

Introduction

Landslide events in King County are most often associated with either unusually heavy seasonal rains or local earthquake activity. Urban areas of western King County have been developed for residential structures in many places. The vistas provided by the Olympic Mountains and Puget Sound are breathtaking backdrops to the Seattle skyline. Despite the possibility of landslide events, property values continue to rise disproportionately and development of available properties continues.

View homes and property values can reach and even exceed \$500,000 in some landslide areas, making even the loss of only a few homes significantly costly.

High Probability Low Impact	High Probability Moderate Impact	High Probability High Impact
Moderate Probability Low Impact	Moderate Probability Moderate Impact	Moderate Probability High Impact
Low Probability Low Impact	Low Probability Moderate Impact	Low Probability High Impact

Landslide Probability vs. Landslide Impacts

Hazard Identification

The slopes of Magnolia, West Seattle, Burien, Des Moines, Vashon Island, Newcastle, Federal Way and many areas of Bellevue have long been developed for their magnificent views of Mount Rainier, the Cascade and Olympic Mountains, and Puget Sound. Three major factors that contribute to landslide activity and possible impacts to structures include soil type, slope angle, and precipitation levels.

Soil conditions vary widely in King County. In geological terms, King County's landscape is very young. As recently as 14,000 years ago, the region was covered by up to 3,000 feet of ice. The Vashon Glacier, which extended from Canada to south of Olympia carved valleys as it expanded and left soil deposits and rock as it retreated. Evidence of this activity is still observed in the "U" shaped valleys and stony soils common to Puget Sound. Seas rose 300 feet worldwide from the global melting following that ice age, creating Puget Sound as we know it today.¹

The top layer of soil in King County is referred to as Vashon till, a stable mixture of rocks, dirt, clay, and sand that reaches depths of up to 30 feet. The next

layer, Esperance sand, is a permeable mixture of sand and gravel. This layer sits upon an impermeable layer of Lawton clay, made up of fine sediments and large boulders. Often, slides occur at this boundary interface when water runs laterally on top of this boundary.²

In some ways, landslide areas are similar to avalanche terrain. Characteristics of landslide hazard areas include:³

1. A slope greater than 15 percent
2. Landslide activity or movement in the last 10,000 years
3. Steam or wave action with erosion or bank undercutting
4. The presence or potential for snow avalanches
5. The presence of an alluvial fan that indicates vulnerability to the flow of debris or sediments
6. The presence of impermeable soils, such as silt or clay, which are mixed with granular soils such as sand and gravel

History of Events

The most recent widespread landslide activity was secondary to the severe winter storm events that hit the Puget Sound region during December 1996 through March 1997. Unusually heavy snow and rain in King County resulted in slides that damaged or destroyed 8,000 homes. Over 100 slides were recorded in King County over a two-month period. Particularly hard hit areas were slopes on Magnolia Hill (Seattle), areas along Interstate-5, and Vashon Island.^{2,4}

A January 15, 1997 slide at Woodward in southern Snohomish County derailed five cars of a freight train. Passenger and cargo rail traffic was interrupted for nine days. Cargo traffic resumed first. Amtrak remained concerned for passenger safety and did not travel on this section of track for several weeks.⁵

Very heavy rains in King County resulted in significant slides and associated damages in 1972.⁶ Seventy percent of the slides occurred during the two following days.⁷

Two weather events in November and December of 1998 caused a number of small slides in King County. Landslides along Interstate-5 near SeaTac Airport briefly closed portions of that northbound roadway.⁸

Landslides have been a significant problem in the Puget lowland areas for many years, and several landslides occur every year during the rainy season. Storms have triggered significant numbers of landslides in 1972, 1986, 1990, 1996, and 1997. Comparison of the locations of (more) recent landslides with those mapped by "Tubbs" reveals that many of the 1997 landslides are in the same general areas as the 1972 landslides.⁹

Heavy rains are not the only cause of landslides. The Nisqually earthquake in February 2001 caused a portion of hillside near Jones Road to slide into the riverbed of the Cedar River. The flow of the river was partially blocked resulting in several homes along the river being damaged by the dammed waters.

Evidence of slide activity can still be seen along the eastern side of Interstate-5 from King County Airport all the way to the Interstate-90 interchange where portions of hillside collapsed carrying trees and debris downhill, but just short of impacting Interstate-5.

Hazard Impacts

Slides have resulted in direct damages to structures, roadways, rail lines, bridges and the blockage of the Cedar River (see “History of Landslide Events”). Indirect impacts included the isolation of small communities on Vashon Island and Magnolia Hill, cost of debris clearance, personal injuries, and economic losses from rail and roadway closures.

Table 5-7: Landslide History		
Event Date(s) & FEMA Event	Area	KC Public Damages
1972 Severe Weather	King County	\$1.8 million
1996-97 Severe Weather (#1100, #1159, #1172)	King County	\$9.0 million
2001 Nisqually Earthquake	Renton/Cedar River	
<i>Source:</i>		

Past Mitigation Efforts

Efforts to reduce landslide-related losses have been ongoing for at least 20 years. Relative-slope-stability maps at several scales were developed in the 1970s for many of the urbanized areas surrounding Puget Sound (Miller, 1973; Artim, 1976; Smith, 1976; and Laprade, 1989). Most cities and many counties in the area regulate development of steep hillsides (Laprade, 1989). Despite these efforts, losses continue to mount because (1) economic growth continues to exert pressure to develop in or near landslide-prone areas; (2) increased erosion and consequent downcutting caused by urban runoff has locally reduced slope stability (Booth, 1989); and (3) new or previously unidentified landslides damage structures that were built in unstable areas before regulations existed.¹⁰

King County Surface Water Management maintains a response program related to landslides. The Emergency and Rapid Response Program funds efforts to prevent and recover from such events.¹¹

In addition to the efforts at zoning and land use regulations initiated by the government, local citizen groups sometimes work to set aside environmentally sensitive or unstable areas as urban buffers. Such an action is being undertaken by the Denny Creek Neighborhood Alliance toward the purchase of property in the Juanita area near northern Lake Washington.¹² The area is well timbered and is being considered as an environmental buffer to prevent landslides.

An extensive list of codes related to land use and building restrictions for King County has been developed over many decades. For a complete list of codes governing building in King County, go to http://www.builtgreen.net/assets/KC_Resources.oc.

Land Slide Endnotes:

¹Crozier, Michael J., Landslides: Causes, Consequences, and Environment, Croom Helm, Australia, 1986, p 195.

²Carter, Don and Scott Maier, "Slide-Wise, Danger Remains Real as Soggy Slopes are still unstable", Seattle Times, January 17, 1997, p A8.

³King County Planning and Community Development Division, "Landslide Hazard Areas", Sensitive Areas: Map Polio, Seattle Washington, 1990, p1.

⁴"It's Been a Winter of Mudslides on Area's Slopes", Seattle Times, January 20, 1997, p A2

⁵Washington State HIVA Draft May 2003

⁶McDoanld, Terrance J., "Landslides", Seattle: A Hazard Vulnerability Analysis, Master's Thesis, Cornell University, 1995, p 147

⁷Tubbs, Donald W., "Landslides in Seattle", Washington State Department of Natural Resources, Information Circular No 52, 1974, p4

⁸REex L. Baum and Aln F. Chleborad, Landslides triggered by Pacific Northwest Storms, November and December 1998, <http://landslides.usgs.gov/Wash-Or/PNW98.html>, January 14, 1999

⁹Rex L. Baum and Alan F. Chleborad, Geosettings and Landslides, Landslides triggered by the Winter 1997-1998 Storms in Puget Lowland, Washington, <http://geohazards.cr.usgs.gov/pubs/ofr/ofr98-239.html>, Jul 13, 1998

¹⁰ibid

¹¹Donald Althausser, Emergency and Rapid Response, King County Department of Natural Resources and Parks, Surface Water Management Division, <http://directory.metrokc.gov/ServiceDetail.asp?ServiceID=6659>, July 2002

¹²Tony Dondero, Group Seeks to Buy Woodlands, Eastside Journal, July