Appendix G:

Hazard Analysis

This Appendix is the Annex B to the Basic Plan of the City of Beaverton's Emergency Operations Plan (EOP).

B Hazard Analysis

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1 Introduction

A hazard analysis is a systematic investigation of potential emergencies/disasters by analyzing history, vulnerability, and probability. It is the foundation for the development of mitigation strategies, planning, and preparedness activities, as well as response and recovery activities. This hazard analysis is based on the Oregon Office of Emergency Management's (OEM's) Hazard Analysis Methodology.

2 Geographic Description

- The City of Beaverton (City) is located 7 miles west of Portland, Oregon in Washington County. It is an incorporated city encompassing 19.61 square miles, with a population over 96,000. The City is a suburban community with a diversified economic base that includes light industrial and high technology businesses, as well as numerous office complexes and retail centers.

- Two major freeways, U.S. Highway 26 (the Sunset Highway) and State Highway 217, connect the City to Interstate 5 (north-south) and to Interstate 84 (east-west). Other major roadways are State Highway 10 (the Beaverton-Hillsdale Highway) and Highway 8 (the Canyon Road -Tualatin Valley Highway), both of which run east and west.

- Multiple rail systems pass through the City, including:

  - The TriMet MAX Light Rail Service (commuter), which extends from Gresham to Hillsboro.

  - Portland and Western Railroad (freight), which passes through the City.

  - Westside Express Service (WES), a commuter rail line that runs from Beaverton to Wilsonville.

- The state's busiest general aviation airport, Hillsboro Airport, is about 10 miles west of the City. Aircraft on approach to, or departure from, this airport and the Portland International Airport may pass over the City of Beaverton, depending on winds and their flight paths.

- The City's climate consists of warm, dry summers and mild, wet winters. Temperatures are usually moderate, ranging from an average January minimum of 34 degrees Fahrenheit (°F) to an average July maximum of 81°F. The annual precipitation is nearly 40 inches, with the majority of the precipitation occurring from November through March. Snowfall occurs on only a few days, if at

all, each year. Snow on the ground is generally of short duration, with depths seldom exceeding 5 inches.

3 Hazard Rating System

The potential hazards that may affect the City of Beaverton are discussed in this addendum in the order of relative risk based on the criteria established in OEM's Hazard Analysis Methodology.

3.1 Criteria

The methodology determines the relative risk by applying severity ratings to four criteria:

- Event History
  - Event history is based on events requiring
    - Activation of the Emergency Operations Center (EOC) or alternate EOC;
    - Three or more Emergency Operations Plan (EOP) functions to be implemented;
    - An extraordinary multi-jurisdictional response; and/or
    - Declaration of a "Local Emergency"
  - A high rating is given for four or more occurrences in the past 100 years, moderate for two to three occurrences, and low for one or none.
- Vulnerability is based on the percentage of the population and property likely to be affected by the incident under an "average" occurrence. High vulnerability affects more than 10% of the population and property, moderate vulnerability affects 1–10%, and low vulnerability affects less than 1%.
- Maximum Threat is the highest percentage of population and property that could be impacted under a worst-case scenario.
- Probability is based on the likelihood of another occurrence within a specified period of time. A high probability incident can be expected once within a 10 to 35 year period, a medium probability once within 35 to 50 years and low, once in 75 to 100 hundred years.

3.2 Severity Rating

The value of the severity ratings are determined based on the following:

- Low = Choose the most appropriate value between 1 to 3 points.
- Medium = Choose the most appropriate value between 4 to 7 points.
- High = Choose the most appropriate value between 8 and 10 points

3.3 Weight Factor

Weight Factors (multipliers) are applied to each of the four categories:

- History = 2
- Vulnerability = 5
- Maximum Threat = 10
- Probability = 7

4 Beaverton Hazards

There are numerous types of hazards that could impact the city, but this assessment covers those that have a greater likelihood of occurring.

4.1 Hazards Assessed

The hazards that have been assessed are:

- Severe weather
  - High Winds
  - Winter Storms
- Earthquakes
- Flood
- Volcano (Ash Fall)
- Hazardous Materials
- Terrorism
- Landslides and Debris flow
- Pandemic/Outbreak

- Drought

4.2 Climate Change

While climate change is not a hazard per se, it can be an influencing factor in the impact of hazards that do occur. Two significant factors are extreme temperatures and drought.

Extreme fluctuation of temperature is one of the expressions of climate change. Both higher than normal and lower than normal temperatures not only impact the citizens of Beaverton, but increase the demands on city response resources. Typically, homes in the northwest are not insulated as well as structures in areas that commonly deal with very high or very low temperatures. For that reason some citizens will not be able to adequately escape the elements. If a hazardous event occurs during an extreme temperature event it is possible that a larger section of the city's population will be adversely effected.

Drought is another expression of climate change, but is not a primary threat to Beaverton at this time. However, considerations for the secondary effects of drought should be on the table to mitigate issues that could impact the city. While Beaverton has a commonly ample water reserve, during a drought a number of hazardous events could cause the loss of water reserves and therefore steps should be considered to mitigate such events.

5 Analysis

5.1 Hazard Analysis Matrix

Hazard	Rating Criteria with Weight Factors				Total Score
	History (WF=2)	Vulnerability (WF=5)	Max Threat (WF=10)	Probability (WF=7)	
Severe Weather - High Winds	H 9	H 8	H 8	H 10	**208**
Severe Weather - Winter Storms	H 9	M 7	H 8	H 10	**203**
Earthquakes	L 1	H 9	H 10	H 8	**203**
Flood	H 9	M 6	M 7	H 10	**188**

Hazard	Rating Criteria with Weight Factors				Total Score
	History (WF=2)	Vulnerability (WF=5)	Max Threat (WF=10)	Probability (WF=7)	
Pandemic	L 1	H 8	H 9	H 8	**188**
Volcano (Ash Fall)	L 1	M 4	H 10	M 8	**178**
Hazardous Materials	H 9	M 4	M 6	H 9	**161**
Drought	L 1	M 5	H 10	M 4	**155**
Terrorism	L 1	L 2	M 5	H 8	**118**
Landslides and Debris Flow	L 1	L 1	L 3	M 7	**86**

5.2 Severe Weather – High Winds (208)

- Coastal hurricane force winds occasionally penetrate inland to the City of Beaverton, resulting in wind gusts of 75 to 80 miles an hour. Approximately 60% of the recorded high winds are from the south or the west.
  - Damage from high winds has generally resulted in downed utility lines and trees.
  - Electrical power can be interrupted anywhere from a few hours to two or three days. Outdoor signs have also suffered damage.
  - If the high winds are accompanied by rain (which they often are), blowing leaves and debris clog catch basins which contributes to localized inundation flooding.
- History: The following dates represent occurrences of wind storms meeting the established criteria.

- October 1962
- November 1962
- October 1967
- January 1971
- November 1981
- November 1982
- January 1991
- December 1995
- December 2007

5.3 Severe Weather – Winter Storms (203)

- Beaverton is at risk from two types of winter storms: snow and ice. The impacts of both storms are similar.
  - Heavy snowfall rarely occurs in Beaverton. When it does occur, many of the subsequent problems are directly related to the public's unfamiliarity in dealing with such conditions.
  - Ice storms may occur as a result of a combination of weather factors, either with or without a related snowfall.
  - The heavy ice on utility lines typically results in outages throughout the City.
  - Heavy snow or ice that occurs before the trees lose all of their leaves can knock down limbs and possibly entire trees and consequently power and telephone lines.
- History – The following dates represent occurrences of winter storms meeting the established criteria.
  - January 1962
  - January 1969
  - January 1979
  - January 1980
  - December 1983
  - February 1989
  - December/January 1991
  - January/February 1993
  - November 1996
  - December 1999
  - December 2008
  - December 2009

5.4 Earthquakes (203)

- Earthquakes from three different sources threaten communities in Oregon and the Pacific Northwest. These sources are crustal, subduction zone and intraplate earthquakes.

- Crustal – the most common earthquakes are crustal earthquakes.
    - Crustal earthquakes typically occur along faults, or breaks in the earth's crust, at shallow depths of 6-12 miles (10-20 km) below the surface.
    - The two largest earthquakes in recent years in Oregon, Scotts Mills (magnitude 5.6) and the Klamath Falls main shocks (magnitude 5.9 and magnitude 6.0) of 1993, were crustal earthquakes.
- Subduction zone – Subduction zone earthquakes occur in places where the tectonic plates that make up the surface of the earth collide.
    - When these plates collide, one plate slides (subducts) beneath the other, where it is reabsorbed into the mantle of the earth.
    - This dipping interface between the two plates is the site of some of the most powerful earthquakes ever recorded, often having magnitudes of 8 to 9 or larger.
    - The 1960 Chilean (magnitude 9.5) and the 1964 Great Alaska (magnitude 9.2) earthquakes were subduction zone earthquakes.
- Deeper intraplate earthquakes occur within the remains of the ocean floor that is being subducted beneath North America.
    - This type of earthquake could occur beneath much of the Northwest at depths of 25–37 miles (40–60 km).
    - The magnitude 6.8 intraplate earthquake that struck the Puget Sound area on February 28, 2001 caused $2 billion in damage but was much less destructive than a crustal earthquake of the same magnitude would have been because of its great depth (33 miles deep).
    - Intraplate earthquakes have also caused damage in the Puget Sound region in 1949 and again in 1965.

■ Based on recorded and geologic history, geologists say the Northwest will experience major to large earthquakes. However, there is no method to estimate when they will take place.

- Recent evaluation of the earthquake threat in Oregon indicates the area may experience a "great" subduction zone earthquake.
    - Earthquake hazard mapping identifies the potential of major damage for Beaverton.
    - Beaverton has mostly silt-type soil, which is subject to liquefaction (a process that takes place during an earthquake which causes sands and silts to lose strength and behave as viscous fluids rather than solids).
- Earthquakes, which have been felt in Beaverton, have originated in other areas.
    - The Mt. Angel earthquake on March 25, 1993, was the first significant earthquake (in recorded history) to originate close enough to Beaverton to be felt. Beaverton experienced only minor damage, but surrounding counties, including Clackamas, incurred significant damage and received a federal disaster declaration.
    - The Nisqually earthquake on February 28, 2001, was felt in the City but did very little damage.
    - Numerous small quakes occurred in the Portland Metro area in 2013, 2014, and 2015. Most of these earthquakes were not strong enough to be felt.
    - Though it was too small to be felt, in 2003 a small quake was detected under Cooper Mountain, in the southern part of the City, on a fault that had been previously designated by geologists as "inactive."
- History – The following dates include significant earthquakes in the Northwest, though not all of them meet the established criteria:
    - 1946 Vancouver Island (7.3)
    - 1949 Olympia (7.1)
    - 1965 Seattle (6.5)
    - 1992 North Plains (3.0–4.0)
    - 1993 Scott Mills (5.6)
    - 2001 Nisqually (6.8)

5.5 Flood (188)

- Flooding is a common natural occurrence faced by Beaverton.
  - The flood season for Beaverton extends from late October through April. Historically the majority of flooding has occurred in December, January, and February.
  - Beaverton has recurrent and substantial flood problems from Beaverton Creek, Fanno Creek, Johnson Creek, South Fork Beaverton Creek, and Cedar Mill Creek. However, only a small percentage of the City's population is typically impacted by flood events.
    - Beaverton Creek, the most significant stream in the community, drains approximately 36 square miles as it flows northwesterly through the major commercial area of Beaverton.
    - Other streams in the City include five tributaries to Beaverton Creek: South Fork Beaverton Creek, Johnson Creek, Hall Creek, Willow Creek, and Cedar Mill Creek.
    - Another significant creek is Fanno Creek, which flows westerly to State Highway 217, then southerly through the City to its confluence with the Tualatin River.
  - Soils in and around Beaverton are silt loams that range in grade from nearly level to steep slopes.
    - Drainage characteristics for those soils are poor along the level areas of the floodplains, but drainage (run-off) improves on sloping terrain.
    - Trees, grass, and shrubs are the dominant vegetation type. The rapid urbanization of the City is leading to a decrease in vegetation, and thus an increase in impervious surface and infringement of natural drainage areas.
- History – The following dates represent occurrences of storms meeting the established criteria:
  - December 1964
  - January 1972
  - January 1973
  - January 1991
  - February 1996
  - November 1996

- January 1974
- Nov/Dec 1977
- December 1981
- January 1982
- January 2003
- February 2003
- December 2007
- December 2015

5.6 Pandemic (188)

- A pandemic is a worldwide outbreak of disease in people. Although a pandemic can be caused by a large variety of diseases, influenza is particularly suited to be the cause of a significantly devastating event, and thus is the disease considered here.
  - The influenza virus is easily spread from person to person, and is continuously reassorting and changing.
  - Pandemic flu is caused by a novel (new) flu virus to which humans have little or no immunity.
  - The flu virus that causes a pandemic can spread easily, and may cause large numbers of people to get sick and die.
  - No one can predict when a pandemic will occur or how severe it will be.
- On average, an influenza pandemic has occurred every 30 to 40 years over the last 400 years. There have been four pandemics since 1900, the most deadly of which took place in 1918.
  - Known as the Spanish Flu, the 1918 pandemic killed 20 to 40 million people worldwide and millions more fell ill.
  - Oregon recorded 49,297 influenza cases and 3,688 deaths between 1918 and 1920, with most occurring during the two months of October and November, 1918.
  - The other flu pandemics occurred in 1957, 1968, and 2009-2010. Fortunately, these pandemics were much less severe than the one in 1918.

5.7 Volcano (178)

- The threat of this hazard is primarily ash fall, which could result from an eruption of Mt. St. Helens. Volcanologists also consider Mt. Hood to be potentially active.

- Beaverton experienced light ash fall from Mt. St. Helens' eruption in May of 1980
- An eruption from Mt. St. Helens or Mt. Hood could potentially cause major damage due to ash fall.
- The amount of ash fall experienced and its impact will depend, to a large degree, on the weather conditions. A substantial part of the City could be impacted from the ash fall.

5.8 Hazardous Materials Incidents (161)

- The City of Beaverton has a history of minor hazardous materials incidents, but none that have risen to the level of major emergency or disaster. However, the increased use of hazardous materials in all aspects of daily life, their increased presence within Washington County, and the proximity of commercial and residential developments to hazardous material facilities raise the probability of a significant future event. This probability is offset somewhat by stricter regulations and tougher regulatory enforcement for facilities and companies that manufacture, transport, or store hazardous materials
- Hazardous materials are commonly used, stored, and/or transported in Beaverton.
    - A hazardous materials incident involves the unintentional release of hazardous substances into the environment and may occur as the result of natural disasters, equipment failure or human error.
    - Hazardous materials incidents may occur at fixed facilities and along transportation routes during transportation-related incidents that involve hazardous and radiological materials.
    - Any hazardous materials incident may represent a potentially dangerous situation. Chemicals that are flammable, explosive, corrosive, toxic, or reactive, along with biological and radioactive materials, pose a special hazard to emergency responders and the general public.
- There are several facilities in or near the Beaverton City limits that keep, use or transport hazardous materials. Under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986 and the Pollution Prevention Act of 1990, these facilities are required to report to the State Fire Marshal.

- There are commercial rail lines that run through downtown Beaverton that frequently carry hazardous materials beyond the large quantity of diesel fuel in the engines.
- Two major pipelines for the transportation of natural gas and flammable liquids pass through the west side of Beaverton.
- There are several freeways and highways that intersect the City. These roadways carry large numbers of vehicles transporting hazardous materials. Shipments containing hazardous materials are prohibited from going through the Vista Ridge tunnel on State Highway 26 and are diverted through Beaverton on State Highway 217.
- There are sites in Beaverton with contaminated soils that are under the supervision of the Oregon Department of Environmental Quality. The types of contamination include petroleum products and lead.
- History – The following dates represent incidents meeting the established criteria:
  - June 1981
  - September 1983
  - November 1983
  - January 1984
  - February 1989
  - June 1997
  - November 1998
  - September 2001

5.9 Drought/Water Shortage (155)

- A water shortage may arise from a number of causes but would likely derive from drought or a significant diversion/interruption of water supplies into the City. Drought involves a period of prolonged dryness resulting from a lack of precipitation. A severe drought could require that strict conservation measures be implemented to assure an adequate supply of potable water for Beaverton residents. Long term drought conditions typically have devastating consequences for agricultural and other businesses dependent on a good supply of water and place portions of the City at risk for wildland fires.
- Although Beaverton has suffered periods of drought in the past, the impacts have not been severe enough to reach major emergency or disaster proportions. The drought of 2000-01 is the worst on record for the City. Hagg Lake, the reservoir behind Scoggins Dam, fell to a

record low of 9%. A combination of effective water management, significant conservation on the part of local irrigators, and adequate potable water supplies from the City ASR wells avert a major water crisis that year. A major drought affected several Oregon counties in 2015 but did not directly affect Beaverton.

- Diversions/interruptions of water supplies to the City could stem from failed reservoirs or wells, ruptured pipelines, or contaminated water sources.

- Climate change forecasts highlight an increased risk for drought conditions in the Pacific Northwest. According to the U.S. National Climate Assessment report Climate Change Impacts in the United States Highlights "Changes in the timing of streamflow related to changing snowmelt are already observed and will continue, reducing the supply of water for many competing demands and causing far-reaching ecological and socioeconomic consequences." (See http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download =1, page 80)

5.10 Terrorism (118)

- Terrorism is the unlawful use, or threatened use of force or violence by a person or an organized group against people or property with the intention of intimidating or coercing societies or governments, often for ideological or political reasons.

- All government facilities, including public schools, libraries, reservoirs, and recreational facilities are potential targets for terrorists. Other potential targets include utilities, transportation systems, and international businesses.

- Possible types of terrorist incidents include:
  - Assault and battery
  - Arson
  - Active Shooters
  - Homicide (assassination)
  - Bombings or bomb threats
  - Interruption of resources, utilities, and/or services
  - Kidnapping and extortion

- Threat to use or the use of chemical, biological, or radiological agents.

- Potential Terrorist targets include:
  - Governmental/diplomatic facilities and events
  - High profile court cases
  - Public and private schools, including universities and research centers.
  - Political fund-raisers, campaigns, and conventions.
  - Elected officials and City events
  - Religious establishments and events
  - Utilities
  - Transportation
  - International businesses/ corporations
  - International sporting events

5.11 Landslides and Debris Flow (86)

- There are several steep slopes (slopes greater than or equal to 25%) within the City. LIDAR (Light Detection And Ranging) technology shows evidence of landslide deposits at the base of some of these slopes indicating that the slope has slid in the past.
  - 4 minor slides are within city limits
  - 1 large slide area is both inside and outside the city limits
  - 1 large slide area is outside, but close to the city limits

- Other than these ancient slides, there are no known active locations prone to landslides, avalanches, or debris flows inside city limits. This may change with future annexations of areas to the north, north east and southwest of current City boundaries.