CHAPTER 10.
BASIN SUMMARY AND VULNERABILITY ANALYSIS

The findings on groundwater, geomorphology, water quality, stream habitat, nearshore habitat and drainage problems, as outlined in the preceding chapters, are summarized here to provide an overall characterization. An eight-step vulnerability analysis was used to assess the environmental conditions of the Judd Creek and Shinglemill Creek subbasins and develop a priority ranking for restoring these subbasins. A modified vulnerability analysis was used to assess the conditions of the remaining 73 streams.

10.1 SUMMARY OF FINDINGS

10.1.1 Groundwater

The groundwater system beneath Vashon-Maury Island has been designated a "sole source aquifer" by the Environmental Protection Agency, because precipitation falling on the island is the only source for groundwater within the aquifer and the aquifer is the primary drinking water source for island residents. As such, it is important to protect the aquifer from contamination from groundwater recharge. Potential contamination sources include: failing on-site septic systems, seawater intrusion, stormwater runoff, leaking underground storage tanks, landfills, industrial properties, land application of pesticides and fertilizers, and wastes derived from animals and livestock.

From the land surface, precipitation either infiltrates downward into the underlying soils or flows overland into isolated ponds, wetlands, or into streams that flow toward Puget Sound. The ability for rainwater to percolate downward and recharge the island's primary aquifer system is directly related to the geologic materials at the surface and to what extent the land surface has been modified or developed. Manmade impervious surfaces like roads and rooftops restrict rainfall from recharging the aquifer. Where such development occurs, the rainfall that naturally would have infiltrated in that area runs off into the surface water drainage system.

The unconsolidated recessional outwash and ice-contact deposits found primarily along the central upland axis of the island are generally considered the most permeable of the surficial geologic materials. These deposits readily allow rainwater to infiltrate below the ground surface and may be considered significant recharge areas. Where these deposits overlie till, groundwater typically perches on top of the till, forming a shallow groundwater system that forms wetlands and lakes in lower areas. The shallow groundwater discharges into the headwaters of many of the island's surface water streams, providing an important source of base flow to their upper reaches. These shallow groundwater systems are highly susceptible to contamination from potential pollution sources such as surface spills, septic systems, and land where fertilizers or pesticides are misapplied. These areas warrant special protection.

10.1.2 Geomorphology

Stream reaches with significant changes in flow regimes are more likely to experience changes in channel geometry than reaches with little change. Reduced forest cover and increased effective impervious area affect watershed flow regime. Observed damage to stream channels tends to correlate to forest cover reduced below 65 percent and to effective imperviousness area of 10 percent or greater.

At current conditions, no basins on Vashon-Maury Island have more than 10 percent EIA and 13 basins have less than 65 percent forest cover. At future buildout, four basins (Shinglemill Creek Subbasin 4, Judd Creek Subbasin 2, Gorsuch Creek, and Ellisport Creek) will have an EIA of 10 percent or more and forest cover of less than 65 percent. Forty-six other basins have less than 65 percent forest cover. Based on this analysis, given projected development patterns, streams are more likely to be impacted by decreased forest cover than by increased EIA. Therefore, limiting forest reduction should be a high priority to protect streams from potential impacts. On streams already indicating impact, reforestation or acquisition of cleared land is recommended.

Streams flowing through outwash soils are typically more susceptible to erosion than those flowing through till. Likewise, streams in steeper slopes are more susceptible to erosion than those on shallow slopes. Streams that are likely impacted should be monitored in reaches that contain soils of high erosive potential.

10.1.3 Water Quality

No waters on Vashon Island were listed on the Department of Ecology's 1998 303(d) list, but the marine waters of Quartermaster Harbor and Puget Sound east of Vashon are listed.

Water quality data from 20 King County sampling stations was available for review. Sampling observation periods varied from one to four years among the King County stations. Parameters reported included pH, DO, water temperature, and turbidity.

East Vashon had five sampling stations. Mean DO levels were above the 9.5 mg/L standard for AA waters. However, minimum DO levels at all locations were below the standard. Three locations had minimum pH levels below the lower limit but within the limit of variability due to manmade causes. Two stations has temperatures above the 16°C limit. Average turbidity was relatively high at two locations, with extremely high maximum turbidity levels associated with rainfall. High levels were reported for the maximum readings at the other locations.

Judd Creek Basin had seven sampling stations. Minimum DO levels were below the standard at all locations. Three stations had minimum pH readings just below the 6.5 lower limit, at 6.4. Average and maximum temperatures were at or below the standard of 16.0°C. For average conditions, turbidity was relatively high at three locations. All locations showed high maximum turbidity.

Shinglemill Creek Basin had three sampling stations. Minimum DO levels were below the standard at two locations. One station had a minimum pH reading below the lower limit of 6.5. Temperatures were below the limit at all locations. Turbidity was relatively high for two stations with elevated maximums.

West Vashon had four sampling stations. One station had an average DO level below the standard. All stations had minimum DO levels were below standard. Two stations had a pH reading below the lower limit of 6.5. One station had a maximum temperature above the limit. Turbidity measurements were somewhat high, and maximum turbidity measurements were high to extremely high at three locations.

Maury Island had one sampling station, with average DO of 8.8 mg/l, below the 9.5 mg/l standard. Temperatures were below the established maximum. The minimum pH at 6.4 was below the 6.5 standard; however, a 0.2 variation is allowed for manmade causes. Average turbidity was 4.3 NTU, but the maximum turbidity event was extremely high with a measurement of 138 NTU associated with heavy rain.

An area-wide problem for Vashon-Maury Island has been lead and arsenic contamination of surface soils by emissions from historical smelter activity in the Tacoma area. The King County Health Department is conducting a study and planning effort to address the contamination. The level of stormwater runoff contamination has not been quantitatively assessed through current monitoring data, and could be a priority for inclusion in future monitoring.

Additional sampling is recommended for agriculture-related parameters for general water quality sampling island-wide. This would include fecal coliform, BOD, ammonia-nitrogen, and in heavily farmed areas, pesticides. In the Vashon Town Center and other areas that have more human activity, consideration should be given to sampling for metals and toxins, in coordination with a Health Department study.

10.1.4 Stream Habitat

The Vashon-Maury Island has 75 mapped streams, ranging from high-gradient streams with little or no salmonid habitat to lower-gradient streams that support substantial salmonid populations. The larger streams originate from a series of groundwater seeps in the upland areas of the island and flow through a system high-gradient ravines before discharging into Puget Sound. Smaller stream systems also originate from the upland seeps and springs and flow through steep, incised ravines to Puget Sound. All of the streams drop through these steep, 10- to 15-percent gradient channels through the bluff line that surrounds the island. Salmonid (salmon and trout) species that inhabit streams on Vashon-Maury Island include coastal cutthroat trout, rainbow/steelhead trout, coho salmon, chum salmon, and chinook salmon.

Stream habitat data are limited for the Vashon-Maury Island system.

Vashon-Maury Island has been moderately altered from historical conditions. Many streams on the island have poor habitat conditions as shown in Table 7-1.. Kerwin et al. (2000) assessed the conditions of the streams. Of the nine parameters examined, access, large woody debris (LWD), streambed sediment, and riparian parameters had the most data. Fish access varied from poor to good, but was rated as poor in 63 percent of streams that were rated. Large woody debris was rated as poor in 50 percent of streams, fair in 25 percent, and good in 25 percent of streams that were rated. Streambed sediment was rated as poor in 88 percent of stream that were rated. Riparian conditions were rated as poor in 75 percent of streams rated.

Fish passage in Vashon-Maury Island streams is poor: 38 of the 75 streams had possible or total barriers. The abundance of fish passage barriers is a predominant limiting factor in this system. The barriers prevent fish access to miles of potential spawning and rearing habitat, significantly impairing the production potential of the two islands.

Habitat conditions on Vashon-Maury Island have been significantly altered by land use practices. The lack of LWD in many of the streams is likely a factor in the lack of pool habitats in many of the streams. Increasing the abundance of LWD may enhance habitat conditions, since it increases stream channel complexity, creates pools and side channel habitat, and provides cover. In high-gradient streams, large woody debris can reduce local gradients by forming plunge pools and slack pools, producing a stepped sequence of pool habitats that can significantly increase available fish habitat in streams.

Many of the habitat barriers and habitat conditions are addressed in the recommended action items.

10.1.5 Nearshore Habitat

The Vashon-Maury Island nearshore accounts for 51 miles of shoreline, which represents more than half of the 96 miles of shoreline in WRIA 9 in King County (when including Vashon and Maury Islands). Tidal patterns tend to circulate around the island, with predominant flow to the south on the east side of the island and to the north on the west side. Eroding steep coastal bluffs, along with contributions from coastal streams, provide material for nearshore sediments and beaches. Nearshore habitats around the island include eelgrass meadows, kelp forests, tide flats, tidal marshes, sub-estuaries, sand spits, beaches, backshore, banks and bluffs. These habitats support a variety of communities and ecosystem functions.

Substantial modifications to the nearshore have occurred: 50 percent of the island's shoreline is armored and 30 percent of the shoreline vegetation has been removed. The waters of Quartermaster Harbor, an important spawning area for forage fish such as sand lance and surf smelt, has been listed for impaired water quality and need protective measures against further impairment.

The Central Puget Sound Basin as a whole is the most heavily urbanized area in the Puget Sound region, and the impacts of human activities have taken a toll on natural resources and the habitat that supports them. Nearshore habitat alterations, degradation, and losses have resulted from a number of activities, including filling, dredging, shoreline armoring, over-water structures, waste and wastewater disposal, nonpoint-source pollution, vegetation removal, shoreline development, roads, and changes in hydrology. Significant landscape changes and species extinction or reduction have occurred in less than 130 years, compounded by slow and inadequate response to habitat and species losses. As a result, many salmonid stocks are in serious decline. In the Puget Sound region, chinook salmon and bull trout are listed as threatened under the ESA. Coho salmon is a candidate species for listing. Although the problems contributing to habitat and species decline are complex and extend beyond the Vashon-Maury Island nearshore, the island's nearshore and its tributary areas are an important and interrelated component of this system.

On Vashon-Maury Island, recommended action items include preservation of these undeveloped shorelines and restoration of the habitat in degraded areas.

10.1.6 Drainage Problems

Of the 221 drainage complaints logged by the County from 1990 through 2002, 88 were requests for information, reports of illegal dumping, or other types not applicable to scope of this report. Most of the remaining 133 complaints can be characterized as isolated, hydrologically independent drainage problems. The reported problems were scattered across the island. No significant concentration of problems occurred in any particular area, except for local flooding along SW Bank Road and in chronic landslide areas.

Overall, many of the problems came from private systems and were small in scale. Of those larger in scale, most have already been addressed by King County Roads Maintenance or other agencies. The remainder are listed for consideration for capital improvement actions.

10.2 WATERSHED VULNERABILITY ANALYSIS

Because of their size and habitat value, Judd and Shinglemill Creek are ranked highest on Vashon-Maury Island for planning purposes and sufficient information was collected to complete a watershed vulnerability analysis. A modified vulnerability analysis of the remaining 73 streams was performed with available information.

The Center for Watershed Protection (CWP) developed an eight-step analysis for assessing the environmental condition of subbasins and their suitability for efforts to improve those conditions. The analysis classifies subbasins as one of the following:

- Sensitive—Impervious cover is less than 10 percent of the subbasin's area and streams are of high quality, with excellent habitat and water quality
- Impacted—Impervious cover is 10 to 25 percent of the subbasin's area and streams show signs of degradation attributable to urbanization, such as higher storm flows, unstable banks, reduced habitat and diminished water quality.
- Non-Supporting—Impervious cover exceeds 25 percent of the subbasin's area and streams can no long support diverse biological communities.

In addition to classifying the subbasins as one of these three categories, the analysis defines each basin as restorable (having enough retrofit potential for meaningful improvements in hydrology and pollutant loading) or not. The eight-step analysis provides the following information for each subbasin:

- An initial classification, based solely on impervious area
- A final classification, based on more detailed assessments of conditions along the stream corridor and throughout the subbasin
- A ranking of subbasin vulnerability to impacts from future changes, based on expected future development
- A priority ranking for which subbasins most merit prompt restoration activities.

Appendix G includes the CWP's description of the analysis process and a spreadsheet showing the results for the subbasins in Judd Creek and Shinglemill Creek. Table 10-1 summarizes these results. The subbasins of Judd and Shinglemill Creeks flowing into Puget Sound were classified as sensitive estuary and restorable. The remaining subbasins were classified as sensitive and restorable.

TABLE 10-1.
RESULTS OF JUDD CREEK AND SHINGLEMILL CREEK
VULNERABILITY ANALYSIS

Subbasin	Classification		Vulnerability Rank[a]	Priority Rank for Restoration Activities[b]
	Initial	Final		
JUD 1	Sensitive Estuary	Sensitive Estuary & Restorable	2	3
JUD 2	Sensitive	Sensitive & Restorable	2	2
JUD 3	Sensitive	Sensitive & Restorable	4	6
SHI 1	Sensitive Estuary	Sensitive Estuary & Restorable	3	4
SHI 2	Sensitive	Sensitive & Restorable	4	5
SHI 3	Sensitive	Sensitive & Restorable	5	7
SHI 4	Sensitive	Sensitive & Restorable	1	1

a. 1 = most vulnerable to impacts from future development; subbasins are ranked the same when the analysis for vulnerability showed no difference between them.
b. 1 = highest priority for restoration activities.

Based on the findings of this analysis, the remaining 73 streams on Vashon-Maury Island would likely be classified "sensitive and restorable." Since qualitative data are lacking for most of these streams, a habitat assessment of these streams would be required to properly classify conditions and identify improvement projects. Aerial photo analysis provides limited value because the overstory is dense along the streams. Therefore, a stream walk is necessary for accurate stream habitat classification.

A preliminary ranking of the remainder of the streams on Vashon-Maury Island was made using a modified vulnerability analysis that accounts for watershed size, percent forest cover and percent effective impervious area. The streams were grouped into two categories: large streams with watersheds of 0.5 square miles or larger; and small streams with watersheds of less than 0.5 square miles. They were ranked as follows:

1. Most vulnerable group: <65% current forest, >10% future EIA, ranked by descending basin area.
2. Next group: <65% current forest, ranked by descending basin area.
3. Next group: <65% future forest, ranked by descending basin area.
4. Next group: ranked by descending basin area.

The results of this analysis are found in Appendix G. A summary of the 10 highest ranking creeks is given in Table 10-2.

TABLE 10-2.
RESULTS OF MODIFIED VULNERABILITY ANALYSIS
10 HIGHEST RANKING CREEKS

WA Trout Stream No.	Stream Name	Priority Rank for Restoration and Preservation Activities[a]
42	Judd	1[b]
12	Shinglemill	1[b]
41	Fisher	1[b]
63	Ellisport	4
65	Gorsuch	5
66	Dilworth	6
44	Raab's	7
37	Tahlequah	8
62	Ellis	9
38	Chen	10

a. 1 = highest priority for restoration activities.
b. Because of their size and habitat value, Judd Creek, Shinglemill Creek and Fisher Creek are ranked highest.

For streams other than Judd Creek, Shinglemill Creek, and Fisher Creek, it is recommended that a habitat assessment be performed for a complete vulnerability analysis to verify classification and preliminary ranking, and to target preservation and restoration capital improvement projects in the appropriate watersheds.