

# CHAPTER ELEVEN

## Nisqually River Basin

### 11.1 BASIN CHARACTERISTICS

The Nisqually River originates on Mount Rainier and flows approximately 78 miles before discharging into the Puget Sound. It is the only river in the nation with its headwaters in a national park and its estuary in a national refuge. The Nisqually River drains an area of approximately 760 square miles.

The Washington State Department of Ecology (Ecology) has designated the Nisqually River Basin as “Water Resource Inventory Area” (WRIA) 11. The Nisqually River Basin planning area includes the unincorporated Pierce County portion of WRIA 11 and the entire length of the main Nisqually River, exclusive of the Muck Creek Basin. The Muck Creek Basin was addressed separately in the Muck Creek Basin Plan (2004). Moreover, the Nisqually River Basin Plan does not cover areas of the Basin that lie within other jurisdictions; such as incorporated towns and cities, commercial timber lands regulated by the Washington State Department of Natural Resources, Thurston and Lewis counties, and federal lands. The only exception is where activities in these areas may contribute to surface water management problems in unincorporated Pierce County.

The Nisqually River Basin planning area was delineated based on the Basin boundaries and other GIS data provided by Pierce County. To allow for more detailed characterization, the planning area was further subdivided into 23 subbasins based on existing topographic and hydrographic data. These Basins and their corresponding areas are listed in *Table 11-1*.

The three largest tributaries in the planning area are Tanwax Creek, Ohop Creek, and the Mashel River. The drainage areas for each of these tributaries cover 11%, 15% and 32% of the total subbasin drainage area, respectively. Other major streams in the planning area include Red Salmon Creek, Murray Creek, Brighton Creek, Horn Creek, Kreger Creek, Lynch Creek, the Little Mashel River, and Elbe Creek.

#### 11.1.1 Nisqually River Basin

##### ***Red Salmon Creek***

Red Salmon Creek is located near the mouth of the Nisqually River and drains directly to Puget Sound through the Nisqually River Delta. The creek flows from south to north along the east side of the delta, and much of the length of the stream is tidally influenced. The Red Salmon Creek subbasin is approximately seven square miles. Much of that drainage area consists of the low-lying areas along the estuary. Portions of the City of DuPont and adjacent areas to the south drain to Red Salmon Creek through two culverts: one under a railroad track and a second under Mounts Road, a county road. There is some type of blockage in the culvert under the railroad track (personal communication with Randy Brake, Pierce County Water Programs, May 2007). Another area drains to Red Salmon Creek from the south through a culvert under Interstate 5.

**TABLE 11-1  
NISQUALLY SUBBASIN AREAS**

Subbasin	Area (sq mi)	Percent of total subbasin drainage area
Alder Lake	9.5	3.6%
Ashford Reach	8.1	3.1%
Brighton Creek	6.5	2.5%
Clear Lake	1.2	0.5%
Copper Creek	8.1	3.1%
Elbe Creek	11.1	4.3%
Goat Cr-Tenas Cr	5.9	2.3%
Harts Lake	5.7	2.2%
Horn Creek	11.5	4.4%
Kreger Creek	10.9	4.2%
LaGrand Reach	4.2	1.6%
Little Mashel River	23.7	9.1%
Lower Mashel River	6.2	2.4%
Lower Ohop Creek	7.0	2.7%
Lower Tanwax Creek	12.7	4.9%
Lynch Creek	17.0	6.5%
Mashel Prairie	1.4	0.5%
Middle Mashel River	19.8	7.6%
Murray Creek	16.3	6.3%
Red Salmon Creek	7.3	2.8%
Upper Mashel River	34.1	13.1%
Upper Ohop Creek	16.1	6.3%
Upper Tanwax Creek	15.2	6.0%
<b>Total</b>	<b>259.5</b>	<b>100%</b>

### **Murray Creek**

Murray Creek subbasin covers approximately 16 square miles between the City of Roy and community of McKenna. The subbasin is a mixture of low-density residential, agricultural and open space land use. The surficial geology is predominated by glacial deposits, and past glaciation has left the area with a deranged drainage pattern. As a result, there are numerous low-lying areas with poor drainage, and wetlands are scattered throughout the subbasin. Minor flooding and drainage problems are common throughout the Basin. All four hydrologic soils groups are found in the subbasin. There are large areas of sandy, well-drained “Type A” soils in the western portion of the subbasin. The eastern portion is mostly “Type D” soils with poor drainage. The middle of the subbasin is a mixture of Types A, C, and D soils.

Murray Creek begins in the southeastern most extent of the subbasin. Drainages in this area have been altered, and some water from the Brighton Creek subbasin gets diverted into the Murray Creek subbasin. The creek flows for approximately 9 miles before discharging into the Nisqually River on the west side of the subbasin. Portions of Murray Creek flow intermittently during dry months. Springs provide flow in some reaches on Murray Creek; one major spring is located approximately 2,000 feet upstream from the mouth of the creek. Lake Serene covers approximately 8 acres and located in the northeast portion of the subbasin.

### ***Brighton Creek***

The Brighton Creek subbasin is a 6.5 square mile area southeast of the Murray Creek subbasin. The subbasin is largely rural, but does have some areas of low-density residential development along State Route 702, Kinsman Road, and Allen Road. It is similar to the Murray Creek subbasin in many respects. The upper portion of the subbasin is relatively flat with poorly drained, “Type D” soils. Minor flooding and drainage problems are common. The lower, southern portion of the subbasin has steeper slopes. The Brighton Creek channel becomes deep and somewhat confined as it approaches the Nisqually River near Harts Lake Loop Road.

### ***Horn Creek***

Horn Creek drains approximately 11 square miles. The drainage area begins in the relatively flat areas around the intersection of State Route 702 and State Route 7, which has some low-density residential development. As water drains west, the stream becomes more defined at Kinsman Road. From there, the stream flows through a gentle sloping valley with some wide floodplains and wetland areas. This valley has some scattered, low-density residential with a number of small farms with livestock. As it approaches the Nisqually River, the Horn Creek valley becomes steeper and the stream is more confined. The mouth of Horn Creek is about 2,000 feet downstream from the Centralia Canal diversion.

### ***Harts Lake***

Harts Lake is located approximately 5 miles southeast of the community of McKenna along Harts Lake Loop Road. This lake is the dominant hydrologic feature of the Harts Lake subbasin, which covers 5.7 square miles. The lake itself is approximately 110 acres. A few hundred feet south of Harts Lake is Little Lake, which is approximately 10 acres. Harts Lake Creek begins approximately 1.5 miles east of the lake, flows west down into the Nisqually River valley and into the southeast side of Harts Lake. The lake outlet is on the southwest side. The outflow stream flows into the Wilcox Flats area adjacent to the Nisqually River and then follows along the hills on the north side of the valley. Historically, Harts Lake Creek flowed directly into the Nisqually River at a confluence that would have been located approximately 1,000 feet upstream of the Centralia Canal diversion. However, the creek has now been diverted north along the valley into a wetland area that eventually drains to Horn Creek. The Wilcox Flats area of the subbasin is used primarily for agriculture. In particular, the Wilcox Dairy is located there. Much of the Wilcox Flats are within the Nisqually River floodplain, and past flooding events have caused damages to structures in this area.

### ***Upper and Lower Tanwax Creek***

Tanwax Creek drains approximately 28 square miles. Tanwax Creek is over 13 miles long, beginning approximately 7 miles north of the town of Eatonville and ending at the confluence with the Nisqually River approximately 7 miles southeast of McKenna. The hydrology of the subbasin is greatly influenced by lakes and wetlands. The largest lake is Tanwax Lake (approximately 174 acres), near the headwaters of the subbasin.

Other lakes in the subbasin include:

- North Twin Lake (13 acres)
- South Twin Lake (13 acres)
- Whitman Lake (29 acres)
- Stidham Lake (8 acres)
- Trout Lake (7 acres)
- Twentyseven Lake (21 acres)
- Mud Lake (20 acres)
- Rapjohn Lake (59 acres)
- Cranberry Lake (34 acres)
- Tule Lake (34 acres)

The soils in the Tanwax Creek drainage are mostly poorly drained, “Type D: soils, although there are some areas of highly permeable “Type A” soils. The Tanwax Basin was divided into upper and lower subbasins to allow for more detailed characterization. The Lower Tanwax subbasin is largely undeveloped; however much of this area has been divided into 20-acre lots that are being sold for rural residential development. The Upper Tanwax subbasin has scattered areas of low-density residential and rural residential development. There are also several small farms and livestock pastures along the upper Tanwax valley.

### **Kreger Creek**

The Kreger Creek subbasin is an 11 square mile drainage area south of the Lower Tanwax subbasin. Like the Tanwax Creek subbasin, lakes and wetlands are important components of the hydrology of Kreger Creek subbasin. The two major lakes in the subbasin are Silver Lake and Kreger Lake. Silver Lake is near the top of the drainage. Historically, the outlet was on the west side of the lake, and water drained west and then south toward Kreger Lake. However, an outlet drainage ditch was constructed on the south side of the lake. This ditch carries the water south, crosses 416th Street East, and then flows southwest to Kreger Lake. Kreger Lake is a large wetland area. Downstream from Kreger Lake, the creek flows southwest, down into the Nisqually River valley and discharges into the Nisqually River. Most of the subbasin is covered by poor draining “Type D” soils. The Kreger Creek subbasin is mostly rural open space. There are some small residential areas along Dean Kreger Road and on the north side of Silver Lake.

### **Clear Lake**

The Clear Lake subbasin is a small, one square mile area consisting primarily of Clear Lake in the north portion of the subbasin and the surrounding area that drains to the lake. The lake covers approximately 156 acres. The lake discharges via a small ditch on its east side, which flows down a steep slope into the upper Ohop Creek valley. Nearly all of the Clear Lake shoreline is covered by residences. The residential development occupies a relatively narrow band around the lake. A second, smaller lake is located in the south portion of the subbasin. Horseshoe Lake covers approximately 12 acres.

### **Upper Ohop Creek**

Ohop Creek is the second largest tributary to the Nisqually River in the Basin planning area. The total drainage area is over 40 square miles. For purposes of this Basin planning effort, the drainage has been divided into three subbasins: the Upper Ohop, Lower Ohop and Lynch Creek. The headwaters are in the steep eastern portion of the Basin. These headwaters drain into the two main tributaries of the Ohop, Twenty-Five Mile Creek and Lynch Creek. Historically, the Ohop Creek drainage Basin included an additional area north of the current extent of the Basin. However, in 1889 the upper portion of Ohop Creek was diverted north into the Puyallup Basin, which reportedly reduced the flow in Ohop Creek by about 30% (Watershed Professionals Network, 2002). Consequently, at its confluence with Twenty-Five Mile Creek (approximately 4 miles north of Eatonville), Ohop Creek is the smaller of the two streams. Approximately 1 mile downstream from the confluence of Ohop Creek and Twenty-Five Mile Creek is Ohop Lake. It is the largest natural lake in the Nisqually Basin with a surface area of 235 acres. Ohop

Lake is long and narrow, approximately 1,000 feet wide and 2 miles long. The Ohop Creek confluence with Lynch Creek is approximately 1,000 feet downstream from Ohop Lake. The drainage area upstream of this confluence is approximately 16 square miles. The Upper Ohop Valley has a flat floor with steep walls. The valley walls are so steep that slope stability is a problem when the soils become saturated. Numerous springs are located along the valley walls. The Upper Ohop subbasin is rural with minimal residential development. The upper drainage along Twenty-Five Mile Creek is almost all mountainous forest land. The one notable area of residential development is the large number of homes that line the east and west shorelines of Ohop Lake.

### **Lynch Creek**

Lynch Creek drains approximately 17 square miles. Most of the subbasin is located in rugged terrain east of Eatonville; most of the subbasin area is undeveloped forested land. Lynch Creek has one major tributary: Berg Creek. The lower reach of Lynch Creek (approximately 1.5 miles) flows along the northern edge of the Town of Eatonville. There has been some development along this reach. Lower Lynch Creek receives stormwater runoff from a large portion of Eatonville via a large ditch. Ohop Lake acts as a sediment trap. Therefore, Lynch Creek is an important sediment source for the Lower Ohop Creek.

### **Lower Ohop Creek**

The Lower Ohop subbasin covers approximately 7 square miles. The subbasin is rural with a few residences in the areas near Eatonville. The Lower Ohop Valley is wide and flat with steep walls. This valley was once used for agriculture and dairy farming. Although there are still some small farms in the valley, this usage has diminished in recent years. Due to the previous agricultural use much of the lower Ohop Creek was straightened, and drainage ditches were built on the valley floor. Much of the Lower Ohop Creek channel has become severely incised and disconnected from the floodplain. Consequently, this reach is much less productive for salmon than it was historically. The Nisqually Tribe has plans for a major habitat restoration project in on about 4 miles of Lower Ohop Creek. The project would involve filling of the incised channel and creating a new meandering channel with lower gradient and better habitat complexity. The timing of this restoration project will depend on the availability of funding. The one mile reach of Ohop Creek just upstream from the confluence with the Nisqually River is forested and relatively undisturbed.

### **Mashel River**

South and east of the Ohop Creek Basin is the Mashel River Basin. The Mashel River is the largest tributary to the Nisqually River; the entire drainage covers over 84 square miles. Major tributaries of the Mashel River are the Little Mashel River, Beaver Creek, and Busy Wild Creek. The headwaters of the Mashel River begin near Mount Rainier and flow west toward the town of Eatonville. The river passes through the southern portion of Eatonville and then flows southwest to the confluence with the Nisqually River. The drainage Basin was divided into four subbasins: the Upper Mashel River, Middle Mashel River, Lower Mashel River, and the Little Mashel River. The Upper Mashel River subbasin covers approximately 34 square miles. This subbasin is all mountainous, forested terrain. A majority of this is new growth forest; the area was intensely harvested by commercial timber throughout the 1950s and 1960s. Harvesting disturbances may have contributed to mass wasting that has occurred along the slopes and banks of the river. The middle Mashel River subbasin is a 20 square mile drainage area beginning at Boxcar Canyon approximately one mile east of the town of Eatonville and ending near the confluence with Busy Wild Creek. This area is also rural and mostly forested. The Lower Mashel River subbasin is 6.2 square miles. The northwestern portion of this subbasin has some development in and around the town of Eatonville. Eatonville draws its drinking water from the Mashel River, and secondary-treated

waste water is discharged to the river downstream from the town. As it approaches the Nisqually River, the Mashel River winds through a steep, sinuous canyon. The confluence with the Nisqually River is approximately one mile downstream from LaGrand Dam. The Little Mashel River subbasin is also rural, consisting of mostly agricultural and forested lands. The agriculture is almost exclusively livestock and is found mainly in the valleys of the northwestern portion of the subbasin. Midway Creek is a major tributary to the Little Mashel River. The confluence of the Little Mashel River with the Mashel River is located approximately ½-mile south of Eatonville.

### ***LaGrande Reach***

The LaGrande Reach is a small (4.2 square mile) subbasin along the Nisqually River between Alder Dam and the Mashel River confluence. The Nisqually River is confined to a steep narrow canyon in this 4.7 mile long reach. LaGrande Dam is located approximately 1.5 miles downstream from Alder Dam. Both dams are used for hydroelectric power generation. Water is diverted from the Nisqually at LaGrande Dam and carried through an aqueduct approximately 1.5 miles to the LaGrande powerhouse, where is discharged back into the river. The subbasin area is comprised of several small drainages along the northeast side of the canyon. The only development in the subbasin is the facilities at the LaGrande powerhouse and State Route 7.

### ***Alder Lake***

Alder Lake is a reservoir that was built in 1945 to generate hydroelectric power for the City of Tacoma. The reservoir has very limited capacity to attenuate flood flows. The Alder Lake subbasin encompasses approximately 9 square miles on the north shore of Alder Lake. This area is mostly drained by small intermittent streams. Alder Lake is seven miles long, with 28 miles of shoreline and a surface area of 3,065 acres at maximum elevation. The subbasin is mostly rural open space, but there is some scattered residential development along the north shore. Also, the small community of Elbe is located at the upstream end of the lake.

### ***Elbe Creek***

The Elbe Creek subbasin covers 11 square miles of drainage area draining to a 4.5 mile reach of the Nisqually River upstream of Alder Lake. Small streams drain the water from the steep slopes of the north side of the upper Nisqually River valley to the valley floor and into the Nisqually River. The largest of these streams is Elbe Creek, which starts on the west side of the subbasin and flows southeast along the valley. The steep slopes of the valley are undeveloped forested land. There is some rural residential development along the valley floor.

### ***Ashford Reach***

The Ashford reach subbasin is similar to the Elbe Creek subbasin. Small streams drain water from the steep slopes in the north across the valley floor to the Nisqually River. The Ashford reach subbasin covers 8.1 square miles and drains to a 5-mile reach of the Nisqually River. The steep slopes in the north are undeveloped and forested. There are some areas of rural residential development on the valley floor, most notably is the small village area of National and Ashford.

### ***Copper Creek***

The Copper Creek subbasin is an 8.1 square mile drainage area draining to a 3-mile reach of the Nisqually River. Most of the area is drained by Copper Creek, which starts in the north part of the subbasin and flows down a steep watercourse to the Nisqually River. The upper portion of the subbasin is forested,

although there has been some past timber harvesting. The subbasin is primarily rural open space, but there is some scattered residential development along the valley floor.

### **Goat Creek and Tenas Creek**

The Nisqually River Basin Planning area extends to the Mount Rainier National Park boundary on the east end of the Nisqually River Basin. It includes a small residential development located near the park entrance. Goat Creek drains an area of rugged mountainous terrain on the north side of the valley. Tenas Creek begins in the park on a steep slope, flows to the valley floor and then west along State Route 706 before discharging into the Nisqually River. Several of the structures in the residential area are built near the lower section of Tenas Creek.

### **Nisqually River Main Stem**

The Nisqually River originates from the Nisqually Glacier on the south slope of Mount Rainier. Water flows approximately 78 miles, west-northwest, to meet salt water at the Nisqually Estuary in South Puget Sound. The LaGrande Canyon, at river mile 40, divides the watershed into two distinct physiographic areas. Below the canyon, the watershed consists of low hills and prairie plains of glacial outwash. Above the canyon, volcanic rock and steeper mountainous terrain dominate the area. The canyon itself contains sheer cliffs extending upwards of 200 feet.

Development along the Nisqually River is relatively limited. Pierce County regulations restrict development in flood hazard zones, channel migration zones, and critical riparian areas. Furthermore, many parcels along the river are publicly owned, or owned by the Nisqually Land Trust. There are a few small communities along the river in the upper valley (above Alder Lake) including Elbe, Ashford, National, and an area of development near the Mount Rainier National Park entrance. Below Lake Alder there is some agricultural and rural residential development in the Wilcox flats area. There is also some residential development around the communities of McKenna and Whitewater Estates.

Elevations in WRIA 11 range from sea level to over 14,000 feet, although most of the Basin lies below 1,000 feet. The steepest subbasins within the Pierce County portion of the watershed are the Mashel and the Upper Nisqually subbasins. With the exception of the Mashel subbasin, the subbasins in the western portion of WRIA 11 are low-elevation and of low relief.

All subbasins in the lower watershed have a rain-dominated hydrologic regime, except for the Mashel subbasin, which has a rain-on-snow dominated hydrologic regime. The low relief of the subbasins, with the exception of the Mashel, limits the potential energy available to move water through the system, resulting in relatively low stream velocities and erosion potential. Mean annual precipitation within the Nisqually watershed generally increases as elevation increases. On average, the lower portions of the watershed receive from 33 to 50 inches of precipitation per year. The higher portions of the watershed receive greater than 70 inches of precipitation annually. The wettest months are November through January, and the driest months are June, July, and August.

The majority of the soils in the upper part of the study area are moderately permeable. Soils in the lower Basin range from highly permeable to relatively impermeable. Soils in the western (lower) portion of the watershed are generally more permeable than those in the eastern portion, with the exception of the Mashel subbasin, which generally has more permeable soils than the Tanwax/Kreger/Ohop subbasin.

In general, the drainage areas east of Eatonville are characterized by steep slopes and mountainous terrain. Subbasins such as Lynch Creek, Upper Mashel River, and Little Mashel River are primarily covered by designated forest lands. Several subbasins along the upper Nisqually, including the LaGrand

Reach, Lake Alder, Elbe Creek, Ashford Reach, Copper Creek and Goat Creek-Tenas Creek, are also steep, mountainous and mostly forested. Although still relatively rural, subbasins west of Eatonville tend to have more development. The drainage areas are characterized by mixed forest, rural residential and agricultural lands. Surface water hydrology is heavily influenced by lakes and wetlands.

## 11.2 LAND USE IN THE NISQUALLY RIVER BASIN

To assess the hydrologic characteristics of a Basin and to determine the potential for water quality/quantity problems requires an accurate understanding of a Basin's existing and proposed land uses. This section will look at both the existing and future land use of this Basin.

Various land uses have different effects on the water quality and the hydrologic components of a watershed. Undeveloped forested land allows for maximum infiltration of rainwater and has the least potential for causing water pollution.

Highly developed areas (characterized by large areas of impervious surfaces), whether residential, commercial, or industrial land uses, increase the surface runoff of stormwater, carrying pollutants picked up from the manmade surfaces into the streams and waterways. Increased stormwater discharges can erode drainage ditches and stream channels, increase turbidity of stream water, deposit sediment in habitats important to fish and aquatic life, and fill downstream flood storage areas.

Poor agricultural practices, such as improperly applied irrigation methods and feeding or watering livestock too close to a stream, can also contribute to water quality problems when the practices increase erosion and disturb soils adjacent to streams. These areas can be significant sources of sediment, fecal coliform bacteria, and nutrients such as nitrate and phosphate. Excess nutrients in water reduce the dissolved oxygen content that fish and other aquatic organisms require.

### 11.2.1 Existing Land Use

The western portion of the Nisqually River Basin (west of Eatonville) has experienced increasing development pressure and is a mixture of rural residential, open space, and agricultural land uses. This area includes the Murray Creek, Brighton Creek, Horn Creek, Harts Lake, Tanwax Creek, Kreger Creek and Lower Ohop Creek subbasins. The relative distribution of land use is approximately 50% rural residential, between 15% and 30% open space, and between 5% and 10% agricultural. The area generally to the east of Eatonville is more mountainous and less developed. This area is approximately 75% forested and 25% rural residential. Existing Land Uses are listed in *Table 11-2*.

### 11.2.2 Future Land Use

The *Comprehensive Plan for Pierce County, Washington (County Comprehensive Plan)* (Pierce County, March 1999) was developed and adopted in 1994 in response to the requirements of Washington's "Growth Management Act" (GMA).

The Plan seeks to obtain and balance 13 different planning goals. These goals include reducing sprawl while still encouraging development, providing public facilities and services to support development, protecting the environment while protecting property owners' rights, promoting economic development, preserving archeological and historical sites, artifacts and structures, and processing permits in a timely manner, while at the same time encouraging citizen participation in the planning process (Pierce County, March 1999). The *Pierce County Comprehensive Plan*, codified as *Title 19A, Pierce County Code*, divides the Nisqually River Basin into rural areas and urban growth area.

**TABLE 11-2  
EXISTING LAND USE IN NISQUALLY BASIN**

Existing Land Use	Area (acres)	Percent of Basin
Agricultural	9,735	6.18%
Commercial/Industrial	228	0.14%
Education	77	0.05%
Open Space/Resource Lands	78,104	49.61%
Public Places/Religious Centers	247	0.16%
Residential	22,518	14.30%
Transportation/Communications/Utilities	874	0.56%
Vacant Land/Undefined	<u>45,650</u>	<u>29.00%</u>
<b>Total</b>	<b>157,433</b>	<b>100%</b>

The land use element of the *Pierce County Comprehensive Plan* includes a growth and development strategy on how and where development will occur in the future. It is important to consider the proximity of existing surface water within the Basin to future designated employment centers, commercial centers, mixed-use districts, moderate density and high- density residential districts, and rural activity centers. The future land use designations that lie within the Nisqually River Basin are listed below.

- Agricultural
- Designated Forest Land
- Moderate-Density Single-Family Residential
- Reserve Five
- Rural Five, Ten, Twenty and Forty
- Rural Activity Center
- Rural Neighborhood Center
- Tourist Commercial
- Village Center
- Village Residential

Most of the Basin is currently zoned for forest land (eastern portion of the Basin) and rural residential development (western portion of the Basin). Designated forest lands can only have one dwelling unit per 80 acres.

Pierce County Planning and Land Services (PALS) staff is not aware of any conversions from commercial forest to subdivisions other than the Park Junction Resort, between Elbe and Ashford. Outside of Eatonville, there are no subdivisions planned or vested. There may be a few vested short plats in the planning area.

Large tracts in the planning area, such as between Ohop and Harts lake, are being converted from commercial timber to rural residential 20-acre parcels. In one instance (Fairbanks County Estates), property owners with 20-acre parcels would like to further divide the parcels. Many of these tracts will be developed in the future. Rural zoning allows for residences, pastures and hobby farms. The development would increase automobile usage in the Basin. These areas may have logging roads that were not intended for increased traffic and may go through critical areas. In addition, people often clear the land to improve their views. Therefore, areas that were once forested will have less trees and native vegetation, more impervious areas, and may have pets, livestock, septic systems, and increased traffic—all possible pollutant sources. Some of these properties have direct access to lakes and wetlands. As the land is developed, stormwater drainage systems, built and natural, will be affected by the runoff (due to decreased forest cover increased impervious areas) and potential increased pollutant loading.

## 11.3 FLOOD CHARACTERISTICS

The months of November, December, and January have very high stream flows due to winter rainfall. The mountain snowpack plays a strong role in controlling summer flow conditions. The low-flow month generally is August because most of the snow has melted and, usually, very little rain falls in July and August. The Nisqually River Basin suffers from severe winter flooding and from low (often nonexistent) summer flows at certain locations.

*Table 11-3* lists the modeled peak flow calculations for various stream reaches within the Basin, derived from the most recent FEMA *Flood Insurance Study*, which was published in 1987.

A number of large flow events have occurred since then. In particular, a storm in February 1996 led to peak discharges of 21,200 cubic feet per second (cfs) at National; 39,500 cfs at LaGrand Dam; and 50,000 cfs at McKenna (USGS stream flow data). By understanding the potential flood condition for a specific area, it better enables Pierce County to identify mitigation alternatives appropriate for the level of risk for that stream or reach.

### 11.3.1 Known Flood Hazards

*Figure 11-1* shows floodplains and wetlands in the Nisqually River Basin. Pierce County regulates the following potential flood hazard areas per the “*Critical Areas*” Ordinance, Chapter 18E.70, *Pierce County Code* (PCC, 2004):

- **Detailed Study Areas**—FEMA Flood Insurance Rate Map and Floodway Map numbered A zones and V zones. This also includes areas within 300 feet horizontal distance from the base flood elevation established for the mapped A and V zones, and areas within 5 feet of vertical height from the base flood elevation established for mapped A and V zones.
- **Unstudied Areas**—FEMA Flood Insurance Rate Map unnumbered A zones and B zones and areas within 300 feet horizontal distance from the mapped areas of the mapped A and B zones.
- **Natural Waters/Watercourse**—Areas within 65 feet horizontal distance from the ordinary high water mark of an identified natural watercourse.
- **Groundwater Flooding Areas**—Areas within 300 feet horizontal distance from a mapped groundwater flooding area.
- **Potholes**—Areas not mapped as a flood hazard area, but within 10 feet of vertical relief from the bottom of an identified pothole or within 2 feet of vertical relief of a potential surface water outlet.
- **Channel Migration Zones (CMZ)**—Areas where detailed Channel Migration Zone CMZ studies have been completed and accepted by Pierce County.

FEMA flood zones are delineated on *Flood Insurance Rate Maps* (FIRM). FEMA has recently made these data available in an electronic format referred to as a *Digital Flood Insurance Rate Map* (DFIRM). DFIRM data was obtained by Pierce County for use in mapping the detailed study areas and the unstudied areas. Flood hazard areas that are based on detailed studies (numbered A and V zones) were developed by FEMA using detailed methods, which result in flood profile plots and base flood elevations specified along the stream reach studied.

**TABLE 11-3  
NISQUALLY BASIN WATERCOURSE FLOW CHARACTERISTICS PEAK DISCHARGE FREQUENCY  
ESTIMATES FROM FLOOD INSURANCE STUDY (FEMA, 1987)**

Flooding Source and Location	Drainage Area (sq. mi.)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
<b>Nisqually River</b>					
At Mouth	711	21,500	29,000	33,000	45,000
Upstream of Horn Creek	488	21,000	28,000	32,000	44,000
Upstream of Tanwax Creek	446	20,500	27,000	31,000	43,000
At Skate Creek Road	79	6,250	9,080	10,400	13,600
At Mt. Rainier National Park	66	5,400	7,910	9,040	11,900
<b>Horn Creek</b>					
At Mouth	15	192	266	299	376
At Harts Lake Loop Road	7	113	155	174	217
<b>Ohop Creek</b>					
At Mouth	44	953	1,345	1,518	1,945
At Kapowsin Eatonville Road	35	893	1,259	1,421	1,820
Upstream of Confluence with Lynch Creek	18	440	615	690	880
Upstream of Confluence with Ohop Lake	13	364	507	572	724
Downstream of Confluence with Twenty-five Mile Creek	10	334	465	524	663
Upstream of Confluence with Twenty-five Mile Creek	2	71	97	109	135
<b>Mashel River</b>					
Upstream of Confluence with Little Mashel River	56	3,650	5,020	5,620	7,070
<b>Little Mashel River</b>					
At Mouth	24	1,450	1,940	2,140	2,630
Upstream of Confluence with Midway Creek	15	1,010	1,370	1,520	1,890
<b>Kreger Creek</b>					
At Silver Lake Outlet	2	31	39	42	51
<b>Tanwax Creek</b>					
Downstream of Mud Lake Outlet	14	270	375	425	535
Upstream of Mud Lake Outlet	9	196	271	306	384
At 352nd Street East (Golden Road)	6	143	197	222	278
At State Highway 161	4	128	177	198	248

Other flood hazard areas that have been mapped by FEMA (unstudied areas) were developed by approximate methods, which provide no specific data such as peak discharges, flood profiles, or base flood elevations. The following reaches within the Nisqually River Basin planning area have been studied by FEMA using detailed methods:

- Nisqually River from the mouth upstream to the confluence with Ohop Creek.
- Nisqually River from the Snoqualmie National Forest boundary to the Mount Rainier National Park boundary.
- Horn Creek from the mouth to Harts Lake Loop Road 3.5 miles upstream.
- Ohop Creek from the mouth upstream to Kapowsin Lake.
- Mashel River from the confluence with the Little Mashel River upstream for 2.4 miles.
- Little Mashel River from the confluence with the Mashel River upstream for 2.4 miles.
- Kreger Creek between Kreger Lake and Silver Lake.
- Tanwax Creek from 0.5 miles upstream of Eatonville Cutoff Road upstream to Tanwax Lake.
- Harts, Kreger, Silver, Rapjohn, Tanwax, Ohop, and Clear Lakes.

FEMA flood hazard areas designated as A and V zones (both numbered and unnumbered) correspond to areas that have a 1% annual probability of being inundated by a flood event. Flood hazard areas designated as B zones are areas with a 0.2% annual probability of being inundated by a flood event.

Pierce County has also developed mapping data for pothole flood hazard areas and CMZ flood hazard areas. Neither of these types of flood hazard areas is currently mapped in the Nisqually River Basin planning area. However, a CMZ study is currently being conducted on the Nisqually River Main Stem between Alder Lake and the Mount Rainier National Park Boundary. There is also a future CMZ study planned for the Mashel River.

Flooding along the Nisqually River has caused the most damage near the community of McKenna (FEMA 1987). A portion of the inundated area reached a depth greater than 3 feet, which meets the depth criteria for a deep and/or fast-flowing floodway. The inundated area encompassed about 80 parcels.

Flood damages have also been sustained in the Wilcox Flats area, approximately 5 miles southeast of McKenna. Some areas upstream of Lake Alder have also sustained flood damage. Main stem flooding has also caused damage near the Nisqually River Delta (FEMA 1987). However, the Delta area is now used primarily for wildlife habitat and livestock grazing. Because there are few structures in the delta area, the potential for future flood damage is limited.

During high flows, the Nisqually River channel has migrated. An example of this type of flooding was seen at the Paradise Estates on the Lewis County side of the river. Pierce County maintains a levee on the north side of the River near the National Park entrance to protect a number of homes and businesses.

Flooding of property was reported on Murray Creek along Hinkleman Road; Kreger Creek south of Silver Lake; Horn Creek near Kinsman Road; upper Tanwax Creek near the Eatonville Cutoff bridge, and Lynch Creek near the confluence with Ohop Creek. Anecdotal evidence suggests that flooding has occurred along Ohop Creek near the outlet to Ohop Lake and downstream of the SR 161 bridge. Flooding of property was also reported on small miscellaneous drainages (unnamed streams). Out of the 13 cases reported, seven were located in the upper Tanwax Creek subbasin.

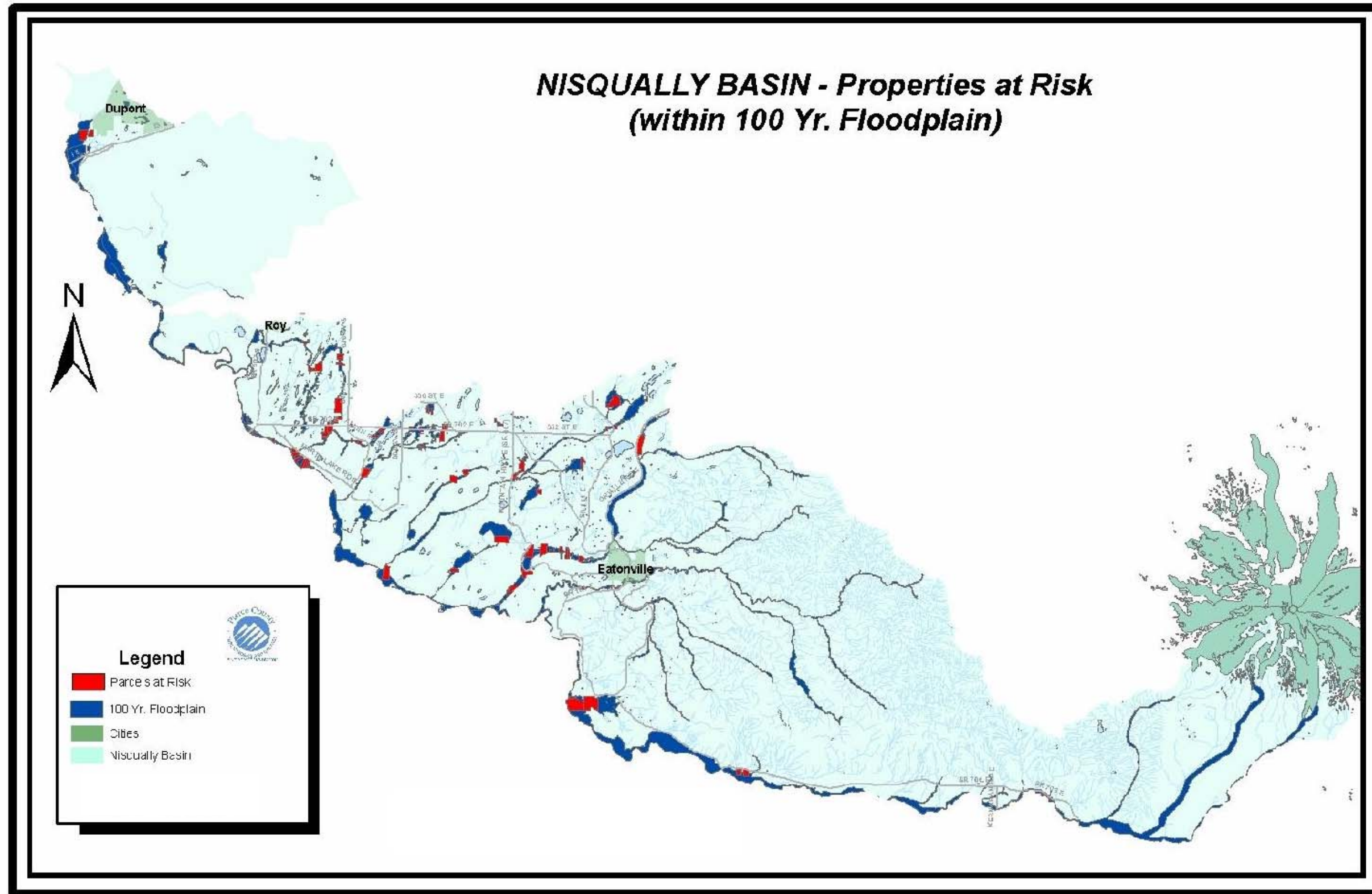


Figure 11-1  
Floodplain extent and location  
Nisqually River Basin



Flooding problems were reported on Cranberry Lake, Rapjohn Lake, Tanwax Lake, Whitman Lake, Ohop Lake, and Clear Lake. In many cases, flooding problems appear to be caused by beavers blocking the outlet to the lake. Beavers were reported to be contributing to flooding on Cranberry Lake, Rapjohn Lake, and Tanwax Lake.

Flooding and drainage problems frequently involved roadway flooding. A total of 60 roadway flooding problems were identified in the study area. Most of these were located in the Murray Creek (10), upper Tanwax Creek (8), Brighton Creek (6), Horn Creek (5), upper Ohop (5) and Kreger Creek (4) subbasins.

### 11.3.2 Causes of Flooding

Major floods in the Nisqually River Basin occurred in 1933, 1965, 1974, 1975, 1977, 1996, and 1997. According to the Federal Emergency Management Agency's (FEMA) *1987 Flood Insurance Study*, major floods typically occur between October and March as a result of rainstorms, sometimes augmented by melting snow. According to the *Pierce County Natural Hazard Mitigation Plan* (2005) the potential for severe flooding is greatest during warm, wet periods when a mid to low level snow pack is combined with long duration rainfall, saturated soils and an elevated water table.

The Natural Hazard Mitigation Plan suggests that there is an increasing potential for urban flooding in Pierce County due to continued population growth and land development. Human alteration of the landscape—including clearing, grading, paving, building construction, and landscaping—has an impact on the hydrologic process. Increasing impervious area decreases infiltration, while clearing of natural vegetation decreases interception storage and allows runoff to flow into streams faster. These effects lead to higher peak flows in streams and greater runoff volumes.

Types of observed within the Nisqually River Basin are:

- Main Stem Flooding
- Tributary Flooding
- Lake Flooding
- Roadway Flooding

#### **Main Stem Flooding**

The *Pierce County Natural Hazard Mitigation Plan* (2005) describes flooding along the Nisqually River as “extremely variable in terms of frequency, severity, and extent.”

Flooding along the Nisqually River has caused the most damage near the community of McKenna (FEMA 1987). Extensive flooding occurred during the February 1996 storm; approximately 80 parcels were inundated by flood waters. Following the flooding of 1996, Pierce County purchased 17 of these parcels at a cost of approximately \$2.5 million. These parcels are now managed by the McKenna Water District. Roughly 60 parcels, including a senior center, remain under private ownership. The taxable value of the remaining parcels is on the order of \$6 million (personal communication with Dennis Dixon, Pierce County Water Programs, 2006).

Flooding in the Wilcox Flats area is suspected to have occurred from floodwaters originating from an ephemeral creek that may serve as an overflow channel to the Nisqually during high river flows.

Along the upper valley (upstream of Lake Alder) there is evidence that the Nisqually River channel has migrated during large events. In November 2006, the headwaters of the Nisqually River received nearly 18 inches of rain in a 36-hour period (Mount Rainier National Park 2006). The resulting flood waters on the Nisqually River caused extensive damage to roads and campgrounds within Mount Rainier National Park where large sections of the north bank eroded. The County-owned levee near the Park Entrance sustained some damage during the flooding event.

### ***Tributary Flooding***

Although there are no known major flooding problems along the tributaries, there is some evidence of minor flooding.

Beavers are a common cause of minor flooding throughout the Basin planning area. Beaver blockages were frequently reported by Basin residents; and as many as eight of the flooding and drainage problems were directly attributed to beavers.

### ***Lake Flooding***

There are numerous small lakes within the planning area, particularly in the lower portion of the Basin. Several of these lakes have houses built around or near the shoreline. In many cases, flooding problems appear to be caused by beavers blocking the outlet to the lake.

### ***Roadway Flooding***

Flooding and drainage problems frequently involved roadway flooding. A total of 60 roadway flooding problems were identified in the study area. Beavers are frequently a cause of roadway flooding because they often build inside culverts to create blockages.

The following items are potential causes of future flooding or flood damages:

- Insufficient maintenance
- Beavers
- Deterioration/failure of existing facilities
- Increased flow from new impervious surfaces
- Diversion or obstruction of drainage courses due to construction
- Filling within floodplain without providing compensatory volume
- Building in floodplain or below maximum flood elevation
- Channel migration (including scour, deposition of sediments and downstream impacts of inadequate efforts to modify channel alignment)
- Lahar flows

Future flooding problems are most likely to arise in areas of residential and commercial development. Although most of the planning area is rural, low-density development can still result in new flooding problems. Most of the low-density development occurring in the planning area is in the western portion of the Basin, particularly areas along major transportation routes.

Future zoning and community planning indicates that there are some areas in the planning area that are expected to have higher-density development. Some of these areas include:

- Vicinity of the city of Roy (Murray Creek subbasin);
- Vicinity of the town of Eatonville (Lynch Creek, lower Ohop Creek, and lower Mashel River subbasins); and
- Upper Nisqually Communities of Elbe, Ashford, and the park entrance (Elbe Creek, Ashford, Copper Creek, Goat/Tenas Creek subbasins).

## 11.4 FLOOD HAZARD IMPACTS

Flooding within the Nisqually Basin can have numerous impacts on the on the way of life within this Basin, and Pierce County in general. Under this section, we will assess the vulnerability of the Basins, improved property, critical facilities, and assess the impact a flooding on the Basin's population and economy.

### 11.4.1 Public Safety and Health

The Nisqually River Basin presents a variety of impacts to life, safety and health. There are no reported losses of life due to flooding within this Basin, but damage and disruption caused by flooding is a severe has been a recurrent problem.

Pierce County has experienced substantial growth in previous years and is expected to support more growth over the next 30 years. According to the U.S. Census, the population of Pierce County in 2000 was 586,203. According to the Puget Sound Regional Council's (PSRC) long-range population forecasts for the forecast analysis zones within Pierce County, the County is expected increase 16% to 812,859, by the year 2010 (PSRC, 2002). According to the *2001 Population and Employment Forecasts* report for the central Puget Sound region, Pierce County is expected to reach the following populations in the years 2010, 2020, and 2030 (PSRC, October 2001):

- 2010: 812,859
- 2020: 892,314
- 2030: 951,747

Future population projections for Pierce County can help to predict future populations within the Nisqually Basin. The estimated 2000 population in the Nisqually River Basin Planning area was 12,881, which is 1.8% of the county's total population 700,820 in 2000. Assuming that the planning area will continue to capture at least 2% of the county's growth, it is predicted that in 2010, the population residing in the Nisqually River Basin planning area will be approximately 16,300 and 18,000 people will reside within the Basin in 2020.

Based on these projections the assumptions for the potential impacts of flooding are as follows:

- There may become increase pressures to develop floodplains within this Basin as land uses change to accommodate the increasing population.
- It should be noted that the current/existing regulatory environment within Pierce County is very focused on not allowing and increase in flood risk exposure due to new development. As long as this regulatory environment remains in tact, the assumption would be that development in responses to this new growth would be directed away from the known flood hazard areas within this Basin.

- There is currently little or no flood warning capability within this Basin. As the population increases within this Basin, the need to increase the County’s flood warning and response capability may increase as well.

There is real-time flood warning capability within the Nisqually Basin. USGS real-time gauges are located at:

- The Nisqually River near Rainer
- The Nisqually river near National
- Mineral Creek near Mineral
- The Nisqually River near LaGrande
- Centralia Power canal
- The Nisqually River near McKenna

There are an additional four stream flow gauges within this Basin available for flood threat recognition. The approximate lead time for flood warning provided within this Basin is 24 to 48 hours based on flood threat recognition system capability within the Basin. Flood prediction is not an exact science. Although gauge readings and historical data are excellent forecasting tools, rivers can continually change. There are also local factors that can contribute to flooding such as stream and creek discharge into a river, snowmelt and damming caused by fallen trees and other debris. Therefore, during flood situations floodplain residents should not rely solely on gage readings and historical flood levels, but should keep an eye on the river and stay tuned to local media reports.

The Nisqually River Main Stem appears to be in generally good condition from a water quality perspective. According to the *Surface Water Quality Assessment Nisqually River Level I Watershed Assessment* (WPN, 2002), the minimum dissolved oxygen concentrations at stations used to collect data for the assessment were well above the state standard, even during late summer. The stream temperature standard was occasionally exceeded at river mile 3.7, but the maximum recorded temperature was only slightly higher than the standard. Fecal coliform levels were occasionally exceeded in winter at river mile 3.7 and river mile 21.8, near the McKenna diversion. Levels at the lower station were slightly higher than the standard.

In November 2000, the Washington State Department of Health restricted harvest status on 74 acres of commercial shellfish beds in the marine waters near the mouth of the Nisqually River (Nisqually Reach) because fecal coliform bacteria concentrations exceeded standards for commercial shellfish harvest.

### 11.4.2 Critical Facilities

Using the parameters to define “Critical Facilities” discussed in [Chapter 1](#) of this risk assessment, Pierce County Water Programs, coordinating with Pierce County Emergency management has identified the critical facilities listed in *Table 11-4* that could be impacted by flooding within the Nisqually River Basin. The basis for this determination is: physical location within a mapped or known floodplain, known history of flooding, and the lack flood protection to the facility. These are facilities that are considered to be vulnerable and in need of an action(s) to mitigate the impacts of flooding. It should be noted that this list does not include critical “infrastructure.”

Since the Pierce County Basin Planning Program has such a strong capital facilities component, it has been assumed that critical infrastructure with vulnerability to flooding within each Basin will be adequately addressed through the Basin Planning problem assessment and action prioritization process. A detailed assessment of these facilities is not provided in this risk assessment for security purposes.

Pierce County Emergency Management has performed this assessment as part of the countywide *Hazard Mitigation Plan* prepared pursuant to the “Disaster Mitigation Act.” The focus of the Pierce County Water Programs’ “Basin Planning Program” as it pertains to critical facilities will be to attempt to provide flood protection to potentially vulnerable critical facilities through the structural approaches identified as actions in the Basin planning programs. The non-structural approaches will be directed by Pierce County’s *Hazard Mitigation Plan*. It is a high priority of both programs to provide protection to critical facilities, and both programs are committed to working together to achieve this objective.

Government Function	Medical	Hazardous Materials	Schools	Other	Total
0	2	0	5	2	<b>9</b>

### 11.4.3 Structures impacted

Table 11-5 shows an estimate of the number of structures on parcels in the floodplain. These estimates were generated using Planimetric data available for this Basin. To identify the potential dollar/loss exposure for the basing, assessed values for improvements to each of the parcels shown to have structures within the 100-year floodplain were accumulated by subbasin. This value is representative of the exposure.

To truly gauge vulnerability, the depth of flooding would need to be identified to apply FEMA’s depth/damage functions to this exposure. This detail of information was not available at the time of the preparation of this assessment. However, total exposure values can be a good gauge of potential flood impact for planning purposes and for identifying potential project benefits when prioritizing mitigation actions.

Structure Type			Total	Market Improvement Value
Commercial	Dwelling	Other		
13	167	80	<b>260</b>	\$26,449,200

### 11.4.4 Repetitive Loss Areas

Utilizing the FEMA definition of “Repetitive Loss” defined under the Community Rating System, there are two identified repetitive loss properties within two repetitive loss areas within this Basin. As description of the two areas is as follows:

#### ***Nisqually Main Stem - Wilcox Reach Repetitive Loss Area***

Pierce County completed a *Repetitive Loss Plan* in July of 2001. This plan identifies one repetitive loss property in the Nisqually River Basin; the property is located in the Wilcox Flats area at the end of 41<sup>st</sup> Avenue South. The owner filed insurance claims in 1980, 1982, 1990, 1991, 1994, 1995, and 1996. According to the owner of the property, the floodwaters do not flow directly onto the property from the Nisqually River, but originate from an unnamed creek east of the property.

The source of the unnamed creek is unknown, but it is ephemeral. The creek may be a historical channel of the Nisqually that currently drains a local drainage and may serve as an overflow channel during high river flows. The *Repetitive Loss Plan* recommended land acquisition as the preferred solution. It is estimated that there are approximately seven additional properties within this reach subject to similar repetitive flooding as the identified property. The total building count for this repetitive loss area is 8. See *Figure 11-2* for a map of this repetitive loss area.

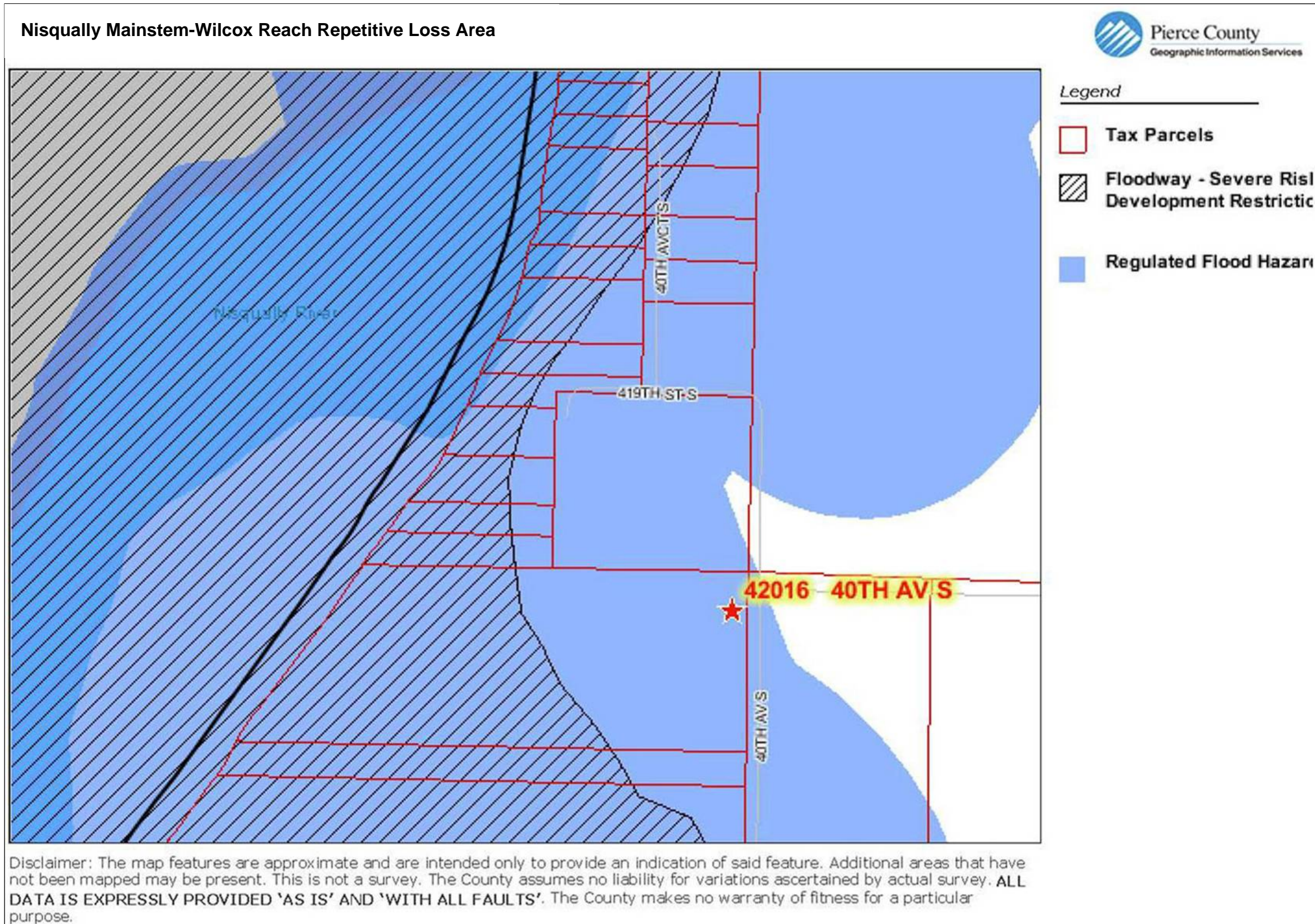
#### ***Ohop Creek Repetitive Loss Area***

This area has been identified repetitive loss area subsequent to the completion of the *Pierce County Repetitive Loss Plan* in 2001, based on new claims data. The current repetitive loss report as of April 30, 2006 shows one identified property in this area.

Ohop Creek is a tributary to the Nisqually River. The terrain of the Ohop Creek Basin consists of nearly level to rolling terrain. Ohop Creek originates north of Ohop Lake, flows into the lake, and continues southward from the lake. Ohop Creek has two tributaries that originate in the eastern portion of the Basin, Twenty-Five Mile Creek and Berg Creek. Twenty-Five Mile Creek conveys flows to Ohop Creek from the northern portion of the Basin. Berg Creek conveys flows to Ohop Creek from the southern portion of the Basin.

The principal cause of flooding along this reach is surface water drainage in to the creek channel was increase stream flow above the capacity of the channel. This results in typical over bank flooding. It is estimated that there are approximately five additional properties within this reach subject to similar repetitive flooding as the identified property.

The total building county for this repetitive loss area is six. See *Figure 11-3* for a map of this repetitive loss area.



**Figure 11-2**  
**Nisqually Mainstem-Wilcox Reach**  
**Repetitive Loss Area**

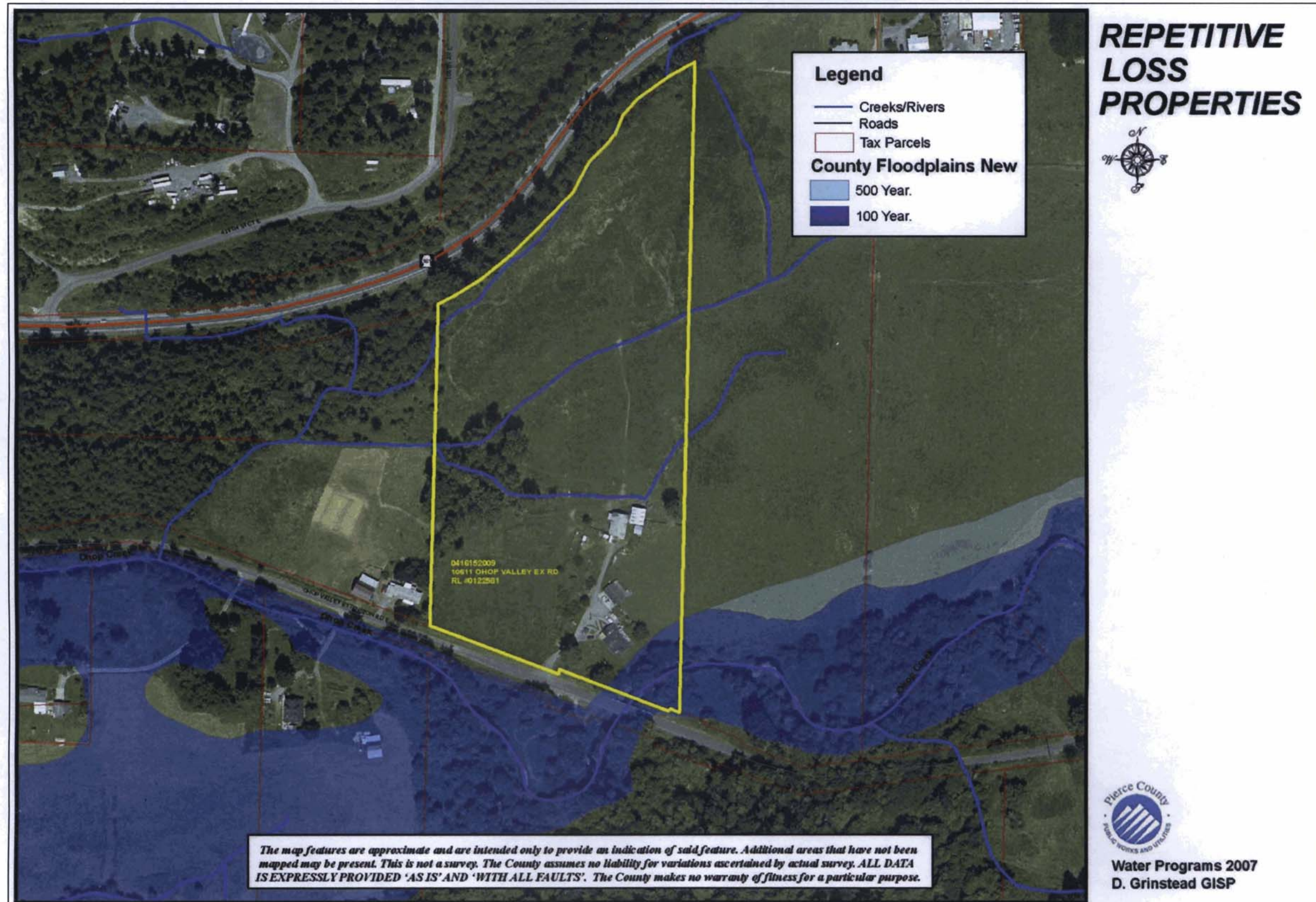


Figure 11-3. Ohop Creek Repetitive Loss Area

### 11.4.5 Insurance Analysis

Flood insurance statistics can help identify vulnerability by regionally isolating areas where claim activity is high and a high rate of flood insurance is in force. *Table 11-6* summarizes vital insurance statistics that can be used to help identify vulnerability within the Nisqually River Basin. The locations of these policies are identified in *Figure 1-2*.

Number of flood insurance policies in force within the Basin (as of May 1, 2007)	74
Number of Policies within a mapped floodplain (FIRM)	6
Number of Policies outside of a mapped floodplain	68
Number of Claims filed within the Basin	19
Number of claims filed for losses outside the 100-year floodplain	2
Estimated number of insurable, primary Structures in mapped floodplains	180
Estimated % of at risk structures with flood insurance coverage	3.3%
% of current flood insurance coverage outside of a mapped floodplain	92%

Based on a review of this data, the following observations can be made:

- Based on the approximate number of primary, insurable structures in the floodplain and the insurance coverage in force within the floodplain, insurance coverage as a form of mitigation appears to be well below the national average. According to a study being conducted for the NFIP by the Rand Corporation, nationwide about 49% of single-family homes in special flood hazard areas (SFHAs) are covered by flood insurance.
- With 92% of the current policies in force located outside of a mapped floodplain, there appears to be some flooding issues within this Basin not addressed via the existing mapping. These could be drainage related flood issues that the Basin Planning Program seeks out, that typically are not captured through standardized floodplain mapping techniques.
- All of the historical claims filed within this Basin have been outside of a mapped floodplain. This once again, suggests that there are flooding issues within this Basin not addressed through flood hazard mapping.
- They very small policy base within this Basin makes it very difficult to establish trends or correlations to identify risk exposure within this Basin.
- The low policy counts within this Basin suggest that there has been wise land use within this Basin, and that new development has been directed away from known flood hazard areas. The continuance of this policy will help to keep the level of risk exposure in balance as this Basin continues to grow.

