Tiger Watershed
LANDSLIDE HAZARD ZONATION PROJECT
King County, Washington

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Priority 3
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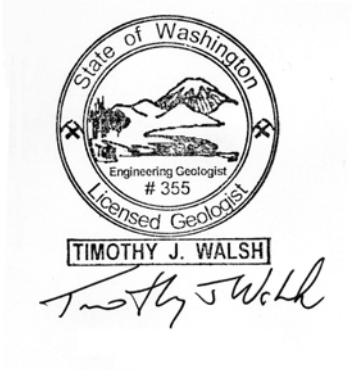

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1.0 Introduction and Summary of Methods

1.1 Use of this report

The purpose of this mass wasting assessment is to identify non-federal, non-tribal areas within the Tiger watershed administrative unit (WAU) that have moderate or high risk of landslides due to the effects of forest management (logging, roading, thinning, yarding, etc.). All lands within the WAU have been divided into designated mass wasting hazard landforms[1]. Maps of these landforms are designed for use by landowners in determining the areas likely to create landslide hazard and by the Department of Natural Resources regional staff to identify sites where future forest practice applications (Chapter 222-20 WAC) may require detailed investigation prior to forest practice classification (Chapter 222-16-050 WAC).

This is a reconnaissance survey, and its relatively broad resolution must be considered when using this document and its accompanying maps. Moreover, the survey was conducted within a constrained timeline that was budgeted to produce a statewide unstable slopes screening tool as quickly as possible. For this reason, it is likely that some landslides or unstable landforms have been overlooked, some benign features have been mistakenly mapped as landslides, and some landslides have been misclassified. Thus, the landslide inventory presented in this report (Map A1 and Form A1) is intended to be a representative but not necessarily exhaustive inventory.

This assessment was largely conducted remotely using the best map and image-based resources available, with support from limited field visits to verify mapping results. However, we note that landslide inventories that are conducted primarily using air photos have been demonstrated to omit up to 85% of the landslides that actually exist on the ground in heavily forested areas (Brardinoni and others, 2002). Furthermore, they tend to skew the location of the majority of landslide occurrences toward recently harvested areas because they are easier to spot than under canopy on air photos (Brardinoni and others, 2002).

Information was collected and compiled in a manner that was designed to respond to the Critical Questions that are outlined in Section II of the Landslide Hazard Zonation (LHZ) protocol, and to direct attention to areas where more detailed analysis is necessary. The objective of the data collection was to generate information sufficient to establish:

- A generalized characterization of mass wasting processes active in the basin;
- Areas of landscape that share similar physical characteristics related to mass-wasting behavior;
- The relative potential for mass wasting to occur among the various landform units.

1.2 Previous Investigations

Numerous studies have been conducted within the Tiger WAU, but none have been in-depth studies on instability within the watershed. Many geologic reports, however, have given insight into geologic stratigraphy and structure, which was used to help identify interbeds and dipping beds.

Stratigraphy and structure identified by Wolfe (1968) was used to identify potential interbeds that might act as weakness planes for deep-seated landslides.

The geologic report completed by Vine (1969) has a small section discussing landslide processes and deposits within the southern section of the watershed. However, the discussion of landslides is generalized to the whole area mapped and does not include any information on specific landslides within the watershed.

1.3 Summary of Methods

This assessment follows the Landslide Hazard Inventory Protocol dated November 30, 2006 (http://www.dnr.wa.gov/forestpractices/lhzproject/lhz_protocol_v2_1_final.pdf). Cadastral and archival topographic maps between 1884 to 1902 were used to determine pre-aerial photography logging activities, transportation routes, and areas affected by forest fires. The early General Land Office plat maps are the earliest map sources for the Tiger WAU and are used as a basis for pre-settlement historical landscape. However, most of the logging activities, transportation routes, and areas affected by forest fires came from the 1899 1:250,000 USGS topographic map and the 1902 USGS Forest Service Map of Washington Showing Classification of Lands. These historical maps were scanned and entered into ArcGIS and georeferenced, in a methodology adapted from Collins and others (2003).

Four sets of aerial photographs acquired between 1958 through 1995 were viewed with a mirrored stereoscope with 3x magnification (Table 1). In addition, two sets of orthophotos from 1998 and 2003 were analyzed in ArcGIS. Unfortunately, some aerial photos were missing from DNR's collection in Olympia, resulting in incomplete flightlines. 1998 black and white ortho-photographs coverage and 2003 color ortho-photos were used as a layer during GIS mapping.

Table 1. Photographic surveys used in this study.

Year	Scale	Image	Flight Number
1958	1:12,000	Black and white	WSF-S-8
1970	1:60:000	black and white	NW-70
1978	1:12,000	black and white	NW-78
1985	1:12:000	black and white	SP-85
1995	1:12,000	color	NW-95
1998	1:12,000	ortho-photographs	NWH-98
2003	1:12,000	ortho-photographs	NWH-03

Slope failures observed on the stereo photos were classified and catalogued according to the mass wasting feature type. For the purposes of this analysis, landslides that failed below rooting depth are categorized as deep-seated landslides (per the Forest

Practices Board Manual); all remaining slides are classified as shallow landslides. The mass wasting feature types include shallow-undifferentiated landslides, debris flows, debris slides and avalanches, rock topple and fall, snow avalanche, and deep-seated landslides (including earthflows).

The mapped landslides were ranked according to their relative level of certainty as questionable, probable, or definite. Features with some combination of distinct head scarps, lateral margins, scoured run-outs, oversteepened toes, obvious deposits with hummocky topography, or vegetation patterns that indicate landslide disturbance were considered to be definite landslides. Features that were more subdued or more concealed by vegetation than those mentioned above made identification of them as landslides less than certain, and were thus considered to be probable landslides. Features that resemble degraded landslides but could have been formed by non-mass wasting processes were considered questionable landslides (following Wieczorek, 1984). Most landslides were mapped from air photos and LIDAR; however several were identified in the field that were not evident on the photos, mostly in areas of heavy canopy or landslides that postdate the most recent photo set.

Following stereo air photo analysis, all observed landslides were mapped directly into GIS. Transfer of mapped features to a digital database was accomplished by "heads-up" digitization of landslides into a GIS map with layers that included streams, roads, townships, geology, and LIDAR digital elevation model (DEM) with LIDAR-derived contours, slope gradients, and hillshades.

LIDAR was available for this area; the maximum horizontal resolution of this map base is about two meters (6 feet). Slope gradients and elevations of small failures that were identified on high-resolution air photos are not accurately estimated by the LIDAR due to raster data smoothing. This method is still superior to the DEM estimates, which has accuracy at best of 10 meters. However, despite limitations, LIDAR was used in place of field measurements for the sake of expediency to estimate the gradients of landslides. It should be emphasized that all slope gradient estimates presented in this report are likely minimum approximations.

Slope gradients for shallow landslides were determined by calculating the average LIDAR DEM-derived slope angle within each landslide initiation polygon. For deep-seated landslides, the average slope angle over the entire landslide polygon was calculated. We found that using the average slope gradient for deep-seated landslides provides the quickest and most reasonable representation of the pre-failure slope surface compared to other GIS slope measurement methods (Bilderback, 2006).

The air photo survey was also used to determine land use and to map rule-identified landforms (inner gorges, bedrock hollows, etc.). The 10m DEM and other GIS products were used to map low-hazard flat areas, low-gradient hillslopes, and ridgetops, according to the LHZ Protocol. The remaining land in the WAU was divided into analyst-described landforms. These landforms were identified from mass wasting and based on physical attributes of the landscape such as slope gradient, elevation, annual precipitation, lithology (from USGS 1:100,000 geologic maps), and slope convergence. These landforms are intended to predict areas within the WAU that are at a mass wasting hazard. Each landform was assigned a landslide frequency rate (LFR), a landslide area rate for delivery (LAR), and an overall hazard rating as called for by the LHZ Protocol.

2.0 Physical Setting Pertinent to Mass-Wasting Interpretations

2.1 Introduction

The Tiger WAU covers 40,654 acres in the Cascade foothills, from Lake Sammamish in King County (Map A1) to just north of the Cedar River. The watershed lies in the middle of the "Issaquah Alps", a spur of the Cascade Mountains that extrudes to the shores of Lake Washington.

Two major highways cross the watershed, Interstate Highway 90, running east to west and Highway 18, running north to south. These highways have encouraged access and growth around and within the watershed, making much of the watershed a working forest in an urban environment (Rose, 1983). The city of Issaquah is within the Tiger WAU as well as many other smaller towns. Forest management must be done with the utmost of care, for landslides can fail onto highway systems as well as urban centers.

2.2 Topography

Tiger WAU is located in King County, on a small spur of the Cascade Mountain Range, locally known as the "Issaquah Alps". Tiger Mountain is the most well known of the Issaquah Alps with other prominent peaks of Squak Mountain and Cougar Mountain. The WAU ranges in elevation from 30 feet at the confluence of Issaquah Creek and Lake Sammamish to 3,000 feet on the summit of Tiger Mountain. Numerous geomorphic landforms dot the watershed, ranging from flat plains to vertical cliffs. Flats (0-10%) are located in river valleys and plains formed by glacial processes and comprise over 25% of the land within Tiger WAU. Low gradient hills (10-40%) dominate Tiger WAU and comprise of 44% of the land. High gradient hills (40% and greater) form much of the steeper mountain terrain within the watershed and comprises of 20% of the land. The remaining 11% of the watershed is comprised of rule identified landforms, ridge tops and noses, and bodies and scarps of active deep-seated landslides (see

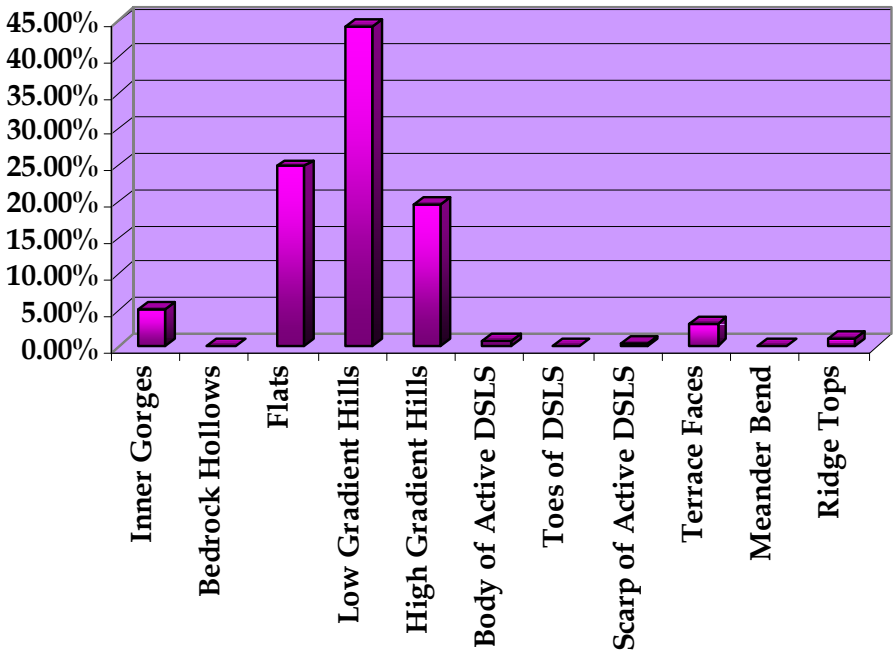

Figure 1: Percent of landforms located within Tiger WAU

Figure 1).

Tiger WAU is more than 75 percent forested, approximately 15% wetlands and pasture and less than 10% urban and cleared areas (Kerwin, 2001; King County, 1996). Increased urban growth within the watershed projects the population to increase by 18 percent by 2020 (KCDNR, 2007). This increase in growth will apply pressure to forested sections of the watershed by either conversion of forested land into urban areas or public criticism of forest management (Rose, 1983).

2.3 Land use and Historical Considerations

General History

The flanks and valleys of the Issaquah Alps were among the first settled areas by European-Americans, most famously by William Pickering in 1862, an early governor of the Washington Territory (Craine, 2003). Timber mills quickly followed, with construction starting by the late 1870's and dotting the region by mid 1900's. Logging first started on skid trails, with timber pulled by horses and oxen, but were replaced in the late 1880's by logging railroads. These railroads crisscrossed through the area as logging interests battled for timber. The High Point Mill Co., which logged much of the area up the north face of Tiger Mountain, built over 9,600 feet of track, the second largest in North America. Many of the mills shut down in the 1930's, due to the depression and less demand for timber (Erickson, 2000). Operations went up and down, with mills slowly closing towards the present with few mills still in production.

Logging railroads in many watersheds have left a legacy of landslides and unstable slopes. Some of the logging railroad grades in Tiger do appear to have stability issues, with the Main Tiger Mountain Road, on the south side of Tiger Mountain (radio towers) as a prime example. This railroad grade, converted to forest road, appears to have organics in the road prism, drainage issues, and sidecast failures. It has triggered numerous road related landslides and will continue to cause failures. Acquisition of historical maps showing the locations of logging railroads, or a general knowledge of the locations of logging railroad grades, especially on steep slopes, could greatly aid in the management of roads.

Forest History

As in much of the Puget Sound Basin, old-growth forests originally dominated the Tiger WAU. Douglas Fir, Western Hemlock, Sitka Spruce and Western Red Cedar were the dominant trees. As timber was cut, it was replanted primarily with Douglas Fir, with minor amounts of Western Hemlock, Sitka Spruce and Western Red Cedar natural regenerating. Hardwood regrowth dominates small patches in the northern section of the watershed primarily in disturbed urban interface zones. The forested sections of the watershed typically are moderate to heavily forested, which is presently in second and third growth coniferous trees. Shrubs, such as Salal, Himalayan Blackberry, and Devil's Club, are common in the understory and in young stands, particularly in disturbed areas. In addition, a great variety of ferns, forbs, and herbs are common as well in the understory.

Plants can sometimes help identify areas that had instability and failures. After a failure, water tolerant plants like alder, vine maple, horsetails, skunk cabbage, and devil's club

become opportunistic in the disturbed land and dominate the area. These plants will form on slopes and can sometimes perfectly outline shallow undifferentiated, debris avalanche and deep-seated landslides. Alder often heavily dominate streambeds after a debris flow.

Hydrology and Climatic Events

The Puget Sound lowland has a mid-latitude marine climate. This climate structure results in the wet season beginning in October, peaking in late November to January and decreasing into spring. The dry months continue into summer, peaking in July to August and gradually decrease into fall (WRCC, 2007).

Wind directions are also tied into climate, with the wind prevailing direction from the south and southwest during the wet season and northwest during the dry season. The average wind velocity is less than 10 mph, however, large winter storms can bring high winds to the region.

Issaquah Creek headwaters originate from the steep slopes of Cougar, Squak, Tiger and Taylor mountains. The basin encompasses about 61 square miles and includes Holder, Carey, Fifteen-mile, and McDonald creeks as tributaries to Issaquah Creek. Stream flow is primarily controlled by rainfall, as the Tiger WAU does not contain any permanent snow packs. Precipitation within the study area is moderate, averaging 50 inches near Squak Mountain to 80 inches at about Highway 18. 75% of the precipitation within the watershed occurs between October and March. Stream flows peak in late fall-to-winter. Rain-on-snow events most likely occur between 1,500 feet to 2,700 feet. Rain-on-snow events have triggered widespread slope failures in many watersheds within the Cascade foothills (Toth, 1991).

Large winter storms bring heavy rains, producing flooding, saturated soils and heavy winds. The earliest storm events were first recorded by European-American settlers in farming journals, dating back to the early 1850's (Wilma, 2004). The major winter storms of 1860, 1861-1862, 1875, 1880, 1892, 1896, 1897, and 1902 most likely caused extensive flooding and mass movement, but no known records exist for these storms within the Tiger WAU. The storms of 1897 and 1902 are well known rain-on-snow events have caused extensive damage throughout the region (Sarikhan and Walsh, 2006). USGS stream monitoring records start in 1964 within the Tiger WAU, however rain records (Brunengo, 2007, personal communication) allow a glimpse into earlier climate events. From 1931 to 1964, rain patterns indicate 1934, 1948, and 1951 to be high rain events that likely caused flooded within Issaquah Creek and possibly landslides. Stream records from the USGS indicate peak flow events occurring in 1975, 1986, 1990, and 1995-1996 (USGS, 2007). Aerial photos were in part chosen by year in an attempt to capture some of these large storm events within the watershed. However, only the and 1978 photos were close to major

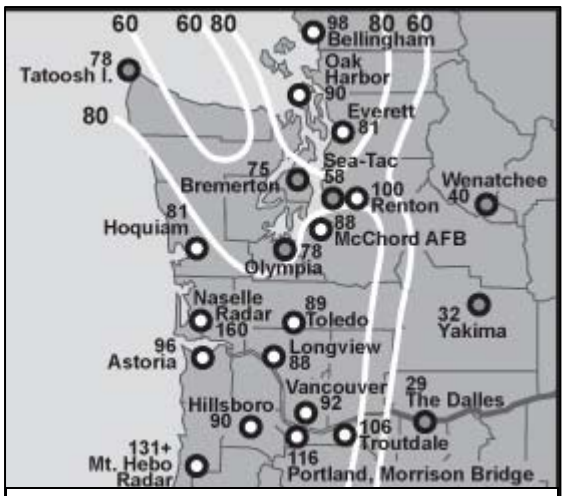

Figure 2: Wind map of the Columbus Day storm in 1962. Modified from Wolf Read, 2005

storm events.

Extra tropical cyclones can cause hurricane force winds and high precipitation within Western Washington. On January of 1921, a massive windstorm, probably equivalent to the Columbus Day Storm of 1962 and the Hanukkah Eve Wind Storm of 2006 brought wind gusts estimated at more than 100 miles per hour. The storm winds were strong enough to topple large stands of old growth trees, with shallow rooted and top-heavy trees, such as spruce and hemlock, being most vulnerable. An estimated three to seven billion board feet of old growth timber was reported to be blown down, causing the storm to be named "The Great Blowdown". Not until the Columbus Day storm has any storm caused so much damage to forests by blowdown (Wilma, 2003). The large amount of downed timber throughout the region created a high forest fire danger and some large forest fires have been attributed to this event. The fire along Rattlesnake Mountain in 1923 could be correlated to this event, along with fires within the Tiger WAU on May 31, 1922 (Wilma, 2000).

The most powerful storm recorded in Western Washington (with perhaps the exception of the Great Gale of 1880 (Read, 2004)) was the Columbus Day storm of 1962. This storm is used as the prime example of an extra tropical cyclone in western Washington. Hurricane strength winds, ranging from 60 mph to over 160 mph were recorded throughout the state (figure 2). The storm brought unparalleled damage to the region, knocking an estimated 11 to 15 billion board feet of timber to the ground. As with "The Great Blowdown" in 1921, the downed timber created a high forest fire danger for the area and a massive salvage operation ensued (Read, 2005) .

The latest extra tropical cyclone hit the region in the winter of 2006, known as the Hanukkah Eve Windstorm of 2006 (figure 3). This storm also brought hurricane force winds into western Washington at a time when soils were saturated by persistent high precipitation storm systems into the area (Read, 2007). The storm caused a large amount of damage within King County, specifically in the Tiger WAU. Transmission power lines that run across the watershed were damage or destroyed by falling timber and wind. Electricity was disrupted for up to 1.2 million residents in Western Washington, which included almost all of eastern King County. Forest management within this watershed is vital to public safety, as highways and utilities run across managed forest areas. Planning must take into account of the variety of climatic events that can occur within this watershed to ensure public safety.

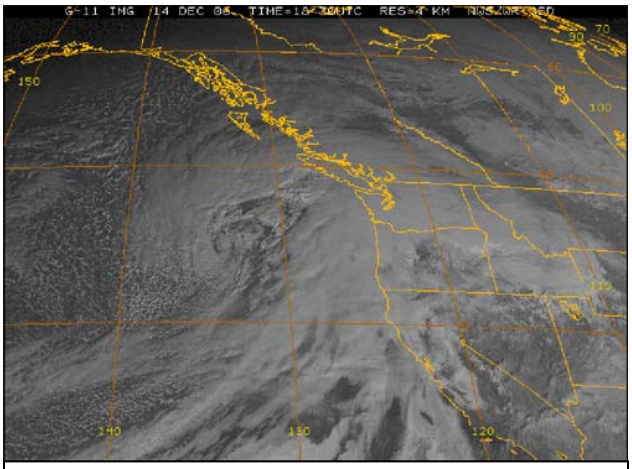

Figure 3: Satellite image of the Hanukkah Eve Windstorm as it approached Washington on December 14, 2006. Modified from Read, 2007

2.4 Geology

Introduction

The Issaquah Alps trend along the south of Highway Interstate 90, from the shore of Lake Washington to the Cascade Mountains, just east of North Bend. The hills are composed of tightly folded and faulted rocks of marine and fluvial origin deposited in the Middle Eocene. Andesite, a volcanic rock intruded into the coastal sediment as well as deposited volcanic ash and lahars on the surface. In the Quaternary, the Cordilleran Ice sheet repeatedly flowed over the Tiger WAU, steeply carving the east and west sides of Squak Mountain as well as completely covering Tiger Mountain. It deposited large amounts of till, outwash sand, and lacustrine (lakebed) deposits.

Regional Geology

The tectonic structure of Washington State has been dominated by oceanic-continental plate convergence for over 100 Ma (Tabor and others, 1993). Washington has been built largely by three major processes; crustal fragments amalgamated onto the western margin of the North American Plate; eruptions generated by subduction of the oceanic plate under the North American Plate and emplacement on the surface and subsurface (as ashfall tuffs, lahars, flows, sills, batholiths, etc.); and erosional processes that eroded and deposited material. Orogenic processes of uplift by crustal deformation, folding, and faulting created the complex mountain structure of Washington (both the Cascadia and Olympics) (Dragovich and others, 2002). Erosion by water, ice and mass wasting throughout this time and to the present carved the landscape into what we know today.

Local Geology

The local geology is best explained in the summary of local geology in the DGER newsletter (Walsh, 1990), seen below:

> The Tiger Mountain State Forest lies in an anomalously west-trending spur of the Cascade Range. The oldest rocks exposed in the forest area the mudstones, sandstones, and conglomerates of the Raging River Formation (Fig. 4). These rocks were deposited in middle Eocene time, about 48 million years ago, in a marine embayment with a margin steep enough to cause abundant slumping of the newly deposited sediments. Nearby volcanoes, to the east and possibly to the south, provided sediment to the bay, as did the older rocks that these volcanoes were built on. Over time, the eastern part of this bay filled with sediments, and the shoreline migrated west to approximately the present location of Interstate Highway 5. Deltas were built out by deposition from large streams rising in northeastern Washington or perhaps Idaho; delta fronts migrated to this area and formed coal swamps in which the sandstones, siltstones, and coals of the Tiger Mountain Formation were deposited. Approximately 45 million years ago, a volcano located where West Tiger Mountain and Squak Mountain now lie began to erupt. This volcano, which produced rocks known as the Tukwila Formation was

probably similar to Mount St. Helens. It produced airfall and ashflow

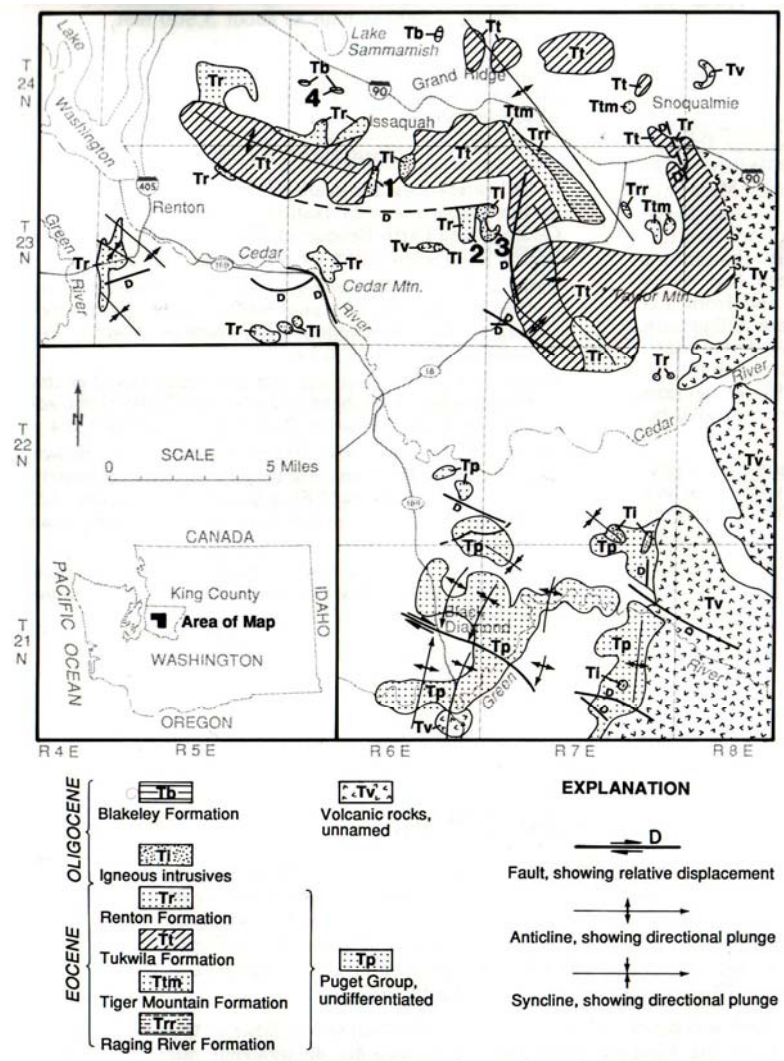

Figure 4. Generalized geologic map of a part of King County, Washington. The numbered localities are referred to in text and lie within the Tiger Mountain State Forest. Unpatterned and unlabelled areas are unconsolidated Quaternary sediments. (Modified from Warren and others, 1945; Vine 1969.)

tuffs (rocks made up of particles exploding out of a volcano) rather than lava flows, as well as debris flows (lahars) that were similar to the Toutle River mudflow that nearly reached Kelso and Longview in 1980. The lava that was within the Tukwila volcano and produced a coarse-grained crystalline rock known as andesite porphyry. The andesite can be seen in the steep walls of Squak and West Tiger Mountains where Issaquah Creek (and precursor streams) have deeply dissected the mountain sides (loc. 1, Fig. 4).

Once the Tukwila volcano ceased erupting, about 41 million years ago, subsidence of the embayment area resumed, and deltas were re-established here, depositing the sandstones, siltstones and coals of the

Renton Formation. Coals from the Renton Formation were mined at the nearby towns of Renton, Maple Valley, Cougar Mountain, and Issaquah. Remnants of small mining operations can still be seen along the trails of the Fifteenmile Creek gorge (loc. 2, Fig. 4).

About 38 million years ago, the volcanoes that produced much of the Cascade Range began to erupt. The products of these are found mostly to the east of Tiger Mountain State Forest. However, several sills (intrusive igneous rocks) produced by these volcanoes can be seen in the State Forest. These sills are like lava flows, but because they are dense and the sediment they intrude are relatively lighter, they flow out under the sediments, commonly at depths less than 300 feet. These sills are well exposed along Fifteenmile Creek and in a quarry along the West Side Road at about the common corner of section 13 and 24 (T23N, R5E) and section 18 and 19 (T23N, R6E) (loc. 3, Fig. 4).

During this time (the Oligocene epoch) large volumes of tuffs were produced in the Cascade Range. There may have been as much as a 5,000-foot thickness of these rocks deposited in the Tiger Mountain State Forest area, but they were eroded when these hills were uplifted. To the west, around Seattle, Bellevue, and Newport Hills, are marine sedimentary rocks that were derived (in part) from the rocks eroded from the Tiger Mountain area and from airfall ash from Cascade volcanoes. These Oligocene marine rocks are known as the Blakely Formation. They are well exposed along the frontage road on the south side of Interstate Highway 90 in section 13 (T24N, R5E) where marine fossils can readily be found (loc. 4, Fig. 4).

Uplifted and erosion probably continued intermittently until about 2 million years ago, when glaciers began occupying Puget Sound lowland. The Tiger Mountain area has exposed sediments recording at least two glaciations. The age of the older one(s) is not known. The younger glaciation is known as the Fraser Glaciation, and its deposits in this area are called Vashon Drift. The drift was deposited between 17,000 and 12,000 years ago in the area of this state forest. The deposits are mostly sands and gravels deposited by meltwater streams, but they include tills (poorly sorted mixtures of many grain sizes commonly known as hardpan), clays, and silts deposited in lakes, and sands and gravels deposited by deltas pouring into ice-dammed lakes, such as the delta that is well exposed in the large gravel pits at the north end of Issaquah. The Vashon ice sheet in this area was thick enough to completely cover East Tiger Mountain, the tallest peak in the forest, although Rattlesnake Mountain, immediately to the east of Tiger Mountain State Forest on the eastern edge of the area in Figure 1, was glaciated only as high as about 3,500 feet.

As glaciers retreated out of the area, blocks of stagnant ice were stranded, forming kettle lakes, and former drainages were rerouted, leaving the present physiography.

Quaternary Geology

During the Quaternary Period, episodes of cold climate events affected western Washington, including the Cascades and Puget Lowlands. In these periods, the Puget lobe of the Cordilleran ice sheet moved south from British Columbia and into the Puget

Lowland, advancing into the fluvial systems into the Cascades. During the most recent Vashon Stade, the ice sheet abutted the western Cascades to an elevation over 3,500 feet in the Tiger Mountain area. As the ice sheets advanced up the Cascadia fluvial systems, they blocked the outlets, impounding large ice-marginal lakes. Locally, two large glacial lakes, Lake Snoqualmie (east of Tiger WAU) and the Cedar River valley formed by the advancement of the ice sheet towards North Bend, where it terminated. The surface elevation of Lake Snoqualmie was at 320 to 400 feet. At about 14,000 years B.P., the ice sheets retreated from the Cascades and completely evacuated the area by 13,700 years B.P. (Dragovich and others, 2007). This deglaciation event unplugged the Cascadia fluvial systems, draining the glacial dammed lakes and forming large fluvial channels, terraces and kettles. The most prominent channel in the Tiger WAU is in the northern section, now occupied by the East Fork of Issaquah Creek.

Stability Issues

As the ice sheet began to shrink and withdraw from the area, fluvial erosion cut through parts of the moraines to drain glacially dammed lakes surrounding present day North Bend. This drainage spilled primarily through the southwest, carving channels in what are now Raging River and the East Fork of Issaquah Creek. The combined rapid retreat by the ice sheet and channel formation of draining dammed lakes created an ideal situation for deep-seated landslide initiation, particularly due to steep unconsolidated material combined with steep slopes from fluvial erosion. Many of the dormant indistinct and relict landslides that were identified within Tiger WAU probably initiated during this event.

The study area is also susceptible to earthquake-induced landslides. Major seismic landslides have been documented in Lake Sammamish as well as Lake Washington (Logan and Walsh, 1995; Karlin and others, 2004). Although none of the landslides within Tiger WAU are known to be triggered by earthquakes, it is probable that some of the deep-seated landslides were triggered by seismic events within the past.

3.0 Summary of Landslide Inventory

Most of the landslides were recorded during this inventory from a review of 1958 to 2003 aerial photographs and recent field investigations (Form A-1). The information from these landslides, once inventoried and mapped, was used in the creation of the landform map (Form A-2).

Mass Wasting Feature Type	Number of Mass Wasting Features Mapped	Area (acres) of Mass Wasting Features
Shallow undifferentiated landslides	532	8.7
Debris flows	23	19.8
Debris slide/avalanche	36	8.1
Deep-seated landslides	121	4,882.0
Rock Topple	1	27.9
Total	713	4,946.3

Table 2. Summary of the type and number of LHZ Protocol-specified mass-wasting features mapped in the Tiger WAU.

Land use was determined for each landslide feature (Appendix B).This assessment found that 76% of the landslides identified were correlated to harvest related activities while 23% were correlated to road systems. The remaining 1% are predominantly old deep-seated landslides that pre-date timber harvest. These landslides may have been triggered by earthquakes, forest fires, and fluvial or glacial erosion.

In reviewing the Tiger WAU, a representative sample of 713 landslides was mapped through aerial photos, LIDAR, and fieldwork. Of these landslides, 532 were shallow landslides, 121 were deep-seated landslides, and one was a rock topple. Two hundred and thirty six of these landslides were interpreted to have delivered sediment and these were used in construction of the overall hazard ratings (Form A-4). One hundred and sixty-four of the landslides were not road related and were used in construction of the hazard rating without roads. No deep-seated landslides were included in these calculations, but their locations and statistics are presented within this report. The deep-seated features should be evaluated during field visits because of the variability of their activity levels and potential to deliver.

Figure 5: Deep-seated landslide in inner gorge of Fifteenmile Creek.

A quick review of Form A-1 will determine whether the deep-seated landslides were identified as 'definite', 'probable', or 'questionable' and their activity level. Deep-seated landslides can range in age from about 14,000 years (glacial related deep-seated landslides) to presently active.

Toes and scarps of deep-seated landslides should also be carefully evaluated even in dormant and extinct landslides in case of reactivation. Active deep-seated landslides are predominately in high gradient slopes throughout the watershed (landform 5) and along glacial terrace faces (landform 11). Many of these landslides appear to become active post-harvest and rarely from roads. Landslide movement usually produces a high amount of activity along the scarps and sometimes the toes. Roads built along these scarps appear to increase landslide activity, as observed along the road on Tiger Mountain near the radio towers (southeast of Tiger 2 Summit, located on 24,000 USGS Map). Further, harvest in recharge areas directly above these landslides may increase groundwater and initiate or reactive them. Landslide slide_id number 2390 (West Tiger Earthflow Complex) appears to be associated or activated by glacial recharge. In 1922, a forest fire burned many of the trees along the ridge of Tiger Mountain, including much of the upper areas within the glacial recharge of the West Tiger Earthflow Complex (slide_id 2390). Aerial photos in 1958 show high activity along the scarps and deformation within the body of the deep-seated landslides. As stands started to regenerate, activity diminished within the landslide. Recharge areas of glacial deep-

seated landslides are rule-identified and need to be carefully evaluated and delineated. This is perhaps most important in areas where urban growth has built on or directly down slope of deep-seated landslides. Landslide slide_id number 2390, 2381, 2382, 2383, 2384, 2301 all have houses on or down slope of these deep-seated landslides and public safety must be kept in mind in any harvest plan or road construction.

Scarps of deep-seated landslides have been observed to initiate many of the shallow landslides recorded in Tiger WAU. Scarps observed in the field usually have thin soils on bedrock outcrops, and shallow landslides can be easily triggered by water concentration, root loss or natural instability.

4.0 Landforms

The Tiger WAU has been delineated into 11 landforms that characterize areas having similar features and identified through the Landslide Hazard Zonation Project Protocol. The first landforms to be delineated were low slope areas with no evidence of mass wasting. These landforms have been split into flats (0% to 10%), low gradient hills (10% to 40%), and ridgetops and noses (0% to 10%). Four named landforms (also known as rule-identified landforms), inner gorges, bedrock hollows, meander bends and toes of deep-seated landslides were delineated by slope gradient and slope shape or convergence. The remainder of the area was then delineated by lithology, delivery potential, slope gradient and slope form. These areas include high gradient hills (40% and greater), bodies of active deep-seated landslides, scarps of active deep-seated landslides, and terrace faces.

The low hazard landforms flats, low gradient hills, and ridge tops and noses have no landslides that were viewed from aerial photos or field checking. Even if there was a landslide within these landforms, their chance of delivering is very low.

Tiger WAU contains earthflows and numerous other rotational type deep-seated landslides. Earthflow bodies behave differently than traditional rotational deep-seated landslides, mainly because the body can be as hazardous in forest practices management as a toe in typical rotational deep-seated landslides. Earthflows can be shallow (compared to rotational deep-seated landslides) and usually behave in a very fluid fashion, somewhat similar to a slow moving debris flow. The earthflow sometimes moves as a whole, fast moving failure, or may slowly creep and move in sections. To add further

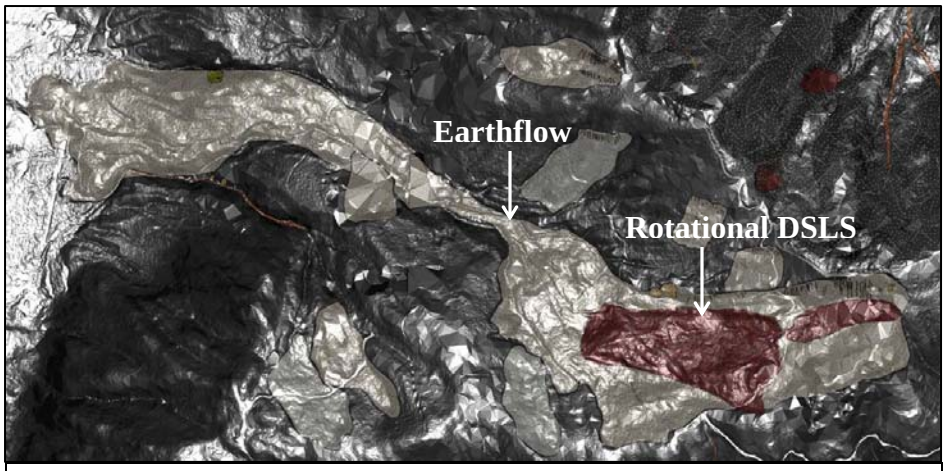

Figure 6: West Tiger Earthflow Complex on the west side of Tiger Mountain, showing the flowing body structure and rotational DSLS within the body.

complications, earthflows can have internal deformation that can result in smaller earthflows within the body and sometimes deep-seated rotational type failures (figure 6). Due to their large size, triggers to movement are difficult to determine, but casual observation suggests forest fires, earthquakes, roads and harvest are the most likely triggers. Because of the wide variety of potential movement and deformation within an earthflow, forest management can be difficult. Harvest units within earthflows sometimes can be cut without any threat of movement within the earthflow; however, at other times, harvest can trigger sudden movement in the earthflow, as observed on many smaller deep-seated landslides on the road up to Poo-Poo Point. Road construction and maintenance is also difficult to determine. Some roads can exist within an earthflow without any risk of future movement while others can trigger movement. Roads can also trap and pond water as the earthflow deforms, potentially triggering substantial movement. When evaluating timber harvest operations or road management within a deep-seated landslide body, contact with a forest practices scientist is recommended.

Inner gorges in Tiger WAU range from small mountain streams to larger incised systems in lacustrine deposits. This landform was mapped based on GIS slope models, SLPSTAB, and random field checks. Field observations showed some of the small mountain inner gorges have discontinuous 70% gradient slopes, often ranging from 67-68% to just above 70%. Larger incised inner gorges in lacustrine deposits dominate the southeastern section of Tiger. Slopes for these inner gorges can reach up to 100 feet or more and usually contain continuous 70% and greater slopes. Slopes can easily become deformed by large rotational deep-seated landslides and earthflows. Landslide scars quickly revegetates and disappear on the hillside. Field observations within this area show that most scallops within the hillside were probably landslides. Further, debris from landslides accumulate at the backs of old growth stumps and this can be one way to determine areas where sliding had occurred (see figure 7). Where bank erosion and slope steepening by fluvial systems is present, shallow undifferentiated landslides and debris avalanches are common. Because this landform contains State Highway 18, any forest management activity within this landform should be conducted under the care of a forest practices scientist.

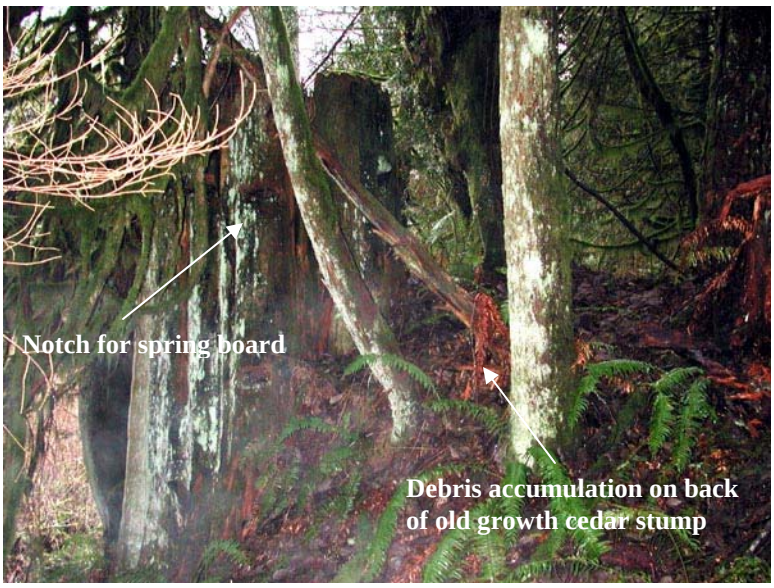

Figure 7: Accumulation of dirt on the back side of stump may help to identify areas that have failed.

Bedrock hollows are steep (>70%) spoon shaped depressions or swales typically 75 to 200 feet across. Some bedrock hollows on the upper flanks of Tiger Mountain are significantly larger than 200 feet across. Bedrock hollow evacuations can trigger debris flows that scour channels forming

inner gorges. Few landslides were viewed in aerial photos in bedrock hollows, but this partially reflects canopy coverage over most of the bedrock hollows and lack of debris flows.

Meander bends form where bank erosion and slope steepening by fluvial systems is present. Active meander bends are located on the banks of Issaquah Creek, as it flows through Squak Valley (between Squak Mountain and Tiger Mountain). Few landslides were viewed on aerial photos within this landform and field checking was limited, as much of the landform is located within the urban interface and access was difficult to obtain.

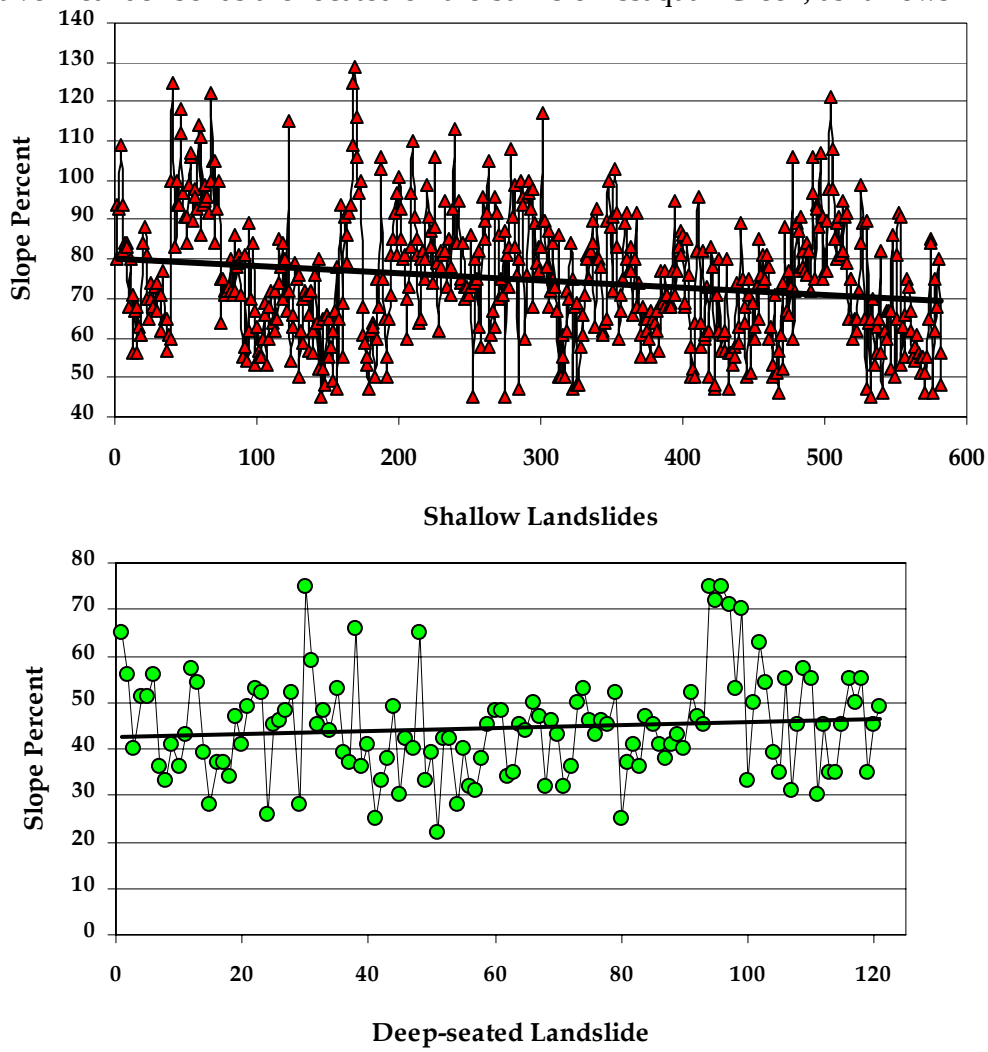

Figure 8: Failure slopes of shallow and deep-seated landslides in Issaquah WAU.

Toes of deep-seated landslides with slopes greater than 65% have been located throughout Tiger. However, only five deep-seated landslide toes were large enough to map. Four of these massive deep-seated landslides (slide_id: 2709, 2381, 2382, 2383) flow into the Squak Valley with their toes located within the Issaquah Creek flood plains. Currently, no active fluvial modification of identified rule deep-seated landslides toes was observed. The last of the five landslide toes identified is located near Tiger Mountain Summit (pass) on Highway 18 (slide_id 2316). This toe is located very close to Highway 18 and poses a threat of delivery of landslides to Highway 18. Smaller very active deep-seated landslides have initiated off this toe and have stopped close to Highway 18. Monitoring should be conducted on this

toe as well as special care when conducting any timber harvest operations or road management within landslide 2316. Harvest within the groundwater recharge area could trigger movement further movement and increase activity of this toe.

Active Scarps form by the movement of deep-seated landslides or earthflows, leaving a steep scarp between the hillslopes and bodies of the deep-seated landslides and earthflows. Once formed, these scarps will initiate landslides or erode until an angle of stability is reached. Further movement of the landslide can create persistent instability along the scarps. Active scarps identified in Tiger WAU contain 244-recorded landslides, by far the most unstable landform identified. Roads and harvest in scarps have been associated with an increase in landslide activity.

Two landforms, high gradient hills and terrace faces, have been identified as a potential threat to public safety. High gradient slopes consist of glacial material and soils, which can be very unstable, to bedrock outcrops, which can be very stable. High gradient hills have been delineated from slopes of 40% gradient and greater. This is to reflect the hazard of deep-seated landslides and earthflows, which on average fail on slopes between 40% to 50% within the watershed. These deep-seated landslides appear to be associated with areas of water concentration and can result in small (1/3 of an acre) to large (100's of acres) earthflows. This landform has 135-recorded landslides, however only 24 of these landslides have delivered to a water source, this landform is considered low hazard by calculation with shallow landslides. High gradient slopes can be located in areas where infrastructure and houses are located, either within or directly down slope. Caution must be taken when planning timber harvest and road construction to determine the hazard down slope and potential hazards to infrastructure and houses. This landform also contains numerous deep-seated landslides, including scarps, bodies, and toes. Scarps and toes of deep-seated landslides identified as active have been parsed out of this landform, however, some scarps and toes of deep seated landslides may still be included within this landform. A field evaluation is recommended for areas where deep-seated landslides have been identified.

Terrace faces are the results of glacial material that has been down cut by fluvial systems. These faces sit between the flat top and the valley bottom and are prone to shallow failures at slopes above 70%. Deep-seated landslides are frequent within the landform, probably from stratigraphy that alternates aquifers and aquicludes. Terrace faces in Tiger WAU have been identified as a hazard to public safety, because of their location in urban centers and along Interstate 90. Numerous deep-seated landslides have initiated on these slopes, although most have been identified as not active. Slope modification, especially in the I-90 corridor, has produced numerous shallow landslides, many of which are located just east of this watershed.

Groundwater recharge areas of glacial deep-seated landslides were not mapped in the LHZ project; however, a quick map of deep-seated landslides that have a potential impact on public safety has been produced (A-2 Hazard Map).

The following section presents the results of this investigation (4.1 Landform Description), which has been split into low- and high-hazard-potential landforms. High-hazard landforms will require careful review and field investigation.

4.1 A-2 Landform Descriptions
Low Hazard Descriptions (Landforms 3,4, and 14)

LANDFORM NUMBER: **3**
LANDFORM NAME: **Flats**
OVERALL HAZARD: **Low**
Description:

Landform "flats" consists of level slopes (0-10%) of various geomorphic origins. Historical and modern harvest and road construction on this landform have produced no known instability or landslides. The LFR and LAR are zero. Confidence is high.

LANDFORM NUMBER: **4**
LANDFORM NAME: **Low Gradient Hills**
OVERALL HAZARD: **Low**
Description:

Landform "low gradient hills" consists of slopes ranging from 10%-40% of various geomorphic origins. Historical and modern harvest and road construction on this landform have produced no known instability or landslides. The LFR and LAR are zero. Confidence is high.

LANDFORM NUMBER: **14**
LANDFORM NAME: **Ridge Tops, Ridge Noses**
OVERALL HAZARD: **Low**
Description:

Landform "ridge tops and ridge noses" consists of level slopes (0-10%) located on the top of hills and mountains. These hills and mountains usually have greater slopes (at least 10-40%, but usually greater), which taper off near the top of near a nose of the ridge. Historical and modern harvest and road construction on this landform have produced no known instability or landslides. The LFR and LAR are zero. Confidence is high.

Moderate to High Hazard Descriptions (Landforms 1, 2, 5- 8, 11, 12)

1 - Inner Gorges

Description of Mass Wasting Units: Inner gorges are steep walled (70% and greater) gullies that formed by a combination of stream action and mass wasting. Inner gorges in Tiger WAU range from small mountain streams to larger incised systems in lacustrine deposits. The inner gorges within lacustrine deposits, which are located primarily along Highway 18, are highly unstable and have a very high frequency of landslides.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent
Material: Glacial material, especially lacustrine and minor amounts of bedrock
Elevation: 96 to 2,860 feet
Total Area: 2,054 acres

Mass Wasting Process: These landforms are naturally unstable and are prone to shallow landslides, soil slopes, debris flows, and debris avalanches. Smaller rotational deep-seated landslides and earthflows have also been activated within inner gorges, most likely from bank erosion and slope steepening by fluvial systems. Deep-seated landslides are almost exclusively located within the lacustrine deposits along Highway 18.

Forest Practice Sensitivity: Road and harvest have had significant impacts in landslide failures. Landslides post-harvest seem to fail because of increased run-off and progress as root strength diminishes. Future harvest in inner gorges would likely cause further slope failures due to loss of root strength and increased water run-off, similar to the way they failed after the last harvest. Road construction on these landforms could increase run-off and exacerbate the unstable nature of inner gorges. This is most clearly apparent along Highway 18, which has suffered from numerous failures along the sidecast and within the road prism of the highway. Extreme storm events and prolonged rain events have initiated numerous shallow landslides, debris flows, and deep-seated landslides regardless of forest practice activity.

Mass Wasting Potential: **Very High regardless of forest practice activity** based on 146 landslides totaling 24.2 acres of failed material. Inner gorges have a Landslide Frequency Rating of 1,921 with roads or 1,316 without roads.

Delivery Potential/Criteria: **Very High**. Inner gorges are part of a drainage network that drain into Issaquah Creek and further into Lake Sammamish. Landslides produced within this landform fail large amounts of fine sediments, potentially causing water quality issues. During the winter storms of 2006-2007, small deep-seated landslides were observed to be delivering high amounts of sediment into streams, primarily within 15-Mile Creek and along Highway 18. Inner gorges have a Landslide Area Rate of Delivery of 318 with roads or 241 without roads.

Hazard Potential Rating: **High for roads and harvest** based on LHZ Protocol and Standard Forest Practices Rules.

Confidence: High, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with field foresters, and field observation. There was limited field verification of landslides within this landform.

2 - Bedrock Hollows

Description of Mass Wasting Units: Bedrock hollows are steep (>70%) spoon shaped depressions or swales usually 75 to 200 feet across, however, can reach much larger size in Tiger WAU. Bedrock hollow evacuations can trigger debris flows that scour channels forming inner gorges. Most bedrock hollows are part of the drainage network on hill slopes and are adjacent to or contain streams.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent
Material: Glacial material with minor amounts of bedrock
Elevation: 639 to 2,896 feet
Total Area: 64 acres

Mass Wasting Process: Bedrock hollows are naturally unstable and are prone to repeated shallow landslides, many of which can initiate debris flows. However, in Tiger WAU, only shallow undifferentiated landslides were observed in bedrock hollows.

Forest Practice Sensitivity: Roads and harvest have had a significant impact in landslide failures. Landslides post-harvest seem to fail because of increased run-off and progress as root strength diminishes. Future harvest in bedrock hollows will likely cause further slope failures due to loss of root strength and increased water run-off, similar to the way they failed after the last harvest. Road construction on these landforms could increase run-off and exacerbate the unstable nature of bedrock hollows.

Mass Wasting Potential: **Very High regardless of forest practice activity** based on 8 landslides totaling .2 acres of failed material. This landform, by calculation, is very high. This landform has a Landslide Frequency Rate of 3,373 with roads or 2,951 without roads.

Delivery Potential/Criteria: **High**. Delivery criteria are based on historical occurrence observed on aerial photographs and proximity of the unstable feature to streams and confirmed during field investigation. Most bedrock hollows are part of the drainage network and inner gorges are adjacent to or contain streams. This landform has a Landslide Area Rate of Delivery of 84 with roads or 42 without roads.

Hazard Potential Rating: **High for roads and harvest** based on LHZ Protocol and Standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observation. There was limited field verification of landslides within this landform.

5 – High Gradient Hills

Description of Mass Wasting Unit: High gradient slopes consist of glacial material and soils, which can be very unstable, to bedrock outcrops, which can be very stable. High gradient hills have been delineated from slopes of 40% gradient and greater. This landform has 136-recorded landslides. Half of the recorded landslides are deep-seated landslides. Only 24 of the shallow landslides have delivered to a water source, thus this landform is considered low hazard by calculation with shallow landslides.

Slopes: Greater or Equal to 40%
Slope Shape: Predominantly planar and convergent
Material: Glacial material to minor amounts of bedrock outcrops
Elevation: 61 to 3,000 feet
Total Area: 7,938 acres

Mass Wasting Process: This landform is prone to debris flows, shallow rapid landslides, and debris avalanches. Shallow rapid landslides sometimes turn into debris flows that scour channels. This landform also contains many small and large deep-seated landslides, many of which are active. Old scarps of dormant or relict deep-seated landslides have initiated shallow landslides. Canopy coverage masked many of shallow landslides on aerial photos.

Forest Practice Sensitivity: Timber harvest is the primary trigger for shallow landslides. Post-harvest landslides seem to occur because of increased run-off from loss of canopy and loss of root strength. Slope failures peak 5 to 15 years after harvest and gradually decrease as re-planted trees age (15 to 30 years) and gain root strength. Road sidecast and culvert failures were more common in the past but are now occurring less frequently probably due to increased awareness of best management practices. Earthflows have been observed to be concentrated in areas with springs and PIP's, or areas where water concentrates. Shallow landslides usually fail over 70% slopes.

Mass Wasting Potential: Low for timber harvest and road management
Based on 24 shallow landslides within a total failed area of 5.3 acres, this landform has a low rate of failure with shallow landslides. This landform has a Landslide Frequency Rate of 82 with roads and 61 without roads.

Delivery Potential/Criteria: **Low** The majority of shallow landslides that have been recorded have not failed into water systems. Failures that have delivered to water systems within this landform deliver to tributary streams or into the main channel of Issaquah Creek. This landform has a Landslide Area Rate of Delivery of 18 with roads and 8 without roads.

Hazard Potential Rating: Low to Moderate for roads management and timber harvest as described in the LHZ Protocol and standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observations. There was limited field verification of landslides within this landform.

6 – Body of Deep-Seated Landslide (Active)

Description of Mass Wasting Unit: Earthflow bodies behave differently than traditional rotational failing deep-seated landslides, mainly because the body can be as hazardous in forest practices management as a toe in traditional rotational deep-seated landslides. Earthflows usually behave in a very fluid type fashion, somewhat similar to a debris flow.
Earthflow bodies of deep-seated landslides have been identified as a hazardous landform, because of the unpredictable nature of movement and sensitivity to water.

Slopes: Greater or equal to 30%
Slope Shape: Predominantly planar and convergent
Material: Thin soils and glacial material
Elevation: 302 to 2,734 feet
Total Area: 379 acres

Mass Wasting Process: Earthflow bodies behave in a fluid manner and can initiate smaller deep-seated landslides, both rotational and earthflows as well as shallow undifferentiated landslides and debris flows. As the earthflow moves and deforms, streams within the body can quickly erode into banks, initiating shallow undifferentiated landslides. These shallow landslides can dam the creeks or initiate a debris flow by the energy created by its movement down slope.

Forest Practice Sensitivity: Harvest in the groundwater recharge areas directly above and on the earthflows may increase groundwater and thus initiate or reactivate them. Glacial recharge areas of earthflows and deep-seated landslides are rule-identified and need to be carefully evaluated and delineated. Proper water management from roads on earthflows is critical. Roads have been observed to trap water within the earthflow, potentially increasing movement of the body. This landform is sensitive to concentrated water and potentially to harvest in the recharge area. The addition of water due to the losses of canopy interception and evapotranspiration may adversely affect the stability of this landform.

Mass Wasting Potential: <u>High for road construction and timber harvest.</u> Because harvest and road management failures are associated with active deep-seated landslides, bodies of deep-seated landslides are at a higher risk for future failure and potential for reactivation of slide activity. This landform, by calculation, is moderate. This landform has a <u>Landslide Frequency Rate</u> of 356 with roads and 214 without roads.

Delivery Potential/Criteria: Moderate. Shallow landslides failing in the bodies of earthflows sometimes fail into streams or tributaries of Issaquah Creek; however, because of the deformed nature of earthflows, many of these creeks can go subsurface one year, only to reappear the next. By calculation, the delivery potential is moderate, with a <u>Landslide Area Rate of Delivery</u> of 142 with roads and 111 without roads.

Hazard Potential Rating: <u>Moderate for roads and harvest</u> as described in the LHZ Protocol and standard Forest Practices Rules.

Confidence: <u>High</u>, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observations. Careful field review will be necessary to delineate all the areas containing increased risk of failures within these features, because field investigation has located a number of features masked by canopy.

7 – Toes of Deep-Seated Landslides

Description of Mass Wasting Unit: Although 117 deep-seated landslides were located within this watershed, only 5 had toes with slopes greater than 65% and were large enough to map. All identified deep-seated landslides toes should be field checked to determine if they are rule-identified 65%

Slopes: Greater than or equal to 65%
Slope Shape: Convergent and Planar
Material: Thin soils and glacial material
Elevation: 90 to 1,412 feet
Total Area: 44 acres

Mass Wasting Process: Toes of deep-seated landslides with slopes above 65% are naturally unstable; however, canopy coverage and limited field access revealed only 9 shallow landslides emanating from toes of deep-seated landslides and one active deep-seated landslide. Toes of deep-seated landslides have a history of initiating shallow rapid landslides, soil slips, debris flows, and debris avalanches.

Forest Practice Sensitivity: Harvest has had significant impacts in landslide failures. Landslides post-harvest seem to fail because of increased run-off and progress as root strength diminishes. Slope failures peak between clearcutting (0 to 5 years) and young standing timber (5 to 15 years) and sharply decrease as root strength redevelops. Future harvest on toes of deep-seated landslides would likely cause further slope failures due to loss of root strength and increased water run-off. Road construction on these landforms could increase run-off and exacerbate the unstable nature of the toes of deep-seated landslides.

Mass Wasting Potential: **Very High for road construction and timber harvest.** Deep-seated landslide toes over 65% are rule-identified in the LHZ Protocol and are high hazard. Based on 6 delivering shallow landslides, this landform, by calculation, is very high. This landform has a Landslide Frequency Rate 3,689 with roads and 3,074 without roads.

Delivery Potential/Criteria: **Low to moderate.** Shallow landslides have been observed to fail in tributaries of Issaquah Creek. However, by calculation, delivery potential is low to moderate. The landform has a calculated Landslide Area Rate of Delivery of 105 with roads or 68 without roads.

Hazard Potential Rating: **Very High to High for roads and harvest** as described in the LHZ Protocol and Standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observation. There was limited field verification of landslides within this landform.

8 – Scarps of Deep-Seated Landslides

Description of Mass Wasting Unit: Active Scarps form by the movement of deep-seated landslides or earthflows, leaving a steep scarp between the hillslopes and bodies of the deep-seated landslides and earthflows. Once formed, these scarps will initiate landslides or erode until an angle of stability is reached. Further movement of the landslide can create persistent instability along the scarps.

Slopes: Greater than or equal to 65%
Slope Shape: Convergent and Planar
Material: Thin soils and glacial material
Elevation: 190 to 2,931 feet
Total Area: 341 acres

Mass Wasting Process: Scarps have initiated numerous shallow undifferentiated landslide and a few debris avalanches. Additionally, some of these shallow undifferentiated landslides were most likely soil slips or soil topples. Smaller deep-seated landslides could also form along the steepened gradient of the active scarps.

Forest Practice Sensitivity: Timber growth on scarps is sparse due to the thin soils and frequent shallow landslides. However, smaller trees, shrubs and plants offer rooting strength that helps stabilize the slope. If scarps are harvested, landslides will most likely increase because of increased run-off and intensify as root strength diminishes. Slope failures in harvest areas usually peak between clearcutting (0 to 5 years) and young standing timber (5 to 15 years) and sharply decrease as root strength redevelops. Road construction on these landforms could increase run-off and exacerbate the unstable nature of the scarps. Aerial photos and field verification have identified roads as a trigger to at least 18 shallow landslides.

Mass Wasting Potential: **Very High for road construction and timber harvest.** Because road management failures and potential harvest failures are associated with active scarps deep-seated landslides, they are at a higher risk for future failure and potential for reactivation of slide activity. This landform, by calculation, is very high. This landform has a Landslide Frequency Rate of 3,689 with roads and 3,074 without roads.

Delivery Potential/Criteria: Moderate. Shallow landslides initiating from scarps can reach side channels on deep-seated landslides, which are streams and tributaries to Issaquah Creek. However, most landslides failing on scarps do not deliver to a stream and fail onto the bodies of deep-seated landslides. This landform, by calculation, is moderate. This landform has a Landslide Area Rate of Delivery of 142 with roads and 119 without roads.

Hazard Potential Rating: **High for roads and harvest** as described in the LHZ Protocol and Standard Forest Practices Rules.

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observation. There was limited field verification of landslides within this landform.

11 – Terrace Faces

Description of Mass Wasting Unit: Terrace faces are the results of glacial material that has been eroded by fluvial systems. These faces sit between the flat top and the valley bottoms are prone to shallow failures at slopes above 70%. Deep-seated landslides are frequent within the landform, probably from stratigraphy that alternates aquifers and aquicludes.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent and Planar
Material: Glacial till and outwash
Elevation: 48 to 1,272 feet
Total Area: 1,314 acres

Mass Wasting Process: Shallow undifferentiated landslides are common within this landform. Deep-seated landslides dot the landform, however, most of these deep-seated landslides appear to activate periodically, possibly by seismic events, and are currently not active. The toes of these landslides on casual field checking found that many of the toes are not greater than 65% and are probably not active.

Forest Practice Sensitivity: Road construction and harvest have both had impacts on slope stability. Road issues such as slope modifications have produced small shallow landslides, mostly along I-90 east of Issaquah. In-unit failures suggest that timber harvest and loss of root strength is a trigger for shallow landslides failures. Future harvest in these areas may cause slope failures due to loss of root strength and increased water run-off similar to the way they failed after the last harvest. However, many of these shallow landslides did not deliver, which reflects a low mass wasting potential.

Mass Wasting Potential: Low for timber harvest and road construction. Based on nine shallow landslides having a total failure area of 0.04 acres, this landform is not very active for shallow landslides. However, deep-seated landslides within this landform should be evaluated on an individual basis. This landform has a Landslide Frequency Rate of 185 with roads or 82 without roads. When calculating with both deep-seated landslides and shallow landslides, the Landslide Frequency Rate is 206 with roads and 103 without roads.

Delivery Potential/Criteria: Low to moderate. Slope failures that occur within this landform usually do not deliver to streams. This landform has a Landslide Area Rate of Delivery of 1 with or without roads. When calculating with both deep-seated landslides and shallow landslides, the Landslide Area Rate of Delivery is 15 with roads and 15 without roads.

Hazard Potential Rating: Low for Roads and for harvest as described in the LHZ Protocol and standard Forest Practices Rules. However, potentially higher in areas with deep-seated landslides

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, personal communication with DNR field foresters, and field observations. There was limited field verification of landslides within this landform.

12 – Meander Bends

Description of Mass Wasting Unit: Meander bends form where bank erosion and slope steepening by fluvial systems is present. Meander bends have been identified where slopes have steepened to 70% or greater slopes. They are located on the banks of Issaquah Creek, primarily as it flows through Squak Valley. Most of the meander bends are on average about 50 feet high. Meander bends are rule-identified by the Forest Practices Manual as a high hazard landform.

Slopes: Greater than or equal to 70%
Slope Shape: Convergent and Planar
Material: Glacial till and outwash
Elevation: 30 to 547 feet
Total Area: 46 acres

Mass Wasting Process: Aerial photo analysis failed to located any shallow landslides on meander bends and lack of field access prevented further investigation; however, shallow landslides, soil slips and debris avalanches have been observed in many other watersheds.

Forest Practice Sensitivity: Road construction and harvest both have impacts on slope stability, as observed in other watersheds. Harvest and road construction should be evaluated near or in meander bends, particularly in Squak Valley, where urban sprawl has surrounded most of the meander bends.

Mass Wasting Potential: High for timber harvest and road construction. Although no landslides were recorded on this feature, meander bends are identified as a high hazard landform. Even though this landform, by calculation, is low, it has a high potential of mass wasting. This landform has a Landslide Frequency Rate of 0 with or without roads.

Delivery Potential/Criteria: High. Slope failures that occur within this landform would fail directly into Issaquah Creek. Even though this landform, by calculation, is low, its potential delivery is high. This landform has a Landslide Area Rate of Delivery of 0 with or without roads.

Hazard Potential Rating: High for Roads and for harvest as described in the LHZ Protocol and standard Forest Practices Rules. However, potentially higher in areas with deep-seated landslides

Confidence: Moderate, based on the number of landslides located in this landform, excellent photo quality and coverage, and field observations. There was limited field verification of landslides within this landform.

5.0 Hazard Ratings

Pursuant to the LHZ Protocol, hazard ratings for mass-wasting landforms were determined by the following: 1) rule-identified status (WAC 222-16-050), 2) the Landslide Frequency Rate (LFR) and Landslide Area Rate for Delivery (LAR), 3) the professional judgment of the analyst, or 4) an interpretation of deep-seated landslide hazard. The Landslide Area Rate for Delivery is the area of delivering landslides normalized for the period of study and the area of each landform. These values are then multiplied by one million for easier interpretation. Limited application suggests that Landslide Area Rates for Delivery less than 76 are low hazard, rates of 76 to 150 are moderate hazard, rates of 151 to 799 are high hazard, and rates greater than 799 are very high hazard (Lingley, 2004). Note that higher Landslide Area Rates for Delivery can be achieved by reducing the area of the Landform. While this may appear to be 'data gerrymandering', it helps limit the area of high-hazard landforms to those areas that are actually demonstrated to have high hazard. The Landslide Frequency Rate is calculated similarly, however the number of delivering landslides is used instead of the area of delivering landslides. As of the writing of this report, the qualitative rating system below is used (Table 3). Form A-4 (Appendix D) summarizes all landform hazard ratings.

Qualitative Ratings	Landslide Frequency Rate	Landslide Area Rate for Delivery
Low	< 100	<76
Moderate	100 to 199	76 to 150
High	200 to 999	151 to 799
Very High	>999	>799

Table 3: Qualitative rating system for the LFR and LAR.

6.0 Note on Confidence in Work Products

The confidence in this mass wasting assessment is High. This rating is based on the Landslide Hazard Zonation Project design to provide a watershed overview of slope stability in a timely manner with minimal field verification. Therefore, fieldwork and the number of aerial photograph sets examined are held to reasonable minimums. Omissions will be present due to the limited field verification of individual features, particularly in forested areas with heavy canopy.

It is critical for the reader to understand that while these decisions are sufficient to characterize aspects of the slope failure as functions of forest management, this assessment would be entirely insufficient and misleading if it is used as a stand alone document for protecting private and public resources or for land use planning. Keep in mind that this is only a reconnaissance study, and undoubtedly, some landslides have been omitted and some benign features may be incorrectly mapped as landslides herein.

In addition, there are several sources of systematic error that reduce the confidence in the work products of this analysis, those being omission, misinterpretation, and limits to accuracy and precision. Omission occurs when mass wasting features are not identified on aerial photographs or in the field due to canopy cover, gaps in the aerial photo record, quality of aerial photos, or interpreter errors. Misinterpretation occurs when a mass-wasting feature is identified but incorrectly classified or data are transposed, and where unrecognized software/file instability occurs. Accuracy involves the degree to which the physical properties of a mass-wasting feature are correctly measured, and precision describes how variability within an assessment can be controlled when making multiple measurements over varying time and spatial scales.

This mass wasting assessment was primarily conducted with aerial photographs, and as a result, there is a high likelihood that errors of omission occurred, primarily in areas covered by mature forest canopies, steep north facing slopes always in shadow at any given time, and those areas covered with extensive glacial deposits (Brardinoni and others, 2002). The scarcity of mass wasting features identified under mature canopy and steep north slope aspect shadow conditions is not necessarily an indication of the relative stability of slopes with mature vegetation regimes or steep north face aspects.

Because many deep-seated landslide features are quite large, remain heavily vegetated during movement, and may not have obvious scars visible through the vegetation canopy, misinterpretation is more likely. A recent detailed study in Cowlitz County, Washington, suggests that up to 25 percent of inferred deep-seated landslides identified from aerial photograph analysis are misinterpreted (Wegmann, 2003). Confidence in work products related to classification of deep-seated landslide processes in this watershed is high due to visibility and completeness of photo coverage.

Another important source of potential error in this assessment is in the accuracy and precision of measurements of mass wasting features. Because less than 50% of landslides were actually visited in the field, it is not possible to report the degree to which location and measurement error in the GIS environment compares to on-the-ground field measurements. Similarly, measurements of slope angle from digital elevation models typically underrepresent the true hill slope angle. Given these sources of error, the confidence in the precise location and accuracy of measurements of individual landslides is considered moderate.

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Slide ID	LSI Process	Certainty	Date	Size	Initial Elevation	Photo Number	Landform	Landform 2	Slope Shape	Gradient	Delivery	Landuse	Activity
2100	1	D	2007	2	1499		7	0	3	58	N	5	
2101	1	D	2007	3	1491		7	0	3	52	N	5	
2102	1	D	2007	3	1492		7	0	3	50	N	5	
2103	1	D	2007	2	1514		1	0	3	64	N	5	
2104	3	D	2007	5	1062		1	8	3	65	Y	3	
2105	1	D	2007	5	1059		1	8	3	82	Y	3	
2106	3	D	2007	5	1064		1	8	3	85	Y	3	
2107	4	D	1995	5	291	NW-95 1-57-235	8	0	2	52	Y	3	AR
2108	1	P	1995	3	662	NW-95 1-57-235	7	0	3	96	N	3	
2109	4	P	1995	5	876	NW-95 1-57-238	8	0	3	47	Y	2	DI
2110	1	P	1995	2	910	NW-95 1-57-238	7	0	3	58	N	3	
2111	1	P	1995	3	906	NW-95 1-57-238	7	0	3	64	N	3	
2112	2	P	1995	5	901	NW-95 1-57-238	1	0	3	67	Y	3	
2113	1	P	1995	3	925	NW-95 1-57-238	1	0	3	82	Y	3	
2114	3	D	2007	5	1215		1	0	3	54	Y	2	
2115	1	P	1995	3	448	NW-95 1-57-238	7	0	2	60	N	1	
2116	1	P	1995	5	760	NW-95 8-60-188	1	0	2	61	Y	3	
2117	1	P	1995	5	839	NW-95 8-60-188	1	0	2	73	Y	3	
2118	1	P	1995	5	664	NW-95 8-60-188	1	0	3	62	Y	3	
2119	1	D	1995	4	1549	NW-95 8-60-188	1	0	3	50	Y	5	
2120	3	P	1995	5	1491	NW-95 8-60-188	7	0	3	84	N	2	
2121	3	P	1995	5	1500	NW-95 8-60-188	1	0	3	46	Y	2	
2122	1	D	1995	4	988	NW-95 8-60-191	1	8	2	83	Y	5	
2123	1	D	1995	3	984	NW-95 8-60-191	1	8	2	78	Y	5	
2124	1	D	1995	3	982	NW-95 8-60-191	1	8	2	47	Y	5	
2125	1	D	1995	3	1185	NW-95 8-60-191	1	8	3	48	N	5	
2126	4	D	2003	5	1244		8	0	3	43	Y	2	AR
2127	4	D	2003	5	1266		8	0	3	46	Y	2	AR
2128	1	D	1995	4	1183	NW-95 8-60-191	1	8	3	71	P	5	
2129	1	D	1995	3	1219	NW-95 8-60-191	1	8	3	62	P	5	
2130	1	P	1995	2	1193	NW-95 8-60-191	1	0	3	80	Y	1	
2131	3	D	2007	5	1225		1	0	3	58	Y	2	
2132	3	D	2007	5	1225		1	0	3	61	Y	2	
2133	3	D	2007	5	1233		1	0	3	56	Y	2	
2134	1	D	1995	2	1239	NW-95 8-60-191	1	0	3	57	P	5	
2135	1	D	1995	2	1232	NW-95 8-60-191	1	0	3	61	P	5	
2136	1	D	1995	3	1233	NW-95 8-60-191	1	0	3	62	P	5	
2137	1	D	1995	2	1226	NW-95 8-60-191	1	0	3	57	P	5	
2138	1	D	1995	3	1244	NW-95 8-60-191	1	0	3	80	P	5	
2139	1	D	1995	2	1157	NW-95 8-60-191	1	0	3	47	Y	5	
2140	1	D	1995	2	1221	NW-95 8-60-191	1	0	3	56	P	5	
2141	1	D	1995	2	1226	NW-95 8-60-191	1	0	3	56	P	5	
2142	1	D	1995	2	1220	NW-95 8-60-191	1	0	3	53	Y	5	
2143	3	P	1995	4	1390	NW-95 8-60-191	7	0	2	75	N	5	
2144	1	P	1995	1	1396	NW-95 8-60-191	7	0	2	58	N	5	
2145	3	D	2007	5	1241		1	0	3	55	Y	2	

2146	3	D	2007	4	1170		1	0	3	51	Y	5	
2147	3	D	2007	4	1194		1	0	3	55	Y	5	
2148	1	P	1995	1	1403	NW-95 8-60-191	7	0	2	55	N	5	
2149	3	Q	1995	4	1524	NW-95 8-60-191	7	0	3	62	N	5	
2150	1	D	2007	4	2546		1	8	2	74	Y	5	
2151	3	D	1995	5	2569	NW-95 8-60-194	1	8	3	68	Y	5	
2152	4	D	2003	5	1132		8	0	3	45	Y	5	AR
2153	1	D	1995	4	2617	NW-95 8-60-194	1	8	1	63	P	5	
2154	1	P	1995	4	2818	NW-95 8-60-194	8	0	2	59	N	2	
2155	1	P	1995	3	2711	NW-95 8-60-194	1	8	3	89	N	2	
2156	1	P	1995	4	1196	NW-95 17-58-69	7	0	3	75	N	5	
2157	1	D	1995	5	1900	NW-95 40-61-122	8	0	3	68	N	5	
2158	1	D	1995	5	1948	NW-95 40-61-122	8	0	3	64	N	5	
2159	3	D	2007	5	1147		1	0	3	51	Y	5	
2160	4	D	2003	5	1174		8	0	3	52	Y	3	AR
2161	1	D	1995	4	1908	NW-95 40-61-122	8	0	3	50	N	5	
2162	4	P	1995	5	1573	NW-95 40-61-122	8	0	2	45	Y	5	AR
2163	1	P	1995	4	1548	NW-95 40-61-122	8	0	2	71	Y	2	
2164	1	P	1995	5	1338	NW-95 40-61-122	8	0	2	75	P	5	
2165	3	D	1995	5	2289	NW-95 40-59-138	1	0	3	80	N	5	
2166	4	P	2003	5	1348		8	0	2	25	Y	2	DD
2167	1	D	1995	3	2305	NW-95 40-59-138	7	0	3	51	N	5	
2168	1	D	1995	2	2344	NW-95 40-59-138	7	0	3	69	N	5	
2169	1	D	1995	2	2360	NW-95 40-59-138	7	0	3	63	N	5	
2170	4	P	2003	5	1127		8	0	2	37	Y	5	DD
2171	4	D	2003	5	2943		1	8	1	41	Y	3	R
2172	1	D	1995	2	2350	NW-95 40-59-138	7	0	2	60	N	5	
2173	1	D	1995	2	2346	NW-95 40-59-138	7	0	2	73	N	5	
2174	1	D	1995	3	2381	NW-95 40-59-138	7	0	1	65	N	5	
2175	1	D	1995	3	2287	NW-95 40-59-138	7	0	2	85	N	2	
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2178	4	P	2003	5	811		8	0	2	36	Y	2	DI
2179	4	P	2003	5	848		8	0	2	47	Y	2	DI
2180	4	P	2003	5	3003		8	0	1	45	Y	3	DD
2181	4	P	2003	5	1371		8	0	3	41	Y	2	AR
2182	1	D	1995	3	2289	NW-95 40-59-138	7	0	3	81	N	2	
2183	1	D	1995	3	2140	NW-95 40-59-138	8	0	2	75	N	2	
2184	1	D	1995	3	2146	NW-95 40-59-138	8	0	2	81	N	2	
2185	1	D	1995	3	2156	NW-95 40-59-138	8	0	2	78	N	2	
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2187	4	P	2003	5	1364		8	0	3	38	Y	2	AR
2188	4	P	2003	5	1459		8	0	3	41	Y	2	AR
2189	4	D	2007	5	1088		8	0	2	43	Y	3	AR
2190	4	D	2007	5	1103		8	0	2	40	Y	5	AR
2191	1	D	2007	2	1148		1	0	2	69	N	5	
2192	1	D	2007	3	1167		1	0	2	85	N	5	
2193	3	D	2007	5	1816		1	0	2	46	Y	5	
2194	3	D	2007	3	2298		8	0	2	55	N	5	
2195	1	D	2007	5	2580		2	8	2	76	N	5	
2196	2	P	1995	5	1447	NW-95 40-61-122	1	0	3	67	Y	5	

2197	2	P	1995	5	1727	NW-95	40-61-122	1	0	1	52	Y	1	
2198	3	Q	1995	5	2084	NW-95	40-61-122	1	0	2	56	Y	2	
2199	1	P	1995	2	1944	NW-95	40-61-122	7	0	3	63	N	2	
2200	1	P	1995	3	1157	NW-95	40-61-122	1	0	3	50	P	5	
2201	1	P	1995	3	1151	NW-95	40-61-122	1	0	3	53	N	5	
2202	1	P	1995	4	1227	NW-95	40-61-122	1	0	3	71	N	5	
2203	1	D	1995	4	1049	NW-95	40-61-122	1	8	3	51	Y	3	
2204	1	P	1995	4	1059	NW-95	40-61-122	1	8	3	46	Y	3	
2205	1	P	1995	2	1274	NW-95	40-61-122	1	8	3	57	N	1	
2206	1	D	1995	3	2812	NW-95	40-59-138	8	0	2	106	N	5	
2207	1	D	1995	3	2587	NW-95	40-59-138	8	0	2	75	N	5	
2208	3	P	1995	5	2863	NW-95	40-59-138	8	0	2	48	N	5	
2209	4	Q	1995	5	2546	NW-95	40-59-138	8	0	3	72	Y	5	AR
2210	1	D	1995	4	2533	NW-95	40-59-140	1	8	3	94	N	2	
2211	1	D	1995	3	2538	NW-95	40-59-140	8	8	3	93	N	2	
2212	1	D	1995	3	2498	NW-95	40-59-140	8	0	3	88	N	2	
2213	1	D	1995	3	2446	NW-95	40-59-140	8	0	3	107	N	2	
2214	1	D	1995	3	2325	NW-95	40-59-140	8	0	3	75	N	2	
2215	4	P	1995	5	2168	NW-95	40-59-140	8	0	3	75	Y	3	AR
2216	1	D	1995	3	1761	NW-95	40-59-140	8	0	3	91	N	2	
2217	1	D	1995	3	1721	NW-95	40-59-140	8	0	3	77	P	2	
2218	1	D	1995	2	1717	NW-95	40-59-140	8	0	3	89	P	2	
2219	1	D	1995	3	2324	NW-95	40-59-140	8	0	2	95	N	5	
2220	1	D	1995	3	2296	NW-95	40-59-140	8	0	2	82	N	5	
2221	1	D	1995	3	2477	NW-95	40-59-140	8	0	2	91	N	5	
2222	1	D	1995	3	2479	NW-95	40-59-140	8	0	2	92	N	5	
2223	1	D	1995	2	2473	NW-95	40-59-140	8	0	2	90	N	5	
2224	1	D	1995	2	2480	NW-95	40-59-140	8	0	2	77	N	5	
2225	1	D	1995	3	2275	NW-95	40-59-140	8	0	2	98	N	5	
2226	1	D	1995	3	2423	NW-95	40-59-140	8	0	2	121	N	5	
2227	1	P	1995	2	1583	NW-95	40-59-136	7	0	3	61	N	5	
2228	1	P	1995	3	1609	NW-95	40-59-136	7	0	3	74	N	5	
2229	1	D	1995	3	2342	NW-95	40-59-140	8	0	2	98	N	5	
2230	1	D	1995	2	2372	NW-95	40-59-140	8	0	2	108	N	5	
2231	1	D	1995	2	2370	NW-95	40-59-140	8	0	2	85	N	5	
2232	1	D	1995	3	2369	NW-95	40-59-140	8	0	3	80	N	5	
2233	1	P	1995	2	1596	NW-95	40-59-136	7	0	3	52	N	5	
2234	1	P	1995	3	1642	NW-95	40-59-136	7	0	3	88	N	5	
2235	1	D	1995	3	1199	NW-95	40-59-136	1	0	2	67	Y	3	
2236	1	D	1995	3	1157	NW-95	40-59-136	1	0	2	77	Y	3	
2237	1	D	1995	3	1085	NW-95	40-59-136	1	0	2	66	Y	3	
2238	1	D	1995	4	2326	NW-95	40-59-140	8	0	3	89	N	5	
2239	1	D	1995	4	2402	NW-95	40-59-140	8	0	3	91	N	5	
2240	4	P	1995	5	1129	NW-95	40-59-140	8	0	3	71	Y	3	DD
2241	4	P	1995	5	1201	NW-95	40-59-140	8	0	2	53	Y	3	DD
2242	1	P	1995	4	847	NW-95	40-59-142	8	0	2	81	P	3	
2243	4	Q	1995	5	1207	NW-95	40-59-142	8	0	4	70	Y	3	DD
2244	4	P	2003	5	1994			8	0	3	33	Y	3	DD
2245	1	D	1995	4	1125	NW-95	40-59-136	1	0	3	73	Y	3	
2246	1	D	1995	3	1183	NW-95	40-59-136	1	0	2	106	Y	3	
2247	4	P	2003	5	1544			8	0	2	50	Y	3	DD

2248	1	D	1995	4	982	NW-95 40-59-136	1	0	3	60	Y	3	
2249	1	D	1995	3	1084	NW-95 40-59-136	1	0	2	72	Y	3	
2250	1	P	1995	3	1038	NW-95 40-59-136	1	0	2	77	Y	5	
2251	1	P	1995	4	1059	NW-95 40-59-136	1	0	2	87	Y	5	
2252	4	P	2003	5	1030		1	0	3	49	Y	3	DD
2253	4	P	2003	5	930		8	0	2	63	Y	3	DD
2254	4	P	2003	5	738		8	0	2	54	Y	3	DD
2255	4	P	2003	5	1195		8	0	2	39	Y	3	DD
2256	1	D	2007	4	1526		7	0	3	50	N	5	
2257	1	D	1995	5	1209	NW-95 40-59-136	1	0	2	91	Y	2	
2258	4	P	1995	5	1427	NW-95 40-59-136	8	0	2	75	Y	3	DD
2259	1	D	1995	2	2145	NW-95 40-59-138	8	0	2	82	N	2	
2260	1	D	1995	2	2112	NW-95 40-59-138	8	0	2	78	N	2	
2261	1	D	1995	2	2099	NW-95 40-59-138	8	0	2	77	N	2	
2262	1	D	1995	4	2713	NW-95 40-59-138	8	0	2	84	N	5	
2263	1	D	1995	4	2808	NW-95 40-59-138	8	0	2	76	N	5	
2264	1	D	1995	3	2769	NW-95 40-59-138	8	0	2	82	N	5	
2265	1	D	1995	3	2722	NW-95 40-59-138	8	0	2	72	P	5	
2266	1	D	1995	3	2838	NW-95 40-59-138	8	0	2	97	N	5	
2267	4	D	2003	5	2131		8	0	2	26	Y	3	DD
2268	4	D	1958	5	2195	WSF-S-8 4-9	8	0	2	45	Y	3	AR
2269	4	D	2003	5	1787		8	0	2	46	Y	2	AR
2270	4	D	2003	5	1425		8	0	3	48	Y	2	AR
2271	4	D	2003	5	1634		8	0	3	52	Y	2	AR
2272	4	P	2003	5	2502		8	0	2	28	Y	2	AR
2273	4	P	2003	5	1681		8	0	4	34	Y	2	AR
2274	4	P	2003	5	1421		8	0	3	35	Y	2	AR
2275	3	D	1958	4	1017	WSF-S-8 4-9	1	0	2	92	Y	3	
2276	1	P	1958	3	950	WSF-S-8 4-9	1	0	2	47	Y	3	
2277	3	D	1958	5	1203	WSF-S-8 4-9	1	0	2	91	Y	3	
2278	3	D	1958	5	1129	WSF-S-8 4-9	1	0	2	53	Y	3	
2279	1	D	1958	4	1187	WSF-S-8 4-9	1	0	2	80	P	2	
2280	1	D	1958	5	1377	WSF-S-8 4-9	1	0	2	100	P	2	
2281	3	D	1958	5	1233	WSF-S-8 4-9	1	0	2	63	Y	3	
2282	3	D	1958	5	1336	WSF-S-8 4-9	1	0	2	55	Y	3	
2283	1	D	1958	3	1182	WSF-S-8 4-9	1	8	2	96	Y	3	
2284	1	D	1958	4	1225	WSF-S-8 4-9	1	8	2	94	Y	3	
2285	1	D	1958	4	1275	WSF-S-8 4-9	1	0	2	60	Y	3	
2286	4	P	2003	5	1499		8	8	2	75	Y	3	AR
2287	1	D	1958	3	1492	WSF-S-8 4-9	7	0	2	76	Y	2	
2288	1	D	1958	3	1511	WSF-S-8 4-9	1	0	2	97	Y	2	
2289	1	D	1958	2	1521	WSF-S-8 4-9	1	0	2	100	Y	2	
2290	1	D	1958	2	1517	WSF-S-8 4-9	7	0	2	93	Y	2	
2291	1	D	1958	2	1543	WSF-S-8 4-9	1	0	2	98	Y	2	
2292	1	D	1958	2	1623	WSF-S-8 4-9	7	0	3	68	N	2	
2293	1	D	1958	3	1408	WSF-S-8 4-9	1	8	3	89	Y	3	
2294	1	D	1958	2	1384	WSF-S-8 4-9	1	8	3	79	Y	3	
2295	1	D	1958	3	2135	WSF-S-8 4-9	8	0	2	77	N	3	
2296	1	D	1958	3	2151	WSF-S-8 4-9	8	0	2	83	N	3	
2297	1	D	1958	3	2159	WSF-S-8 4-9	8	0	2	83	N	3	
2298	1	D	1958	2	2185	WSF-S-8 4-9	8	0	2	117	N	3	

2299	1	D	1958	3	2160	WSF-S-8 4-9	8	0	2	90	N	3	
2300	1	D	1958	3	2141	WSF-S-8 4-9	8	0	2	90	N	3	
2301	4	P	2003	5	790		8	0	3	38	Y	3	DI
2302	1	D	1958	3	2072	WSF-S-8 4-9	1	8	2	78	Y	3	
2303	4	D	2003	5	269		8	0	1	49	Y	3	DD
2304	4	D	2003	5	564		8	0	1	30	Y	3	DI
2305	4	D	2003	5	450		8	0	1	42	Y	3	DI
2306	4	P	2003	5	1402		8	0	2	40	Y	3	DD
2307	4	P	2003	5	296		8	0	1	65	Y	3	DI
2308	4	P	2003	5	348		8	0	2	33	Y	9	R
2309	4	P	2003	5	883		8	0	3	39	Y	3	R
2310	4	D	2003	5	265		8	0	3	22	Y	3	DD
2311	4	D	2003	5	920		8	0	2	42	Y	3	DD
2312	4	D	2003	5	427		8	0	4	42	Y	5	DI
2313	4	P	2003	5	339		8	0	3	28	Y	3	R
2314	4	D	2003	5	2295		8	0	2	40	Y	5	AR
2315	1	D	1958	2	2068	WSF-S-8 4-9	8	0	2	68	N	3	
2316	4	D	2003	5	2501		8	0	2	32	Y	3	DD
2317	1	D	1958	3	2094	WSF-S-8 4-9	8	0	2	87	N	3	
2318	1	D	1958	3	2089	WSF-S-8 4-9	8	0	2	72	P	3	
2319	1	D	1958	1	1980	WSF-S-8 4-9	8	0	2	75	P	3	
2320	1	D	1958	2	1979	WSF-S-8 4-9	8	0	2	84	P	3	
2321	4	D	2003	5	1272		8	0	2	31	Y	3	DD
2322	4	D	2003	5	1429		8	0	2	38	Y	3	DD
2323	1	D	1958	2	1982	WSF-S-8 4-9	8	0	2	73	P	3	
2324	1	D	1958	1	1974	WSF-S-8 4-9	8	0	2	67	P	3	
2325	4	P	2003	5	1335		8	0	2	45	Y	3	AR
2326	4	P	2003	5	1183		8	0	3	48	Y	3	AR
2327	1	P	1958	1	2135	WSF-S-8 4-8	7	0	2	50	N	1	
2328	1	P	1958	2	2161	WSF-S-8 4-8	7	0	1	86	N	1	
2329	2	Q	1958	5	2346	WSF-S-8 4-9	1	0	1	56	Y	5	
2330	1	D	1958	3	2493	WSF-S-8 4-9	8	0	2	50	Y	1	
2331	1	D	1958	3	2494	WSF-S-8 4-9	8	0	3	55	Y	1	
2332	1	D	1958	2	2469	WSF-S-8 4-9	8	0	1	61	Y	1	
2333	1	D	1958	2	2473	WSF-S-8 4-9	8	0	1	50	Y	1	
2334	4	D	1958	5	2788	WSF-S-8 4-9	8	0	2	48	Y	1	AR
2335	1	P	1958	3	2870	WSF-S-8 4-9	8	0	2	72	N	1	
2336	4	D	1958	5	2228	WSF-S-8 4-9	8	0	1	59	Y	3	AR
2337	1	P	1958	3	2841	WSF-S-8 4-9	8	0	2	62	N	1	
2338	1	D	1958	3	2781	WSF-S-8 4-9	8	0	2	70	N	1	
2339	1	D	1958	2	2815	WSF-S-8 4-9	8	0	2	84	N	1	
2340	1	D	1958	2	2805	WSF-S-8 4-9	8	0	2	75	N	1	
2341	1	P	1958	3	1989	WSF-S-8 4-8	1	0	3	47	P	1	
2342	1	P	1958	2	1926	WSF-S-8 4-8	1	0	3	68	P	5	
2343	1	P	1958	3	1921	WSF-S-8 4-8	1	0	3	69	P	5	
2344	1	P	1958	3	1871	WSF-S-8 4-8	8	0	3	48	Y	1	
2345	1	P	1958	3	1851	WSF-S-8 4-8	8	0	3	48	Y	1	
2346	1	P	1958	2	1901	WSF-S-8 4-8	8	0	2	68	P	1	
2347	1	P	1958	3	2010	WSF-S-8 4-8	7	0	4	58	N	5	
2348	4	D	2003	5	2158		8	0	2	45	Y	3	DD
2349	1	P	1958	4	2806	WSF-S-8 4-8	1	0	1	66	Y	1	

2350	2	P	1958	5	2785	WSF-S-8 4-8	1	0	1	46	Y	1	
2351	1	P	1958	3	2551	WSF-S-8 4-8	1	0	1	61	Y	1	
2352	2	P	1958	5	2537	WSF-S-8 4-8	1	0	1	62	Y	1	
2353	2	P	1958	5	2240	WSF-S-8 4-8	7	0	2	60	Y	5	
2354	1	D	1958	2	2787	WSF-S-8 4-9	8	0	2	71	N	1	
2355	1	D	1958	2	2801	WSF-S-8 4-9	8	0	2	81	N	1	
2356	1	D	1958	2	2775	WSF-S-8 4-9	8	0	2	80	N	1	
2357	1	D	1958	2	2771	WSF-S-8 4-9	8	0	2	75	N	1	
2358	4	P	2003	5	2013		8	0	3	48	Y	3	R
2359	1	D	1958	3	2579	WSF-S-8 4-9	8	0	2	82	N	1	
2360	1	D	1958	2	2543	WSF-S-8 4-9	8	0	2	90	N	1	
2361	1	D	1958	3	2571	WSF-S-8 4-9	8	0	2	84	N	1	
2362	1	D	1958	3	2561	WSF-S-8 4-9	8	0	2	63	N	1	
2363	1	D	1958	3	2594	WSF-S-8 4-9	8	0	2	80	N	1	
2364	1	D	1958	2	2599	WSF-S-8 4-9	8	0	2	93	N	1	
2365	1	D	1958	3	2622	WSF-S-8 4-9	8	0	2	80	N	1	
2366	1	D	1958	2	2642	WSF-S-8 4-9	8	0	2	78	N	1	
2367	1	D	1958	3	2675	WSF-S-8 4-9	8	0	2	62	N	1	
2368	1	D	1958	2	2685	WSF-S-8 4-9	8	0	2	61	N	1	
2369	1	D	1958	2	2410	WSF-S-8 4-9	8	0	2	64	N	1	
2370	1	D	1958	2	2396	WSF-S-8 4-9	8	0	2	65	N	1	
2371	1	D	1958	1	2287	WSF-S-8 4-9	8	0	2	90	N	1	
2372	1	D	1958	2	2277	WSF-S-8 4-9	8	0	2	100	N	1	
2373	1	D	1958	3	2258	WSF-S-8 4-9	8	0	2	88	N	1	
2374	1	D	1958	3	2223	WSF-S-8 4-9	8	0	2	72	N	1	
2375	1	D	1958	2	2200	WSF-S-8 4-9	8	0	2	91	N	1	
2376	4	D	2003	5	1883		8	0	3	44	Y	3	DI
2377	4	P	1958	5	2136	WSF-S-8 4-9	8	0	4	53	Y	3	DD
2378	4	P	1958	5	2165	WSF-S-8 4-9	8	0	3	39	Y	3	DI
2379	4	P	2003	5	2265		8	0	2	37	Y	3	DI
2380	4	D	2003	5	2518		8	0	2	66	Y	3	AR
2381	4	D	2003	5	960		8	0	2	36	Y	3	DD
2382	4	D	2003	5	1076		8	0	2	41	Y	3	DI
2383	4	D	2003	5	500		8	0	2	25	Y	9	DD
2384	4	P	2003	5	1050		8	0	3	33	Y	3	DI
2385	1	D	1958	2	2185	WSF-S-8 4-9	8	0	2	103	N	1	
2386	1	D	1958	2	2182	WSF-S-8 4-9	8	0	2	92	N	1	
2387	1	D	1958	3	2147	WSF-S-8 4-9	8	0	2	83	N	1	
2388	1	D	1958	5	2159	WSF-S-8 4-9	8	0	2	60	N	1	
2389	1	D	1958	5	2086	WSF-S-8 4-9	8	0	3	71	N	1	
2390	1	D	1958	4	2035	WSF-S-8 4-9	8	0	3	67	Y	1	
2391	1	D	1958	2	2616	WSF-S-8 4-11	8	0	2	75	N	1	
2392	1	D	1958	2	2610	WSF-S-8 4-11	8	0	2	89	N	1	
2393	1	D	1958	3	2595	WSF-S-8 4-11	8	0	2	92	N	1	
2394	1	D	1958	2	2576	WSF-S-8 4-11	8	0	2	80	N	1	
2395	1	D	1958	2	2573	WSF-S-8 4-11	8	0	2	77	N	1	
2396	1	D	1958	2	2554	WSF-S-8 4-11	8	0	2	77	N	1	
2397	1	D	1958	2	2550	WSF-S-8 4-11	8	0	2	83	N	1	
2398	1	D	1958	2	2532	WSF-S-8 4-11	8	0	2	66	N	1	
2399	1	D	1958	2	2518	WSF-S-8 4-11	8	0	2	80	N	1	
2400	1	D	1958	2	2511	WSF-S-8 4-11	8	0	2	92	N	1	

2401	4	P	1958	5	2629	WSF-S-8	4-11	8	0	2	45	Y	1	AR
2402	1	D	1958	2	2455	WSF-S-8	4-11	8	0	3	68	N	1	
2403	1	D	1958	2	2456	WSF-S-8	4-11	8	0	3	74	N	1	
2404	1	D	1958	2	2438	WSF-S-8	4-11	8	0	3	55	N	1	
2405	1	D	1958	2	2461	WSF-S-8	4-11	8	0	3	61	N	1	
2406	1	D	1958	2	2459	WSF-S-8	4-11	8	0	3	68	N	1	
2407	1	D	1958	2	2439	WSF-S-8	4-11	8	0	3	65	N	1	
2408	1	D	1958	2	2407	WSF-S-8	4-11	8	0	3	62	N	1	
2409	1	D	1958	2	2421	WSF-S-8	4-11	8	0	3	65	N	1	
2410	1	D	1958	2	2410	WSF-S-8	4-11	8	0	3	60	N	1	
2411	1	D	1958	2	2390	WSF-S-8	4-11	8	0	3	55	N	1	
2412	1	D	1958	2	2350	WSF-S-8	4-11	8	0	3	67	N	1	
2413	1	D	1958	2	2350	WSF-S-8	4-11	8	0	3	65	N	1	
2414	4	P	1958	5	2493	WSF-S-8	4-11	8	0	3	44	Y	1	AR
2415	1	P	1958	2	2231	WSF-S-8	4-11	7	0	3	64	N	1	
2416	1	P	1958	2	2208	WSF-S-8	4-11	7	0	3	62	N	1	
2417	1	P	1958	2	2184	WSF-S-8	4-11	7	0	3	67	N	1	
2418	1	P	1958	2	2168	WSF-S-8	4-11	7	0	3	57	N	1	
2419	1	P	1958	3	2331	WSF-S-8	4-11	1	8	1	69	N	1	
2420	1	P	1958	3	2323	WSF-S-8	4-11	1	8	1	77	N	1	
2421	1	P	1958	3	2296	WSF-S-8	4-11	1	8	1	69	N	1	
2422	1	P	1958	4	2316	WSF-S-8	4-11	1	8	3	68	N	1	
2423	1	P	1958	3	2302	WSF-S-8	4-11	8	0	2	77	N	1	
2424	1	P	1958	3	2263	WSF-S-8	4-11	8	0	2	71	N	1	
2425	1	P	1958	3	2262	WSF-S-8	4-11	8	0	2	68	N	1	
2426	1	P	1958	3	2246	WSF-S-8	4-11	8	0	2	69	N	1	
2427	1	P	1958	3	2232	WSF-S-8	4-11	8	0	2	68	N	1	
2428	1	P	1958	3	2224	WSF-S-8	4-11	8	0	2	77	N	1	
2429	1	P	1958	3	2212	WSF-S-8	4-11	8	0	2	95	N	1	
2430	1	P	1958	3	2183	WSF-S-8	4-11	1	8	2	71	N	1	
2431	1	P	1958	3	2172	WSF-S-8	4-11	1	8	2	77	N	1	
2432	1	P	1958	3	2166	WSF-S-8	4-11	1	8	2	83	N	1	
2433	1	P	1958	3	2149	WSF-S-8	4-11	1	8	2	81	N	1	
2434	1	D	1958	2	2531	WSF-S-8	4-11	1	8	2	87	N	1	
2435	1	D	1958	3	2530	WSF-S-8	4-11	1	8	3	86	N	1	
2436	1	D	1958	3	2532	WSF-S-8	4-11	1	8	3	80	N	1	
2437	1	D	1958	2	2522	WSF-S-8	4-11	1	8	3	94	N	1	
2438	1	D	1958	3	2507	WSF-S-8	4-11	8	0	3	93	N	1	
2439	1	D	1958	3	2428	WSF-S-8	4-11	8	0	3	109	N	1	
2440	1	D	1958	3	2419	WSF-S-8	4-11	8	0	3	94	N	1	
2441	1	D	1958	3	2373	WSF-S-8	4-11	8	0	3	82	N	1	
2442	1	D	1958	3	2496	WSF-S-8	4-11	8	0	3	84	N	1	
2443	1	D	1958	2	2321	WSF-S-8	4-11	8	0	3	84	N	1	
2444	1	D	1958	3	2373	WSF-S-8	4-11	8	0	3	83	N	1	
2445	1	D	1958	2	2380	WSF-S-8	4-11	8	0	3	68	N	1	
2446	1	D	1958	1	2335	WSF-S-8	4-11	1	8	3	80	N	1	
2447	1	D	1958	1	2308	WSF-S-8	4-11	1	8	3	56	N	1	
2448	1	D	1958	1	2296	WSF-S-8	4-11	1	8	3	71	N	1	
2449	1	D	1958	1	2298	WSF-S-8	4-11	1	8	3	67	N	1	
2450	1	D	1958	1	2314	WSF-S-8	4-11	1	8	3	56	N	1	
2451	1	D	1958	1	2324	WSF-S-8	4-11	1	8	3	68	N	1	

2452	1	D	1958	3	2324	WSF-S-8	4-11	1	8	3	63	N	1
2453	1	D	1958	1	2303	WSF-S-8	4-11	8	0	3	61	N	1
2454	1	D	1958	1	2290	WSF-S-8	4-11	8	0	3	61	N	1
2455	1	D	1958	3	2247	WSF-S-8	4-11	1	8	3	84	N	1
2456	1	D	1958	3	2246	WSF-S-8	4-11	1	8	3	88	N	1
2457	1	D	1958	3	2244	WSF-S-8	4-11	1	8	3	81	N	1
2458	1	D	1958	4	2247	WSF-S-8	4-11	1	8	3	70	Y	1
2459	1	D	1958	4	2249	WSF-S-8	4-11	8	0	3	65	Y	1
2460	1	D	1958	3	2131	WSF-S-8	4-11	1	8	3	74	N	1
2461	1	D	1958	2	2149	WSF-S-8	4-11	1	8	3	70	N	1
2462	1	D	1958	1	2147	WSF-S-8	4-11	1	8	3	68	N	1
2463	1	D	1958	1	2159	WSF-S-8	4-11	1	8	3	73	N	1
2464	1	D	1958	2	2160	WSF-S-8	4-11	1	8	3	67	N	1
2465	1	D	1958	1	2153	WSF-S-8	4-11	1	8	3	74	N	1
2466	1	D	1958	1	2135	WSF-S-8	4-11	1	8	2	71	N	1
2467	1	D	1958	1	2140	WSF-S-8	4-11	8	0	3	71	N	1
2468	1	D	1958	1	2148	WSF-S-8	4-11	8	0	3	62	N	1
2469	1	D	1958	1	2131	WSF-S-8	4-11	8	0	3	77	N	1
2470	1	D	1958	1	2146	WSF-S-8	4-11	8	0	3	65	N	1
2471	1	D	1958	1	2153	WSF-S-8	4-11	8	0	3	65	N	1
2472	1	D	1958	1	2155	WSF-S-8	4-11	8	0	3	57	N	1
2473	1	D	1958	2	2151	WSF-S-8	4-11	8	0	3	61	N	1
2474	1	D	1958	1	2156	WSF-S-8	4-11	8	0	3	60	N	1
2475	1	D	1958	2	2166	WSF-S-8	4-11	8	0	3	100	N	1
2476	1	D	1958	2	2104	WSF-S-8	4-11	8	0	3	125	N	1
2477	1	D	1958	2	2081	WSF-S-8	4-11	8	8	3	83	N	1
2478	1	D	1958	2	2132	WSF-S-8	4-11	8	0	3	94	N	1
2479	1	D	1958	2	2144	WSF-S-8	4-11	8	0	3	100	N	1
2480	1	D	1958	2	2127	WSF-S-8	4-11	8	0	3	94	N	1
2481	1	D	1958	2	2102	WSF-S-8	4-11	8	0	3	118	N	1
2482	1	D	1958	2	2085	WSF-S-8	4-11	8	0	3	112	N	1
2483	1	D	1958	2	2029	WSF-S-8	4-11	8	0	3	97	N	1
2484	1	D	1958	2	1952	WSF-S-8	4-11	8	0	3	91	N	1
2485	1	D	1958	3	1944	WSF-S-8	4-11	8	0	3	91	Y	5
2486	1	D	1958	2	1946	WSF-S-8	4-11	8	0	3	84	Y	5
2487	1	D	1958	2	1904	WSF-S-8	4-11	8	0	3	99	Y	5
2488	1	D	1958	2	1938	WSF-S-8	4-11	8	0	3	106	Y	5
2489	1	D	1958	2	1944	WSF-S-8	4-11	8	0	3	107	Y	5
2490	1	D	1958	2	1929	WSF-S-8	4-11	8	0	3	90	Y	5
2491	1	D	1958	2	1925	WSF-S-8	4-11	8	0	3	98	Y	5
2492	1	D	1958	2	1912	WSF-S-8	4-11	8	0	3	96	N	5
2493	1	D	1958	2	1926	WSF-S-8	4-11	8	0	3	93	N	5
2494	1	D	1958	2	1921	WSF-S-8	4-11	8	0	3	114	N	5
2495	1	D	1958	3	1941	WSF-S-8	4-11	8	0	3	86	N	5
2496	1	D	1958	2	1935	WSF-S-8	4-11	8	0	3	111	N	5
2497	1	D	1958	3	1851	WSF-S-8	4-11	8	0	3	94	N	1
2498	1	D	1958	3	1861	WSF-S-8	4-11	8	0	3	95	N	1
2499	1	D	1958	2	1848	WSF-S-8	4-11	8	0	3	99	N	1
2500	1	D	1958	3	1831	WSF-S-8	4-11	8	0	3	96	N	1
2501	1	D	1958	3	1833	WSF-S-8	4-11	8	0	3	92	N	1
2502	1	D	1958	3	1805	WSF-S-8	4-11	8	0	3	100	N	1

2503	1	D	1958	2	1801	WSF-S-8	4-11	8	0	3	122	N	1
2504	1	D	1958	2	1798	WSF-S-8	4-11	8	0	3	105	N	1
2505	1	D	1958	2	1746	WSF-S-8	4-11	8	0	3	84	N	1
2506	1	D	1958	3	1775	WSF-S-8	4-11	8	0	3	105	N	1
2507	1	D	1958	2	1726	WSF-S-8	4-11	8	0	3	93	N	1
2508	1	D	1958	3	1751	WSF-S-8	4-11	8	0	3	100	N	1
2509	1	P	1958	2	2354	WSF-S-8	4-11	8	0	3	75	P	1
2510	1	P	1958	3	2363	WSF-S-8	4-11	8	0	3	64	P	1
2511	1	P	1958	3	2461	WSF-S-8	4-11	8	0	3	75	P	1
2512	1	P	1958	2	2394	WSF-S-8	4-11	8	0	3	71	P	1
2513	1	D	1958	3	2426	WSF-S-8	4-11	2	8	2	72	P	1
2514	1	D	1958	3	2417	WSF-S-8	4-11	2	8	2	72	P	1
2515	1	D	1958	2	2407	WSF-S-8	4-11	2	8	2	73	P	1
2516	1	D	1958	2	2267	WSF-S-8	4-11	1	8	2	80	P	1
2517	1	D	1958	2	2247	WSF-S-8	4-11	1	8	2	72	P	1
2518	1	D	1958	2	2286	WSF-S-8	4-11	1	8	2	71	P	1
2519	1	D	1958	2	2279	WSF-S-8	4-11	1	8	2	86	P	1
2520	1	D	1958	3	2345	WSF-S-8	4-11	1	8	2	72	P	1
2521	1	D	1958	3	2257	WSF-S-8	4-11	1	8	2	78	P	1
2522	1	D	1958	2	2310	WSF-S-8	4-11	1	8	2	81	P	1
2523	1	D	1958	3	2337	WSF-S-8	4-11	1	8	2	79	P	1
2524	1	D	1958	2	2364	WSF-S-8	4-11	2	8	2	71	P	1
2525	1	D	1958	2	2348	WSF-S-8	4-11	2	8	2	55	P	1
2526	1	D	1958	2	2344	WSF-S-8	4-11	2	8	2	58	P	1
2527	1	D	1958	3	2394	WSF-S-8	4-11	2	8	2	81	P	1
2528	1	D	1958	1	2453	WSF-S-8	4-11	1	8	2	54	N	1
2529	1	D	1958	2	2454	WSF-S-8	4-11	1	8	2	62	N	1
2530	1	D	1958	1	2444	WSF-S-8	4-11	1	8	2	89	N	1
2531	1	D	1958	1	2450	WSF-S-8	4-11	1	8	2	70	N	1
2532	1	D	1958	1	2455	WSF-S-8	4-11	1	8	2	84	N	1
2533	1	D	1958	1	2450	WSF-S-8	4-11	1	8	2	67	N	1
2534	1	D	1958	1	2456	WSF-S-8	4-11	1	8	2	53	N	1
2535	1	D	1958	1	2441	WSF-S-8	4-11	1	8	2	63	N	1
2536	1	D	1958	1	2408	WSF-S-8	4-11	1	8	2	57	N	1
2537	1	D	1958	1	2412	WSF-S-8	4-11	1	8	2	55	N	1
2538	1	D	1958	1	2409	WSF-S-8	4-11	1	8	2	55	N	1
2539	1	D	1958	2	2473	WSF-S-8	4-11	2	8	2	60	N	1
2540	1	D	1958	1	2493	WSF-S-8	4-11	2	8	2	69	N	1
2541	1	D	1958	2	2491	WSF-S-8	4-11	2	8	2	66	N	1
2542	1	D	1958	1	2484	WSF-S-8	4-11	2	8	2	53	N	1
2543	1	D	1958	2	2479	WSF-S-8	4-11	2	8	2	68	N	1
2544	1	D	1958	3	2483	WSF-S-8	4-11	8	0	2	60	N	1
2545	1	D	1958	3	2432	WSF-S-8	4-11	8	0	2	72	N	1
2546	1	D	1958	1	2483	WSF-S-8	4-11	8	0	2	64	N	1
2547	1	D	1958	1	2481	WSF-S-8	4-11	8	0	2	62	N	1
2548	1	D	1958	1	2481	WSF-S-8	4-11	8	0	2	72	N	1
2549	1	D	1958	2	2485	WSF-S-8	4-11	8	0	2	65	N	1
2550	1	D	1958	1	2460	WSF-S-8	4-11	8	0	2	74	N	1
2551	1	D	1958	2	2456	WSF-S-8	4-11	8	0	2	85	N	1
2552	1	D	1958	1	2457	WSF-S-8	4-11	8	0	2	78	N	1
2553	1	D	1958	3	2450	WSF-S-8	4-11	8	0	2	84	N	1

2554	1	D	1958	2	2450	WSF-S-8 4-11	8	0	2	70	N	1	
2555	1	D	1958	2	2461	WSF-S-8 4-11	8	0	2	80	N	1	
2556	1	D	1958	2	2459	WSF-S-8 4-11	8	0	2	67	N	1	
2557	1	D	1958	3	2315	WSF-S-8 4-11	8	0	3	115	N	1	
2558	3	P	1958	5	2508	WSF-S-8 4-11	1	8	2	67	Y	2	
2559	2	P	1958	5	2422	WSF-S-8 4-11	1	8	2	72	Y	2	
2560	1	P	1958	5	1895	WSF-S-8 4-11	1	8	1	72	Y	2	
2561	4	D	1958	5	1428	WSF-S-8 4-12	8	0	2	65	Y	3	DD
2562	2	P	1958	5	1261	WSF-S-8 4-12	1	8	1	84	Y	3	
2563	1	D	1958	3	2155	WSF-S-8 5-10	1	8	2	54	P	1	
2564	1	D	1958	3	2151	WSF-S-8 5-10	1	8	2	66	P	1	
2565	1	D	1958	1	2059	WSF-S-8 5-10	8	0	2	63	N	1	
2566	1	D	1958	1	2060	WSF-S-8 5-10	8	0	2	79	N	1	
2567	1	D	1958	1	2071	WSF-S-8 5-10	8	0	2	75	N	1	
2568	1	D	1958	1	2073	WSF-S-8 5-10	8	0	2	76	N	1	
2569	1	D	1958	1	2073	WSF-S-8 5-10	8	0	2	50	N	1	
2570	1	D	1958	1	2070	WSF-S-8 5-10	8	0	2	62	N	1	
2571	1	D	1958	1	2073	WSF-S-8 5-10	8	0	2	59	N	1	
2572	1	D	1958	1	1928	WSF-S-8 5-10	1	0	3	70	Y	5	
2573	1	D	1958	1	1924	WSF-S-8 5-10	7	0	3	72	Y	5	
2574	1	D	1958	1	1922	WSF-S-8 5-10	7	0	3	71	Y	5	
2575	1	P	1958	2	1888	WSF-S-8 5-10	1	0	3	66	N	5	
2576	1	P	1958	2	1885	WSF-S-8 5-10	1	0	3	57	N	5	
2577	1	P	1958	2	1878	WSF-S-8 5-10	1	0	3	72	N	5	
2578	1	P	1958	1	1874	WSF-S-8 5-10	1	0	3	56	N	5	
2579	1	D	1958	4	2171	WSF-S-8 7-4	8	0	1	62	P	5	
2580	1	D	1958	4	2450	WSF-S-8 7-4	8	0	2	67	P	2	
2581	1	D	1958	4	2436	WSF-S-8 7-4	8	0	2	78	P	2	
2582	1	D	1958	4	1720	WSF-S-8 7-4	8	0	2	47	P	5	
2583	2	P	1958	5	1691	WSF-S-8 7-4	8	0	1	65	Y	5	
2584	4	D	2003	5	2492		8	0	2	51	Y	3	AR
2585	4	P	2003	5	2386		8	0	3	51	Y	3	DI
2586	1	P	1958	2	1972	WSF-S-8 5-10	1	0	3	62	Y	1	
2587	1	P	1958	2	2193	WSF-S-8 5-10	7	0	2	76	P	1	
2588	4	P	2003	5	2370		8	0	2	56	Y	3	AR
2589	4	P	2003	5	2010		8	0	2	36	Y	3	DD
2590	4	P	2003	5	2020		8	0	2	33	Y	3	DI
2591	4	P	2003	5	2355		8	0	2	41	Y	3	DI
2592	4	P	2003	5	1872		8	0	2	36	Y	3	DI
2593	4	P	2003	5	446		8	0	2	43	Y	3	DI
2594	1	P	1978	3	1400	NW-78 69B-58	7	0	3	65	N	2	
2595	1	D	1978	3	1666	NW-78 69B-58	7	0	3	94	N	2	
2596	1	D	1978	3	1580	NW-78 69B-58	1	0	2	55	Y	3	
2597	1	P	1958	2	2166	WSF-S-8 5-10	7	0	2	64	P	1	
2598	4	P	1958	5	2999	WSF-S-8 5-10	8	0	3	56	Y	3	DD
2599	2	P	1958	5	2848	WSF-S-8 5-10	8	0	1	99	Y	5	
2600	2	D	1978	5	1554	NW-78 69B-58	1	0	1	47	Y	3	
2601	2	P	1978	5	536	NW-78 69B-58	1	0	1	90	Y	3	
2602	3	P	1978	5	769	NW-78 71B-60	1	8	2	86	Y	2	
2603	1	D	1978	4	749	NW-78 71B-60	1	0	1	69	Y	3	
2604	1	D	1978	4	822	NW-78 71B-60	1	0	1	91	Y	3	

2605	1	D	1978	3	831	NW-78 71B-60	1	0	1	79	Y	3	
2606	2	P	1978	5	1198	NW-78 71B-60	1	0	1	64	Y	3	
2607	1	D	1978	2	2464	NW-78 71B-60	8	0	2	86	N	1	
2608	1	D	1978	2	2467	NW-78 71B-60	8	0	2	92	N	1	
2609	1	D	1978	2	2473	NW-78 71B-60	8	0	2	94	N	1	
2610	1	D	1978	3	2420	NW-78 71B-60	8	0	2	109	N	1	
2611	1	D	1978	2	2404	NW-78 71B-60	8	0	2	125	N	1	
2612	1	D	1978	3	2402	NW-78 71B-60	8	0	2	129	N	1	
2613	1	D	1978	3	2405	NW-78 71B-60	8	0	2	116	N	1	
2614	1	D	1978	3	2392	NW-78 71B-60	8	0	2	106	N	1	
2615	1	D	1978	2	2370	NW-78 71B-60	8	0	2	97	N	1	
2616	1	D	1978	3	2350	NW-78 71B-60	8	0	2	100	N	1	
2617	1	D	1978	3	366	NW-78 71B-63	4	0	3	68	N	5	
2618	2	P	1958	5	2887	WSF-S-8 5-10	8	0	1	89	Y	5	
2619	4	P	1958	5	2915	WSF-S-8 5-10	8	0	3	40	Y	3	DD
2620	1	D	1958	3	1866	WSF-S-8 5-12	1	0	1	52	Y	2	
2621	1	D	1978	2	347	NW-78 71B-63	4	0	3	61	N	5	
2622	1	D	1978	2	340	NW-78 71B-63	4	0	3	59	N	5	
2623	1	D	1978	2	397	NW-78 71B-63	4	0	3	53	P	5	
2624	1	D	1978	3	393	NW-78 71B-63	4	0	3	55	N	5	
2625	1	D	1978	2	403	NW-78 71B-63	4	0	3	47	N	5	
2626	1	D	1978	3	446	NW-78 71B-63	4	0	3	62	N	5	
2627	1	D	1978	3	1404	NW-78 72B-56	1	0	3	64	N	5	
2628	1	D	1978	2	1558	NW-78 72B-56	7	0	3	63	Y	5	
2629	1	D	1978	3	1562	NW-78 72B-56	7	0	2	50	P	5	
2630	1	D	1978	2	1572	NW-78 72B-56	7	0	3	60	N	5	
2631	1	D	1978	2	1588	NW-78 72B-56	7	0	3	75	N	5	
2632	2	P	1978	5	1641	NW-78 72B-56	1	0	1	45	Y	3	
2633	1	D	1978	3	900	NW-78 72B-56	1	0	3	68	Y	2	
2634	1	D	1978	4	1130	NW-78 72B-56	1	0	2	103	Y	2	
2635	1	D	1958	3	1421	WSF-S-8 4-9	1	8	2	106	N	2	
2636	1	D	1978	2	1523	NW-78 72B-56	1	0	3	75	P	3	
2637	1	D	1978	2	1533	NW-78 72B-56	1	0	2	65	P	3	
2638	1	D	1958	3	1878	WSF-S-8 5-12	1	0	1	80	Y	2	
2639	1	D	1958	3	1895	WSF-S-8 5-12	1	0	1	45	Y	2	
2640	1	D	1958	2	1913	WSF-S-8 5-12	1	0	1	52	Y	2	
2641	1	D	1978	1	2441	NW-78 72B-56	7	0	4	50	N	5	
2642	1	D	1958	2	1924	WSF-S-8 5-12	1	0	1	65	Y	2	
2643	1	D	1978	2	2317	NW-78 72B-58	1	0	2	55	Y	2	
2644	3	D	1978	4	2381	NW-78 72B-58	1	0	2	50	Y	2	
2645	1	D	1978	3	2377	NW-78 72B-58	1	0	2	65	Y	2	
2646	3	D	1978	3	2053	NW-78 72B-58	1	0	2	65	Y	5	
2647	2	D	1978	5	2027	NW78 72B-58	1	0	1	65	Y	5	
2648	1	D	1978	2	2090	NW-78 72B-58	1	8	2	71	Y	2	
2649	1	D	1978	2	2097	NW-78 72B-58	1	8	2	81	Y	2	
2650	1	D	1978	2	2098	NW-78 72B-58	1	8	2	85	P	2	
2651	1	D	1978	3	2158	NW-78 72B-58	8	0	2	92	N	2	
2652	1	D	1978	3	2153	NW-78 72B-58	8	0	2	97	N	2	
2653	1	D	1978	3	2166	NW-78 72B-58	8	0	2	81	N	2	
2654	1	D	1978	2	2182	NW-78 72B-58	8	0	2	101	N	2	
2655	1	D	1978	3	2203	NW-78 72B-58	8	0	2	93	N	2	

2656	1	D	1978	3	2184	NW-78 72B-58	8	0	2	85	N	2	
2657	1	D	1978	1	2118	NW-78 72B-58	8	0	2	80	N	2	
2658	1	D	1978	1	2127	NW-78 72B-58	8	0	2	81	N	2	
2659	1	D	1978	1	2340	NW-78 72B-58	1	0	1	60	Y	5	
2660	1	P	1958	3	1009	WSF-S-8 5-12	1	0	1	48	Y	3	
2661	1	P	1958	3	1064	WSF-S-8 5-12	1	0	1	66	Y	3	
2662	1	P	1958	4	872	WSF-S-8 5-12	8	0	3	65	N	3	
2663	1	D	1978	2	2341	NW-78 72B-58	7	0	2	70	N	5	
2664	1	D	1978	2	2340	NW-78 72B-58	7	0	3	73	N	5	
2665	1	D	1978	1	2368	NW-78 72B-58	1	0	3	83	N	5	
2666	1	D	1978	2	2090	NW-78 72B-58	8	0	2	97	N	2	
2667	1	D	1978	2	2109	NW-78 72B-58	8	0	2	110	N	2	
2668	1	D	1978	2	2116	NW-78 72B-58	2	8	2	91	N	2	
2669	1	P	1958	3	880	WSF-S-8 5-12	8	0	3	55	N	3	
2670	1	P	1958	3	872	WSF-S-8 5-12	8	0	3	58	N	3	
2671	1	D	1958	5	2155	WSF-S-8 7-4	8	0	1	49	N	5	
2672	1	D	1978	2	2123	NW-78 72B-58	2	8	2	85	N	2	
2673	1	D	1978	2	2341	NW-78 72B-58	9	0	3	81	Y	5	
2674	1	D	1978	2	2378	NW-78 72B-58	9	0	3	64	Y	5	
2675	1	D	1978	2	2370	NW-78 72B-58	2	0	4	65	N	5	
2676	1	D	1978	3	2747	NW-78 72B-58	8	0	2	62	Y	1	
2677	1	D	1978	2	2797	NW-78 72B-58	8	0	2	82	N	1	
2678	1	D	1978	2	2790	NW-78 72B-58	8	0	2	78	N	1	
2679	1	D	1978	3	2559	NW-78 72B-58	1	8	3	81	N	1	
2680	1	D	1978	3	2531	NW-78 72B-58	1	8	3	82	N	1	
2681	1	D	1978	3	2505	NW-78 72B-58	8	8	3	95	N	1	
2682	1	D	1978	3	2462	NW-78 72B-58	8	0	3	73	N	1	
2683	1	D	1978	3	2439	NW-78 72B-58	8	0	3	85	N	1	
2684	1	D	1978	3	2409	NW-78 72B-58	8	0	3	78	N	1	
2685	1	D	1978	2	2369	NW-78 72B-58	8	0	3	71	N	1	
2686	1	D	1978	1	2390	NW-78 72B-58	8	0	3	93	N	1	
2687	1	D	1978	5	2354	NW-78 72B-60	8	0	3	113	N	1	
2688	1	D	1978	3	2473	NW-78 72B-60	8	0	2	84	N	1	
2689	1	D	1978	2	2446	NW-78 72B-60	8	0	2	84	N	1	
2690	1	D	1978	2	2437	NW-78 72B-60	8	0	2	95	N	1	
2691	4	D	1978	5	1226	NW-78 73B-57	8	0	3	57	Y	5	AR
2692	4	D	1978	5	1235	NW-78 73B-57	8	0	3	54	Y	5	AR
2693	3	D	1978	3	2348	NW-78 73B-60	8	0	1	81	Y	3	
2694	2	D	1978	5	2325	NW-78 73B-60	8	0	1	70	Y	3	
2695	1	D	1978	4	2957	NW-78 73B-60	8	0	2	74	P	2	
2696	1	D	1978	5	2949	NW-78 73B-60	8	0	3	75	N	2	
2697	1	D	1978	3	2781	NW-78 73B-60	8	0	3	84	N	2	
2698	1	D	1978	3	2784	NW-78 73B-60	8	0	3	73	N	2	
2699	1	D	1978	3	2789	NW-78 73B-60	8	0	3	70	N	2	
2700	1	D	1978	3	2769	NW-78 73B-60	8	0	3	73	P	2	
2701	1	D	1978	4	2685	NW-78 73B-60	8	0	3	71	Y	2	
2702	1	D	1978	3	2449	NW-70 74D-10	1	8	3	73	N	5	
2703	1	D	1978	3	2530	NW-70 74D-10	1	8	3	86	P	5	
2704	1	D	1978	2	2567	NW-70 74D-10	1	8	1	45	Y	5	
2705	1	D	1978	2	2600	NW-70 74D-10	8	0	3	80	P	5	
2706	1	D	1978	4	2637	NW-70 74D-10	1	8	3	74	P	5	

2707	1	D	1978	4	2621	NW-70 74D-10	1	8	2	75	P	5	
2708	1	D	1978	4	2546	NW-70 74D-10	1	8	2	63	Y	5	
2709	7	D	2003	5	2908		8	0	2	39	Y	3	
2710	4	P	2003	5	1538		8	0	3	47	Y	3	DD
2711	4	P	2003	5	845		8	0	3	41	Y	3	DI
2712	4	P	2003	5	1164		8	0	3	49	Y	3	DI
2713	4	Q	2003	5	1477		8	0	3	53	Y	3	DI
2714	4	P	2003	5	1523		8	0	3	52	Y	3	DI
2715	1	D	1985	3	1068	SP-85 26-071-213	1	0	3	76	Y	5	
2716	2	P	1985	5	1452	SP-85 26-071-213	1	0	1	53	Y	2	
2717	1	P	1985	3	1326	SP-85 20-071-213	1	0	1	82	Y	2	
2718	2	P	1985	5	1579	SP-85 20-071-213	1	0	1	63	Y	5	
2719	1	D	1985	3	1148	SP-85 20-071-213	1	0	1	58	Y	2	
2720	1	D	1985	3	1352	SP-85 20-071-213	1	0	3	96	Y	2	
2721	1	D	1985	3	1354	SP-85 20-071-213	9	0	3	85	Y	2	
2722	1	D	1985	1	1337	SP-85 20-071-213	1	0	1	90	Y	2	
2723	1	D	1985	2	1372	SP-85 20-071-213	1	0	1	92	Y	2	
2724	1	D	1985	2	1400	SP-85 20-071-213	1	0	1	105	Y	2	
2725	1	P	1985	3	923	SP-85 27-072-072	1	0	2	58	Y	3	
2726	1	P	1985	3	975	SP-85 27-072-072	1	0	2	61	N	3	
2727	1	P	1985	3	961	SP-85 27-072-072	1	0	2	67	N	3	
2728	1	D	1985	4	1197	SP-85 27-072-072	1	0	2	63	Y	3	
2729	1	D	1985	3	1335	SP-85 27-072-072	1	8	2	96	N	3	
2730	1	D	1985	3	1368	SP-85 27-072-072	1	8	2	92	N	3	
2731	1	D	1985	3	1402	SP-85 27-072-072	1	8	2	86	N	3	
2732	2	P	1985	5	2002	SP-85 27-072-072	1	0	1	56	Y	2	
2733	1	D	1985	4	2838	SP-85 27-072-075	8	0	2	70	Y	5	
2734	1	D	1985	4	2834	SP-85 27-072-075	8	0	2	75	Y	5	
2735	1	D	1985	3	2652	SP-85 27-072-075	8	0	2	71	N	5	
2736	1	D	1985	3	2621	SP-85 27-072-075	8	0	2	87	N	5	
2737	1	D	1985	3	2513	SP-85 27-072-075	8	0	2	45	N	5	
2738	1	D	1985	3	2488	SP-85 27-072-075	1	8	3	81	N	2	
2739	1	D	1985	3	2454		8	0	3	83	N	2	
2740	1	D	1985	3	2470		1	8	3	73	N	2	
2741	2	P	1985	5	2191	SP-85 27-072-075	1	8	1	65	Y	3	
2742	2	P	1985	5	2290	SP-85 27-072-075	1	8	1	82	Y	3	
2743	1	D	1985	3	2400	SP-85 27-072-075	8	0	2	108	N	1	
2744	1	D	1985	3	2396	SP-85 27-072-075	8	0	2	91	N	1	
2745	1	D	1985	5	2321	SP-85 27-072-075	8	0	3	99	P	1	
2746	1	D	1985	4	1936	SP-85 27-072-075	8	0	2	83	N	3	
2747	1	D	1978	3	2589	NW-78 72B-58	8	0	2	80	N	2	
2748	4	Q	2003	5	1791		8	0	3	28	Y	3	R
2749	1	D	1978	2	2657	NW-78 72B-58	8	0	2	82	N	1	
2750	1	D	1978	2	2668	NW-78 72B-58	8	0	2	75	N	1	
2751	1	D	1978	3	2788	NW-78 72B-58	8	0	2	80	N	1	
2752	1	D	1978	1	2790	NW-78 72B-58	8	0	2	99	N	1	
2753	1	D	1978	3	2797	NW-78 72B-58	8	0	2	91	N	1	
2754	1	D	1978	3	2800	NW-78 72B-58	8	0	2	83	N	1	
2755	1	D	1978	3	2800	NW-78 72B-58	8	0	2	87	N	1	
2756	1	D	1978	3	2818	NW-78 72B-58	8	0	2	74	Y	1	
2757	1	D	1978	3	2804	NW-78 72B-58	8	0	2	106	Y	1	

2758	4	P	2003	5	1898		8	0	3	37	Y	2	DD
2759	4	P	2003	5	1557		8	0	2	37	Y	3	R
2760	4	D	2003	5	1140		8	0	3	34	Y	5	AR
2761	4	D	2003	5	1290		8	0	3	50	Y	3	AR
2762	4	D	2003	5	1231		8	0	3	47	Y	3	AR
2763	3	D	2007	5	1086		1	8	3	66	Y	5	
2764	3	D	2007	5	1079		1	8	3	75	Y	5	
2765	4	D	2003	5	2109		8	0	3	32	Y	3	DD
2766	4	D	2003	5	1705		8	0	2	46	Y	3	DD
2767	4	D	2003	5	1077		8	0	2	43	Y	3	AR
2768	3	D	2007	5	1228		1	0	2	73	N	5	
2769	4	D	2003	5	1402		8	0	3	32	Y	3	AR
2770	1	D	1978	3	2798	NW-78 72B-58	8	0	2	88	Y	1	
2771	1	D	1978	3	2769	NW-78 72B-58	8	0	2	79	Y	1	
2772	3	D	2007	5	1294		1	8	3	67	Y	3	
2773	3	D	2007	5	1303		1	8	3	62	Y	3	
2774	3	D	2007	5	1319		1	8	3	55	Y	3	
2775	4	D	2003	5	1336		8	0	3	36	Y	3	AR
2776	4	D	2003	5	1256		8	0	3	50	Y	3	AR
2777	4	D	2003	5	1242		8	0	3	53	Y	2	AR
2778	4	D	2003	5	1223		8	0	3	46	Y	2	AR
2779	4	P	2003	5	531		8	0	3	35	N	3	DI
2780	4	P	2003	5	503		8	4	3	35	N	3	DD
2781	4	P	2003	5	495		8	4	3	31	P	3	DD
2782	4	P	2003	5	594		0	4	3	30	Y	3	DI
2783	4	P	2003	5	506		8	4	3	50	N	2	DI
2784	4	Q	2003	5	228		8	4	3	45	Y	3	DI
2785	4	P	2003	5	422		8	4	3	35	P	2	DI
2786	4	P	2003	5	431		8	4	3	35	P	3	DI
2787	4	P	2003	5	455		8	4	3	45	P	3	DI
2788	4	P	2003	5	487		8	4	3	55	P	3	DI
2789	4	P	2003	5	515		8	4	2	55	Y	3	DD
2790	4	P	2003	5	560		1	4	2	45	Y	3	DD
2791	1	P	2007	2	372		8	0	3	65	P	5	
2792	1	P	2007	1	286		4	0	3	79	P	5	
2793	1	P	2007	2	324		4	0	3	65	P	5	
2794	1	P	2007	2	306		4	0	3	75	P	5	
2795	4	D	2007	5	812		8	0	2	55	P	5	AR
2796	1	D	2007	2	661		4	0	3	75	P	3	
2797	4	D	2007	5	751		8	4	3	45	P	3	DI
2798	1	D	2007	1	661		4	0	3	60	P	3	
2799	1	D	2007	1	671		4	0	3	65	P	3	
2800	1	D	2007	2	685		4	0	3	62	P	3	
2801	4	D	2007	5	714		8	4	3	57	P	3	DI
2802	4	D	2007	5	728		8	4	3	55	P	3	DI
2803	1	P	2003	5	1325		8	0	3	65	P	2	
2804	1	P	2003	5	1377		8	0	2	65	Y	5	
2805	1	P	2003	1	1304		8	0	3	65	Y	1	
2806	1	P	2003	1	1304		8	0	3	65	Y	1	
2807	1	P	2003	1	1370		8	0	3	65	N	3	
2808	1	P	2003	1	314		8	0	3	80	N	9	

2809	1	P	2003	1	148	8	0	3	65	P	9
2810	1	P	2003	1	285	8	0	3	65	Y	1
2811	1	P	2003	1	332	8	0	2	65	N	1
2812	8	D	2007	5	2015	8	0	3	56	P	3

DSLS Type	Acres	Comments
	0.01	
	0.01	
	0.01	
	0.01	
	0.20	
	0.10	
	0.10	
R	0.70	
	0.01	
C	29.80	
	0.01	
	0.01	
	0.70	
	0.01	
	0.40	
	0.01	Possibly electric tower
	0.30	
	0.30	
	0.40	
	0.10	
	0.10	
	0.10	
	0.10	
	0.01	
	0.01	
	0.01	
R	0.90	
R	0.70	
	0.10	
	0.01	
	0.01	
	0.30	
	0.20	
	0.10	
	0.01	
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	0.01	
	0.01	
	0.10	
	0.01	
	0.30	

	0.10	
	0.10	
	0.01	
	0.10	
	0.10	
	0.20	
R	0.30	
	0.10	
	0.10	
	0.01	
	0.10	
	0.10	DSLS Scarp
	0.20	DSLS Scarp
	0.10	
R	0.60	
	0.10	DSLS Scarp
R	1.80	
	0.01	
	0.10	
	0.30	
C	1.30	
	0.01	
	0.01	
	0.01	
C	12.60	
C	1382.00	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
R	16.60	
C	12.00	
C	226.30	
R	1.10	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
R	0.80	
R	3.30	
R	0.30	
R	0.20	
	0.01	
	0.01	
	0.30	
	0.01	
	0.20	
	0.30	

	0.20
	0.80
	0.01
	0.01
	0.01
	0.01
	0.10
	0.10
	0.01
	0.01
	0.01
	0.10
R	1.70
	0.10
	0.01
	0.01
	0.01
	0.01
C	2.60
	0.01
	0.01
	0.01
	0.01
	0.01
	0.01
	0.01
	0.01
	0.01
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	0.01
	0.01
	0.01
	0.10
	0.10
R	1.40
R	2.40
	0.10
C	13.80
C	55.10
	0.10
	0.01
C	14.40

	0.10
	0.01
	0.01
	0.10
R	1.80
T	3.30
C	1.90
C	58.80
	0.10
	0.30
C	0.90
	0.01
	0.01
	0.01
	0.10
	0.10
	0.01
	0.01
	0.01
C	85.00
C	4.90
E	12.20
C	1.60
C	12.70
C	11.60
C	4.40
E	8.20
	0.10
	0.01
	0.30
	0.20
	0.10
	0.20
	0.40
	0.70
	0.01
	0.10
	0.10
R	4.20
	0.01
	0.01
	0.01
	0.01
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	0.01	
	0.01	
C	155.70	
	0.01	
C	36.70	
C	68.10	
C	12.10	
C	15.20	
R	4.60	
R	39.80	
C	50.70	
C	2.00	
C	33.70	
C	2.70	
C	58.80	
C	51.60	
	0.01	
E	277.50	
	0.01	
	0.01	
	0.01	
	0.01	
E	5.40	
E	4.30	
	0.01	
	0.01	
C	26.70	
C	26.10	
	0.01	Forest Fire?
	0.01	Forest Fire?
	1.20	Old scar visible, Forest Fire?
	0.01	
	0.01	
	0.01	
	0.01	
C	9.90	Active in 1958 aerial photos
	0.01	
C	10.70	
	0.01	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	Forest Fire?
	0.01	
	0.01	
	0.01	Forest Fire?
	0.01	Forest Fire?
	0.01	Forest Fire?
	0.01	
C	9.30	
	0.01	Forest Fire?

	0.40	Old scar visible, Forest Fire?
	0.01	Forest Fire?
	0.20	Old scar visible, Forest Fire?
	0.10	Old scar visible, Forest Fire?
	0.01	DSLS Scarp
	0.01	DSLS Scarp
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	0.01	DSLS Scarp
C	20.50	
	0.01	DSLS Scarp
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C	11.00	
C	1.30	
C	15.80	
C	15.20	
C	50.20	
C	92.70	
C	74.70	
C	79.80	
C	299.00	
	0.01	DSLS scarp
	0.01	DSLS scarp
	0.01	DSLS scarp
	0.70	DSLS scarp
	0.30	DSLS scarp
	0.10	DSLS body
	0.01	DSLS scarp
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C	8.70	
	0.01	DSLS Scarp
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R	6.60	
	0.01	DSLS?
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	0.01	DSLS Scarp
	0.10	
	0.20	
	0.30	
C	6.00	
	1.30	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Interior Scarp
	0.01	DSLS Interior Scarp
	0.01	DSLS Interior Scarp
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	0.01	
	0.01	
	0.10	DSLS
	0.10	DSLS
	0.10	DSLS
	0.10	DSLS
	0.30	DSLS
E	15.40	
C	58.50	
	0.01	
	0.01	
E	17.10	
E	17.20	
E	18.90	
E	85.00	
C	59.70	
C	15.90	Old Quarry
	0.01	
	0.01	
	0.01	
	0.01	
C	12.20	
	1.40	
	0.40	
	0.60	
	0.60	
	0.10	
	0.10	

	0.01	
	1.50	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
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	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	
	1.20	
E	27.10	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.90	
	0.01	
	0.10	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.10	
	0.01	
	0.01	
	1.30	
	0.01	DSLS Scarp
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	0.10	
	0.01	
	0.01	
	0.01	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	
	0.01	
	0.20	DSLS
	0.01	DSLS Scarp
	0.01	
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	0.01	DSLS Scarp
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	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.20	DSLS Scarp
	0.01	
	0.01	
	0.01	
C	1.20	
C	0.90	
	0.01	
	0.80	
	0.01	
	0.20	
	0.01	
	0.01	
	0.01	
	0.01	
	0.10	
	0.01	
	0.01	
	0.01	
	0.01	
	0.10	

	0.10	
	0.10	
E	307.90	
C	9.90	
R	14.30	
E	15.70	
R	41.10	
T	52.70	
	0.01	
	0.50	
	0.01	
	1.30	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.01	
	0.10	
	0.01	
	0.01	
	0.01	
	1.10	
	0.10	DSLS Scarp
	0.10	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	1.60	
	2.20	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.30	
	0.10	
	0.01	DSLS Scarp
E	319.90	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.01	DSLS Scarp

C	54.40	
C	23.10	
R	1.30	
R	9.90	
R	3.40	
	0.10	
	0.10	
C	10.90	
C	7.00	
R	2.00	
	0.20	
C	7.40	
	0.01	DSLS Scarp
	0.01	DSLS Scarp
	0.20	
	0.40	
	0.50	
R	4.40	
R	1.50	
R	0.60	
R	0.90	
R	11.00	
C	2.90	
C	2.00	
C	20.20	
R	2.30	
C	17.20	
T	6.10	
T	12.10	
T	2.30	
T	2.80	
R	0.80	
R	0.60	
	0.01	Approx Location, ID from I-90
	0.01	Approx location, ID from I-90
	0.01	Approx location, ID from I-90
	0.01	Approx location, ID from I-90
	0.50	
	0.01	
R	4.20	
	0.01	
	0.01	
	0.01	
R	1.20	
R	1.10	
	0.10	
	0.10	
	0.01	
	0.01	
	0.01	
	0.01	Urban landuse

0.01	Landuse Urban
0.01	
0.01	
27.90	

Appendix B - Form A-3: Mass Wasting Summary Table

	Total					
Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	255	3	0	3	0	261
2 = young stands (timber 5-15 yrs)	79	3	11	13	0	106
3 = submature timber (15-50 years)	63	8	12	72	1	156
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	133	7	15	11	0	166
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	2	0	0	2	0	4

Landform 1

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	38	3	0	0	0	41
2 = young stands (timber 5-15 yrs)	34	2	7	0	0	43
3 = submature timber (15-50 years)	37	7	11	0	0	55
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	49	4	9	5	0	67
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	0

Landform 2

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	13	0	0	0	0	13
2 = young stands (timber 5-15 yrs)	3	0	0	0	0	3
3 = submature timber (15-50 years)	0	0	0	0	0	0
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	3	0	0	0	0	3
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	0

Landform 4

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	1	0	0	0	0	1
2 = young stands (timber 5-15 yrs)	0	0	0	0	0	0
3 = submature timber (15-50 years)	0	0	0	0	0	0
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	0	0	1	0	0	1
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	0

Landform 5

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	15	0	0	3	0	18
2 = young stands	14	1	3	5	0	9
3 = submature timber (15-50 years)	8	1	0	48	1	58
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	25	3	3	4	0	35
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	1	0	1

Landform 6

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	2	0	0	0	0	2
2 = young stands (timber 5-15 yrs)	0	0	0	3	0	3
3 = submature timber (15-50 years)	0	0	1	1	0	2
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	1	0	1	0	0	2
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	0

Landform 7

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	4	0	0	0	0	4
2 = young stands (timber 5-15 yrs)	1	0	0	1	0	1
3 = submature timber (15-50 years)	1	0	0	0	0	1
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	1	0	0	0	0	1
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	2	0	0	0	0	2

Landform 8

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	182	0	0	0	0	182
2 = young stands (timber 5-15 yrs)	27	0	1	0	0	1
3 = submature timber (15-50 years)	13	0	0	3	0	16
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	43	0	1	1	0	45
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	0	0	0
						244

Landform 11

Activity	Shallow Landslides	Debris Flows	Debris Avalanches	Deep-Seated Landslides	Earthflows	Total
1 = clearcut (timber 0-5 yrs)	0	0	0	0	0	0
2 = young stands (timber 5-15 yrs)	0	0	0	4	0	4
3 = submature timber (15-50 years)	4	0	0	20	0	24
4 = mature timber (>50 years)	0	0	0	0	0	0
5 = road	11	0	0	1	0	12
6 = partial cut	0	0	0	0	0	0
7 = yarding	0	0	0	0	0	0
8 = alpine	0	0	0	0	0	0
9 = other-e.g., housing, agriculture	0	0	0	1	0	1

Appendix C - Form A-4: Landslide Area Hazard Rates

Landforms	**Landform 1 Inner Gorges**	**Landform 2 Bedrock Hollows**	**Landform 3 Flats**	**Landform 4 Low Gradient Hills**	**Landform 5 High Gradient Hills**	**Landform 6 Body of Active DSLS**	**Landform 7 Toes of DSLS**	**Landform 8 Scarp of Active DSLS**	**Landform 11 Terrace Faces**	**Landform 12 Meander Bend**	**Landform 14 Ridge Tops**	**Total WAU**
Years	37	37	37	37	37	37	37	37	37	37	37	37
Landform Area	2054.256024	64.106057	10100.33006	17958.4524	7938.377	379.24908	43.956819	340.8501	1314.1	46.13457	414.6483	40654.46
Number of 'Delivering' Landslides	146	8	0	0	24	4	6	38	9	0	0	235
Area of 'Delivering' Landslides (acres)	24.20	0.20	0.00	0.00	5.30	1.93	0.17	1.79	0.04	0.00	0.00	34
Landslide Frequency Rate (Number of slides/Landform Area/Years) x 10^6	1920.86	3372.79	0.00	0.00	81.71	285.06	3689.12	3013.13	185.10	0.00	0.00	156.23
Landslide Area Rate for Delivery (Delivering Landslide Area/Landform Area/Years) x 10^6	318.39	84.32	0.00	0.00	18.04	137.54	104.53	141.93	0.82	0.00	0.00	22.36
Overall Rating	Very High	High	Low	Low	Low	Medium	High	High	Low	High	Low	

Without Roads

Landforms	Landform 1 Inner Gorges	Landform 2 Bedrock Hollows	Landform 3 Flats	Landform 4 Low Gradient Hills	Landform 5 High Gradient Hills	Landform 6 Body of Active DSLS	Landform 7 Toes of DSLS	Landform 8 Scarp of Active DSLS	Landform 11 Terrace Faces	Landform 12 Meander Bend	Landform 14 Ridge Tops	Total WAU
Years	37	37	37	37	37	37	37	37	37	37	37	37
Landform Area	2054.256024	64.106057	10100.33006	17958.4524	7938.377	379.24908	43.956819	340.8501	1314.1	46.13457	414.6483	40654.46
Number of 'Delivering' Landslides	100	7	0	0	18	3	5	27	4	0	0	164
Area of 'Delivering' Landslides (acres)	18.30	0.10	0.00	0.00	2.40	1.60	0.11	1.50	0.01	0.00	0.00	24.02
Landslide Frequency Rate (Number of slides/Landform Area/Years) x 10^6	1315.66	2951.19	0.00	0.00	61.28	213.79	3074.27	2140.91	82.27	0.00	0.00	109.03
Landslide Area Rate for Delivery (Delivering Landslide Area/Landform Area/Years) x 10^6	240.77	42.16	0.00	0.00	8.17	114.02	67.63	118.94	0.21	0.00	0.00	15.97
Overall Rating	Very High	High	Low	Low	Low	Medium	High	High	Low	High	Low	