Earthquake Risk Assessment

This plan is an update of the 2004 City of Redmond Hazard Mitigation Plan (HMP). Although it is an update, this document has been redesigned so that it looks, feels, and reads differently than the original. This is due to several factors: new hazard information has become available that drives new definitions of risk, the City has matured and new capabilities are now available, and the new format will allow readers to more easily understand the content. In addition, the 2004 HMP included several action items that have been completed, creating an opportunity for developing new mitigation strategies.

5.1 Identify Earthquake Hazards

Earthquakes are vibrations caused by the movement of the Earth's crustal plates. The Earth's crust is, on average, approximately 45 miles thick and consists of several plates that slide over a partially molten layer of the planet.[29] The Pacific Northwest, including Redmond, is located in a subduction zone, characterized by oceanic plates sinking underneath continental plates.[30] In subduction zones, the crust builds up tension, which eventually releases with violent force. The resulting vibration causes distortion and uplift of the surface crust and may be extremely damaging.

The City of Redmond has a 0.2% chance that an earthquake with a peak horizontal acceleration of 0.25 G will occur in any given year (see **Map 13, City of Redmond Probabilistic Seismic Risk**).[31] A G is the average acceleration produced by gravity at the earth's surface (9.80665 meters per second squared). This measurement describes ground shake during earthquakes.

The Puget Sound Region and Redmond are at risk of earthquakes from three sources:[32]

- The Juan de Fuca plate is subducting underneath the North American plate.
- The Seattle Fault, located a few miles south of Redmond
- The South Whidbey Fault, located north of Redmond

Soil Liquefaction and Ground Shaking

Soil liquefaction and intense ground shaking often cause the most damage during an earthquake. Liquefaction occurs when strong earthquake shaking causes an immediate weakening of soils such that the soils take on properties similar to quicksand. Liquefaction most often occurs in artificial fill, and in highly saturated loose and sandy soils, such as low-lying coastal areas, lakeshores, and river valleys.

29 David Hyndman and Donald Hyndman, Natural Hazards and Disasters 2006 Update (Belmont, CA: Thomson Brooks/Cole, 2006).
30 Lynn S. Fichter, "Plate Tectonic Theory: Plate Boundaries and Interplate Relationships," James Madison University Department of Geology & Environmental Science.
31 Earthquake Hazards Program, "National Seismic Hazard Maps-2008," U.S. Geological Survey, http://gldims.cr.usgs.gov/nshmp2008/viewer.htm.
32 Michael A. Fisher et al., "Crustal Structure and Earthquake Hazards of the Subduction Zone in Southwestern British Columbia and Western Washington," U.S. Geological Survey, http://pubs.usgs.gov/pp/pp1661c/pp1661c.pdf.

Susceptibility to liquefaction is measured by the physical characteristics of a soil, such as grain, texture, compaction, and depth of groundwater.[33]

Glacial till covers 60 to 70 percent of the City of Redmond, and is nearly impermeable due to its compact nature and scarcity of organic matter.[34] Deposited alluvium, found in Redmond, is made up of fine particles of silt and clay and larger particles of sand and gravel. According to the United States Geologic Survey (USGS), the seismic stability of alluvium is very poor, and the seismic stability of other post-glacial materials is very poor to fair.[35] The Sammamish River Valley that runs through Redmond is vulnerable to liquefaction during an earthquake.

Earthquake-induced ground shaking is strongest in river valleys and other soft-soil shorelines – conditions common throughout the City of Redmond (see **Map 14, City of Redmond Soil Liquefaction Hazard**). Ground shaking in soft soils layered on stiffer soils or rock is more severe than in areas with little variation between layers. The severity of soil-related natural hazards and ground failure phenomena often depends on status of groundwater, soil saturation, and drought conditions.[36] Soils prone to liquefaction and amplified ground shaking will present the most severe hazards.

Secondary Hazards

A significant earthquake in the Puget Sound Region is likely to cause any of the following secondary hazards: [37]

- Liquefaction
- Landslides
- Tsunamis
- Seiche (a large displacement sloshing of water in a lake, such as Lake Sammamish, causing tsunami type damage)
- Building failure due to structure age and building construction
- Fires from downed power lines, gas or electrical equipment malfunctions
- Hazardous materials spills

A severe earthquake on the South Whidbey Fault may cause activity on other faults.[38]

5.2 Profiling Earthquake Hazard Events

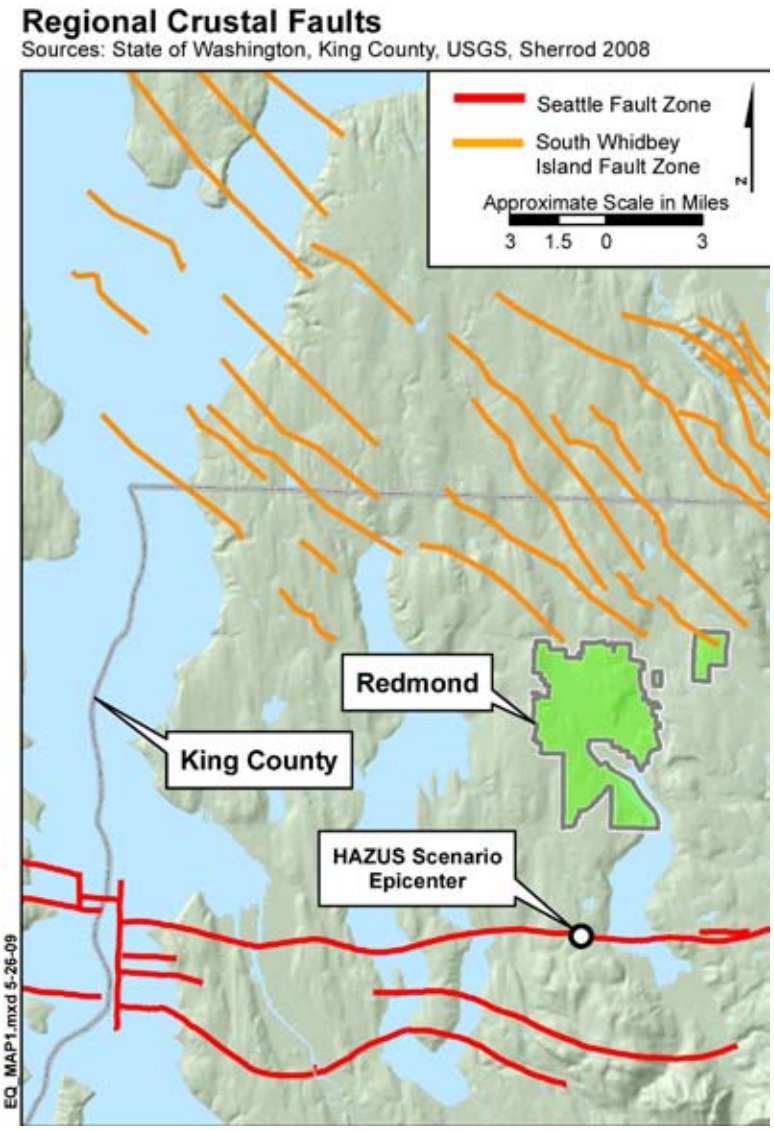
There are three types of earthquakes that occur within the Puget Sound Region:

33 Jorgen Johansson, "Soil Liquefaction Web Site," University of Washington Department of Civil Engineering, http://www.ce.washington.edu/~liquefaction/html/main.html.
34 Tracy Chollak and Paul Rosenfield, "Guidelines for Landscaping with Compost-Amended Soils," City of Redmond.
35 Mineral Information Service, "The Seattle Earthquake of April 29, 1965," California Geology 18, no. 7 (1965).
36 Jorgen Johansson, "Soil Liquefaction Web Site," University of Washington Department of Civil Engineering, http://www.ce.washington.edu/~liquefaction/html/main.html.
37 Cascadia Region Earthquake Workgroup, "Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario, 2005," http://www.crew.org/papers/CREWCascadiaFinal.pdf.
38 Gale Fiege, "South Whidbey Fault Has Potential For Major Quake," The Daily Herald, June 15 2009, http://www.heraldnet.com/article/20090615/NEWS01/706159921.

subduction zone earthquakes, Benioff (deep) earthquakes, and crustal (shallow) earthquakes.[39] These types of earthquakes differ in location, timing and duration, severity, and frequency. Each type of earthquake is profiled individually.

Location of an earthquake is described by the focus and the epicenter. The focus is the first point of movement along the fault line. The epicenter is the corresponding point above the focus at the Earth's surface.

The severity of an earthquake depends on the intensity of surface shaking (peak ground acceleration) and potential damage to the built environment. Severity is commonly measured with the Modified Mercalli Scale or the Richter Scale (Table 12). The City of Redmond is at greatest risk of large, shallow, crustal earthquakes emanating from the Seattle or South Whidbey faults (see **Map 12, Regional Crustal Faults**).



Map 12: Regional Crustal Faults

5.2.1 Subduction Zone Earthquakes

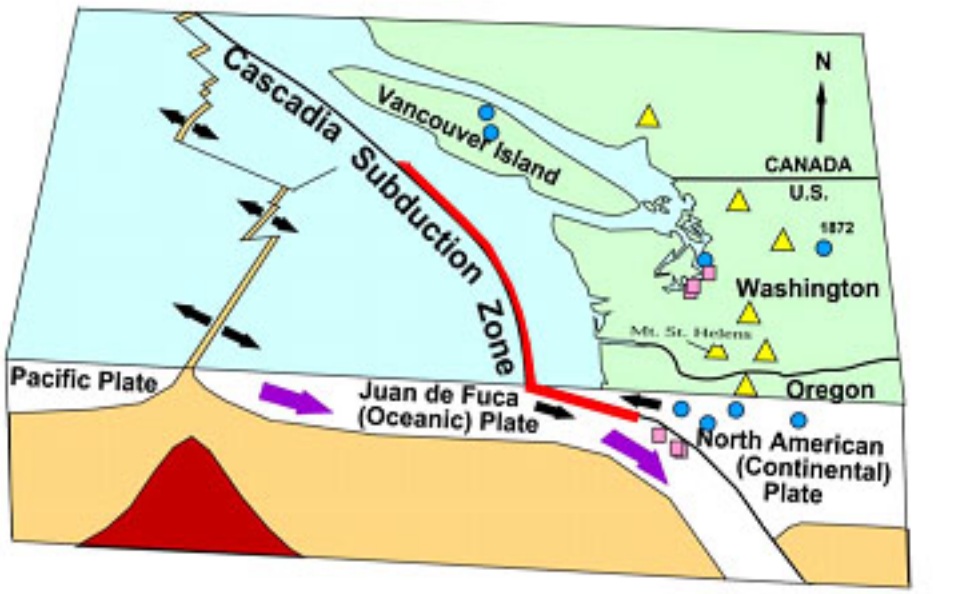
A. Location

Subduction zone earthquakes are caused by the Juan de Fuca Plate sliding beneath the North American Plate. Currently, The Juan de Fuca Plate is sinking below the North American Plate at a rate of approximately 4.5 cm per year. This subduction zone is approximately 200 miles off the Washington coast.[40] This type of earthquake will affect the entire region, including Redmond.

B. Timing and Duration

Subduction zone earthquakes can happen at any time with shaking likely to last several minutes.[41]

39 Ruth Ludwin, "Earthquake Hazards in Washington and Oregon," The Pacific Northwest Seismic Network, http://www.pnsn.org/INFO_GENERAL/eqhazards.html.
40 Michael A. Fisher et al., "Crustal Structure and Earthquake Hazards of the Subduction Zone in Southwestern British Columbia and Western Washington," U.S. Geological Survey, http://pubs.usgs.gov/pp/pp1661c/pp1661c.pdf.
41 Cascadia Region Earthquake Workgroup; Pacific Northwest Seismic Network Staff, "Earthquake Hazards in Washington and Oregon: Three Sources," The Pacific Northwest Seismic Network, http://www.pnsn.org/CascadiaEQs.pdf.



Deep earthquakes (30 miles below the Earth's surface) are within the subducting oceanic plate as it bends beneath the continental plate. The largest deep Northwest earthquakes known were in 1949 (M 7.1) and 2001 (M 6.8).

Shallow earthquakes (less than 15 miles deep) are caused by faults in the North American Continent. The Seattle fault produced a shallow magnitude 7+ earthquake 1,100 years ago. Other magnitude 7+ earthquakes occurred in 1872, 1918, and 1946.

Subduction earthquakes are huge quakes that result when the boundary between the oceanic and continental plates ruptures. In 1700, the most recent Cascadia Subduction Zone earthquake sent a tsunami as far as Japan.

Mt. St. Helens/Other Cascade Volcanos

From PNSN 2008

Figure 6: Earthquake Types in Washington
Source: Ruth Ludwin, Earthquake Hazards in Washington and Oregon: Three Source Zones.

C. Severity

Subduction zone earthquakes are extremely powerful, typically registering a magnitude of 8 to 9+ on the Richter scale.[42] However, due to the location of the Juan de Fuca Plate, an earthquake of 8 or 9 magnitude would have a reduced local impact in Redmond. Such an earthquake would have similar shaking to the 2001 Nisqually earthquake (a magnitude 6.8, Benioff earthquake that lasted 2 minutes) but it would last much longer.

Subduction zone earthquakes cause longer shock waves than Benioff quakes and will be felt from a greater distance than the 2001 Nisqually earthquake.[43]

42 Ray Flynn et al., "The Cascadia Subduction Zone – What is it? How big are the quakes? How often?" The Pacific Northwest Seismic Network, http://www.pnsn.org/HAZARDS/CASCADIA/cascadia_zone.html.
43 Cascadia Region Earthquake Workgroup, "Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario, 2005," http://www.crew.org/papers/CREWCascadiaFinal.pdf.

The Modified Mercalli Scale	Level of Damage	The Richter Scale
1 - 4 Instrumental to Moderate	No damage.	4.3 or Below
5 - Rather Strong	Damage negligible. Small, unstable objects displaced or upset; some dishes and glassware broken.	4.4 - 4.8
6 - Strong	Damage slight. Windows, dishes, glassware broken. Furniture moved or overturned. Weak plaster and masonry cracked.	4.9 - 5.4
7 - Very Strong	Structure damage considerable, particularly to poorly built structures. Chimneys, monuments, towers, elevated tanks may fail. Frame houses moved. Trees damaged. Cracks in wet ground and steep slopes.	5.5 - 6.1
8 - Destructive	Structural damage severe; some will collapse. General damage to foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.	6.2 - 6.5
9 - Ruinous	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	6.6 - 6.9
10 - Disastrous	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.	7.0 - 7.3
11 - Very Disastrous	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.	7.4 - 8.1
12 - Catastrophic	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted.	Above 8.1

Table 12: Modified Mercalli Scale and Richter Scale
Source: FEMA for Kids, "The Disaster Area: Intensity Scales," Federal Emergency Management Agency, http://www.fema.gov/kids/intense.htm.

D. Frequency

The last large subduction zone earthquake to hit Washington State occurred on January 26, 1700 and had a magnitude of 9.0.[44] This type of earthquake occurs, on average, every 400 to 600 years.[45]

5.2.2 Benioff (Deep) Earthquakes

A. Location

Benioff (deep) earthquakes in this region typically occur at a depth of approximately 15 to 60 miles below Western Washington. This occurs when the Juan de Fuca Plate slips against the North American Plate. This kind of earthquake would affect all of Redmond and the surrounding region.[46]

44 Ray Flynn et al., "The January, 1700 Cascadia Subduction Zone Earthquake and Tsunami," The Pacific Northwest Seismic Network, http://www.pnsn.org/HAZARDS/CASCADIA/cascadia_event.html.
45 Cascadia Region Earthquake Workgroup; Pacific Northwest Seismic Network Staff, "Earthquake Hazards in Washington and Oregon: Three Sources," The Pacific Northwest Seismic Network, http://www.pnsn.org/CascadiaEQs.pdf.
46 Ruth Ludwin, "Deep Quakes in Washington and Oregon," The Pacific Northwest Seismic Network, http://

B. Timing and Duration

Benioff earthquakes may happen at any time. Shaking will last a minute or less. Aftershocks are less commonly associated with Benioff earthquakes than with other types of earthquakes.[47]

C. Severity

Benioff Zone earthquakes reach magnitudes of 7.5. These deep earthquakes can be high in magnitude, but the depth makes them less violent in terms of lateral acceleration than a similarly sized crustal (shallow) earthquake.

Compared to a subduction zone earthquake, the shaking from a Benioff earthquake will not be felt as far away and the shaking will not last as long. Due to the dip-slip character of Benioff earthquakes, large aftershocks are not common.[48] Benioff (deep) earthquakes are not the most severe of the types of earthquakes that affect Redmond.[49]

D. Frequency

Benioff earthquakes occur most frequently in Redmond. This type of earthquake occurs roughly every 30 years.[50] There have been three major deep earthquakes in recent history: the 7.1 magnitude 1949 Olympia earthquake, the 6.5 magnitude 1965 Seattle-Tacoma earthquake, and the 6.8 magnitude 2001 Nisqually earthquake.[51]

5.2.3 Crustal (Shallow) Earthquakes

A. Location

When the Juan de Fuca plate subducts beneath the North American plate, deformation of the crust causes crustal faults to form. Shallow earthquakes originate less than 15 miles below the surface of the earth.

The Seattle Fault and South Whidbey Fault (see **Map 12, Regional Crustal Faults**) are the two major crustal fault systems that can affect Redmond.[52] The proximity of both of these faults to Redmond increases the potential damage. HAZUS[53] has been run for possible events that have epicenters within close proximity to Redmond.

www.pnsn.org/INFO_GENERAL/platecontours.html.

47 Cascadia Region Earthquake Workgroup; Pacific Northwest Seismic Network Staff, "Earthquake Hazards in Washington and Oregon: Three Sources," The Pacific Northwest Seismic Network, http://www.pnsn.org/CascadiaEQs.pdf.

48 Ruth Ludwin, "Deep Quakes in Washington and Oregon," The Pacific Northwest Seismic Network, http://www.pnsn.org/INFO_GENERAL/platecontours.html.

49 Cascadia Region Earthquake Workgroup, "Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario, 2005," http://www.crew.org/papers/CREWCascadiaFinal.pdf.

50 Ibid.

51 Ruth Ludwin, "Deep Quakes in Washington and Oregon," The Pacific Northwest Seismic Network, http://www.pnsn.org/INFO_GENERAL/platecontours.html.

52 Michael A. Fisher et al., "Crustal Structure and Earthquake Hazards of the Subduction Zone in Southwestern British Columbia and Western Washington," U.S. Geological Survey, http://pubs.usgs.gov/pp/pp1661c/pp1661c.pdf.

53 HAZUS is FEMA's Methodology for Estimating Potential Losses from Disasters. HAZUS is a powerful risk assessment methodology for analyzing potential losses from floods, hurricane winds and earthquakes. In HAZUS, current scientific and engineering knowledge is coupled with the latest geographic information systems (GIS) technology to produce estimates of hazard-related damage before, or after, a disaster occurs. http://www.fema.gov/plan/prevent/hazus/.

B. Timing and Duration

Crustal earthquakes can happen at any time with shaking that lasts approximately 30 seconds. Crustal quakes have the shortest duration of the three types of earthquakes.[54]

C. Severity

Of the three types of earthquakes, crustal earthquakes are currently thought to present the greatest risk to the Puget Sound region.[55] While they tend not to last as long as the other types of earthquakes, the short shock waves associated with them cause more violent ground shaking for the entire region than the other types of earthquakes.[56]

D. Frequency

The largest known crustal earthquakes in the Puget Sound region took place in the years 900 and 1872. Each had magnitudes of approximately 7.4 on the Richter scale.[57] Recurrence intervals are unknown.

5.3 Assessing Earthquake Vulnerability

5.3.1 Overview

Redmond's vulnerability to an earthquake is based on a variety of factors including its proximity to subduction zones and faults. Vulnerability of the built environment depends on the location, age, material, and condition of manmade structures. The natural environment's vulnerability reflects the existing condition and the characteristics of the event. The City's dependence on regional systems, the density of the population, and available resources impact Redmond's overall vulnerability to an earthquake.

The potential for severe earthquakes makes Redmond very vulnerable to the impacts. While the most intense damage will likely be confined to the liquefaction zone, the whole city and surrounding region will be affected at least marginally.

5.3.2 Profiling the Vulnerabilities

A. Man-made

Table 13: Effect of Earthquakes on Different Types of Buildings represents how each of the different types of earthquakes will affect man-made structures.

54 Cascadia Region Earthquake Workgroup, "Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario, 2005," http://www.crew.org/papers/CREWCascadiaFinal.pdf.
55 Ruth Ludwin, "Earthquake Hazards in Washington and Oregon," The Pacific Northwest Seismic Network, http://www.pnsn.org/INFO_GENERAL/eqhazards.html.
56 Cascadia Region Earthquake Workgroup; Pacific Northwest Seismic Network Staff, "Earthquake Hazards in Washington and Oregon: Three Sources," The Pacific Northwest Seismic Network, http://www.pnsn.org/CascadiaEQs.pdf.
57 Ruth Ludwin, "Shallow Crustal Quakes in Washington and Oregon," The Pacific Northwest Seismic Network, http://www.pnsn.org/HAZARDS/SHALLOW/welcome.html.

Earthquake Type	Skyscrapers	Mid-rise Structures	Wood Structures (under 5 stories)
Subduction Zone	May have structural damage or total collapse.	May have structural damage, but not as much as skyscrapers.	May have structural damage, but not as much as skyscrapers.
Benioff (Deep)	Structural damage is unlikely.	May have structural damage.	May have structural damage, but not as much as mid-rise structures.
Crustal (Shallow)	Structural damage is unlikely.	May have structural damage, but not as much as short, wood structures.	May have structural damage.

Table 13: Effect of Earthquakes on Different Types of Buildings

Developed areas in the soil liquefaction zone are particularly vulnerable to damage and structural failure. In any earthquake, older buildings or buildings that do not meet current codes are more vulnerable.

Approximately 7.5% of residential buildings (or 990 of the 13,386 residential buildings) and almost 49% of commercial and public buildings (or 1,968 of the 4,022 non-residential buildings) in Redmond are located in the low to high liquefaction areas (see **Map 15, City of Redmond Buildings Vulnerable to Soil Liquefaction**).

Developed areas are also vulnerable to secondary hazards of earthquakes such as landslides and fires. See corresponding hazards for specific information regarding vulnerability to secondary hazards.

B. Natural

The vulnerability to the natural environment primarily stems from secondary hazards such as liquefaction or other soil failure, landslides, seiche, fires, and hazardous materials spills. See information regarding specific hazard vulnerabilities for fires, landslides and hazardous materials spills in their appropriate sections.

C. Systems

The systems in Redmond are extremely vulnerable to an earthquake. Sewers, water pipes, culverts, electrical lines, roads and bridges may be severely damaged or fail during an earthquake.

An earthquake will cause a great deal of damage to the transportation systems in Redmond. The roads may be covered by debris or be affected by secondary hazards such as landslides or fires. The bridges are particularly vulnerable to collapse. Damage or collapse of the bridges over the Sammamish River or Bear Creek would isolate the Education Hill neighborhood. Damage or a collapse along SR 520 will isolate the entire City of Redmond.

Since there are no hospitals in Redmond and a large portion of first responders do not live within the city, medican and emergency response systems are vulnerable

to failures in the transportation system. If Redmond is cut off from other cities in the region, emergency responders will have difficulty getting to Redmond. During a regional event, hospitals are likely to be overwhelmed. If transportation networks fail, patients from Redmond may not have access to those facilities.

Goods and services may be limited, contributing to the vulnerability of businesses during an earthquake. Transportation failures and general chaos following an earthquake will complicate normal business operations. Consequently, isolated residents may have minimal access to goods and services that are usually provided by local businesses. Should businesses still be operable after an earthquake, the decrease in economic activity (from both suppliers and consumers) stemming from local or regional isolation may force some businesses to experience financial hardship.

Sanitation and water supply systems are vulnerable to damage or collapse from an earthquake, particularly if they are located in the liquefaction zones. Communication systems may be compromised as a result of downed electric and telephone lines, damage to cell phone towers, or overuse of the system immediately following an event. Compromised communication systems will make it difficult for people to report damage or call for assistance.

D. Populations

The impact of an event will affect different populations in different ways depending on capabilities of the population, available resources, and localized impacts.

Hazard Specific

People inside or near buildings that suffer structural damage during an earthquake may become injured or trapped. People in areas of higher density are more vulnerable to falling debris due to lack of open spaces to escape unsafe structures. People who live in liquefaction zones are more likely to be in need of emergency shelter after an event. Water supply infrastructure is extremely vulnerable to damage during an earthquake, particularly the City wells that are located in a liquefaction zone. All residents living east of Sammamish River and Lake, who rely on well water, are more vulnerable to a subsequent hazardous materials spill or sewer breakage because the water supply may become contaminated (see **Map 20, City of Redmond Water Supply and Sewer Infrastructure**).

Isolated Populations

Road blockage or damage may cause local neighborhoods to become isolated. Isolation will decrease the availability of emergency services and access to vital necessities like food and water. Residents in Education Hill, Overlake and Downtown may be isolated in the days following a major earthquake.

In the event of a major regional earthquake, the entire City may become isolated from the rest of the Puget Sound Region. According to the Washington State Department of Transportation (WSDOT), the floating bridge on SR 520 will likely collapse in the

event of a major earthquake.[58] People in Redmond may be isolated due to the large number of City employees that reside outside the City and the lack of resources, supplies, and increased difficulty to reach medical facilities.

Disabled Persons
Disabled persons are more vulnerable in an earthquake than people who are not disabled because they cannot respond to the event as quickly. Moving out of the way of falling debris or navigating obstacles may be more difficult for a disabled person. This may hinder their ability to get to a safe area or get help.

Children
An earthquake during school hours may separate children from their families. Children may have limited transportation options when attempting to reunite with their parents.

Elderly
Decreased agility makes elderly people more vulnerable to an earthquake. Elderly with compromised immune systems or other health needs may experience delayed emergency services or limited access to prescriptions. People with limited mobility or transportation options are more likely to become isolated in their homes. Those that rely on electrically powered medical devices are particularly vulnerable to power outages.

Limited English Language
Language barriers may inhibit individuals from getting help from emergency services or limit their access to critical information. During work and school hours, it is more likely that people with limited proficiency will be isolated.

Low-income Residents
People with limited financial resources may not be able to pay for immediate emergency services. Should employment centers close as a result of an earthquake, these unexpected days without work may impose a significant financial hardship. Costly mitigation and preparation strategies, like attaching homes to their foundations, may also be difficult for low-income residents. Limited mitigation and insufficient emergency funds make low-income residents vulnerable.

5.3.3 Analyzing Development Trends

Currently, approximately 7.5% of residential buildings and almost 49% of non-residential buildings (commercial and public) in Redmond are located in the liquefaction zone. The City's Future Land Use Map (FLUM) indicates there will be increased density in Downtown. Much of the liquefaction area is zoned for mixed use that will include various combinations of multi-family housing, single-family homes, businesses, manufacturing, urban recreation, parks and open space. For information

58 "WSDOT Projects: SR 520 Program - Safety and Vulnerability." http://www.wsdot.wa.gov/Projects/SR520Bridge/vulnerability.htm

on how development trends are pertinent to secondary hazards, such as landslides and fires, refer to the corresponding sections.

5.4 Scenarios

A. Subduction Zone Earthquake

On September 5th, at 11:35 a.m., a large subduction zone earthquake shook the whole Puget Sound region for nearly ten minutes. It reached 8.1 on the Richter Scale. A metal gas line broke during the earthquake and sparked a fire at the north edge of the City. Since it has not rained in three weeks, four fires began in the immediate aftermath of the earthquake. Due to regional destruction, the Redmond Fire Department is unable to get additional assistance from neighboring communities.

Several high-rise buildings in Seattle and Bellevue completely collapsed in the earthquake. Two days after the shaking, emergency responders are still working to rescue people from the rubble. There are ten reported deaths and over thirty people remain missing.

Most of Redmond's mid-rise and wood-frame buildings are still intact, although there was some damage to the buildings in the downtown area that have brick and stone facades. Some older homes with brick chimneys also experienced damage. Due to transportation network failures, schools remained open until 8 p.m. until all children could be reunited with their families. SR 520 was closed for thirty-six hours until all overpasses were determined to be safe.

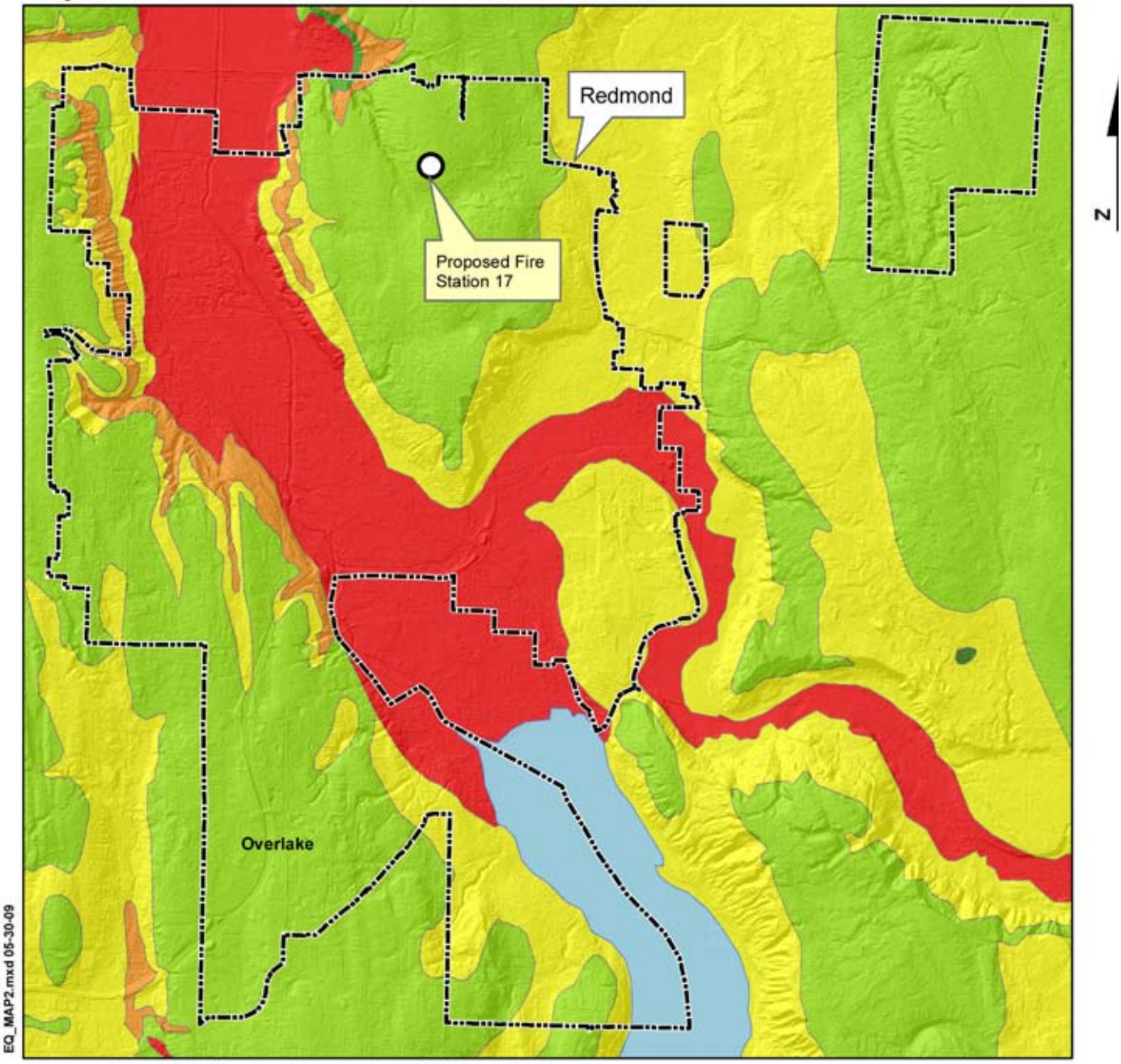
B. Benioff (Deep) Earthquake

On April 15th, at 9:20 a.m., a deep, Benioff earthquake shook the ground for one and a half minutes. In Redmond, there was some soil liquefaction, but it has been minimal and similar to effects from the 2001 Nisqually earthquake. There is little damage to the structures in the City, most of which affect the older downtown buildings with unreinforced masonry. The falling debris downtown injured two people, no deaths were reported. It rained for five days before the earthquake, the ground was fairly saturated. No major landslides have occured, but some people have noticed some slight shifting on some hillsides. Most of the region has not experienced very much damage thus far, so connections remain stable and Redmond remains resilient.

C. Crustal (shallow) Earthquake

See Part 3, Scenario 1. Appendix C shows the global report from HAZUS for a 6.7 magnitude earthquake on the Seattle Fault.

City of Redmond Probabilistic Seismic Risk



Sources: State of Washington, King County, NEHRP, and USGS.

NEHRP Soil Class and Peak Horizontal Ground Acceleration (in %G)

- E-D
- D 32.5%
- C-D
- C 30%
- B-C
- B 25%
- water

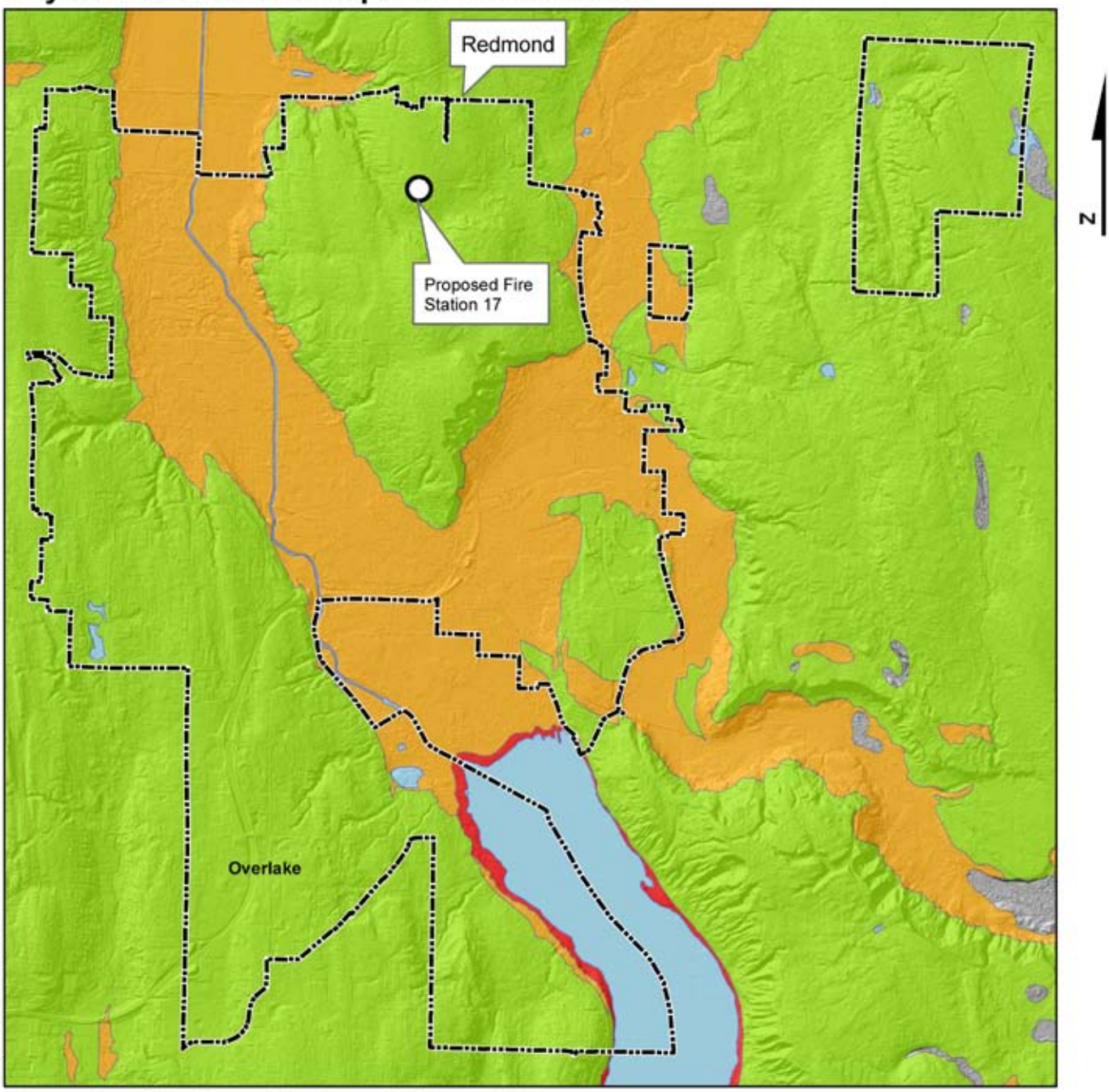
Note: 10% Probability of Exceedance in 50 Years (0.2% per Year)

Approximate Scale in Feet

5,000 2,500 0 5,000

Map 13: City of Redmond Probabilistic Seismic Risk

City of Redmond Soil Liquefaction Potential



Sources: State of Washington, King County, NEHRP, and USGS.

National Earthquake Hazard Reduction Program (NEHRP) Soil Liquefation Potential

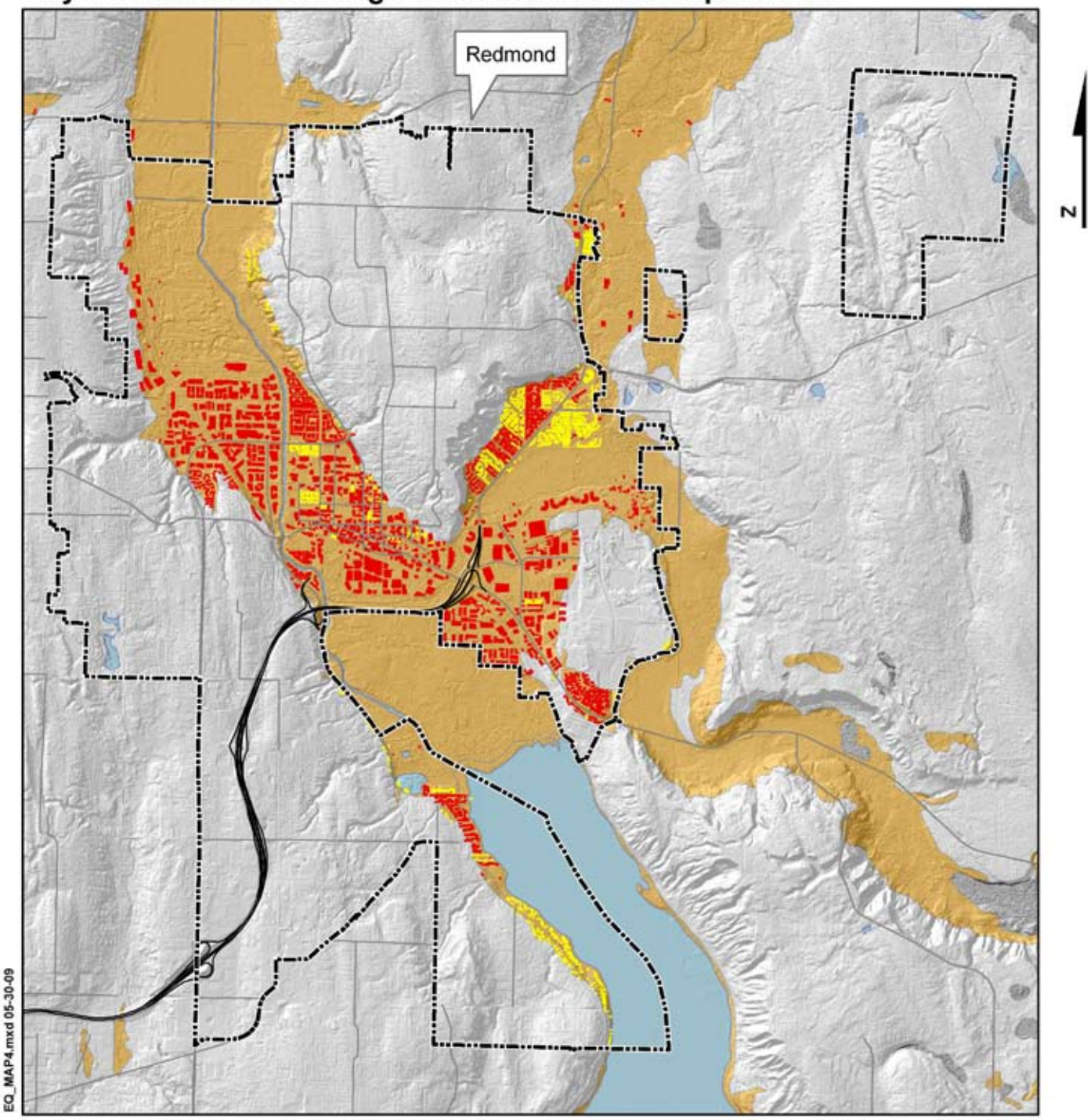
- High to Moderate
- Moderate to Low
- Very Low
- Water

Approximate Scale in Feet

5,000 2,500 0 5,000

Map 14: City of Redmond Soil Liquefaction Hazard

City of Redmond Buildings Vulnerable to Soil Liquefaction



Sources: State of Washington, King County, NEHRP, and USGS.

Residential Buildings

Commercial Buildings

Liquefaction Hazard Area

Approximate Scale in Feet

5,000 2,500 0 5,000

Map 15: City of Redmond Soil Liquefaction Vulnerability