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FINAL OFF-SITE WETLAND MITIGATION PLAN
AT LITTLE SQUALICUM CREEK
FOR THE
PORT OF BELLINGHAM INTERNATIONAL AIRPORT
RUNWAY EXTENSION

Bellingham, Washington

Prepared for

The Port of Bellingham
c/o Mr. Bill Hager
625 Cornwall Avenue
P.O. Box 1737
Bellingham, WA 98227-1737

DEA Project #: POBM0007

Corps Reference Number:
OYB-4-014435

Prepared by

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February 8, 1993

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
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REPLY TO
ATTENTION OF

JUL 26 1993

Regulatory Branch

Mr. William Hager
Port of Bellingham
Administrative Offices
625 Cornwall Avenue
P.O. Box 1737
Bellingham, Washington 98227-1737

Reference: OYB-4-014435
Port of Bellingham

Dear Mr. Hager:

Washington State Departments of Ecology and Fisheries, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers (agencies) met on July 13, 1993, to discuss the off-site mitigation options for additional compensation for impacted wetlands from the completed runway extension at the Bellingham International Airport at Bellingham, Whatcom County, Washington. The following represents the alternatives the agencies have agreed would justly compensate the forested wetlands filled for the runway project.

In lieu of creating approximately 5 acres of wetlands at the permitted Little Squalicum off-site mitigation site, the agencies will require the following:

1. Continue to dedicate the public easements to the beach front at Little Squalicum for public access.

2. All drawings and plans for the Little Squalicum Mitigation Plan completed to date shall be donated to the community group most interested in the conversion of the Little Squalicum area to a wetland.

3. Set aside 75 acres, in perpetuity, of the Port of Bellingham's forested property on the western boundary of the Bellingham Airport in a conservation easement. The easement must be recorded on the title for the property. The 75 acres must include the Airport Creek headwaters and must contain, at a minimum, 30 acres of forested wetlands. A wetland reconnaissance for the 75 acres must be performed.

4. In addition, the agencies have agreed that wetland enhancement and creation in the 75 acres could be performed with minimal effort and expense. In fact, the actual physical enhancement work could be done by a volunteer group such as a regional salmon enhancement group. One such group is the Nooksack Salmon Enhancement Association of Whatcom County. The contact for that group is Mike McRory.

At a minimum, the agencies would like to see the following enhancement projects included in the 75 acres: replant the headwaters, ponded area of Airport Creek with a low lying, easy to maintain scrub/shrub community. Diversity and planting schemes from the on-site detention pond mitigation could be applied. This would improve the habitat function and value of this area and still be within Federal Aviation Administration guidelines for safety at airports.

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EXECUTIVE SUMMARY

The Port of Bellingham constructed a 1,750-foot addition to the existing length of the main runway at the Bellingham International Airport in Whatcom County, Washington. Prior to construction, wetlands were identified on-site by the U.S. Army Corps of Engineers, and it was determined using the Corps' 1989 delineation methodology that 21.1 acres of wetlands would be impacted by the project. Of these, 17.5 acres of relatively low value emergent wetlands (wet pastures) and 3.6 acres of higher value forested and scrub/shrub wetland were delineated.

Federal and state regulatory agencies approved conceptual mitigation plans (completed by Springwood Associates with assistance from Sheldon Associates) designed to compensate for impacts to on-site wetlands. Four separate locations for mitigation (three on-site and one off-site) were approved. Of these, 21.1 acres of replaced, created, and enhanced wetlands are proposed on the project site (on-site mitigation), and 3.1 acres of creation and enhancement are proposed in the off-site location (Little Squalicum Creek). An Individual Permit was issued for the project by the Corps contingent upon completion of final mitigation plans for on- and off-site locations.

This report and the enclosed landscape plans (both by David Evans and Associates, Inc. [DEA]) comprise the Final Off-site Wetland Mitigation Plan for Little Squalicum Creek only. A separate report, "Final On-site Wetland Mitigation Plan for the Port of Bellingham International Airport Runway Extension" dated September 18, 1992 - also by DEA, details on-site mitigation. These two reports should be used in tandem for a complete understanding of project wetland mitigation.

A principle goal of the off-site mitigation is to partially compensate for the loss of functions and values associated with impacts to wetlands on the runway construction site. This goal will be achieved through several objectives specific to the off-site mitigation wetlands.

The final off-site mitigation plan was developed only after a standard mitigation sequencing exercise was completed. Minimal impacts to wetlands were ultimately proposed while still allowing for a feasible project. The Little Squalicum Creek mitigation area was selected to provide the maximum off-site mitigation feasible close to the impact area. The 12.5-acre site contains a degraded stream corridor in a developed area to the west of Bellingham, Washington (Little Squalicum Creek) which drains into Bellingham Bay. The site, owned by Whatcom County Parks and managed by the City of Bellingham Parks Department, will be restored and enhanced by the Port of Bellingham. Site modifications will include grading and planting to create several shallow wetland cells and the creation of a new stream channel potentially providing fish habitat.

Performance standards specific to the off-site mitigation have been established and will be the basis upon which the long-term success of the mitigation will be evaluated. A monitoring plan has been written to describe construction observation activities that will be conducted, physical and biological parameters that will be monitored, length of the monitoring period (eight years), and monitoring methods.

A contingency plan has been written to describe options for rectifying conditions that may interfere with achieving mitigation goals and objectives. Potential contingency actions are proposed to respond to possible problems related to water quality and plant survival issues. The Port has established a financial mechanism offered as a performance security guaranteeing the implementation and long-term monitoring of the on-site mitigation areas.

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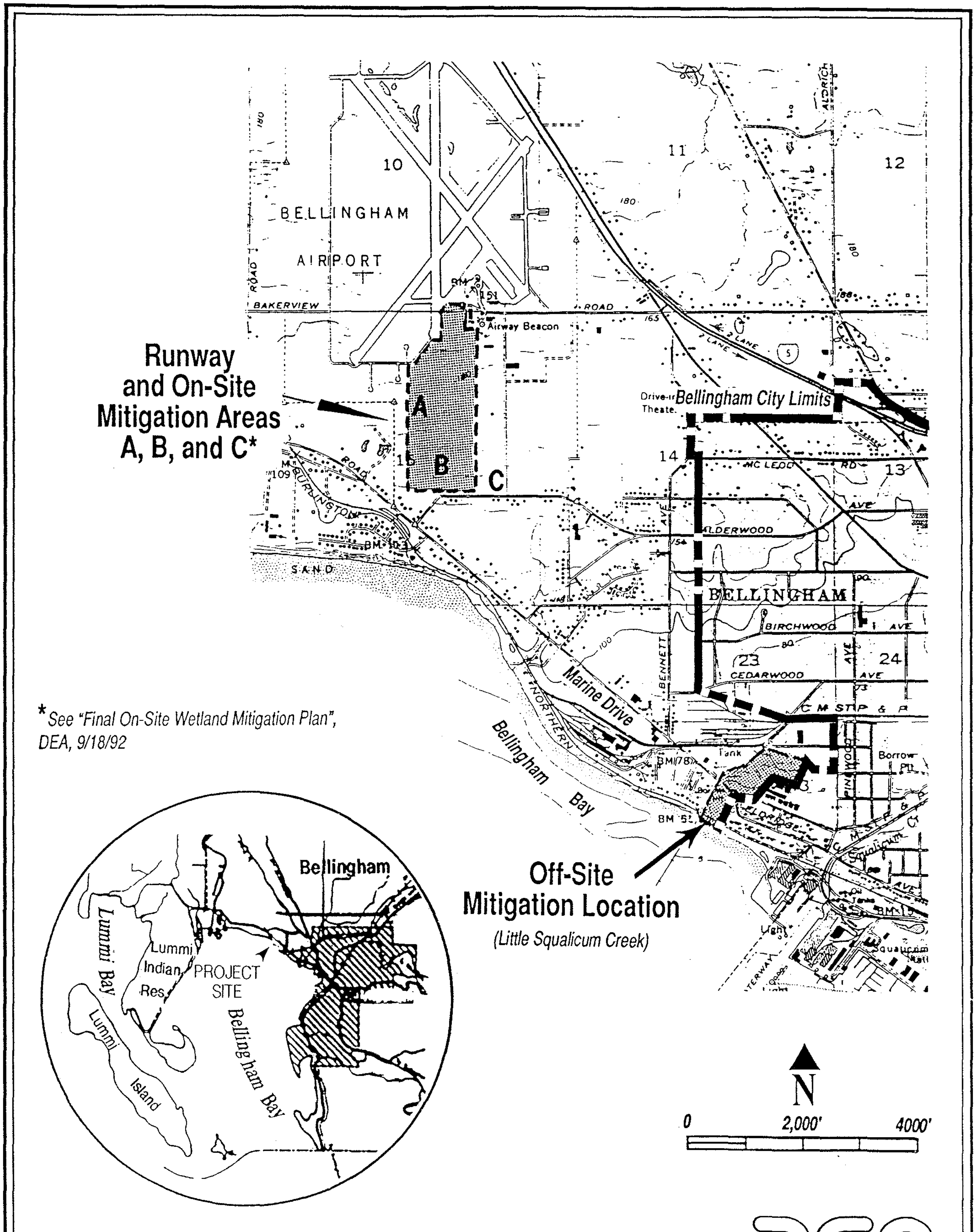
INTRODUCTION

The Port of Bellingham constructed a 1,750-foot addition to an existing 5,000-foot runway at the Bellingham International Airport. The airport is located northwest of the City of Bellingham in Whatcom County, Washington between Interstate 5 (to the east) and Bellingham Bay (to the south), see **Figure 1.** Prior to construction activities, numerous studies were conducted which addressed various aspects of wetlands in the area of the proposed project. The report, "Preliminary Wetland Analysis, Bellingham Airport Proposed Runway Extension" (Jones and Stokes Associates, 1990) describes the wetlands on the project site; provides a quantitative and qualitative assessment of wetlands impacted; and offers a preliminary conceptual on-site wetland mitigation plan.

Fourteen wetlands were delineated by Jones and Stokes (using the Corps' 1989 methodology) in and near the impact site, and the delineation was confirmed by the U.S. Army Corps of Engineers (Corps). Based on review of the site development plan, impacts to wetlands resulting from runway construction were reported to total 21.1 acres on the construction site. Total acreage impacts to wetlands are estimated to be considerably less than the 21.1 acres had the Port opted to re-delineate wetlands and calculate impacts according to the Corps 1987 delineation methodology at a time when that option was available. Impacted wetlands consisted of 17.5 acres of palustrine emergent wetlands, of which 17.1 acres were dominated by mown pasture grasses and 0.4 acres were dominated by sedges, rushes and cattails. The remaining impacted 3.6 acres of wetland were palustrine deciduous forested wetlands.

State and federal permitting agencies determined that adequate mitigation for wetland impacts would occur in on- and off-site locations, see **Figure 1.** On-site conceptual mitigation plans were further described, and off-site conceptual mitigation plans (at Little Squalicum Creek) were initially described, in the report "Draft Wetland Compensation Design, Airport Extension" (Sheldon and Associates, 1991). The report, "Little Squalicum Creek Wetlands Mitigation Plan" (Springwood Associates & Sheldon and Associates, 1992) further details the conceptual plan for the off-site location.

FIGURE 1
Site Map



Source: Springwood Associates, 1992

Table 1 summarizes the acreage of impacted wetlands and on- and of off-site mitigation wetlands. The Seattle District of the Corps issued an Individual Permit to fill the 21.1 acres of wetland. That permit was conditioned on completion and submittal of final on- and off-site mitigation plans to state and federal agencies. The final mitigation plans provide the necessary level of detail for to allow final approval of the design by regulatory agencies, and for construction of the mitigation concepts. **The report in hand and the enclosed set of plans comprise the Final <u>Off-site</u> Mitigation Plan for Little Squalicum Creek only. A separate report, "Final <u>On-site</u> Wetland Mitigation Plan for the Port of Bellingham International Airport Runway Extension" dated September 18, 1992, was prepared by David Evans and Associates, Inc. (DEA) and details on-site mitigation.** Information pertaining to the on-site mitigation area is presented herein only where necessary for continuity and comprehensiveness.

The Little Squalicum Creek site is located south and slightly east of the Bellingham International Airport and just outside the city limits of Bellingham in Whatcom County (Sec. 23, T38N, R2E). In the Little Squalicum Creek mitigation area, 14 separate wetlands totaling approximately 2.8 acres were identified as shown in **Figure 2**. Site modifications on wetland and upland portions of the 12.5-acre site will include grading and planting to create several shallow wetland cells and the creation of a new stream channel potentially providing fish habitat.

Subsequent sections of this report discuss the general goals and specific objectives of the final off-site mitigation plan; the details (e.g., plant selection, grading activities, etc.) of the final mitigation plan; the performance standards which will be used to evaluate the success of the final mitigation plan; the monitoring program for measuring and evaluating plant survivorship, water quality and other parameters; the contingency plans that could be necessary if certain features of the final mitigation plan fail; and finally, the performance security designed to ensure that the work is completed. Appendices provide technical reports related to the final mitigation plan and the previously completed assessment of functions and values of wetlands at the off-site mitigation area.

Table 1.

Wetland Impacts and On- and Off-site Mitigation Acreage

<table>
<tr><th>WETLAND IMPACTS</th><th>ON- & OFF-SITE MITIGATION</th></tr>
<tr><td>Emergent: 17.5 ac.
Forested: 3.60 ac.

Total: 21.1 acres</td><td>On-Site Acreage
Emergent: 14.7 ac.
Scrub-shrub: 6.4 ac.
Total On-site: 21.1 acres

Off-Site Acreage

Creation / Enhancement
Open Water: 0.34 ac. / 0.00 ac.
Emergent: 0.91 ac. / 0.30 ac.
Scrub-shrub: 1.28 ac. / 0.16 ac.
Forested: +0.08 ac. / +0.03 ac.
2.61 ac. / 0.49 ac.
Total Off-site: 3.1 acres

Grand Total On- & Off-site: 24.2 acres</td></tr>
<tr><td colspan="2">ADDITIONAL OFF-SITE MITIGATION

1. Create 2,208 feet of new stream channel and connect to Bellingham Bay.

2. Enhance fisheries habitat of new stream channel.

3. Work with the City of Bellingham Parks Department to create opportunities for passive recreation and environmental education.

4. Monitoring activities for Little Squalicum Creek could be used as the basis for research projects.</td></tr>
</table>

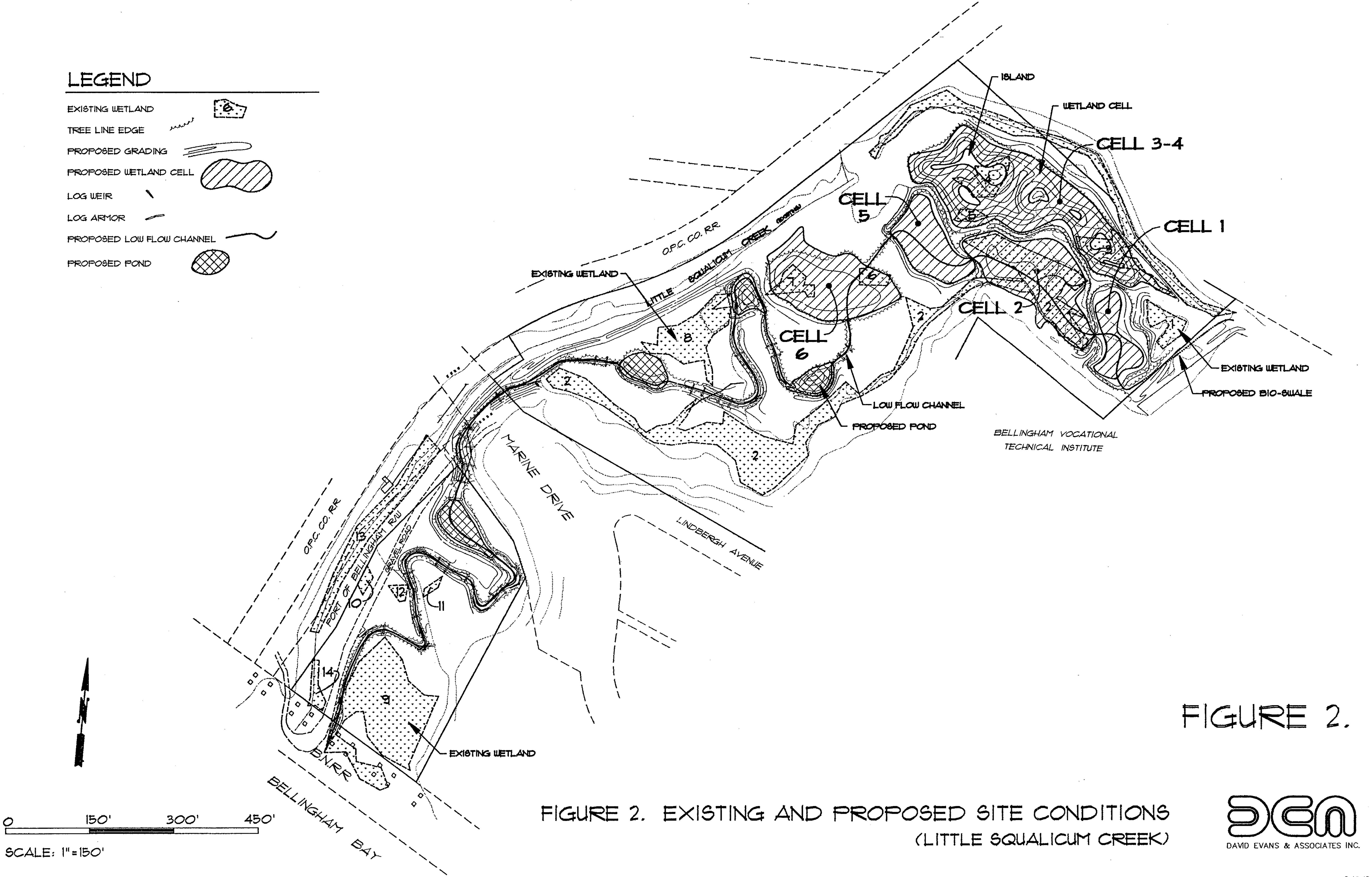


FIGURE 2.

FIGURE 2. EXISTING AND PROPOSED SITE CONDITIONS
(LITTLE SQUALICUM CREEK)

DAVID EVANS & ASSOCIATES INC.

2/8/93

MITIGATION GOALS AND OBJECTIVES

The general goals and specific objectives for the **off-site** mitigation area are described below. The mitigation goals and objectives for the **on-site** mitigation areas were described in the report covering the on-site mitigation (DEA, 1992).

Goal 1 is to partially compensate for the loss of functions and values of the wetlands which were filled for runway expansion at the Bellingham International Airport.

> Objective 1. Provide 1.21 acres of palustrine emergent wetlands through a combination of wetland creation and enhancement.
>
> Objective 2. Provide 1.44 acres of palustrine scrub-shrub wetlands through a combination of wetland creation and enhancement.
>
> Objective 3. Provide 0.11 acres of palustrine forested wetlands through a combination of wetland creation and enhancement.
>
> Objective 4. Provide 0.34 acres of open water wetland through a combination of wetland creation and enhancement.

Goal 2 is to simulate the cover-abundance, vegetative structure, and plant community composition of Pacific Northwest wetlands in the created wetland areas.

> Objective 1. Woody and herbaceous plant species native or naturalized to western Whatcom County will be used in the wetland mitigation plant communities, and plants will be spaced similarly to what is typically found in nature.
>
> Objective 2. As the plantings mature and plant community succession occurs, species composition may change. This is expected to be observed during eight-year monitoring and will be encouraged unless aggressive, weedy species preclude achieving project goals.

Goal 3 is to create, where possible, vegetated buffers in upland areas adjacent to the mitigation wetlands. Buffers will separate the wetlands from nearby possible disturbance.

<u>Objective 1.</u> Woody plant species will be planted peripheral to the wetland cells and the new stream. Existing woody vegetation will be retained to the maximum extent possible.

Goal 4 is to create a new stream which provides potential habitat for salmon.

<u>Objective 1.</u> Construct 2,208 linear feet of new stream channel.

<u>Objective 2.</u> Provide habitat features in the new channel potentially usable by salmon for spawning and overwintering.

<u>Objective 3.</u> Maintain hydrologic separation between the new stream and both the contaminated streambed of the existing Little Squalicum Creek and the source of contamination (Oeser woodprocessing facility).

Goal 5 is to provide opportunities for public education and academic research.

<u>Objective 1.</u> The Little Squalicum mitigation wetland area will be posted with weatherproof signs at least 10 inches by 13 inches in size and bearing "Natural Area Preserve" placed every 350 feet between developed sites and preserved areas, and every 700 feet along all other preserve boundaries. Additionally, up to three interpretive signs will be located in the mitigation area to provide information on the purpose of the mitigation project and the functions and values of wetlands in general.

<u>Objective 2.</u> Make results of the vegetation and stormwater components of the monitoring program available for use by interested agency staff, academic and conservation organizations, and individuals.

Goal 6 is to provide opportunity for passive recreation.

<u>Objective 1.</u> Coordination with the City of Bellingham will result in a trail system which allows for controlled public access through the mitigation area.

public resource created, is invaluable while considered in conjunction with the mitigation opportunities on-site. The Washington Department of Ecology (WDOE) was particularly interested in the opportunities presented for habitat restoration and enhancement.

Plant Selection

The diverse physical conditions to be created on the mitigation site will allow for the creation of equally diverse wetland and upland habitat types. Emergent, scrub/shrub, open water, and forested wetlands areas are expected to result from the maturation of the created and enhanced wetland areas. With the creation of several wetland cells, there is the opportunity for a significant amount of "edge" habitat - or transition zone between wetland habitat types and between wetland and upland habitats.

Emergent plantings will consist of plants tolerant of the wide range of hydraulic conditions anticipated. Woody plant species will be planted where the greatest chance of their success is anticipated. Because water flows which are in excess of the 2-year storm event will overflow the banks of the new stream, there is opportunity for the existing upland forest southwest of Cell 6 to become wetter and potentially to convert to forested wetland over a period of years. Plant species to be planted in the mitigation areas were chosen because of their typical presence in wetlands in the Bellingham area and due to their native or naturalized status.

Site Hydrology and Soils

The little Squalicum Creek mitigation site was formerly used for log storage and gravel extraction. Soil conditions vary widely across the site (See Appendix C, this report). Because site soils drain readily in many areas of the site, it became necessary to design wetland cells and the new stream so they would not leak to underlying porous soils. Consequently, all cells except Cell 3-4, and the entire length of the new stream will be lined with a relatively impervious layer of clay/silt-rich material called Bellingham Drift found commonly in the Bellingham area. Ten to twelve inches of this compacted material on top of native porous soil and gravelly deposits will prevent excessive leakage of surface water flowing through the wetlands and stream. The cross sectional details included as a sheet in the construction plan set (attached) depict the relationship of materials to be used in wetland cell and stream construction.

Wetland Cell 3-4 will be fed by groundwater, not surface water. Cell 3-4 is located in a part of the site where the permanent groundwater table makes a groundwater fed cell more feasible than a surface water fed cell. This area of the site also has a groundwater table during summer months predictably higher than other portions of the site. Elsewhere, on-site groundwater fluctuates widely and was too unpredictable to rely upon for a hydraulic source for the wetlands and stream. If groundwater was used in these areas, it was feared that during dry months, while the groundwater table is deeper in the ground, all surface water would infiltrate into porous gravel layers below grade and seriously reduce stream flow. The decision was made to "perch" surface water in the wetland cells (except for Cell 3-4) and in the stream.

Once the wetland cells and new stream are constructed, it may appear that they are somewhat raised above the grade of the adjacent undisturbed landscape. The reason for this is that there is the need during construction for heavy equipment to be well separated and above the elevation of groundwater during compaction of the Bellingham Drift liner. If heavy equipment operates above a liner which may be too close to groundwater and/or saturated soils, the integrity of the liner is significantly jeopardized because the liner has to be compacted while somewhat dry and on a fairly dry substrate. The elevation of the groundwater table during the anticipated constructed season requires the final grades of the cells and new stream to be above existing grade in some areas of the mitigation site.

Design of Public Amenities

Starting at the confluence of Little Squalicum Creek with Bellingham Bay, the pedestrian trail will run northeasterly and then split in the vicinity of the Marine Drive bridge. One branch of the trail will follow the southern site boundary, while the other branch will run northeasterly near the existing Little Squalicum Creek channel and then turn south at the southern berm of Wetland Cell 5 to join the other trail branch. Educational signs will be placed at strategic locations along the trail to enhance the pedestrian's experience. These public amenities were designed with input from the Bellingham Parks Department.

PERFORMANCE STANDARDS

Performance standards have been established that correspond to the project's mitigation goals and objectives. These standards will be used over time to judge the success of the mitigation project. By monitoring the project for eight years, and by comparing monitoring results to performance standards, an evaluation of the success of the project can be made. That evaluation will help determine if the need for implementing contingency plans exists. The performance standards are as follows:

- Provide 1.21 acres of created or enhanced palustrine emergent wetlands.
- Provide 1.44 acres created or enhanced of palustrine scrub-shrub wetlands.
- Provide 0.11 acres created or enhanced of palustrine forested wetlands.
- Provide 0.34 acres of created or enhanced open water wetlands.
- Establish plant communities in the mitigation areas which are composed of woody and herbaceous plant species native or naturalized to western Whatcom County.
- Ensure that one year after planting, 100% of the number of planted trees and shrubs are alive. This will be a contractual component of professional landscape installation.
- Establish at the end of the monitoring period, a 75% survivorship of all tree and shrub plantings and 75% ground cover within the emergent wetland mitigation areas.
- Establish an upland plant community consisting of trees and shrubs in designated buffer areas bordering wetland cells and the new stream.
- Provide potential salmon spawning and overwintering habitat in the new stream.
- Establish permanent interpretive signs in the mitigation area.

MONITORING PLAN

WETLAND MONITORING PLAN

This monitoring plan pertains to the off-site mitigation area located at Little Squalicum Creek. A separate monitoring plan has been prepared for the on-site mitigation area (DEA 1992). The goals of the monitoring plan are to:

- oversee mitigation construction activities to ensure proper implementation of mitigation design;
- evaluate the mitigation effort relative to the performance standards by measuring the success of plant establishment and the stability of the hydrologic regime over eight years;
- evaluate the need for plant maintenance or adjustments to the hydrologic regime;
- note wildlife and fisheries use in the mitigation area; and
- monitor water quality as a condition of water quality certification.

The monitoring activities and the biological and physical parameters which will be measured and evaluated are described below.

Short-Term Monitoring

Construction monitoring will occur in three sequential steps. These include a pre-construction meeting, construction observation, and a post-construction meeting. These tasks are designed to ensure that the construction of the mitigation site is consistent with the mitigation plan.

Pre-construction Meeting. A pre-construction meeting will be held on-site with the construction contractor; a Port representative; the project's wetland biologist and/or environmental designer; and representatives of regulatory agencies at those agencies' discretion. During this meeting the site conditions and mitigation plan requirements will be reviewed. This will ensure that all parties with jurisdiction or responsibility understand the intent and specifications of the plan.

Construction Observation. Functioning as a construction observer, the project wetland biologist/environmental designer will communicate concerns to ensure that the intent and specifications of the plan are met and that the plan is constructed correctly. He or she will work directly with the general or landscape contractor to provide guidance for meeting plan specifications. The project biologist/environmental designer will also make in-field modifications to the specified layout or placement of elements of the plan to accommodate unforeseen site conditions.

The project wetland biologist/environmental designer will also inspect the quality and quantity of plant material prior to planting. If material is determined to be of quality or quantity less than specified, this will be brought to the attention of the contractor and the Port's representative. Additionally, the wetland biologist/landscape designer will observe planting techniques to confirm their conformance with planting specifications and industry standards. The requirements for these activities will be found in the project's specifications (to be completed at a later date) and plans.

Post-construction Site Meeting. A post-construction review of the completed work will be conducted by regulatory agencies at their option; the project wetland biologist/designer; a Port representative; and the landscape contractor to verify that the plans were properly implemented. The purpose of the field meeting will be to identify any discrepancies between the final mitigation plan and the field plantings and, if necessary, propose corrective measures.

Long-Term Monitoring

Once the plan has been implemented and mitigation has been constructed, the monitoring period will commence. Monitoring will be done to determine the success of the mitigation project. The long-term monitoring plan is designed to evaluate the mitigation effort relative to the performance standards and to determine whether there is a need for plant maintenance or adjustments to the hydrologic regime. Use of the site by fish and wildlife will also be noted during the long-term monitoring.

Parameters. Parameters that will be measured and evaluated during the monitoring period include the survival and condition (vigor and vitality) of original plantings, plant species composition in the developing ecosystem, percent vegetative cover, soil profile descriptions in created wetland areas, hydrological conditions including depth of seasonal saturation or ponding, and fish and wildlife use.

Duration of Monitoring. The mitigation area will be monitored during five years over an eight year period. Monitoring will be conducted during years 1, 2, 4, 6, and 8. The monitoring program will be initiated upon the landscape contractor's successful installation of the mitigation plan. Following installation, a "time-zero" report and as-built drawings will be prepared to document the baseline conditions of the mitigation areas. The first year monitoring report is expected to be submitted approximately 14 months after installation approval. The annual monitoring reports thereafter (completed in each monitoring year) will be submitted to the appropriate agencies within one to two months of completing field monitoring activities.

Monitoring Methods. The following is the sampling technique proposed for monitoring.

Vegetation. Emergent wetland areas will be sampled using permanent transects located in representative areas of the wetland cells. Considering the average size of the cells and the mitigation plantings, a transect length of 100± feet is proposed. Transect endpoints will be permanently marked in the field with iron "T-stakes" or re-bar for ease of location over the years. A specified number of points along each transect will be randomly selected and used throughout the duration of monitoring. For each point, a plot (50cm x 100cm) will be located in emergent vegetation. In each plot the total vegetative cover by species will be estimated.

Forested and scrub-shrub wetland areas will also be sampled. Because plants in these areas will not likely achieve maturity in the initial years of monitoring, measuring the percent areal coverage alone could be misleading and not necessarily indicative of mitigation success. Percent survival can be more meaningful in early years because, if a shrub survives for the first few years, its establishment would likely result in mature growth five or ten years later. Thus, a high percentage of survival in early years is expected to guarantee adequate plant cover at maturity. Therefore, determining percent survival of woody plants will be more useful for early monitoring years and percent areal coverage will be a better measure of planting success in later monitoring years.

A total live count and vigor rating of trees and shrubs will be conducted along permanent transects. Two-meter wide, 100± foot long belt transects will be established through representative planted forested and scrub-shrub portions of the cells. Two, 100± foot long belt transects will also be established in representative areas along the edge of the newly created stream. The total number of living individual plants by species will be compared over time to the original planting design. The overall health of the plantings will be determined from the vigor ratings.

Permanent photographic overview points will be established in representative areas to photodocument plant maturation and other types of ecological changes in the mitigation areas over time. Photographs will be taken during each of the five monitoring years. Photographs will be taken during late summer when vegetative growth is most observable.

Hydrology. Hydrologic conditions will be documented through direct observation in locations where water is ponded and through water level measurements. Staff gauges will be permanently installed in the ponded areas to measure depth of inundation and to determine minimum water levels. Seasonal monitoring during the growing season (March-October), and outside of the growing season (November-February), of each of the five monitoring years will be performed to record fluctuations in surface inundation. In selected non-inundated areas, shallow groundwater wells will be installed at a depth of 18-inches and the depth of soil saturation will be determined at the same interval as the surface water monitoring. Stream flow along the stream enhancement portion of the mitigation site will also be monitored at this interval through visual observation and the presence or absence of flow will be noted. Potentially significant flow events such as prolonged periods of no flow or extreme high flow will be reported as observed.

A qualitative evaluation of the new streambed will be conducted once during each of the five monitoring years. Signs of sedimentation and erosion will be noted. Stream features such as log weirs and root wads will be inspected for proper functioning.

Fish and wildlife observed during monitoring will be noted. Stream monitoring will focus on visually observable salmon activity such as spawning and rearing. Although the Port of Bellingham will not be planting fish in the mitigation area, there may be interest by the Bellingham Maritime Heritage Hatchery in stocking the new stream with fish. Nesting and feeding activity of birds will be the focus of terrestrial wildlife use documentation. The presence of other wildlife such as amphibians, reptiles, and mammals will be noted as well.

Soils. Soil in the created wetland areas will be investigated once during each of the five sampling years using standard field techniques. At least one 18-inch deep soil test pit will be hand dug along each transect where created wetland areas exist, and the soil profile will be described. Soil texture, color, moisture, and hydric soil indicators such as mottles, low chromas, and gleyed conditions will be noted.

The overall success of mitigation relative to performance standards will be evaluated as a result of monitoring. Specific quantitative and qualitative monitoring results; evaluations regarding mitigation success; and any corrective measures will be included as part of the annual monitoring reports which will have a standard format consisting of a narrative section followed by field data forms.

STORMWATER AND WETLAND WATER QUALITY MONITORING PLAN

The source of water for the Little Squalicum Creek mitigation area is existing stormwater runoff from a 340-acre drainage basin composed primarily of large-lot residential development. The 12.5-acre mitigation site is situated at the low end of the basin where it meets Bellingham Bay. Basin stormwater runoff currently collects from sheet flow through a system of existing grassy ditches and culverts upstream of the mitigation site. DEA engineers estimated that approximately 8,100 linear feet of vegetated ditches convey stormwater runoff in the basin. Most of the basin is connected to sanitary sewers.

Water collected upstream of the mitigation site flows through the 3.5-foot diameter buried Birchwood stormdrain which traverses much of the northern portion of the site. Exiting the culvert, water flows into a short degraded section of Little Squalicum Creek and finally into Bellingham Bay. The mitigation plan calls for removal of the on-site portion of the buried culvert and for the redirection of water into a series of wetland cells, then into a new stream channel prior to entering Bellingham Bay.

The wetland cells and the new stream channel and its water will be separate from the adjacent, contaminated portion of Little Squalicum Creek which currently receives runoff from an adjacent industrial facility. Wetland Cell 3-4 is proposed to be at a lower elevation from the surface water-fed mitigation areas and will be hydrologically supplied by groundwater infiltration.

The proposed mitigation site presently consists of low-quality wetlands and a degraded stream channel. The mitigation plan proposes to enhance existing wetlands, create new wetlands, and create a new stream channel. The main focus of the mitigation is not to manage stormwater runoff from an associated development project but to use an existing source of creek hydrology for a wetland/stream enhancement and creation project. Consequently, this project is considered not to fit standard guidelines for monitoring wetlands for stormwater management as outlined in the *Stormwater Management Manual for* *the Puget Sound Basin* (WDOE 1992). The mitigation project is not anticipated to adversely affect the quality of stormwater as it passes through the site, nor is the drainage basin proposed to be altered above the site. Therefore, the level of necessary monitoring for this project will be less stringent compared with more extensive monitoring necessary for development projects where stormwater is discharged to natural wetlands being used as pollution control facilities.

The *Stormwater and Wetland Water Quality Monitoring Plan* is a hybrid plan designed to monitor for several distinct but related purposes. The five purposes for water quality monitoring are:

(1) to document the differences in water quality before and after mitigation construction (accomplished through baseline monitoring);

(2) to monitor the quality of stormwater flowing into and out of the mitigation site to determine if it meets WDOE water quality standards;

(3) to monitor the quality of the water in the created wetlands and stream to determine if the maturation of the wetlands over the eight year monitoring period affects stormwater treatment from year to year;

(4) to determine if water quality varies at different locations in the system; and

(5) to assist in determining the overall success and health of the mitigation wetlands and stream system over time.

The conceptual plan upon which the project's permit was issued committed to the pretreatment of the six-month/24-hour storm event flows prior to their entrance into Cell 1. Flows in excess of that event would bypass the bioswale and enter directly into the wetland cells through a highflow bypass. That design has changed. Accurate stormwater quantity calculations completed subsequent to the preparation of the conceptual plan identified six-month/24-hour flows to be 27 cubic feet per second (CFS) - a quantity in excess of practical pretreatment on-site according to WDOE standards. The conceptually proposed oil/water separator was also determined to be infeasible because this type of pretreatment structure is considered effective by WDOE only for small-scale drainage areas (such as a single parking lot rather than a 340-acre basin). Extensive discussions with WDOE water quality, stormwater and wetland specialists resulted in a modified final design as shown on the attached final plans.

The biofiltration swale was determined to be inadequate to pretreat the 27 CFS; however, the swale was retained in the final design for its expected contribution to the improvement of water quality for design flows of about 1.5 CFS - which is the typical volume conveyed by this system. Consequently, low flows (1.5 CFS) will be pretreated in the bioswale while remaining flows will bypass the swale and enter the wetland cells directly.

To date, there is minimal existing water quality data available to predict the quality of stormwater entering the Little Squalicum mitigation area. In December 1991, one storm event was analyzed for conventionals (pH, dissolved oxygen, solids, and nutrients), metals and total petroleum hydrocarbons (see Appendix B). All results were within acceptable WDOE surface water quality standards except for zinc which WDOE feels may be resulting from the presence of galvanized culverts upstream. Consequently, limited baseline monitoring will occur prior to mitigation construction. With the Landau results in mind, and since (1) much of the drainage basin is comprised of residential development which is primarily connected to sanitary sewers and (2) a considerable portion of basin stormwater is currently flowing through grassy ditches, it was felt that existing water quality may already meet WDOE water quality standards for surface waters of the State. These considerations allowed WDOE staff to relax the need for pretreatment of the sizable, six-month/24 hour storm flows entering the mitigation wetland cells. However, WDOE has required additional water quality monitoring on the mitigation site to determine if the quality of water entering the site meets WDOE standards. Contingencies are proposed in the event that the water entering the mitigation area does not meet such standards (see Contingency Plan section of this report).

Water Quality Monitoring Plan Components:

- For surface water quality monitoring, two storm events will be sampled during all sampling years (years 1, 2, 4, 6, and 8) following construction. Sampling will be spaced throughout the storm season, ideally in the fall and spring of the year.

- Composite, flow-proportional water samples consisting of at least three grab samples will be collected during the initial increase in flow prior to the peak of a storm (the rising limb of the storm) consisting of rainfall greater than 0.1 inch.

- The selected storm events should ideally be preceded by 48 hours of dry weather during November through February and 60 hours during March through October.

- Surface water samples will be collected from the following stations:

  (1) the inlet above the biofiltration swale,

  (2) the outlet of the biofiltration swale,

  (3) the outlet of Cell 6 into the stream, and

  (4) the outlet of the stream onto the beach at high tide mark .

- The composite samples at all four stations will be analyzed for total suspended solids (TSS), total phosphorus (TP), nitrate + nitrite-nitrogen (NO_3 + NO_2-N), total kjeldahl nitrogen (TKN), total zinc (Zn), total lead (Pb) and hardness.

- Separate grab samples at all four stations will be taken during the rising limb of the storm and analyzed for pH, temperature, dissolved oxygen (DO), turbidity, fecal coliform and total petroleum hydrocarbons (TPH).

- Wetland Cell 3-4 is fed primarily by groundwater and is isolated from the surface water-fed system. During periods of high water in one sampling period per monitoring year, Cell 3-4 will be tested for PAH (polynuclear aromatic hydrocarbons) and PCP (pentachlorophenol) using EPA standard protocols for testing hazardous materials. These two substances have been selected for sampling because they are the primary hazardous materials previously identified in the area of the outfall from the adjacent industrial area approximately 100-feet to the west of Cell 3-4. These analyses will be performed to detect any possible groundwater contamination that may be entering and impacting the mitigation site.

- Written reports covering vegetation (as described previously in this report) and water quality monitoring will be submitted at the end of each monitoring year (years 1, 2, 4, 6 and 8).

- This monitoring program needs to be flexible and adaptable to changes in conditions that may occur during the monitoring period. If unexplained problems are detected then additional sampling may be necessary to pinpoint the problems.

After eight years, the mitigation site should be well established and stabilized. Therefore, an eight year water quality monitoring program will be adequate to assess how well the system is functioning. Results of the monitoring will help to assess if the above stated goals have been achieved and to determine the best type and frequency of long-term maintenance and appropriate best management practices for the long-term success of the mitigation project.

CONTINGENCY PLAN

This contingency plan may be implemented in whole or in part whenever the mitigation goals and objectives are determined to be inadequately met. Permitting agencies may require implementation of the contingencies described below, or they may require other contingencies which may be appropriate for unanticipated problems. Two separate parts of the contingency plan are described below. The first part is a description of what will be done if stormwater entering the mitigation area is determined to be below WDOE standards. The second part of the plan describes what will be done if certain elements of the wetland mitigation plan are unsuccessful.

WATER QUALITY CONTINGENCY

During development of the final mitigation plan, it became evident to the project consultants and agencies that pretreatment of the anticipated 27 CFS, six-month/24-hour storm flows would be infeasible given cost and logistical constraints. Consequently, WDOE agreed to the pretreatment of low flows of up to one-and-a-half CFS in a bioswale prior its entrance into Cell 1. Higher flows will bypass the swale and directly enter Cell 2. This pretreatment/bypass scenario was approved by WDOE contingent upon determination if flows entering mitigation wetlands from the 3.5-foot diameter Birchwood stormdrain meet WDOE water quality standards as described in WAC 173-201.

If water quality meets WDOE standards, then no water quality contingency providing greater pretreatment will be needed. If the quality of water entering the mitigation wetlands from the stormdrain is determined to be lower than WDOE standards after the first year of sampling following mitigation construction, then a contingency plan will be implemented in an effort to result in cleaner water entering the wetlands. Events outside the control of the Port, such as a single toxic material spill in the watershed, will be cause for negotiations between the WDOE and the Port regarding any required contingencies responding to water quality data collected during that time. Water quality monitoring will be accomplished as described previously in the Monitoring section of the report in hand.

If water quality improvement is necessary to meet WDOE standards, a coordinated drainage basin level effort will be undertaken to treat contaminants at their predicted sources. The Port of Bellingham has coordinated with the City of Bellingham to facilitate the implementation of Best Management Practices (BMPs) as determined to be most needed in the watershed which supplies water to the mitigation area. Such BMPs will specify (1) the maintenance of existing vegetation in swales and open ditches currently conducting stormwater on public property; (2) the regrading of such swales for increased water residence-time; and (3) the replanting of such swales with vegetation more effective for biofiltration; (4) street cleaning practices; and (5) the stenciling of stormdrains to discourage the dumping of potentially toxic material.

Equally as important, an intensive public awareness and education program will be implemented in an attempt to modify activities (on private property in the basin) which may be adversely affecting water quality. This program will include educational mailings to all owners of private residences, apartments buildings, and commercial businesses in the basin. Mailings will first describe (1) the mitigation project's goals and need for clean water to be successful; (2) the effect that day-to-day activities such as lawn fertilization, car washing, and inappropriate disposal of hazardous materials can have in the drainage basin; and (3) recommendations to modify techniques for these activities to help lessen their potential impacts on water quality in the mitigation wetlands and stream.

If the above described contingencies are necessary, continued testing of water quality in the mitigation area will monitor the success of such a basin-wide approach to treating the source of contaminants. Results of the program will be made public for use as a model for other neighborhoods faced with similar water quality challenges.

WETLAND MITIGATION CONTINGENCY

Replacement of Dead or Dying Plants

Three general categories of potential problems have been considered in contingency planning at this time and include: (1) dead or unhealthy plants; (2) inappropriate grades for development of wetland conditions in created wetland areas, or for the proper flow of water in the new stream; and (3) an inadequate quantity of water in the wetlands or new stream to result in the conditions desired. These potential problems can be addressed as described below.

During the first year following installation, plantings will be guaranteed for survival by the landscape contractor. Woody plant material will be largely container grown, rather than bare-root as specified in the conceptual plan, and will have a correspondingly better chance of survival. If plants die, the monitoring wetland biologist and/or environmental designer will assess the possible reasons for mortality. Recommendations will then be made and, depending on the reason for mortality, could include in-kind replacement of dead plant material; replanting with different plant species; and grade changes (resulting in hydrologic changes) followed by replanting. In the event of an unforeseen catastrophic environmental event (drought, fire, flood, severe freeze, etc.), plant losses could occur that would require replacement of large numbers of plants potentially outside the contractor's guarantee. In that event, performance security provisions are anticipated to cover costs for plant replacement.

Some plant mortality is normal in natural ecosystems and, provided the cover requirements and species targets specified in the performance standards are met during the monitoring period, the monitoring biologist/designer may recommend that dead plants not be replaced but be left in place and that the mitigation be considered successful. Professional judgement and the experience of the monitoring biologist/designer will be used to distinguish normal ecosystem change from excessive mortality, thereby determining the need for contingency actions.

Although reed canarygrass typically occurs in wetlands in Whatcom County, it is considered invasive and a potential threat to mitigation plantings. There is a potential for this grass (and other weedy, invasive species such as Himalayan blackberries) to interfere with establishment and healthy growth of the emergent and scrub-shrub plantings. If reed canarygrass or other weeds begin to pose a threat to the plantings, the monitoring biologist/designer will recommend a control method. Measures to control invasive species could include mowing (or "weed-eating") to reduce vigor and seed production (particularly around the bases of woody plantings), manual removal (weeding), and selective spot-spraying with Roundup, TM. The permitting agencies or Whatcom County may need to approve herbicide application.

Modification of Grades

The existing topography of the site will be extensively modified to provide appropriate soils and hydrology necessary for the success of the mitigation plan. Although considerable effort has been spent studying existing soil conditions and predicting flows, there may be the need to modify grades if areas predicted to be saturated or inundated are not. Evaluation of this potential problem is intimately associated with monitoring of the site's hydrology, and hydrological considerations for problem resolution are described below. If re-grading becomes necessary, it will probably take the form of limited grade lowering to intercept and detain water better in low spots, or raising the elevations of the spillways between cells thereby increasing the depth to which water would pond prior to spilling into the next cell or the stream. Lowering grades in areas where the impervious soil liner exists may not be feasible, in which case raising the height of wiers is the preferred alternative in such areas. Enhancing or repairing the impervious soil liner in the wetland cells or the new stream channel may be necessary if they appear to be leaking.

Modification of Hydrology

It is well understood that hydrology will be seasonal in both the wetland cells and the new stream channel. Flowing water in the stream is anticipated to occur typically from mid-fall to late spring in average rainfall years and otherwise during periods after storms. It is likely that water may not be flowing in the new stream during the dry months of summer and fall. Likewise, wetland cells which are shallow and dependent on surface water flows would be expected to be wet or dry as described above for the stream.

Hydrologic calculations for flows from the Birchwood stormdrain (the primary source of water for all mitigation areas except Wetland Cell 3-4 which is groundwater-fed) indicate that there will be no shortage of water during the rainy months of the year. However, if inadequate surface water quantity appears as a problem, then two contingencies to solve the problem could be considered. The first possible solution would be to direct the flows from the stormdrain flowing from the Oeser facility away from 'old' Little Squalicum Creek and into the new stream channel or wetland cells in the mitigation area. This would require considerable attention to the task of determining if the quality of existing or future flows from Oeser may be contaminated (a task outside the scope of the current mitigation project). A second possible solution to the problem of inadequate surface water flow would be to pump water from the groundwater fed wetland Cell 3-4 into the surface water system. Careful attention to the task of ascertaining that groundwater is not contaminated would be necessary (again, a task outside the scope of the current mitigation project).

Watering of the plantings for their first year will be done by the method of choice of the landscape contractor guaranteeing the plantings, and could take the form of hand-watering from an irrigation truck or through the use of a temporary irrigation system. If plant mortality in excess of that which is tolerable becomes evident as a result of drought, the water main on-site may be tapped with approval from the City of Bellingham for use in irrigation. This contingency will be applied only if determined to be feasible by the City.

PERFORMANCE SECURITY

In order to ensure that the mitigation plan will be properly installed and monitored, and so that contingencies can be implemented if necessary, specific control measures are included in this plan. The Port of Bellingham, being a public municipal corporation, will post a corporate guarantee in the form of a resolution approved by the Port Commission. This resolution, subject to the review of the Army Corps, at that agency's option, will formally recognize the Port's continuing obligations to the wetland mitigation project and will guarantee funding an appropriate annual budget allocation to cover costs of implementation, long-term monitoring and contingencies, if needed.

REFERENCES

Cooper, J. 1987. *An Overview of Estuarine Habitat Mitigation Projects in Washington State.* Northwest Environmental Journal, Volume 3:1, page 112-127.

David Evans and Associates, Inc. (DEA). 1992. *Final On-site Wetland Mitigation Plan for the Port of Bellingham International Airport Runway Extension.*

Jones and Stokes Associates. 1990. *Preliminary Wetland Analysis, Bellingham Airport Proposed Runway Extension.*

Sheldon and Associates. 1991. *Draft Wetland Compensation Design, Airport Extension.*

Springwood Associates and Sheldon and Associates. 1992. *Little Squalicum Creek Wetlands Mitigation Plan.*

Washington State Department of Ecology (WDOE). 1992. *Stormwater Management Manual for the Puget Sound Basin (The Technical Manual).*

APPENDIX A

Agency Correspondence

Gorski

PORT OF BELLINGHAM
Washington State

September 1, 1992

Gail Terzi, Project Manager
Corps of Engineers, Regulatory Branch
Dept. of the Army
P.O. Box C-3755
Seattle, WA 98124-2255

Re: OYB-4-014435; Bellingham International Airport
Runway Extension Project

Dear Ms. Terzi,

This letter amends our letter of request for a time extension dated 8/31/92 by providing you with additional information on the above referenced project.

David Evans and Associates (DEA) has been given authorization to proceed on final plans for off-site mitigation. A copy of the letter is enclosed. A copy of the contract will be sent to you when fully executed.

The Port selected DEA not only because they were more cost effective, but more importantly are able to complete the final plans in a much more timely manner; a concern expressed by the regulatory agencies. DEA has indicated that final plans for the Little Squalicum area will be complete by **November 1, 1992.**

Selection of DEA also allows integration of the Port's permit commitments under one consultant.

Andy Gorski will be the project manager.

The Port of Bellingham therefore respectfully requests an extension of the Little Squalicum final mitigation plan to November 1, 1992.

The on site mitigation plan is being completed. However, the Port requests authorization to utilize the equipment now on site to prepare topography for wetland creation consistent with the draft grading plans.

The Port recognizes that this would be at our risk (should the agencies desire changes), but utilization of the existing equipment will result in considerable cost saving to the federal government and the Port.

ADMINISTRATIVE OFFICES
625 Cornwall Avenue/P.O. Box 1737 Bellingham, Washington 98227-1737
(206) 676-2500 County 398-2600/FAX (206) 671-6411

Thank you for your consideration.

Sincerely,

William Hager, Director
Planning and Environment

c. Russ McMillan; DOE
Andy Gorski; DEA
Darling; POB

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-2255

REPLY TO ATTENTION OF

Regulatory Branch

SEP 4 1992

Mr. William Hager
Port of Bellingham
Post Office Box 1737
Bellingham, Washington 98227-1737

Reference: OYB-4-014435
Bellingham, Port of

Dear Mr. Hager:

In accordance with your request of September 1, 1992, the authorization granted by the Secretary of the Army on May 29, 1992, is hereby modified to include amendments to Special Conditions (f) and (g) of the authorized permit. You were authorized to grade and place 194,800 cubic yards of fill material into 21.1 acres of wetlands to extend the existing airport runway by 1,750 feet at Bellingham International Airport, Whatcom County, Washington, with mitigation consisting of creating 21.1 acres of new wetlands onsite and creation and enhancement of approximately 5 acres of wetlands and creation of approximately 1100 linear feet of new stream channel at a 12.3 acres offsite location at Little Squalicum Creek, Whatcom County, Washington.

Special Condition (f) is hereby modified to allow for a time extension to September 4, 1992 for submittal of a signed contractual agreement for the Little Squalicum offsite mitigation plan.

Special Condition (g) is hereby modified to allow for a time extension to September 18, 1992, for submittal of the final onsite mitigation plan to the Seattle District, Corps of Engineers and U.S. Fish and Wildlife Service for review and November 1, 1992, for submittal of the final offsite mitigation plan. This Special Condition is also hereby modified to allow grading and topographic changes of the onsite mitigation area before review of the above referenced agencies. This modification is at your risk since final designs for grading and topography for onsite mitigation must be approved by the subject agencies.

The terms and conditions contained in the original permit remain in full force and effect.

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

Walter J. Cunningham
Colonel, Corps of Engineers
District Engineer

Copy to
ANDY GORSKI
DEA

PORT OF BELLINGHAM
Washington State

RECEIVED
BELLEVUE
SEP 1 1 1992
DEA

September 10, 1992

Mayor Tim Douglas
210 Lottie St.
Bellingham, WA 98225

Dear Mayor Douglas,

I received from Mr. Elmendorf, a copy of a letter written to you by Mr. Wahl concerning the wetland mitigation plan for Little Squalicum. Since this is a Port project, I am taking the liberty of responding directly to you on our reaction.

Contrary to the theme of the letter; there already has been public review. During the Army Corps wetland permit process, many citizens took the time to respond to the submitted plans.

In an effort to let others aware of our plans, the Port participated in the recent and well publicized Puget Sounder Bellingham Bay Rediscovery program. At that forum, the Port's plans for Little Squalicum were discussed with interested citizens.

For those who contacted the Port directly, copies of the draft plan were provided with a promise to route any suggestions to the consultant for consideration.

As you are aware, the City and County both have reviewed the draft mitigation plan for consistency with future park plans. The new stream channel is required to be approved by the State Department of Fisheries. They will be looking specifically at design details to enable future fish use.

With all that being said, the Port does not have any problem with additional public comment opportunities. We recognize that Bellingham is blessed with resourceful citizens who could provide thoughtful, constructive input.

Since the letter was sent to the City, I would rely on your staff to determine the appropriate forum for additional meetings deemed appropriate.

The forum participants must recognize however that the Port is under a federal requirement to submit the final mitigation plan by November 1. (This deadline was recently been extended to this date and is unlikely to be extended further.) It should also be recognized that the Port bears the ultimate financial responsibility for the success of the wetland project. Suggestions in regard to wetland engineering or plant selection which our consultants believe will adversely impact the success and/or cost of the project can not be considered without the corresponding assumption of responsibility by another party.

Please keep me informed of any additional meeting felt necessary. The Port and our project consultants David Evans and Associates (DEA) will be happy to attend.

Sincerely,

William Hager, Director
Planning and Environment

C. Terence Wahl - 3041 Eldridge Ave.
Byron Elmendorf, City Parks Director

October 23, 1992 POBM0007

Ms. Gail Terzi, Project Manager
Regulatory Branch
U.S. Army Corps of Engineers
Seattle District
P.O. Box C-3755
Seattle, Washington 98124-2255

Re: **Final Off-Site Wetland Mitigation Plan for the Bellingham Airport Runway Expansion Project**
Corps Reference Number: OYB-4-014435

Dear Gail:

During our meeting of October 16, 1992, David Evans and Associates, Inc. (DEA) and Landau Associates, Inc. (Landau) described to you recently available geotechnical information for the proposed Little Squalicum mitigation area. DEA is tasked with preparing final mitigation plans for Little Squalicum based on the goals and mitigation area calculations presented in the conceptual plan prepared by Springwood Associates in the report, "Little Squalicum Creek Wetlands Mitigation Plan", dated January 24, 1992. Landau conducted geotechnical field work on the site (October 8 and 9, 1992) to assist DEA in further evaluating the feasibility of mitigation proposals. New geotechnical information suggests the need for modifications to the conceptual mitigation proposal. During our meeting with you, we discussed (1) the new geotechnical information; (2) the impacts this information has on the feasibility of the conceptual mitigation plan proposed by Springwood; (3) alternative design concepts responding to the new information; and (4) a new submittal date for the final mitigation plan. This letter describes changes to the conceptual plan which DEA/Landau propose to better ensure the success of mitigation.

The Springwood Design

The original conceptual plan as described by Springwood proposed the creation of shallow wetland cells (Cells 1 through 6) in the upper (northeastern) portion of the site. Some soils information was available during conceptual design development for these areas, and these cells were proposed to be lined, or unlined as appropriate, to contain surfacewater or groundwater respectively. Mitigation in the middle portion of the site, between Cell 6 and Marine Drive, was proposed to consist of the seasonal ponding of surfacewater behind berms in areas which today are largely upland vegetated with trees and shrubs. This middle area is identified as Cells 7 and 8 in the Springwood report. No alteration to existing vegetation or soils was proposed in Cells 7 and 8. Below Marine Drive, mitigation was proposed in the form of a new stream corridor designed as a fisheries resource beginning at the downstream

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end of Cell 8 and outletting to Bellingham Bay to the southwest. Another fisheries resource was proposed to be Cell 6 expected to be rearing habitat for fish. In all, mitigation was proposed to include 4.5 acres of created and enhanced wetland and 1,100 linear feet of new stream channel.

New Geotechnical Information

Based on new geotechnical information for the site, we now realize the greatest challenge posed to the successful creation of both wetlands and a new stream channel on-site relates to the site's essentially porous soils. Although there are areas of shallow ponding and soil saturation which currently exist in the on-site wetlands, the soil conditions supporting these wetlands are not uniform throughout the site, and much of the site is underlain with porous soils and gravel. Groundwater fluctuates seasonally, and is located at various elevations in the mitigation areas. Soil porosity and fluctuating groundwater levels require site-specific design solutions as proposed below.

Proposed Design Changes Effecting Mitigation Acreage

The recently available soil porosity information effects the feasibility of conceptual designs for the upper and middle portions of the site. In response to this information, the new stream channel and wetland Cells 1, 2, 5 and 6 are proposed to be raised in elevation and lined with indigenous clay-rich impervious material, and Cells 7 and 8, now determined to be infeasible, are proposed to be replaced with an extension of the new stream channel. This design revision will (1) increase the chance of mitigation success; (2) result in an increase in the length of new stream channel on-site; and (3) decrease the total amount of area in created/enhanced wetland on-site (see table below).

Abandoning the creation of Cells 7 and 8 was determined to be necessary because the porosity of existing soils in these areas would predictably act as a "sink" for any surfacewater flowing into them. This would eliminate a large portion of potential surfacewater flow for the new stream channel downstream. As a result of the possibility of this sink, it was determined Springwood's design for the use of Cell 6 by anadromous fish may not be possible because the hydrologic link between this cell and the new stream below Marine Drive (and ultimately Bellingham Bay) might be broken by the sink. An additional sink area has been identified in the existing deep channel wetland (Wetland #2) which exists in the southwestern corner of proposed Cell 8. This channel, due to its porous side slopes, may never allow water to overtop its banks (as proposed in the conceptual design) thereby preventing any surfacewater flow to the proposed downstream new channel. The undesirable alternative of replacing Cells 7 and 8 with lined cells in the same locations (thereby maintaining the amount of mitigation area proposed in the conceptual plan) would require the removal of a large number of mature trees and shrub masses. We propose that the two cells be replaced with additional stream habitat which would begin at the outlet of Cell 6, meander through a series of three emergent pools, and connect with the currently proposed stream under Marine Drive. This extension will impact existing vegetation much less than the creation of lined cells; it will provide considerably more linear feet of fisheries habitat than was proposed in the original plan (see table below); and it will provide for a more assured hydrologic (fisheries) link between Bellingham Bay and Cell 6.

Toxic soil deposits on-site were described by Landau (January 14, 1992 -Appendix B of above cited report by Springwood) to be located in the vicinity of the Oeser Cedar facility outfall into Little Squalicum Creek. DEA has complied with the recommendation by Landau that all mitigation be maintained a distance of at least 100 feet from the known deposit. Consequently, the western portion of Cells 4 and 5 have been modified in shape to maintain this distance. Cell 4 has been enlarged as much as possible to the north where mature trees were not threatened by such expansion, and Cell 5 has not been expanded in any other direction as opportunity for such was not apparent. This redesign of Cells 4 and 5 results in a small net loss of mitigation area (see table below).

Table of mitigation areas lost and gained with the proposed conceptual design changes.

Removal of Cell 8	(0.82) acre lost
Removal of Cell 7	(0.38) acre lost
Change shape of Cells 4 & 5	(0.14) acre lost
Sub-total lost area	(1.34) acres lost
Addition to Cell 4	0.06 acre gained
Additional streambed & PEM pools	0.32 acre gained
Sub-total gained area	0.38 acre gained
TOTAL mit. area lost with changes	**(0.96) acre lost**
Originally proposed stream channel	1,100 linear feet
Additional stream channel	854 linear feet
Subtotal new channel	+1,954 linear feet
TOTAL net gain of new channel	**854 linear feet gained**

NOTE: Quantities given in this table are based upon conceptual design concepts only. Quantities may vary with final design.

Proposed Design Changes NOT Effecting Mitigation Acreage

There are additional design changes which we discussed which do not change the total square footage of mitigation proposed in the Springwood report. Cells 3 and 4 are now proposed to be combined into one cell in the final mitigation plan. This cell is proposed to be excavated to below the permanent groundwater table to enhance chances of providing a permanently inundated wetland area on-site. Surfacewater from the Birchwood stormdrain is no longer proposed to flow into this groundwater-fed cell, and at low-water flow periods is now proposed to feed the remainder of the mitigation area by flowing from Cell 1 to Cell 2 and then directly to Cell 5 and downstream. At highwater flow periods, surfacewater in excess of the six month/24-hour storm event is proposed to flow directly into Cell 2 and bypass Cell 1. Because the site soils are so porous, and because the groundwater table is known to drop considerably in dry months, it is advantageous to hydrology of the surfacewater fed system to provide no opportunity for surfacewater to infiltrate into porous soils, or into the groundwater system, during dry months.

In order to assist in natural flows between cells, the pipes and flap gates separating cells as proposed in the Springwood report are proposed to be replaced with log weirs over which water will flow from cell to cell. DEA has found these structures to be superior and more maintenance-free than pipes and flap gates which can more easily become clogged.

In the area directly under Marine Drive, the new stream channel will flow in close to the footings supporting the bridge. The Whatcom County Department of Public Works has requested that the channel be impervious in this location to help reduce potential for soil erosion and saturation in the vicinity of the footings. DEA proposes to design an open concrete channel lined with rocks and gravel to comply with this request by the County.

New Final Plan Submittal Date Needed

It is apparent that gaining approval of these conceptual design changes will delay the November 1, 1992 final mitigation plan submittal date. Once regulatory agencies approve the revised conceptual design presented at the upcoming meeting you are scheduling with DOE and USFWS, we would like to schedule a new final plan submittal date. We expect to coordinate soon with the City of Bellingham, as the City must also accept the proposed conceptual design changes before we complete final designs. DEA anticipates approximately three full production weeks to complete the final plan following approval of the design changes by all agencies with jurisdiction.

The changes proposed herein should result in a more successful mitigation project. They in no way reflect an interest by the Port of Bellingham for reducing the amount of mitigation proposed at Little Squalicum. In fact, the changed design will actually cost the Port more money to implement. We look forward to your administrative review of these changes so we can complete our work and satisfy the conditions of the 404 permit. Please call me, Kirk Hackler, or Anne Biklé if you have any questions or comments on the contents of this letter.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager - Natural Resources

cc: Bill Hager, Port of Bellingham
Larry Beard, Landau Associates, Inc.
Deborah Ladd, Landau Associates, Inc.

AFG:crg

November 4, 1992 POBM0007

Mr. Jeff Krausmann
U.S. Fish and Wildlife Service
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan for 404 Permit

Dear Jeff:

A meeting will be held at 2:00pm on November 16, 1992 at the office of the U.S. Fish and Wildlife Service in Olympia regarding proposed revisions to the Little Squalicum Creek wetlands mitigation plan. Gail Terzi of the Corps has coordinated with you to request your attendance at the meeting. I am sending you two documents to assist in your review, prior to the meeting, of the project as it has evolved since the 404 permit was issued. Enclosed you will find: (1) my letter of October 23, 1992 to Gail describing proposed design changes and (2) a plan portraying the concepts described in the letter.

If you have any questions, please call me or Kirk Hackler, the project's environmental designer. We both look forward to meeting with you on the 16th to more fully describe the proposed design changes.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager,
Natural Resources

Encl.

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November 4, 1992 POBM0007

Ms. Gail Terzi, Project Manager
Regulatory Branch
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124-2255

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan for 404 Permit

Dear Gail:

Thank you for scheduling the upcoming meeting to be held at 2:00pm on November 16, 1992 at the office of the U.S. Fish and Wildlife Service in Olympia (3704 Griffin Lane) regarding proposed revisions to the Little Squalicum Creek wetlands mitigation plan. I am sending you a plan portraying the concepts described in my letter of October 23, 1992 to you. At your request, I have sent copies of that letter and the plan to USFWS, DOE, and EPA. Bill Hager plans to attend the meeting.

If you have any questions, please call me or Kirk Hackler. We both look forward to meeting with you on the 16th.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager,
Natural Resources

Encl.

DAVID EVANS AND ASSOCIATES, INC.
ENGINEERS, SURVEYORS, PLANNERS, LANDSCAPE ARCHITECTS, SCIENTISTS
OFFICES IN OREGON, WASHINGTON AND CALIFORNIA
415 118TH AVENUE, S.E.
BELLEVUE, WASHINGTON 98005-3553
(206) 455-3571 FAX (206) 455-3061

November 4, 1992 POBM0007

Cyd Brauer
Washington State Department of Ecology
Mail Stop 7600
P.O. Box 47600
Olympia, Washington 98504-7703

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan for 404 Permit

Dear Cyd:

A meeting will be held at 2:00pm on November 16, 1992 at the office of the U.S. Fish and Wildlife Service in Olympia regarding proposed revisions to the Little Squalicum Creek wetlands mitigation plan. Gail Terzi of the Corps has coordinated with you to request your attendance at the meeting. I am sending you two documents to assist in your review, prior to the meeting, of the project as it has evolved since the 404 permit was issued. Enclosed you will find: (1) my letter of October 23, 1992 to Gail describing proposed design changes and (2) a plan portraying the concepts described in the letter.

USFWS (ph. 753-9046) is located at 3704 Griffin Lane SE in Olympia. To get there from the north, take the I-5 Martin Way exit in Lacey and turn right (head west) on Martin Way. Proceed to the third light (Lilly Road NE) and turn right on Lilly Road NE (you'll be going north). Proceed to Griffin Road which is on your left not far from the intersection of Martin Way and Lilly Road NE (I've been told a landmark is the John Deer tractor dealer).

If you have any questions, please call me or Kirk Hackler, the project's environmental designer. We both look forward to meeting with you on the 16th to more fully describe the proposed design changes.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski
Senior Project Manager,
Natural Resources

Encl.

DAVID EVANS AND ASSOCIATES, INC.
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November 4, 1992 POBM0007

Ms. Linda Storm
U.S. Environmental Protection Service
Aquatic Resources & Wetlands Program
1200 - 6th Ave. WD-126
Seattle, Washington 98101

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan for 404 Permit

Dear Linda:

A meeting will be held at 2:00pm on November 16, 1992 at the office of the U.S. Fish and Wildlife Service in Olympia regarding proposed revisions to the Little Squalicum Creek wetlands mitigation plan. Gail Terzi of the Corps has coordinated with you to request your attendance at the meeting. I am sending you two documents to assist in your review, prior to the meeting, of the project as it has evolved since the 404 permit was issued. Enclosed you will find: (1) my letter of October 23, 1992 to Gail describing proposed design changes and (2) a plan portraying the concepts described in the letter.

USFWS (ph. 753-9046) is located at 3704 Griffin Lane SE in Olympia. To get there from the north, take the I-5 Martin Way exit in Lacey and turn right (head west) on Martin Way. Proceed to the third light (Lilly Road NE) and turn right on Lilly Road NE (you'll be going north). Proceed to Griffin Road which is on your left not far from the intersection of Martin Way and Lilly Road NE (I've been told a landmark is the John Deer tractor dealer).

If you have any questions, please call me or Kirk Hackler, the project's environmental designer. We both look forward to meeting with you on the 16th to more fully describe the proposed design changes.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager,
Natural Resources

Encl.

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November 19, 1992

Ms. Cyd Brower, Wetlands Biologist
Washington State Department of Ecology
Baran Hall
P.O. Box 47600
Olympia, Washington 98504

Re: Water Quality Certification (April 10, 1992) for Port of Bellingham Runway Extension
Public Notice #: OYB-4-014435

REQUEST FOR SCHEDULE EXTENSION AND APPROVAL OF REVISED PLAN - Little Squalicum Creek Wetland Mitigation

Dear Ms. Brower:

David Evans and Associates, Inc. (DEA) is under contract with the Port to produce final mitigation plans for the on- and off-site wetland mitigation areas described in the above referenced Public Notice. This letter formally requests a schedule extension and approval of revised plan for the Water Quality Certification. That Certification was conditioned on... "Ecology's review and approval of a detailed mitigation plan, to be submitted within ninety (90) days after issuance of this...Certification" (Condition 4).

Final plans for the on-site mitigation were submitted by DEA to DOE on September 18, 1992; however, final plans for the off-site (Little Squalicum Creek) mitigation area are still in process. The 90-day schedule was not met for a number of contractual, technical and administrative reasons (see attached letters dated September 4, 1992 from Mr. Walter Cunningham of the Corps to Mr. Hager and October 23, 1992 from me to Ms. Gail Terzi of the Corps.

A revised conceptual plan for Little Squalicum has been prepared by DEA in response to new information on the limiting soil conditions which make the original conceptual design infeasible (see above referenced October 23, 1992 letter for full description). DEA met with you and representatives of the Corps, Washington Department of Fisheries, and U.S. Fish & Wildlife Service on November 16, 1992 to describe the revised conceptual plan. This plan is different from the conceptual plan originally prepared by Springwood Associates (which was approved by DOE in April of this year). **Except for some minor revision suggestions, you and the other agency staff preliminarily approved the new (DEA) conceptual design which will now be redrafted and submitted to you and the others for formal approval prior to completing the final plans.** Ms. Terzi has authorized a four-week final plan production schedule commencing <u>after</u> all agencies with jurisdiction formally authorize the revised conceptual plan.

DAVID EVANS AND ASSOCIATES, INC.
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(206) 455-3571 FAX (206) 455-3061

November 25, 1992 POBM0007

Ms. Gail Terzi
Regulatory Branch
Department of the Army
Seattle District, Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124-2255

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan

Dear Ms. Terzi:

On November 16, 1992, David Evans and Associates, Inc. (DEA) met with you to discuss the revised conceptual plan for the Little Squalicum Creek wetland mitigation project. Conceptual mitigation design was originally proposed by Springwood Associates as part of the Section 404 permit and Water Quality Certificate issued for the project. Certain elements of the original conceptual design for Little Squalicum have been redesigned by DEA in response to additional information related to the porosity of soils at the site. Design modifications, and their justifications, were discussed at the meeting on the 16th.

The conceptual plan presented at the meeting was generally approved by agency attendees; however, additional vegetated islands were proposed by the Department of Ecology to be located in the new groundwater fed wetland cell proposed in the northwestern portion of the site. DEA was asked to submit a revised conceptual drawing (enclosed) based on input given by agency staff at the meeting. Please review this plan for consistency with the general consensus gained at the meeting that the **conceptual plan** is appropriate for development into a **final plan**.

DEA will proceed with preparation of the final plans (and associated written report) once the Corps authorizes the conceptual plan. We anticipate a four-week production schedule to complete the final documents once authorized to do so.

Your timely review and approval of the enclosed conceptual plan would be appreciated. Naturally, once final plans are complete, we will submit them to you for your review and approval. If you have any questions, please call me or Kirk Hackler at DEA.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager, Natural Resources

Encl.

DAVID EVANS AND ASSOCIATES, INC.
ENGINEERS, SURVEYORS, PLANNERS, LANDSCAPE ARCHITECTS, SCIENTISTS
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(206) 455-3571 FAX (206) 455-3061

November 25, 1992 POBM0007

Mr. Mark Schuller
Washington Department of Fisheries
333 East Blackburn Road
Mt. Vernon, Washington 98273

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan

Dear Mr. Schuller:

On November 16, 1992, David Evans and Associates, Inc. (DEA) met with you to discuss the revised conceptual plan for the Little Squalicum Creek wetland mitigation project. Conceptual mitigation design was originally proposed by Springwood Associates as part of the Section 404 permit and Water Quality Certificate issued for the project. Certain elements of the original conceptual design for Little Squalicum have been redesigned by DEA in response to additional information related to the porosity of soils at the site. Design modifications, and their justifications, were discussed at the meeting on the 16th.

The conceptual plan presented at the meeting was generally approved by agency attendees; however, additional vegetated islands were proposed by the Department of Ecology to be located in the new groundwater fed wetland cell proposed in the northwestern portion of the site. DEA was asked to submit a revised conceptual drawing (enclosed) based on input given by agency staff at the meeting. Please review this plan for consistency with the general consensus gained at the meeting that the **conceptual plan** is appropriate for development into a **final plan**.

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Your timely review and approval of the enclosed conceptual plan would be appreciated. Naturally, once final plans are complete, we will submit them to you for your review and approval. If you have any questions, please call me or Kirk Hackler at DEA.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski
Senior Project Manager, Natural Resources

Encl.

DAVID EVANS AND ASSOCIATES, INC.
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November 25, 1992 POBM0007

Ms. Cyd Brower, Wetland Biologist
Washington State Department of Ecology
Baran Hall
P.O. Box 47600
Olympia, Washington 98504

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan

Dear Ms. Brower:

On November 16, 1992, David Evans and Associates, Inc. (DEA) met with you to discuss the revised conceptual plan for the Little Squalicum Creek wetland mitigation project. Conceptual mitigation design was originally proposed by Springwood Associates as part of the Section 404 permit and Water Quality Certificate issued for the project. Certain elements of the original conceptual design for Little Squalicum have been redesigned by DEA in response to additional information related to the porosity of soils at the site. Design modifications, and their justifications, were discussed at the meeting on the 16th.

The conceptual plan presented at the meeting was generally approved by agency attendees; however, additional vegetated islands were proposed by the Department of Ecology to be located in the new groundwater fed wetland cell proposed in the northwestern portion of the site. DEA was asked to submit a revised conceptual drawing (enclosed) based on input given by agency staff at the meeting. Please review this plan for consistency with the general consensus gained at the meeting that the **conceptual plan** is appropriate for development into a **final plan**.

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Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager, Natural Resources

Encl.

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November 25, 1992 POBM0007

Mr. Jeff Krausmann
U. S. Fish and Wildlife Service
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192

Re: Port of Bellingham International Airport, Little Squalicum Creek Wetlands Mitigation Plan

Dear Mr. Krausmann:

On November 16, 1992, David Evans and Associates, Inc. (DEA) met with Dennis Carlson in your absence to discuss the revised conceptual plan for the Little Squalicum Creek wetland mitigation project. Conceptual mitigation design was originally proposed by Springwood Associates as part of the Section 404 permit and Water Quality Certificate issued for the project. Certain elements of the original conceptual design for Little Squalicum have been redesigned by DEA in response to additional information related to the porosity of soils at the site. Design modifications, and their justifications, were discussed at the meeting on the 16th.

The conceptual plan presented at the meeting was generally approved by agency attendees; however, additional vegetated islands were proposed by the Department of Ecology to be located in the new groundwater fed wetland cell proposed in the northwestern portion of the site. DEA was asked to submit a revised conceptual drawing (enclosed) based on input given by agency staff at the meeting. Please review this plan for consistency with the general consensus gained at the meeting that the **conceptual plan** is appropriate for development into a **final plan**.

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Your timely review and approval of the enclosed conceptual plan would be appreciated. Naturally, once final plans are complete, we will submit them to you for your review and approval. If you have any questions, please call me or Kirk Hackler at DEA.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski

Andrew F. Gorski
Senior Project Manager, Natural Resources

Encl.

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December 15, 1992 POBM0007

Ms. Sandra Manning
Sediment Management Section
WA Dept. of Ecology
P.O. Box 47703
Olympia, Washington 98504-7703

Re: **Water Quality Certification (April 10, 1992) for Port of Bellingham Airport Runway Extension**
Public Notice #: OYB-4-01443

REQUEST FOR SCHEDULE EXTENSION AND APPROVAL OF REVISED PLAN - Little Squalicum Creek Wetland Mitigation Plan

Dear Ms. Manning:

Following our phone conversation today, I am sending you this letter and the attached copies of relevant correspondence pertaining to the above referenced project. As we discussed, Gail Terzi of the Corps has approved the revised conceptual plan (attached) and has set a revised deadline of **February 1, 1993** for David Evans and Associates, Inc.'s submission of the final mitigation plan. Gail issued this revised submittal date only after she had coordinated with Cyd Brauer of DOE and Jeff Krausamann of USFWS regarding their approval of the revised conceptual plan.

Please review my November 10, 1992 letter (attached) to Cyd regarding the conditions of the Water Quality Certificate which can no longer be met, and why this is so. As you suggested, a letter from DOE authorizing the February 1, 1993 schedule and revised conceptual plan would serve to formalize the water quality certification process.

You will receive a copy of the final plans and documents by February 1, 1993. Per condition #3 of the Water Quality Certificate, DEA plans to send you a draft version of the stormwater quality monitoring plan for DOE review and comment prior to submittal of final plans and reports. This pre-submittal of that particular section of the final mitigation report should help to shorten DOE's review time once final plans and report are submitted (by February 1) for approval.

DAVID EVANS AND ASSOCIATES, INC.
A PROFESSIONAL SERVICES CONSULTING FIRM
OFFICES IN OREGON, WASHINGTON, CALIFORNIA AND ARIZONA
415 118TH AVENUE, S.E.
BELLEVUE, WASHINGTON 98005-3553
(206) 455-3571 FAX (206) 455-3061

If you have any questions, please call me or Kirk Hackler at (206) 455-3571. Thank you for your attention.

Sincerely,

DAVID EVANS AND ASSOCIATES, INC.

Andrew F. Gorski
Senior Project Manager, Natural Resources

Encl. (4)

cc: Bill Hager, Port of Bellingham (no enclosures)
Cyd Brower, DOE (no enclosures)
Gail Terzi, COE (no enclosures)

December 23, 1992 POBM0007

Ms. Sandra Manning
Sediment Management Section
WA Dept. of Ecology
P.O. Box 47703
Olympia, Washington 98504-7703

Re: **Water Quality Certification (April 10, 1992) for Port of Bellingham Airport Runway Extension**
Public Notice #: OYB-4-01443

DRAFT STORMWATER AND WETLAND WATER QUALITY MONITORING PLAN - Little Squalicum Creek Wetland Mitigation Plan

Dear Ms. Manning:

As promised in my letter of December 15, 1992 to you, I am submitting a copy of a draft version of the *Stormwater and Wetland Water Quality Monitoring Plan* for the above referenced project. This submittal is in partial compliance with Condition #3 of the Water Quality Certificate issued by WDOE for the project. The pages you are receiving with this letter will be included as a section of the final mitigation plan report to be submitted with grading and landscape plans to you by February 1, 1993.

Please review and comment on the attachment by Friday, January 15, 1993 so that we can incorporate your edits and thereby shorten WDOE's review time once final plans and report are submitted to you by February 1st. **Time is of the essence because the Port of Bellingham is required to be under contract for installation of the Little Squalicum Creek mitigation site by March 15, 1993, or FAA construction funding for the mitigation will be lost.** Timely review by WDOE of final documents to be submitted to you by February 1st will be necessary to meet the funding schedule.

Please note that details relating to how water will flow into and through the mitigation site will be described in the final mitigation report and on the construction plans (not yet complete, and not yet submitted to WDOE). Additionally, BMPs for the management of the mitigation site during construction and long-term will be included in the final report for your review.

DAVID EVANS AND ASSOCIATES, INC.
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APPENDIX B

Landau Associates' September 3, 1992 Geotechnical Report

LANDAU
ASSOCIATES,
INC.
Geoenvironmental Engineering and Technologies

September 3, 1992

Port of Bellingham
P.O. Box 1737
Bellingham, WA 98227-1737

Attention: Mr. Bill Hager

RE: SOIL QUALITY CONDITIONS
PROPOSED LITTLE SQUALICUM CREEK WETLANDS
COMPENSATION PROJECT
BELLINGHAM, WASHINGTON

INTRODUCTION

This letter report summarizes existing soil quality data, identifies the probable source and approximate distribution of semivolatile organic compounds in site soil, and provides recommendations for addressing soil contamination during design and construction of the proposed Little Squalicum Creek wetlands compensation project (Project) in Bellingham, Washington. The scope of services outlined in our November 26, 1991 proposal to the Port of Bellingham (Port) included: 1) assessing the present soil quality conditions and the suitability of site soil for development as wetlands compensation; 2) assessing the storm water quality for suitability as recharge to the proposed wetlands compensation cells; 3) obtaining site soil samples for potential future evaluation of their physical properties; and 4) presenting the storm water and soil evaluation results in a brief letter report (draft report submitted January 14, 1992). In addition to these services, Landau Associates performed additional soil sampling and chemical analyses in January and May 1992 to supplement our previously collected soil quality data.

BACKGROUND

The Little Squalicum Creek site (Site) is located within the Little Squalicum Creek drainage in Bellingham, Washington, as shown on the Vicinity Map, Figure 1. The Site is an irregularly shaped parcel of approximately 12 acres. The interior of the Site is relatively level, with a gentle downward slope from northeast to southwest. The perimeter of the Site is bounded by steep slopes rising away from the Site boundaries, except the southwest Site boundary that abuts Bellingham Bay.

P.O. BOX 1029 • EDMONDS, WASHINGTON 98020-9129 • (206) 778-0907 • FAX (206) 778-6409

The Little Squalicum Creek drainage upstream of the Site was filled sometime in the past, and upstream stormwater runoff is conveyed via a 36-inch diameter corrugated metal pipe (CMP) that discharges near the north end of the Site. Other stormwater discharges outfall at the Site, including an outfall from the Oeser Cedar facility, which is located a short distance downstream from the 36-inch CMP outfall. The locations of the CMP and Oeser Cedar outfalls are shown on the Site Map, Figure 2.

A site hazard assessment (SHA) was recently performed for the Site (Parametrix 1991) because of documented upgradient releases by the Oeser Cedar facility to Little Squalicum Creek via its storm sewer outfall. These releases included pentachlorophenol (PCP) and polycyclic aromatic hydrocarbons (PAH) (possibly creosote). Little Squalicum Creek was listed and ranked on the Washington State Department of Ecology (Ecology) Toxic Cleanup Program Hazardous Sites List as a result of the SHA, based on elevated concentrations of phenols, semivolatile organic compounds (including PAH), and TPH in soil, sediment, and/or groundwater samples collected from the Little Squalicum Creek drainage.

Ten test pits were hand-excavated by a Landau Associates representative on December 18, 1991, as part of the soil assessment portion of the Project. Soil samples were collected for chemical analyses from the five test pit locations shown on Figure 2. The soil samples collected for chemical assessment were analyzed for TPH (EPA Method 418.1), semivolatile organic compounds (EPA Method 8270), and selected metals (arsenic, cadmium, chromium, copper, lead, nickel, and zinc) (ICP Method).

The Washington State Model Toxics Control Act (MTCA) Method A soil cleanup criterion for carcinogenic PAH of 1 mg/kg was equaled, but not exceeded, at Exploration SC-6 (near the Oeser Cedar and CMP outfalls), as shown on Figure 2. Relevant soil cleanup criteria were not exceeded at the other December 1991 sampling locations. These analytical results led to follow-up sampling and chemical analyses in the Exploration SC-6 vicinity.

Three additional soil samples (SC-6A, SC-6B, and SC-6C) were collected on January 27, 1992 from the locations shown on Figure 2 and analyzed for TPH (EPA Method 418.1), PAH (EPA Method 8310), and chlorinated phenols (modified EPA Method 8150). TPH concentrations were significantly below the MTCA soil cleanup criterion, or not detected, in all three samples. Carcinogenic PAH were detected in all three samples, and significantly exceeded the MTCA Method A soil cleanup level in the two samples collected to the north and to the west of Exploration SC-6 (sample locations SC-6A and SC-6B). PCP was the only chlorinated phenol detected, was in all three samples, and was present at potentially significant concentrations in the two samples collected at sample locations SC-6A and SC-6B. The concentrations of carcinogenic PAH and PCP for samples SC-6A, SC-6B, and SC-6C are shown on Figures 3 and 4, respectively.

Seven soil samples (SC-11 through SC-17) were collected on May 15, 1992 from the locations shown on Figure 2. Six of the samples were analyzed for PAH (EPA Method 8310) and all seven samples were analyzed for chlorinated phenols (modified EPA Method 8150). Carcinogenic PAH were detected in all samples tested, but only exceeded the MTCA Method A soil cleanup criterion (1 mg/kg) at one location (SC-14). PCP (the only chlorinated phenol detected) was detected in three of the seven samples, and is present at a potentially significant concentration at sample location SC-14. The concentrations of carcinogenic PAH and PCP for Samples SC-11 through SC-17 are shown on Figures 3 and 4, respectively.

DATA INTERPRETATION

The relative concentrations of PAH and PCP are consistent between samples (i.e., higher PAH concentrations are associated with higher PCP concentrations), suggesting the constituents are derived from a common source. Also, the concentration distribution of PAH and PCP indicates a limited area of impact near the Oeser Cedar and CMP outfalls, and extended along the CMP alignment.

PAH and PCP were detected in a stream sediment sample collected near the Oeser Cedar outfall during the SHA, and the Oeser Cedar facility is an identified source for these constituents. Because of these considerations and its proximity, the Oeser Cedar outfall is the probable source of the PAH and PCP detected in soil samples collected from the Exploration SC-6 vicinity.

Because the Exploration SC-6 vicinity is about 4 ft above the creek and upstream of the Oeser Cedar outfall, it is improbable that the constituents of concern were conveyed directly (via water) from the outfall. It is more likely that the distribution of PAH and PCP is the result of excavation and soil disturbance that occurred during construction of the CMP outfall, which reportedly occurred in the early 1970s subsequent to construction of the Oeser Cedar outfall. Based on site observations, it appears that disturbance of stream sediments would have been necessary for construction of the CMP outfall. The distribution of PAH and PCP appear to be elevated along the CMP alignment, further supporting this hypothesis.

CONCLUSIONS AND RECOMMENDATIONS

PAH and PCP concentrations in Site soils are elevated within a limited area in the vicinity of the Oeser Cedar and CMP outfalls, and must be considered during Project design and construction. PAH concentrations equal or exceed MTCA Method A soil cleanup criterion at 4 of the 15 locations, all within about 100 ft of the Oeser Cedar and CMP outfalls. PCP is distributed similar to PAH in site soils, although concentrations are lower and the areal extent is more limited. MTCA Method A soil cleanup criterion have not been established for PCP, and developing MTCA Method B (risk-based) soil cleanup criteria is beyond the scope of this letter report. However, based on PCP Method B soil cleanup criterion developed for other sites, it is unlikely that cleanup criterion below 0.53 mg/kg (the highest PCP concentration detected on site) would be established. Thus, it is likely that PAH distribution would control any cleanup actions within the area characterized as part of this investigation.

PAH (and possibly PCP) concentrations at levels of concern were only detected within about the western third of proposed wetlands compensation Cell 4. We understand that a portion of the wetland compensation area could be eliminated and still achieve the overall Project goal for wetlands compensation. Also, the Port would prefer to eliminate a portion of Cell 4, rather than assume the responsibility for cleanup of environmental conditions caused by others.

Given these considerations, we recommend redesigning the configuration of Cell 4, eliminating the western portion of the cell that may require remediation by others. Additionally, the area exhibiting elevated PAH and PCP concentrations should be identified in design documents, and activities limited within this area to prevent disturbance or spread of PAH and PCP-contaminated soil. We also recommend that similar restrictions be placed on activities within the Little Squalicum Creek stream channel to prevent the disturbance or spread of contaminated sediments identified during Ecology's SHA.

REFERENCE

Parametrix, Inc. and SAIC. 1991. Site Hazard Assessment Summary Report for Little Squalicum Creek, Bellingham, Washington. July 1991.

* * * * * * *

Thank you for the opportunity to provide these services to the Port. Landau Associates looks forward to providing engineering consulting services to the Port on this Project and others in the future. Please contact us if you have any questions or wish to discuss the Project further.

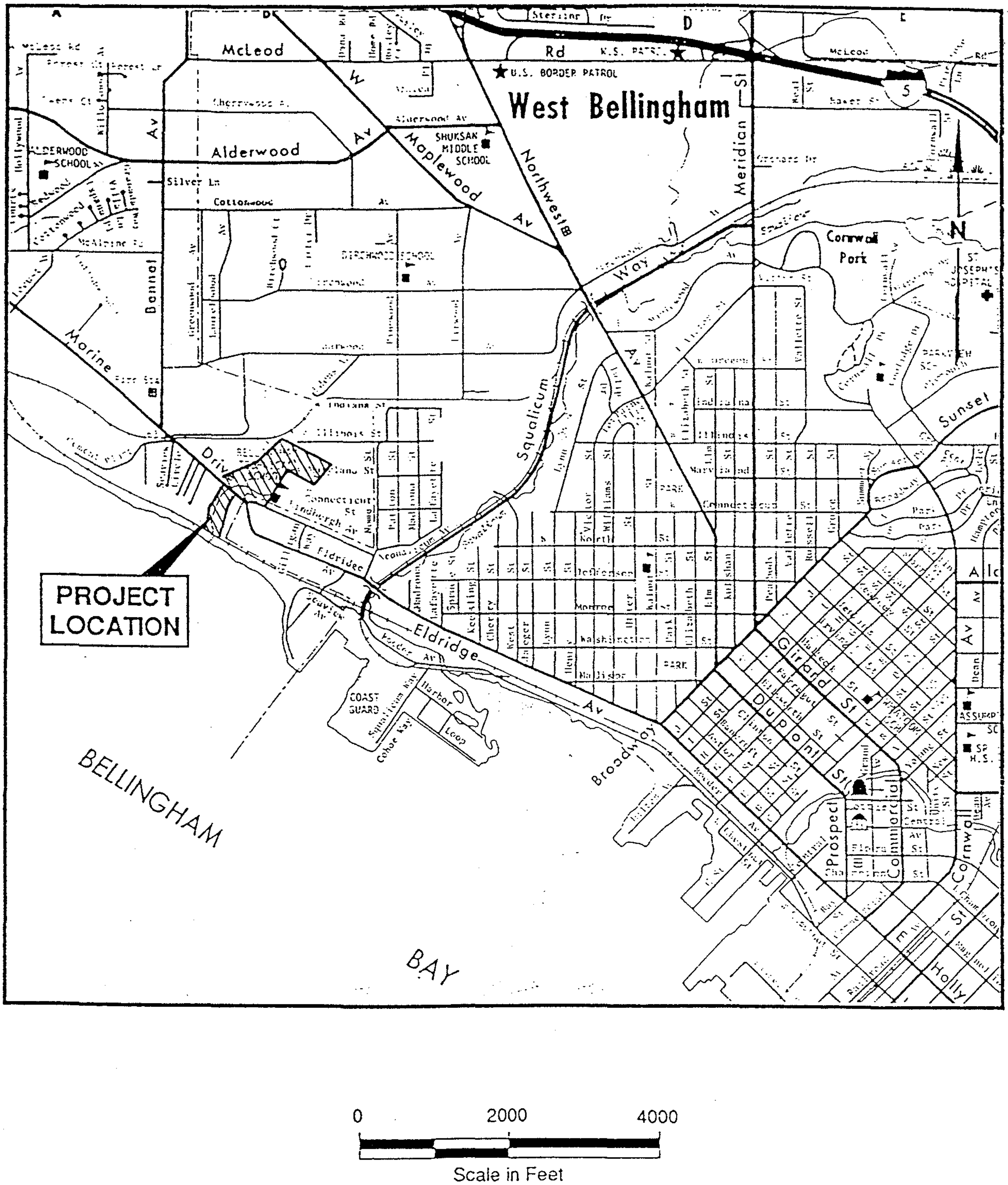
LANDAU ASSOCIATES, INC.

By:

Larry Beard

Lawrence D. Beard, P.E.

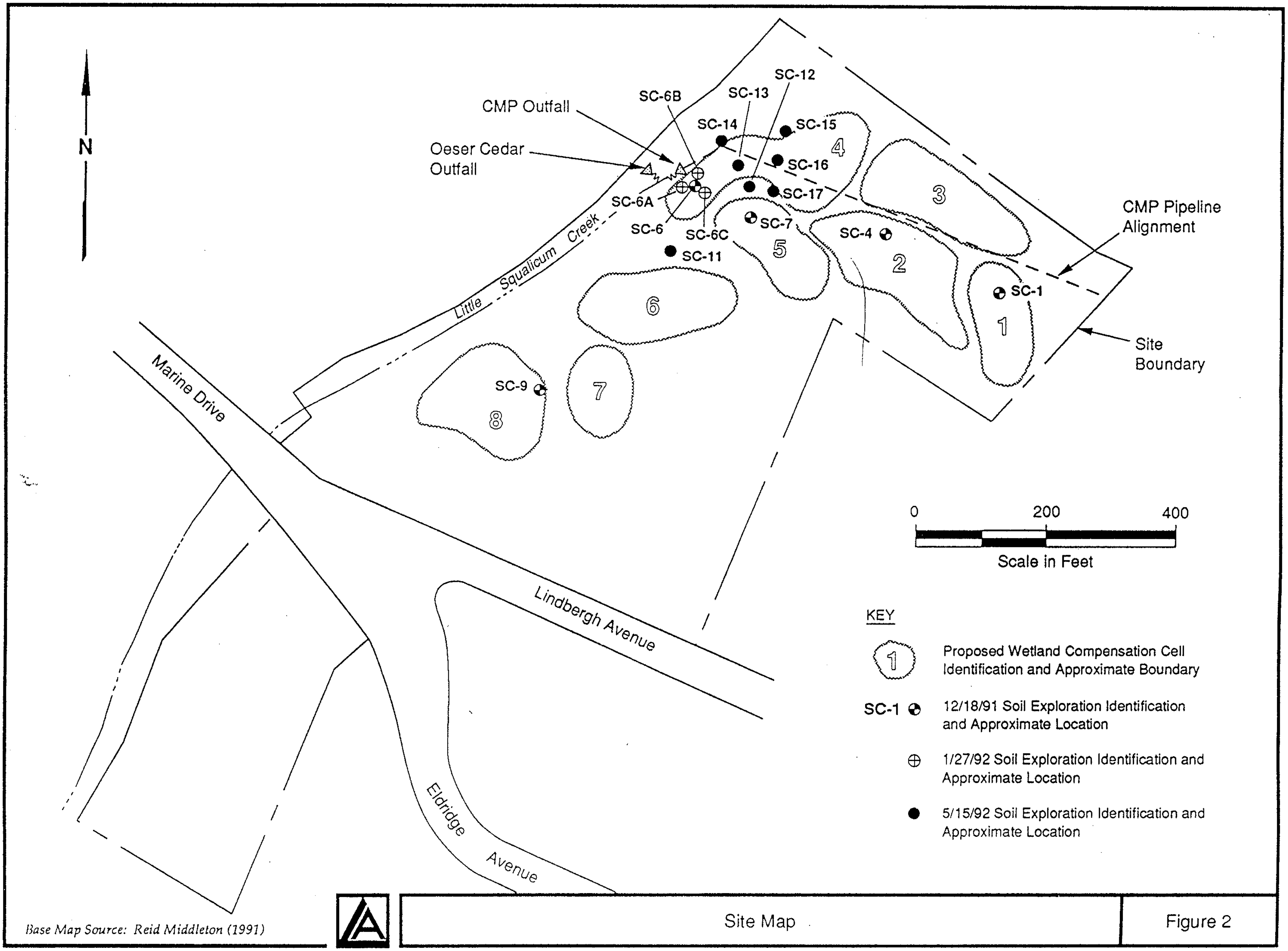
LDB/sms
No. 1018.10



01018.10 Port of Bellingham/Little Squalicum Creek/Wetlands Compensation/Soil Quality Conditions/Letter Report 9/92

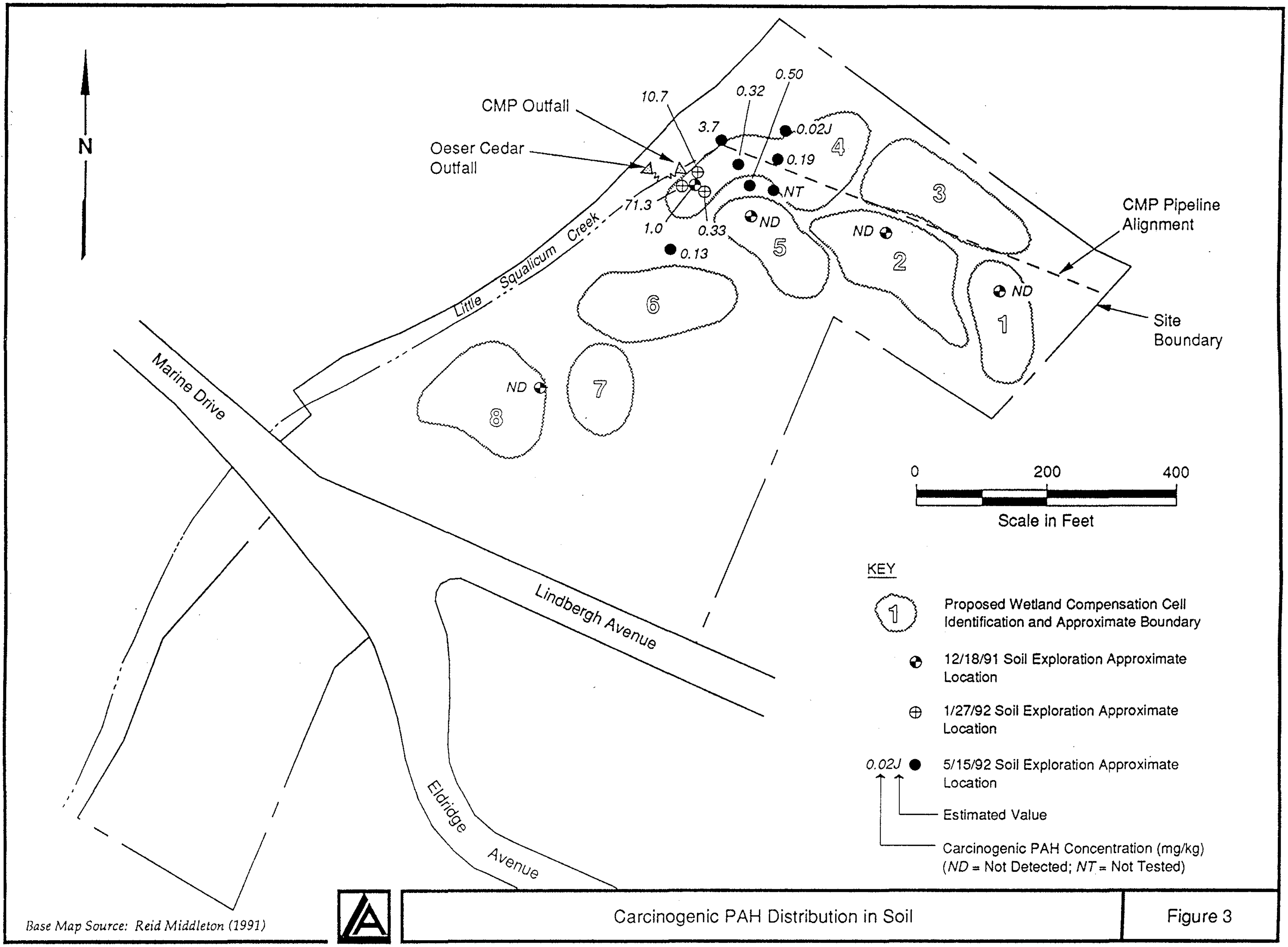
Vicinity Map

Figure 1



Site Map

Figure 2



Carcinogenic PAH Distribution in Soil

Figure 3

APPENDIX C

Landau Associates' February 3, 1993 Geotechnical Report

Geotechnical Report

Wetlands Compensation Project
Little Squalicum Creek
Bellingham, Washington

February 2, 1993

Prepared for

Port of Bellingham
Bellingham, WA

Prepared by

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According to the Site history provided in *Draft Wetland Compensation Design* (Shelton & Associates 1991), the Site has an extensive usage history, including substantial excavation and filling. The Site was mined for sand and gravel from the 1920s to the 1960s, resulting in the broad, flat topography presently on the Site. A number of basins were created onsite for washing gravel during gravel mining operations. These basins were filled in, periodically, as mining progressed. The Site was used as a raw log storage facility for 1 to 5 years in the early 1970s. Test pits excavated as part of the Site Hydraulic Assessment (Watershed Dynamics 1991) and our explorations in 1991 and 1992 indicate that these Site activities resulted in the placement of 3.5 ft or more of fill of variable composition (silt to gravel) over various portions of the Site.

The Little Squalicum Creek drainage upstream of the Site was filled sometime in the past, and upstream stormwater runoff is conveyed via a 36-inch diameter corrugated metal pipe (CMP) that discharges near the north end of the Site. The discharge from this pipe is the primary source of water for the Project wetland mitigation cells and stream channel.

DEA has designed wetland areas and a stream channel on the Site as compensation for wetlands that will be lost during planned expansion of the Bellingham International Airport. The conceptual plan for wetlands compensation recommended by DEA in the October 16, 1992 Corp of Engineers meeting, and as shown on revised DEA plans received January 21, 1993, includes five wetland cells of approximately 3.5 acres and nearly 2,000 linear ft of stream bed channel, as shown on Figures 2a and 2b. DEA has indicated that, because of limited available recharge to the wetlands cells and stream channel, water loss due to infiltration will be minimized. As a result, the wetland cells and stream channel will either be constructed within relatively low permeability soil or constructed using a low permeability soil liner.

3.0 SITE CONDITIONS

3.1 SURFACE CONDITIONS

The Project Site is presently unoccupied and provides pathway access for pedestrians and others to the properties east of the Site and to a small beach on Bellingham Bay. The property is vegetated in a mixture of weeds and grasses, berry bushes, shrubs, and trees.

3.2 SUBSURFACE CONDITIONS

During the site evaluation, subsurface conditions at the Site were explored by excavation of sixteen backhoe test pits on October 8, 1992, six hand explorations on October 9, 1992, and six backhoe test pits on October 19, 1992. The approximate location of these excavations, and previous explorations accomplished during our December 1991 and January 1992 explorations are shown on Figures 2a and 2b. The soil encountered was classified in accordance with the soil classification system presented in Appendix A. A discussion of field procedures and logs of the explorations are also presented in Appendix A.

The depth of excavation during our October 1992 explorations ranged from about 1 to 6 ft below ground surface. Soil conditions were variable and included clean (low silt/clay content) sand and gravel, silty sand and gravel, and occasional silt and clay units.

Fill was noted at several locations in the northeast to central portion of the Site during our recent and previous explorations (SC-1, SC-4, SC-5, SC-18, SC-19, SC-20), and at many explorations adjacent to the gravel access road in the southwest portion of the Site (F2, F4, F12B, F17B, F18). Fill was encountered to a depth of up to 3.5 ft. Fill materials encountered in our explorations varied in composition, but consisted primarily of medium dense to dense, slightly silty to silty, sand and gravel deposits. At several locations fill contained relatively minor amounts of wood, metal, glass, and ash debris. At Test Pit SC-20, fill contained significant amounts of glass and other household refuse.

Native soil encountered consisted primarily of medium dense to dense, slightly silty to silty sand and gravel deposits, with occasional cobbles. Native silt or clay deposits of limited areal extent were also encountered. Except for deposits encountered at Test Pits SC-28 and SC-33, these silt or clay deposits were less than about 1 ft thick in our explorations. A glacial till-like unit was encountered at Test Pits SC-8 and SC-30 (at 1 ft and 3.5 ft depth, respectively), and was logged by Watershed Dynamics (1991) at their Well Location 4a, 6 ft below ground surface (BGS).

Selected soil samples collected from October 1992 exploration locations were analyzed in our laboratory for grain-size analyses and moisture content. Grain size analyses were performed to verify soil field classification and to evaluate material suitability for structural or low permeability fill. Laboratory testing procedures are described, and results are presented, in Appendix A.

Groundwater was encountered at six test pit locations in the northeastern portion of the Site during our October 1992 explorations. Groundwater was also observed by Watershed Dynamics at 8 locations during the period of August and September 1991, as documented in their report (Watershed Dynamics 1991). Groundwater elevations were observed by Landau Associates at two remaining Watershed Dynamics locations on October 9, 1992; other Watershed

Dynamics wells at the site apparently were abandoned. Depth to groundwater observed during Landau Associates' October 1992 visits ranged from approximately 2 to 5-½ ft below the existing ground surface, or elevations of between about 24 and 37 ft (City of Bellingham datum). Landau Associates' observations, and limited observations of others, suggest that the shallow groundwater surface slopes to the west and southwest (to the existing Little Squalicum Creek drainage and Bellingham Bay, respectively).

Observations of groundwater at the Site by Landau Associates and others were generally accomplished during periods when low groundwater elevations would be expected. During wetter periods of the year, groundwater may be closer to the ground surface than was observed during our explorations.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

Geotechnical conclusions and recommendations for the Project were developed based on the results of our recent and previous investigations, our understanding of the Project design needs as conveyed to us by DEA in a December 21, 1992 meeting and January 18, 1993 conversations, and DEA draft design drawings received January 21, 1993.

Most onsite soil consists primarily of slightly silty to silty sand and gravel, and is suitable as structural fill for the small embankments and pathways currently anticipated for the Project. However, Site soil with a silt content higher than about 5 percent may be moisture sensitive and will need to be compacted near optimum moisture content, as determined by ASTM D 1557 test procedures, to achieve the proper compacted density.

Although limited units of low permeability soil were encountered during our explorations, most Site soil appears to be moderately to highly permeable. As a result, a low permeability liner is recommended within the stream channel and applicable wetland cells to reduce water loss by infiltration.

4.2 LOW PERMEABILITY LINER

Because most of the Site is underlain by relatively moderate to high permeability soil, construction of a low permeability lining system is recommended for wetland cells 1, 2, 5, and 6, and the stream channel to reduce infiltration. Because wetland cell 3-4 is designed to intercept shallow groundwater, a low permeability liner is not recommended for these cells. Based on discussions with DEA, a recommendation for a natural soil liner is presented in this report. Other low permeability lining systems, such as a synthetic membrane or amended soil, are not addressed.

Although limited amounts of soil with high silt or clay content were encountered during Landau Associates' site explorations, the relatively clean nature of most of the site soil precludes the use of onsite material as low permeability liner soil. However, a nearby geologic unit, the Bellingham Drift, is suitable for use as a liner material and adequate soil quantities should be available in the Bellingham area. The Bellingham Drift is a marine glacial drift consisting of silt and clayey silt with lesser amounts of sand and gravel. The Bellingham Drift is typically classified as a silt of slight plasticity (ML) using the ASTM classification methods and the Unified Soil Classification System.

Recommendations for the soil liner thickness and material properties are based on our understanding of the Project goals, material availability and Site constraints, and not quantitative leakage criteria. The goal of the soil liner is to significantly reduce infiltration of surface water within the wetlands compensation area from that which would occur if the Project were constructed using existing Site soil. Groundwater conditions limit the extent to which Site grades can be lowered and still allow placement of low permeability soil, and we understand that maintaining acceptable Site grades limits the maximum elevations of wetland cells and the stream channel bottom to approximately those shown on the January 21, 1993 grading plan. The combined impact of these Site constraints is to limit the soil liner maximum thickness. Additionally, the purchase, transport and placement of imported fill material is expensive, making the use of offsite soil materials that are generally available in the Bellingham area (such as Bellingham Drift) necessary for the Project to be practicable. The liner thickness and materials specified were chosen as being likely to significantly reduce infiltration while also being in balance with site and cost constraints. Liner material characteristics and placement recommendations are presented in Section 4.4 of this report.

4.3 STRIPPING AND PROOF ROLLING

All topsoil and organic debris must be stripped away from the areas to be filled with low permeability liner material or structural fill. Following clearing, stripping, and site excavation, but prior to placement of any fill, the exposed subgrade under all areas to be occupied by constructed berms and wetland cell embankments should be proof rolled. The purpose of proof rolling is to compact the soil exposed by cutting and excavation operations, and to detect possible localized zones of soft or loose soil. Proof rolling should be accomplished with appropriate compaction equipment so that the upper 8 inches of subgrade is compacted to approximately 90 percent of maximum dry density, as determined by the ASTM D 1557 test procedure.

Proof rolling should be carefully observed by geotechnical personnel and any areas exhibiting significant deflection, pumping, or weaving that cannot be readily compacted, should be overexcavated and backfilled with appropriately compacted fill soil.

4.4 FILL AND COMPACTION

Based on our review of DEA's grading plan received January 21, 1993, it appears that grading of the Site will result in approximately 1 to 5 ft cuts and 1 to 4 ft fills. Any granular soil free of cobbles, organic matter, and other deleterious material is acceptable for reuse as structural fill for berms and pathways, although soil with silt content above 5 percent may require moisture conditioning. Some Site soil may also be suitable for reuse as planting soil, at the discretion of DEA.

Soil containing organic matter, construction refuse, and other deleterious material was observed during our explorations and is not suitable for reuse as structural fill. Offsite disposal of this material may be necessary.

Any large cobbles or other material greater than about 6-inch diameter should be removed from the structural fill prior to placement. Structural fill should be placed in maximum 10-inch loose lifts and compacted to 90 percent of the maximum dry density, as determined by the ASTM D 1557 test method.

We recommend that the soil used for the low permeability lining material be free of organic material, debris, and stones exceeding 3 inches in maximum dimension. The liner soil should contain at least 50 percent by weight of fines, material passing the U.S. Standard No. 200 sieve, and should contain no greater than 15 percent by weight of material coarser than ¼ inch. The moisture content of soil liner material should be within a range of about 3 percent below, to 3 percent above, optimum moisture content, based on ASTM D 1557 test results. Based on the typical natural moisture content of undisturbed Bellingham Drift in the Project vicinity, it is likely that imported liner soil material will require drying to meet appropriate moisture content recommendations.

Due to constructability considerations, we recommend a minimum soil liner thickness of approximately 10 inches on wetland cell bottoms and within the stream channel where grade requirements limit the allowable liner thickness. Soil liner thickness in other areas should be at least 12 inches thick. The soil liner should be placed in lifts not exceeding 10 inches compacted thickness and should be compacted to at least 85 percent of maximum dry density, as determined by the ASTM D 1557 test procedure.

The soil liner, material, and some site soil are moisture sensitive. Consequently, low permeability liner construction should be accomplished during dry weather and at a time of seasonal low groundwater elevation. Typically, the period between late July to October is the most suitable time frame for this work. Other construction activities may be accomplished during a slightly larger dry weather window (weather permitting), estimated to be between late June through October. Construction during wet periods may result in inadequate compaction and other construction difficulties.

4.5 CUT AND FILL SLOPES

Permanent slopes on the interior of wetland cells or the stream channel should be constructed at 3H:1V (horizontal to vertical) or flatter. Permanent slopes on the downstream side of berms should be constructed at 2H:1V, or flatter. Temporary cut or fill are the responsibility of the contractor, but temporary slopes should be stable between about 2H:1V and 1H:1V, depending on soil conditions.

4.6 EROSION PROTECTION

All exposed surfaces should be protected to limit the potential for erosion. Water flows in the stream channel, at wetland cell outfalls, below weir structures, and at other moderate to high flow velocity locations are susceptible to erosion of the low permeability liner soil and other Site soil. We recommend that projected design flows be evaluated for potential erodability of liner soil and other Site soil. Evaluation of erosion protection measures is beyond the scope of our services.

If erosion protection from higher rate flows is accomplished by the use of rock, or sand and gravel armoring, the erosion protection material may become emplaced into the underlying soil liner material. To reduce potential for this occurrence, a geotextile or soil separation and filter system should be constructed between the low permeability soil liner and the overlying erosion protection. A geotextile or soil separator/filter will also reduce the potential for erosion of the soil liner due to flows within the coarser armor material.

The separation and filter system may be constructed from a synthetic fabric (geotextile) or from a specified gradation of earth material. Typically, a filter constructed of earth material has a thickness of several inches, and requires careful construction practices. A geotextile separator, constructed using a single layer of nonwoven geotextile, is very thin and typically involves a more easily implemented construction process. For the purposes of the Project, we recommend that a geotextile separator be used for the separation between low permeability liner soil and overlying erosion protection material.

4.7 GROUNDWATER

Groundwater was encountered near the proposed base of some wetland cells during our explorations. Moisture sensitive soil, such as the soil liner material, may be difficult to place and compact when groundwater is within about 1 ft of the working grade. Consequently, Site grading and filling operations should be scheduled for dry, late summer and early fall months when groundwater is typically at its lowest level. Even during the dry season, groundwater may be encountered during the excavation and construction of some wetland cells. The Project contractor should be prepared to dewater portions of some wetland cells during construction.

5.0 RECOMMENDATIONS FOR CONSTRUCTION SERVICES

We recommend that a geotechnical engineer or other qualified personnel be present during proof rolling operations and during fill placement/compaction activities to verify that design subgrade conditions are obtained and that appropriate compaction of fill material is achieved. In addition, we recommend that soil density testing be performed on the constructed liners.

6.0 USE OF THIS REPORT

There may be a variation in subsurface conditions at the Site. Accordingly, a contingency for unanticipated conditions should be included in the construction budget and schedule. We should be contacted if variations in subsurface conditions are encountered.

Landau Associates, Inc. has prepared this report for the Port of Bellingham for their use on the Little Squalicum Creek Wetlands Compensation Project in Bellingham, Washington. Our investigation was accomplished in accordance with generally accepted geotechnical engineering

Landau Associates, Inc. has prepared this report for the Port of Bellingham for their use on the Little Squalicum Creek Wetlands Compensation Project in Bellingham, Washington. Our investigation was accomplished in accordance with generally accepted geotechnical engineering practices at the time these activities were accomplished. No other warranty or representation, express or implied, is applicable.

This report was based on our understanding of Project plans as shown on a DEA grading plan received January 21, 1993. If the Project design is changed, Landau Associates should be contacted to evaluate if design changes affect our conclusions and recommendations.

We appreciate the opportunity to provide these services and look forward to assisting you in the future. Please contact us if you have any questions regarding the information contained in this report.

LAWRENCE D. BEARD
STATE OF WASHINGTON
24755
REGISTERED PROFESSIONAL ENGINEER
EXPIRES 1/27/94

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Senior Staff Engineer

LDB/DL/fas
No. 1018.20

7.0 REFERENCES

Shelton & Associates. 1991. *Draft Wetland Compensation Design, Airport Extension.* September 20, 1991.

Watershed Dynamics. 1991. *Hydrologic Assessment on Proposed Little Squalicum Creek Mitigation Site.* September 13, 1991. (An appendix in Shelton and Associates 1991 report.)

Landau Associates, Inc. 1992a. *Draft Report Surface Water Quality and Soil Assessment for the Proposed Little Squalicum Creek Wetlands Compensation Project Bellingham, Washington.* January 14, 1992.

Landau Associates, Inc. 1992b. *Soil Quality Conditions Proposed Little Squalicum Creek Wetlands Compensation Project Bellingham, Washington.* September 3, 1992.

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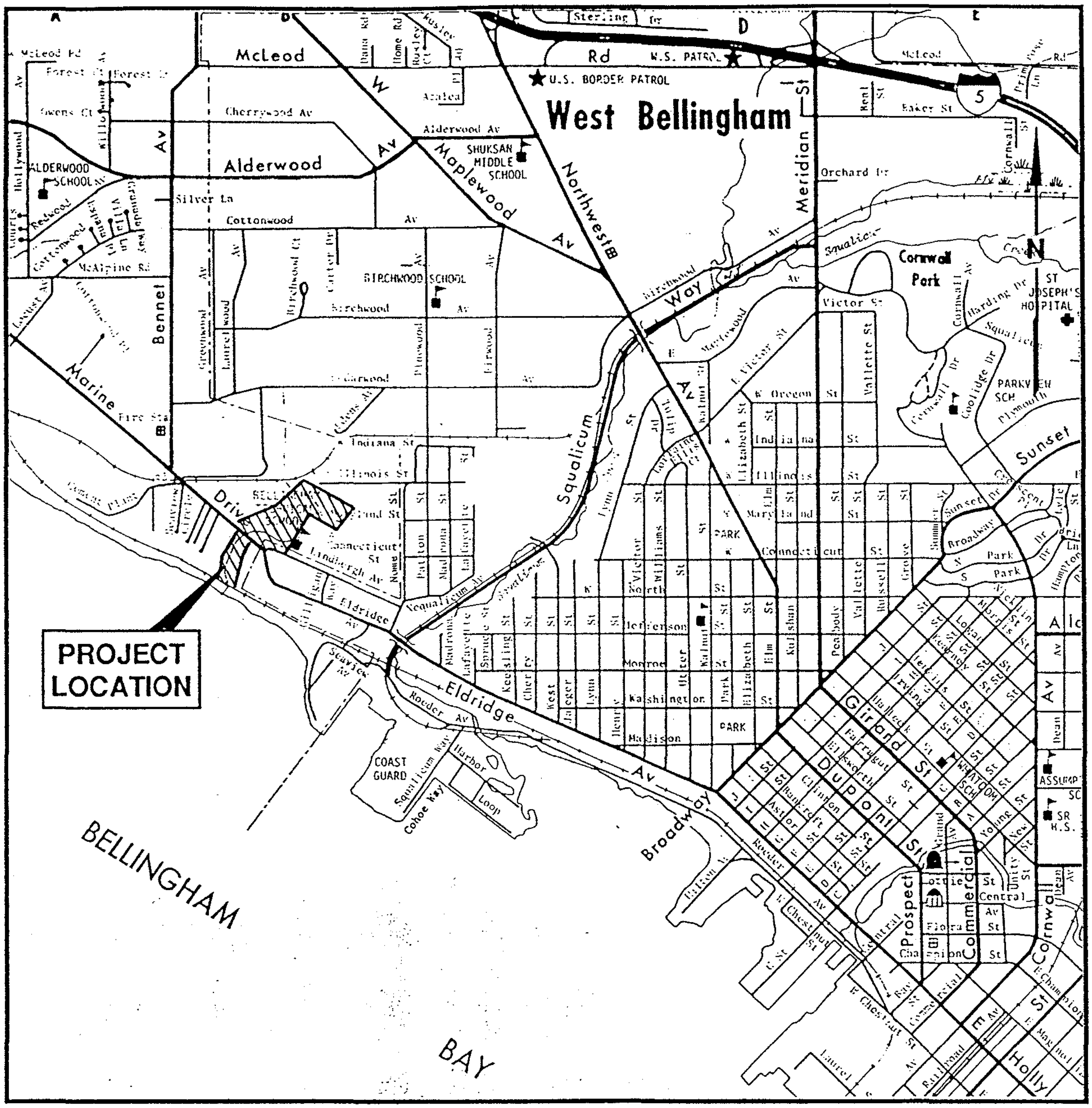

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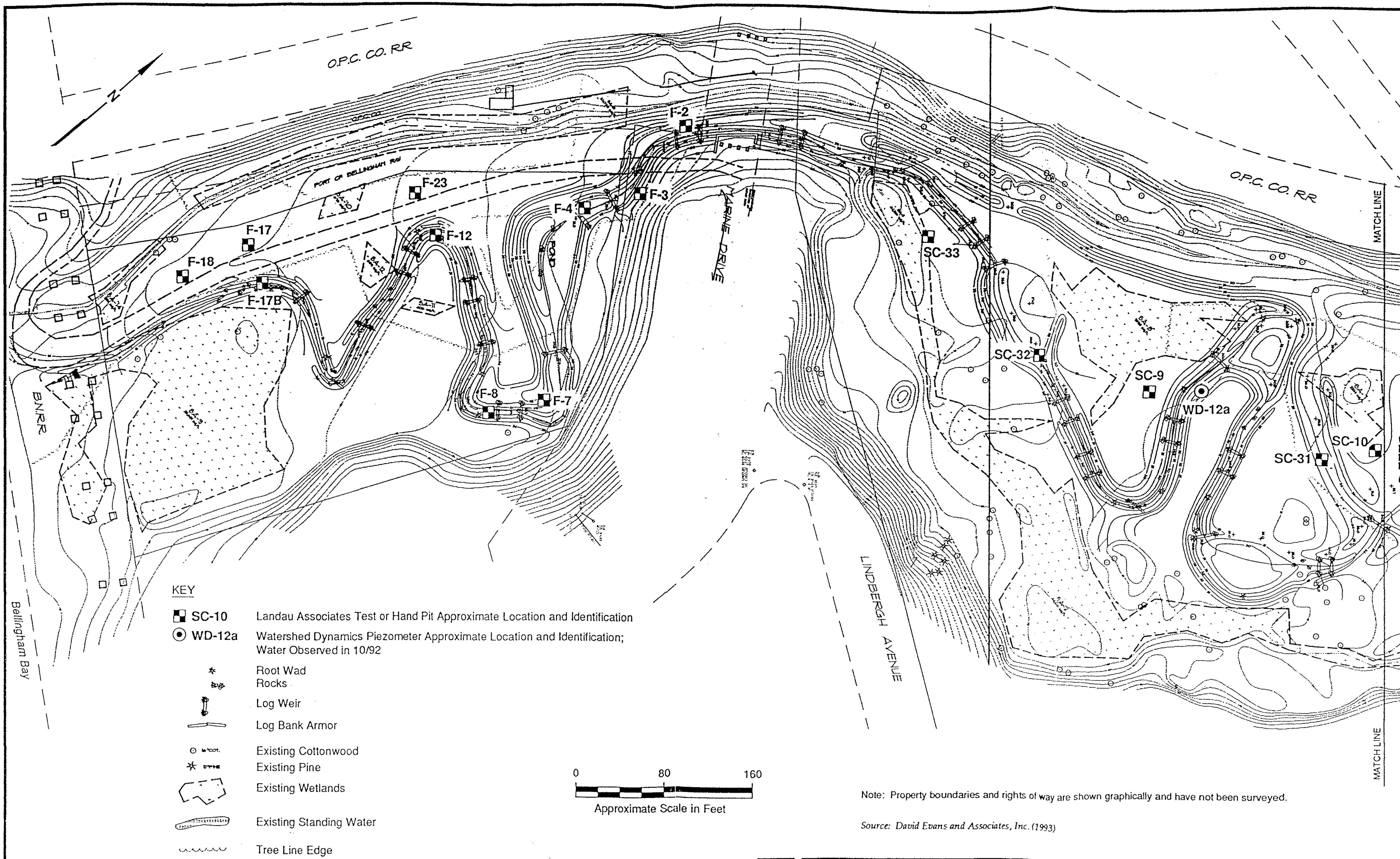
Scale in Feet

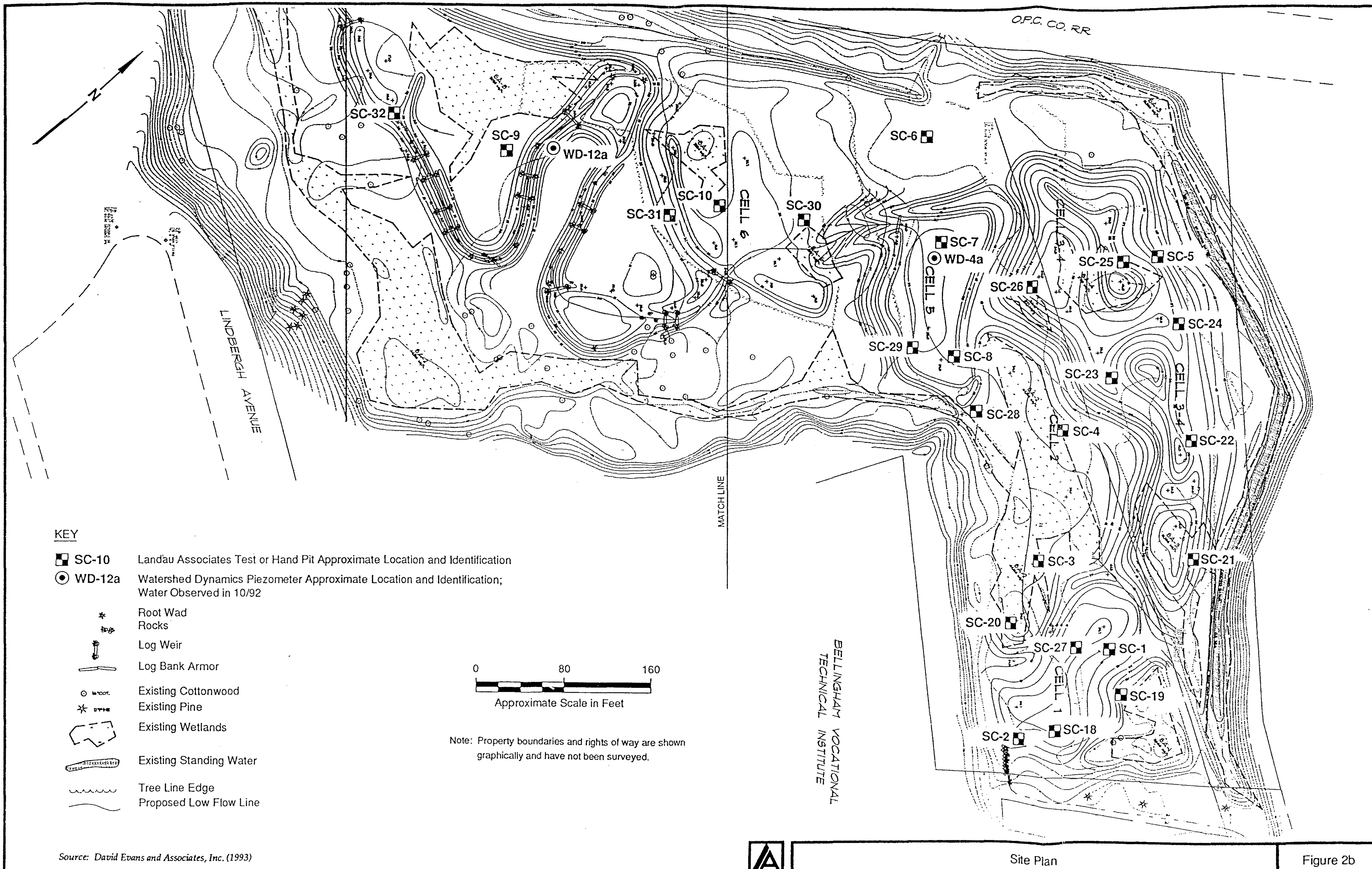
Vicinity Map

Figure 1



Site Plan

Figure 2a



Site Plan

Figure 2b

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APPENDIX A

Field Explorations and Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

Test pits were excavated using a rubber-tire, tractor-mounted backhoe. Hand excavations were advanced with shovel and pick. The field explorations were coordinated and monitored by a geotechnical engineer or geologist from our staff who maintained records of encountered subsurface soil and groundwater conditions, obtained representative soil samples for geotechnical testing, and classified the soil by visual and textural examination. All soil encountered was described using the soil classification system shown on Figure A-1, in general accordance with ASTM D 2488 *Standard Recommended Practice for Description of Soil (Visual-Manual Procedures)*. Logs of October 1992 explorations are presented on Figures A-2 through A-14. Logs of December 1991 explorations from a previous report (Landau Associates 1992a) are presented as Figures A-15 through A-19. These logs represent our interpretation of subsurface conditions identified during the field explorations.

Test pits were located in the field by pacing and estimating distances from Site features, and are approximate . The ground surface elevations shown on the test pit logs are interpolated from a topographic survey prepared by Reid Middleton, Inc., dated October 1991, as shown on Site drawings provided by DEA, dated October 8, 1992. The elevations are referenced to the City of Bellingham datum.

Representative, disturbed samples of the soil encountered during the test pit explorations were obtained and were transported to Landau Associates' Edmonds office for further evaluation and laboratory testing.

LABORATORY TESTING

Laboratory tests were performed on selected samples of the soil encountered during October 1992 explorations to evaluate pertinent physical characteristics. The laboratory program consisted of sample inspection to confirm field soil descriptions, determine natural moisture content, and analyze grain-size distribution. Moisture content was determined in general accordance with ASTM D 2216. The grain-size analysis was accomplished in general accordance with ASTM D 422. Some grain size analyses were limited to a determination of the percentage of the material finer than the U.S. Standard No. 200 sieve. Natural moisture contents and percentage of the sample finer than the U.S. Standard No. 200 sieve are presented on the exploration logs in this appendix. Laboratory test results for soil samples from December 1991 explorations are contained in a previous report (Landau Associates 1992a).

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL (1)	TYPICAL DESCRIPTIONS (2)(3)
COARSE-GRAINED SOIL (More than 50% of material is larger than No.200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No.4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No.4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No.200 sieve size)	SILT AND CLAY (Liquid Limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid Limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand or silty soil
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

Notes: 1. USCS letter symbols correspond to the symbols used by the Unified Soil Classification System and ASTM Classification methods. Dual letter symbols (e.g., SM-SP) for a sand or gravel indicate a soil with an estimated 5–15% fines. Multiple letter symbols (e.g.,ML/CL) indicate borderline or multiple soil classifications.

2. Soil classifications are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D2487.

3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows: Primary Constituent: (>50%) – "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents: >30% and ≤50% – "very gravelly," "very sandy," "very silty," etc.
>15% and ≤30% – "gravelly," "sandy," "silty," etc.
Additional Constituents: >5% and ≤15% – "with gravel," "with sand," "with silt," etc.
≤5% – "trace gravel," "trace sand," "trace silt," etc., or not noted.

NOTES TO TEST PIT LOGS

1. Elevations estimated to the nearest 0.5 ft.based on Reid Middleton, Inc. topographic map dated October 1991. Elevations reference City of Bellingham datum.
2. Percentage of Sample Passing U.S. Stanard No. 200 sieve.

Test Pit SC-18

Approximate Elevation 42 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-0.5	SM	Brown gravelly silty fine to medium SAND with roots and scattered glass (medium dense, moist) (fill)	S-18a (0.5)	9	15%
0.5-1.5	SM	Gray-brown to dark brown at base gravelly silty fine to medium SAND (medium dense, moist) (fill, old topsoil)			
1.5-5.0	SW	Light gray-brown gray fine to medium SAND with trace silt and cobbles (dense, moist to wet)	S-18b (4.5-5.0)	6	3%

Test pit completed to 5.0 ft on October 8, 1992.
Slight groundwater seepage encountered at 5 ft.

Test Pit SC-19

Approximate Elevation 40 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-2.8	SM/ML	Medium brown gravelly silty fine SAND/sandy SILT; heavily rooted upper 8 inches, roots to base; wood debris (medium dense to dense/stiff, moist) (fill)	S-19a (0.0-2.8)	21	47%
2.8-3.0	ML	Dark brown gravelly sandy SILT (medium stiff, moist) (old topsoil?)			
3.0-3.75	GP	Dark blue-gray to gray-brown sandy fine to coarse GRAVEL with silt/clay (dense, moist)	S-19b (3.0-3.75)	6	5%
3.75-5.0	SP-SM	Dark gray and brown fine to medium SAND with silt (medium dense, moist to wet)	S-19c (3.75-5.0)	22	10%

Test pit completed to 5.0 ft on October 8, 1992.
Moderate groundwater seepage encountered at 5.8 ft.

Test Pit SC-20

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-2.0	ML/SM	Brown gravelly sandy SILT/silty fine SAND; upper 6 inches rooted; abundant glass and other debris (medium dense to dense/stiff, moist) (fill)			
2.0-4.0	SP	Brown fine to coarse SAND (medium dense, moist)			

Test pit completed to 4.0 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-21

Approximate Elevation 39 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.5	SM/ML	Brown gravelly silty fine SAND/sandy SILT with roots (medium dense/stiff, moist) (topsoil)			
0.5-1.2	GW-GM	Brown sandy fine to coarse GRAVEL with silt (medium dense, moist)	S-21a (0.5-2.1)	4	6%
1.2-3.0	GP	Brown and gray sandy fine to coarse GRAVEL (dense, moist to wet)			

Test pit completed to 3.0 ft on October 8, 1992.
Moderate to large groundwater seepage encountered at 2.1 to 2.75 ft.

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Log of Test Pits

Figure A-3

Test Pit SC-22

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.5	SM/ML	Brown gravelly silty fine SAND/sandy SILT with roots (medium dense/stiff, moist) (topsoil)			
0.5-1.5	GM	Brown silty sandy fine to coarse GRAVEL (dense, moist)			
1.5-3.2	GP	Rust stained and gray sandy fine to medium GRAVEL (medium dense to dense, moist to wet)			
3.2-4.5	SP	Gray brown fine to medium SAND (medium dense, wet)			

Test pit completed to 4.5 ft on October 8, 1992.
Moderate groundwater seepage encountered at 4.0 ft.

Test Pit SC-23

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.3	SM	Brown gravelly silty fine SAND with roots (medium dense, moist) (topsoil)			
0.3-2.0	GP-GM	Yellow-brown and gray brown sandy fine to coarse GRAVEL with silt and some clay coating (medium dense to dense, moist)	S-23a (0.3-2.0)	5	7%
2.0-3.5	GP	Yellow-brown sandy fine to coarse GRAVEL with trace silt (dense, moist)			

Test pit completed to 3.5 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-24

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.4	SM	Brown gravelly silty fine SAND with roots (medium dense, moist)			
0.4-3.0	GP	Medium brown sandy fine to coarse GRAVEL and COBBLES with trace silt and clay coating near top and sandier zones (dense to very dense, moist to wet)	S-24a (1.0-2.0)	4	2%
3.0-4.5	SP	Gray-brown fine to medium SAND (medium dense, moist to wet)			

Test pit completed to 4.5 ft on October 8, 1992.
Slight to moderate groundwater seepage encountered at 3 ft.

Test Pit SC-25

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.4	SM	Medium brown gravelly silty fine SAND, well rooted (loose to medium dense, moist) (topsoil)			
0.4-1.6	GM	Brown silty sandy fine to coarse GRAVEL (dense, moist)			
1.6-3.0	GW-GC	Gray clayey sandy fine to medium GRAVEL with silt (dense, moist to wet)	S-25a (1.6-3.0)	6	6%
3.0-3.4	GP-GM	Rust brown sandy fine to coarse GRAVEL with silt (dense, wet)			

Test pit completed to 3.4 ft on October 8, 1992.
No groundwater seepage encountered.

Log of Test Pits

Figure A-5

Test Pit SC-26

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.8	ML	Brown sandy SILT with gravel, roots, and debris (medium stiff to stiff, moist) (topsoil-fill)			
0.8-2.5	SM	Brown silty fine and fine to medium SAND grading to gray and cleaner at 2.5 ft (medium dense, moist)	S-26a (1.0-2.5)	17	23%

Test pit completed to 2.5 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-27

Approximate Elevation 40 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.3	SM	Medium brown silty gravelly fine to medium SAND, minimal roots (medium dense, moist)			
0.3-4.0	GP-GM	Light to medium brown sandy fine to coarse GRAVEL with silt and occasional cobbles (medium dense, moist to wet)			
4.0-5.0	CL	Brown-tan silty CLAY with fine sand, (stiff to hard, moist)	S-27a (4.0-5.0)	36	93%
5.0-5.8	SP	Gray fine to coarse SAND with fine gravel (medium dense, wet)			

Test pit completed to 5.8 ft on October 8, 1992.
Substantial groundwater seepage encountered at 5.0 ft.

Log of Test Pits

Figure A-6

Test Pit SC-28

Approximate Elevation 39 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-0.7	ML	Brown sandy gravelly SILT, heavily rooted (medium stiff, moist) (topsoil)			
0.7-2.0	GM	Medium brown and gray-brown silty sandy fine to coarse GRAVEL (medium dense, moist) (fill?)			
2.0-6.0	ML	Dark gray sandy SILT with organics and reeds (soft to medium stiff, moist)	S-28a (2.0-3.0)	50	74%
@ 4.0		Becoming peat-like and tan brown	S-28b (4.0)		
@ 5.0-6.0		Becoming clayier with depth			

Test pit completed to 6.0 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-29

Approximate Elevation 38 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-0.4	ML	Medium brown gravelly sandy SILT with roots (medium stiff, moist) (topsoil)			
0.4-1.4	GM	Gray-brown silty sandy fine to coarse GRAVEL (medium dense, moist)			
1.4-3.0	SP	Yellow brown medium SAND with fine gravel (medium dense, moist)			
3.0-3.5	ML-CL	Tan clayey SILT with sand (medium stiff, moist)			

Test pit completed to 3.5 ft on October 8, 1992.
No groundwater seepage encountered.

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Log of Test Pits | Figure A-7

Test Pit SC-30

Approximate Elevation 34 Ft[(1)]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[(2)]
0.0-0.4	ML	Medium brown gravelly sandy SILT with roots (medium stiff, moist) (topsoil)			
0.4-2.5	GM	Brown to gray silty sandy fine to coarse GRAVEL (dense, moist)			
2.5-3.5	SP	Yellow brown medium SAND with trace gravel (medium dense, moist)			
3.5+	SM	Gray silty fine to medium SAND with gravel (dense, moist) (till?)			

Test pit completed to 3.5 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-31

Approximate Elevation 35 Ft[(1)]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[(2)]
0.0-0.5	ML	Dark brown gravelly sandy SILT with roots (medium stiff, moist) (topsoil)			
0.5-2.0	GP-GM	Dark rust-brown sandy fine to coarse GRAVEL with silt (dense, moist)			

Test pit completed to 2.0 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-32

Approximate Elevation 28 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-0.5	ML	Medium brown gravelly sandy SILT with roots (medium stiff, moist) (topsoil)			
0.5-1.5	GM-GP	Brown silty sandy fine to coarse GRAVEL grading cleaner and with cobbles (dense, moist)			
1.5-3.0	CO	Grading to sandy gravelly COBBLES (very dense, moist)			

Test pit completed to 3.0 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit SC-33

Approximate Elevation 27 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines[2]
0.0-0.3	ML	Medium brown gravelly sandy SILT with roots (medium stiff, moist) (topsoil) (fill?)			
0.3-2.5	GP-GM	Brown to gray-brown sandy fine to coarse GRAVEL with silt (dense, moist) (fill?)			
2.5-4.5	GM	Gray silty sandy fine to coarse GRAVEL with reeds and other organics	S-33a (2.5-4.5)	10	16%
4.5-6.0	ML	Gray sandy SILT with organics (medium stiff to stiff, moist)	S-33b (4.5-6.0)	35	88%

Test pit completed to 6 ft on October 8, 1992.
No groundwater seepage encountered.

Test Pit F2

Approximate Elevation 30 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.3	ML	Brown sandy gravelly SILT with roots (medium stiff, moist) (topsoil) (fill?)			
0.3-1.5	ML/SM	Grading less silty to silty SAND, sandy SILT (fill?)			
1.5-2.0	ML	Dark brown/black sandy SILT with organic material (medium stiff, moist) (old topsoil or fill)			
2.0-3.5	GM	Brown silty sandy fine to coarse GRAVEL (medium dense, moist)			

Test pit completed to 3.5 ft on October 19, 1992.
No groundwater seepage encountered.

Hand Pit F3

Approximate Elevation 28 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.8	SM	Brown silty gravelly fine to medium SAND, well rooted (loose to medium dense, moist)			
0.8-0.9	SM	Light brown silty gravelly fine to medium SAND, few roots (medium dense to dense, moist)			

Test pit completed to 10" on October 9, 1992.
No groundwater seepage encountered.

Test Pit F4

Approximate Elevation 24 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-2.0	SM	Brown silty gravelly fine to coarse SAND, upper 3 inches rooted (medium dense to dense, moist) (fill?)	S-F4a (3-11")	10	18%
2.0-4.0	SP-SM	Brown and gray fine to medium SAND with silt (medium dense, moist to near wet)			

Test pit completed to 4.0 ft on October 19, 1992.
No groundwater seepage encountered.

Test Pit F7

Approximate Elevation 24 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.8	SM	Dark brown silty fine to medium SAND, well rooted (loose to medium dense, moist) (topsoil)			
0.8-2.0	SP-SM	Medium brown silty fine to medium SAND and SAND with silt (medium dense, moist)			
2.0-2.5	ML	Tan brown sandy SILT (stiff, moist)			
2.5-3.0	GM	Brown silty sandy fine to coarse GRAVEL (medium dense to dense, moist to wet)			

Test pit completed to 3.0 ft on October 19, 1992.
No groundwater seepage encountered.

Hand Pit F8

Approximate Elevation 23 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.8	**SM/ML**	**Dark brown silty gravelly fine to medium SAND/sandy SILT becoming less silty with depth and grading to tan brown (medium dense, moist)**			

Test pit completed to 8 inches on October 9, 1992.
No groundwater seepage encountered.

Hand Pit F12

Approximate Elevation 21 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.3	ML	Dark brown gravelly sandy SILT (medium stiff to stiff, moist) (topsoil) (fill?)			
0.3-0.9	SM	Brown gray mottled silty gravelly fine to medium SAND till-like, with small oxidized wood chips (dense, moist) (fill?)			

Test pit completed to 10 inches on October 9, 1992.
No groundwater seepage encountered.

Test Pit F12B

Approximate Elevation 20 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.5	ML/SM	Medium brown sandy gravelly SILT/silty SAND (medium stiff/loose, moist) (topsoil) (fill?)			
0.5-2.0	GM/SM	Brown to dark gray (variable) silty sandy fine to coarse GRAVEL/gravelly SAND with occasional debris (medium dense to dense, moist) (fill?)			
2.0-3.5	ML	Dark brown and gray gravelly sandy SILT with occasional cobbles (stiff, moist) (fill?)			

Test pit completed to 3.5 ft on October 19, 1992.
No groundwater seepage encountered.

Hand Pit F17

Approximate Elevation 18 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.5	SM/ML	Dark to medium brown silty gravelly fine to medium SAND/sandy SILT, becoming sandier with depth (loose to medium dense/stiff, moist)			
0.5-0.6	GM/SM	Tan-brown mottled silty sandy fine to coarse GRAVEL/gravelly fine to coarse SAND (dense, moist) (till?)			

Test pit completed to 7 inches on October 9, 1992.
No groundwater seepage encountered.

Test Pit F17B

Approximate Elevation 18 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.8	ML	Dark brown sandy gravelly SILT (medium stiff to stiff, moist) (topsoil) (fill?)			
0.8-1.2	ML	Tan-brown sandy SILT with gravel (stiff to hard, moist) (fill?)			
1.2-2.0	SM	Brown gravelly silty fine to coarse SAND with variable silt and density (medium dense, moist) (fill?)			
2.0-2.5	SM/GM	Dark gray silty gravelly fine to coarse SAND/ sandy fine to coarse GRAVEL (dense, moist) (till or fill?)			

Test pit completed to 30 inches on October 19, 1992.
No groundwater seepage encountered.

Test Pit F18

Approximate Elevation 16 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description	Sample No./Depth (ft)	Moisture Content (%)	Percent Fines(2)
0.0-0.3	ML	Dark brown gravelly sandy SILT (medium stiff, moist) (topsoil) (fill)			
0.3-3.0	GM-GP	Tan-brown grading to brown sandy silty fine to coarse GRAVEL grading cleaner and looser with depth; noticeable debris, including thin zone of tar or asphalt-like substance at ~2.5 ft (dense to medium dense, moist) (fill)			

Test pit completed to 3.0 ft on October 19, 1992.
No groundwater seepage encountered.

Hand Pit SC-1

Approximate Elevation 41 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-1.6	SW	Gray-brown, fine to coarse SAND with silt, fine gravel and cobbles; two pieces of asphalt observed (dense, moist) (fill)
1.6-2.0	SW	Dark brown to gray brown medium to coarse SAND with fine gravel and silt (dense, moist)

Test pit completed to 2.0 ft on December 18, 1992.
No groundwater seepage encountered.

Hand Pit SC-2

Approximate Elevation 41 Ft[1]

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-1.5	SM	Dark brown silty, gravelly fine to coarse SAND with organic matter and cobbles (dense, moist)

Test pit completed to 1.5 ft on December 18, 1991.
No groundwater seepage encountered.

Hand Pit SC-3

Approximate Elevation 39 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.4	ML/GM	Dark brown SILT and GRAVEL (dense, moist)
0.4-1.5	SW/GW	Gray-brown fine to coarse SAND and GRAVEL with silt, and cobbles (dense, moist)

Test pit completed to 1.5 ft on December 18, 1991.
No groundwater seepage encountered.

Hand Pit SC-4

Approximate Elevation 39 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.4	ML	Dark brown SILT with gravel and broken glass (dense, moist) (fill)
0.4-1.2	SM	Dark brown and dark gray silty fine to coarse SAND with fine gravel, trace of ash material and a piece of rusty pipe (dense, moist) (fill)
1.2-2.0	ML	Red-brown SILT with fine to coarse gravel (dense, moist) (fill)

Test pit completed to 2.0 ft on December 18, 1991.
No groundwater seepage encountered.

Hand Pit SC-5

Approximate Elevation 40 Ft[(1)]

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.4	GM	Brown silty GRAVEL with wood chips (dense, moist) (fill)
0.4-1.7	SW/GS	Brown and light yellow-brown fine to coarse SAND and GRAVEL with cobbles and silt, one pocket of till-like clay material (dense, moist to wet) (fill)

Test pit completed to 1.7 ft on December 18, 1991.
No groundwater seepage encountered.

Hand Pit SC-6

Approximate Elevation 40 Ft[(1)]

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-1.8	SM	Dark gray silty fine to coarse SAND with fine gravel, cobbles, and organic matter (dense, moist)

Test pit completed to 1.8 ft on December 18, 1991.
No groundwater seepage encountered.

Log of Test Pits

Figure A-17

Hand Pit SC-7

Approximate Elevation 39 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-1.7	SM	Dark brown and gray-brown silty fine to coarse SAND with fine gravel, organic matter, and a 2-inch lense of brown fine sand (dense, moist)

Test pit completed to 1.7 ft on December 18, 1991.
No groundwater seepage encountered.

Hand Pit SC-8

Approximate Elevation 39 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.8	GM	Dark brown and gray-brown silty sandy GRAVEL with a trace of wood chips and broken glass (dense, moist to wet) (fill)
0.8-1.1	SM	Gray-brown silty fine to coarse SAND with gravel (very dense, moist) (till)

Test pit completed to 1.1 ft on December 18, 1991.
Groundwater observed at 0.4 ft below ground surface.

Hand Pit SC-9

Approximate Elevation 30 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.4	ML	Very dark brown sandy SILT with organic matter (loose, moist) (fill?)
0.4-1.2	SW	Gray-brown with red-brown mottling fine to coarse SAND with trace of silt (loose, moist) (fill?)
1.2-1.8	SP/SM	Red-brown fine SAND and silty fine SAND with a 0.5-inch layer of roots at 1.2 ft (loose, moist to wet)

Test pit completed to 1.8 ft on December 18, 1991.
Groundwater observed at 1.4 ft below ground surface.

Hand Pit SC-10

Approximate Elevation 33 Ft(1)

Depth (ft)	Unified Soil Classification System Symbol	Description
0.0-0.4	SP/ML	Dark brown fine SAND and SILT with gravel (loose to soft, wet) (fill?)
0.4-1.7	SM	Gray-brown silty fine to coarse SAND with fine gravel (very dense, moist to wet) (fill?)

Test pit completed to 1.7 ft on December 18, 1991.
No groundwater seepage encountered.

APPENDIX D

David Evans and Associates, Inc.'s January 14, 1993 Water Quantity Report

SURFACE WATER QUANTITY REPORT

LITTLE SQUALICUM CREEK OFF-SITE MITIGATION AREA

PORT OF BELLINGHAM INTERNATIONAL AIRPORT

RUNWAY EXTENSION PROJECT

POBM0007

Prepared by:

David Evans and Associates, Inc.
415-118th Avenue, S.E.
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February 8, 1993

INTRODUCTION

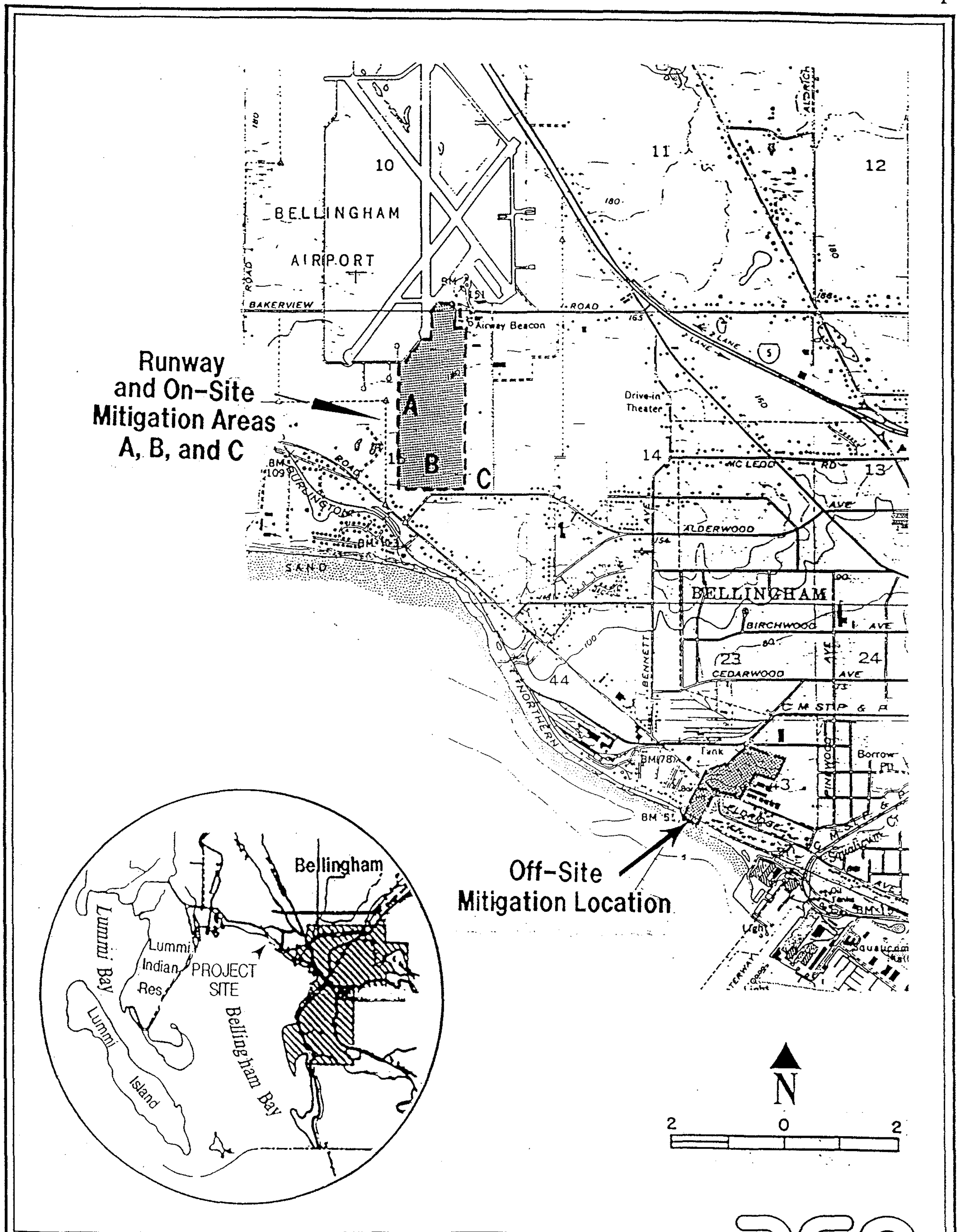
The Port of Bellingham constructed a 1,750-foot addition to the existing length of the main runway at the Bellingham International Airport in Whatcom County, Washington (see Figure 1.) Prior to construction, wetlands were identified on-site by the U.S. Army Corps of Engineers. Mitigation of the impacted wetlands is required.

The Little Squalicum Creek mitigation site is located in Section 23, Township 38N, Range 2E, south and east of the airport on Bellingham Bay. The site lies in a northeast-southwest alignment and is bound on the south and east sides by residential areas and Bellingham Technical College (BCT) properties, on the west by Bellingham Bay, on the north by a vacated railroad line. The area surrounding the Little Squalicum Creek site includes commercial, residential and business park uses. Little Squalicum Creek is a small stream with portions of its drainage basin in Whatcom County and Bellingham, Washington. Due to the sites potential as a mitigation site, the "Little Squalicum Creek Wetland Mitigation Plan," was proposed by Springwood Associates January 24, 1992.

This surface water information report is supporting data for the development of the new stream channel which has now been lengthened to 1,954 feet. The basin which flows into the existing stream is shown in Figure 2. The existing Little Squalicum Creek will remain in the same place and will convey runoff from the westerly areas of the stream basins. These areas consist of sub-basins: A, B, E, G, J, K1, and L1. These flow areas have contamination problems and are not suitable for fishery enhancement. The sub-basin to the east will be the source of flow for the new stream channel. These areas consist of sub-basins C, D, F, H, I, K2, and L2.

The rainfall-runoff relationships for the model were based on synthetic Soil Conservation Service (SCS) Unit hydrograph methodology. The potential maximum retention, and the initial abstraction of each soil complex are based upon the SCS empirical data used to develop the CN values -that being the records of rainfall and runoff for small watersheds (less that 1,000 acres.) These studies indicate that an average of 20 percent of the maximum moisture retention occurs before runoff begins. The remaining 80 percent of the precipitation losses occur mainly as infiltration after the runoff begins. This remaining retention potential is used at an exponentially decaying rate as the rainfall continues.

FIGURE 1
Site Map



Source: *Springwood Associates, 1992*

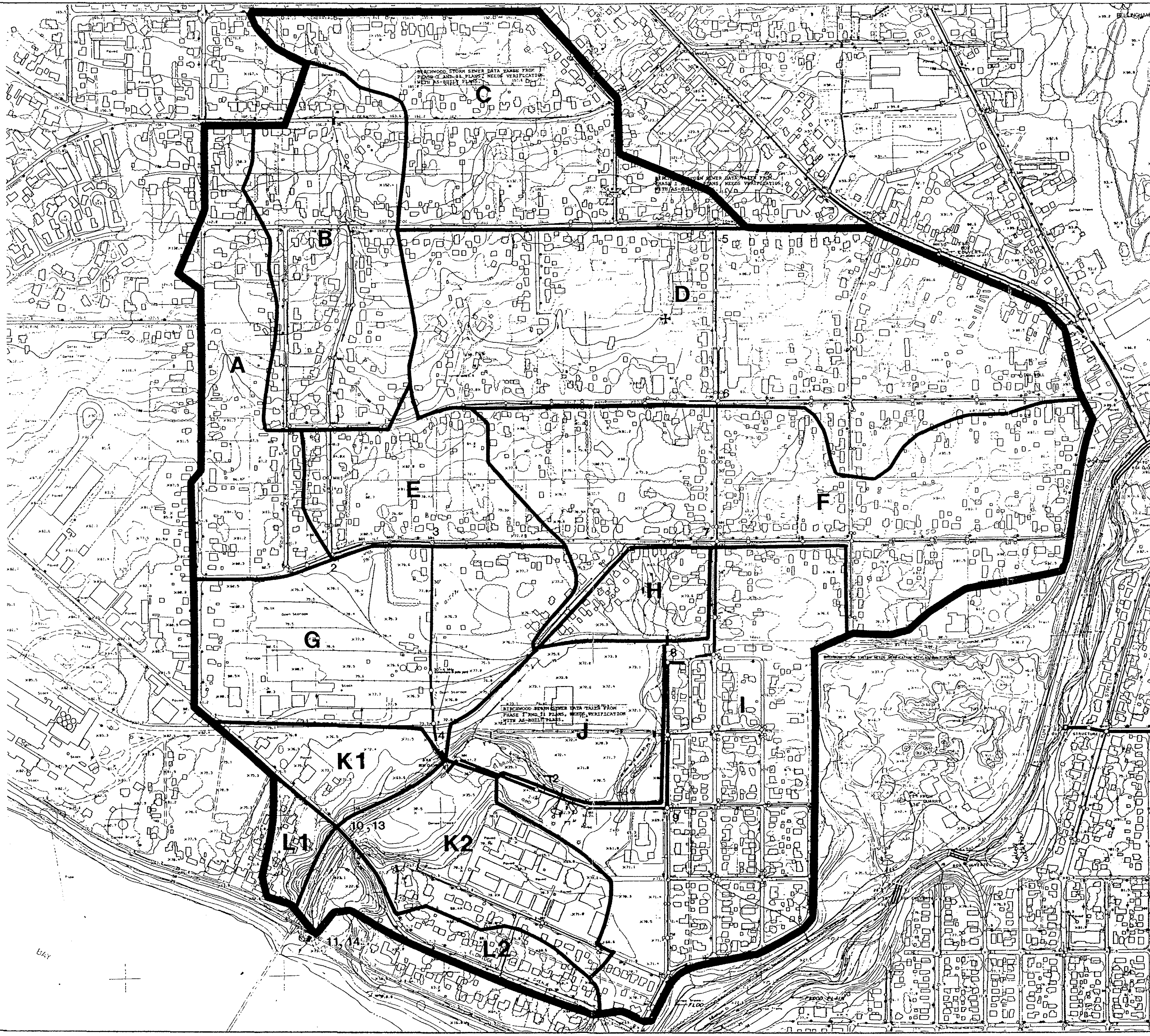


Figure 2
BASIN MAP

The Whatcom County Soil Survey was not complete when the following information was developed. As a result, combination of the Corps of Engineers and the SCS soil information was used to develop basin soil characteristics.

The two soil types identified by the Corps of Engineers and the Soil Conservation Service are shown in Figure 3 and consist of:

Soil Number 82 - Kickerville-Urban Land Complex

		Hydrologic Soil Group
Kickerville -	50%	B
Urban -	30%	
Other -	20%	
	100%	

Soil Number 172 - Urban Land-Whatcom-Labounty Complex

		Hydrologic Soil Group
Urban Land -	40%	
Whatcom -	30%	C
Labounty -	20%	D
Other -	10%	
	100%	

For calculation purposes, the pervious percentages used were:

Soil Number 82

		Hydrologic Soil Group
Kickerville -	100%	B

Soil Number 172

		Hydrologic Soil Group
Whatcom -	60%	C
Labounty -	40%	D
	100	

Based on current land use and density, the percent of impervious area was developed for each soil class. The percent impervious area was determined for the developed condition using Figure 2. Assuming dwellings 24 feet by 40 feet, 10 feet by 30 feet driveways, and 28 feet wide streets, impervious area was added and divided by total area to calculate percentages. Three categories of percent impervious area were computed as 17.25%, 38.5% and 10.94%. These correspond to land use densities. A summary of weighted curve numbers for the pervious area was determined and is in the appendix.

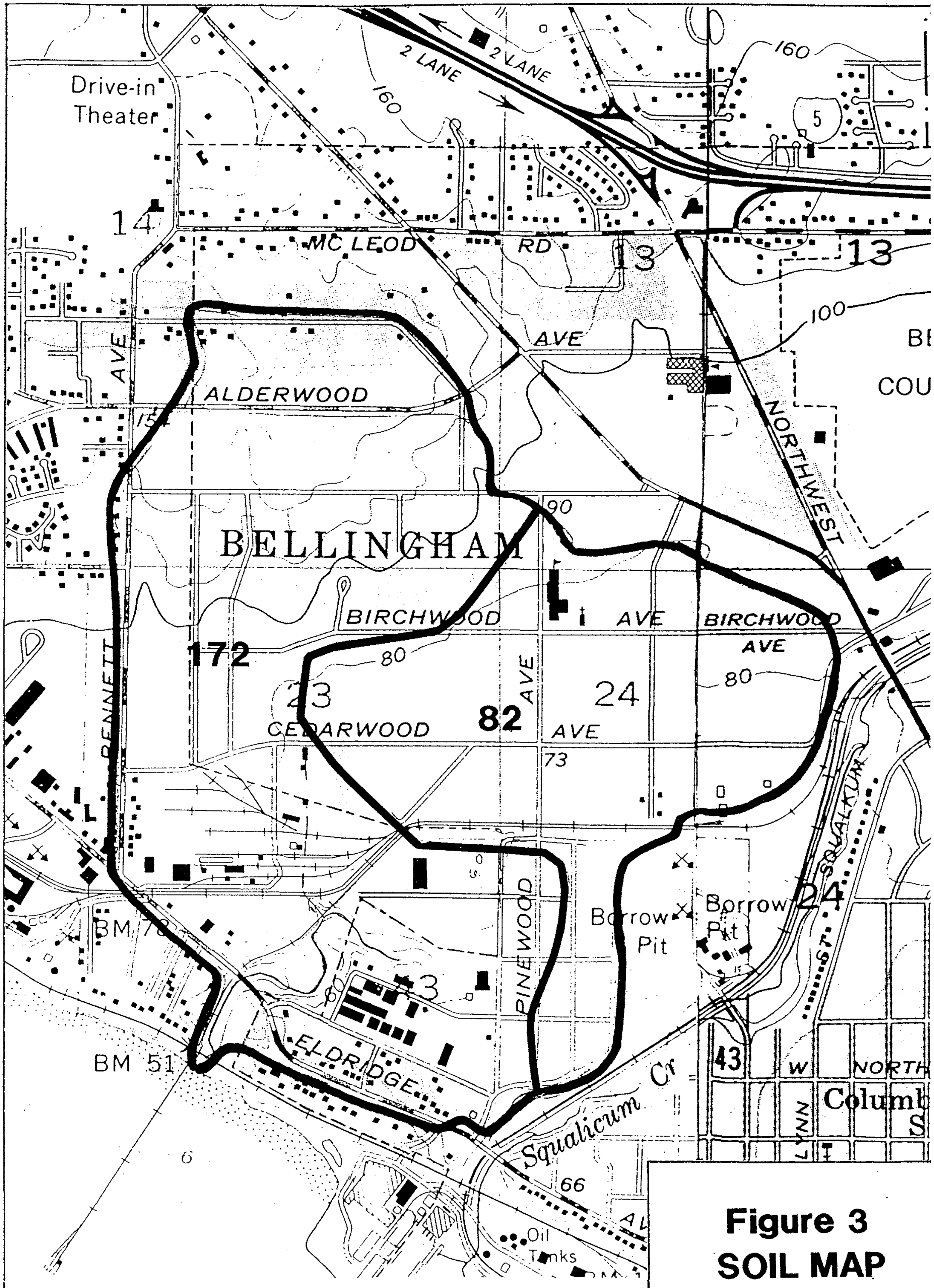


Figure 3
SOIL MAP

The "Waterworks" hydrologic analysis program, by Engenious Systems was used to develop and route hydrographs for selected storm events. There is flow entering the stream channel in two areas, the first from the 30 inch pipe where the channel begins and from the storm drains in Lindbergh Avenue. Using 1.8 inches of rain for a 2-year storm event from the "Precipitation Frequency Atlas of the Western U.S., Volume IX," the "Waterworks" model calculated the 2-year (24 hour) storm event at the 30 inch pipe to be 39.38 cfs covering an area of 347.3 acres. At Lindbergh Avenue, the area is 372.93 acres and the design flow is 42.72 cfs. To develop the 6-month (24 hour) storm event, 64% of the 2-year storm is taken. (64% is based on the Department of Ecology's "Storm Management Manual for the Puget Sound Basin," III-1-1, February 1992.) The largest 6-month storm in the channel is then 0.64(42.72) = 27.34 cfs. The basin ID and reach numbers corresponding to the "Waterworks" model are found on Figure 1, Basin Map.

Utilizing the Corps' "HEC-2" computer program, the dimensions of the new stream channel were determined. A stream with a 2 foot wide bottom and 3:1 side slopes was found to be adequate in low flow situations. The depth, velocity, and flow of the new stream bed were modeled for a 6-month and a 2-year storm event. The depth of flow in the stream ranges between 1 to 1.5 feet during a 6-month storm event. The channel is designed to overflow in the event greater than a 2-year storm.

NOTE: The HEC-2 water surface profile data are available upon request from Harold Peterson of David Evans and Associates, Inc. at (206) 455-3571.

APPENDIX E

David Evans and Associates, Inc.'s February 8, 1993 Wetland Functions and Values Report

WETLAND FUNCTIONS AND VALUES ASSESSMENT REPORT

LITTLE SQUALICUM CREEK OFF-SITE MITIGATION AREA

PORT OF BELLINGHAM INTERNATIONAL AIRPORT

RUNWAY EXTENSION PROJECT

POBM0007

Prepared by:

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February 8, 1993

INTRODUCTION

Compensation for project impacts to medium and high quality wetlands on the airport expansion site is proposed to be accomplished through a combination of on- and off-site mitigation. The following technical report is to be used as an appendix to the report *Final Off-site Wetland Mitigation Plan at Little Squalicum Creek for the Port of Bellingham International Airport Runway Extension.* This appendix evaluates the functional values of existing and proposed mitigation wetlands at the *off-site* (Little Squalicum Creek) area only. The functions and values of impacted wetlands on the runway construction site and of wetlands associated with the three on-site mitigation areas were documented in the *on-site* wetland mitigation report (DEA, 1992).

DEA biologists conducted field investigations, and relied on written, photographic, and other existing documentation as the basis for assessing the functions and values of existing wetlands and mitigation wetlands at the Little Squalicum Creek mitigation area. The results of this evaluation can be used to determine whether proposed off-site wetland mitigation combined with on-site mitigation measures will adequately compensate for wetland impacts resulting from construction of the runway extension.

SITE AND MITIGATION GENERAL OVERVIEW

Steep side slopes and a relatively flat bottom form a ravine through which Little Squalicum Creek flows. Existing vegetation consists of young deciduous forest, blackberry patches and open meadow.

The mitigation proposal for Little Squalicum Creek includes the creation and enhancement of approximately 3.1 acres of wetlands; the creation of approximately 2,208 of new stream channel with associated potential fisheries habitat; and provision for passive recreation and environmental education opportunities in accordance with the site management goals of the City of Bellingham Parks Department.

WETLAND FUNCTIONS AND VALUES

Despite the extensive research that wetland scientists have conducted on the subject of wetland function and value assessment, the professional wetland community and regulatory agencies have not universally accepted and utilized a single function and value assessment method. For this project, DEA employed a qualitative approach based on scientific literature (WDOE 1988; Adamus et al. 1987; Reppert et al. 1979; And Mitsch and Gosselink 1986). The wetland functions and values that DEA considered and which are reported in the literature cited above include: groundwater exchange, water quality improvement, stormwater attenuation and storage, wildlife habitat, and recreational and educational opportunities.

Functions and Values in the Existing Wetlands to be Enhanced

The report, *Draft Wetland Compensation Design - Airport Extension* (Sheldon & Associates, 1991), identified fourteen wetland areas (totalling 2.8 acres in size) using the 1989 FICWD methodology on the Little Squalicum Creek site. The wetlands were delineated, surveyed and their boundaries were confirmed by the Corps. Existing Little Squalicum Creek wetlands are referenced below according to the numbering system used in the Sheldon & Associates report. A summary of the existing functions and values of only those existing wetlands which will be enhanced through mitigation (Wetlands 2 through 7) is presented in **Table E1.** Narrative descriptions of those wetlands are also presented below.

Table E1.
Summary of Functional Values for Proposed Enhancement Wetlands on the Little Squalicum Creek Site

WETLAND	SIZE (AC.)	CLASSIFI-CATION*	GROUND-WATER EXCHANGE	STORMWATER ATTENUATION AND STORAGE	WATER QUALITY IMPROVEMENT	WILDLIFE HABITAT	OVERALL RATING
Existing Wetland 2	0.29	PEM1B	low	low	low to medium	low	low
Existing Wetland 3	0.1	PEM1B	low	low	low to medium	low	low
Existing Wetland 4	0.09	PEM1B	low	low	low to medium	low	low
Existing Wetland 5	0.02	PEM1B	low	low	low to medium	low	low
Existing Wetland 6	0.02 0.01	PEM1B PSS1B	low	low	low to medium	low	low
Existing Wetland 7	0.05	PEM1B	low	low	low to medium	low	low

* Wetland classification according to Cowardin et. al. (1979): PEM1B = palustrine emergent, persistent, saturated wetlands; and PSS1B = palustrine scrub-shrub, broad-leaved deciduous, saturated wetlands.

Wetland 1. This wetland is not anticipated to be impacted by the mitigation proposed in the Little Squalicum Creek corridor. No functions and values assessment was done for this wetland.

Wetland 2. Wetland 2 is located in the northeastern and central portions of the site and consists of essentially unvegetated, narrow channels connecting wider, thickly vegetated wetland areas. Enhancement is proposed for the easternmost vegetated wetland area, a 0.29-acre palustrine emergent meadow dominated by reed canarygrass (*Phalaris arundinacea*). Wetland hydrology is supplied primarily by precipitation and runoff and probably some component of seepage from the steep slope to the south and east.

Because Wetland 2 is perched on fill and infiltration appears to be very slow, groundwater exchange value is considered low for this localized area on the site. Being a flat, low area covered with emergent vegetation, Wetland 2 is rated low for stormwater attenuation and storage. Reed canarygrass has good nutrient absorption capabilities and the potential to provide sediment filtering; therefore, it has a low to moderate rating for water quality improvement. Considered in the context of the surrounding landscape, which includes adjacent forested wetland and adjacent uplands, Wetland 2 is rated low to medium for wildlife habitat. If considered on its own, Wetland 2 has a low rating for wildlife habitat because of plant species diversity, no vegetation class interspersion, minor food-chain support, and little vegetation cover.

The proposed mitigation plan calls for the creation of wetlands by ponding water in the southern section of Wetland 2 and inundating adjacent low-lying uplands to the north. Consequently, the hydrology of the southern section of Wetland 2 will be altered significantly.

This wetland area consists of open forest with a canopy dominated by black cottonwood (*Populus balsamifera*). Other species present include red alder (*Alnus rubra*), willow (*Salix* spp.), and a thick shrub layer comprised almost exclusively of Himalayan blackberry (*Rubus discolor*). The thick blackberry understory will probably be eliminated once the water supply to Wetland 2 increases. Red alder can withstand some inundation, but may be adversely affected if inundation is sufficiently frequent and/or long (Walters, et al. 1980).

Wetland 3. Wetland 3 has two parts: (a) a long linear segment which appears to be the remnant upper channel of Little Squalicum Creek, and (b) a 0.1-acre lobe of disturbed wetland located south of the upper portion of the remnant channel. The disturbed portion of Wetland 3 will be replaced. Currently, Wetland 3 is vegetated with emergent vegetation including soft rush (*Juncus effusus*), common horsetail (*Equisetum arvense*), and Canadian bluegrass (*Poa compressa*). Hydrology sources for the disturbed portion of this wetland appear to be from precipitation, adjacent upland runoff, and possibly surface flow from the remnant channel during storm events. The groundwater exchange rating is low since hydrologic support for Wetland 3 is from precipitation and runoff from adjacent uplands. The stormwater attenuation and storage value of the disturbed portion has a low rating because of its small size and shallow available flood basin. Emergent vegetation could provide some sediment filtering and therefore the rating for water quality improvement is low to moderate. By itself, the disturbed portion of Wetland 3 has a low rating for wildlife habitat value due to its small size, low vegetation class interspersion and low plant species diversity.

Wetland 4. Wetland 4 is a disturbed, isolated 0.09-acre wetland located in the northern corner of the mitigation site between Wetlands 3 and 5. Dominant hydrophytic vegetation includes bentgrasses (*Agrostis* spp.), foxtail (*Alopecurus* sp.), soft rush, toad rush (*Juncus bufonius*), and spike rush (*Eleocharis* sp.). Runoff from surrounding uplands provides water to this wetland.

Evidence of long-term surface ponding suggests that the substrate directly under Wetland 4 has very low permeability and is effectively impervious; therefore, the rating for groundwater exchange is very low. Since Wetland 4 is topographically depressed, it does provide some amount of stormwater attenuation and storage. Due to its small size however, it has a low to moderate rating for groundwater exchange. The emergent vegetation has some potential to provide sediment filtering and therefore the rating for water quality improvement is low to moderate. Due to small size and structurally monotonous plant community (wet meadow) the rating for wildlife habitat is low.

Wetland 5. Wetland 5 is a 0.02-acre palustrine emergent wetland located just south of Wetland 4. Vegetation is dominated by reed canarygrass and also includes red-top (*Agrostis alba*), bluegrass (*Poa* sp.), toad rush, and soft rush. Runoff from adjacent uplands is the water source for this wetland. The very small size of this wetland limits its ability to contribute significantly toward the functions and values being assessed. Therefore, groundwater exchange, stormwater attenuation and storage, water quality improvement, and wildlife habitat have low ratings.

Wetland 6. Wetland 6 is a 0.03-acre palustrine emergent and palustrine scrub-shrub wetland located in the north-central part of the site. Reed canarygrass, colonial bentgrass and soft rush dominate the emergent portion of this wetland and Himalayan blackberry and red-osier dogwood (*Cornus stolonifera*) dominate the scrub-shrub portion. Surface runoff from the surrounding uplands is the hydrology source for this wetland.

Like Wetland 5, small size diminishes the ability of Wetland 6 to contribute significantly toward the functions and values being assessed. For this reason, groundwater exchange, stormwater attenuation and storage, water quality improvement, and wildlife habitat have low ratings. However, if considered in the context of the immediately surrounding landscape, the wildlife habitat rating is low to moderate.

Wetland 7. Wetland 7 is a disturbed, 0.05-acre shallow depression located in the central portion of the site. Hydrophytic vegetation is dominated by reed canarygrass, red-top, and soft rush with invading saplings of Pacific willow (*Salix lasiandra*), Sitka willow (*Salix sitchensis*), black cottonwood and ornamental hawthorn (check sci. name). Precipitation appears to be the primary source of wetland hydrology.

Like Wetland 5 and Wetland 6, the small size of Wetland 7 diminishes its ability to contribute significantly toward the functions and values being assessed. For this reason, groundwater exchange, stormwater attenuation and storage, water quality improvement, and wildlife habitat have low ratings.

Wetlands 8, 9, 10, 11, 12, 13, 14. These wetlands are not anticipated to be impacted by the mitigation proposed in the Little Squalicum Creek corridor. No functions and values assessments were done for these wetlands.

All the existing wetlands and Little Squalicum Creek are considered one landscape unit for the purpose of assessing educational and recreational values. Current uses of the site include recreation and open space. A footpath and dirt road in the Little Squalicum Creek corridor encourage allow for passive recreational use of the site as well as providing access to the existing wetlands, Little Squalicum Creek, and Bellingham Bay from nearby neighborhoods and technical college. Currently there are no formal educational features (e.g., interpretive facilities) at the site, nor is there any on-going wetlands-related research occurring at the site. Based on these use patterns, the site has a low to moderate rating for recreational and educational values. Native Americans use the beach near the mouth of Little Squalicum while fishing in Bellingham Bay. The beach is accessed for fishing via the Bay or from the land via the trail/road along Little Squalicum Creek.

Functions and Values Expected in the Mitigation Wetlands

The off-site mitigation plan will provide for the creation of 2.61 acres of new wetlands, and for the enhancement of 0.49 acres of existing wetlands on the Little Squalicum Creek site. New wetlands will be created by channelling surface water through a series of wetland cells, each cell having plant communities which correspond to a range of hydrologic conditions. Additionally, a groundwater-fed wetland cell will be created exhibiting a complex arrangement of open-water, emergent wetland, and upland vegetated habitat islands. The overall wetland functions and values of the mitigation area will exceed the values of the existing wetlands on the Little Squalicum Creek site. The functions and values of the proposed mitigation wetlands are collectively described below.

Groundwater Exchange. The rating for existing wetlands performing groundwater exchange functions is low. This situation is unlikely to change because the wetland cells will have an impermeable liner to allow retention of as much surface water as possible. The impermeable liner will prevent water from seeping out of the wetland cells, and therefore, the groundwater exchange rating of the mitigation wetlands is considered low.

Water Quality Improvement. It is expected that water flowing through the bioswale and created wetland cells will be cleaned of deleterious materials prior to entering the new stream.

Approximately half of the mitigation area will consist of created or enhanced wetland. Vegetation in these wetlands will increase the sediment filtration function of the mitigation wetlands. Scrub-shrub vegetation will contribute to water velocity attenuation and consequently sediment settling. In addition, created and enhanced wetland area soils will provide cation exchange potential, enhancing the overall water quality improvement function. Thus, the rating for water quality improvement of the mitigation wetlands is medium.

Stormwater Attenuation and Storage. Considered as a whole system, the eight wetland cells will significantly increase the stormwater attenuation and storage function of the mitigation area. Creating additional storage capacity that can accommodate seasonal to permanent ponding will substantially increase the available stormwater storage potential. Additionally, woody vegetation in the forested area to the southwest of Cell 6 will augment stormwater attenuation through physically slowly stormwater velocity as it passes through the area. Because of the additional capacity and attenuation that the wetland cells will provide, the rating for the stormwater attenuation and storage function is medium.

Wildlife Habitat. The created and enhanced wetlands are expected to provide substantially better wildlife habitat. Many wildlife species depend on wetlands for critical needs; and thus increasing the extent of wetlands will add to the wetlands habitat base in the City of Bellingham. Compared to the habitat quality of the existing wetlands, the mitigation wetlands will add important wildlife habitat features. Creating different aquatic environments in each wetland cell, will increase plant species diversity and structure. Also, vegetation class interspersion in the mitigation area will be maximized, thus increasing the number of potential ecological niches. The rating for the wildlife habitat function of the mitigation wetlands is medium to high.

Recreational and Educational Values. The City of Bellingham Parks Department and the Whatcom County Parks Department have recently made an agreement whereby the County will lease the mitigation site to the City for 35 years. The existing dirt road and footpath will be retained and linked to another footpath planned to run along the southern perimeter of the site. The footpath exiting the site at the northern end will be part of the City's regional trail system. The trail network is expected to increase public recreational use of the mitigation site.

Interpretive signage will be installed at six locations throughout the site. Also, opportunities for conducting research on water quality and wetland plant establishment will exist. The emphasis on improving the existing recreational and educational opportunities, as well as creating new opportunities will increase the rating for recreational and educational values to high.

In summary, the functions and values of the mitigation wetlands are expected to be medium to high. Compared to the existing wetlands which they will replace, the mitigation wetlands are distinctly higher in value. **Table E2** summarizes the size and functions and values of impacted wetlands and compensation wetlands. Over time, the mitigation wetlands and surrounding area are expected to become an aesthetically pleasing, diverse natural environment that is markedly better than the current disturbed conditions of the mitigation site.

Stream Channel and Fisheries Enhancement

Surface water runoff from the proposed mitigation wetlands will be directed into a created channel designed to accommodate salmon spawning and provide juvenile fish access to upstream overwintering habitat in the created wetlands. Surface water flows are expected to provide water depth sufficient for salmon spawning.

Table E2.
Functional Values for Impacted Wetlands and Proposed Compensation.

WETLAND	WETLAND TYPE	SIZE (Ac)	OVERALL FUNCTIONAL VALUE
On-site Impacted	Palustrine emergent	17.1	low to medium
On-site Impacted	Palustrine emergent	0.4	low to medium
On-site Impacted	Palustrine forested	3.6	medium to high
On-site Mitigation Area B	Palustrine emergent	12.7	low to medium
On-site Mitigation Area A	Palustrine emergent	2.0	low to medium
On-site Mitigation Area A	Palustrine scrub-shrub	1.4	low to medium
On-site Mitigation Area C	Palustrine scrub-shrub	5.0	medium to high
Off-site Mitigation Little Squalicum Creek	Palustrine forested, scrub-shrub and emergent	3.1	medium to high

In conclusion, approximately 21.1 acres of wetland impacts will be compensated through creating and enhancing 24.2 acres of wetlands which are equal or higher functional value. On-site and off-site mitigation plans propose only partial in-kind replacement of impacted wetlands because airport safety considerations require special limitations on adjacent lands and proportional replacement of low value wetlands is not necessarily desirable. Based on an evaluation of acreage and functions and values for impacted and mitigation wetlands, an adequate balance between wetland impacts and mitigation compensation has been achieved.

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