Landslides Mapped from LIDAR Imagery, Kitsap County, Washington

By Jonathan P. McKenna, David J. Lidke, and Jeffrey A. Coe

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Frontispiece. This deep-seated rotational landslide (landslide 119, see map) located about 5 km northeast of Holly, Washington, flattened a beach-front house. Notice the direction of the rotated trees. Background trees are rotated upslope indicating that they are located on the rotated mass while trees in the foreground are tilted down slope indicating that they are located on the toe of the slope that is overriding the house and beach (photograph: Jonathan P. McKenna, 2003).

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Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)

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Abstract

Landslides are a recurring problem on hillslopes throughout the Puget Lowland, Washington, but can be difficult to identify in the densely forested terrain. However, digital terrain models of the bare-earth surface derived from LIght Detection And Ranging (LIDAR) data express topographic details sufficiently well to identify landslides. Landslides and escarpments were mapped using LIDAR imagery and field checked (when permissible and accessible) throughout Kitsap County. We relied almost entirely on derivatives of LIDAR data for our mapping, including topographic-contour, slope, and hill-shaded relief maps. Each mapped landslide was assigned a level of “high” or “moderate” confidence based on the LIDAR characteristics and on field observations.

A total of 231 landslides were identified representing 0.8 percent of the land area of Kitsap County. Shallow debris topples along the coastal bluffs and large (>10,000 m^2) landslide complexes are the most common types of landslides. The smallest deposit mapped covers an area of 252 m^2, while the largest covers 0.5 km^2. Previous mapping efforts that relied solely on field and photogrammetric methods identified only 57 percent of the landslides mapped by LIDAR (61 percent high confidence and 39 percent moderate confidence), although nine landslides previously identified were not mapped during this study. The remaining 43 percent identified using LIDAR have 13 percent high confidence and 87 percent moderate confidence. Coastal areas are especially susceptible to landsliding; 67 percent of the landslide area that we mapped lies within 500 meters of the present coastline. The remaining 33 percent are located along drainages farther inland.

The LIDAR data we used for mapping have some limitations including (1) rounding of the interface area between low slope surfaces and vertical faces (that is, along the edges of steep escarpments) which results in scarps being mapped too far headward (one or two meters), (2) incorrect laser-distance measurements resulting in inaccurate elevation values, (3) removal of valid ground elevations, (4) false ground roughness, and (5) faceted surface texture. Several of these limitations are introduced by algorithms in the processing software that are designed to remove non-ground elevations from LIDAR data. Despite these limitations, the algorithm-enhanced LIDAR imagery does effectively “remove” vegetation that obscures many landslides, and is therefore a valuable tool for landslide inventories and investigations in heavily vegetated regions such as the Puget Lowland.

Introduction

Landslides are a recurring problem on hillslopes throughout the Puget Lowland (for example, Baum and others, 2000; Troost and others, 2001). Kitsap County is located near the center of the Puget Lowland between Hood Canal and Puget Sound (fig. 1).

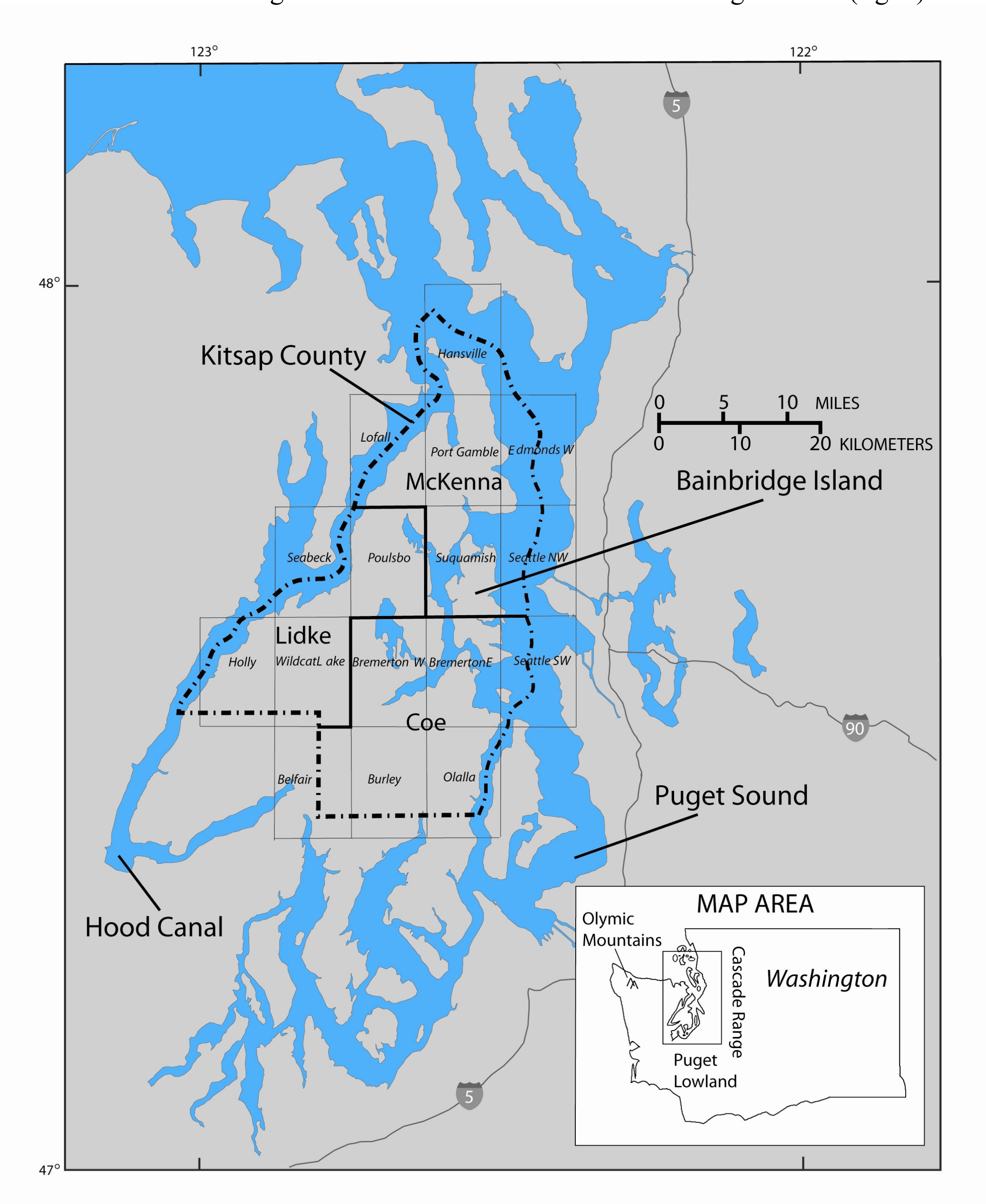


Figure 1. Kitsap County, Washington, index map with quadrangle names and the individual sections mapped by each author.

Kitsap County has a land mass of about 1,020 km^2 (kilometers), about 53 km of fresh-water frontage, and about 338 km of salt-water coastline (Mann and others, 1998). Coastal areas in Kitsap County are especially susceptible to landslides (Washington Department of Ecology, 1979). In the winter of 1996—1997, coastal landslides destroyed millions of dollars in both public and private property and caused the death of a family of four on Bainbridge Island (Gerstel and others, 1997; Mann and others, 1998; Baum and others, 2000). A hazard vulnerability analysis prepared by the Kitsap County Department of Emergency Management (Mann and others, 1998) indicated that the disruption of transportation and destruction of property are the most significant effects of landslides within the county. One of the first necessities for landslide hazard assessments within Kitsap County is an understanding of the distribution and extent of ancient and historical landslide deposits and scars.

In 1997, the Kitsap County Public Utility District commissioned a high-resolution, airborne LIght Detection And Ranging (LIDAR) survey to map areas of groundwater infiltration and runoff on Bainbridge Island (fig. 1). LIDAR imagery is especially useful for topographic mapping in Kitsap County, and in the Pacific Northwest in general, because of its ability to "see through vegetation" that commonly blankets hillslopes in the region (Haugerud and others, 2003). An examination of the detailed topographic data provided by the Bainbridge Island survey revealed a number of landforms, including fault scarps and landslides that had not previously been identified (Harding and Bergoff, 2000) plus a large landslide near Crystal Springs (the Crystal Springs landslide) along the southwest shore of the island. The detailed topographic data prompted a group of local government agencies, as well as the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA), to form the Puget Sound LIDAR Consortium (for more information, visit http://pugetsoundLIDAR.org). The goal of this consortium was to acquire LIDAR data throughout the Puget Lowland, including parts of Kitsap County that were not covered by the original Bainbridge Island survey. These data, which were acquired in 1999, provide an opportunity to map the distribution of landslides throughout the county.

This report and the accompanying LIDAR-based landslide map of Kitsap County collectively provide an overview of the USGS effort to map landslides from LIDAR imagery in the county. The report provides a brief overview of the geologic setting of Kitsap County, previous work on landslides within the county, a description of LIDAR imagery and mapping methods, and a summary of landslide mapping results. As indicated in fig. 1, we divided Kitsap County into three regions and each of the three authors had primary mapping responsibility for one of those regions. The LIDAR- based landslide map of Kitsap County (see map) provides an overview of the distribution of landslides as discernible from the LIDAR imagery throughout the county. The accompanying map contains the deposit identification numbers and shows mapped landslides overlain on a shaded relief map image of the LIDAR data that were generated in ArcMap™ (version 9.1) from the original LIDAR-based Digital Elevation Model (DEM). Although our original mapping of the landslide deposits was performed in ArcMAP™ at scales as large as about 1:2,000, we chose a smaller scale for this map in order to portray the distribution of landslides throughout the county on a single manageable map. Consequently, however, many of the landslides shown at the map scale are extremely small. For those interested in examining the landslide deposits and scarps we mapped in more detail, and (or) interested in viewing the LIDAR-based shaded relief maps in more detail, we have included digital Geographic Information System (GIS) files of these items that can be downloaded at http://pubs.usgs.gov/of/2008/1292. Mapped landslide boundaries in these digital files are intended to be used at scales no larger than 1:10,000. With these downloadable files, we have also included readme.doc files that provide additional information and explanation regarding content and use of these files.

Geomorphic Setting of Kitsap County

Kitsap County lies in the western part of the Puget Trough section of the Pacific Border physiographic province of the United States (Fenneman and Johnson, 1946; Thelin and Pike, 1991). The topographically low region of the Puget Trough is now more commonly called the Puget Lowland and it is flanked by highlands of the Olympic Mountains and Cascade Range to the west and east, respectively. Kitsap County includes all but the southwestern part of the Kitsap Peninsula, and includes Bainbridge Island in its eastern part (fig. 1). The western part of Kitsap County and the Kitsap Peninsula are separated from the eastern flank of the Olympic Mountains by Hood Canal. Puget Sound separates the eastern part of the county from more eastern regions of the Puget Lowland and the Cascade Range farther to the east.

The county ranges in elevation from sea level to about 500 m above sea level in the Green Mountain—Gold Mountain hills (southwestern part of the county). These hills expose and are underlain by basaltic bedrock, but this small mountainous region is atypical in character and elevation compared with most of the county. The vast majority of the county has land-surface elevations that range from sea level to about 150 m above sea level and is characterized mostly by U-shaped valleys, rolling hills, and low plateaus that are glacially eroded remnants of glacial-drift plains (Sceva, 1957; Garling and others, 1965; Deeter, 1979).

Glacially sculpted landforms characterize most of the county. These landforms mostly record the youngest glacial cycle of several cycles of advance and retreat of the Puget lobe of the Cordilleran ice sheet during Pleistocene continental glaciation of this region (for example, Sceva, 1957; Garling and others, 1965; Deeter, 1979). These cycles of glaciation were separated by non-glacial (interglacial) periods of erosion and deposition. Consequently, both glacial and non-glacial deposits underlie the relatively low-relief landforms of the county, and underlie the Puget Lowland in general. These deposits are principally gravel, sand, silt, and clay in various combinations. During each stage of glaciation, the Puget lobe advanced southward into the topographic trough of the Puget Lowland and later retreated back to the north.

Sculpting and erosion of the land surface is very well expressed in the LIDAR imagery (see map). It shows obvious flutes, troughs, mega-striations, and pro-glacial outwash channels which refer only to the channels that were carved and eroded into the pre-existing drift-plain sediments during the youngest glacial advance and retreat that affected the Puget Lowland between about 18 to 16 ka (Porter and Swanson, 1998). The flutes, troughs, striations, and outwash channels are mainly northerly trending features, which now form the northerly trending low hills, U-shaped valleys, and plateaus that characterize the topography of most of the county, the Kitsap Peninsula, and the Puget Lowland.

Geologic Setting of Kitsap County

Most of the Puget Lowland, including Kitsap County, is now covered by the latest Pleistocene glacial, glaciofluvial, and glaciolacustrine deposits, which were deposited during the final advance and retreat (Vashon stade of Fraser glaciation) of the Puget-lobe ice sheet across the Puget Lowland (Sceva, 1957; Garling and others, 1965; Deeter, 1979). Locally, however, older Pleistocene glacial and non-glacial deposits, as well as the Tertiary basaltic basement and marine sedimentary rocks, are found beneath the younger Vashon deposits. With the exception of the Gold Mountain-Green Mountain hills, the older Pleistocene deposits and Tertiary bedrock are only exposed along the lower parts of coastal bluffs and slopes and less commonly along the lower flanks of some deep river valleys. Post-glacial deposits in Kitsap County are relatively minor and consist mostly of beach, lake, bog, and stream sediments, as well as landslides and colluvium along coastal slopes and the flanks of some river valleys.

By far the most widely exposed geologic units in Kitsap County are glacial, glaciofluvial, and glaciolacustrine deposits of the Vashon stade of the Fraser glaciation. For the most part, previous studies of this region all map and subdivide the Vashon deposits in a similar manner. However, differing name designations and slightly differing subdivisions of the Vashon deposits have been presented in geologic mapping and other studies of this region (Sceva, 1957; Garling and others, 1965; Deeter, 1979; Yount and others, 1993; Gold, 2004; Booth and Troost, 2005).

Previous studies subdivide the Vashon deposits into three to five units. The simplest subdivision consists of three units, which include a glacial-advance unit (mostly proglacial outwash) that is overlain in turn by a till unit and a glacial-recessional unit (mostly proglacial outwash). More detailed subdivisions of the Vashon units commonly further subdivide the advance and recessional units. For example, a laminated silt- to clay-rich deposit, the Lawton Clay of the Vashon Drift, locally underlies advance outwash and records proglacial lake deposits that formed in front of the advancing Vashon-stade glacier (Mullineaux and others, 1965). The Lawton is not always represented, nor even where present is it always mapped separately from overlying advance outwash and other glacial-advance-deposit types. Advance outwash deposits of the Vashon commonly include a sandy basal part that in some mapping studies is mapped separately from overlying, gravelly glacial-advance deposits. Where these sandy, proglacial deposits have been identified in Kitsap County they have been mapped and (or) correlated with the Puyallup Sand (Sceva, 1957), Colvos Sand (Garling and others, 1965), or Esperance Sand (Deeter, 1979; Booth and Troost, 2005). Somewhat similar subdivisions of the overlying recessional units have also been presented (Sceva, 1957; Booth and Troost, 2005). The till unit of the Vashon is also known to vary in lithologic and depositional characteristics, but overall it is more homogenous than the underlying and overlying advance and recessional units. Existing geologic maps of Kitsap County and parts of the county do not subdivide the Vashon till unit.

Most of Kitsap County is directly underlain by the till unit of the Vashon. Patches of younger Vashon recessional deposits, which mostly define recessional outwash channels, overlie the Vashon till in some parts of the county. The Vashon advance deposits, principally outwash, are exposed mostly in the sides of drainages and along coastal slopes, where they underlie the till and overlie older glacial or non-glacial pre-Vashon deposits or Tertiary bedrock. Locally, however, parts of the Vashon sequence are absent and the Vashon till or Vashon recessional deposits directly overlie older pre-Vashon deposits or Tertiary bedrock.

Post-Vashon (latest Pleistocene to recent) deposits in Kitsap County are much more limited in extent than are the Vashon glacial deposits. The post-Vashon deposits consist principally of beach deposits along the coast, and lake, bog, and stream sediments in low-lying areas of lakes, bogs, and stream channels farther inland. Latest Pleistocene to recent deposits in Kitsap County also include soil and colluvium veneers and both shallow and deep-seated landslides. Landslides are the focus of this LIDAR-based study and landslides in Kitsap County are concentrated along coastal bluffs and along the flanks of the larger river channels. At least in part because of the widespread distribution of the Vashon drift units, landslide failures in this county are mostly in Vashon deposits and colluvium and soil developed on these deposits.

History of Landslide Mapping in Kitsap County

Kitsap County has a fairly extensive history of landslide mapping efforts that have been carried out as part of dedicated regional slope-stability studies, surficial geologic mapping, or the application of new landslide mapping techniques. The first regional maps of landslides in Kitsap County were produced as part of the Coastal Zone Atlas of Washington (Washington Department of Ecology, 1979). These 1:24,000-scale maps showed categories of relative slope stability within 609.6 m (2000 ft) of the Puget Sound coastline. The maps were created on the basis of aerial-photographic interpretation, geological mapping, topographic mapping, and field observations in the early to mid-1970s. The maps show three primary relative slope-stability categories (stable, intermediate, and unstable) and show two landslide categories (historically active landslides and prehistoric landslides). A similar, 1:42,000-scale slope-stability map covering all areas of Kitsap County was produced by Deeter (1979). This map shows that most unstable areas are either along the coastal slopes or along the flanks of drainages near the coastline.

Surficial geologic maps of parts of Kitsap County at various scales have included landslide deposits. Yount and others (1993) used maps by Garling and others (1965) and Deeter (1979), as well as their own field mapping, to compile a 1:100,000-scale geologic map of surficial deposits in northern and central Kitsap County. This map shows composite historic and prehistoric landslide deposits as a distinct map unit (Qls), and small individual landslides as map symbols. Additionally, this map indicates that most (>90 percent) landslides in Kitsap County are along the Puget Sound coastline. In the southern part of the County, ongoing 1:24,000-scale geologic mapping by Derek Booth and Kathy Troost includes both landslide deposits and mass-wasting deposits (for example, see map of the Ollalla quadrangle, Booth and Troost, 2005). Booth and Troost (2005) define landslide deposits as diamictons composed of broken to internally coherent surficial material and define mass-wasting deposits as colluvium, soil, and landslide debris with indistinct morphology.

Recent landslide mapping in the County has focused on testing the utility of high-resolution LIDAR imagery. Haugerud (2003) included an inventory of large landslides as part of a LIDAR-based geomorphic map of Kitsap County presented at the annual Geological Society of America meeting in Seattle, Washingtion. Gold (2004) used aerial photographs and LIDAR imagery to produce two landslide inventories for an 8 km stretch of coastline along Hood Canal in western Kitsap County. He compared the two inventories and found that both methods produced similar results, but that LIDAR was more effective for defining landslide boundaries in forested terrain.

Discussion of LIDAR Data

LIDAR is also known as Airborne Laser Swath Mapping (ALSM) when the LIDAR data are acquired using aircraft. The LIDAR data used for this investigation were generated from ALSM mapping of the Puget Sound region. The ALSM mapping technique is capable of generating very accurate topographic maps of higher accuracy than other techniques traditionally used to generate topographic maps (Haugerud, 2001). Although the implementation of ALSM mapping is complex, the principle of this topographic- mapping technique is relatively simple and straightforward (for example, Haneberg, 2005). During ALSM mapping, an aircraft flies over a terrain of interest while generating thousands of pulses per second from a laser mounted in the aircraft. Rotating mirrors aim and vary the direction of the densely spaced laser pulses along narrow corridors (swaths) perpendicular to the direction of flight. Based on the speed of light and on the time it takes for individual laser pulses to reflect back from the surface to the aircraft, distances traveled by each pulse can be calculated. These distance measurements are then converted to elevations and map coordinates by combining the distance data with other recorded information that includes the position of the aircraft when the pulse was fired and direction in which the pulse was fired. For this conversion, extremely accurate Global Positioning System (GPS) equipment in the aircraft provides continuous data on the location of the aircraft.

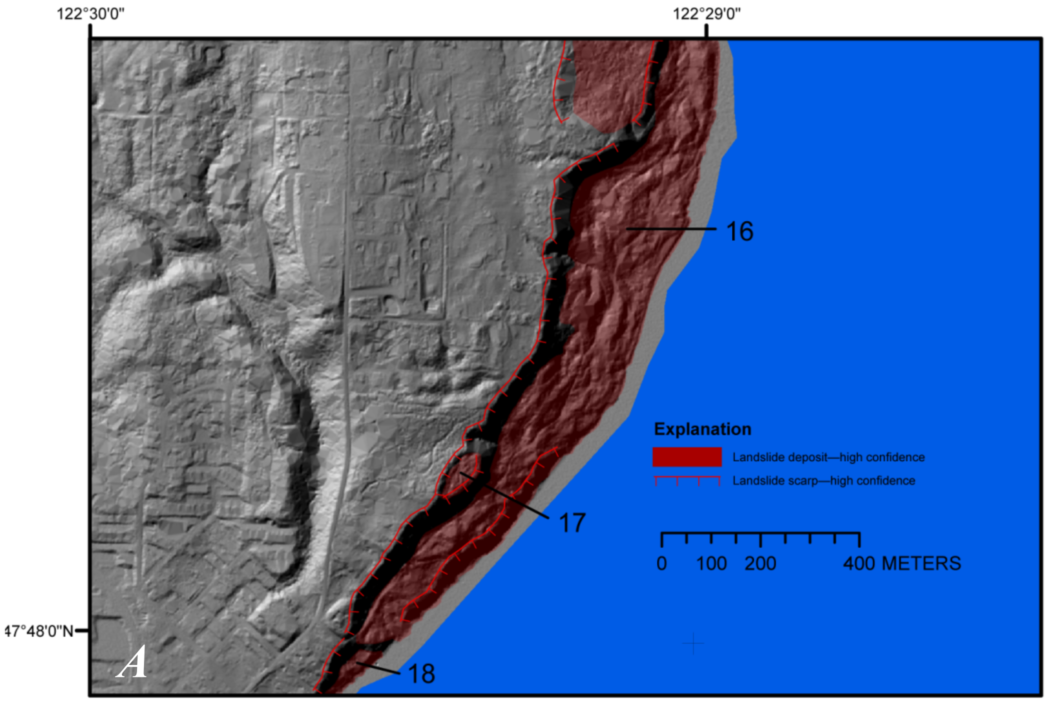
As is characteristic of airborne LIDAR surveys, the initial LIDAR data from the Puget Sound surveys included laser return data from all ground features that produced returns, (for example, buildings, trees, boulders, vehicles, and bridges) as well as returns from the ground surface. Because of the densely vegetated character of the Puget Sound region, trees and other vegetation are typically the most abundant generators of laser returns that do not accurately reflect actual ground surface elevations. These vegetation-related laser returns are extremely significant for studies such as those of forest canopy. However, for geomorphic investigations such as this landslide mapping effort, these vegetation-related laser returns obscure important geomorphic data. As a result of this need for more accurate land-surface elevation data in heavily vegetated regions, data processing techniques (algorithms) have been developed that allow the laser returns from the vegetation to be removed. The resulting digital elevation model of the data essentially reveals the ground surface below the vegetation and is commonly referred to as a “bare-earth” digital terrain model. Such an algorithm, nicknamed “virtual deforestation” (Haugerud, 2001), was used to create a bare-earth DEM dataset from the Puget Sound LIDAR data. This dataset is available on the PSLC website mentioned above. The PSLC website and its links also provide detailed information and discussions of this algorithm, whereas only some aspects and limitations of this algorithm are briefly discussed below.

Essentially, the “virtual deforestation” algorithm identifies laser return signals as either ground or not-ground depending on the surface geometry obtained at nearby locations. Returns identified as not-ground are then removed from the dataset during further data processing by the algorithm. Despite the usefulness and advantages of using the algorithm, it does have some limitations that can locally create artificial features in the resulting DEM. Haugerud and Harding (2001) discuss these limitations and local surface artifacts in detail. In some areas, the algorithm may round corners between low-slope surfaces and vertical faces, such as along steep escarpments. The processing by this algorithm of “negative blunders,” which are incorrect distance measurements that are significantly lower in elevation than are surrounding ground elevations, may create “bomb craters” in areas where nearby valid ground points are mistakenly removed from the dataset. The algorithm can also create false ground-surface roughness that reduces the accuracy of the DEM, and this surface roughness appears to increase as a function of increased land cover, such as vegetation. In areas that yield low return densities, perhaps due to dense vegetation and (or) steep slopes, the algorithm can locally produce an artificial faceted (triangular) surface texture in the DEM. Faceted regions are particularly common along the slopes of some escarpments in Kitsap County (see map). During this investigation, these artificially faceted regions were found to be the most common and troublesome artifact that added uncertainty to the interpretation and mapping of landslide deposits and scarps.

In spite of the limitations discussed above, it should be noted that for Kitsap County, this fully automated algorithm yields a topographic model of the ground surface where the z-value (in xyz space) appears to correspond relatively accurately to the elevation of the ground surface; in most regions it is able to essentially “see through” vegetation to the actual ground surface. Furthermore, the algorithm also captures and reveals surface details, such as hummocky terrain and scarps, which characterize many deep-seated landslides in this region. This further makes the DEM derived from this algorithm an ideal tool for landslide mapping in regions like Kitsap County that contain deep-seated landslides in densely vegetated terrain.

Mapping Methods

The bare earth DEM was the primary LIDAR data used for this study. That DEM was imported into ArcMap software and derivatives of the DEM were generated. Derivatives of the DEM included shaded relief (hillshades), slope, and contour maps. In many instances, topographic profiles were also generated to aid in the evaluation of some of the more subtle or obscure features. Hillshade maps were the principle DEM derivative that we used and these were generated with a constant sun angle of 45 degrees above the horizon, but with varying sun azimuths (for example, 45°, 135°, 270°, and 315°). The use of hillshade images with various sun azimuths was found to be an important tool for these investigations, because varying the sun azimuth of the hillshade produces noticeable to drastically different surface appearances. Figures 2*A* and 2*B* show a hillshade image of the LIDAR DEM near Kingston with a 315° and 135° azimuth, respectively. In this case, the 315° azimuth hillshade (fig. 2*A*) shows more detail within



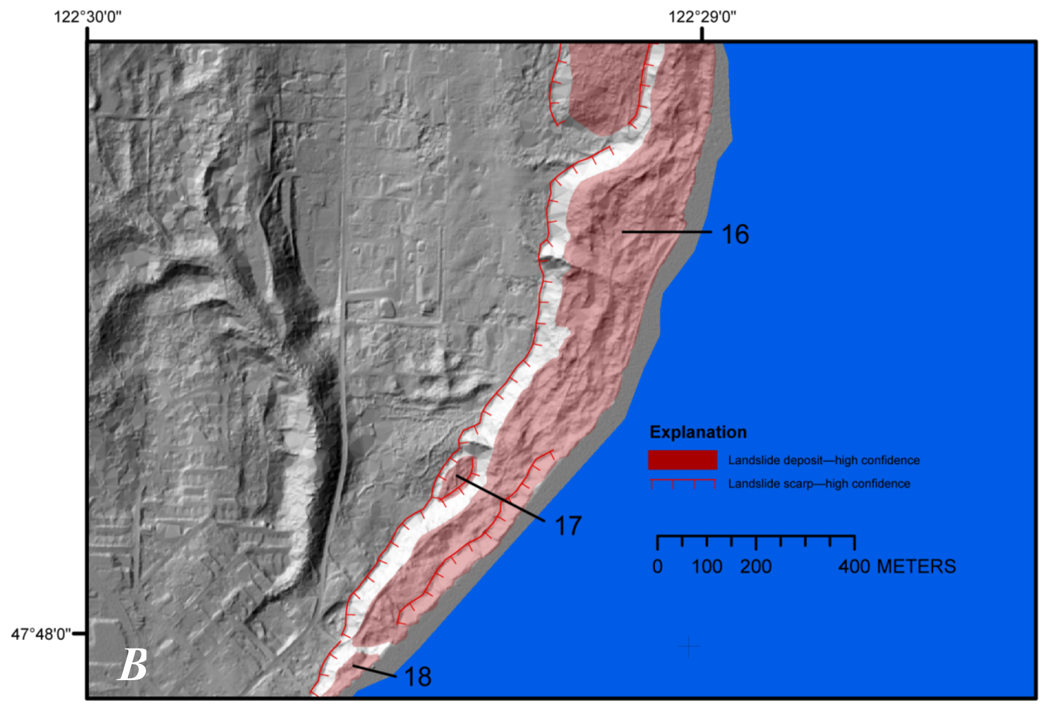


Figure 2. Hillshade images of the LIDAR DEM near Kingston. *A* was created with a 315° azimuth and B with a 135° azimuth. The landslide features are more evident in *A* than *B*. Numbers correspond to the landslide number on the accompanying map.

the landslide than does the 135° azimuth hillshade (fig. 2*B*). In a few cases, the vertical exaggeration of hillshade images were also varied and increased to as much as 200 percent to enhance slope details. Slope map derivatives of the DEM data were used to evaluate features along slopes in areas where apparent indicators of landslide features were vague or just slightly suggestive. The slope-map derivatives were used to better identify the locations of slope breaks and to further verify the existence of hummocky terrain that is characterized by a tumultuous surface morphology. For example, a slope map near Kingston (fig. 3*A*) shows how the jumbled to wavy surface morphology of landslide terrain is characterized by a slope map.

Contour-map derivatives of the DEM (commonly with 2-m contour intervals) were also used in this evaluation (fig. 3*B*). These further aided in the identification of irregular landslide terrain and helped define the boundaries of individual landslide deposits. Lastly, in some cases, topographic profiles across apparent landslide deposits and scarps were generated and used to further evaluate slopes and surface-profile characteristics of landslide deposits and associated headscarps.

Using the derivatives of the LIDAR DEM data described above, the study area was analyzed by systematically panning across the imagery at scales ranging from about 1:15,000 to 1:2000. All slope regions in the county with potential landslide features were examined in detail in the imagery for the presence of escarpments and landslide deposits. We did not map steep escarpments along coastal bluffs as landslide scarps unless they were also associated with an obvious landslide deposit. We mapped landslide deposits and scarps based on the geomorphic expression of features including head scarps and internal scarps, stair-stepped and hummocky terrain, concave and convex slope areas, fracture and fissure features, and deflected stream channels. The deposit boundaries and associated scarps were digitized at scales ranging from about 1:5,000 to 1:2,000. The inventory map, however, is intended to be used at scales no larger than about 1:10,000.

Field Investigations and Final Mapping

After our initial mapping from the LIDAR DEM, we conducted field reconnaissance investigations of the mapped landslide features. These field investigations consisted of about four days in August 2003. Although limited in time and scope, these field investigations provided valuable on-site confirmations of landslide features and provided in sights about the distribution and character of mapped landslides. Our field investigations consisted of visiting as many mapped potential landslides as possible and examining and noting field characteristics of these features, which we broadly classified as indicative, suggestive, or non-indicative of landslide processes. The limited time frame of these field investigations combined with land-accessibility limitations did not permit examination of all of the landslides shown on the accompanying map. For example, only parts of the larger landslides were visited. During our field examinations, we looked for and noted the presence or absence of the characteristic morphologic features mentioned above, as well as the presence of other surface evidence for ground deformation, such as ponds, seeps, springs, pressure ridges, and distressed vegetation and manmade structures. Landslides mapped with moderate confidence often had subtle topographic characteristics visible in the LIDAR that suggested past landslide

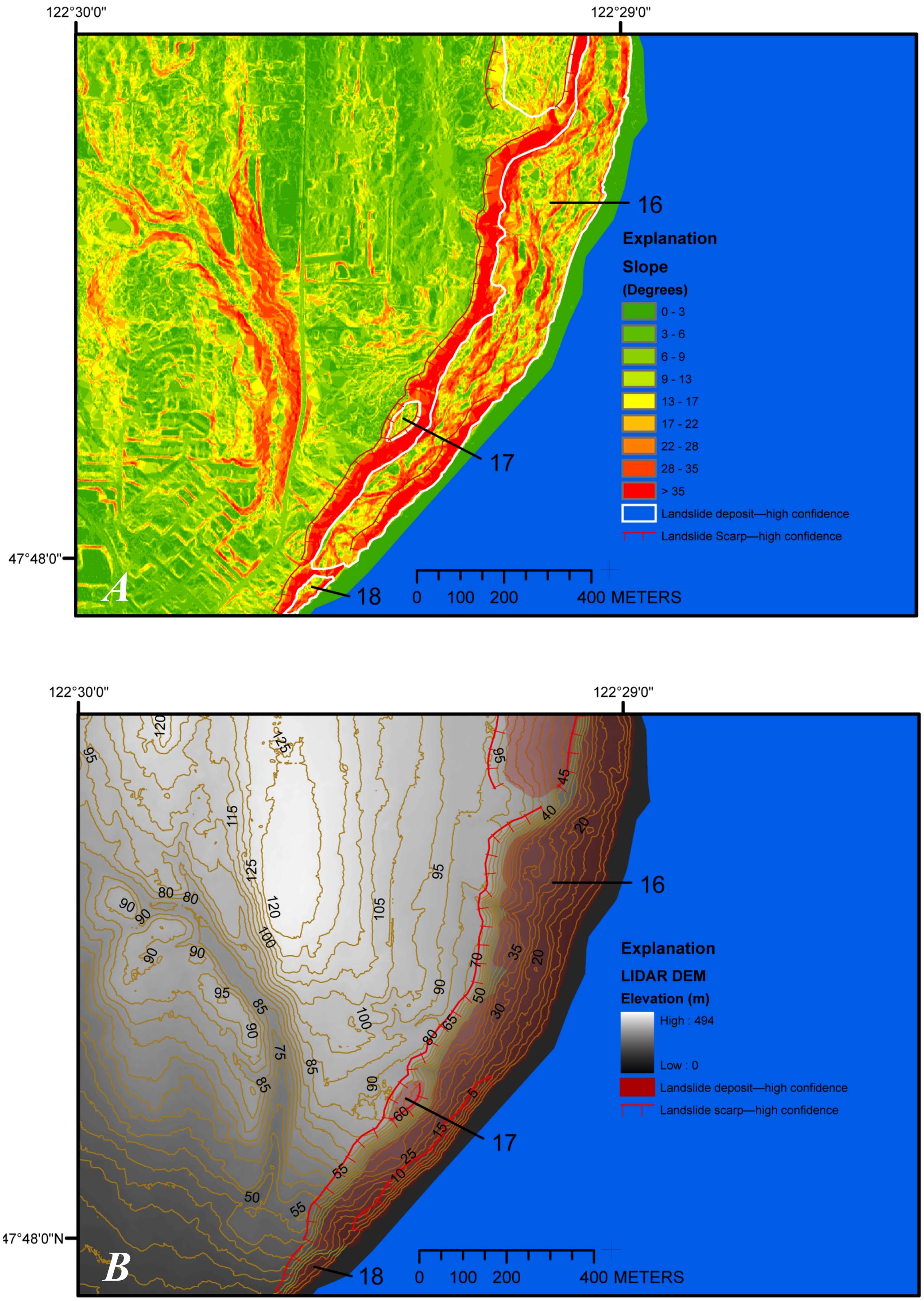


Figure 3. The slope map (*A*) shows hummocky terrain as frequent and random slope changes while the contour map (*B*) represents the same terrain as diverging and converging contours. Escarpments are located at the top of steep slopes and above closely spaced contours.

Figure 4. Vegetation on a landslide mapped with moderate confidence (landslide 143, see map) upslope from Rockaway Beach on the east side of Bainbridge Island (photograph: Jeffrey A. Coe, 2003).

activity, and in some cases, field checking indicated differences in vegetation that could indicate disruption of the ground by past landslide activity (fig. 4).

Following field work, the LIDAR imagery was then re-examined in light of the field observations. During this re-examination, a few landslides were added to the map and a few were removed. Based on insights gained from the field investigations, the confidence-level assignment for some landslides was also changed. For the most part, however, we found that the field investigations mainly reinforced our observations made from the LIDAR DEM.

Discussion of Results

The map shows the landslides mapped in Kitsap County during this investigation. Most of the landslides shown on our map are moderately small to very large landslides and landslide complexes that appear to be mainly deep-seated features. In this section, we briefly discuss characteristics of the landslides mapped, their relationships to the geology and geomorphology, and a comparison of our mapping to previous landslide mapping in Kitsap County. A comparison of the LIDAR-based landslide inventory map to previous landslide mapping is also summarized in table form in the appendix.

The LIDAR imagery appears to be very useful for identifying landslides in the heavily vegetated terrain of Kitsap County. The resolution of the imagery (about 2 m pixels) is most suited for identifying moderate (250 – 10,000 m^2) to large (>10,000 m^2) landslides. In general, the imagery is not suitable for identifying landslide deposits that are less than a few tens of meters across with less than a few meters of vertical topographic expression. The smallest mapped deposit shown on our map covers an area of 252 m^2 (see fig. 5; landslide 32 on the map); landslides of about this size and smaller and are not discernible with much confidence in the LIDAR imagery. Small and (or) shallow landslides are often identified by disrupted vegetation (toppled trees, shallow scars, and so forth) in aerial photography and (or) during onsite investigations. Even if disrupted vegetation is recorded and identifiable in the initial LIDAR data, the disruption is mostly, or entirely, removed during the processing that creates the bare-earth DEM data used for this investigation. LIDAR imagery that has not undergone the "virtual deforestation" algorithm might be useful for identifying shallow landslide features, if disrupted vegetation was actually identifiable in that imagery. From a similar LIDAR-based survey of the Seattle area, Schulz (2004, 2007) noted that most of the small and shallow historical landslides were not discernible in the LIDAR imagery. He also noted, however, that the locations of small historical landslides are concentrated along the escarpments and deposits of larger and more deep-seated landslides and landslide complexes that are apparent in the LIDAR imagery. Kitsap County lacks a comprehensive historical landslide inventory like that which exists for the Seattle area, and for the most part, we were not able to compare the locations of historical landslides to the landslides that we mapped. It seems likely, however, that small historical landslides in Kitsap County probably show concentrations similar to those noted by Schulz for the Seattle area.

Although small landslides do not generally appear to be identifiable in this LIDAR imagery, 43 percent of all the landslide deposits mapped are moderate in size and cover areas between 252 m^2 and 10,000 m^2 (fig. 6, table 1). These moderate-sized landslides are most common in the northern part of Kitsap County, where many of the smaller deposits consist mostly of debris-topples and debris-falls that initiate at the tops of coastal bluffs. The escarpments for these topple/fall deposits are typically vertical or near vertical and often extend from bluff tops to the high-tide mark. An example of such a coastal bluff escarpment is shown in fig. 7. It seems likely that similar coastal bluff escarpments that lack deposits at their base may also have undergone, or might be subject in the future, to similar topples and falls or other types of landslides. Wave action probably removes small landslide deposits faster than they accumulate at the base of some coastal bluffs, which would remove evidence for past topples/falls in these localities. Shoreline erosion on both relatively short- and long-term time scales is also known to be a driving force for erosion, landsliding, and landward migration of the coastal bluffs, and therefore plays a fundamental role in the formation of the relatively shallow coastal bluff failures described above, and in the formation of the more deep-seated failures discussed below (for example, Schulz 2004; 2007; Hampton and Griggs, 2004).

The remaining 67 percent of the mapped landslide deposits cover areas from 10,000 m^2 to about 500,000 m^2 (table 1, fig. 6). We suspect that most or all of these deposits are relatively deep-seated (more than 3 m thick) landslides and landslide

Figure 5. This is the smallest landslide mapped (landslide 32, see map) and is located south of Suquamish. This deposit has and area of approximately 252 m^2 (photograph: Jeffrey A. Coe, 2003).

complexes due to their large area of extent, but we don't have any direct evidence of the thickness of these landslides. The larger of these deposits (those larger than about 50,000 m^2) are most common in southern Kitsap County. The largest deposit mapped (landslide 146, see map) covers an area of about 500,000 m^2 (also see appendix). Internal deformation, including secondary scarps, was identified (both in the imagery and during the field investigations) and mapped within some of the larger deposits. In the imagery, it appears that some of this internal deformation represents one or more reactivations of the landslides. Furthermore, because parts of these landslides apparently have reactivated more recently than have other parts, there is noticeable variation in the morphological expression of landslide features within individual landslides and landslide complexes. For our mapping, we did not attempt to identify age relations of landslides; the landslides we mapped include both historical and pre-historical features, as has been previously noted for Kitsap County and other parts of the Puget Lowland (Washington Department of Ecology, 1979; Deeter, 1979; Schulz, 2004). Many of the large landslides and landslide complexes that we mapped are probably dormant features. However, we did identify some features that suggest recent creep and deep-seated movement of parts of some deposits. On several of these landslide deposits we identified areas of tilted and (or) rotated trees, including the rotated trees apparent in the landslide (landslide 119, see map) that demolished the house shown on the cover of this report. According to residents in this area, this landslide occurred during the very rainy winter of 1996-1997, and

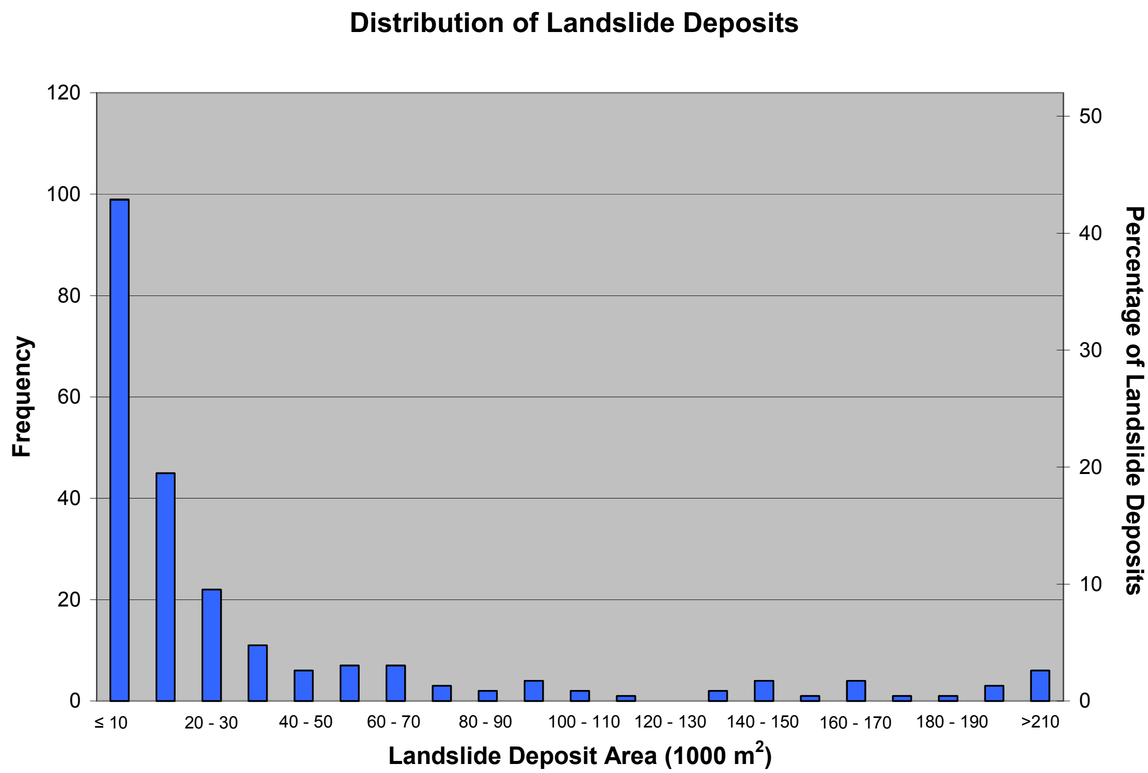


Figure 6. Size distribution of landslide deposits in Kitsap County. Percent of landslide deposits is by the total number of deposits.

movement of the landslide occurred over a period of several days. The rotational character and scale of this landslide are consistent with deep-seated movement. Recent movement was confidently identified along the headscarp of landslide 150 (see map) on the west side of the Port Orchard channel. At this location, an asphalt road leading to residences on the landslide deposit had been vertically offset roughly 20 cm by landslide movement (fig. 8). In other locations, we noted deformation of retaining structures and residences (for example, see fig. 9).

A small deep-seated landslide within Fort Ward State Park (landslide 147, see map) is worthy of further description because of its historical significance. Fort Ward, which was originally known as Bean Point, was established in 1890 to defend the Bremerton Shipyard from enemy attack through the Rich Passage to the south. The landslide within the park covers an area of about 14,000 m^2, and is well defined by LIDAR. It predates the establishment of the Fort because one of the Fort's gun batteries was built within the scar created by the landslide (fig. 10*A*). An examination of the battery in August 2003 revealed minor settling of the battery foundation (fig. 10*B*), but no deformation obviously associated with landslide movement. This appears to be a good example of a deep-seated landslide that apparently has not experienced historical reactivation.

Figure 7. Typical nearly vertical coastal bluff with deposits of apparent falls and topples along bluff toe. The vegetated area at the base of the slopes roughly outlines the deposits of these failures. This picture was taken SW of Point Jefferson (landslide 24, see map) (photograph: Jeffrey A. Coe, 2003).

From our limited field reconnaissance, we can only conclude that parts of some deep seated landslide deposits have experienced reactivations, at least as recently as the winter of 1996—1997. During that winter, above normal precipitation was the principal triggering mechanism (Gertsel and others, 1997). However, in general, the triggering mechanisms for deep-seated landslides in Kitsap County are not well documented, but they probably include precipitation, coastal erosion, and seismogenic ground shaking.

Although most landslide deposits we mapped appear to be deep seated, it seems likely that the majority of recent and historical landslide activity has been shallow because small, shallow landslides dominate the extensive historical record in nearby Seattle, which has similar geology, topography, and climate to Kitsap County (Harp and others, 2006; Schulz, 2004; 2005, 2007). As previously noted, a comparison of the LIDAR-based landslide inventory of the Seattle region with historical landslide records (Schulz, 2004) demonstrated that historical (mostly shallow) landslides were concentrated along and within larger landslide scarps and deposits, which are similar to those mapped in Kitsap County.

Because the steepest slopes in Kitsap County are either along coastal bluffs or along the flanks of deeply-incised river channels draining to the coast, landslides are also most common along, or relatively near, the coast and decrease in frequency as distance from the coast increases (fig. 11). The concentration of landslides along and near the coast is also readily apparent on the map. Sixty-seven percent of the total area covered by landslide deposits in Kitsap County is located within 500 m of the coast, whereas only 12 percent is located beyond 1500 m (table 2). The concentration of landslides along coastal bluffs and river channels suggests that erosion by water exerts strong control on the location of landslides. This erosion occurs by wave action along the base of coastal bluffs, and by stream flow along river channels; these processes ultimately lead to over-steepened coastal bluffs and river banks, which promote landslides. Schulz (2004, 2007) noted similar relations and made similar conclusions regarding landslide controlling factors and locations for Seattle.

Table 1. Distribution of landslide-deposit area in Kitsap County. "Frequency" is the total number of landslide deposits that contain an area within the specified "Area Range of Landslide Deposit." "Percentage" is the percentage of the number of landslide deposits within each area range out of the total number of landslide deposits mapped (231) using LIDAR.

Area Range of Landslide Deposit (m^2)	Frequency	Percentage By Number	Cumulative Percentage By Number
< 250	0	0.0	0.0
250—1,000	3	1.3	1.3
1,000—10,000	96	41.6	42.9
10,000—20,000	45	19.5	62.3
20,000—30,000	22	9.5	71.9
30,000—40,000	11	4.8	76.6
40,000—50,000	6	2.6	79.2
50,000—60,000	7	3.0	82.3
60,000—70,000	7	3.0	85.3
70,000—80,000	3	1.3	86.6
80,000—90,000	2	0.9	87.4
90,000—100,000	4	1.7	89.2
100,000—110,000	2	0.9	90.0
110,000—120,000	1	0.4	90.5
120,000—130,000	0	0.0	90.5
130,000—140,000	2	0.9	91.3
140,000—150,000	4	1.7	93.1
150,000—160,000	1	0.4	93.5
160,000—170,000	4	1.7	95.2
170,000—180,000	1	0.4	95.7
180,000—190,000	1	0.4	96.1
190,000—200,000	3	1.3	97.4
> 200,000	6	2.6	100.0

Several previous landslide investigations in Seattle have proposed that landslide susceptibility is related to certain Pleistocene glacial and non-glacial deposits that underlie that area. In general, the same or very similar Pleistocene units underlie Kitsap County. Comparison of our landslide map to previous geologic and landslide maps of this region (Deeter, 1979; Yount and others, 1993; Gold, 2004; Washington Department of Ecology, 1979) showed that about 77 percent of the mapped landslides involve advance outwash deposits (see the chapter "Geologic Setting of Kitsap County" and

Figure 8. Asphalt-surfaced road offset along the headscarp of landslide 150 (see map) northeast of Bremerton. See clipboard for scale (photograph: Jeffrey A. Coe, 2003).

Appendix). This large percentage may suggest that the physical properties of the advance outwash make it very susceptible to landsliding, which would be similar to observations that have been made in the Seattle area (Tubbs, 1974; Laprade and others, 2000; Coe and others, 2004). For the Seattle area, Tubbs (1974) first noted the prominence of landslides that involve advance outwash deposits (Esperance Sand Member) and further noted that a confining unit (Lawton Clay Member) commonly underlies the advance outwash. He concluded that the hydrologic contrast between these units created perched water tables and increased pore pressures in the overlying sandy advance outwash, which promoted slope failures in the overlying advance outwash. Geologic maps of Kitsap County (Sceva, 1957; Deeter, 1979; Yount and others, 1993; Gold, 2004) similarly show that the sandy to gravelly advance outwash unit in Kitsap County is in many areas underlain by a fine-grained unit and nearly everywhere capped by denser, gravelly and bouldery till. More recent 1:24,000-scale quadrangle mapping in parts of the county suggests that this unit may be, or may correlate with, the Lawton Clay Member of the Seattle area (Booth and Troost, 2005). Although we found that vegetation and colluvium commonly obscured geologic units underlying hillslopes during our field reconnaissance, we did observe the contact between the advance outwash and fine-grained unit in the lower part of some coastal bluffs in some localities. In a few of these localities we also noted small springs along this contact and a few small landslide deposits (some too small to map) of advance outwash along beaches; fig. 12 shows one of these localities.

Figure 9. House and retaining wall on landslide 159 (see map) on the south side of Sinclair Inlet (photograph: Jeffrey A. Coe, 2003).

The large percentage of landslides involving advance outwash, the apparently common presence of an underlying fine-grained unit, the climate, topography, and character and distribution of landslide deposits, are all very similar to those of the Seattle area. These similarities suggest that the differing physical properties (for example, density, grain size, strength, and hydraulic conductivity) of the advance outwash and underlying fine-grained unit may influence the susceptibility and distribution of landslides in Kitsap County in a manner similar to that suggested by Tubbs (1974) for slopes in the Seattle area. Recently, however, Schulz (2007) presented a thorough re-evaluation of landslide relations in the Seattle area and concluded that the occurrence of advance outwash as a source of both shallow and deep-seated landslides in the Seattle region was a function of the continuity and stratigraphic position of the unit, and the topography of the area, which collectively result in the advance outwash underlying prominent parts of slopes. He also showed that most Seattle slides occurred in units that underlie the outwash deposits. He did not dismiss the validity of Tubbs and others (1974) conclusions that the physical properties of the advance outwash and the underling Lawton Clay are factors in landslide activity, but instead argued that coastal and fluvial erosion along the basal parts of coastal and fluvial slopes, are greater and more fundamental factors. Also similar to the Seattle area, and to the relations emphasized by Schulz

B

Figure 10*A* and 10*B*. Foundation of a gun battery located in a landslide scar (landslide 147, see map) at Fort Ward State Park on the south side of the Rich Passage. *A*) Upper surface of the foundation. *B*) Side view showing minor deformation, probably from settling of the foundation (photograph: Jeffrey A. Coe, 2003).

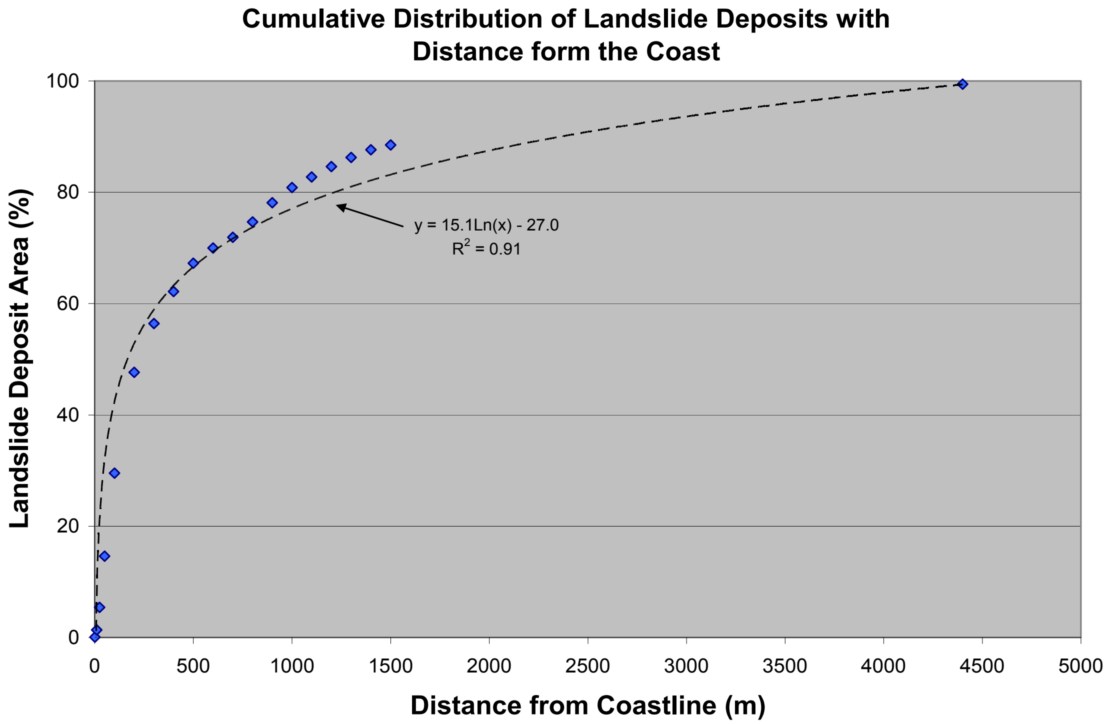


Figure 11. Cumulative distribution of landslide deposits with distance from the coast in Kitsap County, Washington. The fitted line shows the general distribution of the size of the landslide deposits with respect to the distance from the coastline.

(2007), in Kitsap County (1) the advance outwash deposits, which range in thickness from about 2 m to 200 m (Yount and others, 1993), appear to be nearly continuous in the subsurface; and (2) their stratigraphic position in the subsurface and the topography of the region commonly combine to result in the advance outwash underlying prominent parts of the coastal and fluvial slopes. Consequently, these similarities suggest that landslide factors and relations described by Schulz (2007), as well as those described by Tubbs (1974) for the Seattle area, probably apply equally well to Kitsap County.

Comparison of our LIDAR-based landslide inventory map (see map) to previous landslide mapping investigations (Deeter, 1979; Yount and others, 1993; Washington Department of Ecology, 1979; Gold, 2004), which are summarized in the appendix, indicates that we mapped 176 percent of the landslides mapped during all previous investigations. Furthermore, if landslide mapping by Gold (2004), which used the same LIDAR imagery we used, is excluded then our mapping identified twice the number of landslides previously mapped using more traditional methods (for example, aerial photos, topographic maps, and field investigations).

We performed our LIDAR-based mapping without examining the pre-existing maps. Later we examined those maps for the purpose of comparison; results are summarized in the appendix. During that comparison we found some landslides (mostly small to moderate-sized landslides) shown on the pre-existing maps that we had not identified in our initial mapping from the LIDAR imagery. We were able to identify some of these landslides after further evaluation of the imagery and we added them to

Table 2. Distribution of landslide deposits with distance from the coast in Kitsap County, Washington. "Interval Area" is the total land area between the coast and the specified "Distance From Coast." "Landslide Deposit Area" is the total landslide deposit area located within each interval. "Percentage of Total Landslide Area" is the percentage of the "landslide deposit area" within each "Interval Area." "Percentage of total land area" is the percent of each "Landslide deposit area" within the total land area of Kitsap County, which is 93,598,888 m^2.

Distance from Coast (m)	Interval Area (m^2)	Landslide Deposit Area (m^2)	Percentage of Total Landslide Area	Percentage of Total Land Area
100	38,586,524	2,570,088	29.6	0.25
200	74,095,033	4,144,164	47.7	0.40
300	107,594,294	4,905,643	56.4	0.48
400	139,573,031	5,405,648	62.2	0.53
500	170,422,268	5,849,058	67.3	0.57
600	200,306,308	6,085,731	70.0	0.59
700	229,328,913	6,253,244	71.9	0.61
800	257,336,426	6,492,106	74.7	0.63
900	284,392,718	6,793,341	78.1	0.66
1,000	310,456,900	7,032,055	80.9	0.68
1,100	335,661,999	7,196,338	82.8	0.70
1,200	360,123,205	7,356,247	84.6	0.72
1,300	383,854,042	7,499,523	86.2	0.73
1,400	407,155,216	7,619,271	87.6	0.74
1,500	429,785,015	7,694,148	88.5	0.75
4,400	796,967,122	8,645,187	99.4	0.84

our map. However, some of the previously mapped landsides (mostly small and (or)shallow landslides) are either not shown on our map because they were not identified to be landslides in the field or are actually part of larger landslides that we mapped. For example, in a number of localities we found that landslides mapped by the Washington Department of Ecology (1979) and Deeter (1979) as unstable historical landslides occurred within the deposits or headscarps of much larger, deep-seated landslides. In most of these cases, we could not see the small, historical landslide in the LIDAR imagery, but we could identify and map the larger landslide in which the small landslide had occurred. Another example of small/shallow landslides mapped during previous investigations that we could not identify in the LIDAR imagery are 19 landslides in the southernmost part of the area, which were mapped by Gold (2004). He categorized the 19 small landslides as shallow landslides and he indicated that all were visible in aerial photography and that some were also apparent in the LIDAR imagery. However, we could not, even with moderate confidence, identify any of those landslides in the LIDAR imagery and we were also unable to visit any of those localities during our field reconnaissance. This latter example suggests that post-slide aerial photography and (or) field investigations are superior to LIDAR imagery for the identification of small/shallow landslide features. In this region, however, the small/shallow, historical landslides commonly are concentrated along the slopes and scarps of the larger complex landslides, similar to their concentration within landslide complexes in the Seattle region (Schulz, 2004). These larger landslides are readily apparent in the LIDAR imagery.

Figure 12. Small, unmapped landslide along the beach on the east side of the Colvos Passage. Note the color difference in the geologic units visible. Lower unit is a dense, layered silt/sand. Upper unit is less dense than the lower unit and is coarser sand with no visible layering (photograph: Jeffrey A. Coe, 2003).

Summary

We used LIDAR imagery that is publicly available from the Puget Sound Lidar Consortium (http://pugetsoundLIDAR.org) as well as limited field reconnaissance to produce a LIDAR-based landslide inventory map for Kitsap County. The Puget Sound region, which includes Kitsap County, is heavily vegetated and the available LIDAR imagery has been processed by an algorithm that fairly effectively removes vegetation and some cultural features from the raw LIDAR-based topographic data (a digital-elevation model with 2-m pixels). For Kitsap County, we found that this processed LIDAR imagery better revealed the morphologic character of the land surface compared to more traditional tools such as aerial photography, topographic maps, and field investigations because of the removal of dense vegetation from the imagery. The resolution of the LIDAR imagery, however, is best suited for identifying moderate to very large landslides. In general, landslide deposits that are less than a few tens of meters across, and less than a few meters thick, were very difficult to identify in the LIDAR imagery. Consequently, many of the small/shallow historical landslides, which are known to be common in the nearby Seattle region (Schulz, 2004, 2007; Harp and others, 2006), and probably also common in Kitsap County, were mostly not visible in the LIDAR imagery. A comparison of our landslide inventory map to previous landslide mapping in Kitsap County, however, shows that our map defines nearly twice the number of landslides than had been mapped in all previous studies combined.

A similar LIDAR-based landslide-inventory map (Schulz, 2004), as well as later landslide-susceptibility investigations based on that LIDAR mapping and a fairly comprehensive inventory of historical landslides (Schulz, 2005, 2007) have been published for the nearby Seattle area. The results of our LIDAR-based landslide mapping in Kitsap County are similar to the results obtained by Schulz, and we suspect that the landslide susceptibility characteristics of Kitsap County are also similar to those identified in the Seattle area as well. Kitsap County lacks a comprehensive historical landslide inventory, and as such, the type of landslide-susceptibility investigation done by Schulz (2005, 2007) is not possible for Kitsap County and is also beyond the intent and scope of this report. Consequently, and similar to conclusions for the Seattle area (Schulz, 2004), we conclude that our LIDAR-based, landslide inventory map of Kitsap County (see map) is useful in predicting (1) where deep-seated landslides are likely to occur, and (2) where many of the historically more common, small and shallow landslides are also likely to occur. Available data suggest that both types of landslides are most likely along the coastline or within river valleys near the coastline, and often within the boundaries of pre-existing deep-seated landslides.

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Appendix. Descriptions and comparison of each landslide shown on the map to geologic maps of Kitsap County.

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
1 Hansville	North of Hansville	Moderate	74,700	Unstable old slide/unstable recent slide/unstable/ intermediate	Unstable old slide/unstable recent slide/unstable/ intermediate (grade >30°) slopes. Landslide deposit/Esperance sand/pre-Fraser non-glacial deposit/Double Bluff Drift. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Landslide deposit/ Vashon Till	Not part of study area	Yes	Yes
2 Hansville	North of Hansville	High	1,970	Unstable recent slide	Unstable recent slide. Landslide deposit/ Esperance sand. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/ Vashon Till	Not part of study area	Yes	Yes
3 Hansville	Hansville	Moderate	718	Unstable recent slide	Unstable recent slide. Landslide deposit. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Mapped landslide/Vashon advance outwash deposits/Vashon till	Not part of study area	Yes	Yes
4 Hansville	Hansville	High	3,070	Unstable recent slide	Unstable recent slide. Landslide deposit. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Mapped landslide/Vashon till/Vashon recessional outwash deposits	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
5 Hansville	South of Hansville	Moderate	169,000	Intermediate/ unstable/ unstable recent slide	Intermediate (grade >15°)/ unstable slopes/ unstable recent slide. Landslide deposit/pre-Fraser non-glacial deposits. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Vashon till/mapped landslide/Vashon advance outwash deposits/Olympia non-glacial deposits	Not part of study area	Yes	Yes
6 Hansville	South of Hansville	Moderate	49,700	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/ Olympia non-glacial deposits/Vashon till	Not part of study area	Yes	Yes
7 Hansville and Port Gamble	North of Eglon	Moderate	99,800	Stable/unstable recent slide/ unstable	Stable/unstable recent slide/ unstable slopes. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated Esperance sand	Landslide deposit/ Vashon till/beach deposits	Not part of study area	Yes	Yes
8 Port Gamble	Eglon	Moderate	12,600	Intermediate/ unstable	Intermediate (grade >30°)/ unstable slopes. Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Vashon till	Not part of study area	No	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
9 Port Gamble	South of Eglon	Moderate	9,900	Intermediate	Intermediate (grade >30°) slopes. Double Bluff Drift	Pleistocene deposits undifferentiated	Not part of study area	No	No
10 Port Gamble	South of Eglon	Moderate	8,880	Unstable	Unstable slopes. Vashon lacustrine deposits, Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying fine-grained lake sediment overlying Double Bluff Drift overlying Whidby Olympia non-glacial sediment overlying Double Bluff Drift	Vashon recessional outwash deposits/ Pleistocene deposits undifferentiated	Not part of study area	No	Yes
11 Port Gamble	South of Eglon	Moderate	5,060	Unstable	Unstable slopes. Vashon lacustrine deposits, Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying fine-grained lake sediment overlying Double Bluff Drift overlying Whidby Olympia non-glacial sediment undifferentiated	Vashon advance outwash deposits/ Vashon till/ mapped landslide	Not part of study area	Yes	Yes
12 Port Gamble	South of Eglon	Moderate	7,650	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/ Esperance sand. Cross section: Esperance sand overlying fine-grained lake sediment overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Vashon advance outwash deposits/ Vashon till/ mapped landslide	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
13 Port Gamble	North of Kingston	High	192,000	Unstable old slide/unstable recent slide/ unstable	Unstable old slide/unstable recent slide/ unstable slopes. Landslide deposit/ Whidby Olympia non-glacial sediment undifferentiated/Double Bluff Drift. Cross section: Esperance sand overlying fine-grained lake sediment overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ Vashon advance outwash deposits	Not part of study area	Yes	Yes
14 Port Gamble	North of Kingston	High	191,000	Unstable old slide/unstable recent slide/ unstable	Unstable old slide/unstable recent slide/ unstable slopes. Landslide deposit/ Whidby Olympia non-glacial sediment undifferentiated /Esperance sand. Cross section: Esperance sand overlying fine-grained lake sediment overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ Vashon advance outwash deposits	Not part of study area	Yes	Yes
15 Port Gamble and Edmonds West	North of Kingston	High	279,000	Unstable old slide/unstable recent slide	Unstable old slide/unstable recent slide. Landslide deposit/Whidby Olympia non-glacial sediment undifferentiated /Esperance sand. Cross section: Esperance sand overlying fine-grained lake sediment overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial till	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
16 Edmonds West	Kingston	High	192,000	Unstable recent slide/unstable old slide/ intermediate	Unstable recent slide/unstable old slide/ intermediate (grade >30°) slopes. Landslide deposit/ fine-grained lake sediment/Esperance sand/ Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying fine-grained lake sediment overlying landslide deposit overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits Vashon till	Not part of study area	Yes	Yes
17 Edmonds West	Kingston	High	3,690	Unstable recent slide	Unstable recent slide. Landslide deposit/Esperance sand. Cross section: Esperance sand overlying fine-grained lake sediment overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Pre-Fraser non-glacial deposits Vashon till	Not part of study area	Yes	Yes
18 Edmonds West	Kingston	High	3,450	Unstable	Unstable slopes. Esperance sand/ landslide deposit/Whidby Olympia non-glacial sediment undifferentiated deposit. Cross section: Esperance sand overlying landslide deposit overlying Whidby Olympia non-glacial sediment undifferentiated	Beach deposits/pre-Fraser non-glacial deposits	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
19 Edmonds West	North of Indianola	High	16,300	Stable	Stable slopes. Landslide deposit/ Esperance sand/ undifferentiated sediment	Landslide deposit/Vashon till	Not part of study area	Yes	Yes
20 Edmonds West	North of Indianola	Moderate	3,100	Stable	Stable slopes. Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Vashon till	Not part of study area	No	Yes
21 Edmonds West	East of Indianola	High	13,100	Stable/unstable recent slide/ intermediate	Stable/unstable recent slide/intermediate (grade >15°) slopes. Landslide deposit/ Vashon till/beach deposits	Landslide deposit/Vashon till	Not part of study area	Yes	No
22 Seattle Northwest	East of Indianola	High	24,700	Intermediate/ unstable recent slide	Intermediate (grade >15°) slopes/ unstable recent slide. Landslide deposit/Vashon till/beach deposits	Beach deposits/ Vashon advance outwash deposits/ Vashon till	Not part of study area	Yes	No
23 Seattle Northwest	East of Indianola	High	1,290	Not part of study area	Intermediate (grade >30°) slopes. Landslide deposit/Vashon till/Esperance sand. Cross section: Vashon till overlying Esperance sand	Vashon advance outwash deposits/ mapped landslide/ Vashon till	Not part of study area	Yes	Yes
24 Seattle Northwest	East of Indianola	High	6,600	Not part of study area	Intermediate (grade >30°) slopes/unstable recent slide. Undifferentiated sediment. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated	Pleistocene deposits undifferentiated/ Vashon till	Not part of study area	Yes	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
25 Suquamish	Indianola	High	1,540	Not part of study area	Intermediate (grade >30°) slopes/unstable recent slide. Vashon till/Vashon advance outwash deposits/ Whidby Olympia non-glacial sediment undifferentiated /Double Bluff Drift. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Landslide deposit/ pre-Fraser glacial deposits undifferentiated/ Vashon till	Not part of study area	Yes	Yes
26 Suquamish	Indianola	High	16,200	Unstable/ unstable recent slide	Unstable/unstable recent slide. Landslide deposit/Vashon till/ Whidby Olympia non-glacial sediment undifferentiated /Double Bluff Drift. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated overlying Double Bluff Drift	Landslide deposit/alluvium/ pre-Fraser glacial deposits undifferentiated	Not part of study area	Yes	No
27 Suquamish	Indianola	High	9,300	Unstable recent slide	Unstable recent slide. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Mapped landslide, Vashon recessional outwash deposits	Not part of study area	Yes	Yes
28 Suquamish	Indianola	High	5,990	Intermediate/ stable	Intermediate (grade >15°)/ stable slopes. Undifferentiated sediment	Pleistocene deposits undifferentiated/ Vashon recessional outwash deposits	Not part of study area	No	Yes
29 Port Gamble	Northwest of Indianola	Moderate	7,470	Not part of study area	Intermediate (grade >15°) slopes. Vashon till/Esperance sand	Vashon till	Not part of study area	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
30 Port Gamble	Northwest of Indianola	Moderate	14,000	Not part of study area	Intermediate (grade >15°) slopes. Vashon till/Esperance sand	Vashon till	Not part of study area	No	Yes
31 Suquamish	Suquamish	High	9,290	Unstable/ unstable recent slide	Unstable/unstable recent slide. Vashon till/landslide deposit/Whidby Olympia non-glacial sediment	Vashon till/pre-Fraser non-glacial deposits/mapped landslide	Not part of study area	Yes	No
32 Suquamish	Suquamish	High	252	Stable	Stable slope. Vashon till	Vashon till/beach deposits	Not part of study area	No	No
33 Suquamish	West of Agate Point	High	2,640	Intermediate	Intermediate (grade >15°) slopes. Vashon till	Vashon till	Not part of study area	No	No
34 Suquamish	West of Agate Point	High	267	Stable	Stable slopes. Vashon till	Vashon till	Not part of study area	No	No
35 Suquamish	Northeast of Brownsville	Moderate	1,600	Stable	Stable slopes. Vashon till	Vashon till	Not part of study area	Yes	No
36 Suquamish	Northeast of Brownsville	Moderate	2,680	Stable	Stable slopes. Vashon till	Vashon till/alluvium	Not part of study area	No	No
37 Suquamish	North of Brownsville	High	18,400	Unstable recent slide	Unstable recent slide. Landslide deposit/ Esperance sand/Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/Vashon advance outwash deposits	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
38 Suquamish	Northeast of Brownsville	Moderate	77,400	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/ Esperance sand/Vashon advance outwash deposits/ Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Vashon advance outwash deposits/mapped landslide	Not part of study area	Yes	Yes
39 Suquamish	Northeast of Brownsville	Moderate	4,720	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Vashon till/ Esperance sand/Whidby Olympia non-glacial sediment undifferentiated/ landslide deposit. Cross section: Vashon till overlying Esperance Sand overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/Vashon till	Not part of study area	Yes	Yes
40 Suquamish	Northeast of Brownsville	High	64,200	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till/Esperance sand/ fine-grained lake sediment/ Whidby Olympia non-glacial sediment undifferentiated	Mapped landslide/ pre-Fraser non-glacial deposits/ Vashon till	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
41 Suquamish	Northeast of Brownsville	High	30,100	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/ Esperance sand/Vashon advance outwash deposits/ Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ mapped landslide/Vashon till	Not part of study area	Yes	Yes
42 Suquamish	Northeast of Brownsville	High	55,100	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Esperance sand/Vashon advance outwash deposits/Whidby Olympia non-glacial sediment undifferentiated. Cross section: Esperance sand overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ mapped landslide/Vashon till	Not part of study area	Yes	Yes
43 Suquamish	Brownsville	High	14,400	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till	Pre-Fraser non-glacial deposits/ Vashon till	Not part of study area	Yes	No
44 Suquamish	Brownsville	Moderate	1,980	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till	Landslide deposit/Vashon till	Not part of study area	Yes	No
45 Suquamish	Brownsville	Moderate	1,760	Intermediate	Intermediate (grade >15°) slopes. Vashon till/artificial fill	Vashon till	Not part of study area	No	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
46 Suquamish	Northeast of Meadowdale	High	2,100	Unstable	Unstable slopes. Landslide deposit/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/pre-Fraser non-glacial deposits	Not part of study area	Yes	No
47 Suquamish	Northeast of Meadowdale	High	52,700	Unstable	Unstable slopes. Esperance sand/Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits	Not part of study area	No	Yes
48 Suquamish	Northeast of Meadowdale	Moderate	3,370	Unstable	Unstable slopes. Esperance sand	Pre-Fraser non-glacial deposits/ Vashon advance outwash deposits	Not part of study area	No	Yes
49 Suquamish	Northeast of Meadowdale	Moderate	8,180	Unstable	Esperance sand	Vashon advance outwash deposits	Not part of study area	No	Yes
50 Suquamish	Northeast of Meadowdale	Moderate	1,950	Intermediate	Intermediate (grade >30°) slopes. Vashon till/Esperance sand	Vashon advance outwash deposits/ Vashon till	Not part of study area	No	Yes
51 Suquamish	Northeast of Meadowdale	High	2,400	Unstable/ intermediate	Unstable/intermediate slopes. Vashon till/Possession Drift	Landslide deposit/Vashon till	Not part of study area	Yes	No
52 Suquamish	East of Meadowdale	High	11,600	Unstable/ unstable recent slide	Unstable/unstable recent slide. Landslide deposit/ Vashon till/ undifferentiated sediment	Landslide deposit/Vashon till	Not part of study area	Yes	No
53 Suquamish	East of Meadowdale	High	3,160	Unstable/ unstable recent slide	Unstable/unstable recent slide. Landslide deposit/Vashon till/undifferentiated sediment	Landslide deposit/Vashon till	Not part of study area	Yes	No
54 Suquamish	East of Meadowdale	High	1,800	Unstable/unstable recent slide	Unstable/unstable recent slide. Landslide deposit/ Vashon till/ undifferentiated sediment	Landslide deposit/Vashon till	Not part of study area	Yes	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
55 Suquamish	Southwest Bainbridge Island	High	9,610	Unstable recent slide	Unstable recent slide. Landslide deposit/ Vashon till/Esperance sand/ Whidby Olympia non-glacial sediment undifferentiated /Possession Drift undifferentiated/Double Bluff Drift	Landslide deposit/Vashon till/pre-Fraser non-glacial deposits	Not part of study area	Yes	Yes
56 Suquamish	Northwest Bainbridge Island	Moderate	4,760	Intermediate	Intermediate (grade >15°) slopes. Landslide deposit/Vashon till/ Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/Vashon till	Not part of study area	Yes	No
57 Suquamish	Northwest Bainbridge Island	High	45,300	Unstable/ unstable recent slide	Unstable/unstable recent slide. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ Vashon till/ landslide deposit	Not part of study area	Yes	No
58 Suquamish	Northwest Bainbridge Island	High	6,970	Unstable/ unstable recent slide	Unstable/unstable recent slide. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/Vashon recessional outwash deposits/pre-Fraser non-glacial deposits	Not part of study area	Yes	Yes
59 Suquamish	Northwest Bainbridge Island	High	10,400	Unstable recent slide	Unstable recent slide. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/Vashon recessional outwash deposits/pre-Fraser non-glacial deposits	Not part of study area	Yes	Yes
60 Suquamish	Agate Point	High	1,430	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till/Vashon advance outwash deposits	Landslide deposit pre-Fraser non-glacial deposits	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
61 Suquamish	Agate Point	High	26,000	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/Vashon till/pre-Fraser non-glacial deposits	Not part of study area	Yes	No
62 Suquamish	Agate Point	High	1,400	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/beach deposits/Vashon advance outwash deposits	Not part of study area	Yes	Yes
63 Suquamish	Agate Point	High	2,480	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/ beach deposits/ Vashon advance outwash deposits	Not part of study area	Yes	Yes
64 Suquamish	Agate Point	High	3,210	Unstable	Unstable slopes. Landslide deposit/Vashon till/ Whidby Olympia non-glacial sediment undifferentiated	Landslide deposit/ beach deposits/ Vashon advance outwash deposits	Not part of study area	Yes	Yes
65 Suquamish	Rolling Bay	High	15,700	Unstable	Unstable slopes. Vashon till/Double Bluff Drift/Esperance sand/Landslide deposit	Pre-Fraser glacial deposits undifferentiated/ Vashon till	Not part of study area	Yes	Yes
66 Suquamish	Rolling Bay	High	4,940	Unstable	Unstable slope. Vashon till/Double Bluff Drift/ Esperance sand/ Landslide deposit	Vashon advance outwash deposits/ pre-Fraser glacial deposits undifferentiated/ Vashon till	Not part of study area	Yes	Yes
67 Suquamish	Rolling Bay	High	12,500	Unstable	Unstable slopes. Vashon till/Double Bluff Drift/ Esperance sand/ Landslide deposit/Whidby Olympia non-glacial sediment	Vashon advance outwash deposits/ pre-Fraser glacial deposits/ Vashon till	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
68 Suquamish	Rolling Bay	High	3,760	Unstable/ unstable recent slide	Unstable slopes/unstable recent slide. Vashon till/Double Bluff Drift/ Esperance sand/ Landslide deposit/Whidby Olympia non-glacial sediment undifferentiated	Vashon advance outwash deposits/ pre-Fraser glacial deposits undifferentiated/ Vashon till/ mapped landslide	Not part of study area	Yes	Yes
69 Suquamish	Rolling Bay	High	5,940	Unstable/ unstable recent slide	Unstable slopes/unstable recent slide. Landslide deposit/Vashon till/Esperance sand/Double Bluff Drift	Whidby Formation/Vashon till/pre-Fraser glacial deposits undifferentiated	Not part of study area	Yes	Yes
70 Suquamish	Rolling Bay	High	4,160	Unstable/ unstable recent slide	Unstable slopes/unstable recent slide. Landslide deposit/ Vashon till/Esperance sand/Double Bluff Drift	Whidby Formation/Vashon till	Not part of study area	Yes	Yes
71 Suquamish	Yeomalt	High	87,200	Unstable old slide	Unstable old slide. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/Vashon till	Not part of study area	Yes	No
72 Suquamish	Yeomalt	Moderate	5,690	Unstable old slide	Unstable old slide. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated /beach deposits	Pre-Fraser non-glacial deposits/landslide deposit/Vashon till	Not part of study area	Yes	No
73 Suquamish	Yeomalt	Moderate	7,760	Unstable old slide	Unstable old slide. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated / beach deposits	Beach deposits/mapped landslide	Not part of study area	Yes	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
74 Suquamish	Yeomalt	Moderate	12,400	Unstable recent slide/stable	Unstable recent slide/stable slopes. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated / beach deposits/Vashon advance outwash deposits	Beach deposits/mapped landslide	Not part of study area	Yes	Yes
75 Lofall	South of Vinland	Moderate	2,360	Not part of study area	Stable slopes. Vashon till	Vashon till	Not part of study area	No	No
76 Lofall	North of Vinland	Moderate	16,500	Unstable	Unstable slopes. Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Mapped landslide/pre-Fraser non-glacial deposits/Vashon till	Not part of study area	Yes	No
77 Lofall	South of Lofall	High	10,500	Unstable	Unstable slopes. Landslide deposit/Vashon till/fine-grained lake sediment/ Whidby Olympia non-glacial sediment undifferentiated	Vashon till/mapped landslide	Not part of study area	Yes	No
78 Lofall	South of Lofall	High	11,900	Stable	Stable slopes. Vashon till	Alluvium/Vashon till	Not part of study area	No	No
79 Lofall	South of Lofall	Moderate	16,200	Stable	Stable slopes. Vashon recessional outwash deposits	Alluvium/Vashon till	Not part of study area	No	Yes
80 Lofall	Southwest of Port Gamble	High	22,100	Unstable recent slide	Unstable recent slide. Landslide deposit/Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Vashon till/mapped landslide	Not part of study area	Yes	No
81 Port Gamble	Southwest of Port Gamble	High	33,400	Unstable recent slide/unstable	Unstable recent slide/unstable slopes. Landslide deposit/ Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Vashon till/mapped landslide	Not part of study area	Yes	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
82 Port Gamble	Southwest of Port Gamble	Moderate	3,730	Unstable	Unstable slopes. Vashon till/Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/Vashon till	Not part of study area	No	No
83 Port Gamble	South of Port Gamble	Moderate	2,060	Intermediate	Stable slope. Undifferentiated sediment	Pleistocene deposits undifferentiated	Not part of study area	No	No
84 Port Gamble	Little Boston	Moderate	5,600	Not part of study area	Unstable slopes/unstable recent slide. Landslide deposit/Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ Fraser glaciation deposits/landslide deposit	Not part of study area	Yes	No
85 Port Gamble	Little Boston	High	20,300	Not part of study area	Stable slope. Fine-grained lake sediment	Fraser glaciation deposits	Not part of study area	No	No
86 Port Gamble	North of Little Boston	Moderate	3,690	Not part of study area	Intermediate (grade >15°) slopes. Esperance sand/Vashon recessional outwash deposits	Vashon advance outwash deposits	Not part of study area	No	Yes
87 Port Gamble	North of Little Boston	Moderate	5,020	Intermediate (grade >30°)	Intermediate (grade >30°) slopes. Esperance sand	Vashon advance outwash deposits	Not part of study area	No	Yes
88 Port Gamble	West of Eglon	Moderate	4,460	Not part of study area	Intermediate (grade >15°) slopes. Esperance sand/Vashon till	Vashon till/Vashon advance outwash deposits	Not part of study area	No	Yes
89 Port Gamble	Southwest of Hansville	Moderate	3,610	Not part of study area	Intermediate (grade >15°)/ intermediate (grade >30°) slopes. Vashon till/ undifferentiated sediment	Vashon till/Vashon advance outwash deposits	Not part of study area	No	Yes
90 Hansville	Southwest of Hansville	Moderate	10,600	Intermediate/ unstable/stable	Intermediate (grade >30°)/ unstable/stable slope. Vashon till/Double Bluff Drift	Vashon recessional outwash deposits/ Vashon till/Vashon advance outwash deposits	Not part of study area	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
91 Hansville	Southwest of Hansville	Moderate	5,070	Unstable/ unstable recent slide/ intermediate	Unstable slopes/ unstable recent slide. Landslide deposit/Vashon till/fine-grained lake sediment/Esperance sand/ Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying Fine-grained lake sediment overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Vashon recessional outwash deposits/Vashon till/Vashon advance outwash deposits	Not part of study area	Yes	Yes
92 Hansville	Southwest of Hansville	Moderate	20,200	Unstable/ unstable recent slide/ intermediate	Unstable/ unstable recent slide/ intermediate (grade >15°) slopes. Landslide deposit/Vashon till/fine-grained lake sediment/Esperance sand/ Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon till overlying fine-grained lake sediment overlying Esperance sand overlying Whidby Olympia non-glacial sediment undifferentiated	Transition beds/mapped landslide	Not part of study area	Yes	Yes
93 Hansville	South of Hansville	High	13,500	Not part of study area	Stable slopes. Esperance sand/fine-grained lake sediment	Vashon advance outwash deposits	Not part of study area	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
94 Hansville	North of Hansville	Moderate	1,470	Unstable	Unstable slopes. Vashon recessional outwash deposits/ Vashon till/Vashon advance outwash deposits/Whidby Olympia non-glacial sediment undifferentiated. Cross section: Vashon recessional outwash deposits overlying Vashon till overlying Vashon advance outwash deposits overlying Whidby Olympia non-glacial sediment undifferentiated	Pre-Fraser non-glacial deposits/ Vashon till	Not part of study area	No	Yes
95 Hansville	North of Hansville	High	4,600	Unstable old slide/unstable	Unstable old slide/unstable slopes. Beach deposits/ Esperance sand. Cross section: Vashon till overlying Esperance sand overlying Double Bluff Drift	Vashon till/beach deposits/mapped landslide	Not part of study area	Yes	Yes
96 Hansville	North of Hansville	High	20,400	Intermediate/ stable	Intermediate (grade >30°)/ stable slopes. Landslide deposit/Double Bluff Drift/ beach deposits/ Esperance sand/ Vashon till. Cross section: Vashon till overlying Esperance sand overlying Double Bluff Drift	Marsh, bog, and peat deposits/Vashon till	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
97a,b Poulsbo	Two small, closely spaced landslides along N flank of small drainages about 6.0 km WNW of Poulsbo and about 0.3 km E of Hood Canal. Not field checked	Moderate	97a: 7,510 97b: 6,030	Not part of study area	Mapped as intermediate (grade >30%) slopes. Underlying geologic units mapped as Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till	Not part of study area	No (97a,b)	Yes
98a,b Poulsbo	Two small, closely spaced landslides along N and S flanks of small drainages about 8.0 km WSW of Poulsbo and about 0.25 km E of Hood Canal. Field checked, inconclusive, but no evidence for recent activity	Moderate	98a: 15,400 98b: 14,800	Mapped as intermediate slope (grade >15%). Mapped underlying geologic units as pre-Fraser nonglacial sediments, undifferentiated overlain by Vashon till.	Mapped as intermediate (grade >15%) slopes and intermediate (grade >30%) slopes. Mapped underlying geologic units as Esperance sand of Vashon advance outwash overlain by Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till.	Not part of study area	No (98a,b)	Yes
99 Poulsbo	Small landslide along east flank if small drainage about 2.0 km WSW Keyport, directly south of Liberty Bay. Not Field checked	Moderate	63,000	Not part of study area	Mapped as intermediate (grade >15%) slopes. Mapped underlying geologic units as Quaternary sediments undifferentiated and Esperance sand overlain by Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till.	Not part of study area	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
100a—c Poulsbo	Three small, closely spaced landslides along northern flanks of small drainage about 8.5 km W of Keyport and about 0.3 km E of Hood Canal. Field checked; suggestive scarps and deposits, but no evidence of recent activity.	Moderate	100a: 22,5100 100b: 5,500 100c: 12,600	Mapped as intermediate slope (grade >15%). Mapped two small unstable recent landslides (not identified by this study), one north and one south of this small drainage. Mapped underlying geologic units as pre-Fraser nonglacial sediments, undifferentiated overlain by Vashon recessional outwash (sand and gravel).	Mapped as intermediate (grade >30%) slopes. Mapped underlying geologic units as Skokomish gravels overlain by Vashon till.	Mapped as Vashon till and Vashon recessional outwash deposits	Not part of study area	No (100a—c)	Yes
101a,b Poulsbo	Two small, closely spaced landslides on north and south flanks of small drainage about 1.5 km WNW of Bangor Station and about 1.0 km E of Hood Canal. Field checked; evidence inconclusive and no evidence of recent activity	Moderate	101a: 10,1300 101b: 36,600	Area of these landslides only partly shown in mapped coastal zone of Coastal Atlas and mapped as intermediate slope (grade >15%). Mapped underlying geologic units as Vashon till, but area only partly mapped in Coastal Atlas.	Mapped as intermediate (grade >15%) and intermediate (grade >30%) slopes. Mapped underlying geologic unit as Vashon till.	Mapped as Fraser glacial deposits undifferentiated overlain by Vashon till	Not part of study area	No (101a,b)	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
102 Poulsbo	Small landslide along NW flank of small drainage about 1.5 km W of Bangor Station. Field checked; suggestive scarp, but no evidence of recent activity	Moderate	7,990	Not part of study area	Mapped as stable slope. Mapped underlying geologic unit as Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till	Not part of study area	No	Yes
103a—c Poulsbo	Three small, closely spaced landslides about 1.3 km WSW of Brownsville directly W of Burke Bay. Field checked; suggestive scarps and deposits, but now evidence of recent activity.	Moderate	103a: 6,870 103b: 7,4890 103c: 3,870	Mapped slope at 103a as intermediate slope (grade >15%) and slopes at 103b and 103c as stable slopes (grade <15%). Mapped underlying geologic units as Whidbey Formation (?) non-glacial sediments overlain by Vashon till and Vashon recessional outwash (sand and gravel).	Mapped as intermediate (grade >15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated, Vashon lacustrine deposits, and Vashon Esperance sand.	Mapped as Vashon advance outwash and Vashon till. Southern and central slide in outwash; northern slide in till	Not part of study area	No (103a—c)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
104a,b Poulsbo	Two small, closely spaced landslides about 1.1 km NW of Fairview along coastal bluffs of east shore and northern end of Dyes Inlet. Field checked; stair-step topography and possible evidence of recent activity	High	104a: 27,200 104b: 5,030	Mapped 104a and 104b as single, unstable historic landslide. Mapped geologic units as Quaternary landslide underlain by Vashon till, which is overlain nearby by Vashon recessional outwash (sand and gravel).	Mapped much of 104a as unstable prehistoric landslide and 104b as unstable slope. Mapped source area as Kitsap Formation overlain by Vashon Esperance sand and Vashon till.	Mapped as single landslide in Vashon advance outwash overlain by Vashon till	Not part of study area	Yes (104a,b)	Yes
105 Seabeck	Small landslide along east flank of Anderson Creek about 1.7 km SE of Warrenville and Hood Canal. Not field checked	Moderate	30,900	Not part of study area	Mapped as intermediate (grade >30%) and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance sand overlain by Vashon till.	Mapped as Pleistocene deposits undifferentiated overlain by Vashon till	Not part of study area	No	Yes
106a—c Wildcat Lake	Three small landslides along east and west flanks of Big Beef Creek about 3.8 km SE of Seabeck and Hood Canal. Not field checked	Moderate	106a: 30,200 106b: 95,4100 106c: 61,500	Not part of study area	Mapped as intermediate (grade >30%) and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Pleistocene deposits undifferentiated overlain by Vashon till	Not part of study area	No (106a—c)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
107 Wildcat Lake	Small landslide along south flank of Lost Creek about 1.7 km SSE of Wildcat Lake. Not field checked.	Moderate	64,700	Not part of study area	Mapped as intermediate (grade >30%) slopes. Mapped underlying geologic unit as Vashon Esperance gravel overlain by Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till	Not part of study area	No	Yes
108a—k Wildcat Lake and Holly	Series of 11 small to relatively small landslides along flanks of Stavis Creek and its western tributary, about 2.3-4.3 km SE of Hood Point. Some field checked; suggestive scarps and deposits, but evidence inconclusive	Moderate	108a: 86,000 108b: 61,100 108c: 13,300 108d: 6,000 108e: 137,000 108f: 13,900 108g: 7,400 108h: 18,100 108i: 6,890 108j: 143,000 108k: 44,800	Not part of study area	Mapped as mix of unstable, intermediate (grade >30%), and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till	Mapped as Vashon till.	No (108a—k)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
109 Holly	Small landslide along coastal bluff slope of Hood Canal, directly SE of Hood Point	High	4,780	Mapped as unstable historic landslide and mapped adjacent slopes as intermediate (grade >15%). Mapped source area as Vashon recessional outwash (sand and gravel) in contact nearby with Vashon till.	Mapped as unstable historic landslide and mapped adjacent slopes as mix of unstable, intermediate (grade >30%), and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Showed symbol for landslide too small to map. Mapped source area as Vashon advance outwash overlain by Fraser glacial deposits undifferentiated and Vashon till	Mapped unlabeled scarp, but no landslide deposit. Mapped as Vashon advance outwash overlain by Vashon till	Yes	Yes
110 Holly	Landslide along coastal bluffs and slopes of Hood Canal, extending from about 0.3 to 1.3 km S of Hood Point. Field checked; evidence of recent shallow failures. Extent of central and southern parts based mostly on field inspection	High	97,800	Mapped two small unstable historic landslides, one at north end and one in central part of landslide 110. Mapped other parts of 110 as intermediate slopes (grade >15%). Mapped source area as Vashon recessional outwash (sand and gravel).	Mapped two small unstable historic landslides, one in northern and one central part of 110. Mapped adjacent slopes as mix of unstable, intermediate (grade >30%), and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Showed symbol for landslide too small to map in north end of landslide. Mapped source area as Vashon advance outwash overlain by Fraser glacial deposits undifferentiated and Vashon till.	Mapped only southern part of landslide as shallow-seated landslide [86]. Mapped source area as Vashon advance outwash overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
111a, b Holly	Two landslides along east and west flanks of tributary of Boyce Creek, about 0.8 km ENE of Frenchman's Cove of Hood Canal. Field checked 111a; permissive scarp and deposits, but no evidence for recent activity.	Moderate	111a: 155,000 111b: 29,100	Not part of study area	Mapped mostly as intermediate (grade >15%) slopes. Mapped underlying geological units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Vashon advance outwash overlain by Fraser glacial deposits undifferentiated and Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till.	No (111a,b)	Yes
112 Holly	Landslide along north flank of Boyce Creek about 1.2 km ENE of Frenchman's Cove of Hood Canal. Not field checked, but has prominent stair-step topography in LIDAR imagery.	High	188,000	Not part of study area	Mapped as intermediate (grade >15%) slopes. Mapped underlying geological units as Vashon Esperance sand overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Vashon advance outwash overlain by Fraser glacial deposits undifferentiated and Vashon till.	Mapped as deep-seated landslide [85]. Mapped source area as Vashon advance outwash overlain by Vashon till.	Yes (only by Gold (2004))	Yes
113 Holly	Small landslide along south flank of Boyce Creek about 1.4 km ENE of Frenchman's Cove of Hood Canal. Not field checked.	Moderate	26,100	Not part of study area	Included 113 in eastern part of much larger unstable prehistoric landslide that also includes 114a—c, 115a—c, and 116. Mapped source area as Vashon Esperance gravel overlain by Vashon till	Mapped as Vashon advance outwash overlain by Fraser glacial deposits undifferentiated and Vashon till.	Mapped as deep-seated landslide [84]. Mapped source area as Vashon advance outwash overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
114a—c Holly	Three small, relatively closely spaced landslides along southern and western flanks of Boyce Creek, which range from about 0.5 to 1.3 km E of Frenchman's Cove of Hood Canal. Not field checked.	Moderate	114a: 54,000 114b: 26,800 114c: 23,400	Areas of 114b and 114c not included in mapped area of Coastal Atlas. Mapped much of 114a as part of larger unstable prehistoric landslide; mapped adjacent slopes as mix of stable (grade <15%) and intermediate (grade >15%). Mapped geologic units at and near 114a as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped and included 114a-c in central and eastern parts of much larger unstable prehistoric landslide that also includes 113, 115a-c, and 116. Mapped source area as Vashon Esperance gravel overlain by Vashon till	Showed symbol for landslide too small to map in 114a. Mapped mostly as Fraser glacial deposits undifferentiated overlain by Vashon till.	Mapped as Vashon advance outwash overlain by Vashon till.	Yes (114a—c)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
115a—c Holly	Three small, closely spaced landslides along coastal bluff of Hood Canal about 0.5 km south of Frenchman's Cove. Field checked 115a and 115b that show head scarps and hummocky to stair-step topography.	High (115a,b) Moderate (115c)	115a: 9,160 115b: 16,300 115c: 8,670	Mapped areas of 115a and 115b as intermediate slopes (grade >15%). Included 115c in larger, unstable prehistoric landslide that also includes 116 and 117a. Mapped other adjacent slopes as mix of stable (grade <15%) and intermediate (grade >15%) slopes. Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped and included in western part of much larger unstable prehistoric landslide that also includes 113, 114a-c, and 116. Mapped source area as Whidbey Olympia non-glacial sediment undifferentiated and Vashon Esperance sand; both overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Fraser glacial deposits undifferentiated overlain by Vashon till	Mapped 115c as a deep-seated landslide [82] and mapped a shallow-seated landslide nearby [83] that is not shown herein. Did not map 115a,b. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (115a—c)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
116 Holly	Landslide along NE flank of short drainage adjacent to coastal bluffs along Hood Canal, about 0.8 km south of Frenchman's Cove. Field checked; has prominent head scarp and shows evidence for historic movement that includes tilted and rotated trees.	High	167,000	Included 116 in southern part of larger, unstable prehistoric landslide that also includes 115c and 117a. Mapped adjacent slopes as mix of stable (grade <15%) and intermediate (grade >15%) slopes. Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped and included in southwestern part of much larger unstable prehistoric landslide that also includes 113, 114a—c, and 115a—c. Mapped source area as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Showed symbol for landslide too small to map. Mapped source area as Fraser glacial deposits undifferentiated overlain by Vashon till	Mapped as deep-seated landslide [40]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
117a—e Holly	Five small landslides along coastal bluff slopes and adjacent small drainages of Hood Canal, about 1.0 to 1.7 km south of Frenchman's Cove. Tilted trees in area of 117b, but otherwise these five landslides were not field checked	High (117a—d) Moderate (117e)	117a: 20,800 117b: 21,500 117c: 34,600 117d: 10,500 117e: 38,100	Included 117a in larger, unstable prehistoric landslide that also includes 115c and 116. Included 117b-e in nearby, similar unstable prehistoric landslide. Mapped adjacent slopes as mostly intermediate (grade >15%). Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped and included 117b-e in larger unstable prehistoric landslide. Mapped 117a as intermediate (grade >15%) slopes. Mapped source area as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediments undifferentiated and overlain by Vashon till.	Mapped 117c, but not other four landslides. Mapped source area as Fraser glacial deposits undifferentiated overlain by Vashon till	Mapped landslides 117a—c,e as deep-seated landslides [37, 38, 39, 81], but did not map 117d. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (117a—e)	Yes
118 Holly	Small landslides along coastal bluff slope of Hood Canal, directly NE of Nelita. Field checked; evidence for historic shallow failures obvious in field, but not obvious in LIDAR imagery.	High	8,310	Mapped as intermediate slopes (grade >15%) adjacent to stable slopes (grade <15%). Mapped underlying geologic unit as Vashon recessional outwash (sand and gravel).	Mapped relations not entirely clear, but appears to have mapped area of 118 as mix of unstable prehistoric landslide and intermediate (grade >30%) and intermediate (grade >15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain by Vashon Esperance gravel and Vashon till.	Mapped as Fraser glacial deposits undifferentiated overlain by Vashon till	Mapped landslide 118 as shallow-seated landslide [36]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (only by Gold (2004))	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
119 Holly	Landslide along coastal bluff slope of Hood Canal, directly south of Nelita. Field checked; abundant evidence for recent shallow- to deep-seated failures that include destruction of a cabin during the winter of 1996-1997	High	95,100	Mapped as unstable prehistoric landslide, but also mapped small unstable historic landslide along coast in southern part of 119. Mapped adjacent slopes as mix of intermediate (grade >15%) and stable (grade <15%). Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped relations not entirely clear, but appears to have mapped 119 as one or more unlabeled units, and mapped adjacent slopes as intermediate (grade >30%) and intermediate (grade >15%) slopes. Underlying geology: Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as pre-Fraser non-glacial deposits overlain by Fraser deposits and Vashon till.	Mapped as deep-seated landslide [35]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
120a—i Holly	Nine small, relatively closely spaced landslides along coastal bluff slopes of Hood Canal and along flanks of adjacent small drainages, ranging from about 1.1 to 1.7 km WSW of Nelita. Not field checked.	Moderate	120a: 3,250 120b: 18,900 120c: 3,810 120d: 3,180 120e: 3,200 120f: 3,200 120g: 5,900 120h: 12,000 120i: 15,000	Included 120a-h in much larger, unstable prehistoric landslide. Mapped 120i as intermediate slope (grade >15%). Mapped slopes near prehistoric landslide as mix of stable (grade <15%) and intermediate (grade >15%) slopes. Mapped geologic units as Quaternary landslide overlying Vashon recessional outwash (sand and gravel).	Mapped and included 120a-h in much larger unstable prehistoric landslide. Mapped 120i as intermediate (grade >15%) slopes. Mapped slopes near adjacent to prehistoric landslide as mostly mix of intermediate (grade >30%) and intermediate (grade >15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Pleistocene deposits undifferentiated overlain by Vashon till.	Mapped landslides 120b and 120i as deep-seated landslides [51,52] and mapped landslides 120a, 120e, and 120f as shallow-seated landslides [50,78,79]. Did not map other four landslides. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (24a—h) Yes (24i, only by Gold (2004))	Yes
121 Holly	Landslide along west flank of relatively large unnamed drainage, about 1.0 km SW of Nelita. Field checked; has prominent head scarp and hummocky to stair-step topography.	High	167,000	Mapped as unstable prehistoric landslide. Mapped adjacent slopes as mix of stable (grade <15%) and intermediate (grade >15%) slopes. Mapped as Quaternary landslide overlying Vashon recessional outwash (sand and gravel).	Mapped area of 121 as unlabeled unit, and mapped adjacent slopes as mix of unstable, intermediate (grade >30%), and intermediate (grade >15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped source area as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as deep-seated landslide [29]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
122 Holly	Small landslide along north flank of small tributary drainage about 0.6 km SSW of Nelita. Not field checked.	Moderate	32,000	Mapped as intermediate slope (grade >15%) adjacent to stable slope (grade <15%). Mapped underlying geologic units as Vashon recessional outwash (sand and gravel).	Mapped area of 122 as part of larger unlabeled unit, and mapped adjacent slopes as mix of unstable and intermediate (grade >15%) slopes. Underlying Geology: Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	No	Yes
123 Holly	Small landslide along eastern flank of small tributary drainage, about 1.2 km SSW of Nelita. Not field checked.	High	9,970	Mapped as intermediate slope (grade >15%) adjacent to stable slope (grade <15%). Mapped underlying geologic units as Vashon recessional outwash (sand and gravel).	Mapped relations not entirely clear, but appears to have mapped area of 123 as part of larger unlabeled unit, and mapped adjacent slopes as mix of stable, unstable, and intermediate (grade >15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as shallow-seated landslide [34]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (only by Gold (2004))	Yes
124 Holly	Landslide along northern flank of tributary drainage about 1.2 km SSW of Nelita. Field checked; prominent head scarp and deposit slightly hummocky.	High	106,000	Not part of study area	Mapped as intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as deep-seated landslide [33]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (only by Gold (2004))	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
125a—c Holly	Three landslides along flanks of tributaries and main valley of unnamed drainage about 1.3 to 1.7 km SSW of Nelita. Field checked, but was inconclusive.	Moderate	125a: 41,4500 125b: 53,100 125c: 28,600	Not part of study area	Mapped relations not entirely clear, but appears to have mapped areas of 125a-c mostly or entirely in unlabeled unit adjacent to intermediate (grade >15%) and intermediated (grade >30%) slopes. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped landslide 29b as deep-seated landslide [32], but did not map 125a or 125c. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (125a—c only by Gold (2004))	Yes
126 Holly	Small landslide along north flank of small tributary valley of main unnamed drainage, about 1.5 km SSW of Nelita. Field checked; offset road indicate recent to historic activity.	High	25,100	Not part of study area	Mapped area of 126 as intermediate (grade >15%) and stable slope. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as deep-seated landslide [31]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (only by Gold (2004)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
127a,b Holly	Two small, closely spaced landslides along the flanks of two small tributaries of main unnamed drainage, about 1.5 km SSW of Nelita. Not field checked.	Moderate	127a: 12,800 127b: 36,600	Not part of study area	Mapped mostly as intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as Fraser glacial deposits undifferentiated by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped landslide 127b as shallow-seated landslide [30], but did not map 31a. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (127a,b only by Gold (2004))	Yes
128 Holly	Landslide along coastal bluff slope of Hood Canal about 0.5 km south of Tekiu Point. Field checked; shows stair-step topography, graben, and offset logging road that indicates recent to historic activity.	High	60,100	Mapped as unstable prehistoric landslide and mapped adjacent slopes as intermediate (grade >15%). Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped as unstable slope adjacent to unstable prehistoric landslide. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as pre-Fraser non-glacial deposits, Pleistocene deposits undifferentiated, Vashon recessional outwash.	Mapped as deep-seated landslide [28]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
129a,b Holly	Two small landslides along north flank and near mouth of Anderson Creek drainage, about 0.6 km ENE of Anderson Cove of Hood Canal. Field checked; evidence inconclusive.	Moderate	129a: 5,840 129b: 15,600	Mapped 129a and 129b as a single unstable prehistoric landslide. Mapped adjacent slopes as intermediate (grade> 15%). Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Mapped all or parts of 129a+b in western part of larger unstable prehistoric landslide that also includes 130. Mapped adjacent slopes as mix of unstable and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Mapped as single landslide that appears to include these two landslides as well as landslide 130 of this study. Mapped source area as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as deep-seated landslides [74, 75]. Also mapped five other smaller deep- and shallow-seated landslides directly to west [25,26,27,48,49] that are not shown herein. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (129a,b)	Yes
130 Holly	Landslide along N flank and near Anderson Creek drainage, about 0.9 km ENE of Anderson Cove of Hood Canal. Field checked; probable head scarp, internal scarps, and some hummocky topography.	High	51,100	Not part of study area	Mapped as E part of larger unstable prehistoric landslide; includes all or parts of 129a,b. Mapped adjacent slopes as mix of unstable and intermediate (grade >15%) slopes. Mapped underlying geologic units as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undiff. and overlain by Vashon till.	Mapped as landslide that appears to also include landslides 129a,b of this study. Mapped source area as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as deep-seated landslide [24]. Mapped source area as Vashon advance outwash deposits underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
131 Holly	Landslide along north flank of Anderson Creek drainage, about 1.4 km east of Anderson Cove of Hood Canal. Field checked; has prominent head scarp and faint hummocky topography, no evidence of recent activity.	High	338,000	Not part of study area	Mapped as mix of unstable, intermediate (grade >30%), and intermediate (grade > 15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain by Vashon Esperance gravel, which is overlain by both Vashon recessional gravel and Vashon till.	Mapped source area as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till and Vashon recessional outwash.	Mapped as two deep-seated landslides [22,23] separated by narrow strip of Vashon advance outwash. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (only by Gold (2004))	Yes
132a—c Holly	One small and two large landslides along south flank of Anderson Creek drainage about 0.7 to 1.5 km ESE of Anderson Cove of Hood Canal. Field checked; no evidence of movement.	Moderate	132a: 6,940 132b: 167,000 132c: 142,000	Mapped only the areas of 132a and western edge of 132b are included in mapped area of Coastal Atlas, and areas are mapped as intermediate slopes (grade >15%) adjacent to stable slopes (grade <15%). Mapped underlying geologic unit as Vashon recessional outwash (sand and gravel) at 132a and in western part of 132b.	Mapped areas of 132a-c as mix of unstable, intermediate (grade >30%), and intermediate (grade > 15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Mapped source area as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till.	Mapped as five separate deep-seated landslides [20, 21, 47, 72, 73]. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (132a—c only by Gold (2004))	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
133a—c Holly	Three small, relatively closely spaced landslides along flanks of small tributaries on south side of Anderson Creek drainage about 0.5 km SE and ESE of Anderson Cove of Hood Canal. Not field checked	Moderate	133a: 4,220 133b: 10,600 133c: 8,380	Mapped mostly as intermediate slopes (grade >15%) adjacent to some stable slopes (grade <15%). Mapped underlying geologic unit as Vashon recessional outwash (sand and gravel).	Mapped areas of 132a-c as mix of unstable, intermediate (grade >30%), and intermediate (grade > 15%) slopes. Mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till. paper thesis maps are old, worn, and incompletely labeled.	Mapped source area as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till.	Did not map these three landslides, but mapped three small deep-seated landslides [68,70,71] and two shallow-seated landslides [66,67] nearby and directly to north; these five landslides are not shown herein. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	No (133a—c)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
134 Holly	Landslide along NE flank of small drainage directly north and east of Holly along Hood Canal. Field checked; has head scarp and stair-step topography, but no obvious evidence of recent activity.	High	177,000	Included in northeastern part of much larger unstable prehistoric landslide that also includes 135,136,138b-d and parts of 137a-d.Mapped adjacent slopes as mix of stable (grade <15%) and intermediate (grade >15%) slopes. Mapped geologic units as Quaternary landslide on and derived from Vashon recessional outwash (sand and gravel).	Included in northeastern part of much larger unstable prehistoric landslide that also includes 135 and 136 and all or parts of 137a-d and 138b-d. Mapped adjacent slopes as mix of stable, intermediate (grade >15%), and intermediate (grade >30%) slopes. Mapped source areas as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Showed symbol for landslide too small to map in northern end of this landslide. Included area of this landslide in unlabeled unit that underlies low-lying areas in and adjacent to Holly. Unlabeled unit is shown in contact with Fraser and pre-Fraser deposits and Vashon till. Mapped relations may indicate unlabeled unit is landslide	Mapped southern half of landslide 134 as deep-seated landslide [65] and mapped small deep-seated landslide [46] in northern half. Mapped most of northern half of 134, as well as source area, as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
135 Holly	Landslide along west flank of drainage about 0.3 km E of Holly and Hood Canal. Not field checked.	High	54,500	Included in east-central part of same large, unstable prehistoric landslide discussed in landslide 134 (see discussion of landslide 134). Mapped geologic units as Quaternary landslide that appears to be on and derived from Vashon recessional outwash (sand and gravel). Vashon till, and (or) Pleistocene sediments undifferentiated.	Included in east-central part of same large, unstable prehistoric landslide discussed in landslide 134 (see also discussion of 134). Mapped source areas as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Not clear if mapped as landslide. Included landslide 135 in unlabeled unit discussed for landslide 134 and mapped relation shown are like those discussed above for landslide 134.	Mapped as deep-seated landslide [16]. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
136 Holly	Landslide that underlies much of Holly directly east of Holly Bay along Hood Canal. Field check identified numerous retaining walls on properties in Holly, but otherwise field evidence was inconclusive.	High	142,000	Included in west-central part of same large, unstable prehistoric landslide discussed in landslides 134 and 135 (see also those discussions). Mapped geologic units as Quaternary landslide that appears to be on and derived from Vashon recessional outwash (sand and gravel). Vashon till, and (or) Pleistocene sediments undifferentiated.	Included in west-central part of same large, unstable prehistoric landslide discussed in landslide 134 and 135 (see also those discussions). Mapped source areas as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Not clear if mapped as landslide. Included landslide 135 in unlabeled unit discussed for landslide 134 and mapped relation shown are like those discussed above for landslide 134.	Mapped as three very closely spaced, but separate, deep-seated landslides [14, 15, 17]. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
137a—d Holly	Four small, closely spaced landslides along flanks of main drainage and tributaries about 0.6 km E and ESE of Holly and Hood Canal. Not field checked.	High (137a,c,d) Moderate (137b)	137a: 3,440 137b: 14,100 137c: 13,500 137d: 22,200	Included parts or most of these four small landslides in southeastern part of same large, unstable prehistoric landslide discussed in landslide 134, 135, and 136 (see also those discussions). Other parts of landslides 137a-d occur directly outside of the mapped coastal zone shown in the Coastal Atlas. Mapped geologic units as Quaternary landslide that appears to be on and derived from Vashon recessional outwash (sand and gravel). Vashon till, and (or) Pleistocene sediments undifferentiated.	Included parts or most of these four small landslides in southeastern part of same large, unstable prehistoric landslide discussed in landslide 134, 135, and 136 (see also those discussions). Mapped source areas as Vashon Esperance gravel underlain by Whidbey Olympia non-glacial sediment undifferentiated and overlain by Vashon till.	Not clear if mapped as landslides. Included all or parts of these four landslides in unlabeled unit on map. Mapped relations of unlabeled unit suggest it may be intended to represent an area of landslide deposits. See also discussion of landslide 134.	Mapped landslides 137b, 137c, and 137d, as deep-seated landslides [18, 62, 63]. Did not map landslide 137a, but mapped a very small shallow-seated landslide [64], not shown herein, near these landslides. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till.	Yes (137a—d)	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
138a—d Holly	Four relatively closely spaced landslides along flanks of drainages and along coastal bluff slopes of Hood Canal about 0.4 to 0.7 km W to WSW of Holly. Not field checked	Moderate	138a: 115,000 138b: 2,400 138c: 7,150 138d: 18,600	Included landslides 138b-d in southwestern part of same large, unstable prehistoric landslide discussed in landslides 134, 135, 136, and 137 (see also those discussions). Mapped small, unstable historic landslide near coast in the northern tip of 138a, but mapped remaining area of 138a as intermediate slope (grade >15%). Mapped geologic units as Quaternary landslide on and derived from Pleistocene sediments undifferentiated overlain by Vashon till.	Included landslides 138b-d in southwestern part of same large, unstable prehistoric landslide discussed in landslides 134, 135, 136, and 137 (see also those discussions). Mapped small, unstable historic landslide near coast in the northern tip of 138a, mapped remaining area of 138a as intermediate (grade >30%), and/or intermediate (grade >15%) slopes—not entirely clear on map. Mapped relations not entirely clear, but appears to have mapped underlying geologic units as Whidbey Olympia non-glacial sediment undifferentiated overlain in turn by Vashon Esperance gravel and Vashon till.	Showed symbol for landslide too small to map in northern end of landslide 138a, otherwise did not map any of these four landslides. Mapped as Fraser glacial deposits undifferentiated underlain by pre-Fraser non-glacial deposits and overlain by Vashon till	Mapped landslides 138a and 138c as deep-seated landslides [11, 12] and mapped 138b as shallow-seated landslide [60]. Did not map 138b, but mapped a deep-seated landslide [61], not shown herein, directly east of it. Mapped source area as Vashon advance outwash underlain by pre-Vashon interglacial beds and overlain by Vashon till	Yes (138a only by Gold (2004)) Yes (138b—d)	Yes
139 Poulsbo	West of Dyes Inlet, north of Chico	Moderate	8,990	Unstable, Vashon till	Intermediate (grade >15°) to intermediate (grade >30°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated, Vashon till	Not part of study area	No	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
140 Bremerton East	North of Illahee State Park	Moderate	1,290	Stable, undifferentiated Pleistocene sediments	Intermediate (grade >15°)? (difficult to read map) slopes. Esperance Gravel? overlying Vashon recessional gravel	Vashon advance outwash deposits overlying Whidbey Formation	Not part of study area	No	Yes
141 Bremerton East	North of Illahee State Park	Moderate	14,500	Stable, undifferentiated Pleistocene sediments underlain by Whidbey (?) Formation	Intermediate (grade >15°) slopes. Esperance sand? (difficult to read map)	Vashon advance outwash deposits overlying Whidbey Formation	Not part of study area	No	Yes
142 Bremerton East	Between Crystal Springs and Westwood, Bainbridge Island	High	501,000	Unstable old landslide, Quaternary landslide deposit	Unstable old landslide. Adjacent sequence (from youngest to oldest) is Vashon till, Esperance sand, Possession Drift, Whidbey Olympia non-glacial sediment undifferentiated.	No landslide mapped, two small landslides denoted by symbols within undifferentiated Pleistocene deposits, adjacent sequence (from youngest to oldest) is Vashon till, pre-Fraser non-glacial deposits, pre-Fraser gravel, pre-Fraser deposits undifferentiated	Not part of study area	Yes	Yes
143 Bremerton East	Rockaway Beach	Moderate	78,500	Intermediate, Esperance sand overlying Blakely Formation	Intermediate (grade >15°) to intermediate (>30° grade) slopes. Vashon till overlying Esperance sand and Whidbey Olympia non-glacial sediment undifferentiated	Pleistocene deposits undifferentiated, Vashon till, Vashon advance outwash	Not part of study area	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
144 Bremerton East	Rockaway Beach	Moderate	5,790	Stable, Blakely Formation	Intermediate (grade >30°) slopes. Vashon till overlying Esperance sand and Whidbey Olympia non-glacial sediment undifferentiated	Tertiary volcanic and sedimentary rock undifferentiated, Pleistocene deposits undifferentiated	Not part of study area	No	Yes
145 Bremerton East	Rockaway Beach	Moderate	10,400	Stable, Blakely Formation	Intermediate (grade >30°), slopes. Tertiary sedimentary Blakely Formation	Tertiary volcanic and sedimentary rock undifferentiated	Not part of study area	No	No
146 Bremerton East	South Beach, Bainbridge Island	High	18,300	Unstable, Blakely Formation	Intermediate (grade >30°) slopes. Tertiary Vashon undifferentiated underlain by Tertiary sedimentary Blakeley Formation	Tertiary volcanic and sedimentary rock undifferentiated	Not part of study area	No	No
147 Bremerton East	Fort Ward State Park, Bainbridge Island	High	14,400	Stable, but near northern terminus of unstable zone, Vashon till overlying Blakely Formation	Intermediate (grade >15°) to intermediate (grade >30°). Tertiary Vashon undifferentiated underlain by Tertiary sedimentary Blakeley Formation	Vashon till overlying undifferentiated volcanic and sedimentary rocks	Not part of study area	No	No
148 Bremerton East	Fort Ward State Park, Bainbridge Island	Moderate	13,500	Stable, Vashon till overlying Blakely Formation	Intermediate (grade >15°) to intermediate (grade >30°) slopes. Tertiary Vashon undifferentiated underlain by Tertiary sedimentary Blakeley Formation	Vashon till overlying undifferentiated volcanic and sedimentary rocks	Not part of study area	No	No
149 Bremerton East	Near Enetai	High	22,700	Unstable old landslide and unstable, Quaternary landslide deposit and undifferentiated Pleistocene sediments	Unstable old landslide. Geology unclear (can't read map)	Quaternary landslide deposit, Pleistocene deposits undifferentiated	Not part of study area	Yes	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
150 Bremerton East	Near Enetai	High	141,000	Intermediate, undifferentiated Pleistocene sediments	Intermediate (grade >15°) to intermediate (grade >30°) slopes. Unknown geology (can't read map)	Vashon till and Pleistocene deposits undifferentiated	Not part of study area	No	No
151 Bremerton East	Near Enetai	High	34,500	Unstable, undifferentiated Pleistocene sediments	Intermediate (grade >15°) slopes. Esperance sand underlying Vashon till	Vashon till and Pleistocene deposits undifferentiated	Not part of study area	No	Yes
152 Bremerton East	Southeast Bremerton	Moderate	49,700	Stable, Vashon till	Unknown stability, geology unclear (can't read map)	Vashon till and Pleistocene deposits undifferentiated	Not part of study area	No	No
153 Bremerton East	Northeast of Port Orchard	Moderate	3,410	Intermediate, Vashon till and undifferentiated Pleistocene sediments	Unstable slopes. Vashon till and Quaternary sediments undifferentiated	Vashon till overlying Transitional Beds	Not part of study area	No	No
154 Bremerton East	Northeast of Port Orchard	Moderate	13,400	Intermediate, undifferentiated Pleistocene sediments	Unstable slopes. Vashon till and Quaternary sediments undifferentiated	Vashon till overlying Transitional Beds	Not part of study area	No	No
155 Bremerton East	Northeast of Port Orchard	Moderate	13,300	Intermediate, undifferentiated Pleistocene sediments	Unstable slopes. Vashon till and Quaternary sediments undifferentiated	Vashon till overlying Transitional Beds	Not part of study area	No	No
156 Bremerton West	West of Port Orchard, south of Sinclair Inlet	High	46,300	Unstable, Esperance sand overlying Whidbey (?) Formation	Unstable slopes. Quaternary sediments undifferentiated and Whidbey Olympia non-glacial sediment undifferentiated	Pleistocene deposits undifferentiated and Whidbey Formation	Not part of study area	No	Yes
157 Bremerton West	West of Port Orchard, south of Sinclair Inlet	High	69,600	Unstable, Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Whidbey Olympia non-glacial sediment undifferentiated	Quaternary landslide deposit, surrounding unit is Vashon advance outwash deposit	Not part of study area	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
158 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	207,000	Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Vashon till overlying Esperance sand and Whidbey Olympia non-glacial sediment undifferentiated	Vashon advance outwash deposit underlying Vashon till	Not part of study area	No	Yes
159 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	5,860	Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Vashon till overlying Whidbey Olympia non-glacial sediment undifferentiated	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	Yes
160 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	16,200	Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	Yes
161 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	29,400	Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	Yes
162 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	102,000	Esperance sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	Yes
163 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	2,940	Not part of study area	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	No
164 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	57,400	Not part of study area	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	No

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
165 Bremerton West	West of Port Orchard, south of Sinclair Inlet	Moderate	29,600	Not part of study area	Unstable and intermediate (grade >15°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	No
166 Bremerton East	Near South Colby, East of Yukon Harbor	Moderate	3,960	Intermediate, Vashon till	Intermediate (grade >30°) slopes. Quaternary sediments undifferentiated and Vashon till	Pleistocene deposits undifferentiated and Vashon till	Not part of study area	No	No
167 Bremerton East	Near South Colby, southeast of Yukon Harbor	Moderate	9,470	Intermediate, Vashon till, stream deposited Alluvium	Stable slopes. Geology unclear (can't read map)	Vashon till	Not part of study area	No	No
168 Bremerton East	Near South Colby, southeast of Yukon Harbor	Moderate	20,400	Intermediate, Esperance sand	Intermediate (grade >30°), slopes. Esperance sand overlain by Vashon till	Vashon advance outwash overlain by Vashon till	Not part of study area	No	Yes
169 Bremerton East	Near South Colby, southeast of Yukon Harbor	Moderate	30,600	Intermediate, Vashon till	Intermediate (grade >15°), slopes. Geology unclear (can't read map)	Vashon advance outwash overlain by Vashon till	Not part of study area	No	Yes
170 Bremerton East and Olalla	South of Southworth, west of Colvos Passage	High	250,000	Unstable old landslide, Quaternary landslide deposit	Unstable old landslide and unstable slopes. Esperance sand overlain by Vashon till and underlain by Possession Drift(?), Whidbey Formation, and Double Bluff Drift	Vashon till overlying Whidbey Formation	Quaternary landslide deposit, Vashon advance outwash deposits underlain by glacial deposits of pre-Olympia age and reversely magnetized glacial deposits	Yes	Yes
171 Olalla	South of Southworth, west of Colvos Passage	Moderate	3,820	Unstable, Vashon advance outwash	Unstable slopes. Esperance sand overlain by Vashon till	Not part of study area	Vashon till underlain by Vashon advance outwash deposits	No	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
172 Olalla	South of Southworth, west of Colvos Passage	High	280,000	Unstable old landslide and unstable, Quaternary landslide deposit and Vashon advance outwash overlying Whidbey (?) Formation	Unstable old landslide and unstable slopes Esperance sand overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Landslide deposit, Vashon adv. outwash deposits underlain by Lawton clay, glacial deposits of pre-Olympia age, and reversely magnetized glacial deposits	Yes	Yes
173 Olalla	South of Southworth, west of Colvos Passage	Moderate	24,700	Unstable, Vashon advance outwash overlying Whidbey (?) Formation	Unstable slopes. Esperance sand overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Vashon advance outwash deposits underlain by Lawton clay	No	Yes
174 Olalla	Near Fragaria, west of Colvos Passage	Moderate	8,220	Unstable, Vashon Advance outwash overlying Whidbey (?) Formation	Unstable slopes. Esperance sand underlying Vashon Till and overlying Whidbey Formation	Not part of study area	Vashon advance outwash deposits underlain by Lawton clay, Olympia beds, and deposits of pre-Olympia age	No	Yes
175 Olalla	Near Fragaria, west of Colvos Passage	Moderate	4,850	Unstable, Vashon Advance outwash overlying Whidbey (?) Formation	Unstable slopes. Esperance sand underlying Vashon till and overlying Whidbey Formation	Not part of study area	Vashon advance outwash deposits underlain by Lawton clay, Olympia beds, and deposits of pre-Olympia age	No	Yes
176 Olalla	South of Command Point, west of Colvos Passage	Moderate	14,300	Ustable recent landslide and unstable, Quaternary landslide deposit and Whidbey (?) Foramtion	Unstable recent landslide and unstable slopes. Esperance sand underlying Vashon till and overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Vashon advance outwash deposits underlain by glacial deposits of pre-Olympia age, and non-glacial deposits of pre-Olympia age	Yes	Yes

Landslide Number (see map) and 7.5 min. quad. name	General Location (see map)	Confidence Level in Identification of landslides from LIDAR imagery	Area of Landslide Deposit (m^2)	Slope Stabilty from Washington Department of Ecology (1979), scale 1:24,000	Slope stability and geology from Deeter (1979), scale 1:42,000	Geology from Yount and others (1993), scale 1:100,000	Geology from Gold (2004), scale ~1:21,500 [numbers in brackets refer to Gold's landslide ID number]	Previously mapped as a landslide?	Vashon Outwash deposits (Esperance sand or gravel) mapped?
177 Olalla	South of Command Point, west of Colvos Passage	High	132,000	Unstable old landslide, Quaternary landslide deposit and Esperance Sand overlying Whidbey (?) Formation	Unstable and intermediate (grade >15°) slopes. Esperance sand underlying Vashon till and overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Quaternary landslide deposit, Vashon advance outwash deposits underlain by glacial deposits of pre-Olympia age, non-glacial deposits of pre-Olympia age, and reversely magnetized glacial deposits	Yes	Yes
178 Olalla	South of Command Point, west of Colvos Passage	Moderate	3,370	Unstable, Vashon advance outwash overlying Whidbey (?) Formation	Unstable slopes. Esperance sand overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Vashon advance outwash deposits underlain by glacial deposits of pre-Olympia age, and non-glacial deposits of pre-Olympia age	No	Yes
179 Olalla	South of Command Point, west of Colvos Passage	Moderate	5,200	Unstable, Vashon advance outwash overlying Whidbey (?) Formation	Unstable slopes. Esperance sand overlying Whidbey Formation and Double Bluff Drift	Not part of study area	Vashon advance outwash deposits underlain by glacial deposits of pre-Olympia age, and pre-Olympia non-glacial deposits	No	Yes
180 Olalla	South of Olalla Bay, west of Colvos Passage	Moderate	20,200	Unstable old landslide, Quaternary landslide and Whidbey (?) Formation	Unstable old landslide. Esperance sand overlying Kitsap Formation and Possession Drift(?)	Not part of study area	Quaternary landslide deposit, Vashon advance outwash deposits underlain by Olympia beds, pre-Olympia glacial deposits, and non-glacial deposits	Yes	Yes