Low Streamflow Analysis and Summer Low Flow Impact Offset Facility Proposal

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Port of Seattle

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Table 3-2. Low flow vault fill time estimates.

	Estimated Vault Fill Time (days)			
Basin	Mean	Median	Minimum	Maximum
Walker Creek	71	60	22	213
Des Moines Creek	11	8	1	38

3.4 WATER QUALITY DESIGN

3.4.1 Introduction

Ecology has defined standards for water quality related to stormwater release, including periods of low flow. Ecology has jurisdiction to monitor and enforce these standards through their National Pollution Discharge Elimination System (NPDES) Permit. These standards include turbidity, dissolved oxygen (DO), temperature, and dissolved metals. The Port's current stormwater design plans for the third runway construction include a stormwater system and operational procedures to provide the storage and managed release of stormwater during low-flow periods. These stormwater storage facilities employ biofiltration strips, catchbasins, detention pond, and vaults to meet current King County water quality requirements. In addition, the facilities are designed to be retrofitted according to the Ecology Stormwater Management Manual (Ecology 2001) if specific water quality concerns are identified during post-construction monitoring. The Port's monitoring and reporting program (see Section 5) is proposed to assess the performance of the facilities, allowing adaptive management to be used in the implementation of additional water quality measures to ensure that standards will continue to be met.

Des Moines, Miller, and Walker Creeks are all assumed to be Class AA (extraordinary) waters (WAC 173-201A-030). As such, the water quality standards discussed in this report are those listed for Class AA water bodies, which are the most stringent standards. Water quality standards for metals are based on toxicity, are independent of the receiving water classification, and are listed in WAC 173-201A-040 (Toxic Substances). Ecology has started the process to potentially revise state water quality standards. The Port will continue to evaluate the proposed changes as part of the final design process and make any needed changes to the facility.

The state water quality standards applicable to the managed release of stormwater to offset flow impacts are discussed below. Specific design features, assumptions, and other information considered in the design of the facility are included. Operational and monitoring proposals are presented in Sections 4 and 5 of this report. References to stormwater vaults refer only to those vaults proposed to detain stormwater to offset impacts to streamflows. Likewise, references to stormwater and stormwater discharges refer only to the managed release of stormwater to offset flow impacts.

All of the stormwater that will be released to offset the impacts during summer low-flow periods will be collected from new and existing airfield areas. The airfield is a highly managed controlled-access area, and generates stormwater that is generally cleaner than typical urban stormwater (Port of Seattle 2000a).

3.4.2 Turbidity

The state water quality standard for turbidity in class AA waters is a two-tiered standard. For receiving water with turbidity less than or equal to 50 NTU (background flow), discharged water may not increase the receiving waters more than 5 NTU over background. For receiving water with turbidity greater than 50 NTU, discharged water may not increase turbidity of the receiving waters more than 10 percent. Turbidity levels in the streams vary between less than 5 NTU to over 1,000 NTU. The lowest turbidity levels in the streams generally occur during low streamflow (base flow) conditions, which correspond to the majority of periods when the stormwater would be released to the streams to offset flow impacts. It is assumed that the releases of stormwater to offset flow impacts would have to meet the 5 NTU standard most, if not all, of the time. To minimize the need to provide constant background level monitoring of the stream above and below the release locations, releases will be limited to 5 NTU or less to ensure compliance at all times.

There are several operational considerations and water quality BMPs in place at the airport to reduce the sediment and turbidity levels in runoff water going into stormwater storage. The Port uses catchbasins, the Industrial Wastewater System (IWS), and biofiltration strips as BMPs on the existing airfield, and the SMP proposes to retrofit the existing airfield with additional sediment trap BMPs in the bottom of each new detention vault facility. The new airfield surface will incorporate similar BMPs to minimize the amount of sediment and suspended solids that could potentially get into the stormwater vaults. The primary BMP consists of the construction of biofiltration strips in the new and existing airfield areas that treat stormwater as it drains directly from impervious areas of runways and taxiways. The Port will also maintain catchbasins to ensure they continue to trap sediments. Filter strips are already in place in the existing Taxiway "C" airfield area that drains to the stormwater vault (SDS3A) located in the Des Moines Creek watershed (see Section 7 in the SMP). In addition, the airfield is a controlled area subject to very low levels of travel by ground vehicles and frequent cleaning and inspection for debris that could be harmful to aircraft. Consequently, the airfield is generally much cleaner than most urban areas that generate stormwater runoff.

There are also operational procedures outlined in the airport's Stormwater Pollution Prevention Plan (SWPPP) that will minimize opportunities for sediment and suspended solids to enter the stormwater vaults. These include:

- Sweeping ramp areas several times per week.
- Annual inspection of catchbasins and cleaning if the depth of sediment equals or exceeds one-third the depth from the bottom of the basin to the invert of the lowest pipe.
- Proper storage and disposal of sediment removed from catchbasins.
- Hydroblasting of runway skid-mark rubber. Water and removed rubber is vacuumed by the same machine, drained, and deposited at the decant station until disposed as solid waste.

All of these BMPs will limit the amount of sediments and suspended solids that enter the stormwater vaults, and therefore will reduce the turbidity of the water stored in the vaults and discharged to the streams.

All of the proposed stormwater vaults, including those associated with the Flow Impact Offset Facility, employ features designed to provide treatment (settling and removal) of suspended solids and turbidity. These features include:

- Dividing the dead storage area (similar to the areas in the vaults where the stormwater detained to offset flow impacts will be held) into several compartments by constructing short walls within the dead storage area of each vault. The compartments provide areas for suspended solids to settle out and be contained. Each compartment's outlet will be configured so that the suspended solids are captured in the compartments during low-flow release periods. Design considerations of this type are typically included in stormwater vaults. Details will be provided at final design of the stormwater vaults.

- The vaults will include an extra 6-inch depth for the first third of the bottom (minimum) to facilitate trapping sediment that reaches the vault.

- The inlets and outlets in the vaults will be configured to minimize disturbance of sediments and floatables within the vaults. This will be done by locating the inlets and outlets within the middle third of the reserved storage depth. Outlets will incorporate a floating design to accomplish this, as well as to maintain a consistent discharge rate.

- Maintenance of the vaults will remove and properly dispose of collected sediments outside of the anticipated low-flow release periods.

- The vaults will be designed to allow installation of additional water quality measures, if needed. Additional water quality features may include filtration of the discharges, oil/water separators, or aeration.

The design of the stormwater vaults, in combination with the operational and monitoring considerations discussed below, will ensure that release of stormwater will not cause violations in the turbidity standards. The Port is currently investigating filtration of stormwater associated with discharges from a landside drainage basin. This research includes determining the effectiveness of several filtration media in treating the stormwater. The results of this study will be completed before final design of the flow offset facilities, and the data will be used to select the filtration method most appropriate to treat the stormwater discharge, if needed.

3.4.3 <u>Temperature</u>

The state water quality standard for temperature in class AA waters is not to raise the temperature of the receiving water to over 16 degrees Celsius (°C). If the baseline temperature of the receiving water is greater than or equal to 16°C, then discharges cannot raise the temperature more than 0.3°C. To date, Ecology has not applied these requirements to stormwater discharges, although they have required temperature monitoring of certain stormwater discharges. Ecology could apply the temperature standard to future stormwater discharges.

The highest annual temperatures in the streams are usually reached during the summer months, which is the period when the Flow Impact Offset Facility is expected to be in operation. Solar radiation is the primary mechanism by which stormwater temperatures increase in detention ponds. Since the stormwater vaults are typically underground structures, there will generally be no direct solar warming. Underground storage provides a constant temperature that will be lower than open storage facilities, more closely matching a native groundwater seep temperature. Water released from the Flow Impact Offset Facility is not expected to increase instream water temperatures. Since the proposed underground stormwater vaults will result in relatively cool water being discharged, no special design considerations are proposed to manage water temperatures in the vaults associated with the Flow Impact Offset Facility.

The Port has begun to collect water temperature data from existing stormwater vaults and in the streams in order to characterize the expected temperatures of the reserved stormwater discharges. Commencing in the summer of 2001, average daily water temperature data is being collected from the NEPL vault and the SDS3A vault located near the south end of the airfield. Data will be collected from June though October of each year from the dead storage area of each vault. These existing vaults were selected because they are similar in size to the proposed stormwater volumes associated with the Flow Impact Offset Facility. The NEPL vault is partially exposed to sunlight (on its west side and top), while the SDS3A vault is completely underground. By collecting temperature data from both vaults, a range of expected temperatures will be established. Temperature data will be collected from the dead storage zone in each vault in order to approximate the vaults associated with the Flow Impact Offset Facility. This data will be compared to stream temperature data also being collected by the Port to characterize any cooling effects of stormwater releases on water temperatures in the streams.

3.4.4 Dissolved Oxygen

The state water quality standard for DO in Class AA waters is 9.5 milligrams per liter (mg/l). Low DO levels in streams during summer low-flow periods is a potential water quality concern. The Flow Impact Offset Facility will be designed and operated in a manner that will not decrease the DO levels in the streams, and under typical conditions, may act to increase DO levels in the streams.

It is anticipated that DO levels in the stormwater vaults should not be significantly reduced while the water is stored. There should be little, if any, biological activity in the vaults that could consume oxygen as a result of the lack of sunlight and the low biological oxygen demand (BOD) typically seen in stormwater runoff from the airfield (Port of Seattle 2000a). The infrequent and short-lived episodes of elevated BOD due to runway de-icing activities are not expected to impact the DO concentrations of the stormwater detained in the Flow Impact Offset Facility because the stormwater associated with these events moves through the stormwater management system in a matter of hours, is replaced with runoff with the low BOD concentrations more typical of airport runoff (Port of Seattle 2000b), and typically happens during the winter months when reserved stormwater releases from the Flow Impact Offset Facility would not take place. In addition, the Port operates BMPs to move snow containing de-icing chemicals (a potential source of BOD) from the airfield to snowmelt areas that drain to the IWS, further reducing the BOD in water that drains to stormwater vaults.

Vents will be included in the stormwater vaults associated with the Flow Impact Offset Facility to allow for the circulation of fresh air. This will help maintain the dissolved oxygen concentration of the stormwater.

An additional design consideration is the positioning of the inlet(s) to the stormwater vaults associated with the Flow Impact Offset Facility. The inlet(s) will be placed as low as possible in the vault (consistent with the inlet placement parameters in the turbidity section above) in order to facilitate flushing of the vault each time there is sufficient rainfall to generate stormwater runoff. Typically, stormwater inlets in vaults are placed at higher elevations within the vault. As a result, water in the lower or dead storage areas may not be circulated and may stagnate. By placing the inlet at a lower elevation, water already in the lower portions of the vault will be displaced by the incoming water and will not have the opportunity to stagnate. Continually replacing the water in the stormwater vaults should benefit the DO levels in the stormwater. Each stormwater vault associated with the Flow Impact Offset Facility will have its inlet position carefully considered during the final design phase, and placed to enhance this circulating effect as much as possible consistent with other requirements.

Passive aeration of stormwater can be achieved through natural turbulence or agitation of the discharges. Steeply sloped pipes with periodic drop structures will be required to move the water from the vault outlets to the stream elevation. An energy-dissipating structure will be required near the release point at stream level to slow the velocity adequately for entering the stream safely, without causing scour or erosion. Both the steeply sloped discharge pipes and the energy-dissipating structures will provide the turbulence or agitation needed to provide passive aeration. Where insufficient fall is available for this natural aeration process, the installation and operation of aeration devices may be necessary. Other vaults are located near the level of the stream discharge elevation such that active aeration measures may be required through the installation of some type of aeration device. Active aeration systems that could be utilized include microbubble diffusers, gas injection, air injection, mechanical aerators, or aeration hoses. Microbubble diffusers consist of a porous ceramic plate (similar to aquarium aeration stones) and a pump to inject air through the plate. Gas and air injection systems inject a controlled amount of gas or air under pressure into the discharge water pipe. Mechanical aerators physically agitate water and allow air to become mixed with the water. Aeration hoses are flexible porous rubber hoses that have air pumped through them similar to the microbubble diffusers. Information on each of these devices is included in Appendix F. Although the selection of the device(s) to be installed will be made during the final design of the Flow Impact Offset Facility, it is likely that the microbubble diffuser will be selected and installed because of its simplicity, effectiveness, cost, and ability to be installed in the discharge pipes. Other attractive features of the microbubble diffuser include low maintenance requirements, the use of a small compressor or pump to provide air instead of the use of compressed gas tanks, and the ability to be automated to function anytime the reserved stormwater discharge valve is open.

3.4.5 Nutrients

There are no water quality standards for nutrients in the current water quality standards. However, nutrients typically found in urban stormwater could be of potential concern. If nutrient-rich stormwater is stored for long periods, exposure to solar radiation can potentially cause algae blooms. However, it is expected that there will be no adverse water quality impacts associated with nutrients in the release of reserved stormwater for the following reasons:

- There is no significant source of nutrients associated with the airfield areas identified as sources of water for the Flow Impact Offset Facility. Primary sources for nutrients in urban stormwater are fertilizers applied to lawns and landscaped areas. However, the grass infield areas of the airfield are not fertilized or irrigated because lush growth could become a wildlife attractant concern. Any landscaped areas to which fertilizers are applied are located near the terminal and drain to stormwater basins that do not contribute flow to the Flow

Impact Offset Facility. The Port's use of fertilizers includes applying the BMPs listed in the airport's SWPPP, which further reduces the amount of fertilizers and nutrients that enter stormwater. With careful management of fertilizer use at the airport, there is no major source of nutrients for the drainage areas that contribute stormwater to the Flow Impact Offset Facility.

- The operation of BMPs on the airfield (biofiltration swales) would reduce the opportunity and concentrations of any nutrients that exist prior to the stormwater entering the vaults.

- Since the vaults are underground facilities, there is no sunlight that would stimulate the growth of algae often associated with elevated nutrient levels.

- Instream residence time for the stormwater discharged from the Flow Impact Offset Facility is only a matter of hours (the time it takes water to flow from the discharge points in the airport vicinity to the streams' discharge points in Puget Sound). Therefore, there will be minimal opportunity for biological activity (algae blooms) in the streams. Such water quality impacts from nutrients are typically associated with lakes and ponds, where long residence time would provide the opportunity for excess algae growth to occur. Since no lakes or ponds occur in the streams between the airport and Puget Sound, this is not an issue.

Given the above, the Port does not propose any monitoring for nutrients in the discharges from the Flow Impact Offset Facility. Through continued implementation of the SWPPP, the BMPs currently in place that manage the use of fertilizers will continue to minimize the opportunities for nutrients to enter stormwater runoff.

3.4.6 Metals

Metals of concern include copper, lead, and zinc. Washington State water quality standards for these metals are based on the dissolved fraction, are dependent on the hardness of the water, and, as with all water quality standards, are applicable to the receiving waters. Chemistry data from existing airfield stormwater discharges (which are typical of the stormwater that would be reserved for release during low-flow periods) have been reported in the annual stormwater monitoring reports. Metal concentrations in these discharges are reported as total recoverable metals, which are not directly comparable to the dissolved fraction listed in the water quality standards. However, this data does serve as an indication of metal concentrations to be expected in the discharges of stormwater from the Flow Impact Offset Facility. Median metals concentrations from airfield stormwater typically range from 0.012 to 0.031 mg/l copper, 0.001 to 0.003 mg/l lead, and 0.020 to 0.051 mg/l zinc (Port of Seattle 2001b). These values were obtained for stormwater sampled at points prior to entering the receiving waters. Additional treatment that occurs in surface waterways prior to entering the receiving waters will result in lower metals concentrations actually entering the streams. In general, these metal concentrations are also less than typical urban runoff, as discussed in the Port's annual stormwater monitoring reports (Port of Seattle 2000a, 2001b). In addition, the Port has conducted whole effluent toxicity testing of stormwater discharges, as required by its NPDES permit (see discussions in the annual monitoring reports). Stormwater associated with airfield subbasins met the performance standards for whole effluent toxicity according to Ecology guidelines. All this information indicates that the Flow Impact Offset Facility can be managed to meet the water quality standards for metals in the receiving waters.

The following items should be considered in the management of the Flow Impact Offset Facility for compliance with state water quality standards:

- A large portion of metals in urban stormwater is attributed to motor vehicle activity. This is illustrated in the annual stormwater monitoring reports, which show higher metal concentrations are associated with the landside basins where motor vehicle activity is concentrated. Since access to the airfield is strictly controlled, motor vehicle activity is kept to a minimum. Therefore, metal concentrations in stormwater runoff are minimized. The airfield basins are the areas that will be providing stormwater to the Flow Impact Offset Facility, and these areas typically have the lowest lead and zinc concentrations of all airport stormwater discharges (copper concentrations are more consistent in all airport stormwater discharges, but are still relatively low in airfield stormwater).

- Data collected by the Port show that a large fraction of the metal concentrations are associated with particulates (i.e., the metal ions are bound to particulate matter). Therefore, the design and management practices proposed to minimize or reduce particulates and turbidity will also reduce total metal concentrations in the stormwater discharges. Biofiltration swales, settling in vaults, and (additional) filtration are all effective in reducing particulates, and therefore total metal concentrations will be reduced as well. Although these BMPs may not be effective in removing dissolved metals, the majority of the metals are bound to particulates and will be removed. The design features proposed for the reserved stormwater vaults (compartmentalized storage, sloping the vault floor away from the stormwater outlets, careful placement of the stormwater inlets and outlets, and the provision for installation of filters) will ensure that the discharge of sediments and metals bound to particles will be minimized.

- The Port is currently investigating filtration of stormwater associated with discharges from a landside basin. This research includes determining the effectiveness of several filtration media in treating the stormwater. The results of this study will be completed before final design of the flow offset facilities, and the data will be used to select the filtration method most appropriate to treat the discharge from the Flow Impact Offset Facility, if needed.

3.5 ADDITIONAL INFORMATION

There are several other considerations relating to the design and operation of the Flow Impact Offset Facility, including the following items:

- The discharge points for the Flow Impact Offset Facility will be the same as the typical ("live") discharge point for each vault or pond they are associated with. This eliminates the need to permit and construct additional discharge points to the streams. The proposed location of each stormwater discharge point for the Flow Impact Offset Facility is illustrated in the drawings in Appendix F.

- All stormwater management facilities, including those associated with the Flow Impact Offset Facility, will be located within the airport's perimeter fencing, thereby controlling access to the facilities and reducing the potential for damage to the facilities from vandalism.

5. MONITORING PLAN

5.1 WATER QUALITY AND FLOW MONITORING

The Port is proposing a comprehensive monitoring plan for the Flow Impact Offset Facility to ensure that the performance standards are met and that no violations of state water quality standards occur in the receiving waters, and to support an adaptive management strategy. Monitoring consists of three elements: characterization of existing/expected water quality, monitoring of annual test releases from the Flow Impact Offset Facility, and monitoring of the discharges and receiving waters during operation of the facility. Each element is discussed below.

5.1.1 <u>Characterization of Existing/Expected Water Quality</u>

A great deal of water quality data already exists on the Port's stormwater discharges and on the streams. This data has been collected for a variety of purposes, including satisfying the Port's NPDES permit requirements, basin planning activities, and other studies done in the area by the Port and others. The data set includes water quality measurements within the stream systems during the summer periods when the Flow Impact Offset Facility will be scheduled to discharge to the streams. In addition, the Port has started to collect data to characterize the discharges from the Flow Impact Offset Facility. Temperature data is being collected starting in 2001 from the existing NEPL vault and the SDS3A vault in order to characterize the expected temperatures of the Flow Impact Offset Facility. The NEPL vault is partially exposed to sunlight (on its west side and top), while the SDS3A vault is completely underground. By collecting temperature data from both vaults, a range of expected temperatures can be established for each type of vault (buried and partially exposed). Temperature data will be collected from the dead storage zone in each vault in order to approximate the Flow Impact Offset Facility. The Port has collected some instream temperature data beginning in September 2000. Other data that is being collected as part of other Port water quality studies will be used prior to the operation of the Flow Impact Offset Facility to characterize expected water quality within the streams during the summer months (when the facility will be discharging). All of this data will be analyzed and presented in the final design of the facilities associated with the Flow Impact Offset Facility.

5.1.2 <u>Monitoring of Annual Test Releases from the Flow Impact Offset Facility</u>

Each year, prior to the operation of the Flow Impact Offset Facility, the Port proposes to conduct small test discharges from each outlet. The test discharges are intended to confirm the operation of each discharge and to detect and respond to potential problems prior to the annual operation of the Flow Impact Offset Facility. For example, because of the small orifices needed to control discharges to the required rate, a small amount of debris in an orifice could potentially impact the discharge rates. The discharge structures are being designed as floatable structures to maintain a constant discharge rate and minimize the potential to clog with debris or sediment (see Appendix F). Floating debris would be removed at this time to prevent impacts to the annual operation of the facility. Any other problems that may occur within the facility would be detected and corrected at this time.

Water quality sampling of small-volume test discharges is proposed. By conducting this sampling, potential water quality problems can be detected and corrective measures taken prior to scheduled annual releases to the stream systems. Water quality data obtained from the test discharges will be compared to the stream characterization data to determine the potential for water quality violations. If any are indicated, the Port will take corrective action prior to the annual operation of the facility, such as installing portable aerators or additional filtration in the discharges prior to their entry into the streams.

Wherever possible, the Port will install automated dataloggers and/or autosamplers to collect flow data and water quality samples. This will allow the monitoring plan to be flexible if it is determined that samples or data need to be collected more or less frequently than proposed at this time. In addition, it may become possible to automate the operation of the Flow Impact Offset Facility. Valves can be automated to close or open based on signals from dataloggers, and other logic can be programmed into an electronic management system (for example, the valve can be programmed to open only during the low-streamflow period). These systems will be evaluated during final design of the facility.

Water quality sampling of the test discharges will include the following:

- Flow
- Turbidity
- Dissolved Oxygen (DO)
- Temperature
- Metals

5.1.3 Operational Monitoring

The Port is proposing to monitor the operation of the Flow Impact Offset Facility to provide assurance that the facility is achieving its performance goals and not causing any water quality violations in the receiving waters. This will be accomplished by periodic monitoring of both the discharge and receiving waters during the annual operation of the facility, both while the vaults are being filled during the rainy season and while the vaults are discharging through the reserved stormwater outlets. The monitoring proposal for the Flow Impact Offset Facility includes the following monitoring components: water levels within the stormwater vaults, flow, turbidity, DO, temperature, and metals. Additional information on these components is provided below.

5.1.3.1 Water Levels

Water levels within the stormwater vaults will be monitored through installation and operation of a pressure transducer and datalogger in each vault. Average daily water levels will be calculated based on more frequent measurements by the pressure transducer/logger. This data will then be applied to the vault geometry to calculate the volume of water in the stormwater vaults. In addition, vault filling and emptying (average daily water levels) will be monitored throughout the year.

5.1.3.2 Flow

Discharge from each vault will be measured upon opening of the Flow Impact Offset Facility outlets and measured a minimum of weekly throughout annual operation of the facility. In addition, stream gage data will be collected from the King County gages currently active in the Miller, Walker, and Des Moines Creek watersheds in the airport facility and downstream to the mouth of each stream. The Port will coordinate with King County to ensure that data from these gages will continue to be collected in the future.

5.1.3.3 Turbidity

Turbidity data will be taken at discharge points, upstream in receiving waters, and downstream in receiving waters (approximately 100 ft from where the discharges enter the streams). The turbidity measurements will be taken upon opening of Flow Impact Offset Facility outlets and taken a minimum of weekly throughout operation of the facility.

5.1.3.4 Dissolved Oxygen

Dissolved oxygen data will be taken at discharge points and approximately 100 ft downstream from where the discharges enter the streams. The DO measurements will be taken upon opening of Flow Impact Offset Facility outlets and taken a minimum of weekly throughout operation of the facility.

5.1.3.5 Temperature

Water temperature will be measured within the vaults, at discharge points, and in the receiving waters (streams). Temperature measurements within the vaults will be obtained using dataloggers that will provide average daily temperature throughout the year. Instream temperature measurements will be taken at the discharge points, upstream in receiving waters, and approximately 100 ft downstream from where discharges enter the streams. The field temperature measurements will be taken a minimum of weekly upon opening of Flow Impact Offset Facility outlets.

5.1.3.6 Metals

Samples will be analyzed for copper, lead, and zinc. The samples will be obtained from discharge points and receiving waters (approximately 100 ft downstream from where discharges enter the streams). The metals sampling and analysis will occur upon opening of Flow Impact Offset Facility outlets and a minimum of monthly throughout operation of the facility.

5.1.3.7 Schedule

Weekly monitoring of the discharges for the quality parameters (except metals) is proposed as a starting point for monitoring the Flow Impact Offset Facility. Once an adequate volume of data exists, an analysis will be completed on the variability of the water quality parameters, and sampling frequencies can be increased or decreased, as appropriate. Data collected during the pilot program will be included in this analysis. Because the facility will be discharging from a stored volume of water, the water quality of the discharges is not expected to change significantly, until runoff replenishes the vaults. In the event of a significant rainfall event during the operation of the facility (greater than 0.5 inches in a 24-hour period), the Port will conduct additional sampling to ensure that the rainfall did not substantially change the character of the water within the Flow Impact Offset Facility, which could potentially cause a violation of instream water quality standards. Monthly sampling for metals is sufficient because existing data shows that the metals concentrations in stormwater runoff from the airfield is relatively consistent and low compared to stormwater discharges from other urban areas.

5.1.3.8 Locations

Specific monitoring locations, both of the discharges and instream, will be consistent with the requirements of the Section 401 Water Quality Certification and will be precisely located and included in the final design of facilities associated with the Flow Impact Offset Facility. All water quality data will be recorded and reported in an annual monitoring report that will be submitted to Ecology by December 31 of each year. If the monitoring data show that the discharges from the Flow Impact Offset Facility consistently meet water quality standards within the receiving waters, the Port may propose a modified monitoring plan for subsequent operation of the facility. If any water quality problems were encountered during operation of the facilities, the annual report will include a discussion of the immediate actions taken to address the problem and actions taken or proposed to prevent a recurrence of the problem in the future. All sampling and analytical methods used to monitor the Flow Impact Offset Facility will conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136 or to the latest revision of *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association [APHA] et al. 1998). This will ensure that the monitoring methods for the Flow Impact Offset Facility are consistent with other water quality monitoring done under the NPDES permit for the airport.

5.2 BIOLOGICAL MONITORING

Instream biological monitoring will be performed in Miller, Walker, and Des Moines Creeks to assess the impacts of the Port's Flow Impact Offset Facility. The biological monitoring will consist of Benthic Index of Biotic Integrity (B-IBI) monitoring and physical habitat monitoring. Biological monitoring will occur four times per year and will continue through the fifth year after construction, then annually until completion of a 15-year monitoring period. During the years when monitoring is occurring four times per year, monitoring events will occur in January/February, April/May, June/July, and September/October. If monitoring indicates potential adverse effects, the Port will evaluate potential adaptive management strategies (see Section 5.4, Adaptive Management). The biological monitoring protocols are discussed in the following subsections.

5.2.1 B-IBI Sampling Protocol

5.2.1.1 Approach

A measure of biotic integrity will be used to evaluate the existing and future low-flow conditions of Des Moines, Miller, and Walker Creeks. The B-IBI for Puget Sound Lowlands (Kleindl 1995; Karr and Chu 1997) quantifies the overall biotic condition of a stream based on measured attributes of benthic macroinvertebrates compared to regional distributions. B-IBI scores have been shown to