provided within 60 days of the meeting and then another meeting would be scheduled.
9. The meeting adjourned at 11:55 AM.

SIGNED:

W.B. SMITH, P.E. CFM, FLOODPLAIN ADMINISTRATOR  
Office Telephone: (918) 865-6977  
Cell Phone: (918)- 625-2449



Meeting #2 Agenda

**The City of Wagoner Hazard Mitigation Plan Meeting**  
City Hall  
Wagoner, OK

November 7, 2017  
10:00 am

Meeting Agenda

1. Call to order.
2. Introductions.
3. Discuss outstanding data to complete Hazard Mitigation Plan
4. Provide input to Randy Harris - Superintendent of Schools
5. Present general population hazard awareness survey.
6. Discuss changes to initial draft report.
7. Set date and time for Public meeting.
8. Adjourn.

Meeting #2 Attendance

<b>Name</b>	<b>Jurisdiction</b>
Albert Jones	Mayor, City of Wagoner
Chief Kelly Grooms	Emergency Manager, Fire Chief, City of Wagoner
W. B. Smith	Floodplain Administrator, City of Wagoner
Randy Harris	Superintendent of Schools
Chief Bob Haley	Police Chief
Chief Kelly Grooms	Fire Chief
Taylor Tannehill	City Planner
Tony Ponds	Wagoner Police - Deputy Chief
Jim Roberts	Emergency Management Services

## Meeting #2 Minutes



FLOODPLAIN ADMINISTRATOR

November 17, 2017  
City of Wagoner Hazard Mitigation Plan Update Meeting No. 2  
City Council Chambers, City Hall  
231 E. Church Street  
Wagoner, Oklahoma

### Minutes of Meeting No. 1

1. The Meeting was called to order at 10:00 AM
2. Everyone greeted one another
3. All comments have been received and included in the updated version that was provided electronically to Taylor Tannehill. Taylor will distribute the .pdf version to the committee
4. Working with the School Superintendent the past few weeks the School District portion of the Hazard Mitigation Plan is being edited and will be available later today.
5. The public survey (250 hard copies) were distributed to the various committee members and it was agreed that a survey monkey should be developed rather than hard copying and distributing them throughout the community. The Fire and Police Chiefs would provide them to their officers.
6. Smith will send the draft Hazard Mitigation Plan to both Jeff Jacobson and Doc Pruitt (private developers) for their review and input.
7. A public meeting was agreed to be scheduled for 6 PM on December 4th, an hour prior to the regular City Council meeting.
8. A 5-year plan for facilities is being developed
9. The NFIP re-authorization was discussed as well as current FEMA deployment of Region VI personnel due to Hurricanes Harvey, Maria, and Isabel.
10. DEQ will have to review the Hazard Mitigation Plan once adopted by the City Council prior to submittal to FEMA.
11. The meeting adjourned at 11:00 AM.

SIGNED: \_\_\_\_\_

W.B. SMITH, P.E. CFM, FLOODPLAIN ADMINISTRATOR  
Office Telephone: (918) 865-6977  
Cell Phone: (918)- 625-2449



## FLOODPLAIN ADMINISTRATOR

November 19, 2020  
City of Wagoner Hazard Mitigation Plan Update Meeting No. 3  
1:00 PM  
City Council Chambers, City Hall  
231 E. Church Street  
Wagoner, Oklahoma

### Agenda for Meeting No. 3

1. Call to Order
2. Introductions
3. Smith – Power Point Presentation and Review of Updates
4. Discuss Updates and Request Any Additional Data to complete Hazard Mitigation Plan
5. Confirm Date and Time for Second Public Meeting.
6. Adjourn

### Meeting #3 Attendance

<b>Name</b>	<b>Jurisdiction</b>
Albert Jones	Mayor, City of Wagoner
Dwayne Elam	City Administrator - Director of Public Works
Chief Kelly Grooms	Emergency Manager, Fire Chief, City of Wagoner
W. B. Smith	Floodplain Administrator, City of Wagoner
Rhonda Hash	City Clerk
Chief Bob Haley	Police Chief
Robyn Murray	City Planner
Gordon Goins	Code Inspector
Kevin Hershberger	Wagoner Street Department
Daryl Nieto	Developer – Anchor Homes
Jeff Jacobson	Developer – S&J Homes



FLOODPLAIN ADMINISTRATOR

November 19, 2020  
City of Wagoner Hazard Mitigation Plan Update Meeting No. 3  
City Council Chambers, City Hall  
231 E. Church Street  
Wagoner, Oklahoma

Minutes of Meeting No. 3

1. The Meeting was called to order at 1:06 PM
2. Everyone greeted one another, Social Distancing and Masks were advised
3. All comments have been received and included in the updated version that was provided electronically to Robyn Murray – City Planner. Robyn distributed the .pdf version to the committee prior to the meeting. A new local developer has joined the committee as Doc Pruitt is no longer able to attend. During the past 3 years the HMGP has been updated to incorporate OEM and FEMA comments, and to expand the plan for the School District in more detail and additional action items have been included.
4. A public meeting was agreed to be scheduled for 6 PM on December 10<sup>th</sup> at the Civic Center. Smith will make a power point presentation summary of the latest version of the HMGP to any public attendees. Six (6) sets of books will be available on socially distanced tables for review after the presentation. A .pdf of the HMGP will be posted on the City web site and/or public may bring a thumb drive to City Hall to download and review. Public comments will be received until December 31, 2020, and the HMGP will be submitted to Oklahoma Emergency Management for a second review.
5. A 5-year plan for facilities is being developed
6. DEQ will have to review the Hazard Mitigation Plan once adopted by the City Council prior to submittal to FEMA.
7. The meeting adjourned at 2:10 PM.

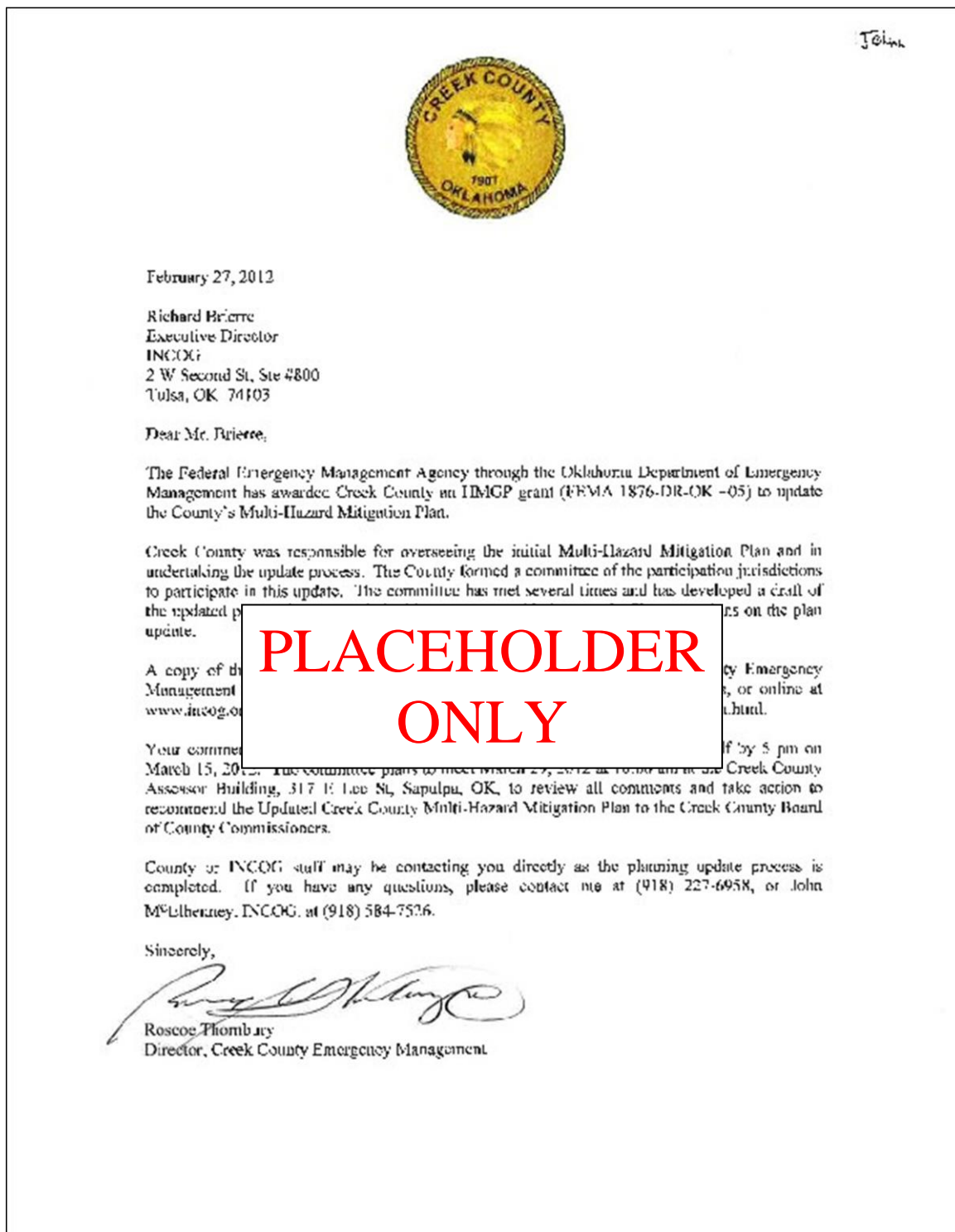
SIGNED: \_\_\_\_\_

A handwritten signature in black ink, appearing to be "W.B. Smith", written over a horizontal line.

W.B. SMITH, P.E. CFM, FLOODPLAIN ADMINISTRATOR/STORMWATER COORDINATOR  
Office Telephone: (918) 865-6977  
Cell Phone: (918)- 625-2449



## ***Appendix 3: Sample Comment Letter***



List of organizations that were sent comment letters.

Floodplain Coordinator  
US Army, Corps of Engineers

Executive Director  
Tulsa Area Chapter American Red Cross

District Operations Director  
Oklahoma Conservation Commission

Assistant Director  
Oklahoma Department of Environmental Quality

State NFIP Coordinator Oklahoma  
Water Resources Board

Director  
Oklahoma Department of Wildlife Conservation

State Hazard Mitigation Officer  
Oklahoma Emergency Management

City of Wagoner  
Council Members

Executive Director  
INCOG



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# ***Appendix 4: Questionnaire***

## HAZARD MITIGATION SURVEY

The City of Wagoner is in the process updating the City Multi-Hazard Mitigation Plan. This will be strategic planning guide to reduce the City's impact from natural hazards and hazardous materials, in fulfillment of the Hazard Mitigation Grant Program requirements of the FEMA. This survey is intended to understand the citizen's awareness and concern of hazards that could impact The City of Wagoner.

For the following hazards, please circle the corresponding number indicating how concerned you are about these hazards affecting The City of Wagoner.

<b>HAZARD</b>	<b>Very Concerned</b>	<b>Concerned</b>	<b>Somewhat Concerned</b>	<b>Not Concerned</b>
Dam/Dike 10 Levee Breaks	40	58	97	98
Drought	15	68	108	103
Earthquakes	23	66	124	80
Expansive Soils	16	40	88	148
Extreme Heat	37	83	96	78
Floods	71	86	99	38
Hailstorms	52	68	112	60
Hazardous Materials Events	60	72	85	75
High Winds	71	109	86	28
Lightning	33	75	119	66
Severe Winter Storms	70	93	93	37
Tornados	129	91	61	13
Wildfires	50	71	95	76
Other Hazard: _____				
Other Hazard: _____				

Last day of survey is November 27, 2017.

If you have any comments, suggestions, or additional concerns, please note them on the back of this survey.

Please return surveys to City Hall to the Attention of Taylor Tannehill, City Planner

## Survey Results

Hazard	Weighted Average Survey Score
Dam Break	2.14
Drought	1.98
Earthquakes	2.11
Expansive Soils	1.74
Extreme Heat	2.27
Floods	2.65
Hailstorms	2.38
Haz Mat Events	2.40
High Winds	2.76
Lightning	2.26
Severe Winter Storms	2.67
Tornados	3.14
Wildfires	2.33

### Scoring:

Not concerned	= 1 point (minimum score per hazard)
Somewhat concerned	= 2 points
Concerned	= 3 points
Very concerned	= 4 points (maximum score per hazard)

### Results:

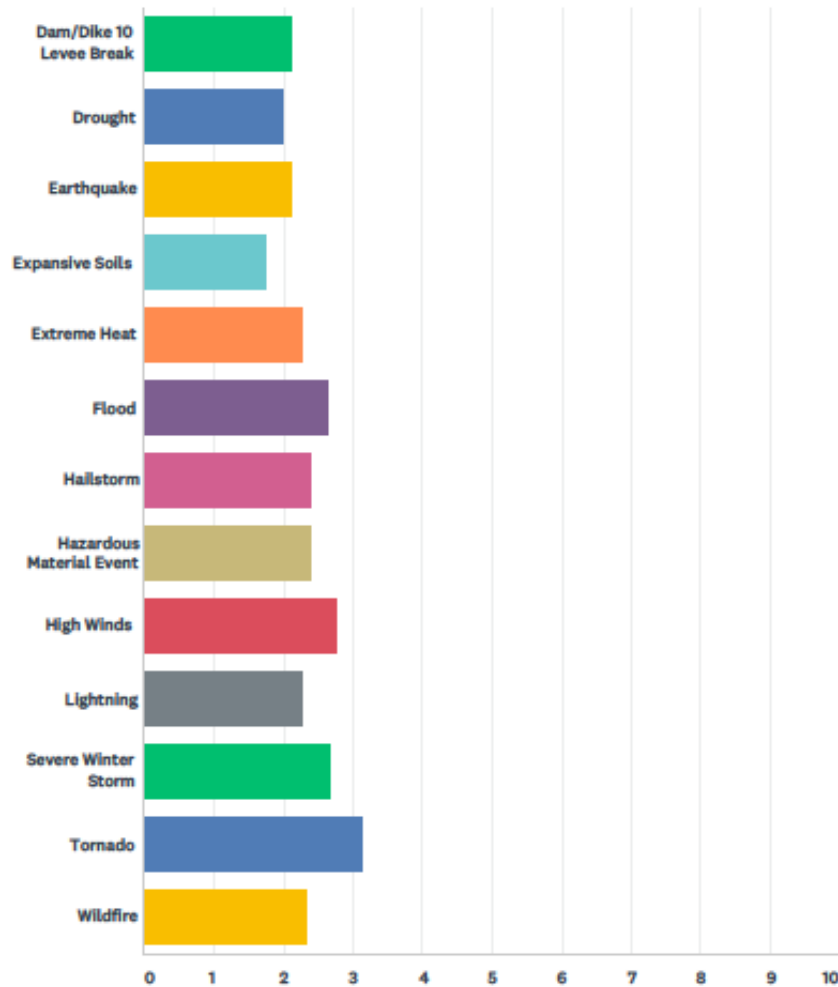
294 Responses

Hazard of Most Concern is Tornado

Hazard of Least Concern is Expansive Soils

**Q1 On a scale of 1-4, please rate each hazard according to how concerned you are for the potential to affect the City of Wagoner.**

Answered: 294 Skipped: 0



	NOT CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	TOTAL	WEIGHTED AVERAGE
Dam/Dike 10 Levee Break	33.45% 98	33.11% 97	19.80% 58	13.65% 40	293	2.14
Drought	35.03% 103	36.73% 108	23.13% 68	5.10% 15	294	1.98
Earthquake	27.30% 80	42.32% 124	22.53% 66	7.85% 23	293	2.11

1 / 3

Hazard Mitigation Survey

SurveyMonkey

Expansive Soils	50.34% 146	30.34% 88	13.79% 40	5.52% 16	290	1.74
Extreme Heat	26.53% 78	32.65% 96	28.23% 83	12.59% 37	294	2.27
Flood	12.93% 38	33.67% 99	29.25% 86	24.15% 71	294	2.65
Hailstorm	20.55% 60	38.36% 112	23.29% 68	17.81% 52	292	2.38
Hazardous Material Event	25.68% 75	29.11% 85	24.66% 72	20.55% 60	292	2.40
High Winds	9.52% 28	29.25% 86	37.07% 109	24.15% 71	294	2.76
Lightning	22.53% 66	40.61% 119	25.60% 75	11.26% 33	293	2.26
Severe Winter Storm	12.63% 37	31.74% 93	31.74% 93	23.89% 70	293	2.67
Tornado	4.42% 13	20.75% 61	30.95% 91	43.88% 129	294	3.14
Wildfire	26.03% 76	32.53% 95	24.32% 71	17.12% 50	292	2.33

## Q2 If you have any comments, suggestions, or additional concerns, please note them below.

Answered: 38 Skipped: 256

#	RESPONSES	DATE
1	None.	11/13/2017 8:11 PM
2	Need a bridge over railroad tracks so we aren't waiting on trains as much. Especially for emergency crews. Fix the hwy 51 road in town, it's awful.	11/11/2017 10:06 PM
3	No more dueling train horns at 1 - 3 am	11/10/2017 5:39 PM
4	Electric Lines falling due to many old poles and connections to old homes.	11/8/2017 11:15 PM
5	Water treatment	11/8/2017 6:10 PM
6	Why don't we have a homeless shelter? Instead of spending money on useless stuff, why not care about our homeless citizens first?	11/8/2017 3:48 PM
7	Water quality how good is it? Do you add fluoride to our water? I have gotten letters over the years that the water is poor.	11/8/2017 9:23 AM
8	More ORGANIZED events take the switch monkey festival and the tractor pull events as one to revenue more vendors at one time	11/8/2017 8:36 AM
9	Storm sewers need improvement. They are not adequate to handle the volume of water we get during heavy rainfalls.	11/8/2017 6:42 AM
10	Downtown floods quite often and desperately needs adequate drainage and road improvement. Additionally, there is congestion and debris from the fire and small businesses are suffering as a result. The road block as well as the blocking of downtown parking and businesses in general is naturally causing people to find alternatives to downtown businesses, in turn stunting growth and development.	11/8/2017 4:16 AM
11	Repaving Cherokee St should be goal number 1	11/8/2017 1:40 AM
12	Please publish information that explains the meanings of the types of sirens, how to know when a threat is over, plus available shelters or other resources.	11/7/2017 10:34 PM
13	Littering/illegal dumping fine signs are absent	11/7/2017 9:55 PM
14	We need a storm shelter like other towns have	11/7/2017 9:23 PM
15	Looks like someone trying to make a job for themselves.	11/7/2017 8:56 PM
16	Sounds outdated, unfortunately not... fall out shelters? Or education on potential scenarios	11/7/2017 8:23 PM
17	Prepare for mass shootings	11/7/2017 7:53 PM
18	Food, potable water, sanitation for long term disaster	11/7/2017 7:28 PM
19	Need more parks and our sports complex	11/7/2017 7:17 PM
20	A community storm shelter would be nice.	11/7/2017 7:10 PM
21	The condition some of these renters and slumlords have their properties in only magnify if indeed there were an extreme situation with the hazard... It's bringing down everyone else's property value and could be a hazard to those around if there was a disaster. We need to enforce the ordinances have these houses taken care of. The the slumlords need to abide by the same rules that everyone else does. No overgrown vegetation and trees. Debris and trash on property or home in disrepair.	11/7/2017 7:01 PM
22	I feel like we should require people to keep trash in their yard minimal and trim their trees off the powerlines. Not have tents/sheds plugged in by extension cords. Its fire hazards.	11/7/2017 6:53 PM
23	Our roads	11/7/2017 6:44 PM
24	I feel that our city will do a great job dealing with any of these disasters.	11/7/2017 6:26 PM

## Hazard Mitigation Survey

SurveyMonkey

25	Lack of access to public tornado shelters is a concern. I've heard of a possible school bond being passed that would include a shelter but that only serves a small part of town.	11/7/2017 6:07 PM
26	Crime	11/7/2017 6:02 PM
27	Thank you for serving our community	11/7/2017 6:02 PM
28	I have concerns about preparations for a derailment / spill / fire	11/7/2017 5:44 PM
29	None	11/7/2017 5:35 PM
30	No	11/7/2017 5:35 PM
31	my concerns are about the power in wagoner going off a lot.	11/7/2017 5:29 PM
32	Someone needs to fix Cherokee st	11/7/2017 5:24 PM
33	Improve city roads and add sidewalks	11/7/2017 5:24 PM
34	NONE	11/7/2017 4:59 PM
35	railway emergency with hazardous materials. are our First Responders adequately prepared. My gut tells me they are not	11/7/2017 4:57 PM
36	None	11/7/2017 4:57 PM
37	The officials seem to be on top of the cities problems.	11/7/2017 4:49 PM
38	N/A	11/7/2017 4:43 PM



# ***Appendix 5: Plan Adoption Resolutions***

RESOLUTION NUMBER ~~2013-103~~

RESOLUTION OF CREEK COUNTY  
ADOPTING THE CREEK COUNTY  
MULTI-HAZARD MITIGATION PLAN UPDATE - 2012

**WHEREAS**, the 2012 Multi-Hazard Mitigation Plan Update (the "PLAN") for Creek County is presented in fulfillment of requirements of the Hazard Mitigation Grant Program (HMGP) for the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), Title 42 United States Code (U.S.C.), Sections 5121 et seq., as amended, and Title 44 Code of Federal Regulations (CFR), Subchapter D-Disaster Assistance, Subpart M-Hazard Mitigation Planning, Sections 206.400, and

**WHEREAS**, jurisdictions, evaluate additional outline a strategy

**WHEREAS**, the next five that are most effective and appropriate for mitigating natural hazards and hazardous materials incidents.

**PLACEHOLDER  
ONLY**

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d property,  
fiction, and

activities for  
nt activities


**NOW, THEREFORE, BE IT RESOLVED BY CREEK COUNTY;**

That the Multi-Hazard Mitigation Plan Update 2012 for Creek County, including the participating jurisdictions, presented in fulfillment of requirements of the Hazard Mitigation Grant Program (HMGP) for the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), Title 42 United States Code (U.S.C.), Sections 5121 et seq., as amended, and Title 44 Code of Federal Regulations (CFR), Subchapter D-Disaster Assistance, Subpart M-Hazard Mitigation Planning, Sections 206.400, et seq., is hereby approved and adopted by Creek County:

That the Plan approved and adopted by this Resolution is more particularly entitled Creek County Multi-Jurisdictional Multi-Hazard Mitigation Plan Update – 2012 (Including Creek County).

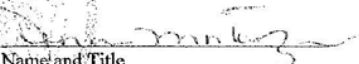
**APPROVED** by the Creek County Board of County Commissioners on December 9, 2013

CREEK COUNTY

  
\_\_\_\_\_  
Name and Title

12/9/13  
\_\_\_\_\_  
Date



**ATTEST:**  
  
\_\_\_\_\_  
Name and Title

12/9/13  
\_\_\_\_\_  
Date

RESOLUTION NUMBER \_\_\_\_\_

RESOLUTION OF THE ALLEN-BOWDEN PUBLIC SCHOOLS  
ADOPTING THE CREEK COUNTY  
MULTI-HAZARD MITIGATION PLAN UPDATE - 2012

WHEREAS, the 2012 Multi-Hazard Mitigation Plan Update (the "PLAN") for Creek County is presented in fulfillment of the requirements of the Hazard Mitigation Grant Program (HMGP) for the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), Title 42 United States Code (U.S.C.), Sections 5121 et seq., as amended, and Title 44 Code of Federal Regulations (CFR), Subchapter D Disaster Assistance, Subpart B-Hazard Mitigation Planning, Sections 201.100 et seq., is hereby approved and adopted by the Allen-Bowden Public Schools:

**PLACEHOLDER  
ONLY**

WHEREAS, the Plan approved and adopted by this Resolution is more particularly entitled Creek County Multi-Jurisdictional Multi-Hazard Mitigation Plan Update - 2012 (Including the Allen-Bowden Public Schools) and is attached to this resolution.

WHEREAS, the objective of this Plan is to provide guidance for each jurisdiction's activities for the next five-years and to ensure that Creek County and other jurisdictions implement activities that are most effective and appropriate for mitigating natural hazards and hazardous materials incidents.

NOW, THEREFORE, BE IT RESOLVED BY THE ALLEN-BOWDEN PUBLIC SCHOOLS,

That the Multi-Hazard Mitigation Plan Update 2012 for Creek County, including the participating jurisdictions, presented in fulfillment of requirements of the Hazard Mitigation Grant Program (HMGP) for the Federal Emergency Management Agency (FEMA), according to the Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), Title 42 United States Code (U.S.C.), Sections 5121 et seq., as amended, and Title 44 Code of Federal Regulations (CFR), Subchapter D Disaster Assistance, Subpart B-Hazard Mitigation Planning, Sections 201.100 et seq., is hereby approved and adopted by the Allen-Bowden Public Schools:

That the Plan approved and adopted by this Resolution is more particularly entitled Creek County Multi-Jurisdictional Multi-Hazard Mitigation Plan Update - 2012 (Including the Allen-Bowden Public Schools) and is attached to this resolution.

APPROVED by the Allen-Bowden Public Schools Board of Education on Jan. 13, 2014

ALLEN-BOWDEN PUBLIC SCHOOLS

[Signature] Supt. 1/13/14  
Name and Title Date

ATTEST:

[Signature] 1/13/14  
Name and Title Date

# ***Appendix 6: Hazard Summary***

# Natural Hazard Assessments

Each hazard is assigned a likelihood rating based on the criteria and methods described below.

Likelihood of Event "Rating" is based on the following definitions		
Highly likely (HL)	Event is probable within the calendar year.	
Likely (L)	Event is probable within the next three years.	
Occasional (O)	Event is probable within the next five years.	
Unlikely (UL)	Event is possible within the next ten years.	

Based on History, and using the information described above, Likelihood of Event is "Quantified" as follows:		
Highly Likely (HL)	Event has 1 in 1 year chance of occurring	1/1 = 100%
Likely (L)	Event has 1 in 3 years chance of occurring	1/3 = 33%
Occasional (O)	Event has 1 in 5 years chance of occurring	1/5 = 20%
Unlikely (UL)	Event has 1 in 10 years chance of occurring	1/10 = 10%

Which results in the following "Ranges" of Likelihood:	
Event is "Highly Likely" to occur – History of events is greater than 33%.	
Event is "Likely" to occur – History of events is greater than 20%, but less than or equal to 33%.	
Event could "Occasionally" occur – History of events is greater than 10%, but less than or equal to 20%.	
Event is "Unlikely," but is possible of occurring – History of events is less than 10%.	

Example: NWS-NCDC records show that 38 tornadoes were reported in Example City between 01/01/1950 and 12/31/2003. 38 events divided by 53 years = 0.72(72%) which would make future occurrences "Highly Likely" to happen.

This table's format, categories, and the criteria for completing the table, was supplied by the Oklahoma Department of Emergency Management, 06/29/2004.

**Table: The City of Wagoner Hazard Summary**  
**Summary of Hazards for The City of Wagoner Multi-Hazard Mitigation Plan**

Hazard Event	History	Estimated Total Dollar Loss (\$\$)	Average Cost Per Event (\$\$)	Likelihood Percentage	Likelihood Rating
Floods	9 events from 1950 thru 2015	10,780,000	138,205	78/60>100%	HL
Tornado	61 events from 1950 thru 2015	51,933,000	851,361	61/61=100%	HL
High Wind	287 events from 1950 thru 2015	1,916,000	6,676	287/61>100%	HL
Lightning/Thunderstorm	5 events from 1950 thru 2015	268,000	53,600	5/61=8%	UL
Hailstorms	207 events from 1950 thru 2015	365,000	1,763	207/61>100%	HL
Winter Storms	30 events from 1950 thru 2015	50,155,000	1,671,833	30/61=49%	HL
Extreme Heat	10 events from 1950 thru 2015	0	0	10/61=16%	O
Drought	3 events from 1950 thru 2015	0	0	11/61=18%	O
Expansive Soils	zero events from 1950 thru 2015	0	0	0%	UL
Wildfire	34 grass fire runs in 2015-2016	126,000	126,000	>100%	HL
Earthquake	One significant event from 1950 - 2016	0	0	0%	UL
Hazmat Events	2 vehicle accident runs in 2016 (2), 19 Total 1950-2020	12,000	12,000	>100%	HL
Dam Break	zero events from 1950 thru 2015	0	0	0%	UL

Note: where zero events or zero dollar amounts are shown, this means there was no data reported for the hazard event.

1. For the City of Wagoner Fire Department
2. For the City of Wagoner Fire Department

# ***Appendix 7: Risk Assessment and Vulnerability Analysis for the City of Wagoner and the School District***

## **Appendix 7: 3.1 Identifying Hazards**

---

There were 13 hazards investigated by the CWEMAC. These were considered to all be relevant to the City of Wagoner and the School District, following the committee's hazard information search. Hazard identification was discussed at the initial hazard mitigation planning meetings, held on October 18, 2016.

The hazards are listed in Table 2.3. The table lists each hazard, the items that were considered in how the hazard was identified, and why each hazard was identified. Hazard information was obtained from the City Emergency Management, Community Officials, review of FIRMs, and City, School District, and public input.

## **Appendix 7: 3.2 Profiling Hazard Events**

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This section provides a profile of each hazard. In this section, the letter "X", when included in a subsection identification label, refers to a specific hazard's subsection, as follows:

X=1 Flood Hazard	X=8 Drought Hazard
X=2 Tornado Hazard	X=9 Expansive Soils Hazard
X=3 High Winds Hazard	X=10 Wildfire Hazard
X=4 Lightning Hazard	X=11 Earthquake Hazard
X=5 Hail Storm Hazard	X=12 Hazardous Material Hazard
X=6 Winter Storm Hazard	X=13 Dam Break
X=7 Heat Hazard	

Subsection 3.2.X.1 describes each hazard, subsection 3.2.X.2 identifies the location of the hazard, subsection 3.2.X.3 identifies the extent (such as severity or magnitude) of the hazard, subsection 3.2.X.4 provides information on previous occurrences, subsection 3.2.X.5 discusses the probability of future occurrences, and subsection 3.2.X.6 discusses vulnerability and impact. Each hazard affects the City of Wagoner, as a whole, except floods, expansive soils, wildfires, and dam breaks which are location specific.

## **3.2.1 Flood Hazard**

3.2.1.1 Flooding is defined as the accumulation of water within a water body and the overflow of the excess water onto adjacent lands. The floodplains are the lands adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding.

Flooding can take many forms including river floods (riverine), Internal Drainage, and flash floods. The most likely event for serious flooding would be flash flooding due to storm water drainage backup caused by a large amount of rain from a thunderstorm. Flash floods occur with little or no warning and can reach peak flow within a few minutes. Waters from flash floods move with great force and velocity and can roll boulders, tear out trees, destroy buildings, and sweep away bridges. These walls of water can reach heights of 10 to 30 feet and generally carry large amounts of debris. Most flood deaths are due to flash floods.

3.2.1.2 The location of the flood hazard in The City of Wagoner, including the School District property, is its regulatory floodplain, as defined by the City's FEMA Flood Insurance Rate Maps (FIRMs). The regulatory floodplain lies in several watersheds within the City of Wagoner. The flood hazard for the City of Wagoner is shown on Map Number 6 in Appendix 1.

The FEMA defined regulatory floodplain is shown on the City of Wagoner Flood Insurance Rate Map (FIRM) panels. One specific area of concern is behind Dike 10 due to Interior Drainage Flooding. This area was originally shown as a Special Flood Hazard Area, but was removed by a LOMR in 2012. Five (5) residential properties with structures and the City's School District Bus Barn are in the Interior Drainage floodplain, and this area remains an area of concern for flooding due to the operation of the valves discharging stormwater runoff into Ft. Gibson Lake, or are located in the USACE Flowage Easement, and have had repetitive flooding issues. When Ft. Gibson Lake reaches Elev. 561.5 the gates for the Outlet Structure are closed; thus, rainfall from approximately 566 acres flows into the area behind Dike 10 and "ponds" until Ft. Gibson Lake drops below Elev. 562 when the gates are re-opened. This area is currently under restudy by the City's Floodplain Administrator with potential re-mapping of the Interior Drainage area and possible mitigation using a permanent pumping system.

3.2.1.3 The severity of a flood is determined by several factors; including, rainfall intensity, duration, and location, and ground cover imperviousness and degree of saturation. The magnitude of the flood hazard is the regulatory floodplain. The regulatory floodplain is defined as the area inundated by the runoff from the rainfall having a one-percent chance (100-Year) of occurring in any given year. Although flooding is an identified hazard, the effects have been minimal except for a few locations in the City. The regulatory floodplain is identified in the City's Flood Insurance Rate Maps (FIRMs) as Zone A and Zone AE with floodway. The following table describes the FIRM's flood zones.

Table 3-1

<b>FLOOD ZONES</b>		
<b>Zone A</b>	The 100-year or Base Floodplain. There are seven types of A zones:	
	<b>A</b>	The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This is often called an unnumbered A zone or an approximate A zone.
	<b>A1-30</b>	These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the firm shows a BFE (old format).
	<b>AE</b>	The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
	<b>AO</b>	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	<b>AH</b>	Shallow flooding base floodplain. BFE's are provided.
	<b>A99</b>	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
<b>Zone V and VE</b>	<b>AR</b>	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
	<b>V</b>	The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM.
<b>Zone B and Zone X (shaded)</b>	<b>VE</b>	The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM.
	Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.	
<b>Zone C and Zone X (unshaded)</b>	Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood.	
<b>Zone D</b>	Area of undetermined but possible flood hazards.	

3.2.1.5 Historically, the City has recognized flooding as a hazard. The City joined the National Flood Insurance Program (NFIP) in 1982, adopting a Flood Damage Prevention Resolution, and requiring that all future development be built one foot above the 100-year base flood elevation. According to the National Climatic Data Center, from 1950 through 2010, The City of Wagoner has had 9 flood events, causing an estimated \$10,780,000 in total damages. There are also a number of local storm drainage issues throughout the City that contribute to localized street flooding.

FEMA data shows there is one (1) Severe Repetitive Loss property in The City of Wagoner. The other unofficial repetitive loss properties are in an area behind Dike 10 that was believed to have been inadvertently removed from the Special Flood Hazard Area. There are structures in this area that were not permitted by the City of Wagoner and were constructed within the USACE Flowage Easement without authorization.

The City of Wagoner recognizes flooding as a hazard, joining the NFIP in 1982, and continues to enforce its flood damage prevention ordinance. There have been four reported flood hazards in the City of Wagoner during this same 61 year time period.

Appendix 6 summarizes previous occurrences in The City of Wagoner of this hazard.

3.2.1.6 The probability of future flooding from the regulatory floodplain is statistically a one-percent chance of occurring in any given year, the 100-year floodplain. The City and



participating communities require all new development to develop in compliance with their flood damage prevention ordinance. Therefore, new development will not cause an increase in the flood hazard by not increasing the hazard on to adjacent property and building new structures above the regulatory flood elevation; both provisions of the ordinance. The probability of future flood damage should not increase with future development. According to the likelihood rating from Appendix 6, the likelihood of a flood hazard in the City is “highly likely” because there were 9 significant flood events from 1950 through 2020. There were also many more localized flooding events, primarily street flooding, due to storm drainage system issues.

Nine flooding events have been reported in Wagoner from 1950 through 2010. This indicates an “highly likely” likelihood rating for a flood hazard event occurring in the future, according to the likelihood rating defined in Appendix 6.

3.2.1.7 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

The low-lying areas in the floodplains and the Dike 10 area would be more susceptible to flooding than areas on higher ground. Roadways in the area are vulnerable and have a history of having to be closed during flooding events. This can cause temporary interruptions to the highway and road system and has the potential to isolate a community for a period of time.

Table 3-2

<b>CONTRIBUTING FACTORS TO THE FLOOD HAZARD</b>	
<b>Factor</b>	<b>Effect</b>
<b>Precipitation Rate</b>	As the rate of precipitation increases, the ground's infiltration rate is exceeded. This is the dominant factor in flash flooding events, and can overwhelm any or all of the following factors.
<b>Training Echoes</b>	Storm cells that follow each other (much like box cars on a train) can repeatedly deposit large amounts of water on the same watershed, overwhelming its ability to handle runoff.
<b>Slope of Watershed</b>	Steeper topography (hills, canyons, etc.) will move runoff into waterways more quickly, resulting in a quicker, flashier response to precipitation.
<b>Shape of Watershed</b>	Longer, narrower watersheds will tend to "meter out" runoff so that water arrives from down shed (nearer to the mouth of the stream) areas faster than from up shed areas. In watersheds that are more square or circular than elongated, runoff tends to arrive in the main stem at the same time, intensifying the response. This factor becomes more significant with larger watersheds.
<b>Saturation of Soils</b>	Saturated or near-saturated soils can greatly reduce the rate at which water can soak into the ground. This can increase runoff dramatically.
<b>Hardened Soils</b>	Extremely dry soils can develop a pavement or "crust" that can be resistant to infiltration. This is especially true in areas of recent wildfire, where plant oils or resins may cause the soil to be even more water-resistant.
<b>Urbanization</b>	The urban environment usually intensifies the response to heavy precipitation. The two dominant urban factors are: 1) increased pavement coverage, which prevents infiltration and dramatically increases runoff; and 2) Urban systems are designed to remove water from streets and byways as quickly as possible. This accelerates the natural response to precipitation by placing runoff in waterways much more quickly.
<b>Low-water crossings</b>	The vast majority of flash flood related deaths occur in vehicles. Many of these deaths occur at low-water crossings where the driver is unaware of the depth of the water or the consequences of driving into it.

It is estimated that 5.5 % of the improved property (3,261 parcels) in the City are located in the 1% (100 year) floodplain. It is unknown the number of people that reside in these residences; these structures are valued at \$4.5 million dollars. There are approximately 94 structures located in the Zone A area on the Un-named North Tributary; approximately 21 structures located in the Zone A areas on the Un-named South Tributary, and approximately 60 structures located in the Zone AE area on East Coal Creek.

There are approximately six (6) improved properties with structures in the City of Wagoner in the regulatory floodplain that have known repetitive flooding issues though only one (1) is noted on the FEMA records. There are an unknown number of people that occupy these buildings.

A typical flood hazard would be an event where rainfall causes runoff to exceed the Wagoner channel capacity spilling runoff into the floodplain fringe, the area between the Wagoner channel and the edge of the regulatory floodplain. This area of inundation would still be regulated by Wagoner's Flood Damage Prevention Ordinance where new buildings are protected under the ordinance and older structures are addressed below in section 3.2.1.4.

The City of Wagoner considers water that stays within the Wagoner beds or does not rise above curbs and causes no damage to be a minor severity. And Wagoner considers water that fills the floodplain, blocks streets and enters homes and businesses to be a major severity.

## **3.2.2 Tornado Hazard**

3.2.2.1 A tornado is a rapidly rotating vortex or funnel of air extending to the ground from a cumulonimbus cloud. When the lower tip of a vortex touches earth, the tornado becomes a force of destruction. The path width of a tornado is generally less than a half-mile, but the path

length can vary from a few hundred yards to dozens of miles. A tornado moves at speeds from 30 to 125 mph, but can generate winds exceeding 300 mph.

3.2.2.2 The City of Wagoner is located west of Tulsa, Oklahoma. The following figure obtained from the FEMA web site shows central Oklahoma, along with the area around Fort Worth Texas, to be the area of highest number of recorded tornados per area in the country. Within The City of Wagoner, no area of the City (including the City of Wagoner) is any more or less at risk from the tornado hazard.

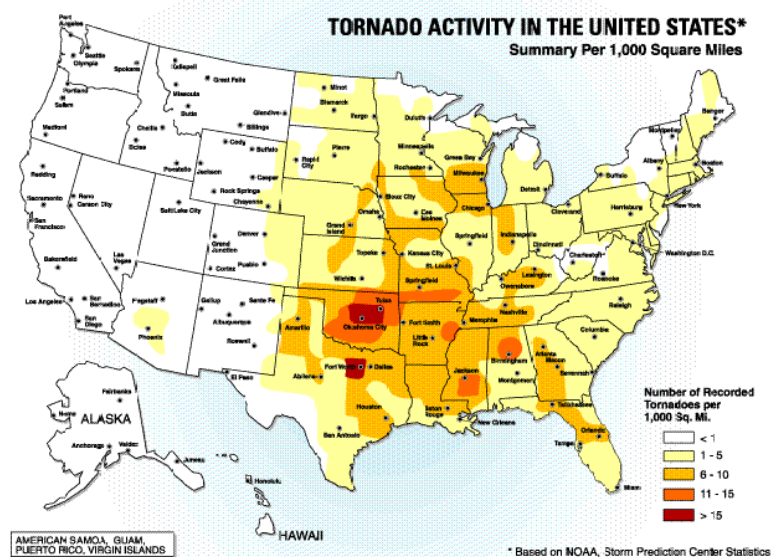


Figure 1.1 The number of tornadoes recorded per 1,000 square miles

3.2.2.3 The severity of tornados is measured on the Fujita Tornado Scale (see table below). Almost 70% of all tornados are measured F0 and F1 on the Fujita Tornado Scale, causing light to moderate damage, with wind speeds between 40 and 112 miles per hour. F4 and F5 tornados are considerably less frequent, but are the big killers. 67 percent of all tornado deaths were caused by F4 and F5 storms, which represent only 1% of all tornados. From 1950 through 2010, The City of Wagoner experienced four tornados with a Fujita Scale magnitude greater than F3.

**Table 3-3  
Fujita Tornado Scale**

Category	Wind Speed (mph)	Damage
F0	Gale tornado (40-72)	<b>Light:</b> Damage to chimneys, tree branches, shallow-root trees, sign boards
F1	Moderate tornado (73-112)	<b>Moderate:</b> Lower limit is beginning of hurricane wind speed—surfaces peeled off roofs, mobile homes pushed off foundations or overturned, cars pushed off roads
F2	Significant tornado (113-157)	<b>Considerable:</b> Roofs torn off frame houses, mobile homes demolished, boxcars pushed over, large trees snapped or uprooted, light-object missiles generated
F3	Severe tornado (158-206)	<b>Severe:</b> Roofs and some walls torn off well-constructed houses, trains overturned, most trees in forest uprooted, cars lifted off the ground and thrown
F4	Devastating tornado (207-260)	<b>Devastating:</b> Well-constructed houses leveled, structures with weak foundations blown off some distance, cars thrown and large missiles generated
F5	Incredible tornado (261-318)	<b>Incredible:</b> Strong frame houses lifted off foundations and carried considerable distance to disintegrate, automobile-sized missiles fly through the air in excess of 100 yards, trees debarked

On February 1, 2007, the Fujita scale was decommissioned in favor of the more accurate Enhanced Fujita Scale, described in the following table. None of the tornados recorded on or before January 31, 2007 will be re-categorized. Therefore maintaining the Fujita scale will be necessary when referring to previous events.

**Table 3-4  
Enhanced Fujita Tornado Scale**

Enhanced Fujita (EF) Scale		
Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
<b>EF0</b>	65-85	<b>Light damage:</b> Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
<b>EF1</b>	86-110	<b>Moderate damage:</b> Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
<b>EF2</b>	111-135	<b>Considerable damage:</b> Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
<b>EF3</b>	136-165	<b>Severe damage:</b> Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
<b>EF4</b>	166-200	<b>Devastating damage:</b> Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
<b>EF5</b>	>200	<b>Incredible damage:</b> Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

source: [http://en.wikipedia.org/wiki/Enhanced\\_Fujita\\_Scale](http://en.wikipedia.org/wiki/Enhanced_Fujita_Scale)

Wagoner considers a tornado event measuring EF0 on the Enhanced Fujita Tornado Scale to be of minor severity. And Wagoner considers tornado events measuring EF1 through EF5 on the Enhanced Fujita Tornado Scale to be of major severity.

3.2.2.4 According to the National Climatic Data Center, from 1950 through 2010, The City of Wagoner has experienced 61 tornados, causing an estimated \$51.9 million in property damage. In this same time period, there has been no reported tornado within the City of Wagoner.

Appendix 6 summarizes previous occurrences in The City of Wagoner of this hazard.

3.2.2.5 Meteorological conditions have not changed, so future tornado events should occur at the same probability as previous events. No area of the City is any more or less at risk from the tornado hazard. According to the likelihood rating from Appendix 6, the likelihood of a tornado hazard in the City is “highly likely” because there were 61 reported tornado events from 1950 through 2010.

No reported tornado within the City of Wagoner from 1950 through 2010 indicates an “unlikely” likelihood rating for a tornado hazard event occurring in the future, according to the likelihood rating defined in Appendix 6. However, considering the probability over the whole City, the community should use a likelihood of “highly likely”.

3.2.2.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

Wagoner is located in what is considered an active part of tornado alley. Every structure in the City is vulnerable to tornados. Structures, automobiles, persons, agriculture, and utilities can sustain damage from tornados. Utility service outages can affect large segments of the population for long periods of time.

Utility infrastructures, such as power lines, substations, water towers and water wells are vulnerable and can be severely damage or destroyed from a tornado. Emergency vehicles responding to the devastated areas can have trouble responding due to down power lines and debris in roadways. Livestock are vulnerable during tornado events and are often killed since there is little protection for the animals on the open range. People caught in the path of a tornado who don’t take shelter have the potential of being injured or killed. Residents most vulnerable to tornados are those living in mobile homes.

Advances in meteorology and the use of Doppler radar allow efficient prediction of tornado formation. A network of storm watchers attempt to identify funnel clouds and report to various networks to alert the population. Even though these advances have significantly improved the available response time, tornados can still occur unexpectedly and without warning.

Advances in meteorology and the use of Doppler radar allow efficient prediction of tornado formation before they occur. A network of storm watchers attempt to identify funnel clouds and report to various networks to alert the population. Even though these advances have significantly improved the available response time, tornados can still occur unexpectedly and without warning.

Utilizing storm spotters and early warning systems, City residents can take appropriate precautions during these events. As a result, casualty rates are low. The popularity of mobile/manufactured housing has increased susceptibility of existing structures to tornados. The

use of better building techniques, tie-down systems and the availability of storm shelters all help mitigate losses in the City.

A typical tornado hazard for Wagoner would be an EF0 event, as defined in Table 3-4 above, the Enhanced Fujita Tornado Scale. The worst case tornado hazard would be an EF5 event, as defined in Table 3-4 above.

### 3.2.3 High Wind Hazard

3.2.3.2 Wind is defined as the motion of air relative to the earth's surface. Extreme windstorm events are associated with cyclones, severe thunderstorms, and accompanying phenomena such as tornados and downbursts. Winds vary from zero at ground level to 200 mph in the upper atmospheric jet stream at 6 to 8 miles above the earth's surface. The mean annual wind speed in the mainland United States is reported by FEMA to be 8 to 12 mph, with frequent speeds of 50 mph and occasional wind speeds of greater than 70 mph. Oklahoma wind speeds average 10 miles per hour.

3.2.3.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from a high wind hazard than another. And this includes the City of Wagoner.

3.2.3.3 The magnitude of the high wind hazard is categorized on various wind scales, such as the Beaufort, Saffir-Simpson, and the Fujita measurement scales. The tables below containing the Beaufort and Saffir-Simpson scales show that there is little consensus of opinion as to what wind speeds produce various damages. (The Fujita Scale and Enhanced Fujita Scale are shown in section 3.2.2, "Tornado Hazard"). The National Weather Service (NWS) issues Severe Thunderstorm Warnings whenever a thunderstorm is forecast to produce wind gusts to 58 miles per hour (50 knots) or greater and/or hail one inch in diameter or larger. Hail size increased from ¾ inch to one inch on January 5, 2010, for warning issues. The hail hazard will be addressed in Section 3.2.5.

**Table 3-5**  
**Saffir-Simpson Scale**

Category	Wind Speed (mph)	Storm Surge (feet)	Damages
1	74-95	4- 5	<b>Minimal:</b> Trees, shrubbery, unanchored mobile homes, and some signs damaged, no real damage to structures
2	96-110	6-8	<b>Moderate:</b> Some trees toppled, some roof coverings damaged, major damage to mobile homes
3	111-130	9-12	<b>Extensive:</b> Large trees are toppled, some structural damage to roofs, mobile homes destroyed, structural damage to small homes and utility buildings
4	131-155	13-18	<b>Extreme:</b> Extensive damage to roofs, windows, and doors, roof systems on small buildings completely fail, some curtain walls fall
5	155+	18+	<b>Catastrophic:</b> Roof damage is considerable and widespread, window and door damage is severe, extensive glass failure, entire buildings could fall

**Table 3-6  
Beaufort Scale**

<b>Force</b>	<b>Wind Speed (knots)</b>	<b>Description</b>	<b>Damages</b>
0	Less than 1	Calm	Smoke rises vertically.
1	1-3	Light air	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	4-6	Light breeze	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	7-10	Gentle breeze	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate breeze	Dust and loose paper are blown about. Small branches begin to move
5	17-21	Fresh breeze	Branches of a moderate size move. Small trees in leaf begin to sway.
6	22-27	Strong breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
7	28-33	High wind, near gale	Whole trees in motion. Effort needed to walk against the wind.
8	34-40	Gale	Some twigs broken from trees. Cars veer on road. Progress on foot is seriously impeded.
9	41-47	Strong gale	Some branches break off trees, and some small trees blow over. Construction/temporary signs and barricades blow over.
10	48-55	Whole gale, storm	Trees are broken off or uprooted, structural damage likely.
11	56-63	Violent storm	Widespread vegetation and structural damage likely.
12	64+	Hurricane	Severe widespread damage to vegetation and structures. Debris and unsecured objects are hurled about

3.2.3.4 According to the National Climatic Data Center, there have been 287 recorded high winds events in The City of Wagoner during the period of 1950 through 2010, causing an estimated \$1,916,000 in property damage. During this same time period, there have been 45 reported high wind events in the City of Wagoner.

Appendix 6 summarizes previous occurrences in the City of this hazard.

3.2.3.5 The majority of the United States is at some risk of high wind hazards, including The City of Wagoner. Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a high wind hazard in the City is “highly likely”.

For the City of Wagoner, the 45 reported events indicate a “highly likely” likelihood rating of this high wind hazard occurring in the future. The likelihood rating is defined in Appendix 6.

3.2.3.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the

following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

Property damage and loss of life from windstorms are increasing due to the increasing use of manufacturing housing and mobile homes in Wagoner. This type of structure provides less resistance to wind than conventional construction. With older structures aging, and the increased use of aluminum-clad mobile homes, the impacts of wind hazards will likely continue to increase.

In addition to structural issues, high winds can affect electrical and other utilities with service outages. Power lines can ground out or be knocked down causing loss of electrical service. There could also be loss of water, sewer, and communications abilities.

A typical high wind hazard in Wagoner would be a Beaufort Scale Force 4 event, as defined in Table 3-6 above, the Beaufort Scale. The worst case high wind hazard would be Beaufort Scale Force 10 and greater event, as defined in Table 3-6 above,

And this would also be the typical and worst case scenarios for the City of Wagoner.

### **3.2.4 Lightning Hazard**

3.2.4.1 Lightning is a discharge of atmospheric electricity, accompanied by a vivid flash of light, frequently from one cloud to another, sometimes from a cloud to the earth. The accompanying thunder sound is produced by the electricity passing rapidly through the atmosphere.

Within the thunderstorm clouds, rising and falling air causes turbulence which results in a buildup of a static charge. The negative charges concentrate in the base of the cloud. Since like charges repel, some of the negative charges on the ground are pushed down away from the surface, leaving a net positive charge on the surface. Opposite charges attract, so the positive and negative charges are pulled toward each other. This first, invisible stroke is called a stepped leader. As soon as the negative and positive parts of the stepped leader connect there is a conductive path from the cloud to the ground and the negative charges rush down it causing the visible stroke. Thunder is caused by extreme heat associated with the lightning flash. In less than a second, the air is heated from 15,000 to 60,000 degrees. When the air is heated to this temperature, it rapidly expands. When lightning strikes very close by, the sound will be a loud bang, crack or snap. Thunder can typically be heard up to 10 miles away. During heavy rain and wind this distance will be less, but on quiet nights, when the storm is many miles away, thunder can be heard at longer distances.

3.2.4.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from a lightning hazard than another. And this includes the City of Wagoner.

3.2.4.3 The type of lightning is a measure of the severity of the lightning hazard. Cloud-to-ground is the more severe type in terms of potential cause of damage. The table below from the National Climatic Data Center shows the types and frequency categories of lightning. The more severe type of lightning; coupled with an increased frequency, pose a greater lightning hazard.



**Table 3-7: Type of Lightning**

Type	Contraction	Definition
Cloud to Ground	CG	Lightning occurring between cloud and ground.
In Cloud	IC	Lightning occurring within the cloud.
Cloud to Cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud to Air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.

**Table 3-8: Frequency of Lightning**

Frequency	Contraction	Definition
Occasional	OCNL	Less than 1 flash per minute.
Frequent	FRQ	About 1 to 6 flashes per minute
Continuous	CONS	More than 6 flashes per minute.

Wagoner considers any lightning event of less than 1 flash per minute as minor, and any event of greater than 1 flash per minute as major.

3.2.4.4 For The City of Wagoner, the National Climatic Data Center (NCDC) reports five lightning events during the 61 year period from 1950 through 2010, causing \$268,000 in property damage. With the frequent wind and thunderstorm activity the City experiences, it is certain that lightning strikes occurred more often, but were just not all reported. There were no reported lightning events in the City of Wagoner during this same time period.

Appendix 6 summarizes previous occurrences in The City of Wagoner of this hazard.

3.2.4.5 Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a lightning hazard in The City of Wagoner is “unlikely” because there were five reported events from 1950 through 2010.

For the City of Wagoner, no reported events indicate an “unlikely” likelihood rating of this lightning hazard occurring in the future. The likelihood rating is defined in Appendix 6.

3.2.4.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

Lightning strikes can also cause high-voltage power surges that have the ability to seriously damage equipment. Property damage from power surges and resulting fires can destroy not only the electronics in private homes, but the structure itself.

The largest vulnerability to lightning is the potential loss of human life. Property damage can also occur to structures and electrical equipment. People outdoors during a thunderstorm is exposed and at risk of injury from lightning. Most people are injured or killed by lightning will participating in some form of recreation.

A typical lightning hazard would be lightning that stays in the air, not touching the ground. The worst case lightning event would be a cloud to ground lightning type where the lightning strikes a large public gathering location, which could result in mass casualties.

### 3.2.5 Hail Storm Hazard

3.2.5.1 Hail is frozen water droplets formed inside a thunderstorm cloud. They are formed during the strong updrafts of warm air and downdrafts of cold air, when the water droplets are carried well above the freezing level to temperatures below 32 deg F, and then the frozen droplet begins to fall, carried by cold downdrafts, and may begin to thaw as it moves into warmer air toward the bottom of the thunderstorm. This movement up and down inside the cloud, through cold then warmer temperatures, causes the droplet to add layers of ice and can become quite large, sometimes round or oval shaped and sometimes irregularly shaped, before it finally falls to the ground as hail.

3.2.5.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from the hail storm hazard than another. And this includes the City of Wagoner.

3.2.5.3 The severity of the hail hazard depends on the hailstone size. The magnitude of a hail storm is as follows;

**Table 3-9  
HAILSTONE SIZES**

<b>Diameter</b>	<b>Example</b>		<b>Diameter</b>	<b>Example</b>
1/4 inch	Pea		1 ¾ inches	Golf Ball
1/2 inch	Marble		2 ½ inches	Tennis Ball
3/4 inch	Penny		2 ¾ inches	Baseball
7/8 inch	Nickel		3 inches	Tea Cup
1 inch	Quarter		4 inches	Grapefruit
1 ½ inches	Ping Pong Ball		4 ½ inches	Softball

The National Weather Service (NWS) issues Severe Thunderstorm Warnings whenever a thunderstorm is forecast to produce wind gusts of 58 miles per hour (50 knots) or greater and/or hail size one inch in diameter or larger. Prior to January 5, 2010 the criteria for hail was ¾ inch or larger.

Wagoner measures the extent of the hail hazard by the size of the hail.

Wagoner considers any hail event that causes major property damage or death to be a major severity, generally hail stone diameters one-inch and greater, and minor severity events are hail events that cause little property damage and no injuries, generally hail stones of less than one-inch in diameter.

3.2.5.4 According to the National Climatic Data Center, The City of Wagoner experienced 207 hail hazard events of hail diameter 1-inch and greater during the period from 1950 through 2010, causing an estimated \$365,000 in property damage. During the same time period, the City of Wagoner has had 25 reported hail events.

Appendix 6 summarizes previous occurrences in the City of this hazard.

3.2.5.5 Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a future hail hazard in The City of Wagoner is “highly likely” because there were 207 reported hail events of 1-inch or greater from 1950 through 2010.

For the City of Wagoner, the 25 reported events indicate a “highly likely” likelihood rating of this hail hazard occurring in the future. The likelihood rating is defined in Appendix 6.

3.2.5.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

The impact of the hazard can range from damage through destruction of structures and personal property to bodily injury, depending on the diameter. The National Climatic Data Center has reported hail in the City up to 2 ¾ -inches in diameter.

A typical hail storm hazard would be hailstones that are noticeable but cause no damage, ¼ inch to ½ inch. The worst case hail storm event would be a hail storm event where the hailstones exceed the maximum diameter reported by a recording agency such as the National Climatic Data Center, causing wide-spread structure damage and at a time of a large public outdoor gathering causing injuries to persons not under cover of a substantial structure.

Hail is capable of causing considerable damage to crops, buildings, and vehicles. Hail can also strip leaves and small limbs from non-evergreen trees. While large hail poses a threat to people caught outside in a storm, it seldom causes loss of human life.

## **3.2.6 Winter Storm Hazard**

3.2.6.1 All winter storms are accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A severe winter storm is one that drops 4 or more inches of snow during a 12 -hour period, or 6 or more inches during a 24- hour span. An ice storm occurs when freezing rain falls and freezes immediately on impact. All winter storms make driving and walking extremely hazardous. The aftermath of a winter storm can impact a community or region for days, weeks, and even months. People can become stranded on the road or trapped at home, without utilities or other services. Residents, travelers and livestock may become isolated or stranded without adequate food, water and fuel supplies. The conditions may overwhelm the capabilities of a local jurisdiction. Winter storms are considered deceptive killers as they indirectly cause transportation accidents, and injury and death resulting from exhaustion/overexertion, hypothermia and frostbite from wind chill, and asphyxiation; house fires occur more frequently in the winter due to the lack of proper safety precautions while using home heating equipment.

3.2.6.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from the winter storm hazard than another, including the City of Wagoner.

3.2.6.3 A winter storm can range from moderate snow (2 to 4 inches over 12 to 24 hours) to blizzard conditions (4 to 6 inches over 12 to 24 hours) with high winds, freezing rain or sleet, heavy snowfall with blinding wind-driven snow and extremely cold temperatures that last several days. Some winter storms may be large enough to affect several states while others may affect only a single community. All winter storms are accompanied by cold temperatures and blowing snow, which increases the severity of the winter storm.

The Balthrop Ice Scale attempts to quantify the severity of the winter storm hazard. The scale is shown in Table 3-10.

**Table 3-10: The Balthrop Ice Scale**

Level	Cause	Effect
Level 1; Nuisance Event, No Major Impact	Freezing rain and sleet, but little ice accumulation. Roads not hazardous. Ice forming on grass.	Little to no effect on the State of Oklahoma.
Level 2; Minor Event, Caution Advised	No measurable ice. Black ice on roads and bridges. Winter Weather Advisory.	Untreated roadways and bridges may become hazardous and slick. Livestock may need additional supplemental feed.
Level 3; Major Event, Isolated Emergency Conditions in the State of Oklahoma	Ice accumulations of ¼ to ½ inches. Reduced visibility. Winter Storm Warning.	Widespread hazardous road conditions. Travel discouraged. Isolated power outages because of down power lines from ice accumulations. Tree damage. Livestock loss potential increases. Supplemental feed necessary.
Level 4; Extreme Event, The State of Oklahoma Under Full State of Emergency	Crippling event. Winds over 35 mph. Little to no visibility. Ice accumulations of more than ½ inch. Blizzard Warning.	Road conditions hazardous to impassable. People and livestock isolated. Widespread power and utility outages. Infrastructure damage. High potential for loss of livestock. Structures threatened from accumulating ice. Communications infrastructure lost from ice accumulation. May be a long lasting event.

3.2.6.4 According to the National Climatic Data Center, 30 snow and ice events were reported in The City of Wagoner from 1950 through 2010, causing an estimated \$50,155,000 of property damage.

The 30 severe winter storm events were wide ranging, so no individual community was solely affected, so the City of Wagoner would be included in the City events.

Appendix 6 summarizes previous occurrences for The City of Wagoner of this hazard.

3.2.6.5 Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a winter storm hazard in The City of Wagoner is “highly likely”.

Based on the severe winter storms being wide ranging hazards, there is also a “highly likely” likelihood rating of this severe winter storm hazard occurring in the City of Wagoner.

3.2.6.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

A typical winter storm hazard would be a Level 1 event, as defined by the Balthrop Ice Scale, a nuisance event. The worst case winter storm hazard would be a Level 4 event, where transportation is stopped, widespread power outages occur, livestock loss is likely, and the duration may be long.

Wagoner is affected periodically by heavy snow and ice that cause damage. Trees and power lines fall due to the weight of ice and snow causing damage to their surroundings as well as blocking

streets and roads. Icy roads cause accident rates to increase and impair the ability for emergency vehicles to respond which can result in more injuries and a higher loss of life.

Winter storms can range from accumulating snow and/or ice over just a few hours to blizzard conditions with blinding wind-driven snow that can last several days. The aftermath from a damaging winter storm can continue to impact the City for weeks and even months. Economic losses can occur to livestock producers and any business in the affected areas. Carbon monoxide poisoning is always a possibility as homeowners and businesses use alternative heat sources to keep warm. Personal health can be affected in a variety of ways including mental and physical stress, frostbite or related injuries and inability to travel for care.

### 3.2.7 Heat Hazard

3.2.7.1 A heat hazard is defined as when the temperature exceeds the body's ability to cool itself. Humid conditions can worsen the hazard by limiting the body to cool itself. The National Weather Service issues an excessive heat warning when the heat index (a measure of the temperature combined with the relative humidity) is at least 105°F for more than 3 hours per day for 2 consecutive days, or if the heat index is greater than 115°F for any period of time.

3.2.7.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from the heat hazard than another. And this includes the City of Wagoner.

3.2.7.3 The severity of the extreme heat is dependent on a combination of temperature and humidity. High temperatures, when combined with high humidity can put an area in the "Extreme Danger" category on the National Weather Service Heat Index scale. When extreme heat is combined with drought, excessively dry hot conditions that contribute to a high risk of life-threatening heat-related illnesses may result. The heat index is a measure of the severity of a heat hazard. The heat index can be related to a range of specific heat disorders. The City of Wagoner can experience heat index reading into the heat stroke range.

**Table 3-11  
Heat Index**

Temperature (F) versus Relative Humidity (%)						
°F	90%	80%	70%	60%	50%	40%
80	85	84	82	81	80	79
85	101	96	92	90	86	84
90	121	113	105	99	94	90
95		133	122	113	105	98
100			142	129	118	109
105				148	133	121
110						135

HI	Possible Heat Disorder:
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	Heat stroke highly likely with continued exposure.

3.2.7.4 According to the National Climatic Data Center, from 1950 through 2010, The City of Wagoner experienced ten extreme heat events. No structural damage was recorded for the heat hazard for the City.

The ten heat hazard events were wide ranging hazards, so no individual community was solely affected, so the City of Wagoner would be included in the City events.

Appendix 6 summarizes previous occurrences in the City of this hazard.

3.2.7.5 Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a heat hazard in The City of Wagoner is “occasional”.

Based on the heat hazard events being wide ranging events, there is also an “occasional” likelihood rating of the heat hazard occurring in the City of Wagoner. The likelihood rating is defined in Appendix 6.

3.2.7.6 The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

A typical heat hazard would be to persons experiencing temperatures reaching 90 degrees, as described in Table 3-11 above. The elderly population is most at risk from this high heat hazard. The worst case heat hazard event would be to persons exposed to temperatures exceeding 130 degrees where heat stroke is likely.

Heat kills by pushing the human body beyond its limits. Under normal conditions, the body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.

Most heat disorders occur because the victim has been overexposed to heat or has over exercised for his or her age and physical condition. Other conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality.

Extreme heat can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, damage to food supplies may occur as the heat damages agricultural crops and livestock are susceptible to heat related injuries or death.

Young children, elderly people, and those who are sick or overweight are more likely to become victims to extreme heat. Other conditions that can limit the ability to regulate temperature include fever, dehydration, heart disease, mental illness, poor circulation, sunburn, prescription drug use, and alcohol use. Another segment of the population at risk is those whose jobs consist of strenuous labor outside. When temperatures reach 90 degrees and above, people and animals are more likely to suffer sunstroke, heat cramps, and heat exhaustion.

Another extreme heat hazard is air pollution. During summer months, consistent high temperatures and stagnant airflow patterns cause a build-up of hydrocarbons to form a dome-like ceiling over large cities. The abundance of factories, automobiles, lawn equipment, and other internal combustion machines emit high particulate matter that builds and worsens with the increase in temperature. The resulting stagnant, dirty, and toxic air does not move away until a weather front arrives to disperse it. When the particulate matter reaches a pre-determined level, an ozone alert is issued for the Tulsa area and implementation measures are undertaken to reduce

the use of cars and the output of the offending chemicals. Ozone alerts usually include advisories for the elderly and those with breathing difficulties to stay indoors in air-conditioned environments.

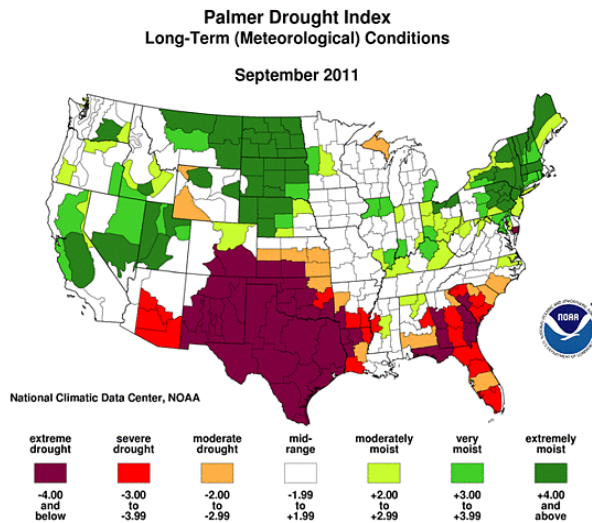
Extreme heat can have a structural impact. Roads can buckle during times of extreme heat. Tar becomes soft and can allow concrete to settle, creating gaps and uneven surfaces. Extreme heat leads to rapid evaporation of ponds and lakes, depleting water sources used by both farmers and the community. Often times, residents use additional water during extreme heat to counter the drying of soils and prevent vegetation from dying. This additional strain on water systems can lead to low water pressure, and can cause water shortages when firefighters are trying to save property and brush land dried out by the extreme heat.

## **3.2.8 Drought Hazard**

3.2.8.1 A drought is a period of drier-than-normal conditions that results in water-related problems. Precipitation (rain or snow) falls in uneven patterns across the country. When no rain or only a small amount of rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells decreases. If dry weather persists and water supply problems develop, the dry period can become a drought. The first evidence of drought usually is seen in records of decreased rainfall. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and rivers or on water levels in lakes and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after the drought begins. A period of below-normal rainfall does not necessarily result in drought conditions. Some areas of the United States are more likely to have droughts than other areas. In humid, or wet, regions, a drought of a few weeks is quickly reflected in a decrease in soil moisture and in declining flow in streams. In arid, or dry, regions, such as Oklahoma, people rely on ground water and water in reservoirs to supply their needs. They are protected from short-term droughts, but may have severe problems during long dry periods because they may have no other water source if wells or reservoirs go dry.

3.2.8.2 The location of this hazard is uniform over the entire City area. No area of the City is more or less at risk from the drought hazard than another. And this includes the City of Wagoner.

3.2.8.3 The Palmer Drought Index was developed in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought severity index. The Palmer Index is most effective in determining long term drought; a matter of several months. It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. NOAA has used this index to classify the drought hazard through the continental United States. As of September, 2011, The City of Wagoner was in the severe to extreme severity range of the Palmer Drought Index. The national map showing the September 2011 Palmer Drought Index is shown below.



The Palmer Drought Index does not extend down to a sub-City level. So is the City is in a Minus 4 drought index, all jurisdictions within the City are considered at a Minus 4 drought index, including the City of Wagoner.

3.2.8.4 One of the greatest natural disasters in U.S. history and the most severe and devastating to Oklahoma was the decade-long drought in the 1930s that has become known as the Dust Bowl. Reaching its peak from 1935 through 1938, high temperatures and low rainfall combined to destroy crops and livestock. High winds literally blew the land away, causing massive soil erosion. Hundreds of small rural communities were ruined and about 800,000 people were displaced. The total expenditure by the American Red Cross for drought relief in Oklahoma in 1930-1931 was the third largest ever in the nation.

According to the National Climatic Data Center, there have been three drought events in The City of Wagoner from 1950 through 2010. The three drought hazard events were wide ranging, so no individual community is solely affected, so the City of Wagoner would be included in the City events.

Appendix 6 summarizes previous occurrences in the City of this hazard.

3.2.8.5 Meteorological conditions have not changed so future events should occur at the same probability as the previous events. According to the likelihood rating from Appendix 6, the likelihood of a heat hazard in The City of Wagoner is “occasional”.

Based on heat hazard events being wide ranging hazards, there is also an “occasional” likelihood rating of this hazard occurring in the City of Wagoner. The likelihood rating is defined in Appendix 6.

3.2.8.6 The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

A typical drought hazard would be a mid-range to moderate Palmer Drought Index, where some form of voluntary water rationing would be encouraged but not required, and the only damage would be to under watered lawns. The worst case drought hazard event would be a Palmer Drought index of negative 4.00 and below, an extreme drought, where it lasts for months to years.



Droughts increase the wildfire hazard and reduce the water supply. Lack of fresh water is damaging to livestock and crops. Another problem associated with drought is stale water. Areas of stale water are known to produce deadly bacteria.

Drought impacts in a number of ways, spanning all regions, and is capable of affecting the economy as well as the environment. Specific impacts can include

- reduced crop, rangeland;
- increased livestock and wildlife mortality rates;
- reduced income for farmers and agribusiness;
- increased fire hazard;
- reduced water supplies for municipal/industrial, agricultural and power uses;
- damage to fish and wildlife habitat;
- increased consumer prices for food;
- reduced tourism and recreational activities;
- unemployment;
- reduced tax revenues because of reduced expenditures; and
- foreclosures on bank loans to farmers and businesses.

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. While drought impacts in Wagoner are numerous and often dependent upon the timing and length of individual drought episodes, the greatest impacts of drought are usually experienced in the agricultural community. In addition to the obvious direct losses of both crop and livestock production due to a lack of surface and subsurface water, drought is frequently associated with increases in insect infestations, plant disease, and wind erosion.

One of the most significant potential impacts of drought relates to public water supply. Reduced flows in rivers, and reduced lake and reservoir levels, have a significant effect on the amount of water available for municipal use. There may be a need to stop washing cars, cease watering the grass and take other water conservation steps.

Water shortages can also affect firefighting capabilities in both urban and rural settings through reduced water flows and pressures. Most droughts dramatically increase the danger of wildfires. Although droughts are most associated with summer and high temperatures, droughts can impact the City during winter months.

### **3.2.9 Expansive Soils Hazard**

3.2.9.1 Soils and soft rock that tend to swell or shrink due to changes in moisture content are commonly known as expansive soils. Changes in soil volume present a hazard primarily to structures built on top of expansive soils. The most extensive damage occurs to highways and streets. The effect of expansive soils are most prevalent in regions of moderate to high precipitation, where prolonged periods of drought are followed by long periods of rainfall. Expansive soils can be recognized either by visual inspection in the field or by conducting laboratory analysis. Shales, clay shales, and residual soils containing smectite often have a characteristic "popcorn" texture, especially in semiarid areas.

3.2.9.2 The Natural Resources Conservation Service (NRCS) has identified the soils in The City of Wagoner. The expansive tendency of a soil is a function of its shrink-swell potential. The locations of these types of soils are shown on Map Number 8 in Appendix 1. And this includes the City of Wagoner.

The soil data for The City of Wagoner is from the State Soil Geographic (STATSGO) data base. The STATSGO data base is designed for multi-City resource planning, and is not detailed enough for interpretations at the City level. The soil maps for STATSGO are compiled by generalizing the more detailed SSURGO soil maps, Soil Survey Geographic (SSURGO) data base. The STATSGO data base is raster GIS data; each map unit is assigned an attribute value by sampling areas on more detailed maps and expanding the data statistically to characterize all map units. Raster type data cannot be used for spatial analysis; however, it is shown in Map Number 7 for a general location of expansive soils throughout the City.

Overlaying the City of Wagoner community shows the City of Wagoner may have areas of moderate shrink-swell potential soils. However, because of the generalized soils information, all the City of Wagoner should continue to take this expansive soils hazard risk into consideration in future development.

3.2.9.3 The NRCS sorts this shrink-swell potential soil property in The City of Wagoner into five categories; very low, low, moderate, high, and very high. This is the range of magnitude of an expansive soils hazard. Shrink-swell potential categories are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The categories are very low, a change of less than 1%; low, 1 to 3%; moderate, 3 to 6%; high, 6 to 9%; and very high, greater than 9%. Map Number 7 in Appendix 1 illustrates the majority of the City falls into the low shrink-swell potential category.

3.2.9.4 No information is available for the City of Wagoner area, including Wagoner, on how expansive soils have damaged structures. This hazard develops gradually and thus not usually reported, largely because a catastrophic expansive soils hazard event has not occurred.

3.2.9.5 The soils properties have not changed so future occurrences of soils expansion and contraction will continue. An estimate of future occurrences is rated as “unlikely”, shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6, because no data is reported for this hazard. The likelihood rating of “unlikely” applies to the City of Wagoner also. The likelihood rating is defined in Appendix 6.

3.2.9.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4.

The impact of expansive soils is to foundations of structures, and occurs slowly over time, compared to a tornado. Structure foundations such as in homes and commercial buildings, concrete slabs in driveways and sidewalks, and parking lots, are at risk to this hazard. Asphalt surfaces such as highways and runways could be affected. These structures are affected because expansive soils cause uneven settlement of the soil under the structures’ foundations. Excessive or uneven settlement can cause cracks in the foundation and damage to the structure above the foundation.

A typical expansive soils hazard would be to structures built in areas of high shrink-swell potential that were not built with any foundation displacement protection, such as post-tension reinforcing in foundations. The worst case expansive soils hazard event would be to structures as described above, but during extreme and extended drought conditions where the soils dry out to such a depth causing voids to occur which would increase the circumstances for foundations to deflect causing foundation and structure damage.

Due to the generalized soils information, specific site analyses cannot be made for certain to determine if the communities and school sites may have high and very high shrink-swell potential

soils to be impacted by. Therefore, mitigation actions will be recommended to better quantify this hazard for each site.

### **3.2.10 Wildfire Hazard**

3.2.10.1 Wildfires are defined as the uncontrolled burning of highly vegetated areas, usually in forests and wooded areas.

Wildfires are often referred to as grass fires in The City of Wagoner. The amount of control the fire departments have on the burning vegetated area is a factor in calling the fire a wildfire. Also, the size of the burning vegetated area is a factor; a small area of burning vegetation is often referred to as a grass fire while a large area of burning vegetation is called a wildfire. Both size and control are factors in how this hazard is named, but specific criteria as when to refer to burning vegetation as a wildfire have not been established.

3.2.10.2 According to City Emergency Management, fire locations are more frequent around the more populated areas. This area is referred to as the wildland-urban interface. The amount of risk to this hazard can vary by location. The wildland-urban interface is where the main risk and vulnerability is to this wildfire hazard. This interface is defined as the area ½ mile either side of a community's corporate limits. Locations in a community within the ½ mile wildland-urban interface are at less risk primarily due to the reduction of vegetated area because of the community's homes, structures, and infrastructure. Areas in the unincorporated areas of the City outside the wildland-urban interface have a lower risk from the hazard because they are away from the populated areas.

When applying the ½ mile buffer to the City of Wagoner, Wagoner has an area inside its wildland-urban interface placing the interior portion at less risk from a wildfire than the area within the ½ mile interface. These areas are shown on Map Number 9 in Appendix 1.

3.2.10.3 The extent of a hazard is the strength or magnitude of the hazard; a scale or way to quantify the magnitude of the hazard. The Keetch-Byram Drought Index (KBDI), created by John Keetch and George Byram in 1968 for the United States Department of Agriculture's Forest Service, quantifies the probability of a wildfire based on soil moisture and other conditions related to drought. Designed as an index for fire potential assessment. It is a continuous index, relating to the flammability of organic material in the ground. The KBDI attempts to measure the amount of precipitation necessary to return the soil to full field capacity. It is a closed system ranging from 0 to 800 units. Zero is the point of no moisture deficiency and 800 is the maximum drought that is possible. At any point along the scale, the index number indicates the amount of net rainfall that is required to reduce the index to zero, or saturation.

KBDI levels and its relationship to expected fire potential are reflected as follows:

- KBDI = 0 – 200: Soil moisture and large class fuel moistures are high and do not contribute much to fire intensity. This is typical of spring dormant season following winter precipitation.
- KBDI = 200 – 400: Typical of late spring, early growing season. Lower litter and duff layers are drying and beginning to contribute to fire intensity
- KBDI = 400 – 600: Typical of late summer, early fall. Lower litter and duff layers contribute to fire intensity and will burn actively.
- KBDI = 600 – 800: Often associated with more severe drought with increased wildfire occurrence. Intense, deep-burning fires with significant downwind spotting can be expected. Live fuels can also be expected to burn actively at these levels.

The City of Wagoner considers the wildfire hazard with a KBDI level of 0-400 to be of minor severity. And The City of Wagoner and the participating Public School consider the wildfire hazard with a KBDI level of 400-800 to be of major severity.

3.2.10.4 In The City of Wagoner, municipal and rural volunteer fire departments respond to numerous grass fires every year, but that number could not be determined. However, the City of Wagoner responded to 34 grass fire events in 2015-16. The City of Wagoner Fire Chief reports this is representative of the grass fires occurrences throughout the City.

Appendix 6 summarizes previous occurrences in Wagoner of this hazard.

3.2.10.5 The City of Wagoner Fire Department are continuing campaigns to educate the public on the causes and effects of fires. However, all fires cannot be prevented so this hazard will continue. The likelihood rating for wildfires in the City is “highly likely” due to the close proximity to the open range areas on all sides of the City. This estimate of future occurrences is taken from the Likelihood Rating scale in the Hazard Summary Table in Appendix 6. The likelihood rating is defined in Appendix 6.

3.2.10.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

A typical wildfire hazard would be a grass fire, in which a Fire Department is dispatched to put out the fire before it causes any damage to crops, structures, or persons. The worst case wildfire scenario would be an event that could not be controlled before it overwhelms a community, causing damage to crops, structures, and persons.

The number of structures within each community’s wildland-urban interface, the area more vulnerable to a wildfire than the interior of the community, is shown in section 3.3.11 and the damage estimate for those structures is shown in section 3.4.6. However, for the City of Wagoner, the ½ mile interior interface covers only the City of Wagoner and a small portion of Wagoner County.

Periods of drought, dry conditions, high temperatures, and low humidity set the stage for wildfires. People start more than four out of every five wildfires, usually as debris burns, arson, or carelessness. This is why the City Emergency Management considers the wildland-urban interface at higher risk from wildfires; where the rural setting meets the populated areas. Lightning strikes are another leading cause of wildfires, a non-man-made occurrence. Wildfires that do not encounter a human population are difficult to calculate damages. Homes and businesses that are burned in naturally occurring fires are usually privately owned.

When wild lands are destroyed by fire, the resulting erosion can cause heavy silting of streams, rivers, and reservoirs. Serious damage to aquatic life, irrigation, and power production then occurs.

## **3.2.11 Earthquake Hazard**

3.2.11.1 An earthquake is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. For hundreds of millions of years, the forces of plate

tectonics have shaped the Earth as the huge plates that form the Earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates. Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70 to 75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach \$200 billion. There are 45 states and territories in the United States at moderate to very high risk from earthquakes, and they are located in every region of the country. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes—most located in uninhabited areas. The largest earthquakes felt in the United States were along the New Madrid Fault in Missouri, where a three-month long series of quakes from 1811 to 1812 included three quakes larger than a magnitude of 8 on the Richter scale. These earthquakes were felt over the entire Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking.

3.2.11.2 The faults most likely to affect The City of Wagoner (including the City of Wagoner) are the New Madrid Fault, centered in the Missouri Bootheel region, and the Meers Fault, located in southwestern Oklahoma near Lawton. The distance from the Missouri Bootheel region to Wagoner, OK, (in the center of The City of Wagoner) is approximately 380 miles, and the distance from the Meers fault region to Wagoner is approximately 170 miles.

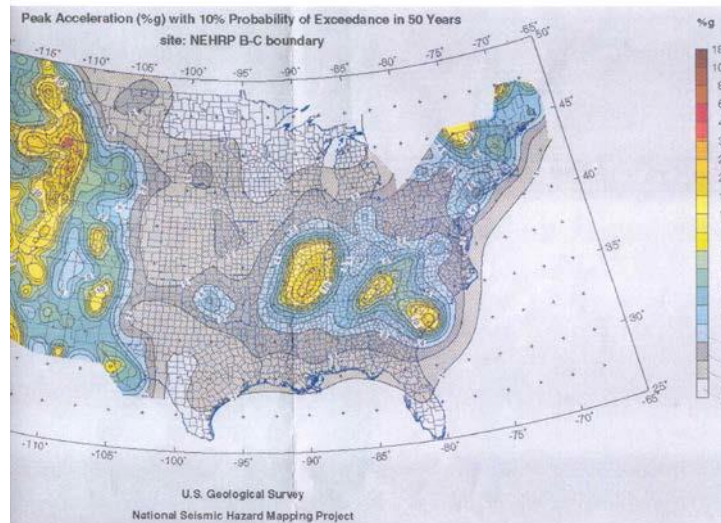
3.2.11.3 The severity of an earthquake can be expressed in several ways. The magnitude of an earthquake, usually expressed by the Richter Scale, is a measure of the amplitude of the seismic waves. The Richter Scale, named after Dr. Charles F. Richter of the California Institute of Technology, is the best-known scale for measuring the magnitude of earthquakes. The scale is logarithmic. An earthquake of magnitude 2 is the smallest earthquake normally felt by people. Earthquakes with a Richter value of 6 or more are commonly considered major; great earthquakes have magnitude of 8 or more on the Richter scale.

**Table 3-12**  
**The Richter Scale**

<b>Magnitude</b>	<b>Description</b>
1 to 3	Recorded on local seismographs, but generally not felt.
3 to 4	Often felt, with little to no damage reported.
5	Felt widely, slight damage near epicenter.
6	Damage to poorly constructed buildings and other structures within 10 kms.
7	"Major" earthquake. Causes serious damage up to 100 km (recent Taiwan, Turkey, Kobe, Japan, Iran and California earthquakes).
8	"Great" earthquake, great destruction, loss of life over several 100 km (1906 San Francisco, 1949 Queen Charlotte Islands).
9	Rare great earthquake, major damage over a large region over 1000 km (Chile 1960, Alaska 1964, and west coast of British Columbia, Washington, Oregon, 1700)

The City of Wagoner considers an earthquake of magnitude 4 and below on the Richter Scale to be a minor severity earthquake, and an earthquake greater than a magnitude 4 on the Richter Scale to be of major severity.

The USGS National Seismic Hazard Mapping, shown below, shows The City of Wagoner in the 2%g (peak acceleration), 10% probability of exceedance in 50 years area. According to the FEMA 386-2, "Understanding Your Risks", Step 1; areas with 2%g peak acceleration or less have a relatively low seismic risk, and an earthquake risk assessment is not warranted.



3.2.11.4 According to the National Climatic Data Center, there have been no earthquake events in The City of Wagoner (including the City of Wagoner) from 1950 through 2010. On November 5, 2011, the state experienced its largest and third largest earthquakes in state history. A 4.8 magnitude earthquake occurred near Prague at about 2:12 am, and then a 5.6 magnitude earthquake occurred near Sparks at about 10:53 pm. Both earthquakes were centered in Lincoln City, a City southwest of The City of Wagoner in central Oklahoma. The later earthquake surpassed the then largest earthquake in state history, a 5.5 magnitude earthquake near El Reno on April 9, 1952.

3.2.11.5 However, most earthquakes in the state are not felt. According to the National Climatic Data Center, there have been no earthquake events in The City of Wagoner from 1950 through 2010; a likelihood rating of “unlikely”. This estimate of future occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6. The likelihood rating of “unlikely” also applies to the City of Wagoner. The likelihood rating is defined in Appendix 6.

3.2.11.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities is the same for each participating community as well as the City and the participating school, and is discussed as follows.

A typical earthquake event would be a magnitude 1 to 4 on the Richter Scale, which would be largely unfelt and no damage. The worst-case earthquake hazard would be a magnitude 9 on the Richter Scale, causing a large amount of structure damage and personal injury over a large area.

All structures, homes, businesses and transportation infrastructure are vulnerable to an earthquake. Earthquakes occurring near the City can still impact the Wagoner. Timely notification of events can allow residents to take precautions in the event of aftershocks.

## 3.2.12 Hazardous Material Hazard

3.2.12.1 Hazardous materials are chemical substances that, if released or misused, can pose a threat to the environment or human health. These chemicals are used in industry, agriculture, medicine, research, and consumer goods. Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These substances are most often released as a result of transportation accidents or chemical accidents at

plant sites. In the State of Oklahoma, communities are required to list facilities that either use or store Extremely Hazardous Substances (EHS) in their Emergency Operations Plans (EOP). EHS facilities are a subset of the Tier 2 facilities; and like the Tier 2 facilities, EHS facilities are reported annually to the Oklahoma Department of Environmental Quality by the users. The EHS facilities are incorporated into the City of Wagoner plan update.

3.2.12.2 The locations of the City of Wagoner EHS facilities are listed in the following table, and shown in Map Number 9 in Appendix 1.

**Table 3-13  
The City of Wagoner  
EHS Sites**

<b>Facility Name</b>	<b>Street Address</b>	<b>City</b>
Ametek Prestolite Motors	1211 W Cherokee	Wagoner
Ametek Prestolite Motors	305 S. McQuarrie Ave	Wagoner
Calvary Plastics	Hwy 16 S	Wagoner
Cellxion Lightweight Division	300 SE 15th Suite A	Wagoner
Elastomer Specialties Polymer	2210 S. Hwy 69	Wagoner
Former McJunkin Red Man Corp	1300 N. Labarge Ave	Wagoner
Kevin Grover GMC Inc	1440 S. Dewey	Wagoner
O'Reilly Auto Parts Store 159	510 West Cherokee	Wagoner
Open Molded Plastics Inc.	902 S. Adams	Wagoner
Stacys Motor Company	705 W Cherokee	Wagoner
Sustainable Solutions Inc.	300 SE 15th Street Ste B	Wagoner
Tracys Body Shop	407 W Cherokee	Wagoner
Unarco Industries LLC	400 SE 15th	Wagoner
Union Pacific Railroad	302 S Main Street	Wagoner
Wagoner City Maintenance Shop	300 SE 3rd St	Wagoner
Wagoner Wastewater Plant	N4270 Rd (South of E760 Rd)	Wagoner
Wagoner Water Plant	Recreation Road (North of Whitehorn Cove Rd)	Wagoner
Wagoner Ford Line Merc	1510 W 51 Hwy	Wagoner
Wagoner Transmission	310 SE 2nd Street	Wagoner

There are nineteen EHS sites identified by DEQ that are located in the City of Wagoner.

3.2.12.3 The extent of the hazardous material hazard in The City of Wagoner is the EHS fixed location sites. The sites include buildings or property where EHS materials are manufactured or stored, and are regulated nationally under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) by the U.S. Environmental Protection

Agency (EPA), and in Oklahoma by the Department of Environmental Quality.

3.2.12.4 For the evaluation of previous occurrences of hazardous material events, traffic accidents with gasoline spills were included in the number of hazardous material events experienced by the City, in addition to responding to incidents at EHS facilities. Throughout the City, the committee members report their municipal fire departments respond to more than one vehicle accidents with gasoline spills per year. The City of Wagoner City of Wagoner quantified vehicle accident runs in 2011, responding to 24 events. The City of Wagoner Emergency Management Director reports this is representative of the vehicle accident occurrences throughout the City.

No data on traffic accident with gasoline spills was available for the City of Wagoner, but committee discussions indicate the City of Wagoner data is appropriate for the City of Wagoner.

Appendix 6 summarizes previous occurrences of this hazard.

3.2.12.5 Chemicals and hazardous materials are used throughout our society today, and will continue to be used in the future. And The City of Wagoner will continue to be exposed to this hazard. The likelihood rating for hazardous material events in the City is “highly likely”. This estimate of future occurrences is taken from the Likelihood Rating scale in the Hazard Summary Table in Appendix 6 because the committee members report numerous vehicle accidents with gasoline spills every year. The likelihood rating of “highly likely” also applies to the City of Wagoner. The likelihood rating is defined in Appendix 6.

3.2.12.6 The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

Many parts of Wagoner are susceptible to hazardous materials events due to the higher volume of traffic on the state highways that cross through Wagoner, SH 16, SH48, and SH66. Potential impacts include disruptions in transportation if highways are shut-down. Local businesses and residences can be affected by the roads being closed. Soils and waterways could become contaminated by spills. Wagoner will follow their emergency operations plans in the event of any hazardous material events.

A typical hazardous material hazard scenario would be an automobile accident where gasoline (which is not an EHS) is spilled and the local fire department responds. The worst case scenario would be responding to facility that contains a hazardous material that has not been properly documented so the responders may not be properly prepared for the hazardous material they would be encountering. The quantity of a hazardous substance is not the sole factor in the severity of a hazardous material event. Location, weather, population, topography, vegetation all could be factors in the event’s severity. But one gallon of gasoline spilled on a flat, impervious surface on a calm dry day in an unpopulated area would constitute an event of minor severity, where a tanker truck carrying a hazardous substance rupturing near a waterway on a hill in a populated area would constitute an event of major severity.

### **3.2.13 Dam Break Hazard**

3.2.13.1 A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams typically are constructed of earth, rock, concrete, or mine tailings.

A dam break is the collapse, breach, or other failure resulting in downstream flooding. Dam breaks are primarily caused by hydrologic or structural deficiencies. A hydrologic deficiency is inadequate spillway capacity, caused by excessive runoff from a large amount of precipitation.



Structural deficiencies include seepage, erosion, cracking, sliding, and overturning, mainly caused by the age of a dam and lack of maintenance.

The Oklahoma Water Resources Board coordinates the Oklahoma Dam Safety Program to ensure the safety of dams in the state. The program requires inspections every five years for low hazard structures and every three years for significant hazard structures. The program requires annual inspections for high hazard dams. Dams are designated as high hazard dams due to the presence of occupied dwellings immediately downstream. The following table lists the 7 dams in the area that could affect the City of Wagoner as listed in the OWRB Dam Safety program categorized as significant hazard or high hazard.

**Table 3-14**  
**Dams that Could Affect the City of Wagoner in the Oklahoma Dam Safety Program**  
 (Source: OWRB – 2017)

NAME	WAGONER	CITY	HAZARD CATEGORY
Upper Spavinaw	N/A	Tulsa	High
Spavinaw Lake	N/A	Tulsa	High
Salina Dike	N/A	GRDA	High
W.R. Holway Res	N/A	GRDA	High
Lake Ft Gibson	N/A	USACE	High
Markham Ferry	N/A	GRDA	Significant
Pensacola Dam	N/A	GRDA	Significant

3.2.13.2 The dams listed in Table 3-14 above pose a high or significant risk, per the OWRB, to occupied dwellings in The City of Wagoner. Their locations are shown in Map Number 10 in Appendix 1 or are shown on the OWRB Dam Inventory List on their website. An emergency action plan (EAP) is required by the OWRB and FERC for all high hazard category dams or FERC Licensed Projects. An element of the EAP is an inundation map showing the area inundated in the event of its dam break. For the five high hazard category dams, the OWRB or the USACE has EAPs for all of the dams. For the Significant Hazard, FERC has an EAP.

For these high hazard category dams, the Wagoner area that would be inundated is as follows. Depending on the location of a dam breach, the initial location of concern would be the Dike No. 10 area on the east side of Wagoner. The outlet valve would need to be closed to prevent water from Ft Gibson Lake from inundation the Interior Drainage Area and causing flooding to the east side of Wagoner. In the event of a dam breach of Pensacola Dam the inundation area is very similar to the 1% floodplain limits shown on the FEMA FIRM. In the event of a dam breach for Markham Ferry Dam the inundation area is significantly smaller due to the volume of water storage behind the dam in Lake Hudson for a normal breach but again similar to the inundation area of Pensacola Dam with a maximum breach.

The specific area of inundation from a break of any of these six dams would be in the respective dam's emergency action plan (EAP). Maps for the inundation areas resulting from a dam breach are included in the EAPs. For each of the six dams no infrastructure within the City of Wagoner is specifically called out as at risk. The Pensacola Dam and Markham Ferry Dam and Salina Dike, which are all GRDA dams, the only infrastructure that is called out are the structures immediately downstream of the respective dams. The GRDA high hazard and significant hazard category dams do not have EAPs on file with the OWRB; only with FERC.

Each one of the school sites are outside of the regulatory floodplain so probably outside an inundation area of any dam break. Since the limits of the dam inundation are shown to be almost coincident with the FEMA 1% floodplain limits, it is assumed that there is no inundation of the school sites as a result of an upstream dam breach.

Further due to the incomplete nature of the available data, the location of this hazard in The City of Wagoner cannot be quantified; the data is deficient. So the hazard is kept in the plan because it cannot be determined if a jurisdiction is not affected by the hazard. A mitigation action will be recommended to be included in the City of Wagoner action plan to accurately document the location of the dam breach hazard throughout the City, the location of the entire hazard, and the number of structures affected.

There are no dams within the City of Wagoner.

3.2.13.3 The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,500 dams in the state that falls within its jurisdiction. The dam safety program categorizes dams into three hazard categories; high, significant, and low. The OWRB defines these categories as follows. Low hazard dams are those where a break would result in no probable loss of human life and low economic losses. Significant hazard dams are those dams where a break would result in no probable loss of human life but can cause economic or disruption of lifeline facilities. High hazard dams are those dams where a break will probably cause loss of human life.

3.2.13.4 According to the National Climatic Data Center, there have been no dam break events in The City of Wagoner from 1950 through 2010. Its impact on the City would be similar to the flood hazard. The City of Wagoner has never been flooded by a dam break.

3.2.13.5 Continued dam inspection and proper maintenance should continue to keep these dams from failing. Owners of the dams either contract with private engineering firms to annually inspect the dams as required and report to the Oklahoma Water Resources Board or FERC or the USACE performs its own inspections of its dams. Entities that use impoundments from dams for a water source are responsible for any required maintenance. According to the City Emergency Management Department, there have been no dam breaks in The City of Wagoner from 1950 through 2010; a likelihood rating of “unlikely”. The likelihood of future hazard event occurrences is shown in the Likelihood Rating field in the Hazard Summary Table in Appendix 6. With no dam break occurrences in the City of Wagoner, the likelihood rating of “unlikely” applies to the City of Wagoner. The likelihood rating is defined in Appendix 6.

3.2.13.6 The impact of the hazard in terms of the number of structures and buildings and the potential damage the hazard may cause to the structures and buildings is discussed in the following sections 3.3 and 3.4. The impact of the hazard in terms of the capabilities or activities on the community is discussed as follows.

The worst case scenario of this hazard would be an unexpected break of a high hazard dam, so the emergency personnel could not enough advanced warning time to notify people in the area of inundation of the impending event.

The emergency action plans (EAP) for the Grand River Dam Authority (GRDA) high or significant hazard categorized dams are complete, but the data is classified, thus a deficiency, as discussed in section 3.2.13.2. Therefore, the consequences of these dams breaking were quantified to the best of our ability based on coordination of data with GRDA staff. A mitigation action will be recommended to be included in the Wagoner action plan to partner with the GRDA to accurately document the location of the hazard throughout Wagoner, the location affected, and the number of structures affected.

As long as dams exist so does the chance for failure. The Oklahoma Water Resources Board (OWRB) coordinates the Oklahoma Dam Safety Program to ensure the safety of more than 4,500 dams in the state that falls within its jurisdiction. Dams falling within the OWRB's jurisdiction are non-Federally constructed and maintained dams which are: 1) greater than 6 feet in height with storage capacities of 50 acre-feet or more; and/or 25 feet or greater in height with storage capacities of 15 acre-feet or more. The program requires inspections every five and three years for low and significant hazard structures, respectively. It requires annual inspection of the State's high-hazard dams, so designated due to the presence of one or more habitable structures downstream with loss of life and flooding likely to occur if a dam were to fail. Similarly, those GRDA dams that are FERC Licensed are required to have Emergency Action Plans and to maintain the structures in a safe manner.

Flooding potential exists if an upstream GRDA dam break should occur at these high or significant hazard dams. Obviously the impact of this would be devastating and many people would have to relocate to carry on normal lives. Disruption to businesses and schools would occur.

The hazard classifications are based upon current conditions, including population and land-use patterns below the dams. Such conditions can shift over time, such that a structure that is not considered high-hazard may receive such designation in the future, should, for example, dwellings built within the floodplain below the dam. Other high-hazard dams may have such designation lowered should land-use patterns change, reducing the threat of loss to life or property. Mitigation aspects, such as relocations of vulnerable properties, can reduce the number and magnitude of high-hazard dams. To protect vulnerable populations the State of Oklahoma and the City of Wagoner, the following law is in place:

***State Law 785:25-7. Warning and evacuation plans.***

- Owners of existing or proposed dams classified as high hazard, regardless of the size of such dams, and any other dam as determined by the Board, shall provide an adequate warning system and written evacuation plan to protect downstream lives and property, with a written description of said system and written evacuation plan to be approved by and filed with the local Civil Defense authorities.
- Additionally, the written description of the warning system and approved evacuation plan shall be filed with the Board.

## Appendix 7: 3.3 Assessing Vulnerability: Identifying Assets

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This section describes vulnerability in terms of the type and number of existing buildings and critical facilities in the hazard location. The vulnerability analysis utilized FEMA publication 386-2, “Understanding Your Risks,” Step 3, in order to determine the building value and contents value to determine a total value per building at risk from the hazard.

The City of Wagoner Assessor classifies properties into three (3) types; residential, commercial, and agricultural. A value for each property with a structure was determined by the assessor. The contents value was determined as a percentage of the building value, based on the Contents Value table in FEMA 386-2, Step 3.

The following table shows this information for all buildings in the City of Wagoner. This table will be referred to for all hazards that do not vary by location throughout the City.

**Table 3-15**  
**CITY of WAGONER: TOTAL BUILDINGS**

Category	Number of Structures	Structure Value (\$)
Residential	2,375	202,359,252
Commercial	317	66,018,881
Agricultural	66	6,949,058
Exempt/Unknown	143	100,606,567
Total	3,261	375,933,758

Flood hazards, dam break hazards, wildfire hazards, and hazards from expansive soils are the only four hazards that vary in magnitude in a pre-determined location. A hypothetical tornado was analyzed in the tornado hazard section. For these hazards, GIS models were used to determine the buildings in a hazard location.

For each hazard, the assets (buildings) at risk from that hazard are tabularized in each hazard’s section, or referred to the above table. The total number of buildings at risk, the building type, the building value, its contents value, and the total value is shown. These tables follow the format in FEMA 386-2, worksheets 3a “Inventory Assets”.

This assessment also analyses the critical facilities at risk from each hazard. Information on mobile homes is not tracked by the City of Wagoner Assessor; therefore, it is not included in the City of Wagoner vulnerability assessment.

Facilities that are classified to be critical by The City of Wagoner are listed in the following table, Table 3-16, and shown on Map Number 4 in Appendix 1. These facilities are critical to the City in they provide public safety and emergency response services to the public in the event of a hazard occurrence or they are necessary to preserve welfare and quality of life to the community. The critical facilities in the City of Wagoner are noted in the “City” column.

**Table 3-16**  
**CITY CRITICAL FACILITIES**

<b>TYPE</b>	<b>NAME</b>	<b>ADDRESS</b>	<b>CITY</b>
City Government	City of Wagoner Town Hall	231 E Church St	Wagoner
City Govt	The City of Wagoner Courthouse	307 E Cherokee St	Wagoner
City Govt	The City of Wagoner Assessor	307 E Cherokee St	Wagoner
City Govt	The City of Wagoner Emergency Mgmt.	807 W Cherokee St	Wagoner
Fire Department	City of Wagoner Fire Department	807 W Cherokee St	Wagoner
Police Department	Wagoner Police Department	105 S. Casaver Ave	Wagoner
Water Treatment Facility	Wagoner Water	N4270 Rd (South of E760 Rd)	Wagoner
Wastewater Facility	Wagoner Water	Recreation Road (North of Whitehorn Cove Rd)	Wagoner
Electric	Fort Gibson Dam Generation Facility	Grand River	Wagoner
School Supt	Wagoner Schools, 5 sites	308 NE 2nd St	Wagoner
Hospitals	Wagoner Community Hospital	1200 W Cherokee St	Wagoner

Some facilities are private and are included for reference.

### 3.3.1 Flood Hazard

FEMA data shows there is one (1) Severe Repetitive Loss (SRL) property in The City of Wagoner. There are at least six (6) structures that have recurring flooding within the City of Wagoner. Damaged structures are rebuilt in conformance with the City's, or respective community's flood damage prevention ordinance. As grants funds become available, the City of Wagoner plans to work with the property owner to remove the structure from the floodplain.

For all structures at risk from a flood hazard in the City of Wagoner, those buildings on property intersecting the regulatory floodplain are summarized below.

**Table 3-17**  
**CITY of WAGONER: TOTAL BUILDINGS IN REGULATORY FLOODPLAIN**

	<b>Number of Buildings</b>	<b>Building Value (\$\$)</b>	<b>Contents Value (\$\$)</b>	<b>Total Value (\$\$)</b>
Residential	155	21,320,080	10,660,413	31,980,493
Commercial	11	1,200,000	1,119,208	2,319,208
Agricultural	14	1,541,162	1,541,162	3,082,324
Total	180	24,061,242	13,320,783	37,382,025

Any future building in a flood hazard will be built in conformance with the City's Flood Damage Prevention Ordinance and Stormwater Ordinance as part of the City's membership in the NFIP; therefore, future buildings will not be considered at risk from the regulatory floodplain.

### 3.3.2 Tornado Hazard

The City of Wagoner has not been hit by a tornado.

The City of Wagoner was hit by an F-4 tornado on June 8, 1974. The path of the tornado is shown on Map Number 13 in Appendix 1. It was reported by committee members to have done substantial damage to all structures in a quarter-mile width along its path. To illustrate the structures at risk if this tornado occurred today, the current buildings within this tornado's path of destruction were determined and their building, contents, and total value were estimated. This estimate is shown in the following table.

**Table 3-18**  
**BUILDINGS IN TORNADO SCENARIO**

<b>Type</b>	<b>Number of Buildings</b>	<b>Building Value (\$\$)</b>	<b>Contents Value (\$\$)</b>	<b>Total Value (\$\$)</b>
Residential	140	8,149,708	1,074,854	12,224,562
Commercial	8	2,271,425	2,271,425	4,542,850
Agricultural	1	27,092	40,638	67,730
Total	149	10,448,225	6,386,917	16,835,142

### 3.3.3 Dam Break Hazard

The OWRB Dam Safety Program requires all high hazard category dams to prepare an emergency action plan (EAP) which would make a determination on the number of structures and infrastructure in each dam's dam break inundation area. As discussed in section 3.2.13, the High Hazard (OWRB) and Significant Hazard (FERC) have EAPs that contain the number of structures in their respective dam break inundation area. For each of the six dams no infrastructure within the City of Wagoner is specifically called out as at risk. The Pensacola Dam and Markham Ferry Dam and Salina Dike, which are all GRDA dams, the only infrastructure that is called out are the structures immediately downstream of the respective dams. The GRDA high hazard and significant hazard category dams do not have EAPs on file with the OWRB; only with FERC.

None of the EAPs made an estimate of the values of these structures, nor any other improvements that may be affected by its dam break.

### **3.3.4 High Wind Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.5 Lightning Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.6 Hail Storm Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.7 Winter Storm Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.8 Heat Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.9 Drought Hazard**

All areas, and all buildings, in the Community are at equal risk from this hazard. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section.

### **3.3.10 Expansive Soils Hazard**

The properties at risk from this hazard are properties located on high and very high shrink-swell potential soil types. The locations of expansive soils are shown in Map Number 8 in Appendix 1. As discussed in the profile of the expansive soil hazard, due to the generalized raster soils information for The City of Wagoner, site specific analyses cannot be made with certainty to determine if the City of Wagoner may have high and very high shrink-swell potential soils for be impacted by. Therefore, mitigation actions will be recommended to better quantify this hazard for each site.

Structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots are vulnerable to this hazard because expansive soils cause the ground under the foundations to settle unevenly. Asphalt surfaces such as highways and runways could be affected. This causes cracking and damage to the foundation and structure above the foundation,

such as buildings wall and a road's pavement.

### **3.3.11 Wildfire Hazard**

The wildland-urban interface is where the City is most vulnerability to this wildfire hazard. Because the City of Wagoner community is not very large in area, the area inside its wildland-urban interface is small. The Wagoner School District is participating in the plan, as listed in Chapter 1, and all of their schools are inside the communities' corporate limits.

The City of Wagoner has an area inside the ½ mile wildland urban interface, as shown on Map Number 9 in Appendix 1.

Table 3-19 shows the numbers of structures within the City of Wagoner's wildland-urban interface.

**Table 3-19  
STRUCTURES IN THE  
WILDLAND-URBAN INTERFACE**

<b>Community</b>	<b>Type</b>	<b># of Structures</b>
Wagoner	Residential	1216
Wagoner	Commercial	155
Wagoner	Agricultural	3



Fires can also destroy nonstructural assets such as agriculture, vegetation, and vehicles. Vulnerability of these non-structural assets, both in identifying these assets and estimating their damage potential was not quantified.

### **3.3.12 Earthquake Hazard**

All areas, and all buildings, in the City are at equal risk from this hazard, including the City of Wagoner. The total number of buildings, and value, in the Community is shown in the table at the beginning of this section. Vulnerabilities include all structures, homes, businesses and transportation infrastructure.

### **3.3.13 Hazardous Material Hazard**

The public is most at risk from hazardous materials when they are being transported. The City has defined the major transportation routes and is shown in Map Number 10 in Appendix 1. These major transportation routes include three state highways through the City of Wagoner; State Highways 16, 51, and 69.

## Appendix 7: 3.4 Assessing Vulnerability: Estimating Potential Losses

For each hazard, an analysis was done to determine the potential dollar losses to vulnerable buildings identified in Section 3.3. The analysis followed the methodology discussed in FEMA 386-2, step 4, and the format of FEMA 386-2 worksheet #4 “Estimate Losses” where applicable.

Only the flood hazard and the hypothetical tornado analyses identified structures with varying amounts of damage. The wildfire hazard section totaled structures and damages within the wildland-urban interface.

### 3.4.1 Flood Hazard

For the flood hazard, for this planning exercise, all structures on property intersecting the regulatory floodplain are evaluated at one foot below the base flood elevation. (Actual first floor elevations were not surveyed and the best available topography has 10 foot contour intervals making windshield surveys plus and minus five feet.) Using FEMA 386-2, part 4, building damage with one foot of flood depth is estimated to be 14 percent of the building value, and content damage is estimated to be 21 percent of the building value.

**Table 3-20**  
**CITY of WAGONER: DAMAGE ESTIMATE WITH ONE-FOOT FLOOD DEPTH**

Type	Number of Buildings	Building Value (\$\$)	Building Damage Value (\$\$)	Contents Damage Value (\$\$)	Total Damage Value (\$\$)
Residential	7	962,875	134,803	101,102	235,904
Commercial	1	119,208	16,689	25,034	41,723
Agricultural	1	110,083	15,412	23,118	38,529
Total	9	1,192,167	166,913	14,9253	316,156

### 3.4.2 Tornado Hazard

The City of Wagoner has not been hit by a tornado.

For the tornado hazard analysis, the path and impact area of the F-4 tornado to hit the City of Wagoner in 1974 is depicted in Map Number 13 in Appendix 1. As discussed in Section 3.3.2, the current buildings at risk from this tornado were determined. The FEMA 386-2 literature states there are no standard loss estimation models and tables for tornados. Therefore, all buildings within this tornado’s impact area were estimated to be completely destroyed. The potential loss from this tornado today is shown in the following table.

**Table 3-21**  
**TOTAL BUILDINGS IN TORNADO SCENARIO**

Type	Number of Buildings	Building Value (\$\$)	Contents Value (\$\$)	Total Value (\$\$)
Residential	140	8,149,708	1,074,854	12,224,562
Commercial	8	2,271,425	2,271,425	4,542,850
Agricultural	1	27,092	40,638	67,730
Total	149	10,448,225	6,386,917	16,835,142

### **3.4.3 Dam Break Hazard**

As stated in section 3.3.3, for each of the six dams no infrastructure within the City of Wagoner is specifically called out as at risk. The Pensacola Dam and Markham Ferry Dam and Salina Dike, which are all GRDA dams, the only infrastructure that is called out are the structures immediately downstream of the respective dams. The GRDA high hazard and significant hazard category dams do not have EAPs on file with the OWRB; only with FERC.

### **3.4.4 Hazardous Material Hazard**

The locations of the EHS locations and the major transportation routes are shown on Map Number 9 in Appendix 1. These major transportation routes include three state highways through the City of Wagoner; State Highways 16, 51, and 69.

### **3.4.5 Expansive Soils**

The potential damage to structures and infrastructure located on high and very high shrink-swell potential soils is dependent on the design of its foundation and quality of the construction of the foundation. Both factors were beyond the scope of this multi-hazard mitigation plan. Set damage estimates based on a percentage of the structure value were not used because of the wide variation of the factors involved in a foundation's stability. Structures with foundations such as homes and businesses, concrete slabs in driveways and sidewalks, and parking lots, are vulnerable to this hazard because expansive soils causes the ground under foundations to settle unevenly. Asphalt surfaces such as highways and runways could be affected. This causes cracking and damage to the foundation and structure above the foundation, such as a building's wall and a road's pavement.

### **3.4.6 Wildfires**

For this vulnerability analysis of wildfires, the structures within each community's wildland-urban interface and the City's WUI were inventoried and value estimated from the City Assessor database; shown in Table 3-22. The contents of the structure were estimated based on the structure value and total value is the sum of the structure's value and its contents value. For this planning process, the structure is considered a total loss if burned by the wildfire and the estimated value of the loss due to the wildfire is the total value, and also shown in Table 3-22.

**Table 3-22**  
**WILDLAND-URBAN INTERFACE DAMAGE ESTIMATE**

<b>Community</b>	<b>Type</b>	<b># of Structures</b>	<b>Value of Structures \$\$</b>	<b>Value of Contents \$\$</b>	<b>Total Value \$\$</b>
Wagoner	Res	1216	45,132,033	22,566,017	67,698,050
Wagoner	Comm	155	24,482,208	24,482,208	48,964,417
Wagoner	Ag	3	373,433	373,433	746,867

### **3.4.7 All Other Hazards**

The magnitude of the damage to structures from all the other hazards does not vary by location. The total building and content value for all structures in Community is totaled and shown in the table in the beginning of Section 3.3.

## **Appendix 7: 3.5 Assessing Vulnerability: Analyzing Development Trends**

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This section discusses the community's vulnerability in terms of a general description of land use and development trends so that mitigation options can be considered in future land use decisions. Three areas were analyzed. These are the types of existing and proposed land uses, development densities in the hazard areas, and anticipated changes in land use

3.5.1 The Wagoner County Assessor assigns three land use categories for the City. These are residential, commercial, and agricultural. Land use changes can occur, and are initiated by the property owner, usually to accommodate a new development. The City's Board of Adjustment reviews each change request, and takes into account hazards and hazard prone areas in ruling on any land use change request.

3.5.2 There are 4,575 parcels of property in Wagoner. Of these, 3,261 parcels are developed. It must be noted that no new building development will be added to the flood hazard because any new building will conform to the Community's Flood Damage Prevention Ordinance, which the Community will continue to vigorously enforce. It will be recommended for all new construction to investigate the shrink-swell potential of its soils, and design and construct the foundation with the soils' properties as a consideration.

3.5.3 It is anticipated the City of Wagoner will have significant development in the short and long term, and new infill development will continue; utilizing existing infrastructure within the community. No changes in development impacted Wagoner's overall vulnerability.

End of Hazard Mitigation Narrative