Severe Storms 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.

4.1 Identifying Severe Storm Hazards

Severe local storms are categorized by atmospheric disturbances, with cold temperatures and various forms of precipitation. In Redmond's typically mild climate, irregular severe storms include high winds, freezing rain, sleet, heavy snowfall or hail. Some severe storms are accompanied by thunder and lightening. Since Redmond is not mountainous, six or more inches of snow in a 24-hour period is considered severe.

The following list shows the number of days with measurable amounts of snow and rain in the previous eight years in the City of Redmond.[21] A measurable amount of precipitation is at least 0.01" of rain and ice or 0.1" of snow.

Annual Counts of Days with Measurable Snow and Rain		
Year	**Snow**	**Rain**
2008	10	175
2007	7	190
2006	4	186
2005	3	174
2004	3	167
2003	2	180
2002	7	160
2001	0	182
2000	5	166
1999	0	183

Table 11: Annual Count of Days with Measurable Snow and Rain
Source: Office of the Washington State Climatologist, Temperature data from 1999-2008, Courtesy of Karin Bumbaco, Assistant State Climatologist.

The trajectory of these systems determines the local effect. Storms with a southern origin bring heavy rain. Storms coming from the north bring cold air and the potential for snow and ice. Any winter storm, regardless of its trajectory, can be accompanied by high winds. Storms with sustained winds above 30 mph generally cause low impact, widespread damage, while winds above 50 mph are powerful enough to

21 Office of Washington State Climatology. http://www.climate.washington.edu/climate.html

cause significant damage.

Climate change predictions indicate that storms in the Northwest are likely to occur more frequently and be more severe. Although Redmond does not typically experience more than a week of snow each year, it is likely that these events will become more common. Redmond can expect to receive more ice and snow in the winter months.

4.2 Profiling Severe Storm Hazard Events

A. Location

The entire City of Redmond may be affected by a severe storm; however, microclimates within the City may increase the vulnerability in specific areas. Narrow culverts are vulnerable to ice jams and hilltops are subject to lightning. The hill and valley topography creates several wind tunnels. Steep slopes increase the likelihood that Rose Hill and Education Hill will experience more adverse effects of a severe storm.

B. Timing and Duration

Most severe storms in Redmond occur between November and April when the jet stream[22] moves over the West Coast, and Pacific low-pressure systems are more frequent.[23] Storms can last anywhere from a few hours to several days. Weather forecasting abilities will provide Redmond, at minimum, a few hours warning prior to an extreme weather event.

C. Severity

Storms in Redmond are likely to have a severity of low to moderate. Historically, storms have been relatively short in duration and have had mostly localized impacts. The main concern about a severe storm in Redmond is the potential to isolate citizens and businesses if roads are blocked by snow or ice. This may cause some financial hardships for the City, but it is unlikely to cause widespread, permanent damage or loss of life.

D. Frequency

Although Redmond does experience some days with temperatures below freezing and receives some snow, severe weather is not typical of Redmond winters. The proximity to the Puget Sound keeps the climate moderate, with some incidents of snow. Over the last 20 years, Redmond has experienced an average 3.1 inches of snow per year. During that period, the most snow recorded in one month was 17.9 inches. There has not been a month with an average daily minimum temperature below freezing.[24]

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22 Jet streams are relatively narrow bands of strong wind in the upper levels of the atmosphere. The winds blow from west to east in jet streams but the flow often shifts to the north and south. Jet streams follow the boundaries between hot and cold air. Since these hot and cold air boundaries are most pronounced in winter, jet streams are the strongest for both the northern and southern hemisphere winters.

23 National Weather Service, "JetStream - Online School for Weather," http://www.srh.noaa.gov/srh/jetstream/global/jet.htm.

24 Western Regional Climate Center, "National Weather Station 457470 for period 1986 to 2000," http://www.wrcc.dri.edu/.

Redmond experiences high winds (with velocities of 50 mph) approximately once every two years. Winds that exceed 60 mph occur approximately once every 50 years. King County has reportedly experienced at least one serious windstorm per calendar year.

Previous Occurrences
The last significant windstorm to affect the City of Redmond occurred in 2006. In the Seattle region, hundreds of thousands of homes remained without power for several days after the storm. The lack of heat forced many residents to leave their homes and seek shelter in hotels or emergency facilities. The power outages closed many businesses, even Microsoft shut down large portions of its Redmond campus.[25]

The last major winter storm was in December 2008, when the City received almost nine inches of snow in one day. The snow limited the ability of people and services to move around the City. Police officers had difficulty responding to calls in some neighborhoods. Garbage collection suspended service for 11 days. The Old Redmond Schoolhouse Community Center, Redmond Senior Center and Old Fire House Teen Center were closed Dec. 18-26, and City offices officially closed for two days.[26]

Probability of Future Events
Reports from the International Panel on Climate Change and the University of Washington Climate Impact Group confirm that the region's climate is changing and that the impacts will be far reaching. The City of Redmond can expect an increase of severe storm events in the future.

While changes in overall annual precipitation are not projected to be significant, the timing and character of precipitation is projected to change. Winters will bring more rain and less snow in the mountains. Summers will generally tend to be dryer, increasing susceptibility to flash floods as a secondary hazard to severe summer rainstorms. In addition, the probability of secondary hazards will increase, including saturated soil hazards such as landslides and falling trees.

4.3 Assessing Severe Storm Vulnerability

4.3.1 Overview

Due to a typically mild climate, Redmond is vulnerable to severe storms. Ice, snow and strong winds can damage infrastructure, isolate citizens and limit access to essential services. Although storms may cause some structural damage, the main vulnerabilities to a severe storm are systems and populations that may not be able to withstand temporary isolation or limited transportation.

25 Scott Sistek, "The craziest year ever for weather?" Komo News, January 1, 2007, http://www.komonews.com/news/local/5051876.html.
26 Mary Stevens Decker, "City looking to improve winter storm response plan," *The Redmond Reporter*, *http://www.pnwlocalnews.com/east_king/red/news/37461739.html.*

4.3.2 Profiling the Vulnerabilities

A. Man-made

The majority of the building stock in Redmond will be able to withstand the impacts of a snow, wind or ice storm. However, the vulnerability to such a storm varies by the location and the type of structure. Buildings located on hilltops are more vulnerable to lightning and those located on steep slopes are vulnerable to landslides. Flat-roofed buildings and other structures that accumulate snow may be susceptible to collapse under heavy snow.

B. Natural

Severe storms impact the natural environment by increasing stormwater runoff, as well as increasing flooding and tree displacement. Such alteration of the natural environment will impact fish and wildlife habitat. However, these are natural processes; absent prolonged climate changes, animals and their ecosystems are resilient to temporary changes in weather. However, severe storms may have an impact on species and habitats that are already stressed. For example, increased runoff could increase the saturation rate of soils, thus increasing the likelihood of downed trees in high wind. Sand on roadways to provide friction on icy surfaces may create sedimentation problems in local streams and rivers, thereby affecting salmon habitat.

The critical areas likely to be affected by severe storms are fish and wildlife habitat and wetlands. Redmond has more than ten different areas containing sizable wetlands.[27] At least 19 species of birds and six species of mammals are found within the wetlands in City of Redmond. See **Map 8, City of Redmond Wetlands** for the location of wetlands in Redmond.

Additionally, Redmond is home to endangered salmon. The Salmon Habitat Recovery Plan for Water Resource Inventory Area 8 recommends restoring floodplain connectivity and channel meander as well as riparian forest and large woody debris to the Sammamish River channel.[28] These aspects of the waterways in Redmond could all potentially be disrupted by severe storms.

C. Systems

Roads in Redmond are vulnerable to severe storms. Excess precipitation is likely to limit access and isolate citizens, but it is unlikely to cause major permanent damage to the transportation network. Heavy rain, ice or snow may make roads impassible or limit visibility to the extent that driving is not safe. Although the City does have a snow/ice removal plan, large residential sections of the City, particularly in the North Redmond and Education Hill neighborhoods, may not have vehicular access until the snow/ice melts. **Map 5, City of Redmond Motorized Transportation Network**, shows the road network in Redmond.

27 *SAO Wetland Wilderness Lookup Table, King County Dept. of Environmental Services, Paul McCombs, GIS Data Team Lead, KCGIS Center.*

28 WRIA 8 Coordination Team, Lake Washington/Cedar/Sammamish Watershed, "Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8), Chinook Salmon Conservation Plan," http://www.govlink.org/watersheds/8/planning/chinook-conservation-plan.aspx, 2007.

Redmond has put most of the power lines underground; however, the remaining above-ground lines are vulnerable to high winds, ice and heavy snow. Additionally, heavy rainfall may loosen soils, making power poles and towers more susceptible to failure in high winds.

Water supply and sewer facilities may be vulnerable to severe storms with massive rainwater that quickly accumulates. Stormwater drains and culverts may overflow during a heavy rain event and cause flooding.

Power outages and limited accessibility may force businesses to temporarily shut down. These unexpected closures can result in large financial losses. Loss of power can cause large product losses for food service businesses. Since businesses operate within an inter-connected system, the closure of one may have large impacts on other businesses in the area. Smaller businesses may not be able to recover from the loss of business or damages caused by a severe storm.

Severe storms can leave residents completely isolated and without access to emergency assistance. Currently there are no hospitals in Redmond. Road closures may prevent residents that require significant medical care from access to necessities.

D. Populations

Isolated Populations
Residents of Redmond living on steep slopes, or areas accessed only by a steep slope are vulnerable to isolation during a heavy snow or ice event. Downed trees and power lines will further restrict mobility. People living in areas that are accessed only by one road may also become isolated in a severe storm. Each of Redmond's three hills may be isolated for several days.

Persons with Disabilities
Persons with disabilities may not be able to access vital services due to road closures. People with medical devices that require constant electricity are vulnerable to a power outage.

Children
Children may need to be reunited with parents, if road closures occur once they are separated (such as during the school day). **Map 7, City of Redmond Community Facilties**,shows the location of several types of community facilities, including schools. Children are likely to be concentrated in these areas if the events occur during a school day.

Elderly
Elderly people with compromised immune systems are particularly vulnerable to the cold if there is a power outage in the winter. Additionally, they may not be able to

access emergency medical facilities. People who rely on electricity for medical devices will be especially vulnerable. **Map 9, City of Redmond Concentration of People 65 Years or Older and Retirement Home Locations** shows the location of retirement homes; elderly housing facilities are highly concentrated within Redmond.

Limited English Language
Power outages may be particularly isolating to limited English language speakers, as non-English speakers face additional challenges when accessing emergency information. **See Map 10, City of Redmond People with Limited English Language Capability**, for the location of people that speak limited English.

Low-income Residents
According to an income analysis shown in **Map 11, City of Redmond Median Income by Block Group**, the majority of Redmond's low-income population is located on the edges of the City, furthest from services and resources. These residents may have limited transportation options and minimal financial capabilities in a severe storm. Absence from work due to isolation will be an additional burden for limited income households.

4.3.3 Analyzing Development Trends

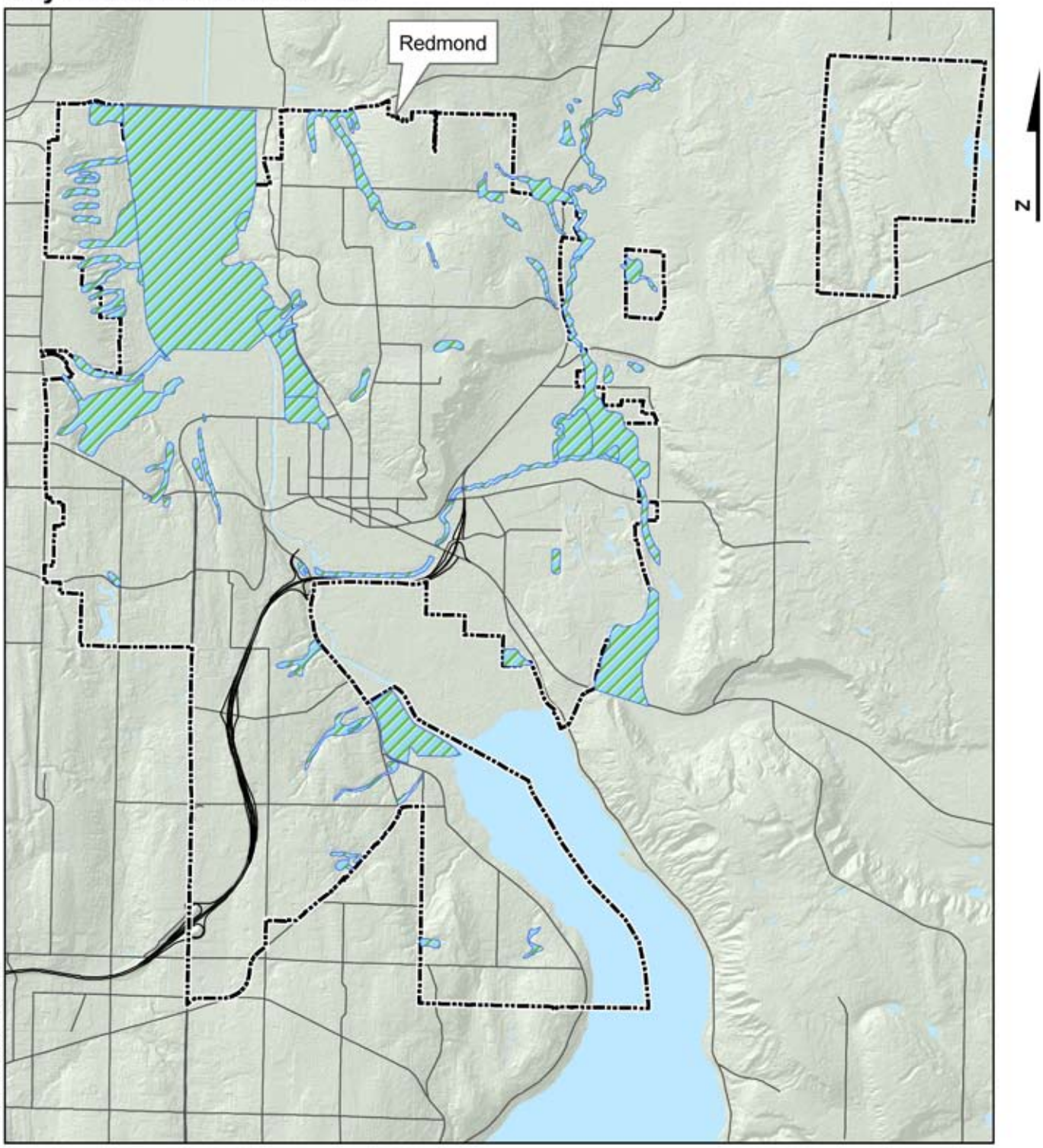
New residential expansion on the edges of town increases the number of people that are likely to become isolated during a severe storm. The lack of neighborhood-commercial land use in these neighborhoods show that there will be limited, if any, additional private capabilities to provide services during a storm. Small commercial facilities in residential areas could assist in distributing goods and services or they could simply provide a psychological break for isolated residents.

The Future Land Use Map (FLUM) shows that the City is concentrating growth in central areas such as Downtown and Overlake; this development will reduce the risk of isolation. Similarly, increased density will ensure better access to emergency facilities and resources.

4.4 Scenario

See Scenario 2 in the Part 3 Introduction.

City of Redmond Wetlands



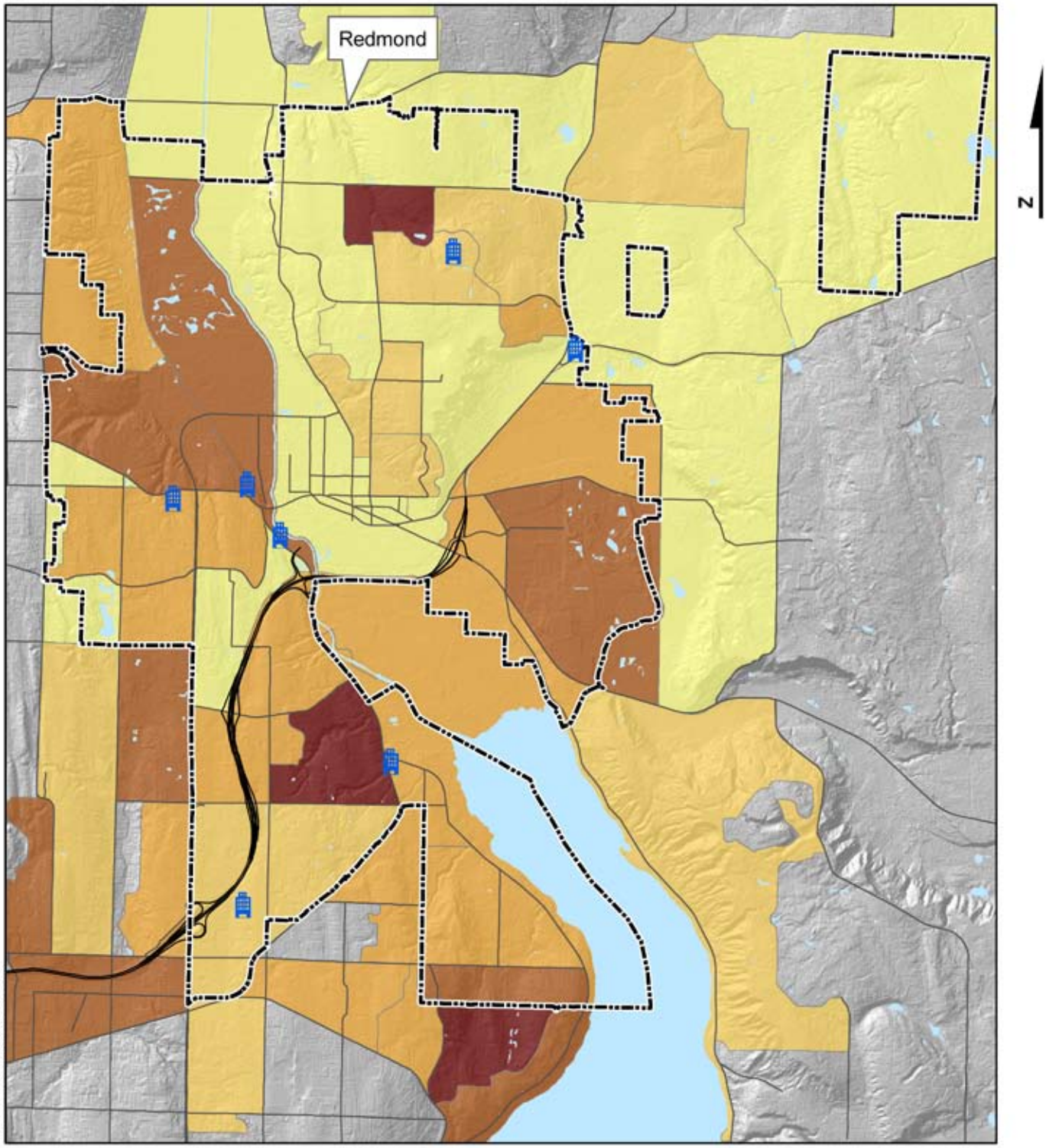
Sources: King County

Wetlands

Approximate Scale in Feet
5,000 2,500 0 5,000

Map 8: City of Redmond Wetlands

City of Redmond Concentration of People 65 Years or Older and Retirement Home Locations



Sources: King County, US Census

Number Residents per Block Group over 65 Years Old

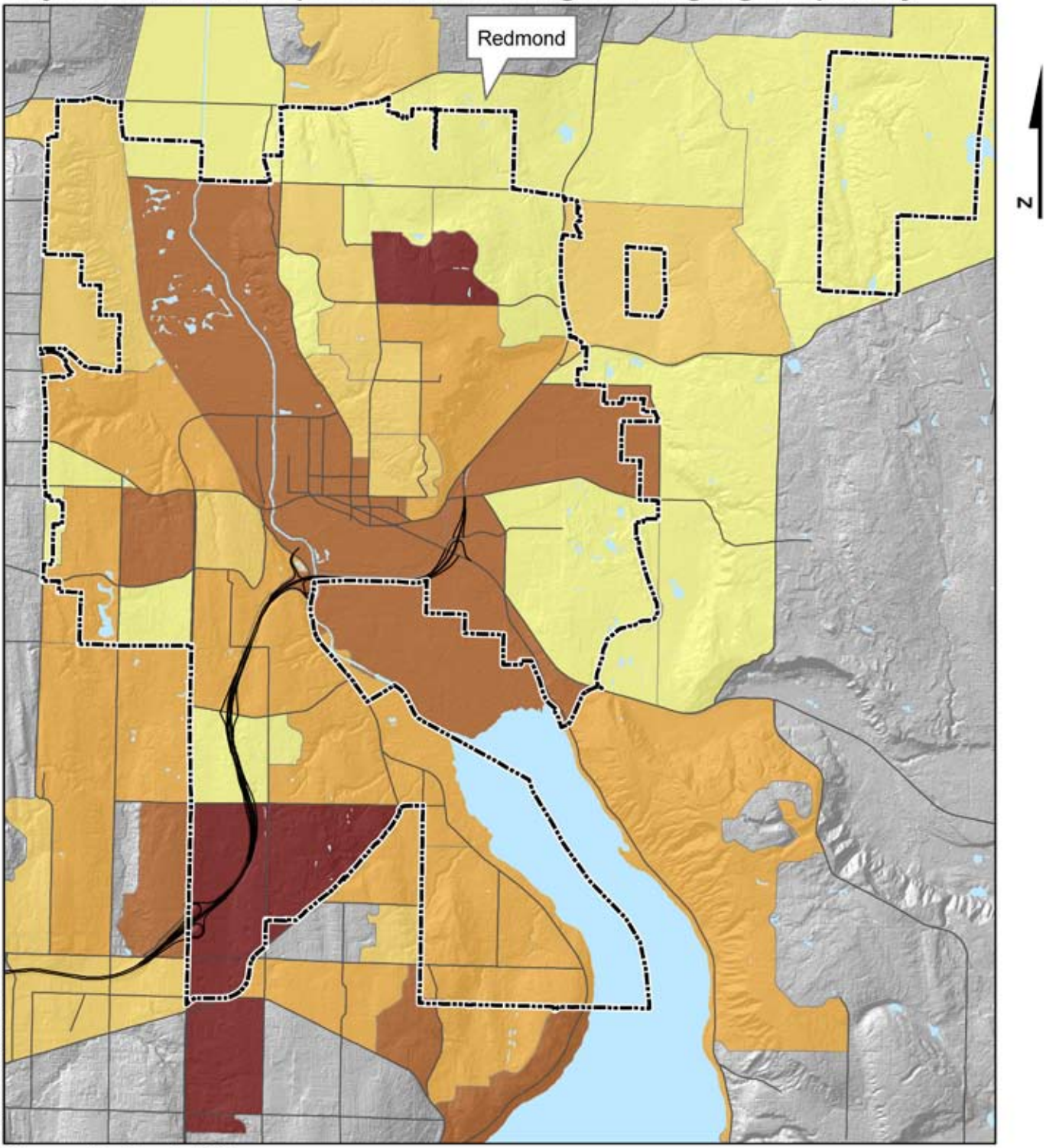
- 0 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300+
- Retirement Homes

Approximate Scale in Feet

5,000 2,500 0 5,000

Map 9: City of Redmond Concentration of People 65 Years or Older and Retirement Home Locations

City of Redmond People with Limited English Language Capability



Sources: King County, US Census

Number of People with Limited English Language

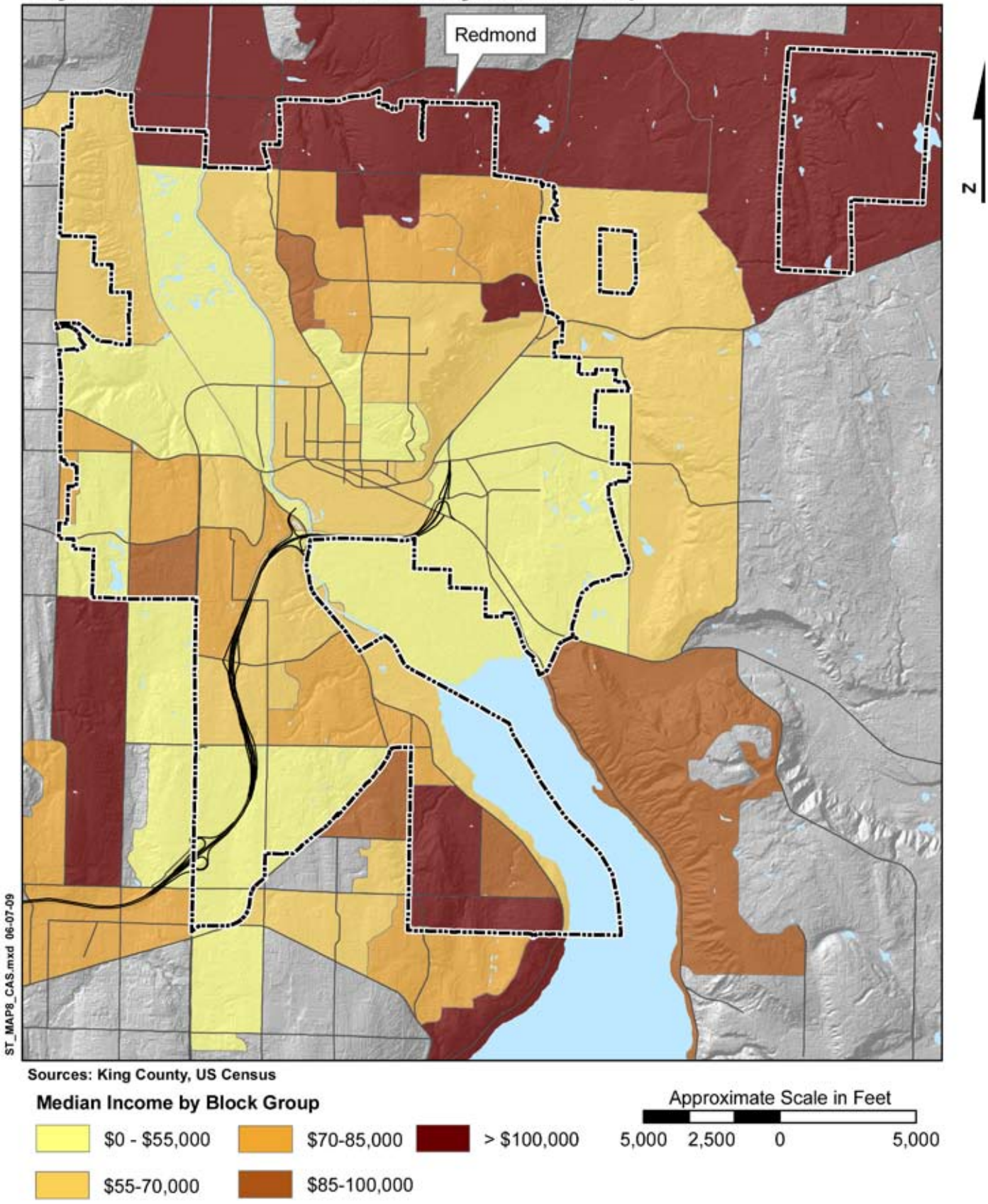
- 0 - 50
- 50-100
- 100-200
- 200-300
- 300+

Approximate Scale in Feet

5,000 2,500 0 5,000

Map 10: City of Redmond People with Limited English Language Capability

City of Redmond Median Income by Block Group



Map 11: City of Redmond Median Income by Block Group