CHAPTER IV, SECTION 10

WATER QUALITY AND HYDROLOGY

Changing the Airport's landscape, as would happen with the proposed Master Plan Update alternatives, could affect the hydrology of the Airport area as well as the downstream systems. Alternatives 2, 3, and 4 (the "With Project" alternatives) would include earthwork and the addition of impervious land surface area. These factors would decrease the amount of rainfall infiltrating the soil and increase stormwater runoff flow rates and volumes. Unmitigated, these changes in hydrology could cause downstream flooding, channel erosion, and degraded in-stream habitat. Detailed hydrologic modeling of the Airport and its surrounding watersheds was performed to quantify the magnitude of downstream impacts and to determine appropriate mitigation strategies.

Preliminary estimates indicated that 61 acre-feet of new on-site detention storage volume would be required for proposed developed areas draining to Miller Creek, and 31 acre-feet of storage would be required for areas draining to Des Moines Creek. These detention volumes would attenuate peak runoff rates from the Airport to provide protection from downstream flooding for storms having up to a 100-year return period. New impervious areas would increase annual runoff volumes to lower Miller Creek by 6 to 8 percent and volumes to Des Moines Creek by 1 to 2 percent. Most of the additional volume would flow through the downstream systems at rates that have low erosion potential. Higher runoff volumes could be partially offset by stormwater infiltration where on-site soils are suitable. Stormwater infiltration also would recharge shallow groundwater. In both creeks, low and median flow rates would be largely unaffected throughout the year, and high flows would increase slightly, most likely with no adverse impacts on stream channel characteristics.

Although Miller and Des Moines Creeks occasionally violate Class AA (extraordinary) water quality standards for selected parameters during storm flow conditions, water quality generally appears to be good. Some shallow and perched groundwater has been contaminated by leaking fuel distribution systems and underground storage tanks at the Airport. Other shallow, perched groundwater is assumed to be good quality. Deeper, regional groundwater resources used as drinking water are excellent quality and have no history of detectable levels of pollution.

Although pollutant loading would increase somewhat because of greater amounts of stormwater runoff associated with the "With Project" alternatives, compliance with mitigation requirements would be expected to prevent significant pollution or degradation of surface and groundwater resources.

(1) METHODOLOGY

The objectives of this analysis were to characterize existing hydrologic conditions in downstream systems, to evaluate hydrologic impacts, and to determine appropriate mitigation. HSP-F[1] Version 10.0, a continuous simulation hydrologic model, was used to model the hydrology of the Airport, Miller Creek, and Des Moines Creek.[2] Data included in this document were generated as part of the modeling analysis contained in **Appendix G.**

The HSP-F model for Miller Creek was based on an earlier HSP-F model of the entire watershed developed for King County to use to evaluate the Lake Reba Detention facility for stormwater control.[3] Flood frequency estimates from this earlier model were subsequently used in FEMA floodplain studies for Miller Creek.[4] For this analysis, the previously developed HSP-F model was upgraded with stream channel characteristics data from the FEMA studies and calibrated with five years of stream flow data (July 1989 to June 1994) collected by King County Surface Water Management Division from gages at the Lake

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1/ *User Manual for Release 10, Hydrologic Simulation Program - FORTRAN (HSP-F), Environmental Protection Agency, 1993.*

2/ *HSP-F Hydrologic Modeling Analysis For Sea-Tac Airport Master Plan Update EIS,* Montgomery Water Group, 1995. (currently in Preliminary Draft version)

3/ *Miller Creek Regional Stormwater Detention Facilities Design Hydrologic Modeling,* Northwest Hydraulics Consultants, 1990.

4/ *Miller Creek, Normandy Park, Washington, Limited Map Maintenance Study,* Northwest Hydraulics Consultants, 1991.

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Reba Detention facility and lower Miller Creek (as shown in **Exhibit IV.10-1**).

The HSP-F model for Des Moines Creek was based on recent hydrologic studies including a hydrologic model developed for the 1994 SASA EIS and another model used to design Tyee Pond.[5] Data from the *Des Moines Creek Watershed Plan*[6] also were used in developing the HSP-F model. The Des Moines Creek model was extended downstream to South 208th Street and calibrated with five years of stream flow data (October 1989 to July 1994) collected by King County Surface Water Management Division at the inlet to Tyee Pond (**Exhibit IV.10-1**).

Hydrologic simulations were based on 47 years of hourly precipitation records collected at the Airport from 1947 through 1994. The simulations focused on the operational impacts of the proposed Master Plan Update alternatives.

Representative locations along Miller Creek and Des Moines Creek were selected to evaluate the alternatives. Three locations were evaluated along Miller Creek, including below the Lake Reba Detention facility (Location A in **Exhibit IV.10-1**), at First Avenue S. (Location B), and near the mouth of the creek (Location C). Two locations were evaluated along Des Moines Creek, including below the confluence of the east and west branches (Location D) and at South 208th Street (Location E). Both Miller Creek and Des Moines Creek were simulated for a 47-year period. At each location, hydrologic parameters including flood frequencies, annual flow duration, annual runoff volumes, and flow exceedance characteristics as is listed in **Table IV.10-1** were summarized and evaluated.

A flood frequency analysis for existing conditions was done to characterize the peak flow rates in the creeks, which then served as a basis for determining the adequacy of the prescribed stormwater management facilities in attenuating peak flow rates under Alternative 2, 3, or 4. For the flood frequency analysis, various return periods for the peak flows were considered, including 100-year, 10-year, 2-year, and 1.11-year periods. Peak flows for each of these return periods have a probability of occurring, during any given year, of 1 percent, 10 percent, 50 percent, and 90 percent, respectively. The 100-year and 10-year return periods are conventionally used to evaluate flooding potential, while 2-year and 1.11-year return periods are most commonly used to evaluate stream channel erosion and sedimentation potential. Comparing flow durations and annual runoff volumes of Alternatives 2 through 4 against those of Alternative 1 provided an indication of stream channel erosion potential. Differences in annual runoff volumes among the alternatives also were calculated to evaluate changes in recharge to shallow groundwater.

Determining flow exceedance characteristics for the alternatives allowed a comparison of average flow rates during different seasons of the year when habitat requirements for aquatic species may vary. For purposes of this analysis, low, median, and high flow rates were evaluated during different seasons of the year representing 90, 50, and 10 percent flow exceedance levels, respectively.

Analysis of water resources in the Miller and Des Moines Creek basins was based on review of existing data. Potential impacts of each alternative on surface and groundwater resources were assessed by comparing estimates of pollutant loads in stormwater runoff for each alternative with existing water quality, state water quality standards, and other relevant water quality criteria, and known pollutant characteristics (e.g., fate, transport, and toxicity). In addition, required and practicable mitigation measures are discussed.

(2) EXISTING CONDITIONS

The following paragraphs summarize the existing surface water and ground water quality.

(A) Hydrology

Miller Creek watershed has a total basin area of 5,183 acres as is listed in **Table IV.10-2**. The watershed has about 1,224 acres of effective impervious land area with 60 impervious acres at the Airport. Des Moines Creek watershed has a total basin area of 3,585 acres. Des Moines Creek watershed has about 1,202 acres of effective impervious area with 369 impervious acres at the Airport.

The primary land uses in the watersheds are residential and commercial. Approximately

[5] *South Aviation Support Area Final Environmental Impact Statement*, Port of Seattle, 1994

[6] *TR-20 Model Files for Des Moines Creek Pond C (Tyee Pond)*, King County Surface Water Management Division, [illegible].

62 percent of the land use in the Miller Creek basin is residential, 14 percent is commercial (non-Airport), and 4 percent is Airport. Approximately 29 percent of the land use in the Des Moines Creek basin is residential, 23 percent is commercial (non-Airport), and 27 percent is Airport. Both Miller Creek and Des Moines Creek watersheds are urbanized and exhibit "flashy" stream flow characteristics associated with developed basins. Storm flow rates measured in the creeks at the established gage stations, as well as those modeled, generally showed rapid flow rate increases in response to rainfall and rapid decreases at the cessation of storms. Between 1987 and 1991, King County Surface Water Management Division received drainage and flooding complaints in the Miller Creek watershed, some of which were flooding and erosion problems along Miller Creek.[7]

Flood frequencies under existing conditions were computed by using 47 years of hydrologic simulation for Locations A, B, and C along Miller Creek and Locations D and E along Des Moines Creek (as shown in **Exhibit IV.10-1**). The 100-year flow rates in Miller Creek, for instance, ranged from 171 cubic feet per second (cfs) below the Lake Reba Detention facility to 468 cfs at the mouth (**Table IV.10-4**). The 2-year flow rates ranged from 80 cfs below the Lake Reba Detention facility to 173 cfs at the mouth. The 100-year flow rates in Des Moines Creek were estimated to be 232 cfs below the confluences of the east and west branches and 280 cfs at South 208th Street, while the 2-year flow rates at these locations were 103 cfs and 112 cfs, respectively (**Table IV.10-5**).

Average seasonal flow rates were computed for existing conditions to illustrate the range that occurs throughout the year. Low, median, and high flow rates were calculated for Location B along Miller Creek and for Location D along Des Moines Creek (**Exhibits IV.10-2** and **IV.10-3**). Stream flow rates are highest from October through April, coinciding with the wet season. Flows in the streams typically reach their lowest rates between May and September. Similar seasonal flow characteristics were found at Locations A, C, and E and are listed in **Appendix G.**

(B) <u>Surface Water Quality</u>

Surface water resources within the vicinity of the Airport are shown in **Exhibit IV.10-4.** Portions of three drainage basins are within the vicinity of the Airport: the Lower Green River basin, the Miller Creek basin, and the Des Moines Creek basin. Presently, minimal runoff from the Airport drains to the Lower Green River basin. Approximately 19% of the existing Airport surface area is in the Miller Creek basin, and approximately 81% is in the Des Moines Creek basin, with portions from each basin going to the Industrial Wastewater System (IWS).

The Miller and Des Moines Creek basins exhibit similar drainage patterns, topographic characteristics, and land uses. Drainage from both basins flows to Puget Sound. Several tributaries, lakes, and wetlands are associated with each of these drainages. The Seattle-Tacoma International Airport covers an estimated 5 percent of the Miller Creek basin and 30 percent of the Des Moines Creek basin.

Miller Creek and Des Moines Creek and their tributaries are classified by the Washington Department of Ecology as Class AA (extraordinary) waters.[8] Surface waters are classified on the basis of both present and potential water uses. Classes range from Class AA (extraordinary) to Class C (fair). Although Miller and Des Moines Creeks are classified as Class AA (extraordinary) waters, they presently fail to meet some of the state water quality standards listed in **Table IV.10-6.**

Water quality degradation in Miller and Des Moines Creeks and their tributaries is characteristic of pollutants commonly found in urban stormwater runoff. Such pollutants, including nutrients, organics (e.g., oil and grease), metals, fecal coliform bacteria, and suspended solids, have contributed to occasional violations of Class AA water quality standards and federal water quality criteria in these basins. Miller and Des Moines Creek storm flow monitoring data

[7] *Drainage Complaints Information for Miller/Salmon/Seola Basin Planning Area, King County Surface Water Management Division, 1992.*

[8] *Washington Administrative Code - Water Quality Standards for the Surface Waters of the State of Washington.* WAC 173-201A, November 25, 1992.

indicate that state Class AA water quality standards are occasionally violated for pH, dissolved oxygen, and ammonia (as shown in **Table IV.10-3**). In addition, these data indicate that fecal coliform bacteria numbers frequently exceed state water quality standards. Potential sources of fecal coliform bacteria include failing septic systems in residential areas near Miller and Des Moines Creeks. Total phosphorus levels observed in storm flow samples often exceed the U.S. Environmental Protection Agency total phosphorus criterion of 100 µg/L, which is recommended to prevent nuisance algal growths in streams.[9] Except for occasional contributions of glycol and ammonia following deicing events and elevated copper and zinc, pollutant concentrations observed in airport stormwater runoff are comparable to storm flow monitoring data results collected from locations upstream and downstream of the Airport in both basins. These data appear to indicate that pollutant sources in both basins are widespread and not limited to the Airport. Runoff from portions of state highways 509, 518 and 99 within these drainage basins are likely major contributors to elevated levels of metals and suspended solids in Miller and Des Moines Creeks.[10]

National and local (Bellevue, Washington) studies of urban runoff have shown that copper, lead, and zinc are generally the most common and abundant metals in urban runoff.[11] The U.S. Environmental Protection Agency has determined that most metals in stormwater runoff are associated with or bound to suspended solids and, thus, generally are not available to aquatic life as potential toxicants. Approximately 40 percent or more of the total copper and zinc in stormwater runoff may be in dissolved forms.[12] Therefore they can be taken up by aquatic life through water, plants, and other animals ingested. Copper, zinc, and lead are generally the metals of most concern in urban stormwater runoff.

Urban and Airport stormwater runoff contribute to elevated levels of pollutants in Miller and Des Moines Creeks during storms. Many of these pollutants (e.g., organics and metals) are bound to suspended solids that pass rapidly through the systems and are deposited in the sediments of receiving waters, including Puget Sound. Consequently, concentrations of these solids-bound pollutants in streams quickly diminish as storm events pass and base flow conditions return.[13]

Existing pollutant loading contributions to Miller and Des Moines Creeks have been estimated for the Airport, the remainder of the basins, and the total basin. The relative pollutant contribution from Airport stormwater runoff was compared to total pollutant loading in each basin. Pollutant loadings for seven pollutants (TSS, BOD, TP, copper, lead, zinc, and oil and grease) in Airport stormwater runoff have been estimated based on water quality monitoring data. Pollutant loadings from the Airport may be over-estimated as stormwater samples were collected on the front end of storm events when pollutants concentrations appeared to be higher compared to the remainder of the storm flow event[14].

Annual pollutant loadings were estimated for these pollutants for the remainder of the Miller and Des Moines Creek basins by multiplying a range of established low and high loading rates for different land uses (e.g., open space, commercial, residential) by the appropriate land use areas. Total pollutant loadings were then calculated by adding Airport contributions to the remainder

[9] *Toward a Cleaner Aquatic Environment.* K.M. MacKenthun, U.S. Environmental Protection Agency, Washington, D.C. 1973 (As cited by U.S. EPA 1986)

[10] Personal communication with David Masters, King County Surface Water Management Division, March 22, 1995

[11] *Toxicants in Urban Runoff.* Galvin, D.V. and R.K. Moore, Municipality of Metropolitan Seattle, Seattle, WA. 1982. *Bellevue Urban Runoff Program Summary Report.* Pitt, R. and P Bissonnette, City of Bellevue, Storm and Surface Water Utility, Bellevue, WA. 1984. *Effects of Seattle Area Highway Stormwater Runoff on Aquatic Biota.* Highway Runoff Water Quality Report No. 11. Portele, G.J., B.W. Mar, R.R. Horner, and E.B. Welch, Department of Civil Engineering, University of Washington, Seattle, WA. 1982. *Results of the Nationwide Urban Runoff Program, Volume 1 - final Report.* Water Planning Division, U.S. Environmental Protection Agency, Washington, D.C. 1983.

[12] *Results of the Nationwide Urban Runoff Program, Volume 1 - final Report.* Water Planning Division, U.S. Environmental Protection Agency, Washington, D.C. 1983.

[13] *Toxicants in Urban Runoff.* Galvin, D.V. Pages 176-210 in R. Seabloom and G. Plews, eds. Proceedings of the Northwest Nonpoint Source Pollution Conference. Washington Department of Social and Health Services, Olympia, WA. 1987.

[14] *Seattle Tacoma International Airport Stormwater Pollution Prevention Plan,* Port of Seattle, June, 1995.

of these basins (**Table IV.10-7**). All pollutant loading rates used were based on data collected in Pacific Northwest region (i.e., Portland, Seattle, King County) studies. Therefore, it is expected that actual pollutant loading rates would be accurately represented by the estimated loadings and actual loading rates would likely fall somewhere in between the low and high loading estimates. Based on estimated loading rates, the Airport contributes about 2 to 39% of the total TSS, BOD, TP, copper, lead, zinc, and oil and grease pollutant loads in the Des Moines Creek basin and between less than 1 and 4% of the total loading for these pollutants in the Miller Creek basin.

The percent contribution of Airport stormwater runoff to total annual pollutant loading varies for the different parameters, depending on the loading rate used for estimating loadings from the remainder of the Miller and Des Moines Creek basins. Using the lower loading rates for the different land uses, the Airport contributes a higher percentage of the total pollutant loading. Using the higher loading rates, the Airport contributes a lower percentage of the total pollutant loading. The relative contributions of these pollutants to the total pollutant loadings in each basin is generally lower than the percent of each basin that the Airport covers (i.e., 30% of the Des Moines Creek basin and 5% of the Miller Creek basin). The only exception being that the Airport could contribute as much as 39% of the total copper loading in the Des Moines Creek basin based on estimated total copper loadings using the lower loading rate for the appropriate land uses in the remainder of the basin. A majority of the total pollutant loads for these seven pollutants comes from stormwater runoff from other urbanized areas within each basin. Estimated contributions from the Airport to the total pollutant loadings for these pollutants supports the statements that Airport runoff is generally comparable or cleaner than stormwater runoff from other urban areas in these basins for these pollutants and that sources of pollutants to the creeks are widespread in these basins.

The *Annual Stormwater Monitoring Summary Report* [15] also indicates that Airport stormwater runoff is generally cleaner or comparable to urban runoff for TSS, BOD, TP, total copper, total lead, total zinc, and oil and grease. It should be noted; however, that based on limited Airport stormwater monitoring for dissolved metals (i.e., copper, lead, and zinc), a majority of the copper and zinc appears to be in dissolved ionic forms. Therefore, the Airport may contribute to a higher percentage of the total dissolved copper and zinc pollutant loadings in Miller and Des Moines Creeks. This is important because dissolved metals are more toxic to aquatic biota. The stream monitoring study of Miller and Des Moines Creeks being conducted by the Port of Seattle this winter (1995-1996) at selected locations upstream and downstream of Airport stormwater discharges of the receiving waters is expected to determine toxicity of Airport stormwater runoff and creek water quality.

Other pollutants sometimes found in Airport stormwater runoff include ethylene and propylene glycol, potassium acetate, and ammonia. Ethylene and propylene glycol are presently used in the deicing of aircraft, and urea and potassium acetate are used to de-ice runways and taxiways at Sea-Tac Airport. In general, deicing of large numbers of aircraft occurs infrequently; however, deicing of some aircraft (MD-80) occurs frequently. Anti-icing of runways and taxiways occurs infrequently during snow storms or when water is present on runways and taxiways and temperatures are at or below freezing. As a result, relatively small quantities of these substances are used annually during Airport operations compared to other large airports. In 1991, an estimated 115,000 gallons of deicing fluid were used at Sea-Tac Airport[16]. *All* of the aircraft deicing areas drain to the Industrial Wastewater System (IWS). Runways and taxiways drain to a separate storm drainage system. Some glycols and ammonia (from degradation of urea) have been observed in stormwater runoff.

Most of the glycols from aircraft deicing are collected and conveyed to the IWS and treated by the IWS treatment plant before being discharged to a sewer line that carries effluent to the Midway Sewer Treatment

[15] *Annual Stormwater Monitoring Summary Report*, Port of Seattle, August 1995.

[16] *Draft Sea-Tac Airport Comprehensive Stormwater and Industrial Wastewater Plan: Task 4 Report- De-icing Fluids Handling Practices*, prepared by KCM, Inc. for the Port of Seattle, 1994.

Plant. Glycols have been observed in four of seven monitored stormwater outfalls. Glycol concentrations monitored in Airport stormwater runoff are generally two orders of magnitude below levels reported to have acute toxic effects on salmonids. Levels of glycols in Airport stormwater runoff samples have ranged from below analytical limits of detection (<5 mg/L) to 479 mg/L[17]. Although unlikely, glycol levels in stormwater runoff, which contribute to biochemical oxygen demand, may contribute to reductions in dissolved oxygen and chronic effects on aquatic biota (e.g., reduced growth or increased susceptibility to disease).

Ammonia (from the degradation of urea used in runway anti-icing) levels observed in Airport stormwater runoff occasionally exceed both Class AA acute and chronic toxicity standards. Ammonia levels (from degradation of urea) in stormwater runoff samples have ranged from below limits of detection (<0.01 mg/L) to 13.1 mg/L. Elevated levels of glycols and ammonia in Airport stormwater runoff may contribute to adverse impacts on the biota of receiving waters.

Some heavy metals, particularly copper, lead, and zinc appear to violate both chronic and acute toxicity standards for aquatic life. Because metals data are reported as total metals and state water quality standards are based on dissolved ionic forms, it is uncertain whether or not chronic and acute toxicity standards for these metals are occasionally violated. State water quality standards (not shown in **Table IV.10-2**) govern dissolved metals and vary depending on receiving water hardness.

Water quality data available for Miller and Des Moines Creeks indicate that water quality has been degraded by urbanization and pollutant loading from urban stormwater runoff. Although Miller and Des Moines Creek monitoring data show that pollutants in storm flow and base flow occasionally violate selected Class AA water quality standards, water quality generally appears to be good, as indicated by the presence of resident and anadromous salmonid populations (e.g., trout and salmon). Salmonids, which require cold, clean water, generally are indicators of good water quality. Even though base flow water quality may be considerably better than storm flow water quality, limited base flow data for conventional parameters on Miller Creek indicate that temperature, dissolved oxygen, and pH infrequently violate state water quality standards.[18] These base flow data also indicate that numbers of fecal coliform bacteria frequently exceed the Class AA water quality standard. Violations of these parameters are not necessarily an indication of the presence of toxic concentrations of pollutants or poor water quality. Although no base flow data are available for Des Moines Creek, it appears likely that Des Moines Creek base flow water quality is similar to that of Miller Creek, since no permitted industrial discharges are present and because Des Moines Creek has similar drainage area, watershed, and land use characteristics.

Historically, fuels spills from the Airport have had a significant adverse impact on water quality in Des Moines Creek. Three fuel spills to Des Moines Creek have been reported since 1973. Each of these spills resulted in the mortality of fish and aquatic life in Des Moines Creek.[19] In 1973, an uncertain quantity of fuel was spilled into Des Moines Creek. The cause of this first spill was not reported. The 1985 and 1986 spills, which occurred at the Olympic tank farm and the Northwest tank farm, respectively, were caused by problems with the stormwater drainage and containment systems at those facilities. The spill at the Olympic tank farm occurred when a valve on a stormwater discharge line was inadvertently left open, permitting the spilled fuel to discharge to Des Moines Creek. All stormwater is now retained within the spill containment berms and pumped to the Industrial Wastewater System. Spills at the Northwest tank farm resulted from a mechanical failure. Spill containment systems at the Northwest tank farm have

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17/ *Stormwater Pollution Prevention Plan*, Port of Seattle, June, 1995.

18/ Personal communications with Tim Yokers, Process Supervisor, Southwest Suburban Sewer District, on August 11, 1994.

19/ *South Aviation Support Area Final Environmental Impact Statement*. Port of Seattle, Seattle, WA, 1994.

been improved to contain potential future spills.[20]

The IWS is a separate conveyance system that collects and conveys wastewater from airport operations in the cargo, hangar, and gate areas, including deicing wastewater, to three IWS lagoons and a dissolved air flotation treatment facility in the southwest corner of the Airport. Collected wastewater, which includes glycols, is treated at the IWS treatment plant to meet NPDES permit effluent limits before being discharged to an 18-inch line that goes to the Midway Sewer Treatment Plant and then to a deep water outfall in Puget Sound. The Port of Seattle is presently in negotiations to settle a notice of intent to sue for alleged violations of the NPDES permit discharge limits for the IWS effluent.

(C) **Groundwater Quality**

The Airport lies on the Des Moines Drift Plain, which is the topographic area between Puget Sound and the Duwamish Valley. Three distinct groundwater aquifers (shallow, intermediate, and deep) have been identified in the Des Moines Drift Plain. Shallow, intermediate, and deep groundwater are separated by low-permeability silt and clay layers within the drift plain. In addition, in some locations groundwater is perched in depressions located on top of relatively impervious glacial till material and beneath the thin mantle of Alderwood and Everett gravelly sandy loam soils common in this region (see Chapter IV, Section 19). Perched groundwater is often found within 5 to 15 feet of the ground surface during the wetter months (October through March) but generally recede during drier months. Perched groundwater may appear on the surface as hillslope seeps, but is not likely a significant contributor to base flow conditions in Puget Lowland streams such as Miller and Des Moines Creeks. Perched groundwater zones are discontinuous. Although no comprehensive surveys or mapping of shallow, perched groundwater has been done in the vicinity of the Airport, the presence of Alderwood and Everett series soils and seeps around Miller and Des Moines Creeks and associated wetlands is an indicator of their presence. The availability of perched groundwater is typically too limited for use as a drinking water supply. There is no known use of this groundwater as a source of drinking water in the Airport vicinity, and its quality is unknown though assumed to be generally good. Some specific areas of perched shallow groundwater beneath the Airport is contaminated by aviation fuel.[21]

In addition to perched groundwater, shallow, intermediate, and deeper regional aquifers underlie the Airport. Based on recent geotechnical investigations in potential borrow site areas to the north and south of the Airport, an uppermost aquifer is located about 30-100 feet beneath the surface at an elevation of about 300 feet above sea level. This upper level aquifer (also called advance outwash or shallow aquifer), which has been contaminated in five locations from leaking jet fuel, and rental car fuel distribution systems at the Airport, is not used for domestic water supply. In addition, available site data indicates that impacts on the aquifer tend to be localized and contamination has not moved far or been identified at significant distances away from the sites. Contaminated soil and groundwater at these sites is in various stages of characterization and clean-up by the responsible parties.

There are several stages to management of groundwater contamination: discovery and reporting; identification and characterization of the sources, types, and extent of contamination; evaluation and selection of remedial responses; implementation of remedial responses (i.e., clean-up); and monitoring and sampling to confirm clean-up has been successful[22]. Characterization of some localized groundwater contamination has been completed and clean-up is ongoing. At some locations, contamination is in the process of being characterized and appropriate remediation will be developed as necessary to protect environmental and human health. In some cases, long-term monitoring may be an appropriate management strategy if there is no immediate threat to human or environmental health.

20/ *Stormwater Pollution Prevention Plan.* Port of Seattle, Seattle, WA. June, 1995.

21/ Personal communication with Roger Nye, Toxics Clean-up Program, Washington State Department of Ecology. Personal communication on August 18, 1994.

22/ Letter from Mr. Roger Nye, Washington Department of Ecology Toxics Clean-up Program, dated February 27, 1995 to Mr. Ronald Park, Assistant Planner, City of Des Moines.

Sources of contamination (e.g., leaking underground storage tanks and fuel distribution systems) typically are corrected immediately upon detection.

Management of groundwater contamination at the Airport is being conducted according to all applicable environmental regulations, including the Washington Model Toxics Control Act (MTCA). The Washington Department of Ecology (Ecology) is responsible for implementing MTCA, including listing areas or sites of known contamination and delisting sites as clean-up activities are completed. Ecology's Toxics Clean-up Program has confirmed that some areas of contamination have been cleaned-up. All Ecology Toxics Clean-up Program files, including a list of known areas of groundwater contamination and the status of completed and activities at the Airport (i.e., records) are available to the public by appointment at the Washington Department of Ecology Northwest Regional Office in Bellevue.

The intermediate or, Highline Aquifer (also called the Third Coarse Grained Deposit (Qc(3)) is located at an elevation between about 227 and 108 feet above mean sea level, which is over 100 feet beneath the surface of the Airport. The Seattle Water Department (SWD) has three operating wells in the Highline Aquifer. **Exhibit IV.10-4** shows the locations of these production wells. The Highline Water District (HWD), formally Water District 75, operates two wells in a deep aquifer (also called Fourth Coarse Grained Deposit (Qc(4)), which is located at about sea level. The two HWD wells serve as a source of drinking water for over 39,000 customers[23]. The Des Moines well and the Angle Lake well (HWD wells) are located about a mile southwest and south of the Airport, respectively. The Des Moines well is located near Borrow Source Area 3 (Chapter IV, Section 19 Earth, includes a discussion of Borrow Source Areas). All three SWD wells are located north of SR 518 and the Airport. Two SWD wells, Riverton Heights Wells #1 and #2, are located near Borrow Source Area 5. The third SWD well, Boulevard Park is located further north.

The three SWD wells are part of a well field in the Highline Aquifer developed as part of an artificial recharge and recovery demonstration program. Treated Cedar River water is injected into the wells from the fall to spring, stored temporarily, and later withdrawn during peak summer demand periods between summer and early fall.

According to well logs, the static surface water level of the Highline Aquifer is approximately 80 to 200 feet beneath the ground surface. Overlying aquitards of glacial till and clay, which have very low and low permeabilities, protect the integrity of the Highline Aquifer by restricting downward movement of contaminants through these layers. For these reasons, the U.S. EPA considers the Highline Aquifer to have a low susceptibility to contamination from contaminants originating from the ground surface.[24] There is no threat of contamination to SWD wells from existing contamination at the Airport because the wells are located up gradient and/or cross gradient of existing contamination and the direction of groundwater flow. These wells would become more susceptible to contamination if excavation of potential fill source materials at Borrow Source Area 5 remove aquitards (e.g., glacial till) providing a potential pathway for contaminants originating on the ground surface to reach the underlying aquifer. However, even with removal of these material, their up gradient/cross gradient location continue to protect them from contamination associated with the Airport.

Highline Water District wells also are protected from existing contamination by overlying aquitards. As indicated previously, additional studies are being conducted to better determine detailed groundwater movement patterns in the vicinity of the Airport. Both the Des Moines well and the Angle Lake well are over a mile south or southwest of the nearest area of localized contamination near the Alaska Airlines hangar and are considered, given current data, to be up gradient and/ or cross gradient of the Airport.

Most of the contamination at the Airport is jet fuel, which has relatively low water

[23] *Groundwater Contamination Susceptibility Assessment*, Highline Water District, SeaTac, WA, 1994.

[24] *Final Report Highline Well Field Aquifer Storage and Recovery Project*, Seattle Water Department, 1994.

solubility and generally binds to soil particles. Gasoline, which is also present, contains hydrocarbon constituents that while more mobile than jet fuel, also have relatively low water solubilities and a tendency to adsorb to sand, silt, and clay particles. Geologic materials present between existing contamination and Highline Water District wells would restrict movement of contaminated groundwater from perched groundwater and the upper aquifer to the deep Aquifer. In addition, there is no indication from groundwater monitoring well data that contamination is moving toward either of these wells. Migration potential of contaminants is low due to the low hydraulic conductivities, ranging from about 0.3 to 0.00003 feet per day[25], low flow rates and high pollutant adsorption and retention capacity of geologic materials (i.e., till and clay units) between localized areas of contamination and the wells. Therefore, it is unlikely that potable water would become contaminated or be ingested and existing localized areas of groundwater contamination do not represent a potential threat to human or environmental health. In addition, groundwater management activities being conducted in compliance with MTCA regulations are being designed to clean up any potential threats to human or environmental health.

Although neither the Highline Aquifer nor the deep aquifer is a sole-source aquifer, wellhead protection plans are being prepared to protect these wells from pollution within the 10-year time of travel zone, which is the area within about a half-mile radius of each well. Deep Aquifer water quality is excellent. There have been no violations of drinking water standards or detectable volatile organic carbons in these wells.[26] In conjunction with the federal Wellhead Protection Program, Highline Water District and the Seattle Water Department are in the process of preparing wellhead protection plans. The plans include identification and evaluation of potential sources of groundwater pollution adjacent to these wells and specific measures for preventing groundwater contamination. To comply with existing laws, an approved wellhead protection plan must be in place by mid-1996.[27] Groundwater contamination susceptibility assessments have been completed for these wells, the first step in the wellhead protection planning process.

Based on previous geotechnical studies and ongoing groundwater monitoring in the vicinity of groundwater contamination, uppermost groundwater beneath the Airport is located in perched zones that are laterally discontinuous and likely do not discharge to Miller or Des Moines Creeks. Flow of groundwater in the shallow aquifer (advance outwash aquifer) generally appears to be toward the west. The shallow aquifer discharges to Miller and Des Moines Creeks where the creeks intersect advance outwash deposits. Groundwater contamination areas are located near the terminals on the east side of the Airport. Groundwater flow rates are generally slow (a few feet per year). Because localized areas of contaminated groundwater are isolated and small, geologic deposit conductivity rates are low, and contamination is being monitored and cleaned up, it is unlikely that contaminated groundwater would reach Miller or Des Moines Creeks.

A more detailed recent geohydrology study at the Airport completed by the Port of Seattle characterizes subsurface geology, aquifers, and aquitards, groundwater occurrence, movement, and recharge and discharge relationships in the vicinity of the Airport (**Appendix Q-A** of the Final EIS). This study confirms that:

- There are four zones of groundwater occurrence: perched zone; upper or shallow aquifer (Vashon Advance Outwash (QVA)), Intermediate or Highline Aquifer (Third Coarse Grained Deposit (Qc(3)), and Deep Aquifer (Fourth Coarse Grained Deposit (Qc(4));
- Ground water is occasionally perched on top of glacial till, within fill, or in isolated lenses of sand within glacial till deposits.
- Perched groundwaters beneath the Airport are generally seasonal, laterally discontinuous, and likely do not

[25] *Geology of Seattle Washington*, Bulletin of the Association of Engineering Geologists, 28(3):239-302, 1991.

[26] Personal communication with Jay Gibson, Planning and Construction Manager, Water District No. 75 on November 15, 1994.

[27] Letter from Scott Haskins, Acting Superintendent of Water, Seattle Water Department, December 21, 1994 to Michael Cheyne, Port of Seattle.

discharge to Miller or Des Moines Creeks.

- Perched groundwater is generally separated from the uppermost aquifer (advance outwash) by an aquitard of glacial till (10-50 feet thick); this aquitard restricts the downward movement of contamination from localized areas of perched groundwater to the upper aquifer.
- The upper aquifer is generally located in advance outwash deposits and generally flows west; discharge from this aquifer to Miller and Des Moines Creeks occurs in areas where the creeks intersect these deposits.
- A 50-to-100 foot thick aquitard of very low permeability silt and clay material (Lawton Clay) generally exists between the upper and intermediate or Highline Aquifer; this aquitard restricts the movement of pollutants from isolated areas of contamination in the upper aquifer to the intermediate aquifer; the Lawton Clay aquitard appears to be discontinuous to the south near Borrow Source Area 1.
- Downward movement of contaminants through clay and till aquitards is restricted by the very low hydraulic conductivity and high absorption capacity of the silt and clay particles in these deposits.
- Removal of the glacial till aquitard at borrow source areas would increase the susceptibility of the upper aquifer to contamination from substances originating on the ground surface; in addition, removal of the glacial till aquitard would expose underlying advance outwash deposits and increase upper aquifer recharge area and recharge volumes; these increases could be reduced in the future if new developments create impervious surfaces in these areas.
- Construction of the parallel third runway would reduce the upper aquifer recharge area, but an overall net increase in upper aquifer recharge area and volumes would result from activities in borrow source areas.

(3) FUTURE CONDITIONS

Potential construction and operational impacts are evaluated for five different construction phases scheduled for completion by the years 2000, 2010, and 2020.

(A) Do-Nothing (Alternative 1)

Hydrology in Miller Creek and Des Moines Creek would not change appreciably in future years under Alternative 1 (Do-Nothing). Opportunities for new development in the upper reaches of the basin are limited and would be subject to increasingly more stringent stormwater detention standards. While annual stormwater volumes would increase with additional development, flood frequencies would remain about the same. Efforts such as improving the efficiency of existing regional stormwater detention facilities and constructing new facilities could improve stream flow conditions by further attenuating peak flow rates, thereby reducing flooding, erosion, and sedimentation. These issues would be addressed as part of future basin planning activities jointly conducted by King County Surface Water Management Division, the Port of Seattle, and the cities of Burien, Des Moines, and SeaTac.

Construction would not have the potential to affect surface water and groundwater quality if a proposed new parallel runway and associated terminal options were not constructed. Because of various conditions of the Port of Seattle National Pollutant Discharge Elimination System Permit (NPDES) that would be implemented regardless of whether the proposed Master Plan Update alternatives are completed, the quality of Airport stormwater runoff and water from the Industrial Wastewater System (IWS), which discharges to the Midway Sewage Treatment Plant outfall could improve. Because pollutant sources in both the Miller and Des Moines Creek basins and Puget Sound appear to be widespread and because the Airport likely contributes only a fraction of the total pollutants to these waters, the potential for improvement of these receiving waters is unlikely to be significant.

In the case of SR 509/South Access, the roadway alignment could include at least 3 miles of roadway length in the Des Moines Creek watershed and 0.7 miles in the Miller

Creek watershed.[28] The SR 509 roadway alignment would impact several wetlands and cross Des Moines Creek in up to three different locations. Coordinating mitigation associated with the Master Plan Update improvements with the mitigation for this roadway, in instances where these project areas impact a common resource, would increase the effectiveness of the mitigation and minimize the likelihood of significant cumulative impacts.

(B) **"With Project" Alternatives (Alternative 2, 3 and 4)**

Under the "With Project" alternatives, approximately 97 acres of new impervious surface area and 264 acres of fill area would drain to Miller Creek. Approximately 95 acres of new impervious surface area and 282 acres of fill area would drain to Des Moines Creek.

Stormwater leaving the Airport area would be detained according to Washington State Department of Ecology standards. To meet these standards, preliminary hydrologic modeling indicated that approximately 61 acre-feet of new stormwater detention volume would be needed on-site in the Miller Creek watershed, and 31 acre-feet would be needed on-site in the Des Moines Creek watershed.

A conceptual layout of the stormwater management facilities and discharge locations is shown in **Exhibit IV.10-5**. Hydrologic simulations indicate the peak flow rates in Miller Creek would be slightly lower in comparison to Alternative 1 for the flood frequencies listed in **Table IV.10-4**. At Location B, for instance, the 100-year peak flow rate was predicted to decrease from 293 cfs under Alternative 1 to 292 cfs under Alternatives 2, 3, or 4. Peak flow rates for return periods of 1.11 years and 2 years were estimated to be lower for Alternatives 2, 3, or 4 compared to those of Alternative 1 (shown in **Table IV.10-7A**). In Des Moines Creek, in-stream peak flow rates for Alternative 2, 3, or 4 were predicted to be the same for the 100-year return period compared to those of Alternative 1 (see **Table IV.10-8**). For the 1.11-year, 2-year, and 10-year return periods, flow rates predicted for Alternatives 2, 3, and 4 were less than those for Alternative 1. On-site detention, combined with diverting 66 acres of impervious surface area at SASA from the stormwater system to the industrial waste system,[29] caused the lower peak flow rates in Des Moines Creek for these return periods. Regulating peak flow rates to the 10-year return period rate and more frequently occurring flows would decrease future flooding and erosion potential in Des Moines Creek.

By adding impervious and compacted fill areas to the watersheds, the "With Project" alternatives would increase the annual runoff volumes in Miller Creek and Des Moines Creek. Annual runoff volumes would be increased by 6 to 11 percent at various locations in Miller Creek and 1 to 2 percent in Des Moines Creek (**Table IV.10-9**). However, 91 to 93 percent of the incremental volume in Miller Creek would occur at rates less than the 1.11-year return period flow rate, and 97 percent would occur at rates less than the 2-year return period flow rate. Approximately 92 to 96 percent of the incremental volume in Des Moines Creek would occur at rates less than the 1.11-year return period flow rate, and 97 to 99 percent would occur at rates less than the 2-year return period flow rate. The 1.11-year and 2-year return period flow rates are generally considered to be responsible for defining the shape of stream channels; therefore, most of the additional volume added to the creeks would pass downstream at rates having low erosion potential.

Flow exceedance characteristics were determined for both Miller Creek (**Exhibit IV.10-6**) and Des Moines Creek (**Exhibit IV.10-7**) for different seasons of the year. Low and median flows for both creeks were largely unaffected during the summer months (May-September) and only slightly affected during the winter months (October-April). In Miller Creek, high flows increased on average by 0.2 cfs during the summer months and 1.4 cfs during the winter months when comparing Alternative 1 (Do-Nothing) to the "With Project" (Alternatives 2, 3 and 4). In Des Moines Creek, high flows increased on average by 0.1 cfs during the summer months and increased on average by 0.6 cfs during the winter months when comparing

[28] *SR 509/South Access Road Discipline Draft Report - Water Quality*, Shapiro and Associates, Inc., 1994.

[29] *South Aviation Support Area Final Environmental Impact Statement*, Port of Seattle, 1994.

Alternative 1 to Alternatives 2 through 4. The magnitude of changes in flow was similar at Locations A, C, and E. These relatively small changes in flow rates would not appreciably alter the existing character of these stream channels.

Two variations in the design of Alternatives 2 through 4 include runway lengths of 7,000 feet and 7,500 feet instead of an 8,500-foot length. The 7,000-foot and 7,500-foot runway lengths would create approximately 18 percent and 12 percent less impervious area, respectively, compared to the 8,500-foot runway length. A corresponding reduction in the magnitude of peak runoff rates entering the stormwater management facilities would result. Since flow rates leaving the facilities are limited by stormwater release rate criteria[30] the peak flow rates at the outlets would be about the same for each of Alternatives 2 through 4, regardless of runway length. Smaller amounts of detention volume would be required for the 7,000-foot and 7,500-foot runway lengths to attenuate peak flow rates to Department of Ecology criteria. In comparison to the 8,500-foot length, the 7,000-foot and 7,500-foot runway lengths would result in more infiltration and less annual runoff volume.

Potential construction impacts on surface water quality generally would be primarily related to short-term increases in total suspended solids from erosion and sedimentation. Such impacts would be mitigated by implementation of an approved stormwater pollution prevention plan and erosion and sedimentation control plan, which are required conditions of the Port of Seattle NPDES permit for the Airport. These plans would be required before construction could begin and would include specific performance standards and contingency plans.

Another potential construction impact on water quality involves a range of pollutants used during construction (e.g., fuels, lubricants, and other petroleum products, and construction waste such as concrete wash water). Pollution could result from accidental spills of these substances, from leaking storage containers, from refueling, and from construction equipment maintenance activities. Because spilled petroleum products and other substances generally are bound to soil particles, spilled substances are unlikely to reach or contaminate surface water or groundwater. Potential transport also is related to the distance of a spill site from surface and groundwater resources, the size of the spill, construction site characteristics (e.g., soils and topography), and contractor preparedness. Impacts from potential spills can be mitigated by implementation of best management practices (e.g., construction waste handling plans and fueling and vehicle maintenance plans) and strict contractual requirements of contractors.

Potential increases in suspended solids or other pollutants (e.g., spilled petroleum products) from construction sites are directly related to the size of the construction area, the amount of exposed soil, topography, proximity to water bodies, and the effectiveness of erosion and sediment control plans. Phase 1 construction activities scheduled for completion by the year 2000 have the greatest potential to affect surface and groundwater quality because construction areas total 193 acres (for an 8,500-foot runway). Phase 1 construction activities include construction of the new parallel runway, realignment of South 156th Way and South 154th Street, and construction of other airport infrastructure. Unless mitigated effectively through compliance with grading and drainage design standards, runway construction, which involves clearing, grading, and filling of 249 acres, would contribute significant quantities of sediment to Miller Creek and Des Moines Creek and temporary increases in suspended sediment levels. Without effective mitigation, Phase 1 construction of the 7,500-foot runway or 7,000-foot runway option also would result in temporary increases in suspended solids in Miller and Des Moines Creeks. Because of the smaller areas affected, the 7,500-foot and 7,000-foot runway options would have incrementally lower risks of temporarily increasing the concentration of total suspended solids in these creeks.

Construction activities scheduled for completion by the year 2010 (Phases 2 and 3) are limited to airport infrastructures required to support airport operations, including

[30] *Stormwater Management Manual for the Puget Sound Basin*, Washington State Department of Ecology, 1990.

expansion of existing parking, creation of a new parking garage, and expansion of the north and south satellites. All of these proposed construction activities (involving about 80 acres) are within the Des Moines Creek drainage basin. Increased erosion and sedimentation during construction of landside options would contribute to temporary increases in total suspended solid levels. Potential impacts on water quality are not expected, however, since implementation of erosion and sedimentation control plans (which are required before construction begins) would effectively control erosion through prevention or collection of eroded material in nearby catch basins. If Best Management Practices (BMPs) are not effectively implemented, Phase 2 and 3 construction activities could result in temporary increases in suspended sediment levels in Des Moines Creek.

Activities scheduled for completion by the year 2020 (Phases 4 and 5) involve about 40 acres or about 22% of the total area affected by Phases 1 through 3. Activities include construction of new taxiways, additional expansion of the north and south satellites, additional expansion of existing parking facilities, and new aircraft maintenance facilities within the South Aviation Support Area (SASA). Proposed landside construction activities, which generally would redevelop previously developed areas, are within the Des Moines Creek drainage basin. If erosion and sedimentation control and construction waste management plans are effectively implemented, significant temporary increases in suspended sediment levels or other pollutants in Des Moines Creek from Phases 4 and 5 construction activities are unlikely.

Potential increases in total suspended solids (TSS) in Miller and Des Moines Creeks from sheet and rill erosion of fillslopes and cutslopes have been estimated (Please see Chapter IV, Section 23 for a more detailed discussion on erosion and sedimentation estimates). Sediment yielded from fillslopes and borrow source areas and actual amount of sediment reaching the creeks would be expected to be reduced by removal of suspended solids by stormwater management facilities (i.e., wet vaults, wet ponds, and biofiltration swales). The primary mechanism for delivery of sediment from these sites to Miller and Des Moines creeks is in stormwater runoff as suspended solids. It is assumed that all sediment yielded from fillslopes and cutslopes would be delivered to stormwater management facilities and proposed conceptual stormwater runoff control wet vaults, wet ponds, and biofiltration swales would remove at least 80% of suspended solids in stormwater runoff. Therefore, 20% of the estimated sediment yields would be delivered to Miller and Des Moines Creeks as TSS.

During and up to 1 year after construction, it is estimated there would be an increase in TSS loading of between about 28 to 71 tons per year to Miller Creek and between about 24 to 60 tons per year to Des Moines Creek, depending on the effectiveness of erosion controls. Based on estimated existing sediment loadings (as TSS) for Miller Creek and Des Moines Creek, these represent estimated increases of about 11 to 27% (Miller) and 14 to 36% (Des Moines) during and immediately after construction. As vegetation becomes established the first year after completion of construction, average annual increased sediment loading would be expected to decrease exponentially to about 10 tons per year on Miller Creek and 7 tons per year on Des Moines Creek; these represent an increase of about 4% compared to existing total loading for both creeks. These estimated increased loadings may be higher than actual loadings, as some of the eroded material would be expected to be deposited at the base of slopes and would not be delivered to stormwater runoff facilities or Miller and Des Moines Creeks. Actual increases in sediment loading to the creeks depends on the effectiveness of the erosion and sediment control measures implemented as part of an approved erosion and sediment control plan. Numbers could be higher if untreated stormwater runoff from construction and borrow source areas reaches Miller and Des Moines Creeks.

In addition to potential impacts to surface water, activities at borrow source areas could affect groundwater resources by altering geology and changing groundwater recharge, movement, and discharge patterns. In general, precipitation percolates through shallow mantles of soil to underlying glacial till (except at borrow source area 3 where till is generally absent), contributing to seasonally perched groundwater, groundwater recharge, and groundwater discharge to Miller and Des Moines Creeks (along slopes near the creeks). Removal of glacial till layers at most borrow source areas would expose underlying advance or recessional outwash deposits increasing potential recharge and susceptibility to contamination of the uppermost aquifer, which is located in advance outwash deposits. Removal of glacial till layers and exposure of more permeable advance and recessional outwash could result in proportional reductions in perched groundwater or increases in upper aquifer (advance outwash aquifer) recharge. Potential impacts on perched groundwater and upper aquifer recharge, discharge, and movement patterns depends on the geology at these sites, proposed grading plans and future site development. Please see Chapter IV, Section 23 "Construction Impacts" of the Final EIS for a more detailed discussion of potential impacts to surface and groundwater.

Potential operational impacts on surface and groundwater quality are related primarily to the amount of new impervious surface area and increased stormwater runoff. Airport stormwater outfalls to Miller and Des Moines Creeks are shown in **Exhibit IV.10-8.** About 193 acres of new impervious surface would be created upon completion of Phase 1 (i.e., Year 2000). Drainage from the new runway and taxiways would be detained on-site and then conveyed to both Des Moines Creek and Miller Creek. Although proposed stormwater management facilities would remove some pollutants from airport runoff, Miller and Des Moines Creeks would receive increased loadings of organics, metals, fecal coliform bacteria, and nutrients during storms. Increases in the loadings of these pollutants in these creeks during storms would contribute to violations of Class AA water quality standards for dissolved oxygen, copper, lead, zinc, and ammonia. These increases would adversely affect the beneficial uses of these streams and could result in acute and chronic effects on aquatic biota (i.e., impairment of the propagation of aquatic biota).

Concentrations of glycols detected in Airport stormwater runoff are several orders of magnitude below levels reported to have acute effects on salmonids.[31] Increases in the quantities of glycols or runway anti-icers (i.e., urea and potassium acetate) in stormwater runoff could contribute on adverse effects on aquatic biota in Miller and Des Moines Creeks.

Operational activities related to Phases 2, 3, 4, and 5 would not have significant adverse effects on water quality. Completion of these phases, which consist almost entirely of redevelopment of previously developed areas, would not significantly increase impervious surface areas, stormwater runoff, or pollutant loading to Miller and Des Moines Creeks.

Under Phases 2 through 5, pollution of surface water and groundwater could result from airport operations via the use or leakage of hazardous materials (e.g., fuels and other petroleum products) stored in large quantities at the Airport. Causes of past fuel spills to Des Moines Creek have been remedied through containment and recovery measures now in place. Future spills of fuel and other substances used at the Airport are unlikely to reach Des Moines Creek because tenants are required to prepare and implement spill prevention, control, and countermeasures plans. In addition, the Port of Seattle also is required to prepare a Spill Prevention, Control and Countermeasures Plan as part of the NPDES Permit issued and enforced by the Washington Department of Ecology. The permit contains a series of general and specific conditions designed to prevent and control delivery of pollutants to Miller and Des Moines Creeks and Puget Sound.

Chapter IV, Section 16 "Plants and Animals" includes a discussion of the portions of Miller Creek and Des Moines Creek, and their tributaries which would be directly affected and require relocation as a part of the Master Plan Update improvements.

(C) Preferred Alternative (Alternative 3)

As was described earlier, approximately 97 acres of impervious surface area and 262 acres of fill area would drain to Miller Creek with the Preferred Alternative (Alternative 3). Approximately 95 acres of impervious

[31] *Seattle-Tacoma International Airport De-Icer/Anti-Icer Study.* Prepared by Woodward-Clyde Consultants for the Port of Seattle 1993.

surface area and 282 acres of fill area would drain to Des Moines Creek. To meet the Washington State Ecology standards, approximately 61 acre-feet of new stormwater detention volume would be needed on-site in the Miller Creek watershed, and 31 acre-feet would be needed on-site in the Des Moines Creek watershed.

Hydrologic simulations indicate the peak flow rates in Miller Creek would be slightly lower in comparison to the Do-Nothing for the flood frequencies assessed. At Location B, for instance, the 100-year peak flow rate would decrease from 293 cfs under Alternative 1 to 292 cfs under with the Preferred Alternative. Peak flow rates for return periods of 1.11 years and 2 years were estimated to be lower compared to those of Alternative 1. In Des Moines Creek, in-stream peak flow rates would be the same for the 100-year return period compared to those of Alternative 1. For the 1.11 year, 2-year, and 10-year return periods, flow rates would be less than those for Alternative 1. On-site detention, combined with diverting 66 acres of impervious surface area at SASA from the stormwater system to the industrial wastewater system,[32] would cause the lower peak flow rates in Des Moines Creek for these return periods. Regulating peak flow rates to the 10-year return period rate and more frequently occurring flows would decrease future flooding and erosion potential in Des Moines Creek.

By adding impervious and compacted fill areas to the watersheds, the annual runoff volumes would increase in Miller Creek and Des Moines Creek. Annual runoff volumes would be increased by 6 to 8 percent at various locations in Miller Creek and 1 to 2 percent in Des Moines Creek. However, 91 to 93 percent of the incremental volume in Miller Creek would occur at rates less than the 1.11-year return period flow rate, and 97 percent would occur at rates less than the 2-year return period flow rate. Approximately 92 to 96 percent of the incremental volume in Des Moines Creek would occur at rates less than the 1.11-year return period flow rate, and 92 to 97 percent would occur at rates less than the 2-year return period flow rate.

Flow exceedance characteristics were determined for both Miller Creek and Des Moines Creek for different seasons of the year. Low and median flows for both creeks would be largely unaffected during the summer months (May-September) and only slightly affected during the winter months (October-April). In Miller Creek, high flows would increase on average by 0.2 cfs during the summer months and 1.4 cfs during the winter months when comparing Alternative 1 (Do-Nothing) to the Preferred Alternative. In Des Moines Creek, high flows would increase on the average by 0.1 cfs during the summer months and increase on average by 0.6 cfs during the winter months when comparing Alternative 1 to the Preferred Alternative. The magnitude of changes in flow would be similar at Locations A, C, and E. These relatively small changes in flow rates would not appreciably alter the existing character of these stream channels.

Potential construction impacts on surface water quality generally would be primarily related to short-term increases in total suspended solids from erosion and sedimentation. Such impacts would be mitigated by implementation of an approved stormwater pollution prevention plan and erosion and sedimentation control plan, which are required conditions of the Port of Seattle NPDES permit for the Airport. These plans would be required before construction could begin and would include specific performance standards and contingency plans.

Another potential construction impact on water quality involves a range of pollutants used during construction (e.g., fuels, lubricants, and other petroleum products, and construction waste such as concrete wash water). Pollution could result from accidental spills of these substances, from leaking storage containers,, from refueling, and from construction equipment maintenance activities. Because spilled petroleum products and other substances generally are bound to soil particles, spilled substances are unlikely to reach or contaminate surface water or groundwater. Potential transport also is related to the distance of a spill site from surface and groundwater resources, the size of the spill, construction site characteristics (e.g., soils and topography), and contractor preparedness. Impacts from potential spills can be mitigated by implementation of best management practices (e.g., construction

[32] *South Aviation Support Area Final Environmental Impact Statement*, Port of Seattle, 1994.

waste handling plans and fueling and vehicle maintenance plans) and strict contractual requirements of contractors.

Potential increases in suspended solids or other pollutants (e.g., spilled petroleum products) from construction sites are directly related to the size of the construction area, the amount of exposed soil, topography, proximity to water bodies, and the effectiveness of erosion and sediment control plans.

Operational activities related to Phases 2, 3, 4, and 5 would not have significant adverse effects on water quality. Completion of these phases, which consist almost entirely of redevelopment of previously developed areas, would not significantly increase impervious surface areas, stormwater runoff, or pollutant loading to Miller and Des Moines Creeks.

Under Phases 2 through 5, pollution of surface water and groundwater could result from airport operations via the use or leakage of hazardous materials (e.g., fuels and other petroleum products) stored in large quantities at the Airport. Causes of past fuel spills to Des Moines Creek have been remedied through containment and recovery measures now in place. Future spills of fuel and other substances used at the Airport are unlikely to reach Des Moines Creek because tenants are required to prepare and implement spill prevention, control, and countermeasures plans. In addition, the Port of Seattle also is required to prepare a Spill Prevention, Control and Countermeasures Plan as part of the NPDES Permit issued and enforced by the Washington Department of Ecology. The permit contains a series of general and specific conditions designed to prevent and control delivery of pollutants to Miller and Des Moines Creeks and Puget Sound.

Chapter IV, Section 16 "Plants and Animals" includes a discussion of the portions of Miller Creek and Des Moines Creek, and their tributaries which would be directly affected and require relocation as a part of the Master Plan Update improvements.

(4) CUMULATIVE IMPACTS

Hydrology in Miller Creek and Des Moines Creek could be affected by future development and large-scale projects in the watersheds. In the Des Moines Creek watershed, proposed non-Master Plan Update projects and other urban development would add impervious surface area in the watersheds and reduce infiltration. As with all new development, these projects would be required to provide stormwater management facilities designed to Ecology standards. As currently planned, impacts from each project would be mitigated on a project-by-project basis.

Although it is anticipated that construction and operational impacts on water quality would be mitigated through implementation of NPDES permit requirements, detention requirements, and compliance with state water quality standards, construction and operation of the proposed Master Plan Update alternatives and other projects in the vicinity could contribute to cumulative adverse effects on surface water and groundwater resources. Implementation of an erosion and sedimentation control plan would reduce temporary increases in total suspended solids but may not eliminate them. Similarly, the potential for pollutant loading would be reduced but not eliminated by the required stormwater management facilities (e.g., detention facilities, wet ponds, biofiltration swales). The proposed project in combination with other proposed development in these drainage basins would result in increased pollutant loading to receiving waters and adverse cumulative effects on water quality.

These other projects also could contribute to cumulative effects on groundwater. Conversion of forests and other vegetated areas to impervious surfaces contributes to reduced infiltration and groundwater recharge. Reductions in pervious areas would reduce recharge to perched groundwater and aquifers. Assuming that shallow groundwater discharges are a component of base flows in Miller and Des Moines Creeks, incremental reductions in groundwater discharge could reduce base flows in these creeks.

(5) MITIGATION

The following stormwater management mitigation would be required unless basin plans determine that other criteria would be acceptable:

- Provide stormwater detention for construction and operation of new on-site development. Detention criteria would be based upon Department of Ecology standards limiting 2-year peak flow rates from the developed portions of the site to 50 percent of the existing 2-year rate, limiting the developed 10-year flow rate to the existing 10-year rate, and limiting the developed 100-year flow rate to the existing 100-year rate. Stormwater detention volumes would be provided with either underground storage vaults, as shown in **Exhibit IV.10-5**, or with regional storage ponds. Detention requirements of Ecology's *Stormwater Management Manual for the Puget Sound Basin* are more stringent than those of the *King County Surface Water Design Manual*, the latter of which have been adopted by the City of SeaTac. The *King County Surface Water Design Manual* is presently being revised and the revised version is expected to contain design standards that are comparable to or more stringent than Ecology's manual.

- Stormwater quality treatment would be provided with a combination of wet vaults and biofiltration swales.
- Design stormwater facility outlets to reduce channel scouring, sedimentation and erosion, and improve water quality. Where possible, flow dispersion and outlets compatible with the proposed stream mitigation (Appendix P) should be incorporated into engineering designs.
- To mitigate potential reductions in shallow groundwater recharge and incremental reductions in base flows in these creeks, infiltration facilities would be constructed where feasible. One location has been identified as suitable for shallow infiltration facilities an area in the northeast corner of the Airport.[33].
- Existing and proposed new stormwater facilities should be maintained according to procedures specified in the operations manuals of the facilities.
- The potential for using constructed aquifers within the runway fill, as described in **Appendix Q-C**, should be further investigated.
- Tyee pond would be relocated and enlarged as part of the SASA project. The relocated and enlarged pond would be a three-celled system with 40 to 45-acre feet storage capacity located north of the main SASA footprint. The first two cells would be densely vegetated emergent wetland cells for enhanced biofiltration and water quality improvement and the third cell would be off-line, providing detention for large storm events[34].

[33] Draft Technical Memorandum dated June 28, 1995 from Dan Cambell, Hong West & Associates, Inc. to Jim Peterson and John Genkshow, HDR Engineering, Inc.

Various mitigation requirements, as stipulated by federal, state, and applicable local laws, policies, and design standards, would be applicable to construction and operation of the proposed new parallel runway and landside development at the Airport. These requirements would be components of the proposed design and are expected to reduce potential impacts on surface water and groundwater quality. For example, potential temporary increases in suspended solids levels in Miller and Des Moines Creeks or their tributaries from construction activities would be reduced by implementation of an effective erosion and sedimentation control plan, which is required before construction could begin.

Effective erosion and sedimentation control could be achieved by using a system of erosion controls (e.g., mulching, silt fencing, sediment basins, and check dams) that are properly applied, installed, and maintained. In a study of construction sites in King County between January 1988 and April 1989, the most common reasons for ineffective erosion control plans included failure to install Best Management Practice (BMP) erosion controls, improper installation of erosion controls, and failure to maintain erosion controls.[35] The Port of Seattle may need to include specific provisions in its agreements with contractors to ensure that erosion control measures are properly installed and maintained during construction activities (e.g., performance bonds).

Use of BMPs at construction sites, such as spill containment areas, phasing of construction activities (to minimize the amount of disturbed and exposed areas), and conducting activities during the dry season (April through September), also should prevent or reduce potential impacts on surface water and groundwater quality. According to the NPDES permit (Permit No. WA-002465-1) issued by the Washington State Department of Ecology, the Port of Seattle is

[34] *South Aviation Suppport Area Final Environmental Impact Statement*, Port of Seattle, 1994.

[35] *Erosion and Sediment Control: An Evaluation of Implementation of Best Management Practices on Construction Sites in King County, Washington January 1988-April 1989.* Prepared by C. Tiffany, G. Minton, and R. Friedman-Thomas for the King County Conservation District, Renton, WA. King County, 1990.

responsible for developing and implementing a construction erosion and sedimentation control plan to prevent and control the potential for water quality impacts on surface water from all construction activities at the Airport.

Temporary and permanent terraces are recommended for fillslopes and cutslopes wherever possible because they reduce sheet and rill erosion. Terraces reduce slope length, reducing potential rill development and surface erosion. Terraces also increase deposition, reducing transport of eroded materials from construction sites. Other BMPs and mitigation that could be used to reduce potential increases in TSS from construction activities include graveling of access roads, use of wheel wash facilities, and covering of loads. Prohibiting fuel storage, refueling, or maintenance of construction equipment at borrow source areas or implementing best management practices, such as installing proper temporary fuel storage and spill containment or designated maintenance areas would eliminate or reduce spills and contamination potential.

Several required and numerous optional practices are used to mitigate the potential for operational impacts on surface water and groundwater quality. The Port of Seattle's National Pollutant Discharge Elimination System (NPDES) permit requires the Port to prepare several plans and to carry out several studies to identify pollutants coming from the Airport, and to prevent and control potential operational impacts on surface and groundwater resources from industrial wastewater system (IWS) and storm drainage system (SDS) discharges.

- Specific plans required as part of compliance with the NPDES permit include:
  - a stormwater pollution prevention plan (SWPPP);
  - a spill prevention, control and countermeasures plan (SPCCP);
  - a construction erosion and sediment control plan for each project exposing more than 5 acres of ground;
  - a pond sludge characterization and treatment disposal plan; and
  - a solid waste disposal plan.
- Specific studies required as part of compliance with the NPDES permit include:
  - an engineering and treatability study of the IWS
  - a vehicle washwater study
  - annual stormwater monitoring reports
  - whole effluent (both IWS and stormwater) toxicity studies
  - a marine sediment monitoring study.
- Major elements of the SWPPP include:
  - monitoring of base flow and stormwater runoff from the Airport outfalls;
  - identification and implementation of operational BMPs and applicable source control BMPs that do not require capital improvements (by December 31, 1995);
  - identification and implementation of BMPs requiring capital improvements (by June 30, 1997);
  - development of a list of pollutants that would be present in stormwater and estimation of annual quantities of these pollutants in stormwater discharges;
  - inspection of SDS periodically to ensure they are functioning properly and that there are no illegal discharges (i.e., to the SDS); and
  - modification of the existing plan whenever there is an alteration of airfield facilities or their design, construction, operation or maintenance, which causes the SWPPP to be less effective in controlling pollutants.

In addition, the Port of Seattle is conducting a stream study of Miller and Des Moines Creeks to determine the effects of Airport stormwater discharges on aquatic biota. Implementation of these plans and mitigation measures is expected to identify potential existing water quality problems caused by airport operations and to control and reduce the potential pollutant loading to Miller and Des Moines Creeks and Puget Sound from the Airport.

The Port of Seattle has completed or is in the process of completing a number of operational BMPs and capital improvements that are expected to reduce the amount of pollutants in stormwater runoff. The Port of Seattle has implemented a strategy to reduce anti-icing fluids.[36] This strategy minimizes the amount of potassium acetate and urea required to anti-ice runways and taxiways and the frequency of anti-icer use by:

- Using remote sensors to provide temperature and moisture data on runway and taxiway

[36] *Stormwater Pollution Prevention Plan*, Port of Seattle, June 30, 1995.

surface conditions to determine when chemicals need to be applied;

- Applying chemicals before ice forms, which requires less chemical compared to deicing;
- Applying chemicals at specified rates using applicators with metering systems.

This procedure is expected to reduce the amount of potassium acetate and ammonia in stormwater runoff and in Miller and Des Moines Creeks.

In accordance with the SWPPP, the Port of Seattle has completed or is in the process of completing a number of mitigation actions. Operational, source control, and capital improvement BMPs completed and implemented as part of the SWPPP are expected to reduce the amounts of fecal coliform bacteria, potassium acetate, glycols, ammonia, and other pollutants in stormwater runoff from reaching Airport stormwater outfalls and Miller and Des Moines Creeks. Recent capital improvements correcting specific identified problems include:[37/,38/]

- Installation of an elevated berm to contain washwater from solid waste containers and prevent drainage of fecal coliform bacteria to Outfall 002.
- Connection of areas in the C and D Concourse to the IWS.

The Port of Seattle continues to monitor stormwater quality. The results of ongoing base flow and stormwater runoff water quality monitoring are used to determine the need for additional BMPs and capital improvements to the SDS. The Port of Seattle develops BMPs and structural improvements in coordination with Ecology, as necessary, to mitigate operational impacts on water quality and aquatic biota in Miller and Des Moines Creeks. These are reflected, in part, by periodic revisions to the SWPPP.

A number of capital improvements to the IWS are scheduled to be completed on or before June 30, 1997, including:

- Connecting the Port Maintenance Shop Yard and a portion of the U.S. Postal Service aircraft parking area near the North Satellite, which presently drain to the SDS and Outfall 002, to the IWS;
- Connecting a suspected glycol source: an area north of the South Satellite to the IWS;
- Connecting the aviation industrial activity area now draining to Outfall 007, which is suspected of contributing to elevated ammonia and BOD with stormwater runoff, to the IWS; and
- Connecting snow storage areas, which have been identified as probable sources of glycols, to the IWS.

These improvements are expected to reduce the amounts of anti-icing and deicing chemicals (e.g., potassium acetate, ammonia, and glycols) reaching SDS outfalls and Miller and Des Moines Creeks.

The Stipulated Settlement Agreement and Agreed Order of Dismissal, which dismissed Ms. Brasher's, Normandy Park Community Club's, and the City of Des Moines' appeal of the Port's NPDES permit contained the following provisions:[39/]

- Creating a Monitoring Team, including representatives appointed by the appellants;
- Conducting at least two additional sampling events of permitted stormwater outfalls in 1995;
- Contributing funds to the Des Moines Creek Basin planning and visioning process;
- Developing a short-term monitoring plan in cooperation with the Monitoring Team to sample Miller Creek basin outfalls and the outfall from Lake Reba examining glycol, BOD TSS, flow, ammonia, and turbidity and develop appropriate responses, as necessary, for any identified water-quality problems.

Additional mitigation for potential operational impacts to surface water quality would be considered depending on the results of the stream monitoring study[40/] and the effects of Airport stormwater runoff on Miller and Des Moines Creeks. Monitoring of selected stations upstream and downstream of Airport outfalls to Miller and

37/ *Stormwater Pollution Prevention Plan*, Port of Seattle, June 30, 1995.

38/ *Annual Stormwater Monitoring Report Summary*, Port of Seattle, August 30, 1995.

39/ *Stipulated Settlement Agreement No. 94-157*, Washington Pollution Control Hearings Board, 1995.

40/ *Stormwater Receiving Environment Monitoring Plan*, Port of Seattle, August, 1995.

Des Moines Creeks is planned for this winter (95/96). Potential additional mitigation that would be considered includes use of alternative, FAA-approved runway anti-icing chemicals (e.g., calcium magnesium acetate and sodium formate) or diversion of runway runoff to the IWS during anti-icing events. The latter option is being evaluated as part of ongoing IWS engineering study, which includes capital improvements to increase the treatment efficiency and capacity of the IWS treatment plant.

Basin planning is another method for investigating mitigation of water quality impacts on Miller and Des Moines Creeks and Puget Sound from Airport and urban runoff. Although the Airport affects relatively small proportions of both the Miller and Des Moines Creek drainage basins (approximately 5 and 30 percent, respectively), activities on these areas could significantly affect these drainages. The Port of Seattle is actively participating in basin planning activities in the Miller and Des Moines Creek basins with local jurisdictions, including King County and the cities of Des Moines, Normandy Park, Sea-Tac, and Burien.

(6) WATER CERTIFICATION

49 USC 47106(c)(1)(B) requires that Airport Improvement Program applications for airport projects involving the location of a new runway may not be approved unless the Chief Executive Officer of the state in which the project is located, or the appropriate state official certifies in writing that there is "reasonable assurance" that the project will be located, designed, constructed, and operated in compliance with applicable air and water quality standards. Therefore, certification from Washington State's Governor's Office is required indicating that the proposed project will comply with all applicable water quality standards. Certification is issued in the form of a Governor's Water Quality Certificate.

It is anticipated that the Governor's Certificate will be issued before completion of the Record of Decision.

AR 022175

TABLE IV.10-1

Seattle-Tacoma International Airport
Environmental Impact Statement

SUMMARY OF HYDROLOGIC PARAMETERS EVALUATED

Parameter	Relevance of Parameter
Flood Frequencies	Flood frequencies for Alternative 1 establish baseline conditions and allow evaluation of the performance of stormwater detention facilities under Alternatives 2 through 4. Flood frequencies are useful for evaluating flooding and erosion potential.
Flow Duration	Increases in flow duration may indicate potential for increased stream channel erosion.
Annual Runoff Volume	Increases in runoff volumes relative to Alternative 1 may indicate increased stream channel erosion potential and reductions in shallow groundwater recharge.
Flow Exceedance	Flow exceedance parameter allows seasonal evaluation of low (90 percent exceedance), median (50 percent exceedance), and high flow (10 percent exceedance) conditions, which could be related to aquatic habitat requirements.

TABLE IV.10-2

Seattle-Tacoma International Airport
Environmental Impact Statement

DESCRIPTION OF WATERSHEDS

	Watershed	
Category	Miller Creek[41]	Des Moines Creek[42]
Existing Watershed		
Total Area (Acres)	5,183	3,585
Impervious Area (Acres)	1,224	1,202
Existing Land Uses in the Watershed (Acres)		
Residential	3,238	1,052
Commercial	727	815
Airport	193	983
Open (parks, cemeteries, etc.)	720	735
Forest/Wetland	305	*
Airport - Alternative 1 (Do-Nothing)		
Total Area (Acres)	193	983
Impervious Area Draining to Industrial Waste System (Acres)	50	204
Impervious Area Draining to Storm System (Acres)	60	369
Airport - Alternatives 2, 3, and 4 ("With Project")		
Total Area (Acres)	519	1,187
Impervious Area Draining to Industrial Waste System (Acres)	50	270
Impervious Area Draining to Storm System(Acres)	157	464

* Forested and wetland area for Des Moines Creek are included among the other land use categories.

Source: Northwest Hydraulics, 1990; Shapiro & Associates, Gambrell Urban, 1994.

41/ *Miller Creek Regional Stormwater Detention Facilities Design Hydrologic Modeling*, Northwest Hydraulics Consultants, 1990.

42/ Shapiro and Associates, and Gambrell Urban, 1994.

TABLE IV.10-3
WATER QUALITY PARAMETERS FOR AIRPORT STORMWATER RUNOFF COMPARED WITH STORMFLOW WATER QUALITY DATA FOR MILLER AND DES MOINES CREEKS (AVERAGE (RANGE))

Parameter	TP	SRP	N02+N03 - N	NH3	HARD	FC	pH	FOG	TURB	TSS	Cu	Pb	Zn	DO	T	Source
Upper Miller Cr. (Above SR 518)	0.103 (0.081-0.138)	0.024 (0.006-0.046)	0.319 (0.080-0.959)	ND	18 (8-40)	(640-3400)	ND	1.1 (0.8-1.4)	16 (6-28)	23 (4-51)	0.022 (0.012-0.043)	0.023 (6.006-0.055)	0.054 (0.007-0.080)	ND	ND	King County, 1994
Lake Reba Inlet Streams	0.099 (0.030-0.217)	0.020 (0.010-0.029)	0.375 (0.154-0.715)	0.401[a] (0.126-0.675)	38 (23-53)	(420-7200)	6.73[a]	1.1 (1.0-1.6)	11 (6-16)	41 (4-147)	0.019 (0.006-0.097)	0.011 (0.001-0.040)	0.060 (0.036-0.090)	ND	ND	King County, 1994
Downstream from Lake Reba	0.106 (0.083-0.134)	0.033 (0.007-0.059)	0.541 (0.344-0.847)	ND	34 (18-51)	(720-2480)	ND	1.4 (1.0-1.8)	7 (5-12)	22 (10-49)	0.006 (0.004-0.008)	0.004 (0.001-0.007)	0.049 (0.035-0.069)	ND	ND	King County, 1994
[illegible]lker Creek	0.132 (0.061-0.200)	0.048 (0.011-0.101)	0.766 (0.469-1.130)	ND	63 (46-90)	(620-1920)	ND [illegible]	1.2[b]	12 (3-31)	39 (9-108)	0.009 (0.002-0.013)	0.007 (0.002-0.013)	0.034 (0.022-0.053)	ND	ND	King County, 1994
Trib.0354 (Lake Burien)	(0.093 (0.070-0.109)	0.025 (0.017-0.040)	0.192 (0.083-0.265)	ND	12[a] (9-15)	(500-3400)	ND	0.9[b]	20 (19-20)	23 (18-29)	0.008[a] (0.004-0.012)	0.013[a] (0.007-0.020)	0.037[a] (0.021-0.052)	ND	ND	King County, 1994
Lower Miller Cr. (below Marine View Dr.)	0.107 (0.063-0.247)	0.036 (0.006-0.065)	0.852 (0.569-1.240)	ND	64 (33-97)	(320-1240)	ND	1.4 (1.0-1.7)	14 (2-41)	64 (5-291)	0.003 (0.002-0.005)	0.001 (0.001-0.002)	0.017 (0.013-0.023)	ND	ND	King County, 1994
Miller Cr. @ WWTP	ND	ND	ND	ND	ND	(28-3600)	7.4 (6.1-8)	ND	ND	ND	ND	ND	ND	11.1 (8.3-12.2)	12 (6-21)	Yokers, 1994
Sea-Tac Storm water Runoff Discharge to Miller Cr.	0.096[a] (0.091-0.100)	ND	ND	(<0.01-27)	86 (27-158)	(3->4000)	6.66 (6.4-6.85)	2.2 (1.1-3.3)	6.4 (4.1-10)	10 (2-22)	0.040 (0.023-0.064)	0.005 (0.001-0.008)	0.280 (0.022-1.030)	ND	ND	Port of Seattle, 1995
Sea-Tac Storm water Runoff discharge to Des Moines Cr.	0.086[a] (0.078-0.093)	ND	ND	(0.01-8.69)	75 (36-99)	(10-132)	6.77 (5.76-7.14)	3.4 (1.1-8.3)	6 (1-11)	4 (3-6)	0.040 (0.020-0.084)	0.004 (0.001-0.008)	0.100 (0.009-0.234)	ND	ND	Port of Seattle, 1995
Des Moines Cr. at South 192nd Street	0.267	ND	0.317	0.802	ND	31,00[f]	6.7	1.3	22.3	28.55	0.020	0.013	0.157	7.2	8.9	Port of Seattle, 1993
Des Moines Cr. @ Tyee Pond	0.248	ND	2.361	0.319	ND	5,700[f]	7.42	0.67	8.70	8.93	0.017	0.005	0.061	6.54	10.9	Port of Seattle, 1993
Des Moines Cr. @ South 200th St.	0.208	ND	1.123	0.167	ND	4,500[f]	7.52	0.64	5.36	4.54	0.009	0.004	0.045	7.14	10.9	Port of Seattle, 1993

Unbracketed numbers - Applicable water quality standards
(xx-xx) - Range of Actual Data

- TP - total phosphorus (mg/L)
- SRP - Soluble reactive phosphorus (mg/L)
- N02+N03-N - nitrite plus nitrate nitrogen (mg/L)
- NH3 - ammonia nitrogen (mg/L)
- HARD - Hardness ($CaCO_3$ mg/L)
- FC - fecal coliform bacteria (#/100 mL)
- FOG - freon extracted oil and grease (mg/L)
- TURB - turbidity (nephalometric turbidity units or NTU)
- TSS - total suspended solids (mg/L)
- Cu - total copper (mg/L)
- Pb - total lead (mg/L)
- Zn - total zinc (mg/L)
- T - temperature (_C)
- DO - dissolved oxygen (mg/L)

NOTES:
- a arithmetic mean value of two samples
- b only one sample with FOG above the limits of detection (1.0 mg/L or 0.25)
- c 86% of samples collected between January and July 1994 (25 of 29) contained more than 100 organisms per 100 ml.
- d September and October 1994 stormwater monitoring data for outfalls 006-008 (refer to Exhibit IV.10-8).
- e September and October 1994 stormwater monitoring data for outfalls 002-005 and 009-010 (refer to Exhibit IV.10-8)
- f Geometric mean of 4 samples
- ND No data

Sources: King County, 1994. Unpublished storm flow monitoring data received from Kate Rhoads, King County Surface Water Management. Yokers, Jim, 1994, Southwest Suburban Sewer District. Personal communication, unpublished data. Port of Seattle, 1995. Monthly Stormwater Discharge Monitoring Reports. Port of Seattle, 1993. *Stormwater and Industrial Wastewater Quality at Seattle-Tacoma International Airport.* Port of Seattle. Port of Seattle, 1995, *Annual Stormwater Monitoring Summary Report.*

TABLE IV.10-4

Seattle-Tacoma International Airport
Environmental Impact Statement

EXISTING FLOOD FREQUENCIES FOR LOCATIONS ALONG MILLER CREEK

Return Period (Years)	Probability (%)	Alternative 1 (Do-Nothing) Flow Rates (cfs)		
		Stream Location		
		A	B	C
100	1	171	293	468
10	10	125	185	293
2	50	80	109	173
1.11	90	47	64	104

Location A is below the Lake Reba Detention facility (Exhibit IV.10-1).
Location B is at First Avenue South.
Location C is near the mouth of the creek.
Source: Montgomery Water Group, 1995.

TABLE IV.10-5

Seattle-Tacoma International Airport
Environmental Impact Statement

EXISTING FLOOD FREQUENCIES FOR LOCATIONS ALONG DES MOINES CREEK

Return Period (Years)	Probability (%)	Alternative 1 (Do-Nothing) Flow Rates (cfs)	
		Stream Location	
		D	E
100	1	232	280
10	10	154	178
2	50	103	112
1.11	90	74	76

Location D is below the confluence of the east and west branches (Exhibit IV.10-1).
Location E is at South 208th Street.
Source: Montgomery Water Group, 1995.

TABLE IV.10-6

Seattle-Tacoma International Airport
Environmental Impact Statement

WASHINGTON STATE DEPARTMENT OF ECOLOGY CLASS AA FRESHWATER WATER QUALITY STANDARDS

Parameter	Standard
Fecal coliform bacteria	Shall not exceed a geometric mean of 50 colonies per 100 mL, and shall have not more than 10 percent of the samples used to calculate the geometric mean exceeding 100 colonies per 100 mL.
Dissolved oxygen	Shall exceed 9.5 mg/L.
Total dissolved gas	Shall not exceed 110 percent of saturation at any point of sample collection.
Temperature	Shall not exceed 16°C due to human activities. Temperature increases from point source discharges shall not, at any time, exceed $t = 23/(T + 5)$, where t = the permissive temperature increase measured at the mixing zone boundary and T = highest ambient temperature outside the mixing zone in the vicinity of the discharge. Incremental increases resulting from non-point source activities shall not exceed 2.8°C.
pH	Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.2 units.
Turbidity	Shall not exceed 5 NTU over background when the background turbidity is 50 NTU or less, or have more than 10 percent increase in turbidity when background turbidity is more than 50 NTU.
Toxic, radioactive, or deleterious material concentrations	Shall be below those that may adversely affect characteristic water uses, cause acute or chronic conditions in the most sensitive aquatic biota, or adversely affect public health.
Aesthetic values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Source: WAC 173-201A. November 25, 1992.

TABLE IV.10-7

Seattle-Tacoma International Airport
Environmental Impact Statement

LOW AND HIGH ESTIMATES OF STORMWATER RUNOFF POLLUTANT LOADING CONTRIBUTIONS (pounds/year)

for seven pollutants from the Seattle-Tacoma International Airport to Miller and Des Moines Creeks compared to the total pollutant loads for these basins.

	Airport[1]	Remainder of Basin[2]		Total Basin Loading[3]		% from Airport	
		Low	High	Low	High	Low	High
Des Moines Creek							
Parameter[4]							
TSS	22,764	311,106	1.221.353	333,870	1,244,117	6.8	1.8
BOD	23,614	73,129	123.558	96,743	147,172	24.4	16.0
TP	212	986	4,187	1,198	4,399	17.7	4.8
Tot. Cu	103	161	285	264	388	39.0	26.6
Tot. Pb	15	413	553	428	568	3.5	2.6
Tot. Zn	232	1,129	1,547	1,361	1,779	17.0	13.0
O&G	5,954	32,363	32,363	38,317	38,317	15.5	15.5
Miller Creek							
Parameter							
TSS	2,995	522,300	2,669,300	525,295	2,672,295	0.6	0.1
BOD	3,058	139,775	209,900	142,833	212,958	2.1	1.4
TP	54	2,052	8,969	2,106	9,023	2.6	0.6
Tot. Cu	11	243	448	254	459	4.3	2.4
Tot. Pb	3	635	857	638	860	0.5	0.3
Tot. Zn	54	2,024	2,638	2,078	2,692	2.6	2.0
O&G	1,179	61,110	61,110	62,289	62,289	1.9	1.9

1/ Annual airport pollutant loads taken from the *Seattle-Tacoma International Airport Stormwater Pollution Prevention Plan*, Port of Seattle, June, 1995.

2/ Pollutant loads for basin, excluding the Airport.

3/ A range of low and high pollutant loading rates for different land uses (e.g., residential, commercial, open space) based on data from the Pacific Northwest was obtained from the literature. Total annual pollutant loadings were calculated by multiplying the loading rates by the appropriate land use areas within each basin (Table IV.10-2)

4/ TSS - total suspended solids; BOD - biochemical oxygen demand; TP - total phosphorus; Tot. Cu - total copper; Tot. Pb - total lead; Tot. Zn - total zinc; O&G - oil and grease.

TABLE IV.10-7A
FLOOD FREQUENCIES AND RATES FOR LOCATIONS ALONG MILLER CREEK FOR ALTERNATIVE 1 AND ALTERNATIVES 2, 3 AND 4.

Return Period (Years)	Probability (%)	Alternative 1 Flow Rates (cfs) Stream Location			Alternatives 2-4 Flow Rates (cfs) Stream Location		
		A	B	C	A	B	C
100	1	171	293	468	166	292	454
10	10	125	185	293	119	181	285
2	50	80	109	173	76	105	170
1.11	90	47	64	104	46	63	103

Location A is below the Lake Reba Detention facility (Exhibit IV.10-1). Location B is at First Avenue South. Location C is near the mouth of the creek.

TABLE IV.10-8
FLOOD FREQUENCIES AND RATES FOR LOCATIONS ALONG DES MOINES CREEK FOR ALTERNATIVE 1 AND ALTERNATIVES 2,3 AND 4.

Return Period (Years)	Probability (%)	Alternative 1 Flow Rates (cfs) Stream Location		Alternatives 2-4 Flow Rates (cfs) Stream Location	
		D	E	D	E
100	1	232	280	232	280
10	10	154	178	149	173
2	50	103	112	96	108
1.11	90	74	76	68	74

Location D is below the confluence of the east and west branches (Exhibit IV.10-1).
Location E is at South 208th St.

TABLE IV.10-9
ANNUAL RUNOFF VOLUMES TO MILLER CREEK AND DES MOINES CREEK

	Miller Creek Stream Location			Des Moines Creek Stream Location	
	A	B	C	D	E
Annual Runoff Volume (acre-feet)					
Alternative 1	1,680	2,880	5,054	3,525	4,184
Alternatives 2-4	1,781	3,124	5,361	3,586	4,223
Change in Annual Runoff Volume					
(acre-feet)	101	244	307	61	39
(%)	6	8	6	2	1
Percent of Volume Increase Flowing at < $Q_{1.11}$[1]	93	91	92	96	95
Percent of Volume Increase Flowing at < $Q_{2.00}$[2]	97	97	97	99	98

[1] $Q_{1.11}$ is the in-stream peak flow rate for a 1.11-year return period.
[2] $Q_{2.00}$ is the in-stream peak flow rate for a 2-year return period.
Source: Montgomery Water Group, 1995.

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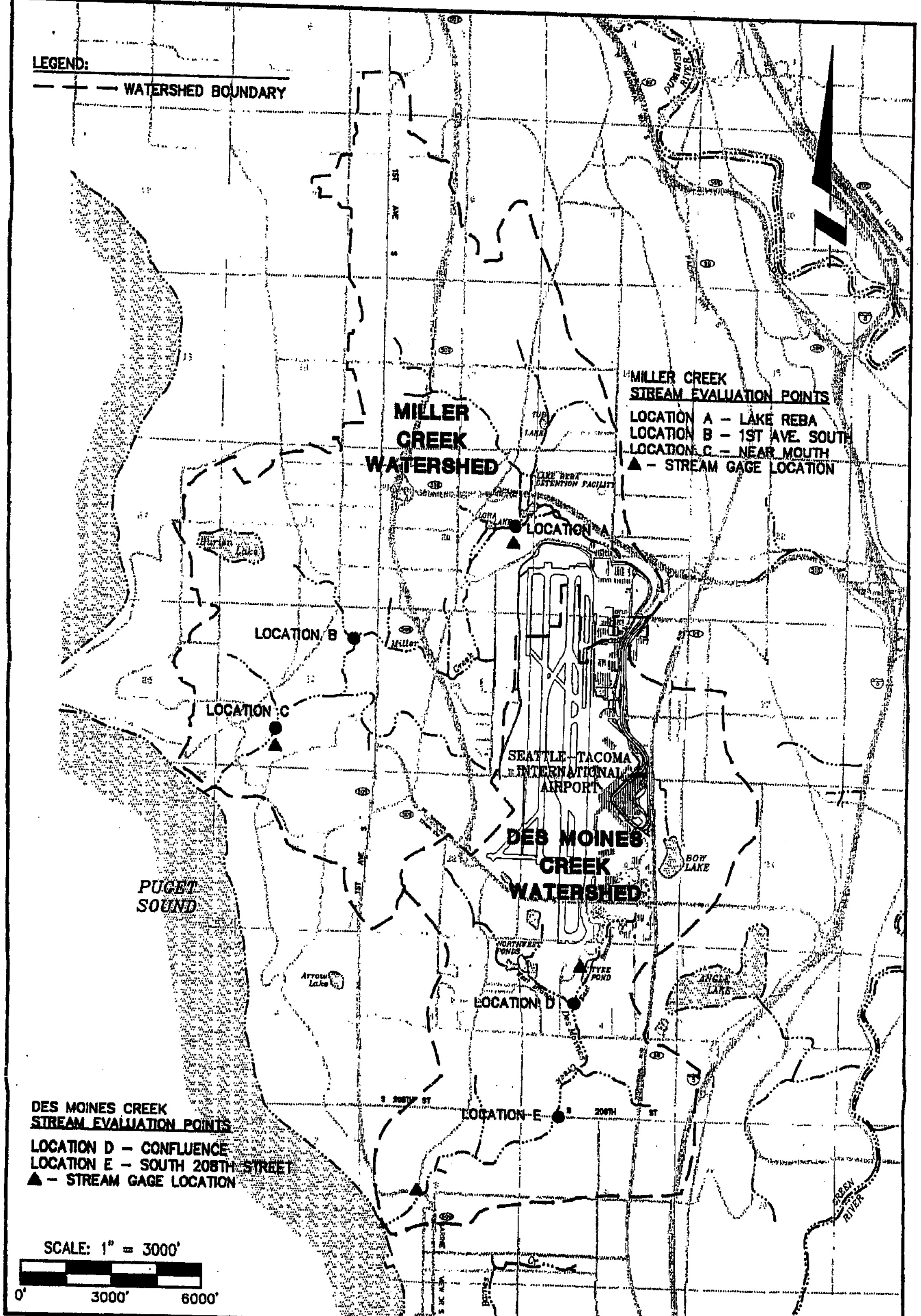
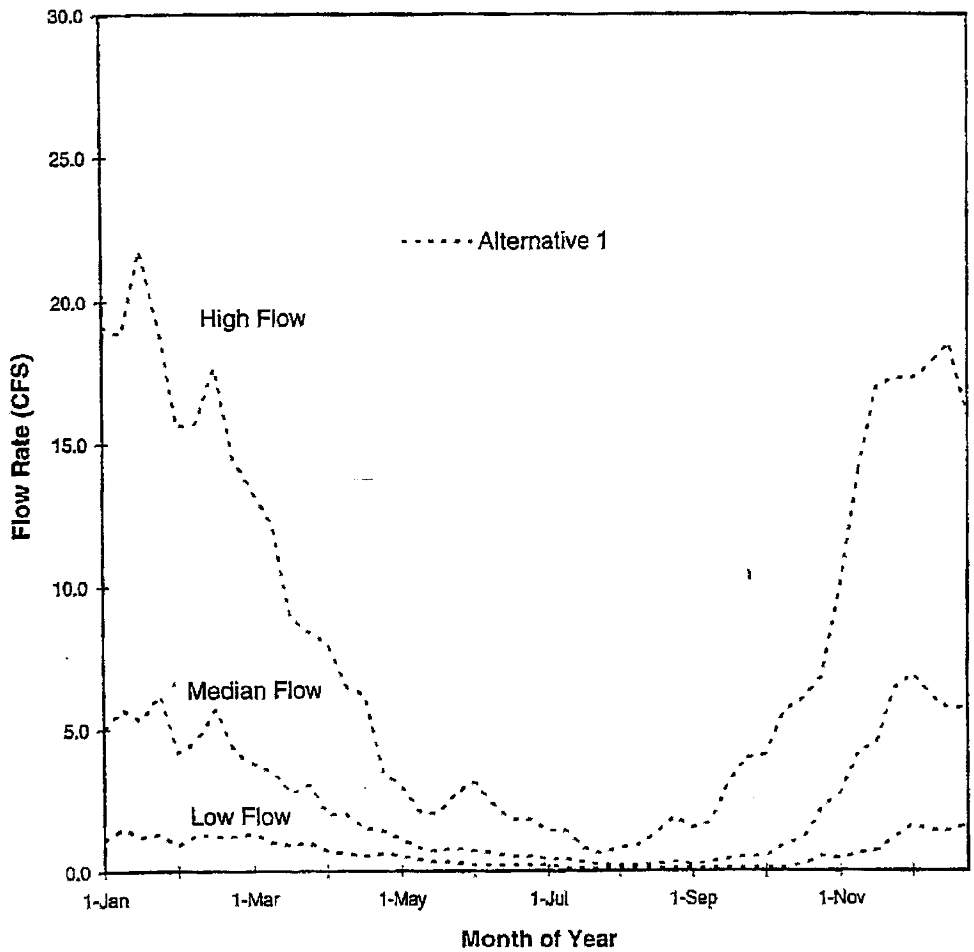


Seattle - Tacoma International Airport

Miller Creek And Des Moines Creek Watersheds

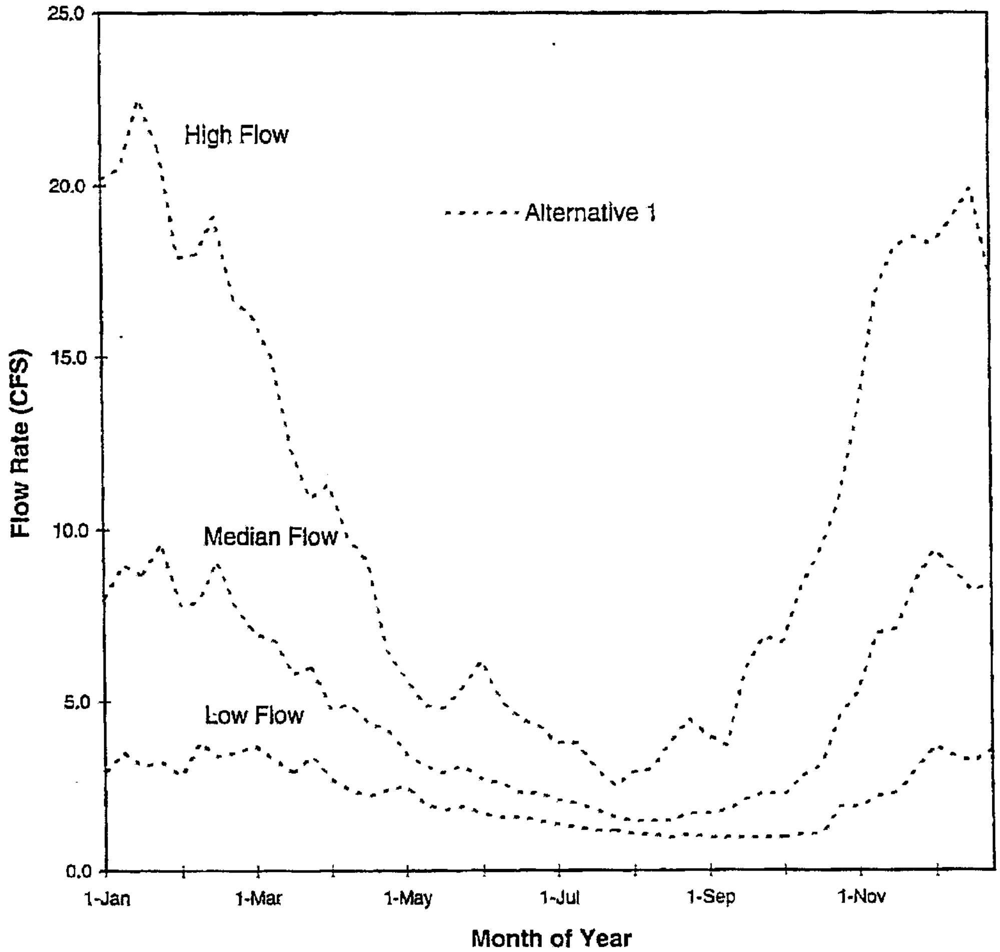
EXHIBIT IV.10-1

Exhibit IV.10-2. Average low, median, and high flow rates for Alternative 1 at Location B along Miller Creek.

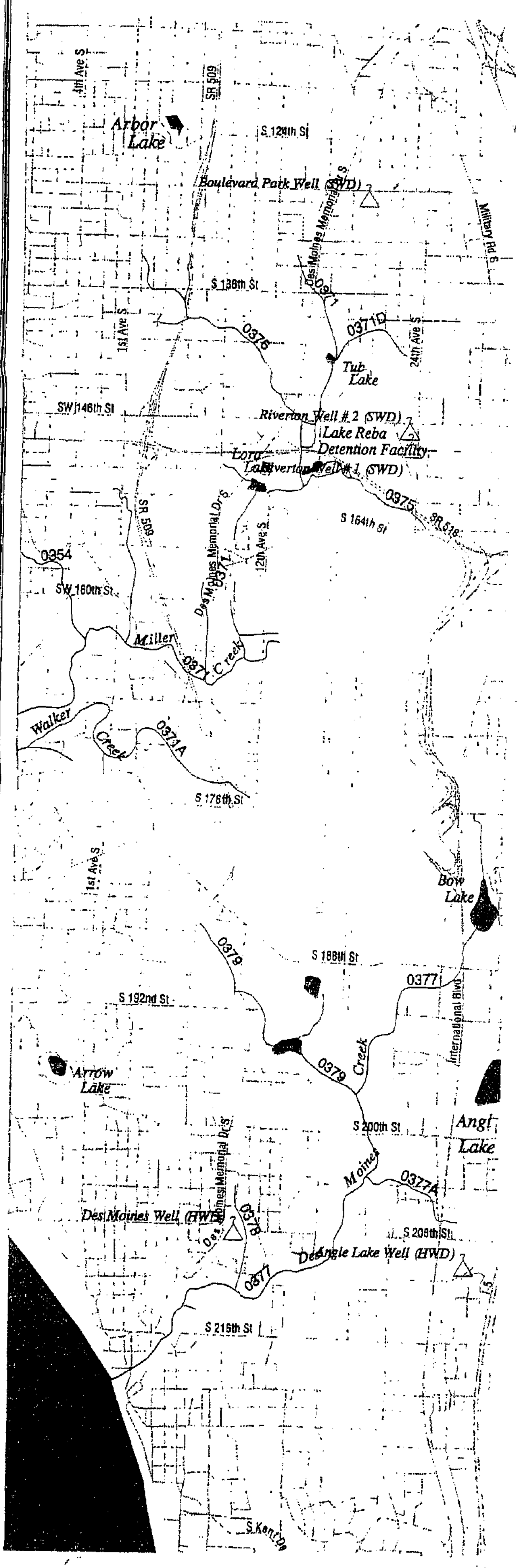


Source: Montgomery Water Group, 1995.

Exhibit IV.10-3. Average low, median, and high flow rates for Alternative 1 at Location D along Des Moines Creek.



Source: Montgomery Water Group, 1995.



Seattle-Tacoma International Airport
Environmental Impact Statement
for the Master Plan Update

Exhibit IV.10-4

Water Resources: Streams and Lakes

Class 2. Perennial stream with salmonids.

Class 2. Perennial. Salmonids undetermined.

Class 3. Intermittent stream.

Unclassified stream.

Lake

Drinking Water Supply Wells:
Highline Water District (HWD)
Seattle Water Department (SWD)

Source: Gambrell Urban, Inc. and
Shapiro & Associates, 1995
King County Basin Reconnaissance Reports, 1987
King County Sensitive Areas Map Folio, 1990

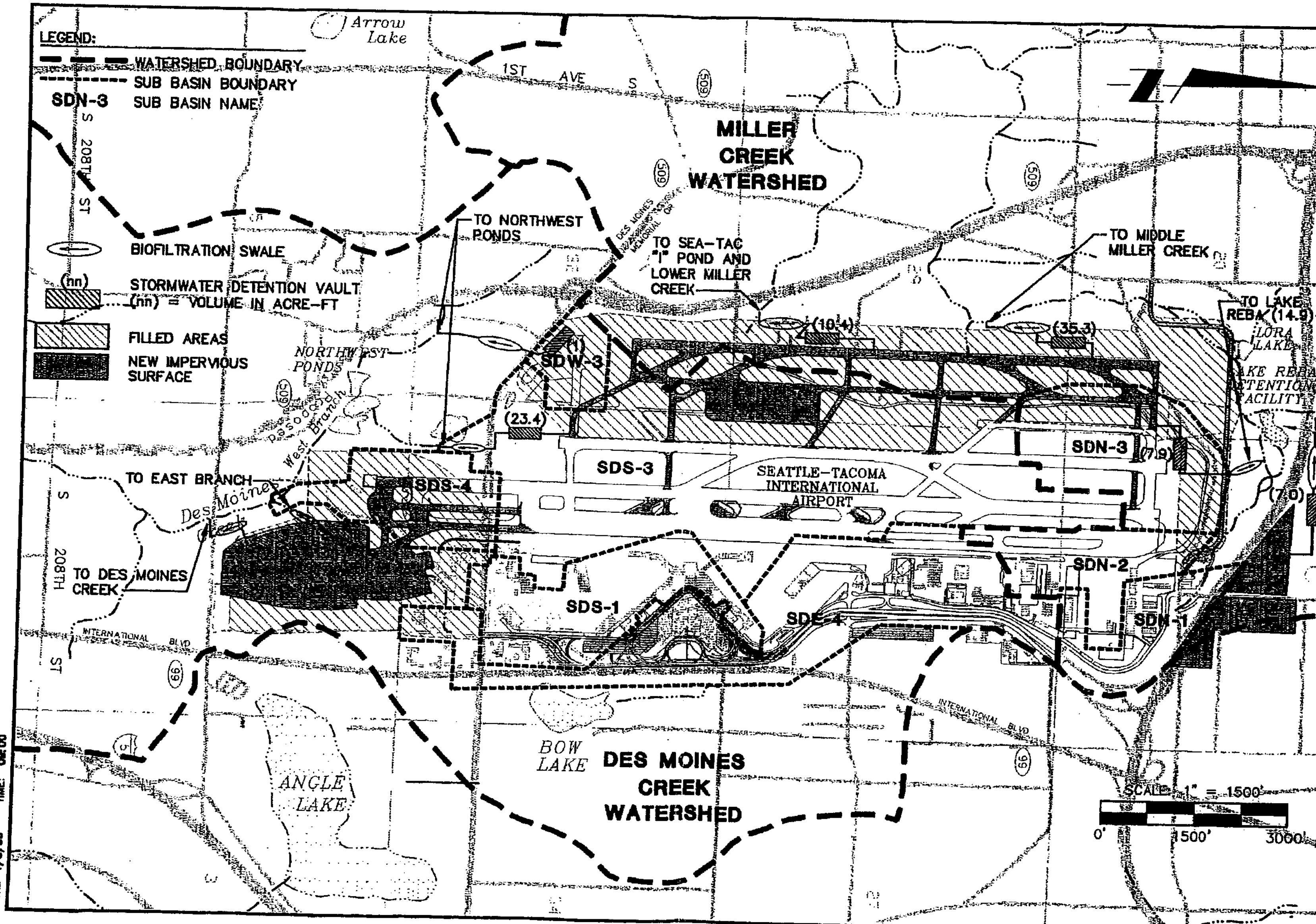
Scale 1" = 2,500'

0 2500 5000

Scale in Feet

Projection: Lambert Conformal Conic
Coordinate System: State Plane NAD27

November 20, 1995



Seattle - Tacoma International Airport

Conceptual Layout of Proposed Stormwater Management System

EXHIBIT: IV.10-5

CAD CONTROL BLOCK REF: EXHIBIT3.DWG
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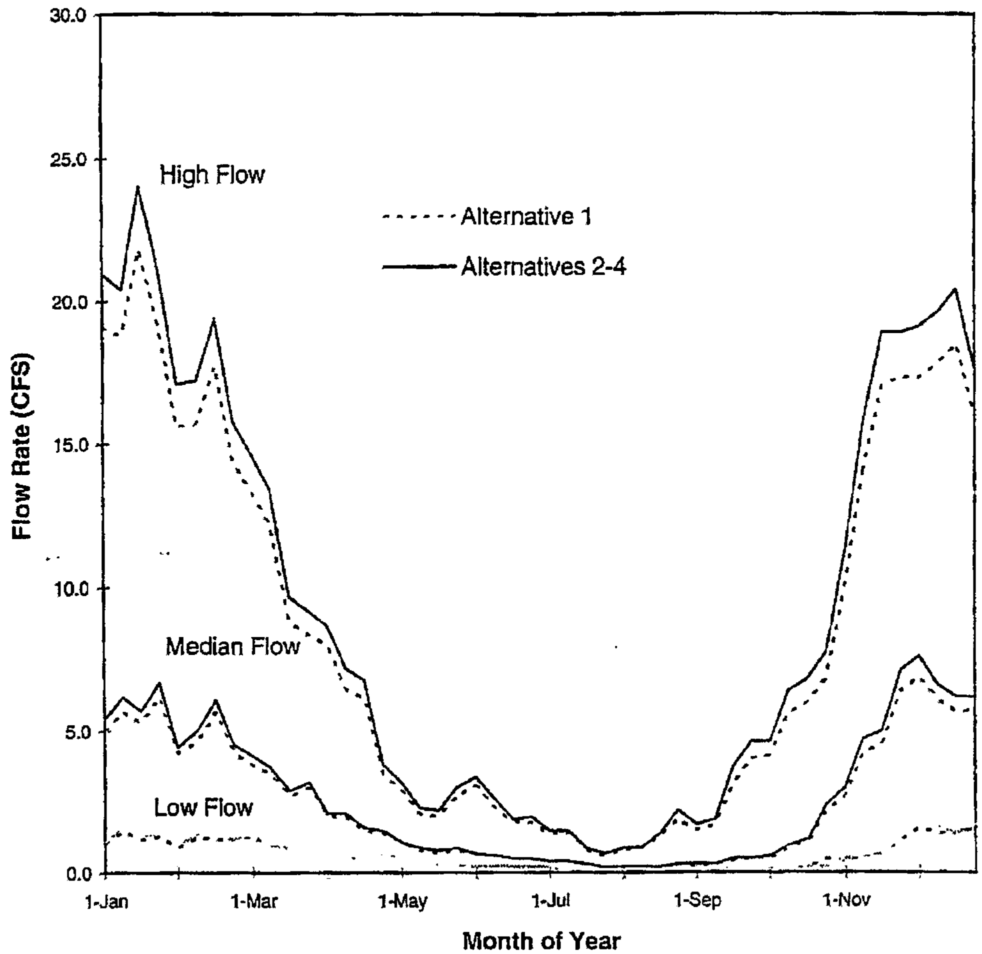
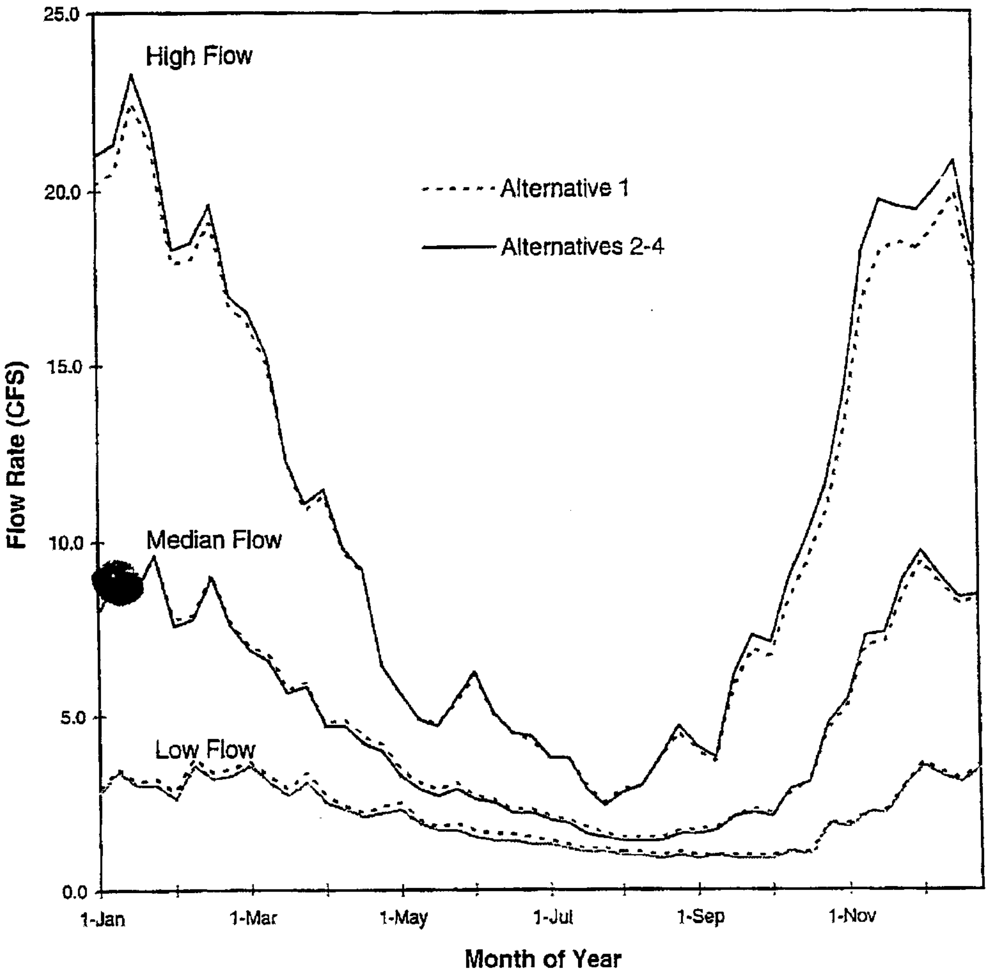
Exhibit IV.10-6. Average low, median, and high flow rates for Alternative 1 and Alternatives 2-4 at Location B along Miller Creek.

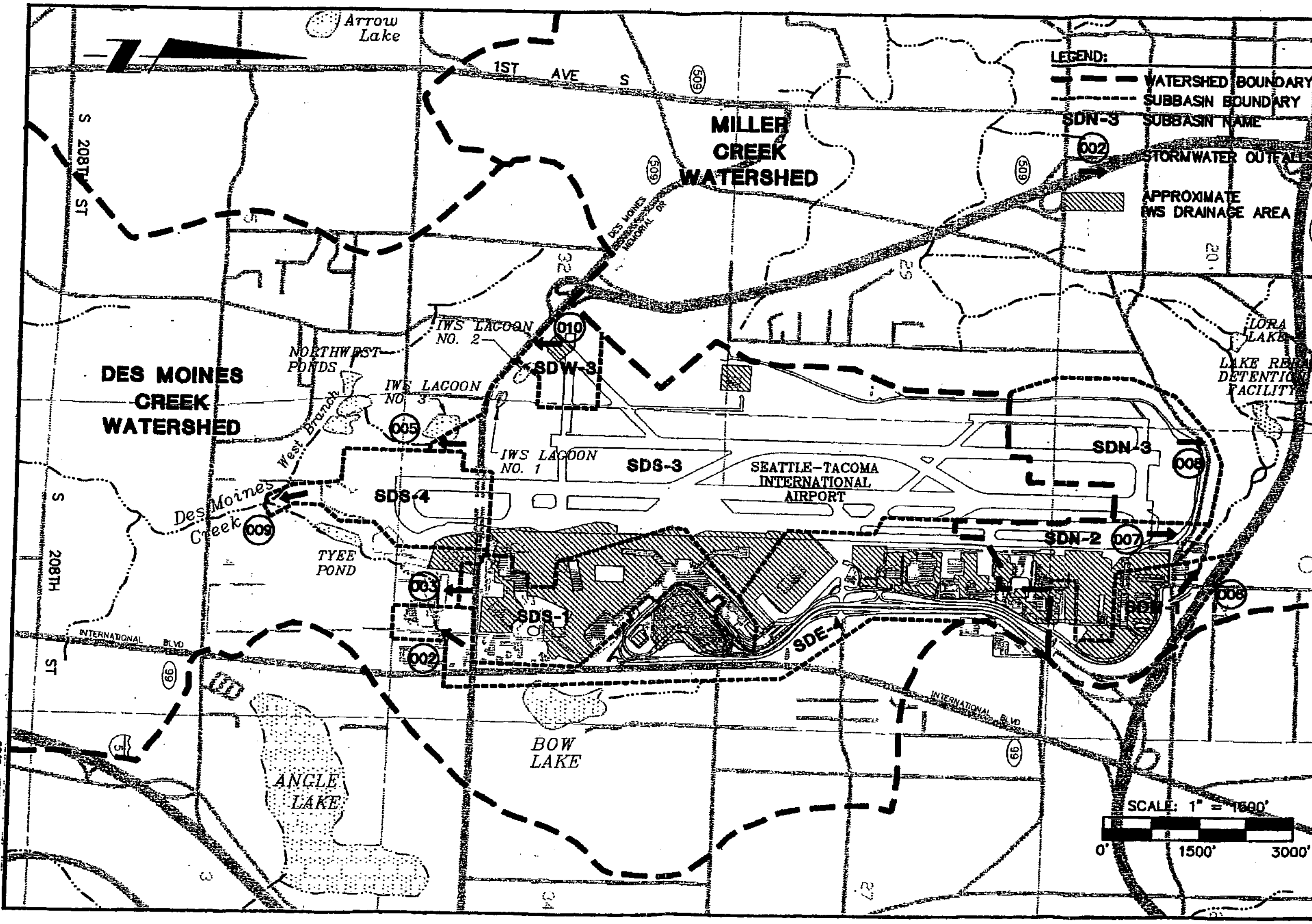


Source: Montgomery Water Group, 1995.

Exhibit IV.10-7. Average low, median, and high flow rates for Alternative 1 and Alternative 2-4 at Location D along Des Moines Creek.



Source: Montgomery Water Group, 1995.



Onsite Basins At SEA-TAC Airport

EXHIBIT IV.10-8

Seattle - Tacoma International Airport