Final

Natural Resource Mitigation Plan

Master Plan Update Improvements
Seattle-Tacoma International Airport

November 2001

Port of Seattle

Parametrix, Inc.

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NATURAL RESOURCE MITIGATION PLAN
SEATTLE-TACOMA INTERNATIONAL AIRPORT
MASTER PLAN UPDATE IMPROVEMENTS

Prepared for

PORT OF SEATTLE
Seattle-Tacoma International Airport
P.O. Box 69727
Seattle, Washington 98168-0727

Prepared by

PARAMETRIX, INC.
5808 Lake Washington Blvd. N.E., Suite 200
Kirkland, Washington 98033-7350

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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation/ Acronym	Formal Name
ACOE	U. S. Army Corps of Engineers
AMA	Aircraft Movement Area
AOA	Airport Operation Area
ARFF	Airport Rescue and Fire Fighting
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ASTM	American Society for Testing Materials
BIBI	Benthic Index of Biotic Intergrity
BMPs	Best Management Practices
cfs	Cubic feet per second
CPOM	Coarse particulate organic matter
CWA	Clean Water Act
cy	Cubic yard
DNR	Washington Department of Natural Resources
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FPOM	Fine particulate organic matter
FSEIS	Final Supplemental Environmental Impact Statement
FW	Farmed wetland
GIS	Geographic information system
HPA	Hydraulic Project Approval
HSPF	Hydrologic Simulation Program–FORTRAN
IFR	Instrument Flight Rule
ILA	Interlocal Agreement
IWS	Industrial waste system
IWTP	Industrial waste treatment plant
JARPA	Joint Aquatic Resource Permit Application
KCSWM	King County Surface Water Management
LWD	Large woody debris
MSE	Mechanically stabilized earth
NAVAIDS	Navigation aids
NEPL	North Employee Parking Lot

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

Abbreviation/ Acronym	**Formal Name**
NPDES	National Pollutant Discharge Elimination System
NRMP	Natural Resource Mitigation Plan
OHW	Ordinary high water
OHWM	Ordinary high water mark
PGIS	Pollution-generating impervious surface
Port	Port of Seattle
RDF	Regional detention facility
RM	River mile
ROW	Right-of-way
RPZ	Runway protection zone
RSA	Runway Safety Areas
SAMP	Special Areas Management Plan
SASA	South Aviation Support Area
SCS	Soil Conservation Service
SDS	Stormwater drainage system
SR	State Route
STEP	South Terminal Expansion Project
STIA	Seattle-Tacoma International Airport
STS	Satellite Transit Shuttle
SWPPP	Stormwater Pollution Prevention Plan
TESC	Temporary erosion and sediment control
USDA-WSD	United States Department of Agriculture-Wildlife Services Division
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VFR	Visual Flight Rule
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WHMP	Wildlife Hazard Management Plan
WRIA	Water Resource Inventory Area
WQC	Water Quality Certification
WQS	Water Quality Standard
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

As currently configured, Seattle-Tacoma International Airport (STIA) is unable to efficiently meet existing and future regional air travel demands. In response to growth forecasts for passenger and cargo volumes at STIA, a variety of facility improvements are planned to meet travel demands in the Puget Sound Region and reduce aircraft arrival delays during poor weather. These improvements were developed through a master planning process, then updated to reflect revised growth forecasts for passenger use. Some of the planned improvements will cause unavoidable impacts to wetlands, streams, floodplains, and drainage channels within the project area. This *Natural Resource Mitigation Plan* (NRMP) describes the actions that the Port of Seattle (Port) will implement to mitigate for unavoidable wetland and stream impacts associated with Master Plan Update improvements.

The STIA Master Plan Update improvements will affect wetlands, streams, floodplain, drainage channels, and stormwater in the Miller and Des Moines Creek basins. To construct the projects, fill material would be permanently placed in approximately 980 linear ft of Miller Creek, approximately 5.24 acre-ft of the Miller Creek 100-year floodplain, approximately 18.37 acres of wetland, and about 1,290 linear ft of drainage channels. About 2.05 acres of wetland impact would occur during construction, with these wetlands being restored following construction.[1] In addition, new impervious surfaces will affect stormwater runoff and water quality conditions.

Mitigation is planned for on-site and off-site areas. The on-site mitigation areas are not expected to mitigate impacts to avian species[2] that pose aircraft safety concerns. A critical need of the mitigation projects is to restore wetland and stream buffer functions in a manner that avoids creating new avian wildlife hazards and reduces existing avian wildlife hazards.

Consistent with federal and state mitigation requirements, this plan describes actions the Port will take to:

- Avoid and minimize impacts to wetlands and streams by reducing impact areas. Impact area will be reduced by using retaining walls to minimize fill impacts, locating stormwater detention in uplands, and avoiding wetlands in borrow areas.
- Restore temporary impacts to wetlands caused by project construction, including construction of stormwater management facilities.
- Compensate for the impact by providing in-kind mitigation that replaces ecological functions lost by filling wetlands and streams. Compensatory mitigation will restore and enhance ecological and hydrologic functions to over 177 acres[3] of land to be protected with

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[1] The Port has been asked by Ecology and the Army Corps of Engineers to increase the amount of mitigation for both temporary and permanent impacts that typically last for several years. This increased mitigation at Wetland A17 is included in this plan.

[2] Avian habitat functions will be replaced by creating and restoring wetland habitats at an off-site location in Auburn. Non-avian wildlife using mitigation sites are not a hazard to aircraft safety unless they attract avian predators, or move onto active runways.

[3] Increased mitigation requested by the Corps of Engineers at two on-site locations is reflected in this volume.

restrictive covenants. To comply with Federal Aviation Administration requirements regarding wildlife attractants near airports, off-site mitigation is planned to replace wildlife habitat functions the impacted wetlands currently provide. On-site mitigation is planned to replace the other functions provided by the impacted wetlands.

- About 112 acres of the mitigation occurs on-site, restoring natural wetland and stream conditions to currently developed portions of the Miller and Des Moines Creek basins. Elements of the on-site mitigation will replace the impacts to wetland functions caused by the project and will:
- Restore and enhance riparian wetlands adjacent to Miller and Des Moines Creeks
- Restore and enhance salmon habitat
- Enhance stream buffers
- Remove existing land uses that are detrimental to adjacent wetlands and streams
- Protect water quality and stream hydrology
- Over 65 acres of mitigation to replace wildlife habitat function will occur at an off-site mitigation area in Auburn, where existing degraded wetlands and abandoned farmland will be restored to a high quality, diverse wetland ecosystem.

A complete description of the goals and objectives of each mitigation project are described in this report. For each mitigation project, an engineering and landscape design is presented and discussed. This NRMP also provides detailed performance and monitoring standards, which as permit requirements, will be enforced by permitting agencies to assure that the projects are constructed as designed, periodically evaluated for success, and adaptively managed. Monitoring and adaptive management will ensure that the hydrologic and ecological benefits described in the plan are ultimately achieved.

Overall, the Master Plan Update improvements design and mitigation will protect wetlands and aquatic resources following guidance provided by state and federal protocols, including Regulatory Guidance Letter (RGL) 01-1 (ACOE 2001). The substantial mitigation described here compensates for identified impacts to hydrology (peak flow and low flow), water quality, wetlands (temporary, permanent filling, and indirect), and streams. This mitigation prevents cumulative impacts attributable to the proposed actions from occurring.

1. INTRODUCTION

In response to growth forecasts for passenger and cargo volumes at Seattle-Tacoma International Airport (STIA), a variety of facility improvements are planned to meet the air transportation needs of the Puget Sound Region and reduce aircraft arrival delays during poor weather. These improvements were developed through a master plan process, then updated to reflect revised growth forecasts for passenger use. The Master Plan Update projects have been planned to minimize impacts to wetlands and streams. However, some of the planned improvements will cause unavoidable impacts to wetlands, streams, floodplains, and drainage channels within the project area. This *Natural Resource Mitigation Plan* (NRMP) describes the mitigation actions that the Port of Seattle (Port) will implement to mitigate potential unavoidable wetland and stream impacts associated with Master Plan Update improvements. Actions taken to mitigate potential stormwater and water quality impacts due to the proposed projects are summarized in this plan (Section 6); and are described in detail in the *Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Update Improvements* (Parametrix 2000a, 2001a). This NRMP describes actions that will be implemented according to all conditions of the Section 401 Water Quality Certification (WQC) (Ecology 2001a).

The mitigation plan includes two major elements: (1) mitigation actions (described in Sections 1 through 7 of this document), and (2) detailed plan sheets that graphically depict the mitigation design (included as Appendices A-F of this report). Compensatory mitigation has been proposed to occur on approximately 177 acres, with about 112 acres of on-site mitigation within the Miller and Des Moines Creek basins and about 65 acres of off-site mitigation at the Auburn mitigation site. This mitigation plan and the mitigation designs have been revised in response to: (1) comments received on the Public Notice of September 1999 and December 2000 regarding the type and amount of mitigation, and (2) issues raised by the Washington State Department of Ecology (Ecology), the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), the Washington State Department of Fish and Wildlife (WDFW), the City of Auburn, and the U.S. Army Corps of Engineers (ACOE) on previous drafts of the mitigation plan. The plan describes specific actions taken to:

- *Avoid and minimize* impacts to wetlands and streams.
- *Replace wetland functions on-site* to the maximum extent practicable by restoring and enhancing wetlands in the Miller and Des Moines Creek basins, where compatible with airport operations, and where restoration will reduce wildlife attractants near the airport.
- *Enhance and restore stream habitat functions* through buffer restoration and instream habitat enhancement.
- *Restore wetland functions and create new, high quality wetlands off-site* to replace avian habitat functions in compliance with Federal Aviation Administration (FAA) Advisory Circular 150/5200-33.

The compensatory mitigation plan includes both on-site and off-site mitigation projects including:

On-Site

- Vacca Farm restoration — Miller Creek channel relocation and enhancement, wetland and floodplain restoration, and buffer enhancement
- Miller Creek instream habitat, wetland, and riparian buffer enhancements
- Restoration of temporary construction impacts
- Replacement of drainage channels adjacent to Miller Creek
- Tyee Valley Golf Course wetland mitigation and Des Moines Creek riparian buffers
- Trust funds for stream restoration projects in the Miller and Des Moines Creek basins
- Riparian wetland and buffer restoration at the Des Moines Way Nursery site

Off-site

- Wetland restoration, enhancement, and creation in Auburn

1.1 PURPOSE AND NEED FOR THE PROJECT

As currently configured, STIA is unable to efficiently meet existing and future regional air travel demands. The airfield operates inefficiently during poor weather because it accommodates aircraft in a single arrival stream only. As a result, significant arrival delay occurs during poor weather. Aircraft are either held on the ground in their originating city, slowed en route, or placed in holding patterns to await clearance to land at STIA. These conditions result in inefficient operation of the existing airfield, as described in the Final Environmental Impact Statement (FEIS) and Final Supplemental Environmental Impact Statement (FSEIS) for the Master Plan Update projects (FAA 1996, 1997a).

With or without improvements, airport activity is expected to increase as a result of regional population growth. As aviation demand grows, aircraft operating delay will increase exponentially. The increased passenger, cargo, and aircraft operations will place increasing burdens on the existing terminal and support facilities. Without improvements, the roadway system, terminal space, gates, cargo, and freight processing space would become more inefficient and congested, and the quality of service at STIA would be reduced.

While STIA currently has sufficient operation capability during good weather conditions, the existing runway capabilities cause arrival delays during poor weather. For instance, when weather worsens from Visual Flight Rule (VFR) 1 to VFR 2, average arrival delay increases by more than ten fold (from 1 minute to 11.4 minutes). Delays further worsen when Instrument Flight Rule (IFR) 1/2/3 conditions occur. In these cases, average arrival delay increases more than twenty fold over VFR 1 (from 1 minute to 21.7 minutes). Because these statistics represent averages, some flights experience less delay, while others experience greater delays. The FAA's National Plan of Integrated Airport Systems concludes that when annual average delays exceed 9 minutes, an airport is experiencing severe delay.

Using average aircraft operating costs developed by the FAA, STIA aircraft delays are estimated to cost the airlines about $42 million annually under 1992 demand levels. When annual aircraft operations reach 425,000, delay costs are anticipated to exceed $176 million annually. Without the third parallel runway, at this level of activity, average VFR 2 arrival delay would exceed 40 minutes and IFR delay would exceed 70 minutes. A third parallel runway, located 2,500 ft west of the existing 16R/34L runway, would permit staggered dual-stream arrivals in poor weather conditions. It would decrease average arrival delays by about 80 percent compared to taking no action, and result in a savings of $132 million per year.

Based on this analysis, and as a result of planning for the Master Plan Update improvements, the Puget Sound Regional Commission and other regional officials have identified the following needs for STIA:

- Improve the poor weather airfield operating capability (over 85 percent of total STIA delays are incurred by aircraft arriving during poor weather).
- Provide sufficient runway length to accommodate warm weather operations and payloads for aircraft types operating to the Pacific Rim.
- Provide Runway Safety Areas (RSAs) that meet FAA standards.
- Provide efficient and flexible land-side facilities to accommodate future aviation demand.

1.2 PROJECT LOCATION

STIA is located within the City of SeaTac in King County, Washington, situated 12 miles south of downtown Seattle (Sections 20, 21, 28, 29, 32, and 33, Township 23N, Range 4E; and Sections 4 and 5, Township 22N, Range 4E, W.M.) (Figure 1.2-1). On-site mitigation projects are located in the vicinity of STIA, while the off-site mitigation project is located southeast of STIA in the City of Auburn, Washington (Figure 1.2-1).

Mitigation for the Master Plan Update improvements is proposed on land currently owned by the Port within the acquisition area at STIA (Figure 1.2-2) or at the site in Auburn, Washington, which the Port has owned since 1995 (see Figure 1.2-1). The Auburn mitigation site is located on the west side of the Green River and south of South 277th Street (SE¼ Section 31, Township 22N, Range 4E, W.M.).

The Port is also proposing to establish two trust funds to be used to support local stream restoration efforts in both the Des Moines and Miller Creek basins. Stream restoration projects may occur on property not owned by the Port.

1.3 PROJECT DESCRIPTION

The Master Plan Update improvements include construction activities that will fill approximately 18.37 acres of wetlands in the Miller Creek[4] and Des Moines Creek watersheds. Master Plan

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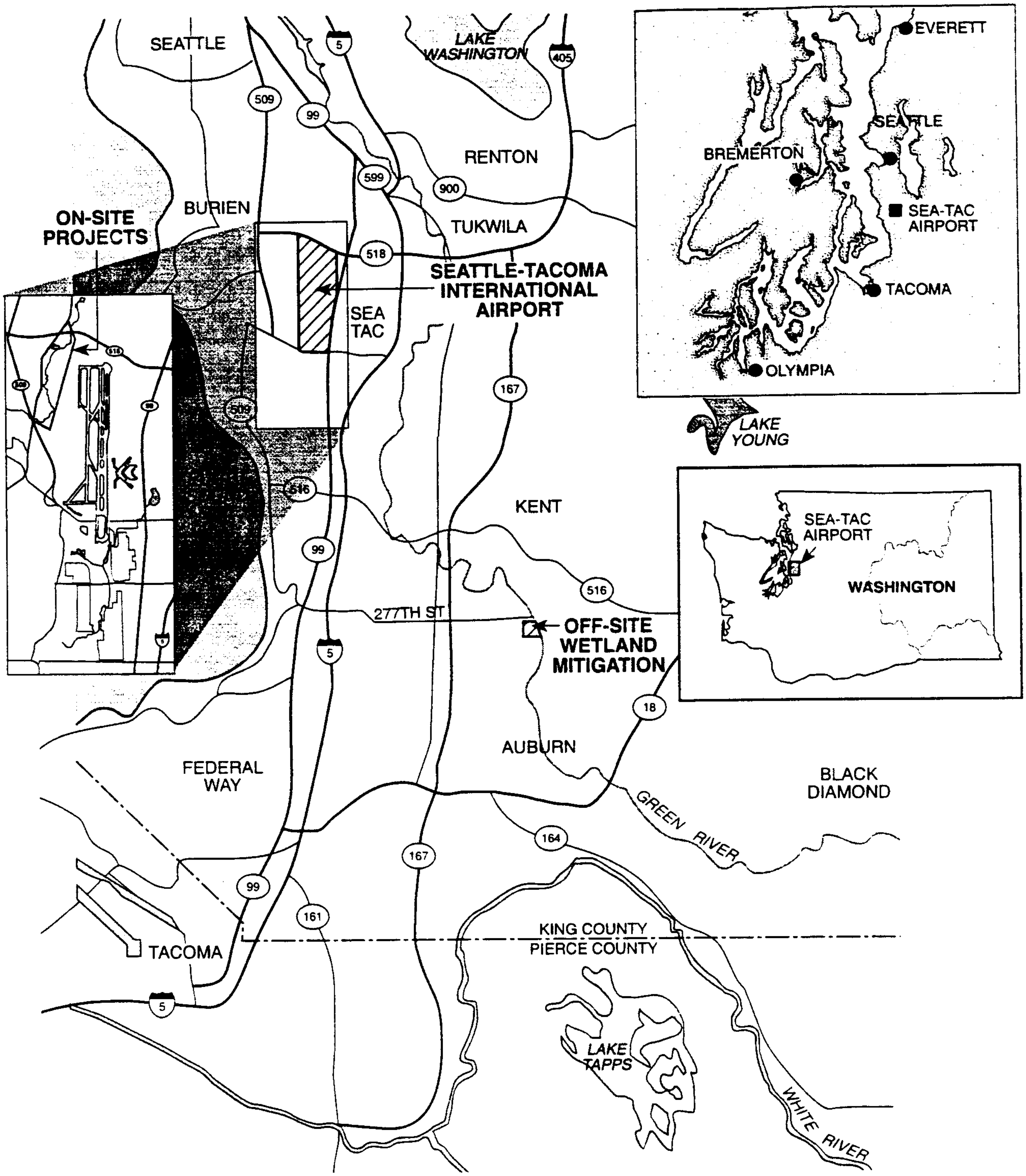
[4] References to Miller Creek watershed include Walker Creek.



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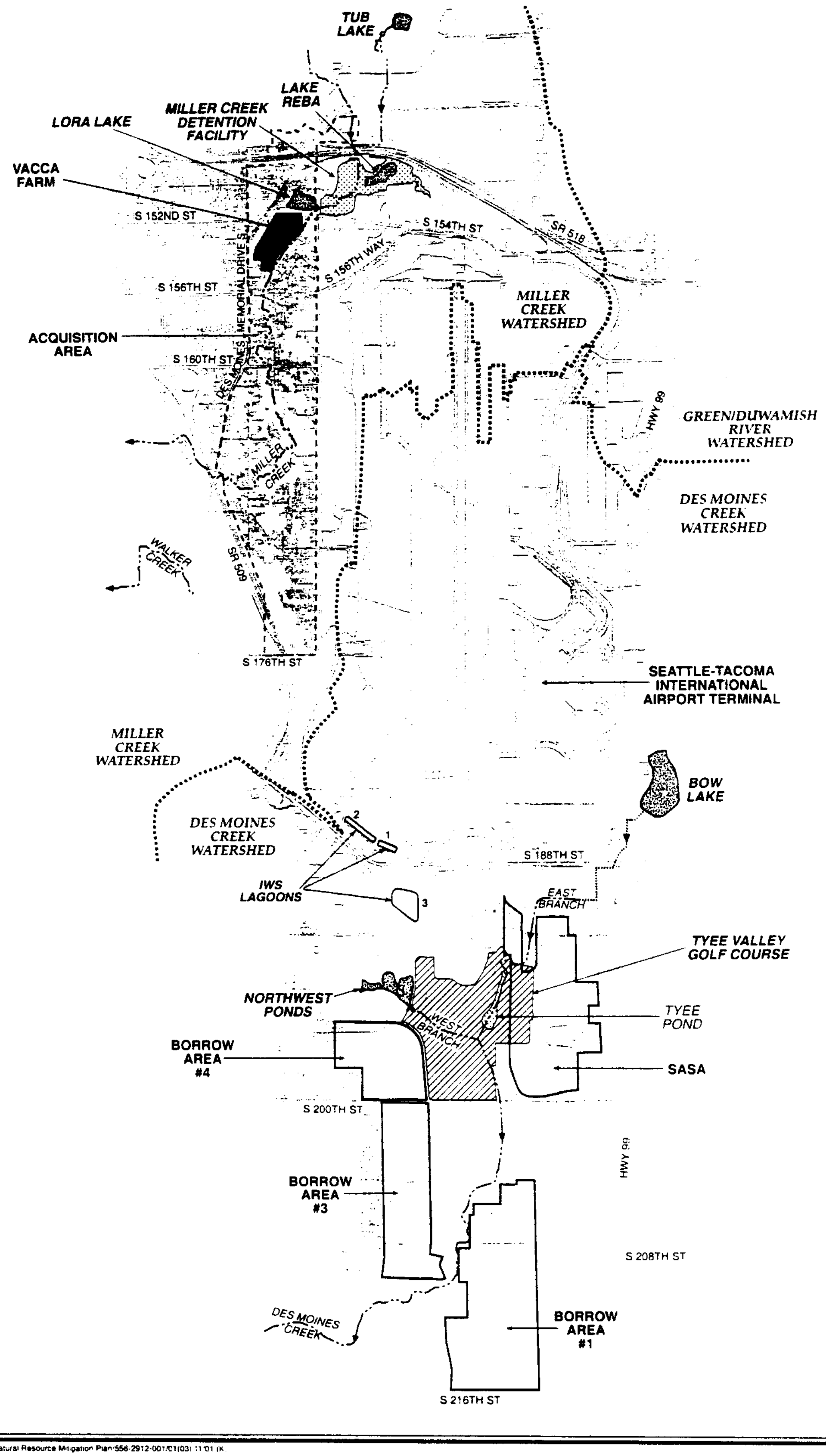
SCALE IN FEET

0 7,500 15,000

Figure 1.2-1
Location of Seattle-Tacoma International Airport and Off-Site Wetland Mitigation Site



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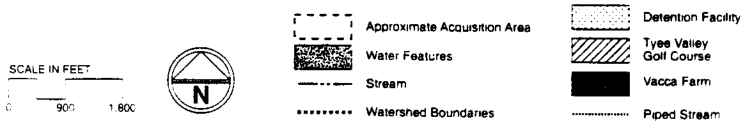

- Approximate Acquisition Area
- Water Features
- Stream
- Watershed Boundaries
- Detention Facility
- Tyee Valley Golf Course
- Vacca Farm
- Piped Stream

Figure 1.2-2
Locations of Existing Water Features, Stormwater Facilities, Watershed Boundaries, and Acquisition Area of STIA

Update improvement projects are summarized in Table 1.3-1. Elements of the project that will result in wetland, floodplain, stream, and drainage channel impacts include the following:

- Adding an 8,500-ft-long third parallel runway (16X/34X) with associated taxiway and navigational aids
- Establishing standard RSAs for existing runways 16R/34L and 16L/34R
- Relocating South 154th Street north of the extended RSAs and the new third runway
- Developing the South Aviation Support Area (SASA) for cargo and/or maintenance facilities
- Using on-site borrow sources for the third runway embankment
- Relocating, redeveloping, and expanding support facilities (passenger terminal facilities, stormwater facilities [including outfalls], electrical substations, utility corridors, etc.)

These elements of the project are described more fully below.

Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport.

Project	Description
Runway and Taxiway Projects	
Property Acquisition, Street and Utility Vacation	Includes purchasing property and demolishing existing structures between existing STIA boundary west to Des Moines Memorial Drive and State Route (SR) 509. Required for third runway embankment fill and construction impact mitigation. Acquisition and demolition is also required for the south runway protection zone (RPZ).
Embankment Fill	Embankment for third runway, constructed using imported fill. Approximately 16.5 million cubic yards (cy) will be placed over a 5- to 7-year period. Existing roads and streets under embankment footprint will be removed.
Interconnecting Taxiways	New connecting taxiways between existing runway and third runway. Project is located on existing airfield, requiring only minimal grading.
Runway 16X/34X	Paving of third runway after completion of embankment fill.
Extension of Runway 34R by 600 ft	Extend runway by 600 ft for improved warm weather and large aircraft operations. Project is located at the southern end of the east runway.
Additional Taxiway Exits on 16L/34R	Construction of new ramps to the existing terminal apron.
Dual Taxiway 34R	Improvements to taxiways serving the South Aviation Support Area (SASA) and south apron.
Borrow Sites	
Borrow Sites	Sources of fill for third runway embankment, located on STIA property south of the airport. Approximately 6.7 million cy of material will be excavated from three sites and transported across airport property to the embankment.
Runway Safety Areas	
Runway 34R Safety Fill	Extend runway safety fill to meet FAA standards.
RSAs 16R/16L	Extend safety fills by 1,000 ft to meet FAA standards.
Relocation of Displaced Threshold on Runway 16L	Airfield taxiway improvements. The runway threshold (i.e., the emergency landing pad at end of runway pavement) to be relocated onto new RSA.

Table 1.3-1. **Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

Project	Description
Miller Creek Sewer Relocation	Relocate sewer around third runway embankment and runway safety fills. New sewer will run along new alignment of South 154th Street.
FAA Navigation Aids (NAVAIDS)	
New Airport Traffic Control Tower	New air traffic control tower will be located in existing developed area near terminal.
Relocate Airport Surveillance Radar (ASR), Airport Surface Detection Equipment (ASDE), NAVAIDS	Existing radar and navigation equipment will be relocated to allow construction of third runway.
Airfield Building Improvements	
New Snow Equipment Storage	New building to house snow removal equipment.
Weyerhaeuser Hangar Relocation	Relocate existing hangar on west side of airfield to allow construction of third runway. New hangar will be located near south end of third runway.
Terminal/Air Cargo Area Improvements	
Relocation of Airborne Cargo	Relocate existing cargo building from air traffic control tower site to north cargo area. Located in existing developed area near terminal.
Central Terminal Expansion	Passenger terminal remodel. Located in existing developed area at terminal.
South Terminal Expansion Project (STEP)	Passenger terminal remodel. Located in existing developed area to the south of the main passenger terminal.
Northwest Hangar Relocation	Relocate Northwest Airlines hangar to site now occupied by Delta hangar. Located in existing developed area.
Satellite Transit Shuttle (STS) System Rehabilitation	Remodel and upgrade underground transit system linking terminal to satellites.
Redevelopment of North Air Cargo	New or expanded air cargo facilities along Air Cargo Road at north end of airport.
Expansion of North Unit Terminal (North Pier)	Addition to new passenger terminal located north of existing terminal. Located in existing developed area (Doug Fox parking lot and airport access freeway).
New Airport Rescue and Fire Fighting Facility (ARFF)	Replaces facility displaced by new North Terminal. The new facility will be located to the north of the North Terminal.
Cargo Warehouse at 24th Avenue South	New air cargo facility located north of SR 518 on 24th Avenue South.
Westin Hotel	New hotel located immediately north of main passenger terminal. Located in existing developed area at terminal.
Roads[a]	
Temporary SR 518 and SR 509 Interchanges	Temporary access ramps to serve construction of third runway embankment and runway safety fill; will be removed after project completion.
South 154th Street /South 156th Way Relocation	Relocate public roadway to allow construction of third runway embankment and runway safety fills. Existing road will be demolished.

Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).

Project	Description
South 154th Street /South 156th Way Bridge Replacement	Relocate existing South 156th Way bridge over Miller Creek to accommodate the third runway footprint and South 154th Street /South 156th Way relocation. In-water work associated with this project is limited to removal of the existing bridge and bank restoration.
Improvements to Main Terminal Roads	Transportation circulation, seismic, and other improvements to roadway systems serving terminal.
Improved Access and Circulation Roadway Improvements	Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities.
North Unit Terminal Roadways	Improvements to existing roadway system to serve the new North Terminal and garage.
Improvements to South Access Connector Roadway (South Link)	Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities. Will connect terminal and garage area to South Access roadway and SR 509 extension south of airport.
Parking	
Main Parking Garage Expansion	Expand parking facility at main passenger terminal on north and south sides (existing developed areas), and add floors to portions of existing garage.
North Employee Parking Lot (NEPL), Phase 1	New parking facility for employees, located north of SR 518.
North Unit Parking Structure	Construction of new garage serving new North Terminal facility. Facility will be located at existing Doug Fox parking lot.
The South Aviation Support Area	
SASA and Access Taxiways	New airport support facility for cargo and/or maintenance, located at the south end of the airport south of the Olympic Tank Farm and South 188th Street. Airplane access will be by new parallel taxiway constructed along Runway 34R.
Relocation of Existing Facilities to the SASA	Airport operation support facilities will be relocated to the SASA once SASA site development is completed. Many of these facilities must be relocated from their present locations due to main terminal expansion (i.e., STEP and North Terminal), including northwest hangar, ground support equipment, ground and corporate aviation facilities, new airport maintenance building, and United maintenance complex.
Stormwater Facilities[b]	
SASA Detention Pond	Create regional stormwater detention pond for the SASA project and other sites. Pond is 33.4 acre-ft and discharges to Des Moines Creek.
NEPL Vault	A 13.9 acre-ft vault to retrofit the NEPL; discharges to Miller Creek via Lake Reba.
Third Runway Vaults and Ponds	Stormwater detention vaults and ponds at the north, west, and south sides of the airport, discharging to Miller, Walker, and Des Moines Creeks.
STIA Retrofit Facilities	Detention vaults or ponds to provide flow control retrofitting for existing STIA discharges to Des Moines Creek. Vaults to be constructed in combination with third runway facilities when possible.
Cargo Vault	Detention vault for North Cargo Facility (4.5 acre-ft discharging to Miller Creek via Lake Reba).

Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).

Project	Description
Natural Resource Mitigation	
Miller Creek Relocation	Approximately 980 ft of Miller Creek immediately downstream of the Miller Creek detention facility will be relocated to accommodate third runway embankment and runway safety fill.
Miller Creek Buffer and Wetland Enhancement	Establish a 100-ft buffer (average) along approximately 6,500 linear ft of Miller Creek and riparian wetlands associated with Miller Creek within the acquisition area. Enhance approximately 10.25 acres of existing wetlands along the stream and protect with 40.86 acres of enhanced wetland buffer.
Miller Creek Floodplain and Wetland Restoration	Excavate approximately 9,600 cy from the Vacca Farm site adjacent to Miller Creek to compensate for approximately 8,500 cy of floodplain fill for third runway embankment and north safety fill. Restore and enhance approximately 19 acres of stream habitat, floodplain wetlands, aquatic habitat in Lora Lake, and buffers at Vacca Farm.
Miller Creek Instream Habitat Enhancement	Project 1: South of the Vacca Farm site, approximately 440 ft of channel. Remove rock riprap, footbridges, and trash. Place large woody debris (LWD) throughout this section of the stream. Plant riparian areas along the stream with native wetland and upland plant species. Project 2: Approximately 150 ft upstream of South 160th Street, approximately 235 ft of channel. Install LWD in the stream channel, grade a small section of the west bank of the stream to create a gravel bench in the floodplain, remove two rock weirs to improve fish passage, and plant the upland area with native trees and shrubs. Project 3: Immediately downstream of South 160th Street, approximately 380 ft of channel. Grade a section of the east bank, remove a rubber-tire bulkhead, and install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs. Project 4: Miller Creek immediately upstream of 8th Avenue South, approximately 420 ft of channel. Grade portions of both banks. Remove footbridges and portions of concrete block walls. Install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs. In addition to these specific enhancements, debris such as tires, garbage, and fences will be removed throughout the entire stretch of Miller Creek from the Vacca Farm site south to Des Moines Memorial Drive. In areas where access is readily available, LWD will be selectively placed throughout the stream to improve instream habitat conditions.
Des Moines Way Nursery	Restore 2.2 acres of wetland by removing fill and commercial development from wetlands. Enhance about 0.8 acres of wetland lawn to shrub dominated wetland. Enhance 450 linear feet of Miller Creek. Protect site with about 2.7 acres of restored buffers.
Drainage Channels Relocation	Relocate a minimum of 1,290 linear ft of drainage channels to accommodate the third runway embankment. Plant buffers along the drainage channels with native grass and shrubs.
Restoration of Temporarily Impacted Wetlands	Approximately 2.05 acres of wetland located west of the third runway embankment, north of relocated South 154th Street, and west of the Miller Creek relocation project, will be temporarily filled or disturbed during embankment construction. When construction activities are completed, remove fill material, restore pre-disturbance topography, and plant wetlands with native shrub vegetation.

Table 1.3-1. **Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

Project	Description
Tyee Valley Golf Course Wetlands Enhancement and Des Moines Creek Buffer Enhancement	Restore approximately 4.5 acres of emergent wetland area and approximately 1.6 acres of buffer located within Tyee Valley Golf Course to a native shrub vegetation community. The enhancement actions will be integrated into plans to construct a regional detention facility (RDF) on the golf course (King County Capital Improvement Project Design Team 1999). The enhancement will convert the existing turf wetland to native shrub wetland community. Enhance approximately 3.4 acres (average 100 ft wide) of buffer and 1.0 acre of existing wetland along Des Moines Creek.
Wetland Habitat (including Avian Habitat) near the Green River in Auburn	Restore wetland functions to a 65-acre parcel near the Green River in the City of Auburn. Create and/or restore approximately 17.2 acres of forest, 6.0 acres of shrub, 6.2 acres of emergent, and 0.60 acre of open-water wetland. Enhance protective buffers totaling about 15.90 acres.

[a] Temporary roads used to haul fill material from three on-site borrow areas to construction sites are included in the analysis of the borrow areas and not listed here.

[b] Des Moines Creek Basin Plan Committee will construct an RDF on the Tyee Golf Course to provide regional flow control. This project will eliminate the need for STIA retrofit facilities described above. As this is a cumulative action subject to future federal action, it is not a Master Plan Update improvement.

1.3.1 Runways and Taxiways

To overcome aircraft arrival congestion during poor weather conditions, the Port proposes to build a new 8,500-ft runway on approximately 16.5 million cy of fill on the west side of the existing STIA airfield (Figure 1.3-1). The existing airfield plateau will be extended west over 12th Avenue South. The current location of 12th Avenue South will be the approximate centerline of the new runway. To construct the third runway and extend the airfield plateau, a large embankment with four mechanically stabilized earth (MSE) retaining walls will be constructed. The MSE retaining walls are located at the northern, central, and southern portions of the embankment (see Figure 1.3-1), and have been designed to avoid and minimize direct impacts from the embankment to Miller Creek and associated wetlands. Security and emergency access roads will be constructed around the runway perimeter. New and relocated interconnecting taxiways will also be constructed.

To accommodate the third runway embankment, stormwater management facilities, and a neighborhood noise abatement area, the Port has purchased land west of the existing runway. Most of this land consists of private residences. In this report, this area is referred to as the "acquisition area." The acquisition area is generally bounded by SR 518 to the north, South 176th Street to the south, Des Moines Memorial Drive to the west, and 12th Avenue South to the east (see Figure 1.3-1). Several parcels in and adjacent to the acquisition area are voluntary acquisitions and may or may not be acquired by the Port. However, no additional action, other than demolitions, will be taken in the voluntary acquisition areas. At the north end of the third runway, South 154th Street will be relocated to accommodate the new runway (see below).

1.3.2 Runway Safety Area Extensions / South 154th Street Relocation

RSA extensions are necessary for the existing runways and the new third runway to ensure that they meet current FAA standards. The RSA extensions are to be created at the north end of the existing airport runways south of SR 518, and at the southern end of the new third runway. The RSA

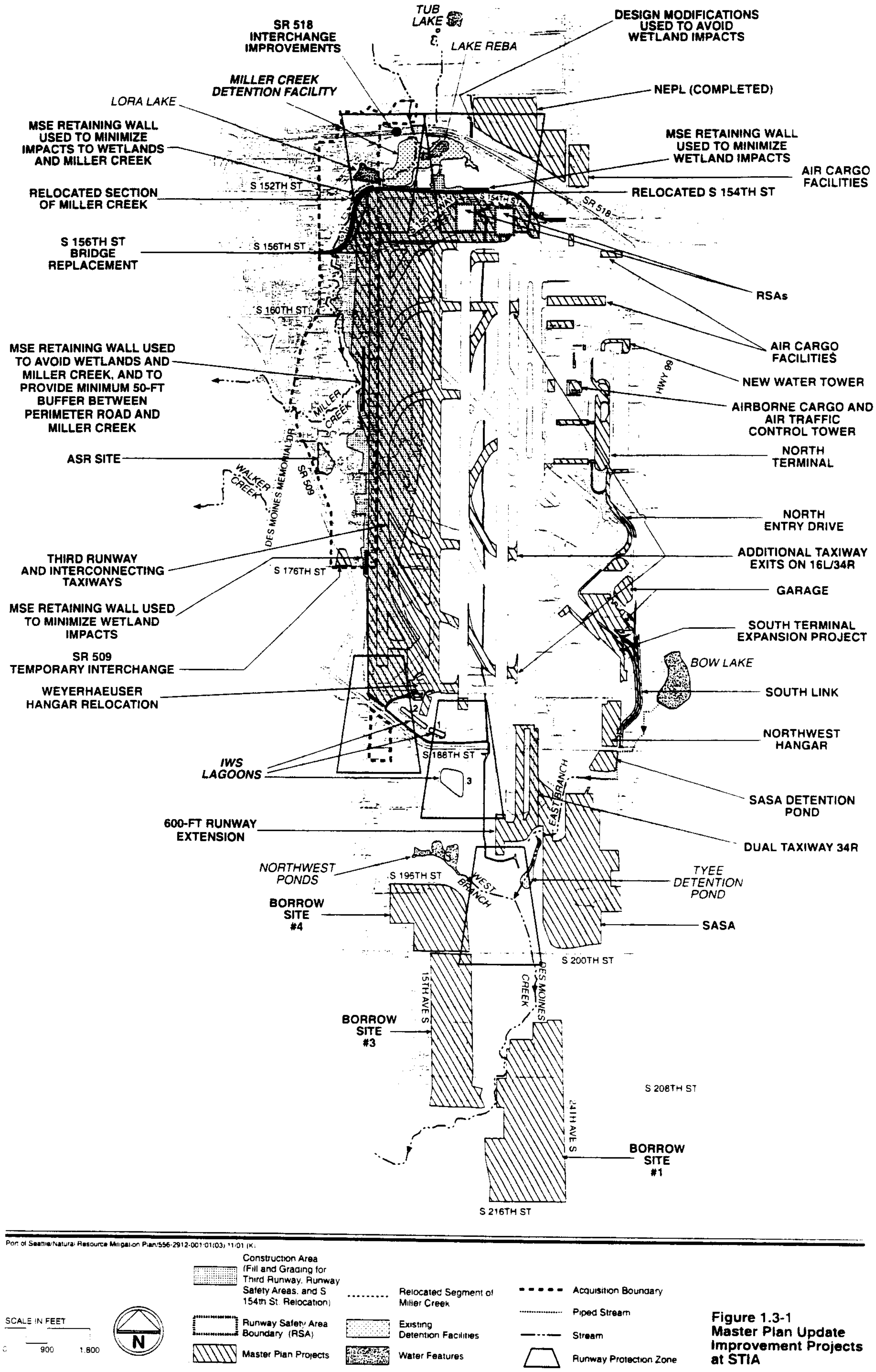

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Figure 1.3-1
Master Plan Update
Improvement Projects
at STIA

extensions at the north end of the two existing runways, as well as the new third runway construction, will require relocating South 154th Street (Figure 1.3-2). The relocated road section will be located approximately 55 to 650 ft north of the current alignment. The new alignment will be north and west of the third runway embankment, connecting with South 156th Way at Des Moines Memorial Drive. In addition, a portion of an existing sewer line will be relocated to parallel the new road alignment.

South 156th Way currently crosses over Miller Creek on an existing timber bridge. The existing bridge will be replaced with a new bridge that spans the stream and floodplain of Miller Creek as part of the South 154th Street relocation (see Figure 1.3-2).

A MSE retaining wall will be constructed along the north side of the relocated road to minimize filling of the forested wetlands located north of the roadway (see Figure 1.3-2). The MSE wall at this location will extend up to approximately 50 ft in height.

1.3.3 The South Aviation Support Area

The SASA (see Figure 1.3-1) will provide space for aircraft maintenance/support and air cargo facilities. The FEIS for the Master Plan Update improvements identified several existing uses that would be moved to the SASA, primarily due to the expansion of the Main Terminal. These uses include Northwest Airlines' aircraft maintenance and hangar, the U.S. Post Office airmail facility, and possibly Airborne cargo. The SASA will also allow air cargo and aircraft maintenance facilities of airlines and other tenants to be expanded. The SASA facility will accommodate:

- Relocated line maintenance and cargo facilities that must be moved prior to expansion of passenger terminal facilities
- Line maintenance requirements
- Aircraft maintenance facilities in response to existing and/or future market demands
- Expansion of cargo handling and maintenance capabilities
- Other aircraft support facilities

1.3.4 On-Site Borrow Source Areas

On-site borrow areas are proposed to be excavated as a source of fill to be used to construct portions of the runway embankment. Three on-site borrow areas are located on airport property between 24th Avenue South and 15th Avenue South, and between South 196th and South 216th Streets (see Figure 1.3-1). These borrow areas are planned to supply approximately 6.7 million cy of fill material. Current engineering estimates suggest that Borrow Site 1 will supply up to 4.2 million cy, and Borrow Sites 3 and 4 will supply 2.5 million cy.

An additional 2.4 million cy is available from on-site sources within the third runway footprint. This fill material will be obtained through excavation at the south end of the third runway, where materials are stockpiled and where the existing ground elevation is above the final grade for the runway. The fill material from these sources has been tested for structural integrity and found to be suitable for use in the RSAs and portions of the infield.

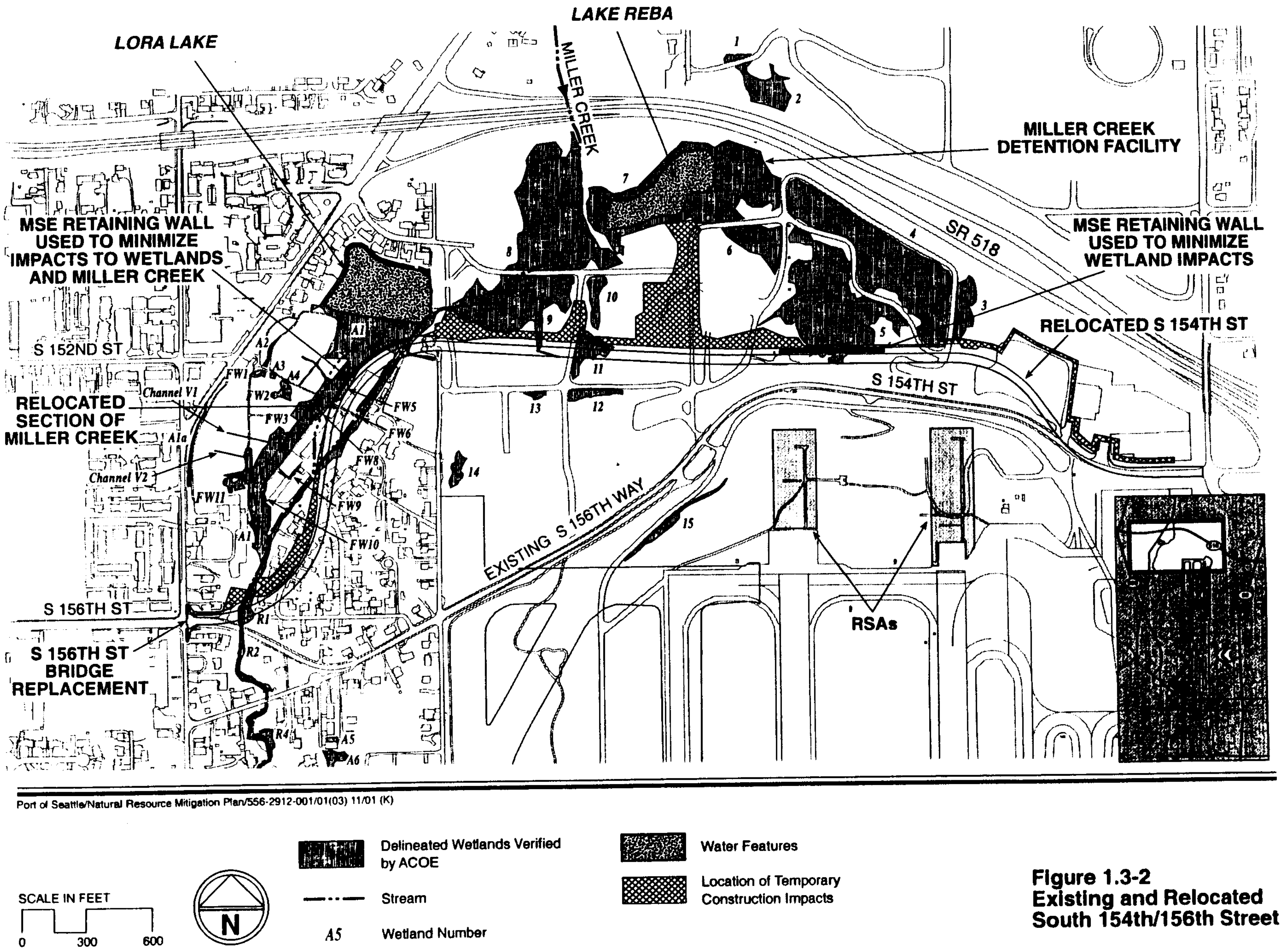

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Figure 1.3-2
Existing and Relocated
South 154th/156th Street

1.3.5 Other Support Facilities

Stormwater, electrical, water, sewer, and other utilities must be provided to new or reconstructed airport facilities. Utilities that will result in unavoidable wetland impacts include the placement of stormwater detention facilities for the runway embankment, relocation of a sewer line, and the SASA detention pond. These wetland impacts are discussed in more detail in Section 3 of this report, and in the *Wetland Functional Assessment and Impact Analysis Master Plan Update Improvements Seattle-Tacoma International Airport* (Parametrix 2001b).

1.4 RESPONSIBLE PARTIES

The Port is the applicant and owner of this project. The name and phone number of the Port representative in charge of environmental permitting and compliance for the project is: Ms. Elizabeth Leavitt, Manager-Aviation Environmental Programs; Port of Seattle; P.O. Box 68727; Seattle, WA 98168-0727; (206) 433-7203.

1.5 DOCUMENT ORGANIZATION

The organization of this document is based on the *Guidelines for Developing Freshwater Wetlands Mitigation Plans and Proposals* (Ecology 1994a). Following the introduction to the project and mitigation actions in Section 1, Section 2 describes existing ecological conditions, and in particular, existing conditions of wetlands and streams within the project area. Section 3 summarizes the direct and indirect impacts of the project to wetlands and other Waters of the U.S. (described in detail in Parametrix 2001b).

Section 4 summarizes the overall mitigation plan and the mitigation monitoring plan. The mitigation sequencing approach and specific mitigation projects are summarized. The overall monitoring approach, methods, and schedules required to assure the ecological benefits of the mitigation are summarized. The adaptive management approach that will be used to implement maintenance and contingency measures at the mitigation sites is also described. Section 4 also describes the integrated weed management strategy that will be used to control invasive non-native species. Finally, Section 4 summarizes the relationship between the *Wildlife Hazard Management Plan* (WHMP) for controlling wildlife hazards near the airport, and each mitigation project.

Section 5 provides detailed mitigation plans, performance standards, monitoring approach, and implementation schedules for the on-site mitigation in the Miller and Des Moines Creek basins. Section 5 also describes mitigation to replace functions of drainage channels, mitigation for temporary construction impacts, and monitoring of wetlands adjacent to the construction projects. On-site mitigation at the Des Moines Way Nursery site is described in Appendix N. Appendices A through F provide detailed engineering drawings of each mitigation project. Other appendices (Appendices G through Q) provide various detailed supporting information requested by agency staff.

The *Comprehensive Stormwater Management Plan* that is proposed to avoid, minimize, and mitigate impacts to water quantity and/or quality in Miller and Des Moines Creeks is summarized in Section 6. Section 7 describes the mitigation plans, performance standards, monitoring approach, and schedules for the off-site wetland mitigation in Auburn.

Natural Resource
Assessment

2. EXISTING CONDITIONS IN THE PROJECT AREA

This section describes the wetlands, streams, floodplains, and drainage channels in areas that will be temporarily or permanently impacted as a result of Master Plan Update improvements. The wetlands within the project area are described in detail in the *Wetland Delineation Report Master Plan Update Improvements Seattle-Tacoma International Airport* (Parametrix 2000b) and the *Wetland Functional Assessment and Impact Analysis* (Parametrix 2001b). Additional detailed information on species listed under the Endangered Species Act (ESA) is provided in the *Biological Assessment Master Plan Update Improvements Seattle-Tacoma International Airport* (Parametrix 2000c). Additional detailed information on existing ecological conditions relevant to the mitigation design at each site is included with the descriptions of each mitigation project in Sections 5 and 7.

2.1 WETLANDS

Wetland delineations have been completed throughout the project area (FAA 1996; Parametrix 2000b). ACOE has verified the wetland delineations on all properties within the acquisition area, with the exception of parcels containing Wetland A20 (ACOE 2000).

2.1.1 Wetland Delineation Methodology

Parametrix staff completed field investigations to identify and delineate wetlands in the acquisition area between March 1998 and November 2000. During these site visits, they inspected the project area (Figure 2.1-1) for wetland characteristics and related drainage features. Project staff identified and delineated wetlands in the project area using the Routine Determination Method outlined in the *Washington State Wetland Identification and Delineation Manual* (Ecology 1997) and the *U.S. Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987). The delineation methodology incorporated the following regulatory guidance letters and memoranda: ACOE Regulatory Guidance Letters 82-2, 86-9, and 90-7 (ACOE 1982, 1986, 1990); 3-92 Memorandum (ACOE 1992); 5-94 Public Notice (ACOE 1994); Ecology, 3/95 Public Notice (Ecology 1995).

To be considered a wetland, under normal circumstances, an area must have hydrophytic (wetland) vegetation, hydric soils, and wetland hydrology (Ecology 1997; Environmental Laboratory 1987). Areas that do not exhibit indicators for one or more of these three parameters are generally not regulated wetlands. However, in some cases when normal circumstances do not hold, all three parameters may not be present. Additional evaluations were completed to identify wetlands in disturbed and farmed areas (Parametrix 2000b).

ACOE made site visits to confirm wetland identifications and boundary delineations between July 1998 and November 2000. Modifications to delineated wetland boundaries that were requested by ACOE during those site visits have been made and are reflected in the mapping and analysis presented in this report. A summary of all the wetlands identified in the study area is presented in Table 2.1-1.

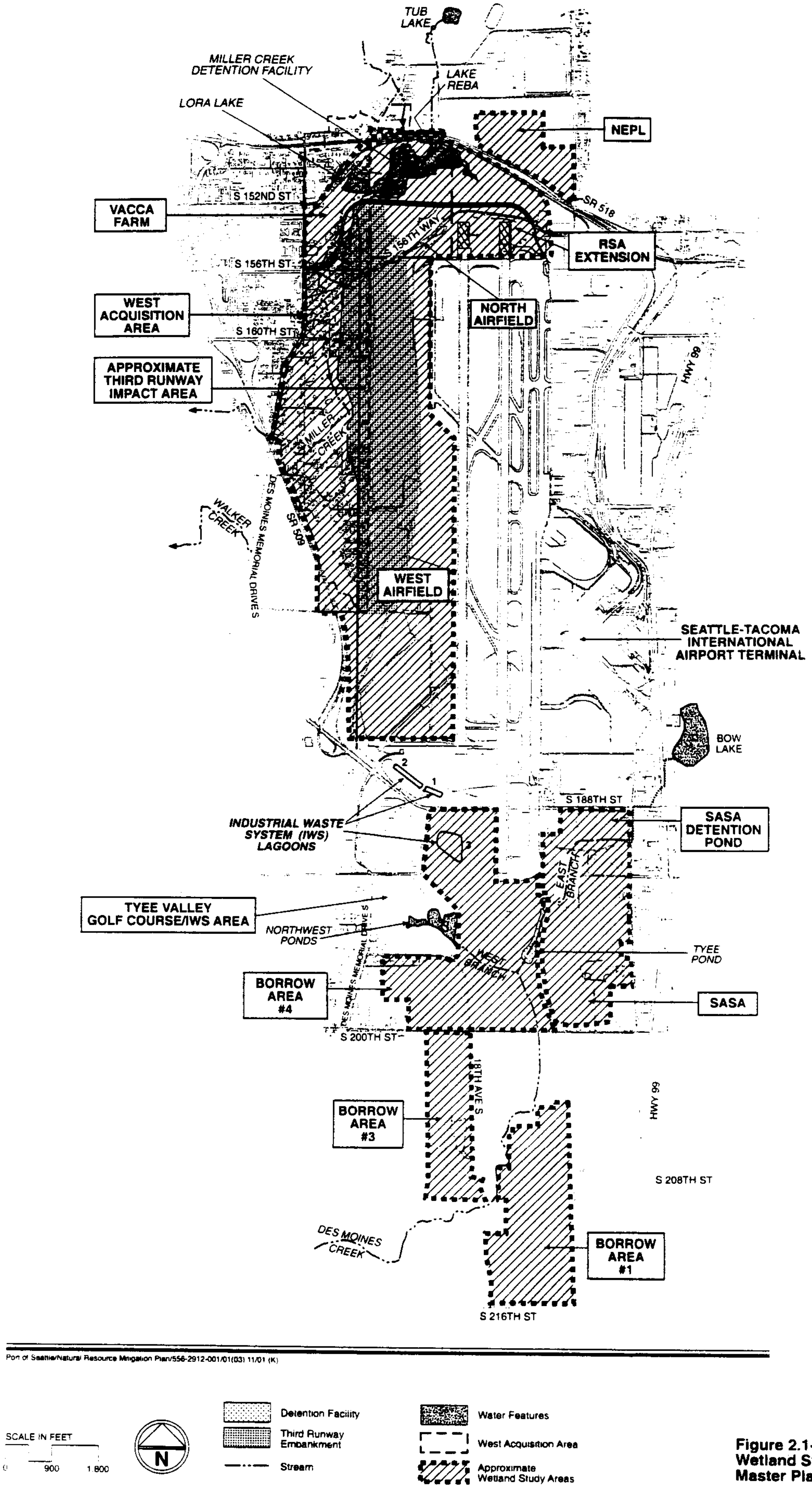

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Figure 2.1-1
Wetland Study Area for the Master Plan Update at STIA

Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area.

Wetland [a]	Classification [b]	Area (Acres)	Drainage Basin
North Employee Parking Lot /Des Moines Way Nursery Areas			
1	Forest	0.07	Miller
2	Forest	0.73	Miller
N8, N9, N10	Emergent, Forest (90/10)	0.86	Miller
	Subtotal	**1.66**	
Runway Safety Area Extension			
3	Forest	0.56	Miller
4	Forest	5.00	Miller
5	Forest/Scrub-Shrub (70/30)	4.63	Miller
6	Scrub-Shrub	0.86	Miller
	Subtotal	**11.05**	
Third Runway Project Area			
North Airfield			
7[c]	Forest/Open Water/Emergent (30/50/20)	6.68	Miller
8	Scrub-Shrub/Emergent (80/20)	4.95	Miller
9	Forest/ Emergent (40/60)	2.83	Miller
10	Scrub-Shrub	0.31	Miller
11	Forest/Emergent (80/20)	0.50	Miller
12	Forest/Emergent (20/80)	0.21	Miller
13	Emergent	0.05	Miller
14	Forest	0.19	Miller
West Airfield			
15	Emergent	0.28	Miller
16	Emergent	0.05	Miller
17	Emergent	0.02	Miller
18	Forest/Scrub-Shrub/Emergent (50/20/30)	3.56	Miller
19	Forest	0.56	Miller
20	Scrub-Shrub/Emergent (90/10)	0.57	Miller
21	Forest	0.22	Miller
22	Scrub-Shrub/Emergent (90/10)	0.06	Miller
23	Emergent	0.77	Miller
24	Emergent	0.14	Miller
25	Forest	0.06	Miller
26	Emergent	0.02	Miller
W1	Emergent	0.10	Miller
W2	Forest/Emergent (20/80)	0.22	Miller
	Other Waters of the U.S.	0.02	Miller
Vacca Farm Site			
FW1	Farmed Wetland	0.03	Miller

Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).

Wetland [a]	Classification [b]	Area (Acres)	Drainage Basin
FW2	Farmed Wetland	0.09	Miller
FW3	Farmed Wetland	0.59	Miller
FW5	Farmed Wetland	0.08	Miller
FW6	Farmed Wetland	0.07	Miller
FW8	Farmed Wetland	0.03	Miller
FW9	Farmed Wetland	0.01	Miller
FW10	Farmed Wetland	0.02	Miller
FW11	Farmed Wetland	0.11	Miller
A1a	Shrub	0.07	Miller
	Other Waters of the U.S.	0.02	Miller
West Acquisition Area			
35a-d	Forest/Emergent (40/60)	0.67	Miller
37a-f	Forest/Emergent (70/30)	5.73	Miller
39	Forest/Scrub-Shrub/Emergent (25/50/25)	0.90	Miller
40	Scrub-Shrub	0.03	Miller
41a and b	Emergent/Open Water (60/40)	0.44	Miller
44a and b	Forest/Scrub-Shrub (70/30)	3.08	Miller
A1	Forest/Scrub-Shrub/Emergent (15/15/70)	4.59	Miller
A2	Scrub-Shrub	0.05	Miller
A3	Scrub-Shrub	0.01	Miller
A4	Scrub-Shrub	0.03	Miller
A5	Emergent	0.03	Miller
A6	Forest	0.16	Miller
A7	Forest	0.30	Miller
A8	Forest/Scrub-Shrub (30/70)	0.38	Miller
A9	Scrub-Shrub	0.04	Miller
A10	Scrub-Shrub	0.01	Miller
A11	Scrub-Shrub	0.02	Miller
A12	Scrub-Shrub	0.11	Miller
A13	Forest	0.12	Miller
A14a and b	Forest/Scrub-Shrub/Emergent (50/25/25)	0.19	Miller
A15	Emergent	0.04	Miller
A16	Scrub-Shrub/Emergent (20/80)	0.09	Miller
A17	Forest/Scrub-Shrub/Emergent (10/20/70)	2.66	Miller
A18	Scrub-Shrub	0.01	Miller
A19	Emergent	0.04	Miller
Lora Lake	Open Water	3.06	Miller
	Other Waters of the U.S.	0.33	Miller
Riparian Wetlands			
R1	Emergent	0.17	Miller
R2	Scrub-Shrub/Emergent (70/30)	0.12	Miller
R3	Scrub-Shrub	0.02	Miller

Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).

Wetland [a]	Classification [b]	Area (Acres)	Drainage Basin
R4	Emergent	0.11	Miller
R4b	Forest/Emergent (25/75)	0.11	Miller
R5	Emergent	0.05	Miller
R5b	Forest/Emergent (25/75)	0.07	Miller
R6	Forest/Emergent (25/75)	0.21	Miller
R6b	Emergent	0.09	Miller
R7	Forest/Emergent (25/75)	0.04	Miller
R7a	Emergent	0.04	Miller
R8	Scrub-Shrub/Emergent (40/60)	0.40	Miller
R9	Forest	0.38	Miller
R9a	Forest/Scrub-Shrub/Emergent (25/50/25)	0.74	Miller
R10	Scrub-Shrub	0.04	Miller
R11	Emergent	0.42	Miller
R12	Forest	0.03	Miller
R13	Emergent	0.12	Miller
R14a	Scrub-Shrub/Emergent (25/75)	0.13	Miller
R14b	Emergent	0.08	Miller
R15a	Forest/Scrub-Shrub/Emergent (25/65/10)	0.79	Miller
R15b	Forest/Emergent (25/75)	0.25	Miller
R17	Forest	0.31	Miller
	Subtotal	**51.33**	
Borrow Area 1			
32	Emergent	0.09	Des Moines
48	Forest/Emergent (20/80)	1.58	Des Moines
B1	Forest/Scrub-Shrub (30/70)	0.27	Des Moines
B4	Scrub-Shrub	0.07	Des Moines
B11	Emergent	0.18	Des Moines
B12[d]	Scrub-Shrub	0.63	Des Moines
B14	Scrub-Shrub/Emergent (70/30)	0.78	Des Moines
B15 a and b [d]	Scrub-Shrub	2.05	Des Moines
	Other Waters of U.S.	0.01	Des Moines
	Subtotal	**5.66**	
Borrow Area 3			
29	Forest	0.74	Des Moines
30	Forest/Scrub-Shrub (80/20)	0.88	Des Moines
B5	Forest/Scrub-Shrub (40/60)	0.08	Des Moines
B6	Forest/Scrub-Shrub (30/70)	0.55	Des Moines
B7	Forest/Scrub-Shrub (30/70)	0.03	Des Moines
B9	Forest	0.05	Des Moines
B10	Forest	0.02	Des Moines
	Subtotal	**2.35**	

Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).

Wetland[a]	Classification[b]	Area (Acres)	Drainage Basin
South Aviation Support Area (SASA)/Tyee Valley Golf Course			
28[d]	Scrub-Shrub/Emergent/Open Water (50/30/20)	35.45	Des Moines
52	Forest/Scrub-Shrub/Emergent (80/10/10)	4.70	Des Moines
53	Forest	0.60	Des Moines
G1	Emergent	0.05	Des Moines
G2	Emergent	0.02	Des Moines
G3	Emergent	0.06	Des Moines
G4	Emergent	0.04	Des Moines
G5	Emergent	0.87	Des Moines
G6	Emergent	0.01	Des Moines
G7	Forest/Scrub-Shrub (30/70)	0.50	Des Moines
G8	Emergent	0.04	Des Moines
WH	Open Water	0.25	Des Moines
DMC	Forest/Scrub-Shrub/Emergent (15-15-70)	1.08	Des Moines
	Subtotal	**43.67**	
Industrial Waste System (IWS) Area			
IWS a and b	Forest	0.67	Des Moines
	Subtotal	**0.67**	
South Aviation Support Area Detention Pond			
E1	Forest	0.23	Des Moines
E2	Forest	0.04	Des Moines
E3	Forest	0.06	Des Moines
	Subtotal	**0.33**	Des Moines
TOTAL		**116.72**	

[a] Wetlands are labeled according to the following protocol:

- Wetlands without a letter designation (e.g., Wetland 35) were described by Shapiro and Associates, Inc. (FAA 1995).
- Wetlands with an 'A' designation (e.g., Wetland A5) are wetlands occurring within the west acquisition area.
- Wetlands with an 'N' designation (e.g., Wetland N8) occur north of SR 518.
- Wetlands with an 'R' designation (e.g., Wetland R) are riparian wetlands occurring within the west acquisition area.
- Wetlands with a 'W' designation (e.g., Wetland W1) are wetlands occurring within the west airfield area.
- Wetlands with a 'G' designation (e.g., Wetland G5) are wetlands occurring within the Tyee Valley Golf Course or the SASA areas.
- Wetlands with an 'E' designation (e.g., Wetland E1) are wetlands occurring within the SASA detention pond area.
- Wetlands with an 'IWS' designation (e.g., IWSa) are wetlands occurring near the IWS lagoon.
- Wetlands with a 'B' designation (e.g., Wetland B5) are wetlands occurring within the borrow sites.
- Wetland numbers followed by a small case letter designate subsections of a larger wetland (i.e., Wetland 35a) where constructed features (i.e., driveways) fragment a larger wetland.

[b] Numbers indicate approximate percentage of cover by respective wetland classes (Cowardin et al. 1979).

[c] This area includes Lake Reba.

[d] Portions of the wetland area are estimated.

2.1.2 Wetland Descriptions

About 120 wetlands totaling about 117 acres were identified[5] within the study area in the Miller and Des Moines Creek basins (see Table 2.1-1; Figures 2.1-2, 2.1-3, and 2.1-4). These wetlands range in size from 0.01 to about 35 acres (see Table 2.1-1), and include slope, depressional, and riparian wetlands (Brinson 1993). Palustrine forested, scrub-shrub, emergent, and open-water wetland classes are present within the project area (see Table 2.1-1). A detailed description of all wetlands found within the study area is provided in the *Wetlands Delineation Report* (Parametrix 2000b). Many of the wetlands in the project area are small, degraded by past and ongoing human disturbance, and isolated from other wetlands by areas of unsuitable habitat (e.g., roadways, buildings). Ecological functions of wetlands within the study area are described in the *Wetland Functional Assessment and Impact Analysis Report* (Parametrix 2001b). Mitigation for impacts to the ecological functions that the wetlands provide is described in Section 5 of this document.

2.2 STREAMS

Several stream systems (Walker, Miller, Des Moines, and Gilliam Creeks) occur in the project area. These have been evaluated as part of the environmental review for the Master Plan Update improvements (FAA 1996, 1997a; KCSWM 1987; Hillman et al. 1999; Parametrix 2000c). The following sections describe these stream systems. Additional detailed information on existing ecological conditions in the streams is provided in the *Biological Assessment* (Parametrix 2000c), as well as in the detailed mitigation plan descriptions in Section 5.

2.2.1 Miller Creek Basin

Miller and Walker Creeks, the two streams located in the Miller Creek basin, are near or within the project area. Miller Creek originates at Arbor Lake (near the corner of 5th Avenue, south of South 124th Street) and flows approximately 5.3 miles to Puget Sound. Walker Creek originates in Wetland 43 west of SR 509 (U.S. Geologic Survey [USGS] Des Moines Quadrangle 1995) and flows into Miller Creek approximately 500 ft upstream of its mouth at Puget Sound (Figure 2.2-1). While a portion of the Walker Creek drainage basin is located within the study area, the stream itself is located approximately 1,000 ft downslope of, and west of, the project area.

2.2.1.1 Miller Creek

Miller Creek is located in southwest King County and has a basin size of approximately 8 square miles. The Miller Creek basin lies within the Cities of SeaTac and Burien. Flows in Miller Creek originate at three locations: (1) the Arbor, Burien, Tub, and Lora Lakes complex; (2) Lake Reba; and (3) seeps located on the west side of STIA. Miller Creek generally flows south and southwest toward Puget Sound. On the west side of the airport, a number of drainage channels convey water from the plateau and hillslopes to the stream. These channels (King County 1990) have been ditched, and function primarily as surface or groundwater conveyance channels.

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[5] Other wetlands and aquatic habitats outside the study area are known to occur in the Miller, Walker, and Des Moines Creek basins.

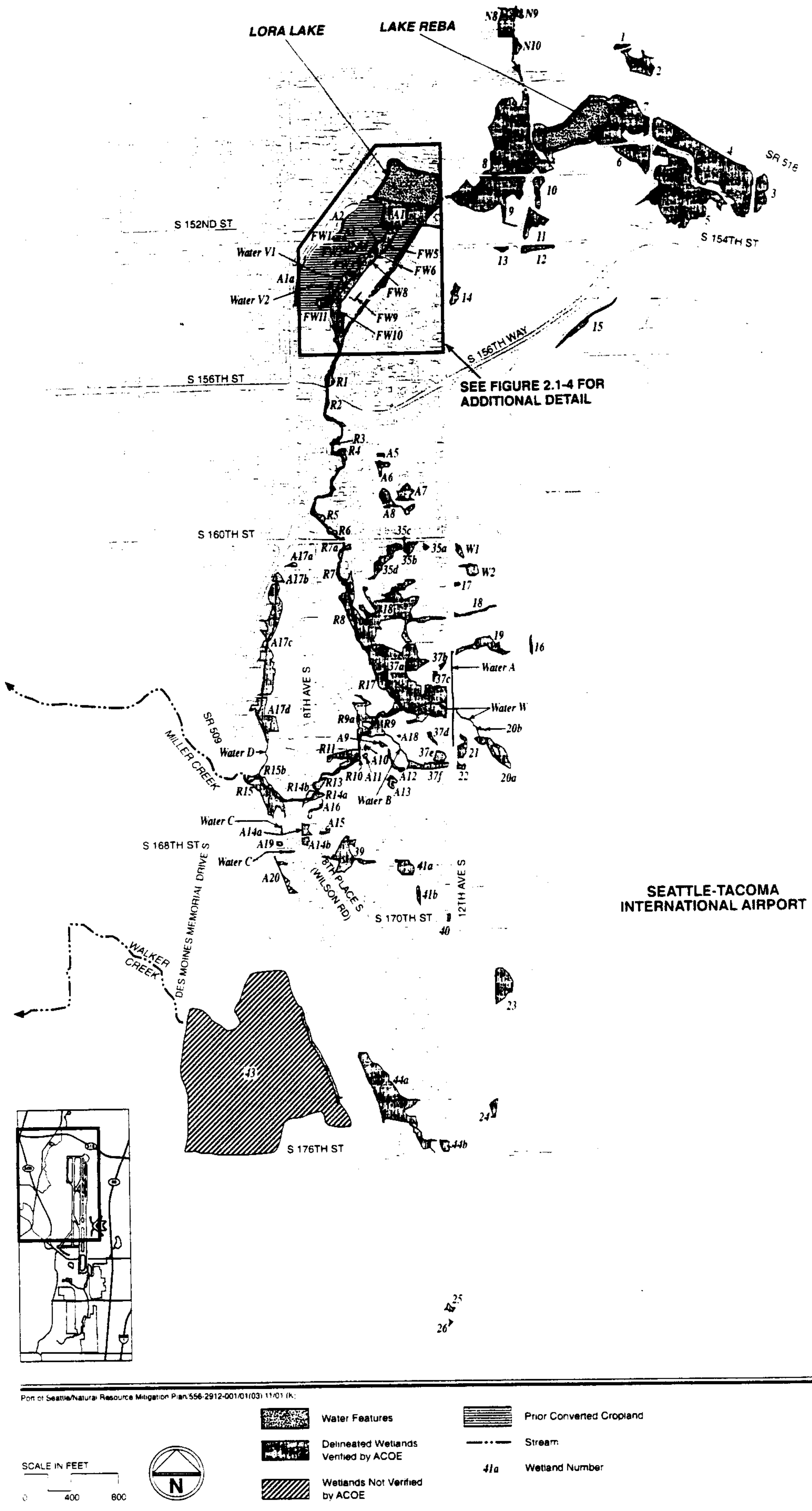

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Figure 2.1-2
Wetlands in the Miller Creek Basin Near STIA

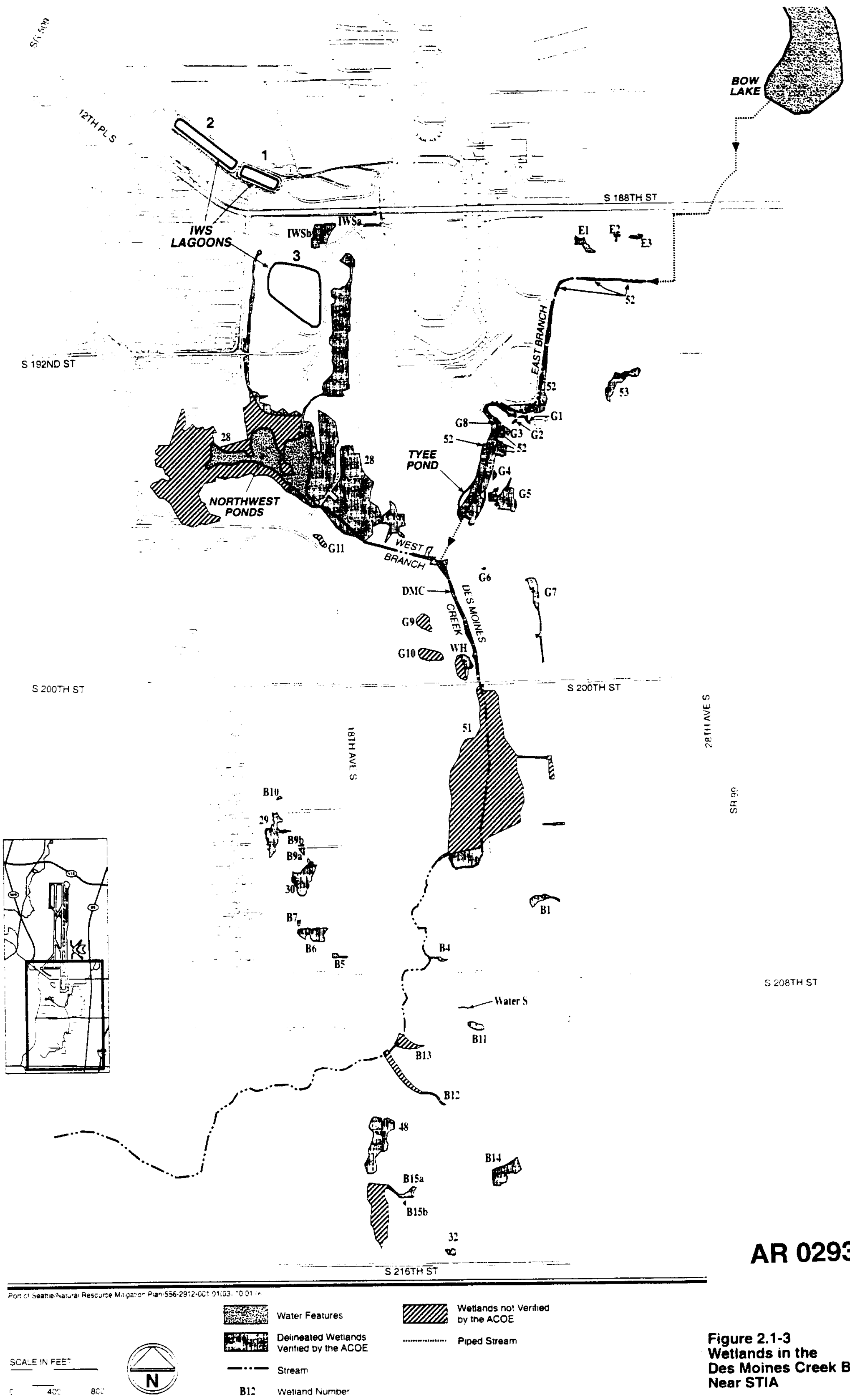
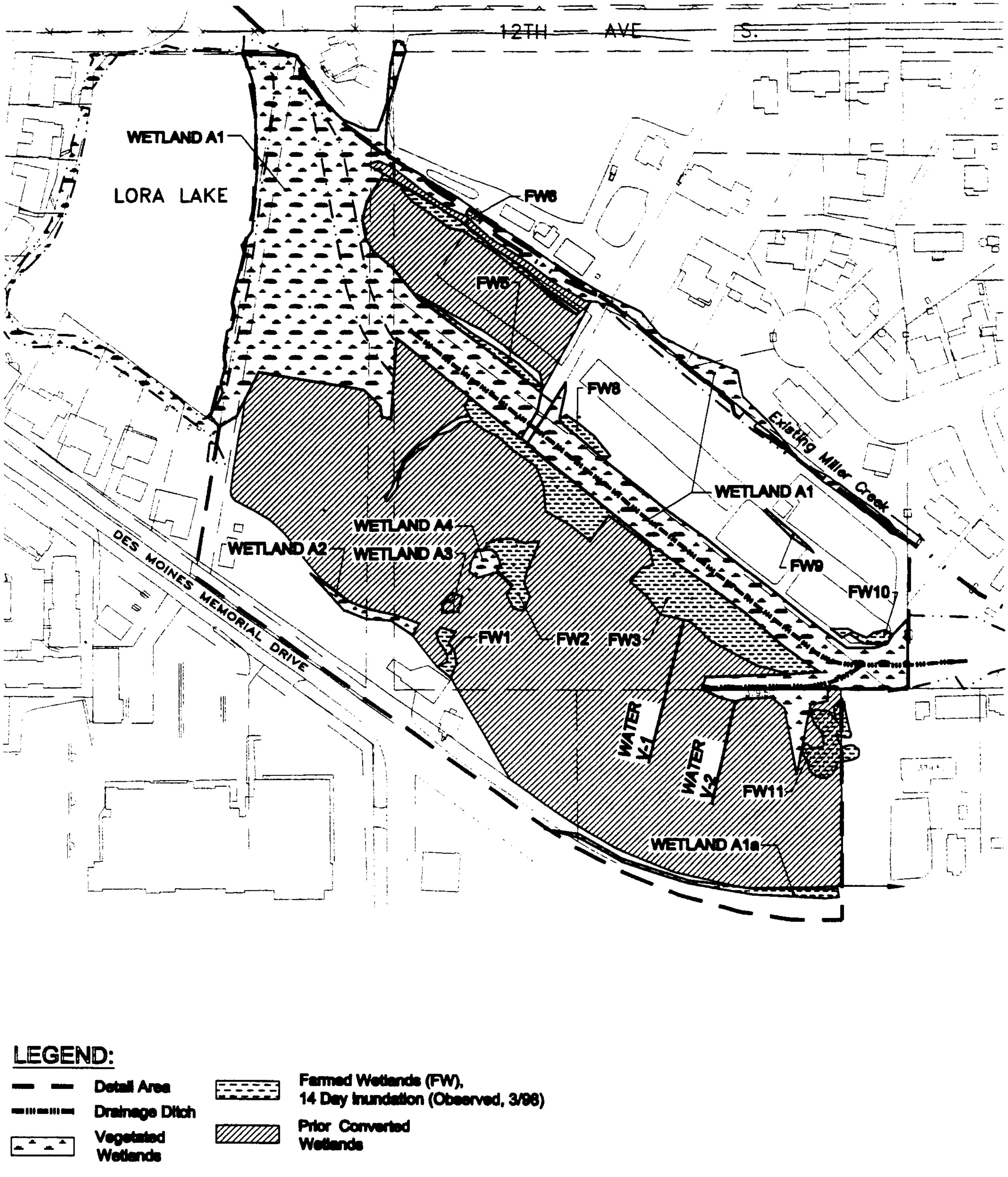


Figure 2.1-3
Wetlands in the Des Moines Creek Basin Near STIA



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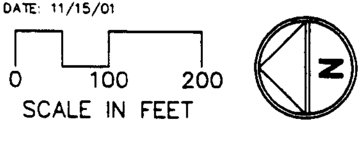
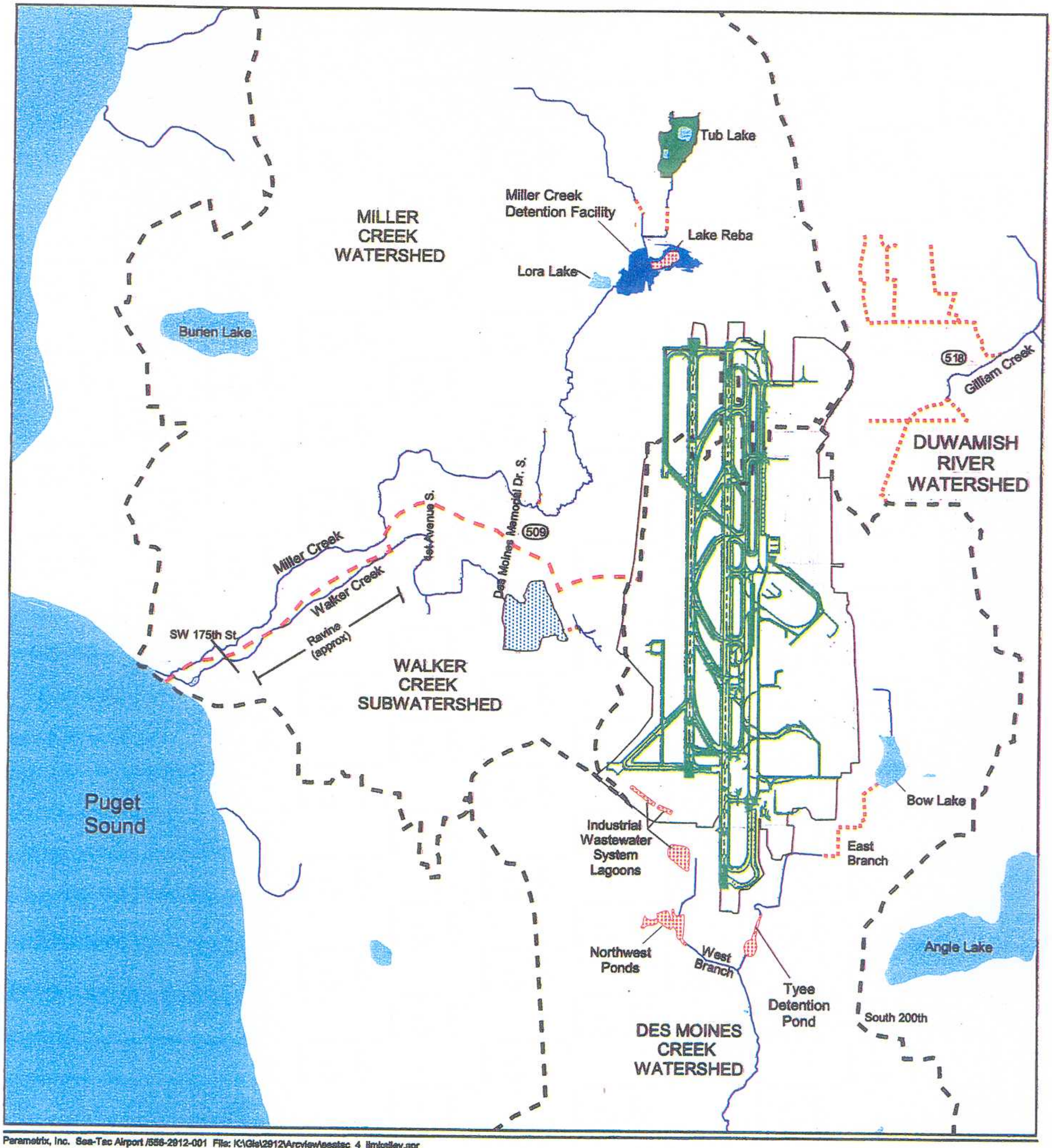


Figure 2.1-4
Jurisdictional Wetlands
on the Vacca Farm Site



Parametrix, Inc. Sea-Tac Airport /556-2912-001 File: K:\Gis\2912\Arcview\seatac_4_jimkelley.apr
Source: Roads based on King County data. Water bodies derived from USGS hypsography data.
Detention boundaries are approximate. Estimated wetland boundaries are based on field reconnaissance by Parametrix, Inc.

Figure 2.2-1 Location of Miller Creek, Walker Creek, and Des Moines Creek Near STIA

Most of the 5,140-acre Miller Creek watershed is developed with residential and commercial properties. Approximately 62 percent of the land use in the basin is residential, 15 percent is commercial, 3 percent is STIA[6] (excluding the IWS drainage area, which treats stormwater runoff prior to being discharged to Puget Sound), and the remaining 20 percent is undeveloped (Montgomery Water Group 1995). Much of the undeveloped land in the watershed is owned by the Port. Commercial land uses are scattered along Des Moines Way, Ambaum Boulevard, and First Avenue South. Some agricultural uses are also found in the upper watershed. Although urbanization throughout the basin has altered the stream and riparian ecosystems, Miller Creek continues to support fish and wildlife species.

Stream Classification

WDFW has classified the lower reaches of Miller Creek as Class II salmon-bearing waters. Miller Creek is designated as an extraordinary (Class AA) quality water body by the Water Quality Standards for Surface Waters of the State of Washington (Washington Administration Code [WAC] 173-201). However, Miller Creek has failed to meet some of the state water quality standards (WQSs) (FAA 1996). Occasional violations of Class AA WQSs for pH, dissolved oxygen, and ammonia have also occurred in the basin (FAA 1996). Runoff from residential, commercial, and agricultural properties has contributed to water quality degradation. Pollutants such as nutrients, organics, metals, fecal coliform bacteria, and suspended solids that are commonly associated with urban runoff have been found in Miller Creek and contribute to occasional violations of state and federal WQSs.

The floodplain in the stream reach between South 156th Way and South 160th Street is relatively confined to the channel ravine and is approximately 60 to 100 ft wide. In the stream reach south of South 160th Street, the floodplain is approximately 80 to 150 ft wide in the upper reaches. However, farther downstream, it widens to approximately 200 to 250 ft.

Urbanization and agriculture have significantly altered the floodplains associated with Miller Creek. The wetland filling, riparian vegetation removal, culvert installation, and streambank armoring have reduced stream channel and floodplain capacities. Increased development and impervious surface areas in the basin result in increased stormwater runoff rates and volumes.

The 100-year floodplain in the vicinity of the Vacca Farm site is several acres in size (Figure 2.2-2). The wetland area and poor drainage that existed prior to agricultural drainage activities are evident from the 100-year floodplain estimated by the Federal Emergency Management Agency (FEMA). The approximate 100-year flood elevations, determined by FEMA as part of its study, vary from 266 ft at the Miller Creek detention facility outlet to approximately 265 ft at the downstream end of the Vacca Farm site (see Figure 1.2-2). A floodway has also been delineated and mapped in a portion of the floodplain.

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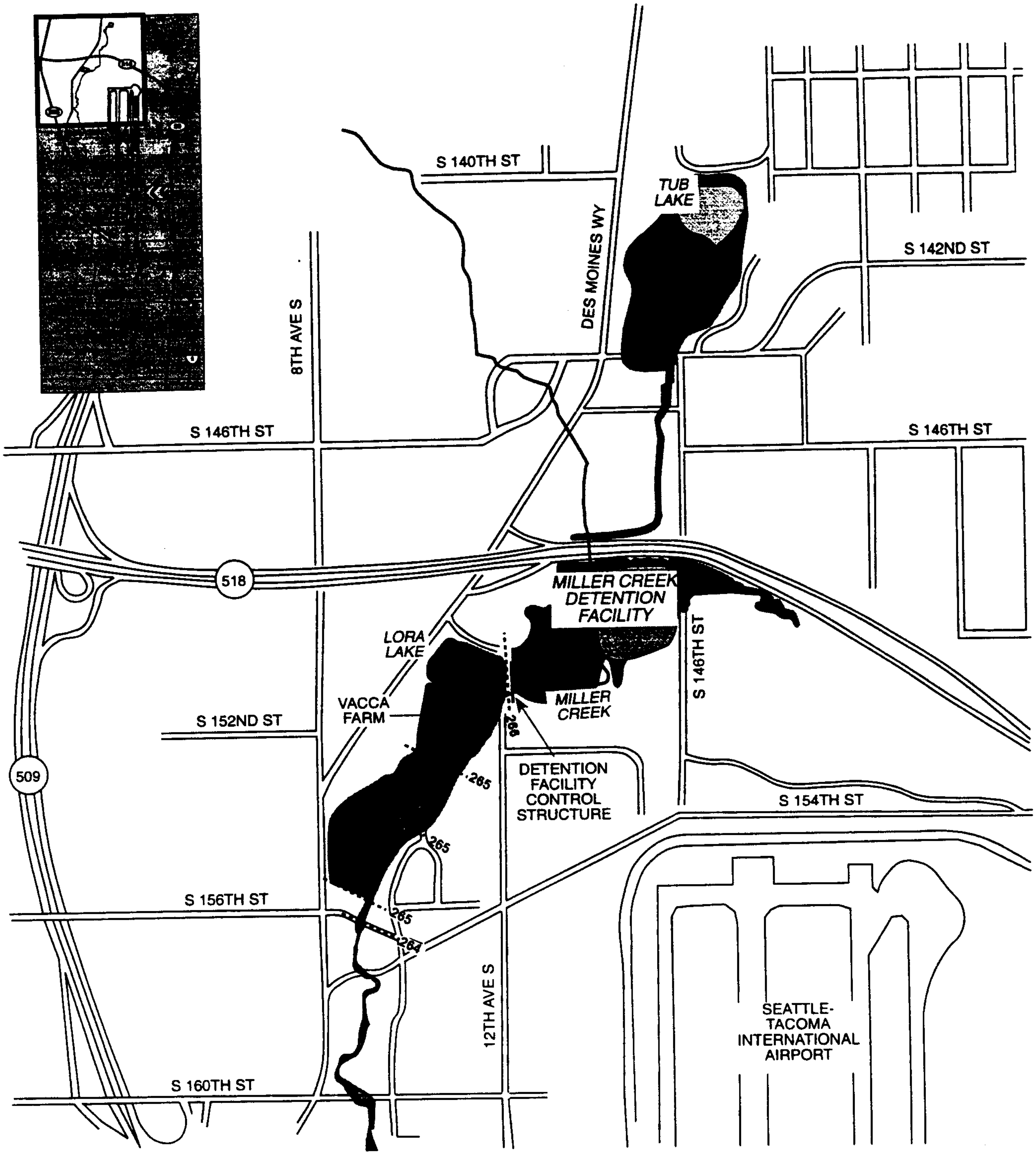
[6] This area will increase to 9 percent with acquisition of west side property.



Source: FEMA 1995

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NOT TO SCALE

.... 100-year Flood Elevation (approximately 265.4 ft)

▥ Floodway

■ 100-Year Floodplain

Figure 2.2-2
Miller Creek
100-Year Floodplain

Miller Creek Tributary Drainage Channels

Intermittent drainage channels (referred to as Waters A, B, C, D, and W) are located within the Miller Creek basin in the acquisition area and on the west side of the existing runway (see Figure 2.1-2). These channels are regulated as Waters of the U.S. by ACOE, and portions of them are mapped by the *King County Sensitive Areas Portfolio* (King County 1990).[7]

Water A is an approximately 814-ft-long by 5-ft-wide (0.09-acre) drainage ditch. This ditch collects surface water runoff from 12th Avenue South, the airport security road, and several upslope wetlands (Wetlands 19, 21, and 22). A portion of Water W, which originates in Wetland 20, also drains westward into Water A. These waters drain into Wetland 37 through a culvert under 12th Avenue South and convey channelized flow to **Water W** for approximately 494 ft (0.03 acre) to Miller Creek. Water A and portions of Water W are mapped in the King County sensitive area map folio (King County 1990) as an unclassified stream.

Water B is an approximately 314-ft-long by 4-ft-wide (0.03-acre) incised channel that conveys water from the west end of Wetland 37f northwest to riparian Wetland R9, which, in turn, drains to Miller Creek.

Water C is a discontinuous ditch that flows through culverts or cement-lined channels on Parcel 251. The exposed ditch totals approximately 170 linear ft (0.01 acre) from South 168th Street to Miller Creek.

Water D is a intermittent stream that begins east of Des Moines Memorial Drive and north of South 160th Street. The channel flows approximately 1,830 linear ft (0.16 acre) through several sections of Wetland A17 and enters Miller Creek on Parcel 243, approximately 200 ft upslope of Des Moines Memorial Drive.

2.2.1.2 Walker Creek

Walker Creek is the major tributary of Miller Creek that drains a 540-acre watershed. The creek originates in Wetland 43 west of SR 509. Several small seep areas located east of SR 509 feed into Wetland 43. Walker Creek flows for approximately 1.3 miles southwest and generally parallel to Miller Creek before joining Miller Creek less than 500 ft upstream of Puget Sound (see Figure 2.2-1). Land use in the Walker Creek basin consists of residential and commercial development in densities similar to those described for Miller Creek. A small portion of Port property drains to Walker Creek. However, no portion of the active runway, airfield, or airport operations area drains to Walker Creek.

The contributing basin to Walker Creek, including Wetland 43, is shown in Figure 2.2-1. Streamflow rates are typically highest between October and April during the wet season and lowest between May and September (FAA 1996). Walker Creek receives stormwater runoff originating from residential and commercial development within the basin, which has likely increased the

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[7] Other small drainage ditches are present on the Vacca Farm site and connect to Wetland A1. These are described in Parametrix 2000a.

frequency and magnitude of peak flows. Upstream of Southwest 175th Street, FEMA classified the floodplain as areas where the 100-year flood depth is less than 1.0 ft, or the drainage area is less than 1 square mile. FEMA also mapped a more extensive (several acres) floodplain from the confluence of Walker and Miller Creeks to Puget Sound.

In the lower gradient upper reaches, Walker Creek flows through confined rockery-hardened banks, several culverts, and along roadside ditches. As the gradient increases, Walker Creek flows through a ravine (downstream of 1st Avenue South); however, field evaluations of this area could not be conducted due to limited access to private property. As the gradient decreases below the ravine and above the confluence with Miller Creek, the stream is again confined by urban development, including yards, ditches, and culverts. Walker Creek has riparian cover along most of its length. Trees and shrubs are the dominant vegetation type; however, mowed lawn is also common along the banks (Hillman et al. 1999).

Walker Creek is unclassified by King County; however, it would likely be classified as a Washington Department of Natural Resources (DNR) type 3 stream due to stream size and salmonid use. No studies have measured water quality in Walker Creek; it is likely that the stream has pollutant loads typical of streams in Puget Sound lowland urbanized watersheds, and similar to Miller Creek. Walker Creek supports coho salmon (*Oncorhynchus kisutch*) and chum salmon (*O. keta*) spawning, although a recent survey found that approximately 75 percent of the coho salmon spawning in the stream was from hatcheries (Hillman et al. 1999). The stream has limited LWD, undercut banks, or other types of cover features (Hillman et al. 1999), which in turn limits fish habitat in the stream.

2.2.2 Des Moines Creek Basin

The Des Moines Creek drainage basin consists of about 3,750 acres situated primarily south and southeast of the airport (see Figure 1.2-2). The Des Moines Creek watershed is largely urbanized and includes portions of the Cities of Des Moines, Normandy Park, SeaTac, and Burien. STIA occupies approximately 23 percent of the watershed (excluding other Port properties such as the Tyee Valley Golf Course and noise abatement areas). Much of the area directly southeast of the airport was once developed as residential areas, but has been purchased by the Port as part of the Noise Remedy Program. The Tyee Valley Golf Course occupies the area immediately south of the airport. The remainder of the watershed is mixed residential, commercial, and industrial uses.

2.2.2.1 Des Moines Creek

The headwaters of the east branch (considered the mainstem by most locals) originate at Bow Lake, 3.7 river miles (RM) from Puget Sound. The upper half-mile of the east branch, from Bow Lake downstream to about RM 3, is conveyed through underground pipes. The west branch originates from the Northwest Ponds stormwater detention complex located at the western edge of the Tyee Valley Golf Course and joins the east branch at approximately RM 2.4. Downstream of South 200th Street (RM 2.2), the stream flows through Des Moines Creek Park, a forested riparian wetland. The park includes an incised ravine at about RM 1.8. The ravine is a high-gradient reach in which the stream has cut to hardpan for most of the length providing little quality fish habitat. The stream is paralleled within this ravine by a paved trail and/or service road and sewer line protected in places by rock bank armoring. The stream drops about 300 ft in elevation from the golf course to a small estuarine mouth at Puget Sound. Two unnamed tributaries enter the stream at about RMs 0.7 and 1.9 (Williams et al. 1975).

Des Moines Creek is designated as an extraordinary (Class AA) quality water body by the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201). From the west branch downstream of the Northwest Ponds, it is a Class II salmon-bearing stream.

2.2.2.2 Drainage Channel

A small drainage channel (**Water S**) is present in Borrow Area 1, south of South 208th Street and east of Des Moines Creek (see Figure 2.1-3). Water S, classified as a Water of the U.S., contains intermittent flow, but does not contain wetland soil or vegetation. **Water S** is a 90-ft-long by 3-ft-wide (0.01-acre) channel that conveys water from a small spring into a 4-inch drainage pipe.

2.2.3 Gilliam Creek

Gilliam Creek[8] is a small stream that receives runoff from STIA and discharges to the Green/Duwamish River in the vicinity of the City of Tukwila (see Figure 2.2-1). Gilliam Creek, which has been impacted by development, is extensively culverted and receives stormwater runoff that causes high peak flows and low base flows. Fish use of this stream is primarily by resident fish because of the migration barriers that limit anadromous fish passage (Taylor Associates 1996 in City of Tukwila 1997). Fish access between the Green River and Gilliam Creek is restricted by a culvert and flap gate where the stream drains into the Green/Duwamish River. Culverts limit adult salmonid access to much of this tributary, although juvenile chinook and coho salmon have been reported in the stream. The resident fish expected to inhabit this stream and long piped sections include cutthroat trout (*Oncorynchus clarki clarki*), western brook lamprey (*Lampetra richardsoni*), carp (*Cyprinus* sp.), peamouth (*Mylocheilus caurinus*), largescale sucker (*Catostomus macrocheilus*), threespine stickleback (*Gasterosteus aculeatus*), and sculpin (*Cottus* sp.).

About 50 percent of Gilliam Creek is contained in culverts, and much of the remainder of the stream flows in constructed ditches. Riparian vegetation is lacking along most of the stream corridor or is predominantly herbaceous and provides little shade.

Urban development within the watershed has altered native soils and vegetation, resulting in increased scour and sedimentation in Gilliam Creek. Changes such as stream channelization and the removal of LWD have increased stream degradation and fine sediment input. Scour and erosion characterize the upper reaches of the stream, resulting in downstream sedimentation in the lower reaches. Base flow measurements of water quality indicated that concentrations in Gilliam Creek do not meet Washington State Class A WQSs for pH, dissolved oxygen, dissolved copper, dissolved lead, dissolved zinc, and fecal coliform bacteria (Herrera and RW Beck 2000).

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[8] Master Plan Update improvements do not add new impervious area, alter wetlands, alter stream channels, or alter stormwater management (including the IWS) in a manner that could impact Gilliam Creek. For these reasons, no natural resource mitigation in this basin is necessary.

Natural Resource Impacts

3. NATURAL RESOURCE IMPACTS SUMMARY

The STIA Master Plan Update improvements will impact wetlands, streams, floodplain, drainage channels, and stormwater in the Miller and Des Moines Creek basins. To construct the projects, fill material will be placed in approximately 980 linear ft of Miller Creek, approximately 5.24 acre-ft of the Miller Creek 100-year floodplain, approximately 18.37 acres of wetland, and about 1,290 linear ft of drainage channel. In addition, new impervious surfaces will impact stormwater runoff and water quality conditions. The impacts of these actions, which are the basis for the mitigation described in Sections 4, 5, and 7 of this report, are described in the FSEIS (FAA 1997a) for the project. Wetland and stream impacts resulting from STIA Master Plan Update improvements are summarized in the discussion that follows. Detailed analyses of these impacts are presented in the following documents:

- *Wetland Functional Assessment and Impact Analysis* (Parametrix 2001b)
- *Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 2000a, 2001a)
- *Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport* (FAA 1997a)

3.1 WETLANDS

The FSEIS for the Master Plan Update (FAA 1997a) improvements identified 12.23 acres of wetland that will be directly impacted by Master Plan Update improvements (FAA 1997a; Parametrix 1996a). These determinations represented the best available information at the time of publication. Information supporting these determinations was obtained through field delineations and aerial photographic interpretation. Aerial photographic interpretation was used in the west side acquisition area where the Port lacked access to private properties necessary to conduct wetland delineations and subsequent agency review.

Since the publication of the FSEIS, the Port has purchased property and delineated wetlands that are subject to temporary or permanent impacts from the runway embankment, construction activities, and stormwater management (see *Wetland Delineation Report*, Parametrix 2000b). All wetlands within the acquisition area have been delineated.

3.1.1 Permanent Impacts

Permanent wetland impacts from Master Plan Update improvements will affect about 18.37 acres (Table 3.1-1, Figures 3.1-1 and 3.1-2, and the *Wetland Functional Assessment and Impact Analysis* [Parametrix 2001b]). Mitigation for these impacts is described in Sections 4 (overview), 5 (on-site), and 7 (off-site).

Permanent wetland impacts (fill and potential indirect) include approximately 8.17 acres of forest, 2.98 acres of shrub, and 7.22 acres of emergent habitat. Lower quality wetlands (Category III and Category IV) account for about 50 percent of the wetlands impacted by fill (Table 3.1-2). The remaining wetland impact areas affect higher quality Category II wetlands. All impacted wetlands have been subjected to significant historic or ongoing disturbances that have reduced their ecological value and ecosystem function (Parametrix 2001b) below what would be expected for undisturbed wetlands occurring in undeveloped areas. Regardless of wetland rating or evidence of human degradation, the functions of each wetland have been analyzed and mitigated.

Table 3.1-1. Summary of wetland impacts for Seattle-Tacoma International Airport Master Plan Update improvements by construction project.

Wetland Number	Vegetation Type [a]	Indirect Impact (acres)	Direct Impact (acres)	Total Impact (acres)[b]	Vegetation Types Impacted (acres)		
					Forest	Shrub	Emergent
Runway Safety Area Extension							
5	Shrub	0.00	0.14	0.14	0.07	0.07	0.00
	Subtotal	**0.00**	**0.14**	**0.14**	**0.07**	**0.07**	**0.00**
Third Runway Project Area							
North Airfield							
9	Forest/Emergent	0.00	0.03	0.03	0.01	0.00	0.02
11	Forest/Emergent	0.16	0.34	0.50	0.40	0.00	0.10
12	Forest/Emergent	0.00	0.21	0.21	0.04	0.00	0.17
13	Emergent	0.00	0.05	0.05	0.00	0.00	0.05
14	Forest	0.00	0.19	0.19	0.19	0.00	0.00
West Airfield							
15	Emergent	0.00	0.28	0.28	0.00	0.00	0.28
16	Emergent	0.00	0.05	0.05	0.00	0.00	0.05
17	Emergent	0.00	0.02	0.02	0.00	0.00	0.02
18	Forest/Shrub/ Emergent	0.55	2.29	2.84	1.28	0.75	0.81
19	Forest	0.00	0.56	0.56	0.56	0.00	0.00
20	Shrub/Emergent	0.00	0.57	0.57	0.00	0.51	0.06
21	Forest	0.00	0.22	0.22	0.22	0.00	0.00
22	Shrub/Emergent	0.00	0.06	0.06	0.00	0.01	0.05
23	Emergent	0.00	0.77	0.77	0.00	0.00	0.77
24	Emergent	0.00	0.14	0.14	0.00	0.00	0.14
25	Forest	0.00	0.06	0.06	0.06	0.00	0.00
26	Emergent	0.00	0.02	0.02	0.00	0.00	0.02
W1	Forest/Emergent	0.00	0.10	0.10	0.00	0.00	0.10
W2	Forest/Emergent	0.00	0.22	0.22	0.04	0.00	0.18
West Acquisition Area							
35a-d	Forest/Emergent	0.04	0.63	0.67	0.27	0.00	0.40
37a-f	Forest/Emergent	0.36	3.75	4.11	2.86	0.00	1.25
40	Forest	0.00	0.03	0.03	0.00	0.03	0.00
41a and b[c]	Emergent	0.00	0.44	0.44	0.00	0.00	0.44
44a and b	Forest	0.00	0.26	0.26	0.18	0.08	0.00
A5	Emergent	0.02	0.01	0.03	0.00	0.00	0.03
A6	Forest	0.09	0.07	0.16	0.16	0.00	0.00
A7	Forest	0.00	0.30	0.30	0.30	0.00	0.00

Table 3.1-1. **Summary of wetland impacts for Seattle-Tacoma International Airport Master Plan Update improvements by construction project (all values are in acres) (continued).**

Wetland Number	Vegetation Type [a]	Indirect Impact (acres)	Direct Impact (acres)	Total Impact (acres)[b]	Vegetation Types Impacted (acres)		
					Forest	Shrub	Emergent
A8	Forest/Shrub	0.00	0.38	0.38	0.07	0.31	0.00
A12	Shrub	0.06	0.02	0.08	0.00	0.08	0.00
A 18	Shrub	0.01	0.00	0.01	0.00	0.01	0.00
Vacca Farm Site							
A1	Forest/Shrub/ Emergent	0.00	0.59	0.59	0.09	0.09	0.41
FW 5	Farmed Wetland	0.00	0.08	0.08	0.00	0.00	0.08
FW 6	Farmed Wetland	0.00	0.07	0.07	0.00	0.00	0.07
Riparian Wetland							
R1	Emergent	0.00	0.13	0.13	0.00	0.00	0.13
	Subtotal	**1.29**	**12.94**	**14.23**	**6.73**	**1.87**	**5.63**
South Aviation Support Area/Tyee Valley Golf Course							
52	Forest/Shrub/ Emergent	0.54	0.00	0.54	0.54	0.00	0.00
53	Forest	0.00	0.60	0.60	0.60	0.00	0.00
E2	Forest	0.00	0.04	0.04	0.04	0.00	0.00
E3	Forest	0.00	0.06	0.06	0.06	0.00	0.00
G1	Shrub (Slope)	0.00	0.05	0.05	0.00	0.05	0.00
G2	Emergent	0.00	0.02	0.02	0.00	0.00	0.02
G3	Emergent	0.02	0.04	0.06	0.00	0.00	0.06
G4	Emergent	0.04	0.00	0.04	0.00	0.00	0.04
G5	Emergent	0.47	0.40	0.87	0.00	0.00	0.87
G7	Forest/Shrub	0.00	050	0.50	0.13	0.37	0.00
	Subtotal	**1.07**	**1.71**	**2.78**	**1.37**	**0.42**	**0.99**
Borrow Area and Haul Road							
28	Emergent	0.00	0.07	0.07	0.00	0.00	0.07
B11	Emergent	0.00	0.18	0.18	0.00	0.00	0.18
B12	Forest	0.04	0.03	0.07	0.00	0.07	0.00
B14	Shrub	0.00	0.78	0.78	0.00	0.55	0.23
	Subtotal	**0.04**	**1.06**	**1.10**	**0.00**	**0.62**	**0.48**
Mitigation[d]							
Auburn area 7	Emergent	0.00	0.02	0.02	0.00	0.00	0.02
Auburn area 9	Emergent	0.00	0.03	0.03	0.00	0.00	0.03
Auburn area 10	Emergent	0.00	0.07	0.07	0.00	0.00	0.07
	Subtotal	**0.00**	**0.12**	**0.12**	**0.00**	**0.00**	**0.12**
TOTAL		**2.40**	**15.97**	**18.37**	**8.17**	**2.98**	**7.22**

[a] All wetlands are palustrine, based on USFWS wetland classification system (Cowardin et al. 1979).

[b] Values are rounded to two significant figures. Wetland impact may be subject to minor changes.

[c] This area includes 0.18 acre of open water habitat.

[d] Impacts in this area result from access road construction.

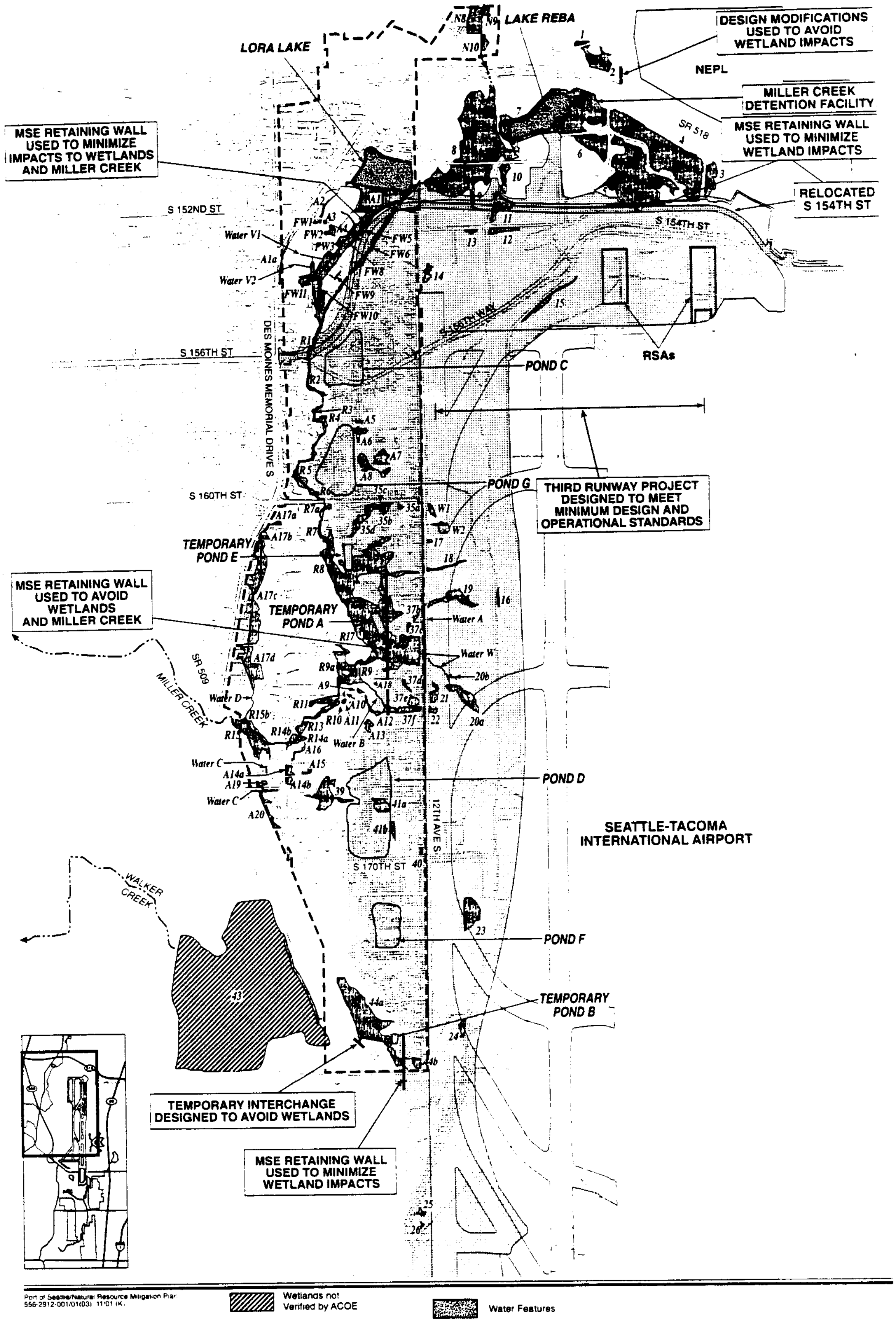

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Figure 3.1-1 Wetland Impacts in the Miller Creek Basin Near STIA

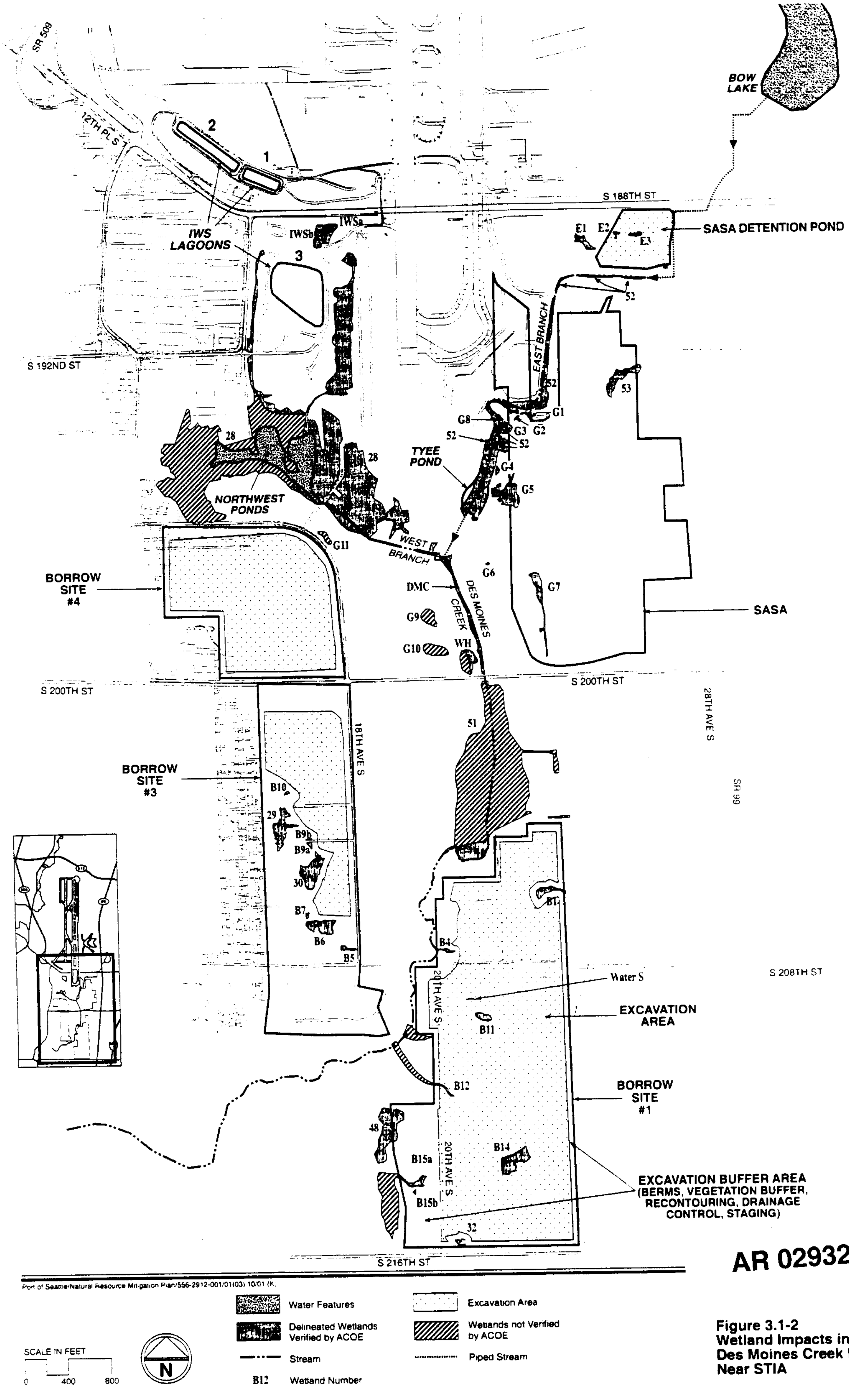

Figure 3.1-2
Wetland Impacts in the Des Moines Creek Basin Near STIA

Table 3.1-2. Summary of permanent wetland impacts by project and wetland category[a] (in acres).

Project	Category II	Category III	Category IV	Total
RSA	0.00	0.14	0.00	**0.14**
Third Runway	8.37	4.89	0.97	**14.23**
Borrow Area 1 and Haul Rd	0.14	0.96	0.00	**1.10**
SASA	0.54	1.20	1.04	**2.78**
Off-site Mitigation[b]	0.00	0.12	0.00	**0.12**
TOTAL	**9.05**	**7.31**	**2.01**	**18.37**

[a] Wetlands are categorized according to Ecology (1993).

[b] Impacts result from a permanent access road in an emergent wetland at the Auburn mitigation project.

3.1.2 Temporary Construction Impacts

During Master Plan Update improvement project construction, a maximum of 2.05 acres of wetland could temporarily be disturbed by construction activities, stormwater management, and temporary erosion and sediment control (TESC) facilities (Table 3.1-3 and Figure 3.1-3) (Parametrix 2001b). Upon completion of construction, temporarily impacted areas will be restored. Restoration activities will include removing invasive plant species, planting native species, and regrading temporarily impacted emergent wetlands to create higher quality forest, shrub, and open water wetlands.[9] The category rating of these wetlands will not change as a result of the temporary impacts or the mitigation.

Approximately 43.34 acres of wetland will be disturbed during mitigation activities (Table 3.1-4) (Parametrix 2001b). These impacts include temporary and permanent access road construction in wetlands and use of wetlands for temporary construction staging. Areas subject to temporary construction impacts will be regraded and replanted following construction. At the mitigation site in Auburn, construction impacts to emergent wetlands dominated by pasture grasses may exceed 36 months, but could be substantially less if construction windows (daily and annual) are extended.

3.1.3 Fragmentation and Indirect Impacts

Where fill impacts to wetlands result in small fragments of remaining wetlands, the remaining wetland area has been considered permanently impacted, and tabulated in Table 3.1-1. For example, the small areas of Wetland A6 and A8 located between the runway embankment and proposed stormwater detention facilities may not persist as functioning wetland following completion of the project. *Fragmentation impacts* were evaluated by considering if, given the remaining fragment of wetland and the future project condition, the wetland would be capable of providing the suite of functions it currently does. Where the remaining wetland was, as a result of mitigation, incorporated into enhanced and protected buffers, it typically would remain functional. If, however, a wetland fragment were to remain isolated from other more significant habitat, its functions would be impaired and the indirect impact was considered significant. In these cases, the area of the wetland fragment was added to the amount of direct impacts.

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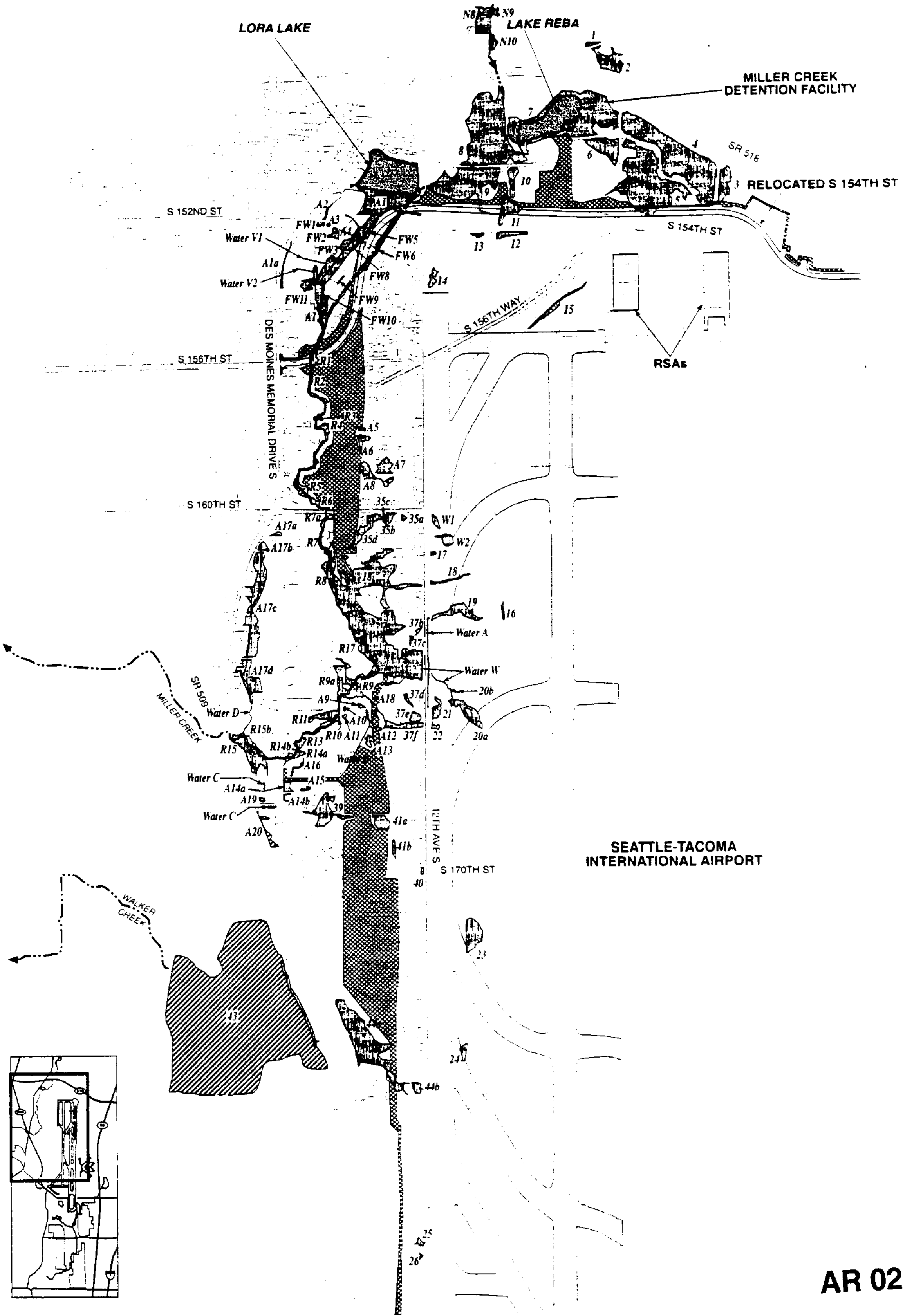
[9] Methods for assessing temporary impacts are described in Section 2.1 of the *Wetland Functional Assessment and Impact Analysis* (Parametrix 2001b). To supplement restoration and reduce temporal impacts, additional mitigation for temporary impacts is included in this plan.

Table 3.1-3. Summary of direct temporary construction impacts to wetlands in the proposed Master Plan Update improvement area.

Wetland	Duration	Area (acres)	Vegetation Types (acres)			Impacts
			Forest	Shrub	Emergent	
Runway Safety Area Extension						
4	1 year	0.20	0.20	0.00	0.00	Temporary construction disturbance could occur in the portion of the wetlands that borders the construction area. These impacts could include minor soil disturbance or siltation caused by installation and removal of erosion control fences. Small amounts of shrub or herbaceous vegetation could be trimmed during installation or maintenance of the fences.
5	1 year	0.20	0.10	0.10	0.00	
Third Runway						
9	1 year	0.16	0.11	0.00	0.05	Construction activity and noise could disturb wildlife during portions of the construction period.
A1	1.5 years	0.05	0.01	0.01	0.03	
18	3 years	0.22	0.04	0.07	0.11	The temporary erosion and sediment control (TESC) collection swales and a collection pond in Wetland 37 would eliminate water quality and habitat functions during the construction period. (Note: Permanent stormwater management facilities will be located outside of wetland areas. Impacts of temporary Pond E have been considered permanent.)
37	2 years	0.71	0.14	0.18	0.39	
A12	3 years	0.03	0.00	0.03	0.00	
A13	3 years	0.01	0.01	0.00	0.00	A narrow band of temporary disturbance could result from installation of erosion control fences adjacent to the fill footprint and the security road. This disturbance will be within 30 ft of Miller Creek for about 100 linear ft. These impacts could include minor soil disturbance or siltation caused by installation and removal of erosion control fences. Small amounts of shrub or herbaceous vegetation could be trimmed during installation or maintenance of the fences. Construction activity and noise could cause disturbance to wildlife.
44a	0.5 year	0.00				**SR 509** - Temporary Interchange - Construction activity and noise could disturb wildlife during portions of the construction period.
	3 years	0.28	0.18	0.10	0.00	**Embankment TESC** - The TESC pond would eliminate habitat and water quality functions during the construction period. Construction activity and noise could disturb wildlife during portions of the construction period
South Aviation Support Area						
52	2 years	0.17	0.00	0.05	0.12	Temporary construction disturbance could occur in the portion of the wetlands that borders the bridge construction area. These impacts could include minor soil disturbance or siltation caused by installation and removal of erosion control fences. Small amounts of shrub or herbaceous vegetation could be trimmed during installation or maintenance of the fences Construction activity and noise could disturb wildlife during the construction period.
TOTAL		2.05	0.79	0.54	0.72	



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SCALE IN FEET

0 400 800

N

▨ Wetlands Not Verified by ACOE

▩ Delineated Wetlands Verified by ACOE

-·-·-·- Stream

▒ Water Features

▦ Location of Temporary Construction Impacts

41a Wetland Number

Figure 3.1-3
Location of Temporary Wetland Impacts in the Miller Creek Basin Near STIA

Table 3.1-4. Summary of wetlands disturbed during mitigation activities.

Wetland	Vegetation Types	Total Area (acres)	Vegetation Type Disturbed (acres)		
			Forest	Shrub	Emergent
Temporary impacts to wetlands associated with implementing mitigation that includes excavation or installation of temporary roads					
FW 1, 2, 3, 8, 9, 10, and FW 11[a]	Farmed Wetlands	0.88	0.00	0.00	0.88
A1[a]	Forest/Shrub/Emergent	3.74	0.56	0.56	2.62
A2[a]	Shrub	0.05	0.00	0.05	0.00
A3[a]	Shrub	0.01	0.00	0.01	0.00
A4[a]	Shrub	0.03	0.00	0.03	0.00
Auburn Area 1[b]	Emergent	1.55	0.00	0.00	1.55
Auburn Area 2[c]	Emergent	0.06	0.00	0.00	0.06
Auburn Area 3[c]	Emergent	5.11	0.00	0.00	5.11
Auburn Area 4[c]	Emergent	0.99	0.00	0.00	0.99
Auburn Area 5[c]	Emergent	3.27	0.00	0.00	3.27
Auburn Area 6[c]	Emergent	0.35	0.00	0.00	0.35
Auburn Area 8[c]	Emergent	0.60	0.00	0.00	0.60
Auburn Area 11[c]	Emergent	0.01	0.00	0.00	0.01
Auburn[d]	Emergent	2.20	0.00	0.00	2.20
	Subtotal	**18.85**	**0.56**	**0.65**	**17.64**
Temporary impacts in wetlands associated with enhancement planting					
18[e]	Forest/Shrub/Emergent	1.27	1.27	0.00	0.00
28[f]	Forest/Shrub/Emergent	4.50	0.00	0.00	4.50
37a[e, i]	Forest/Emergent	1.96	1.50	0.00	0.46
A1[e, i]	Forest/Shrub/Emergent	0.34	0.34	0.00	0.00
A9[e, i]	Shrub	0.04	0.00	0.04	0.00
A10[e, i]	Shrub	0.01	0.00	0.01	0.00
A11[e, i]	Shrub	0.02	0.00	0.02	0.00
A13[e, i]	Forest	0.12	0.12	0.00	0.00
A16[e, i]	Shrub/Emergent	0.05	0.00	0.00	0.05
A17[e,i], Water D	Forest/Shrub/Emergent	2.85	0.27	0.53	2.05
N8, N9, N10[e]	Emergent/Forest	0.86	0.08	0.00	0.78
R1[e]	Emergent	0.04	0.00	0.00	0.04
R2[e, i]	Shrub/Emergent	0.12	0.00	0.06	0.06
R3[e, i]	Shrub	0.02	0.00	0.02	0.00
R4[e, i]	Emergent	0.11	0.00	0.00	0.11
R4[b, e, i]	Forest/Emergent	0.11	0.03	0.00	0.08
R5[e, i]	Emergent	0.05	0.00	0.00	0.05
R5[b, e, i]	Forest/Emergent	0.07	0.02	0.00	0.05
R6[e, i]	Forest/Emergent	0.21	0.05	0.00	0.16
R6[b, e, i]	Emergent	0.09	0.00	0.00	0.09
R7[e, i]	Forest/Emergent	0.04	0.04	0.00	0.00
R7[a, e, i]	Emergent	0.04	0.04	0.00	0.00
R8[e, i]	Shrub/Emergent	0.40	0.00	0.20	0.20
R9[e, i]	Forest	0.38	0.38	0.00	0.00

Table 3.1-4. **Summary of wetlands disturbed during mitigation activities (continued).**

Wetland	Vegetation Types	Total Area (acres)	Vegetation Type Disturbed (acres)		
			Forest	Shrub	Emergent
R9 [a, e, i]	Forest/Shrub/Emergent	0.30	0.30	0.00	0.00
R10 [e, i]	Shrub	0.04	0.04	0.00	0.00
R11 [e, i]	Emergent	0.42	0.00	0.00	0.42
R12 [e, i]	Forest	0.03	0.03	0.00	0.00
R13 [e, i]	Emergent	0.12	0.00	0.00	0.12
R14[a, e, i]	Shrub/Emergent	0.13	0.13	0.00	0.00
R14[b, e, i]	Emergent	0.08	0.00	0.00	0.08
R15[a, e, i]	Forest/Shrub/Emergent	0.79	0.25	0.40	0.14
R15[b, e, i]	Forest/Emergent	0.25	0.06	0.00	0.19
R17 [e, i]	Forest	0.31	0.31	0.00	0.00
Waters B, D, V1 and V2[g]	Open Water	0.21	0.00	0.00	0.21[j]
Auburn [e,h]	Emergent	9.13	0.00	0.00	9.13
	Subtotal	**25.35**	**5.26**	**1.28**	**18.03**
TOTAL		**43.34**	**5.82**	**1.93**	**35.67**

[a] Temporary impacts will be associated with restoration activities at the Vacca Farm site. Wetlands A1 and farmed wetland (FW) 11 extend off-site. Values given are for the portion of the wetland occurring on site.

[b] Temporary impacts result from constructing temporary roads to provide access to the mitigation site.

[c] Excavation activities in wetlands at off-site mitigation area to increase habitat diversity/complexity will include construction of temporary roads to access the interior portion of the site to conduct monitoring and maintenance activities, and creation of approximately 3 acres of temporary staging area.

[d] Maximum of 2.20 acres of existing off-site ditches and FW will be converted to a wetland drainage channel that connects the mitigation site to the 100-year floodplain of the Green River.

[e] Enhancements activities in these wetlands may include excavation for temporary irrigation systems.

[f] Planting and removal of culverts will occur in the wetland located at the Tyee Valley Golf Course.

[g] Existing drain tiles will be removed and natural wetland topography restored.

[h] Mowing, discing, and planting will occur in an existing low quality emergent wetland.

[i] These wetlands are in the Miller Creek buffer.

The calculated permanent impacts to wetlands (18.37 acres) also include about 2.4 acres of indirect wetland impacts (see Table 3.1-1) that could occur in certain locations where there are changes to wetland hydrology, shading, or fragmentation resulting in loss of wetland functions (Parametrix 2001b). While these indirect impacts could result in the loss of some wetland functions from an area, they may not necessarily remove all functions. For example, where the SASA bridge crosses Wetland 52, shading will eliminate wetland vegetation and therefore, some wildlife habitat function will be lost from this wetland. The wildlife corridor and hydrologic functions provided by this wetland will remain. In other areas, if wetland hydrology were reduced or eliminated, vegetation would remain and habitat or other functions would continue to be provided. Even though indirect impacts will not, in all cases, eliminate all wetland functions, these impacts are mitigated at ratios in excess of 3:1.

Other indirect impacts to wetlands that could affect their function include noise and human disturbance, changes in water quality impacts, and changes in surface hydrology. These impacts could alter or reduce the level of some functions, but would not eliminate the wetlands themselves or their functions. These impacts are also mitigated by this plan because, in most cases, land use conditions that have degraded these wetlands are removed, and restoration actions are implemented to enhance wetland function (Parametrix 2001b).

3.1.4 Watershed Impacts

The wetland impacts, minimum amount of known wetlands, and wetland restoration actions are summarized by the on-site sub-watersheds of Water Resource Inventory Area (WRIA) 9 in Table 3.1-5. The Master Plan Update improvements result in about 3.3 to 4.0 percent of wetlands in these sub-basins. In all cases, because of the physical attributes of the mitigated wetlands, including their hydrologic connectivity, the mitigation provides Category III wetlands and buffers. These losses are compensated on-site by mitigation described in Sections 4, 5, and 7.

3.2 STREAMS

Impacts to streams resulting from Master Plan Update improvements include filling approximately 980 ft of Miller Creek (Figure 3.2-1). Filling a portion of Miller Creek to accommodate the runway embankment and road relocations will result in a loss of surface water conveyance that must be replaced through mitigation (see Section 5.2). The section of Miller Creek to be relocated, adjacent to the Vacca Farm site, is an artificial (ditched) stream channel constructed in silty soils. The natural stream was moved to its present location and constructed as a straight channel to improve the area for farming; consequently, it provides limited fish habitat.

3.3 FLOODPLAINS

Fill for the proposed Master Plan Update improvements will result in the loss of approximately 5.24 acre-ft of floodplain storage where the segment of Miller Creek will be relocated (see Figures 1.3-2 and 3.2-1). Without mitigation, encroachment on the floodplain would result in loss of flood storage capacity and potential increases in flooding in downstream areas.

Table 3.1-5. **Changes in wetland and aquatic habitat areas in the Miller, Walker, and Des Moines Creek basins (WRIA 9).**

Watershed and Sub-Area		Area	Impact	Restoration
Miller Creek Basin				
Arbor Lake		3.7	0.00	0.00
Lake Burien		30	0.00	0.00
Riparian wetlands near S. 144th Way		2.00	0.00	0.00
Tub Lake Peatland/N. SeaTac Park Wetlands		21.01	0.00	0.00
North Employee Parking Lot Wetlands 1,2		0.81	0.00	0.00
Des Moines Way Nursery		0.86	0.00	2.00
Runway Safety Areas/North End		27.84	2.75	0.40
Vacca Farm Mitigation		8.07	0.00	6.60
Miller Creek Riparian		1.05	1.05	0.03
Third Runway Embankment		15.74	11.03	1.2
	Total	**111.08**	**14.83**	**10.23**
NET CHANGE[a]: -4.5 acres	**-4.0%**			
Walker Creek Basin				
Wetland 43		33.43	0.00	0.00
Wetland 44		3.08	0.54	0.28
Miscellaneous		0.99	0.99	0.00
	Total	**37.5**	**1.53**	**0.28**
NET CHANGE[a]: -1.25 acres	**-3.3%**			
Des Moines Creek Basin				
WSDOT Wetland B		6.60	0.00	0.00
Bow Lake Wetlands		25	0.00	0.00
SASA Area		7.22	2.95	0.17
Borrow Areas		24.24	1.04	0.00
Tyee Valley Golf Course		38.51	0.07	0.00
	Total	**101.57**	**4.06**	**0.17**
NET CHANGE[a]: -3.89 acres	**-3.8%**			
TOTAL		**250.15**	**20.42**	**10.68**
NET CHANGE -9.74 acres	**-3.9%**			

[a] Estimates of changes exceed actual changes, because they do no include riparian wetlands outside the project area, wetlands at the mouths of Miller, Walker, and Des Moines Creeks, or other wetlands that are likely to be present on undeveloped or developed areas. See Tables 4.1-2 and 4.1-3 in Section 4 for a summary of the mitigation planned to compensate for wetland functions associated with these changes.

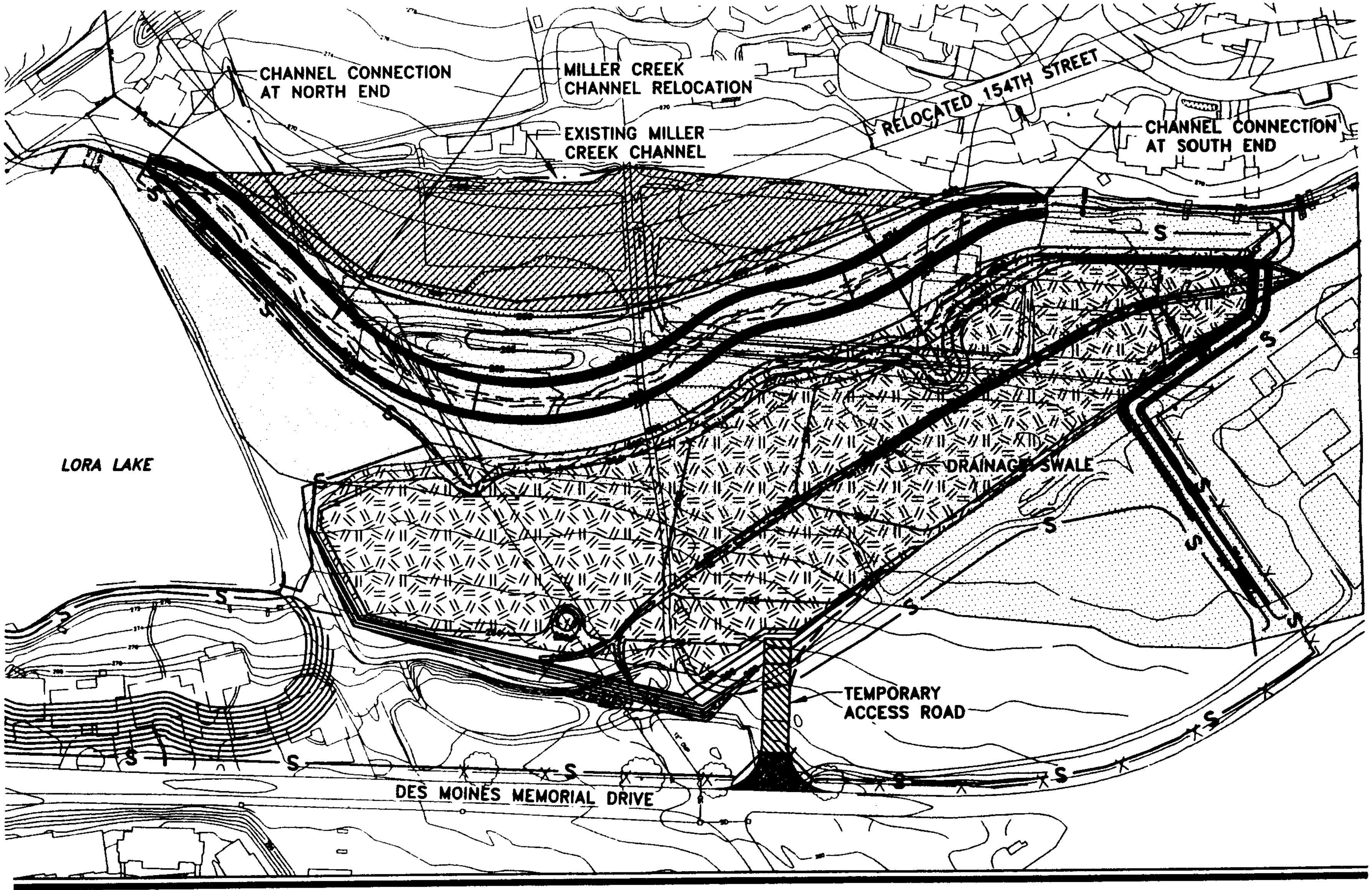

Figure 3.2-1
Miller Creek
Relocation and Floodplain
Grading at the Vacca Farm Site

Flooding impacts in the Miller Creek basin as a result of the project are unlikely because required mitigation will include adherence to floodplain development standards and floodway management requirements of FEMA, FAA, Ecology, King County, and the City of SeaTac. Floodplain development standards prohibit any reduction in the 100-yr floodplain or base flood storage volume. Compensatory mitigation is required for any proposed filling of the 100-yr floodplain to achieve no net loss in flood storage capacity.

Temporary floodplain impacts during construction could include temporary fill for construction access roads and construction in the floodplain as floodplain and wetland mitigation plans are implemented. Since construction will occur during the dry season when the probability of a significant flood is very low, this potential impact is not significant.

3.4 DRAINAGE CHANNELS

Construction of the runway embankment will fill approximately 1,290 ft of three drainage channels near 12th Avenue (Figure 3.4-1) and portions of an agricultural drainage channel at the Vacca Farm site. Portions of Channels A, W, and B will be filled to accommodate the embankment for the third runway (see Figure 3.4-1). These channels do not contain fish habitat. Their primary function is to convey roadside runoff and seepage flow from the hill slopes to the riparian wetlands adjacent to Miller Creek. Without mitigation, filling these channels could result in reduced base flows reaching Miller Creek; however, mitigation actions to reroute seepage and stormwater flow to the riparian wetlands will continue to provide comparable base flow to the stream. Because appropriate mitigation actions will be implemented (see Section 5.2.3), no impacts to Miller Creek will occur from filling these drainage channels.

A drainage ditch located in the Vacca Farm site (see Figure 2.1-4) parallels Miller Creek for approximately 800 ft. The ditch, which is part of Wetland A1, provides positive drainage for the adjacent farmland, connecting to Miller Creek near South 156th Way. A portion of the channel (approximately 400 ft) would be restored to natural wetland grades and vegetation.

3.5 WATER QUANTITY AND WATER QUALITY

The permanent activities associated with implementation of the Master Plan Update improvements will include grading, filling, paving new streets and runways, and constructing new buildings. These improvements will increase impervious surface areas in the Miller Creek and Des Moines Creek watersheds. Details describing stormwater quality and quantity can be found in Section 6.

Additional impervious surfaces could further increase stormwater runoff rates and volumes, and pollutant loads to the receiving streams. Unless mitigated, changes in runoff are expected to increase flooding and erosion, and degrade instream habitat and water quality in Miller Creek downstream of stormwater inputs from the improved areas. The impervious surface areas could reduce the groundwater recharge occurring in the development footprints, resulting in less groundwater seepage during low-flow periods.

Operational impacts to water quality from fuel spills that could occur where fuel is routinely handled are avoided by routing runoff to the IWS through an established drainage system. Such spills do not enter the stormwater system, and thus do not discharge to wetlands, streams, or other

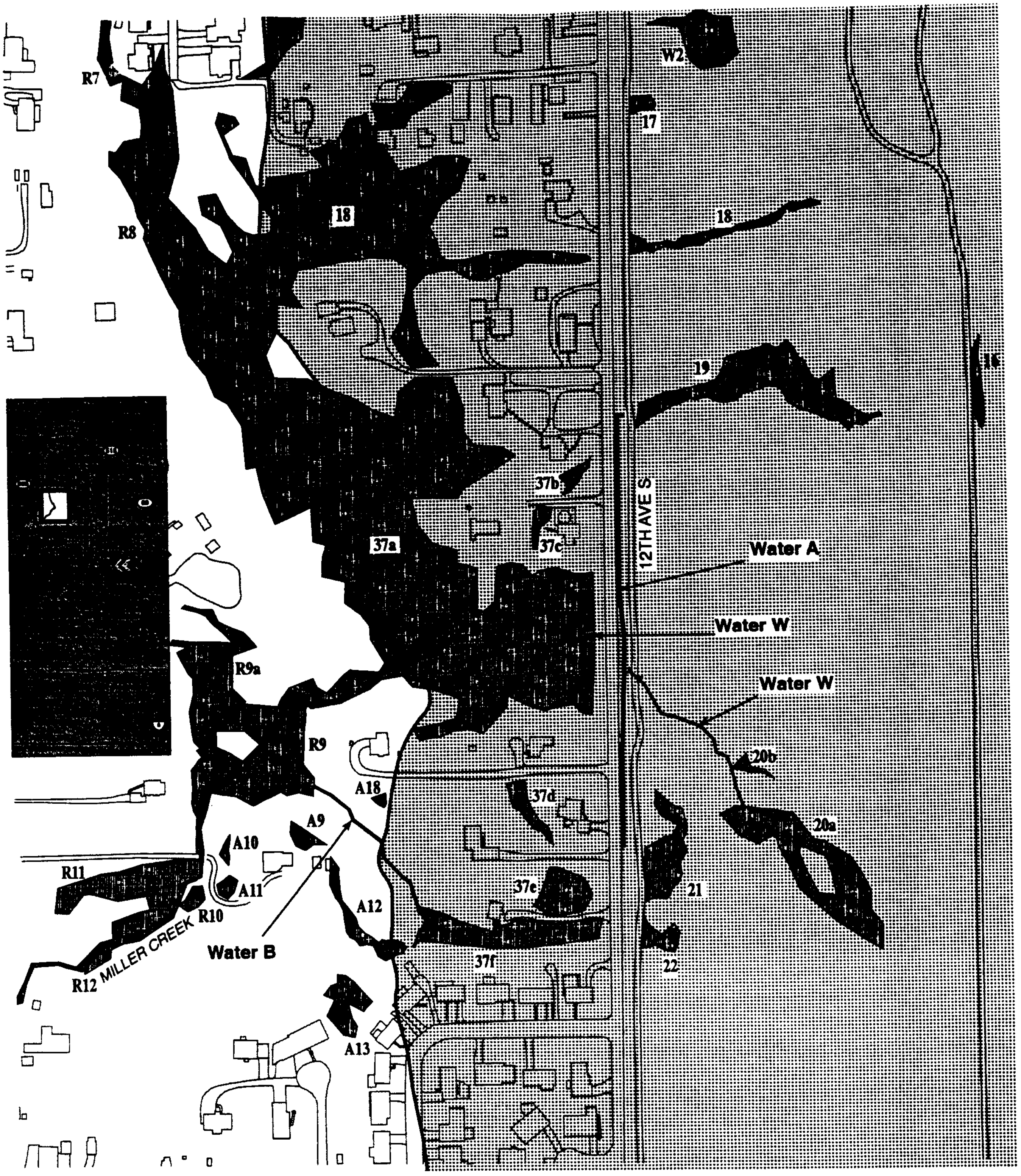

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Figure 3.4-1 Location of Drainage Channel Impacts in the Miller Creek Basin

surface waters. Emergency fuel spills that occur outside the fuel handling areas could enter the stormwater drainage system (SDS), where they can be controlled and treated through emergency actions.

In the Miller Creek basin, Master Plan Update improvement projects will result in a net increase of 105.6 acres[10] of impervious surface area, increasing the overall impervious area in the basin by about 1 percent above the existing baseline condition (about 23 percent of impervious surface [Parametrix 2000a, 2001a]). In the Walker Creek Basin, Master Plan Update improvements will result in an increase of 6.2 acres. In the Des Moines Creek Basin, Master Plan Update improvements will result in an increase of 128.2 acres of impervious surface, increasing the overall impervious area in the basin by about 4 percent above the existing base condition (approximately 32 percent impervious [Parametrix 2000a, 2001a]). A total of 417 acres will drain to the IWS under future conditions.

The new impervious surfaces could increase stormwater runoff rates (FAA 1996) and volumes. Unless mitigated, changes in runoff are expected to increase flooding and erosion and degrade instream habitat and water quality in Des Moines and Miller Creeks downstream of stormwater inputs from the improved areas. Chinook salmon (*Oncorhynchus tshawytscha*) critical habitat in the estuaries of Miller and Des Moines Creeks will not be directly altered by runoff from new impervious surfaces in the Master Plan Update improvements. In addition, existing hydrologic impacts from existing impervious surfaces will be mitigated.

The impacts of these actions are further discussed in the project Environmental Impact Statement (EIS) and *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a). Without the proposed mitigation identified in Section 6.1 of this report, this new impervious surface could cause increased flooding, erosion, and habitat and water quality degradation in the Miller and Des Moines Creek watersheds. The *Comprehensive Stormwater Management Plan* summarizes the 1994 base watershed drainage area conditions and future conditions for Miller and Des Moines Creeks (Parametrix 2000a, 2001a).

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[10] The net change in impervious area includes a reduction of approximately 50 acres of impervious surfaces (streets, driveways, and rooftops) that will result when existing houses and streets are removed in the acquisition area. Demolition in these areas is ongoing and is expected to be completed by 2002. Over 75 acres of the acquisition area is preserved as on-site mitigation.

Mitigation and
Montoring Summary

4. SUMMARY OF MITIGATION, MONITORING, MAINTENANCE, AND CONTINGENCIES

This section provides an overview of the mitigation, performance monitoring, maintenance, and contingency actions incorporated into the Master Plan Update improvements to mitigate adverse project impacts to wetlands, streams, floodplains, and drainage channels. In addition, the Port has made extensive efforts throughout the Master Plan Update planning process to avoid, minimize, and rectify, as well as compensate for, adverse impacts.

The mitigation strategy (summarized in Section 4.1) focuses on compensatory mitigation actions to replace wetland and stream functions impacted by the Master Plan Update improvements (Parametrix 2001b). Key elements of the compensatory mitigation plan are targeted at restoring functions on-site and include sediment and nutrient retention (water quality), organic carbon production and export, surface water storage (floodwater detention and storage), and aquatic habitat functions (e.g., instream aquatic habitat and riparian habitat), as discussed in Section 4.1.

Section 4.2 discusses how mitigation sites and the beneficial ecological functions to be established on them will be protected in the long term. This section describes the establishment and enhancement of protective buffers, the adequacy of buffers to protect the desired functions from potential impacts, and long-term protection by establishing restrictive covenants.

The Port's mitigation plans include enforceable performance standards (Sections 5.1, 5.2, and 7) and a long-term monitoring plan, described in Section 4.2. Monitoring and evaluation of the projects against these performance standards will allow the success of mitigation projects to be evaluated by the Port and regulatory agencies and provide assurance that the ecological benefits of the mitigation are ultimately achieved. The monitoring section discusses the adaptive management approach that the Port will use to evaluate performance of the mitigation site and implement contingency measures if performance standards are not met. In addition, Section 4.3 summarizes the monitoring methods to evaluate hydrology, vegetation and wildlife habitat on the mitigation sites, the monitoring and control of hazard wildlife (USDA 2000), and an integrated weed management strategy for managing invasive non-native plant species.

Mitigation types proposed by the Port in this mitigation plan meet the mitigation criteria defined by ACOE (2001) in Regulatory Guidance Letter (RGL) 01-1. These mitigation types include: establishment (at Auburn); restoration-rehabilitation (on-site and at Auburn); restoration-re-establishment (on-site); enhancement (on-site and at Auburn); and protection (on-site).

4.1 MITIGATION STRATEGY

The primary strategy for mitigating natural resource impacts was to design the least damaging practical alternative to avoid and minimize wetland and stream impacts. Where impacts to wetlands and streams were found to be unavoidable, compensatory mitigation is proposed such that there is no net loss of wetland functions or area. The functions targeted in the design of the mitigation projects, were based on the functions impacted by wetland loss (see Parametrix 2001b) and by designing the mitigation sites with the habitat or other attributes required to provide the desired ecological functions.

The mitigation plan also proposes mitigation areas in excess of impact areas to account for the temporal losses of wetland function (losses of function over time) from both temporary and permanent impacts. The potential uncertainty in mitigation success is also recognized by the increased acreage of mitigation.[11] The comprehensive approach that the Port has taken to avoid, minimize, rectify, and compensate for impacts to wetlands and aquatic resources is summarized in Table 4.1-1, Figure 4.1-1, and Figure 4.1-2. The compensatory wetland and stream mitigation projects are summarized in Table 4.1-2. The recommended preference for selecting wetland mitigation sites in Washington is as follows: (1) on-site and in-kind; (2) off-site, within the watershed, and in-kind; (3) off-site, out of the watershed, and in-kind; and (4) off-site, out of the watershed, and out-of-kind (Ecology 1990). The Port's proposed mitigation for wetland impacts has followed these recommendations. Therefore, most mitigation for impacts to wetland, stream, and floodplain functions are on-site and in-kind, occurring within the Miller and Des Moines Creek basins.

On-site mitigation actions in WRIA 9 are summarized in this Section 4.1.1, and described in detail in Section 5 (for aquatic habitat, floodplain, stream, and wetland restoration) and Section 6 (for water quality and water quantity). Off-site wetland mitigation in WRIA 9 is proposed to replace avian wildlife habitat and is summarized in Section 4.1.2, and described in detail in Section 7.

Mitigation for the loss of ecological functions provided by wetlands unavoidably impacted meets or exceeds requirements to mitigate for lost wetland area and functions (Table 4.1-3 and Table 4.1-4). In Miller and Des Moines Creek basins, the Port proposes to restore and enhance non-avian habitat wetland functions on over 34.3 acres of wetlands and aquatic habitat, providing mitigation for impacts to 18.37 acres. Buffers associated with restored streams and wetlands in the basin will total approximately 55 acres.[12] Off-site mitigation at the Auburn mitigation site will consist of creating approximately 30 acres of new wetlands, enhancing 19.5 acres of existing emergent wetlands, and creating approximately 15.9 acres of forest and buffer habitat.

Additional mitigation to replace ecological functions will be provided in the form of funding for stream enhancement and provision of extensive buffers and on-site water quality and water quantity controls on stormwater runoff. These mitigation actions provide further assurance that all wetland functions potentially impacted are replaced, and there is significant ecological restoration of the impacted watersheds.

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[11] The uncertainty in the ultimate success of the mitigation projects is greatly reduced by careful design that is based on several years of observations of mitigation site conditions. Uncertainties are further reduced by requirements for a 15-year monitoring period, identification of enforceable performance standards, planning of contingency options, and an adaptive management approach to monitoring the projects.

[12] The size and adequacy of the buffers proposed to protect existing and proposed functions at mitigation sites are discussed in Section 4.2 and as part of the detailed description of each project.

Table 4.1-1. Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements.

Mitigation Requirement	Proposed Mitigation Action
New Third Runway	
Avoid the impact by not taking a certain action or parts of an action.	Avoid fill in wetlands and Miller Creek by designing the runway to meet the minimum operational, engineering, safety, and maintenance standards. Locate, where feasible, permanent stormwater detention ponds in uplands. Avoid excavation within 50 ft of Category II and III wetlands in Borrow Area 3. Avoid wetlands in Borrow Area 1 where practical. Construct retaining walls at the northwest end of the runway to reduce impacts to Miller Creek and Category II wetlands (Wetlands 8, 9, and A1) located at the north end of the project. Install a retaining wall near the west-central portion of the embankment to reduce impacts to Category II Wetlands 18 and 37 and avoid relocating a second segment of Miller Creek.
Minimize the impact by limiting the degree or magnitude of the action.	Place a retaining wall near the southwest end of the runway to reduce impact to a Category II wetland (Wetland 44). Design Borrow Areas 1 and 3 with a 150- to 200-ft setback from Des Moines Creek to minimize potential impact to the stream and its buffers. Implement stormwater pollution prevention plans (SWPPPs) prior to any construction project.
Rectify the impact by restoring the affected environment.	Remove temporary stormwater management facilities located in wetlands following construction. These disturbed areas will be restored to pre-construction conditions
Reduce the impact over time by preservation and maintenance actions during the life of the action.	Establish and enhance a 100-ft average (minimum 50-ft) forested buffer on both banks of Miller Creek to reduce potential construction and operational impacts to riparian wetlands and aquatic resources. Maintain hydrology to wetlands by directing seepage water from the embankment to wetlands downslope of the embankment (Hart Crowser 2000c, 2001b; Appendix Q). Provide water quantity and water quality mitigation to protect aquatic habitat in Miller Creek from stormwater impacts during operation. Reduce temporal losses from construction by adding additional mitigation (Wetland A17).
Compensate for the impact by replacing, enhancing, or providing substitute resources.	Restore the Vacca Farm wetland/floodplain area, including fill removal, creating new floodplain, restoring wetland hydrology and vegetation, and providing protective buffers. Restore and enhance Miller Creek instream habitat in the Vacca Farm area. Restore natural channel morphology to a ditched and channelized reach of the stream. Enhance instream habitat and place LWD in Miller Creek and enhance adjacent riparian buffers between Vacca Farm and Des Moines Memorial Drive. Enhance wetlands along Miller Creek within the 100-ft buffer by restoring native vegetation and removing invasive non-native species. Construct replacement drainage channels west of the embankment to replace filled drainage channels.

Table 4.1-1. **Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements (continued).**

Mitigation Requirement	Proposed Mitigation Action
	Restore wetlands on the Tyee Valley Golf Course, including restoring wetland vegetation to reduce wildlife hazards and improve water quality. Restore and enhance wetlands, buffers, and Miller Creek at the Des Moines Way Nursery site. Reduce temporal losses by providing wetland additional enhancement as mitigation for temporary impacts. Enhance aquatic habitat in Des Moines Creek by restoring a 100-ft-wide forest/shrub buffer along the stream between the Northwest Ponds and the proposed SR 509 right-of-way (ROW). Provide a $300,000 trust fund to enhance fisheries habitat in Miller and Des Moines Creeks. Create replacement wetlands at an off-site location for the loss of wildlife habitat within 10,000 ft of the airport runways. Monitor mitigation projects for compliance with performance standards and other permit conditions. Monitor stormwater runoff for compliance with National Pollutant Discharge Elimination System (NPDES) requirements. Monitor remaining wetlands downslope of the new embankment (i.e., between the embankment and Miller Creek) for indirect impacts to wetland hydrology.
Runway Safety Areas	
Avoid the impact by not taking a certain action or parts of an action.	Construct retaining walls to support relocated South 154th Street and avoid permanent fill in Wetlands 3 and 4.
Minimize the impact by limiting the degree or magnitude of the action.	Construct retaining walls to support relocated South 154th Street and reduce permanent fill and minimize temporary impacts in Wetland 5. Implement SWPPPs prior to any construction project.
Rectify the impact by restoring the affected environment.	Restore wetland areas temporarily impacted by required TESC facilities and provide additional mitigation (Wetland A17) to reduce temporal losses.
Reduce the impact over time by preservation and maintenance actions during the life of the action.	Provide water quantity and water quality mitigation to protect wetlands and other receiving waters from stormwater impacts during operation.
Compensate for the impact by replacing, enhancing, or providing substitute resources.	Restore the Vacca Farm wetland/floodplain area to provide hydrologic and water quality functions. Create replacement wetlands for wildlife habitat (greater than 10,000 ft from the airport runways at the Auburn site).
Monitor the impact and take appropriate corrective actions.	Monitor remaining wetlands for indirect impacts to hydrology. Monitor mitigation projects for compliance with performance standards and other permit conditions. Monitor stormwater runoff for compliance with NPDES requirements.
South Aviation Support Area	
Avoid the impact by not taking a certain action or parts of an action.	Design the SASA footprint to avoid relocation of Des Moines Creek. Temporary impacts to Des Moines Creek and Wetland 52 are not anticipated.

Table 4.1-1. Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements (continued).

Mitigation Requirement	Proposed Mitigation Action
Minimize the impact by limiting the degree or magnitude of the action.	Design the SASA to avoid direct impacts to forested wetland (Wetland 52) that provides groundwater discharge functions.
Reduce the impact over time by preservation and maintenance actions during the life of the action.	Design water quantity and water quality mitigation to protect wetlands from stormwater impacts.
Rectify the impact by restoring the affected environment.	Restore potential temporary impacts to Des Moines Creek and Wetland 52.
Compensate for the impact by replacing, enhancing, or providing substitute resources.	Restore wetlands on the Tyee Valley Golf Course to provide water quality and hydrologic benefits to replace lost wetland functions.
	Construct replacement wetlands for wildlife habitat (greater than 10,000 ft from the airport runways at the Auburn site).
	Enhance and restore a 100-ft-wide forest/shrub buffer along Des Moines Creek to enhance aquatic habitat.
	Provide a trust fund for enhancement of fisheries habitat of Des Moines Creek.
Monitor the impact and take appropriate corrective actions.	Monitor Wetland 52 for indirect impacts to wetland hydrology.
	Monitor mitigation projects for compliance with performance standards and other permit conditions.
	Monitor stormwater runoff for compliance with NPDES requirements.
On-site Borrow Source Areas	
Avoid the impact by not taking a certain action or parts of an action.	Redesign development areas within Borrow Areas 1 and 3 to avoid excavation of 12 wetlands (Wetlands B1, B4, B5, B6, B7, B9, B10, B15a, B15b, 29, 30, and 48).
Minimize the impact by limiting the degree or magnitude of the action.	Establish a 150- to 200-ft buffer between Borrow Area 1 and Des Moines Creek to avoid impacts to stream hydrology and riparian buffers.
	Follow a TESC Plan to eliminate siltation reaching wetlands or Des Moines Creek from excavation activities.
	Establish final surface grades in Borrow Area 1, and construct interceptor swale system in Borrow Area 3, to direct surface water runoff and groundwater seepage to wetlands near borrow areas, and minimize and avoid indirect hydrology impacts.
Reduce the impact over time by preservation and maintenance actions during the life of the action.	Maintain BMPs throughout the operating period to ensure adjacent wetlands will be protected from adverse construction-related activities.
	Preserve wetlands and buffers adjacent to Borrow Area 3.
Compensate for the impact by replacing, enhancing, or providing substitute resources.	Restore wetlands on the Tyee Valley Golf Course to compensate for water quality and hydrologic support functions impacted in the Des Moines Creek basin.
	Enhance a 100-ft-wide forest/shrub buffer along Des Moines Creek to enhance aquatic habitat.
	Provide a trust fund for enhancement of fisheries habitat of Des Moines Creek.
Monitor the impact and take appropriate corrective actions.	Monitor Wetlands B1, B4, B5, B6, B7, B9, B10, B15a, B15b, 29, 30, and 48 for potential indirect impacts to wetland hydrology from excavation activities.
	Monitor stormwater runoff and TESC for compliance with NPDES requirements.

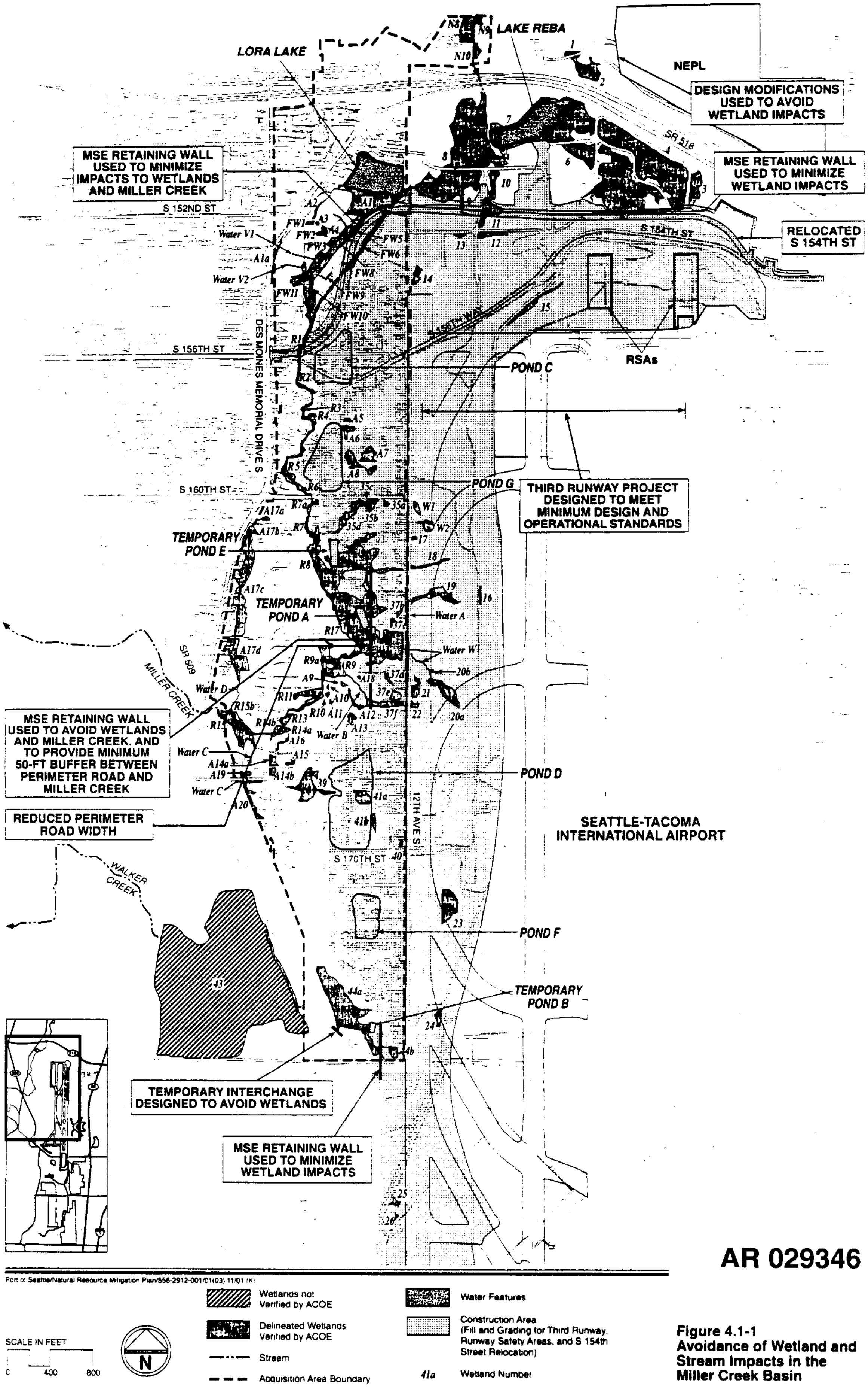

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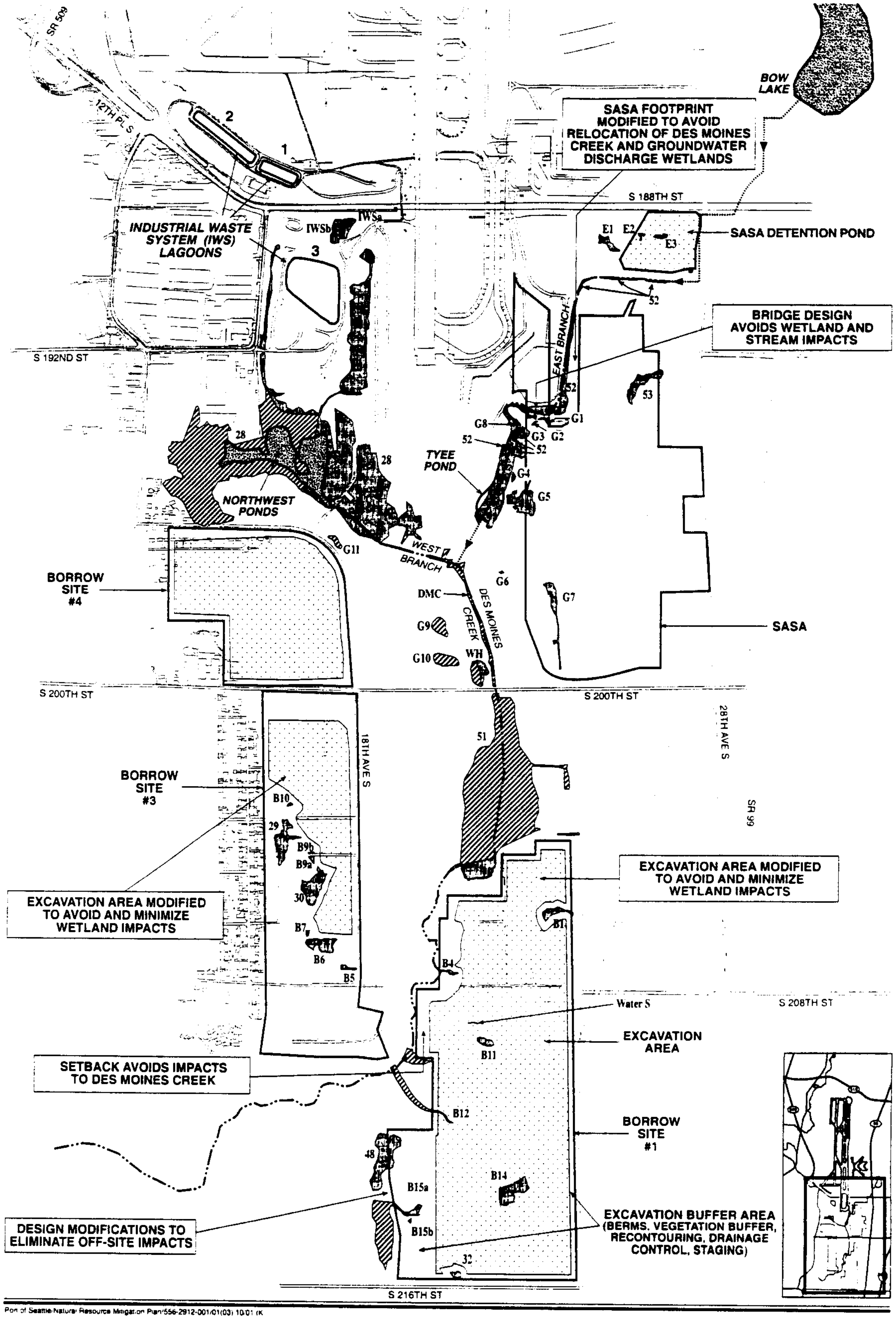
Figure 4.1-1
Avoidance of Wetland and Stream Impacts in the Miller Creek Basin



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▩ Water Features

■ Delineated Wetlands Verified by the ACOE

—·—·— Stream

B12 Wetland Number

⬚ Excavation Area

▨ Wetlands not Verified by the ACOE

··········· Piped Stream

SCALE IN FEET

0 400 800

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Figure 4.1-2
Avoidance of Wetland and Stream Impacts in the Des Moines Creek Basin

Table 4.1-2. **Summary of compensatory mitigation (on and off site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport.**

Impact	Mitigation Action	Target Functions to Replace	Explanation and Key Attributes that Provide Target Functions[a]
ON-SITE MITIGATION			
Permanent Impacts			
Approximately 980 linear ft of Miller Creek channel will be filled to accommodate third runway embankment and South 154th Street relocation.	Relocate approximately 1,080 ft of Miller Creek channel. Enhance 450 ft of Miller Creek channel at Des Moines Way Nursery.	Fish and aquatic habitat Amphibian habitat Organic matter export	The channel design includes instream habitat features, including improved substrate conditions, LWD, channel diversity, and increased channel length. A buffer around the new channel will be vegetated with native trees and shrubs to provide shade and organic matter inputs to the stream.
Drainage channels will be filled near 12th Avenue South to accommodate the third runway embankment.	Create new permanent drainage channels.	Organic matter export functions Groundwater exchange functions	Approximately 1,290 ft of new permanent drainage channels will provide ecological functions by planting the channel margins with native vegetation to provide buffer functions. Functions include shade to control water temperatures and provide organic matter input. The channels will be designed to connect to the embankment drainage layer material to promote groundwater discharge. Connection to wetlands and Miller Creek will promote organic matter transport and export to the creek.
Approximately 8,500 cy of Miller Creek floodplain will be filled to accommodate third runway embankment and South 154th Street relocation.	Replace lost floodplain.	Flood storage	Approximately 9,600 cubic yards of soil will be excavated to suitable elevations that achieve storage of 5.94 acre-ft of floodwaters. Suitable grades and elevations will allow overbank and backwater flooding to occur in this floodplain.

Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).

Impact	Mitigation Action	Target Functions to Replace	Explanation and Key Attributes that Provide Target Functions[a]
Approximately 18.37 acres of wetland will be filled during construction of the third runway embankment and other construction-related projects.	Restore about 12.3 acres of prior converted cropland, farmed wetland, or other wetland on the Vacca Farm site to shrub-dominated wetlands (including removal of 1 acre of fill). Restore about 2.8 acres of the Des Moines Way Nursery site to shrub dominated wetlands (Including removal of 2 acres of fill).	Nutrient and sediment trapping functions Organic matter export Groundwater exchange Small mammal habitat Reduced waterfowl habitat	Plowed farmland will be stabilized with dense shrub and herbaceous plantings. Overbank and backwater flooding will occur to promote organic matter export. Subsurface drainage systems will be removed to promote natural groundwater discharge and flow patterns. Hummocks vegetated with dense native vegetation in wetlands and buffers will be provided as habitat for small mammals. This attribute will be augmented with LWD in wetlands and buffers. Large areas of emergent vegetation, open water, or long-term flooding that could promote waterfowl use will be avoided.
	Restore wetland buffer conditions (1.81 acre) around the north and west sides of Lora Lake.	Fish, amphibian, and aquatic habitat Organic matter export Reduce wildlife attractants	Converting lawn areas to riparian buffer communities will be established by planting with native wetland and upland shrub vegetation (refer to Table 5.1-1 in Section 5). Overhanging dense shrub vegetation will improve aquatic habitat, reduce waterfowl use of shoreline areas, and promote export of organic matter from shoreline to aquatic habitats. Removal of a concrete bulkhead along the Lora Lake shoreline will improve shoreline habitat for amphibians, fish, and aquatic insects.
	Enhance approximately 10.25 acres of wetlands along Miller Creek	Nutrient and sediment trapping Small mammal habitat	Removing structures and restoring native wetland vegetation (Table 4.1-3) will enhance riparian and other wetlands. Areas of non-native vegetation will be removed and native trees and shrubs planted in the wetland.

Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).

Impact	Mitigation Action	Target Functions to Replace	Explanation and Key Attributes that Provide Target Functions[a]
	Restore wetlands on the Tyee Valley Golf Course.	Nutrient and sediment trapping Organic matter export Reduce waterfowl habitat Small mammal habitat	Dense native shrub vegetation will be planted in Des Moines Creek floodplain and riparian areas (see Table 4.1-3). The wetland and riparian vegetation will promote increased export of organic matter to Des Moines Creek compared to the existing turf vegetation.[b] Shrub communities will reduce waterfowl use and improve habitat for small mammals.
Temporary Impacts			
Construction of temporary stormwater management ponds and other projects may temporarily impact up to 2.05 acres of wetland.	Restore forest and shrub communities to Wetland A17. Restore approximately 125 ft of Water D. Restore wetland areas after construction is complete.	Nutrient and sediment trapping Organic matter export Groundwater exchange Small mammal habitat	Restoration of wetlands that will be temporarily filled or disturbed will restore functions that previously existed on these sites. Restoration will include establishing pre-disturbance topography, removing three culverts in Water D, and planting the area with native shrub or forest vegetation. Integration of these areas with the replacement drainage channel mitigation and the embankment drainage layer will promote restoration of pre-existing hydrologic and water quality functions.
Indirect and Cumulative Impacts			
Filled wetlands near Miller Creek will reduce aquatic habitat value of the stream.	Establish and enhance buffers along Miller Creek.	Nutrient and sediment trapping Organic matter export Small mammal habitat	Conversion of residential landuses to vegetated stream buffers will promote nutrient and sediment trapping functions and reduce pollutant loading. Greater densities of riparian vegetation will increase shade, instream habitat, and organic matter export to Miller Creek. Riparian buffer vegetation will contribute to bank stabilization, sediment, and nutrient removal. It will also provide small mammal habitat (see Table 4.1-3).

Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).

Impact	Mitigation Action	Target Functions to Replace	Explanation and Key Attributes that Provide Target Functions[a]
Additional development in the watersheds could result in additional cumulative impacts.	Participate in developing and implementing Miller Creek and Des Moines Creek basin plans.	Aquatic habitat Stream and/or watershed hydrology	These planning processes will identify effective, long-term solutions to restore additional fish habitat functions to Miller and Des Moines Creeks. Projects are anticipated to focus on restoring watershed hydrology through increased regional stormwater detention facilities and improved fish habitat through habitat restoration projects. The Port will contribute staffing resources and funds to support these efforts. The Port will work with other cooperating jurisdictions to plan and implement appropriate watershed restoration projects.
	Provide trust fund to watershed restoration projects.	Cumulative impacts to aquatic habitat	The Port will establish a trust fund to help promote aquatic habitat and other watershed restoration actions.
The runway fill or borrow area excavation may eliminate water sources that contribute to remaining wetlands downslope of the runway.	Design internal drainage and conveyance channels to promote and retain wetland hydrology and streamflow. Monitor wetlands adjacent to the third runway embankment and borrow areas to ensure wetland hydrology is maintained.	Groundwater exchange Organic matter export	Subsurface and surface replacement channels will continue to collect and distribute groundwater currently surfacing near 12th Avenue South to Miller Creek and associated wetlands. Surface drainage patterns and conveyance swales will be designed to collect and distribute groundwater seepage and surface runoff to wetlands downslope of the borrow areas.
OFF-SITE MITIGATION			
Permanent Impacts			
Approximately 18.37 acres of wetland wildlife (avian) habitat will be lost.	Replace high quality wetland and avian habitat functions off-site at an overall ratio of 2:1.	Passerine bird habitat Waterfowl habitat Small mammal habitat Flood storage	A variety of wetland classes and vegetation types on a large protected site will provide high quality habitat for a diverse array of birds and small mammals. Open water habitat (including vegetated aquatic beds) will support waterfowl and other bird species that require small ponds for forage or nesting.

Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).

Impact	Mitigation Action	Target Functions to Replace	Explanation and Key Attributes that Provide Target Functions[a]
			Waterfowl and other marsh birds will use flooded persistent and non-persistent emergent plant communities for forage and nesting. These communities will produce organic matter and aquatic insects that provide forage in open water areas.
			Shrub wetland will fringe marsh communities and provide nesting and forage habitat for songbirds as well as export organic matter to emergent areas.
			Multi-storied forest communities will provide habitat to songbirds, raptors, and small mammals.
			A densely vegetated 100-ft-wide buffer will provide additional upland habitats and protect interior upland and wetland habitats from potential disturbances if off-site areas are developed.
			Microhabitat features-including LWD, vegetated hummocks, interspersion of vegetation types, and proximity to the Green River riparian corridor-will further enhance the area for wildlife.
			Excavation of portions of the site below an elevation of 45 ft and connection to the floodplain of the Green River by enhancing existing drainage channels will provide flood-storage functions.

[a] Analyses of the ecological functions provided at each wetland mitigation site are found in Tables 4-13 to 4-16 in the *Wetland Functional Assessment and Impact Analysis* (Parametrix 2001b). All mitigation areas (including, but not limited to, streams, wetlands, buffers, and floodplains) located within 10,000 ft of a runway shall be subject to the provisions of the Port's *Wildlife Hazard Management Plan* (USDA 2000) for the management of wildlife and wildlife attractant areas. On-site mitigation may provide replacement habitat functions for birds, but credit is not sought for this function, as management of birds pursuant to the WHMP may restrict this function.

[b] These enhancements will be coordinated with the Des Moines Creek Basin Committee's proposed RDF.

Table 4.1-3. Summary of wetland mitigation credit for Seattle-Tacoma International Airport Master Plan Update improvements. (All impacts and mitigation occur in WRIA 9.)

Mitigation	Mitigation Area (ac)	Mitigation Credit
ON-SITE		
Wetland Restoration – Credit ratio 1:1		
Remove Fill Adjacent to Lora Lake	1.00	1.00
Remove Fill at Des Moines Way Nursery Site	2.00	2.00
Remove Fill at Wetland A17	0.30	0.30
Vacca Farm (prior converted cropland and other upland)	6.60	6.60
Temporary Impacts	2.05	2.05
Subtotal	**11.95**	**11.95**
Wetland Enhancement – Credit ratio 1:2		
Des Moines Way Nursery	0.86	0.43
Vacca Farm (Farmed Wetland, Other Wetlands, Lora Lake)	5.70	2.85
Wetlands in Miller Creek Wetland and Riparian Buffer	10.25	5.12
Tyee Valley Golf Course	4.50	2.25
Wetland in Des Moines Creek Buffer	1.01	0.51
Subtotal	**22.32**	**11.16**
Buffer Enhancement- Credit ratio 1:5		
Miller Creek Buffer, South of Vacca Farm	40.86	8.17
Vacca Farm	4.58	0.92
Lora Lake	1.81	0.36
Tyee Valley Golf Course Mitigation Area Buffer	1.57	0.31
West Branch Des Moines Creek Buffer	3.38	0.68
Des Moines Way Nursery	2.73	0.55
Subtotal	**54.93**	**10.99**
Preservation – Credit Ratio 1:10		
Borrow Area 3 Wetland	2.35	0.24
Borrow Area 3 Buffer	21.20	2.10
Subtotal	**23.55**	**2.34**
Total On-Site [a, b]	**112.75**	**36.44**
OFF-SITE		
Wetland Creation[c] - Credit ratio 1:1		
Forest (17.20 acres), shrub (6.0 acres), emergent (6.20 acres), and open water (0.60 acres)	29.98	29.98
Wetland Enhancement - Credit ratio 1:2	19.50	9.75
Buffer Enhancement - Credit ratio 1:5	15.90	3.18
Total Off-Site	**65.38**	**42.91**
TOTAL	**178.13**	**79.35**

[a] Mitigation credit has not been assigned for relocating a portion of Miller Creek channel, instream enhancement projects, drainage channel replacement, or a $300,000 trust fund for watershed restoration.

[b] In- basin mitigation area divided by wetland impacts (18.37 acres permanent plus 2.05 acres temporary) provides a 5.5:1 aerial replacement ratio.

[c] Based on maps of hydric soils, mitigation can be also characterized as restoration.

Table 4.1-4 Wetland acreage impacts and mitigation by wetland function.

		On-Site[a]		Auburn		
Function	Impact[b]	Acres	Credit	Acres	Credit	Comment
Resident/ Anadromous Fish	8.6	74.60	30.42	-	-	On-site mitigation includes mitigation for direct impacts to Miller Creek and indirect impacts that may occur through alteration of riparian and hydrologically connected wetlands. For the Miller Creek enhancement areas, buffer averaging areas greater than 100-feet from Miller Creek were excluded from providing this function.
Passerine Birds	14.9	-	-	65.38	42.91	On-site mitigation credit is not sought for this function due to potential wildlife management actions.
Waterfowl	1.9	-	-	6.80	6.80	On-site mitigation credit is not sought for this function due to potential wildlife management actions.
Amphibians	9.8	87.05	31.95	65.38	42.91	The Lora Lake shoreline restoration, restoration at the nursery site, removing human uses, and establishing native plant communities provided by the on-site mitigation will provide habitat for several species.
Small Mammals	13.2	87.05	31.95	65.38	42.91	Wetland restoration and enhancement, eliminating human uses, and establishing native plant communities provided by the on-site mitigation will provide habitat for several species.
Exports Organic Matter	10.9	87.05	31.95	-	-	On-site mitigation includes increasing production and quality of organic matter in wetlands and riparian areas through restoration and enhancement. Maintenance actions that remove organic matter from wetlands, streams, and buffers will also be removed.
Ground Water Exchange	-	-	-	-	-	Impacts to this function, provided by slope and riparian wetlands (13.6 acres), are avoided by project design and by low flow augmentation.
Flood Storage	4.6	4.6	4.6	25	25	This function is mitigated on-site by new flood storage at Vacca Farm and by stormwater detention facilities that are designed to maintain or decrease peak stream flows during flood events.
Nutrient/Sediment Trapping	16.3	87.05	31.95	65.38	42.91	In basin mitigation for this function is provided by wetland restoration and enhancement and by the changes in land use that convert pollution generating land uses in mitigation areas to native vegetation. The retrofitting of existing pollution generating surfaces with BMPs for water quality treatment also improve water quality of runoff.

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[a] Preservation of wetland and buffer near Borrow Area 3 is excluded from this table.

[b] Functional ratings for Wetlands that exceed low are included in these values.

However, all mitigation areas (including but not limited to wetlands, streams, buffers, and floodplains) and other lands located within 10,000 ft of a runway are subject to the provisions of the Port's WHMP (USDA 2000) for management of wildlife and wildlife attractants (FAA Advisory Circular 150/5200-33). No open-water habitat is to be created within 10,000 ft of the airfield as part of this mitigation plan. As explained in this plan, on-site mitigation is planned to reduce certain existing wildlife hazards to comply with FAA mandates regarding wildlife attractants near airports. Thus, on-site mitigation focuses on providing aquatic habitat enhancements for fish, amphibians, and invertebrates when such can be accomplished without increasing waterfowl use. On-site mitigation also replaces flood storage functions impacted and enhances the biological and physical functions of riparian areas near Miller and Des Moines Creeks. These areas will provide small mammal and song bird habitat, though this is not their primary purpose.

Mitigation for wildlife habitat (bird and small mammals) is provided off-site. The off-site mitigation is designed to provide a large, high-quality, diverse wetland system and is located in the City of Auburn. At this site, habitat mitigation can be provided that is consistent with the FAA Record of Decision (1997c) and Advisory Circular 150/5200-33 and RGL 01-1 (ACOE 2001) regarding wildlife attractants and mitigation near airports.

4.1.1 On-Site Mitigation

Following the recommended preference for on-site mitigation, a number of on-site mitigation elements are proposed to compensate for Master Plan Update improvements affecting wetlands, hydrology, water quality, and aquatic habitat in the Miller and Des Moines Creek basins. Mitigation projects in Miller and Des Moines Creek basins are designed to replace all lost wetland functions with the exception of avian habitat. On-site mitigation is also directed toward removing certain existing land use conditions that, over time, have contributed to degraded wetland and aquatic habitats in these basins. The mitigation projects designed for the Master Plan Update improvements (see Table 4.1-2 and Figure 4.1-3) have been developed in direct response to agency guidelines for on-site functional mitigation.

4.1.1.1 Miller Creek Basin

The focus of mitigation in the Miller Creek basin is to restore and enhance ecosystem functions to the aquatic/wetland systems along a significant portion of Miller Creek. Mitigation actions in the Miller Creek basin will restore wetland, stream, and riparian functions to a 1.5-mile reach, or approximately one third of the entire length of Miller Creek.

The Miller Creek watershed has been modified and habitats degraded by historical and on going agricultural, residential, commercial, and industrial development. Approximately 80 percent of the watershed has been converted from its original forested condition to residential or commercial land

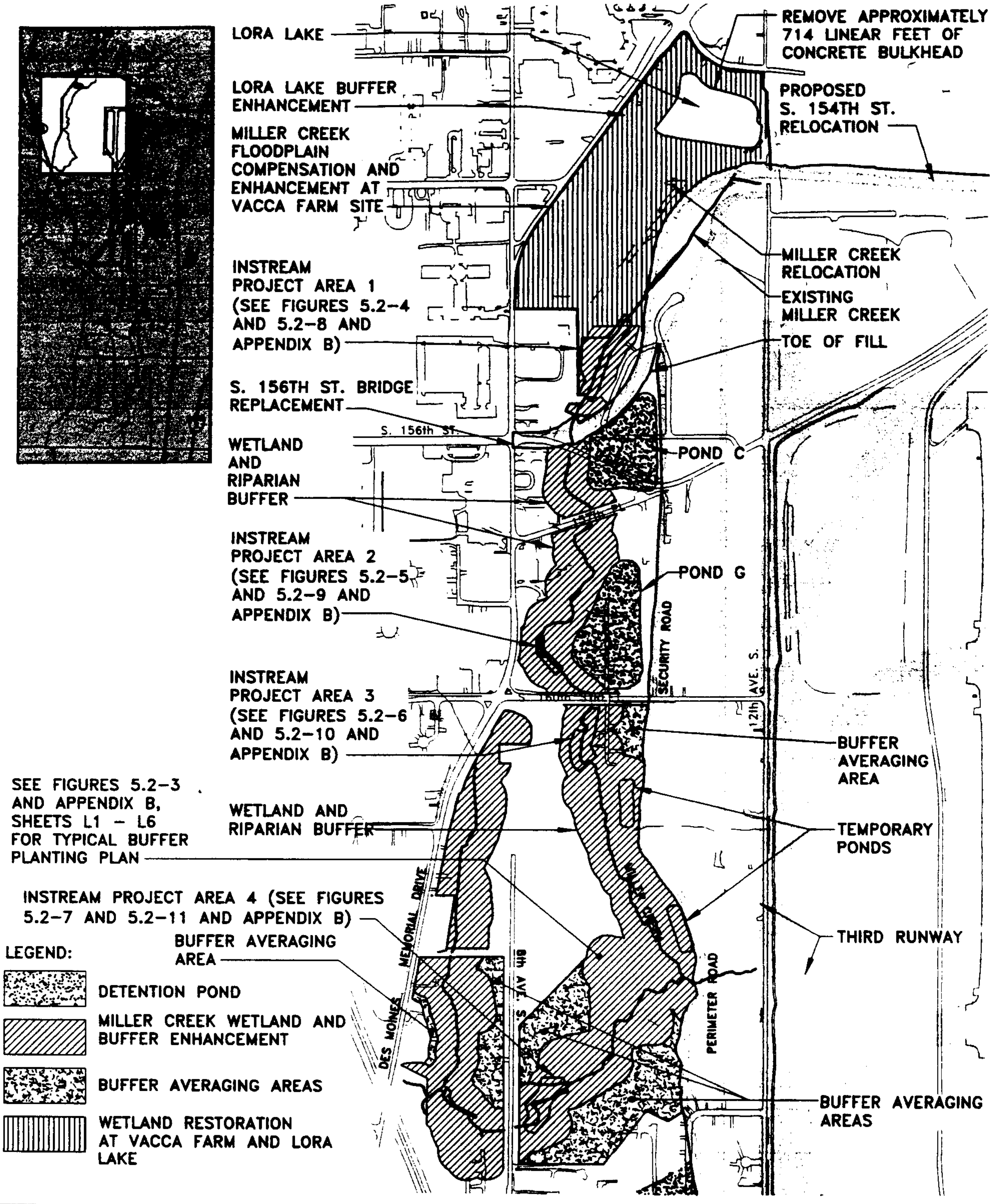

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Figure 4.1-3
Locations of Mitigation Projects in the Miller Creek Basin

uses (Parametrix 2000a, 2001a). Increased impervious surfaces have resulted in increased runoff rates and volumes, which have contributed to erosion and down cutting in high-energy reaches and increased sedimentation and habitat degradation in low-gradient reaches (FAA 1996; KCSWM 1994). Runoff from residential, commercial, and agricultural areas has increased input of sediment, nutrients, and pollutants to the stream. Upland and wetland riparian areas adjacent to the stream have been altered from the original forest and/or shrub cover to impervious surfaces, agricultural fields, residential lawns, or ornamental landscaping. Native plant and animal habitats have been reduced in size and fragmented, resulting in a loss of species diversity.

The natural channel morphology of Miller Creek has been altered, particularly in reaches above South 160th Street. Extensive areas of the channel have been armored with riprap or retaining walls, and dredged or straightened to protect property adjacent to the stream or to drain land for agricultural uses. For much of its length, Miller Creek lacks connections to adjacent floodplains, floodplain wetlands, or riparian areas due to filling of adjacent wetlands, as well as dredging and straightening of the channel to increase conveyance. These changes have resulted in a lack of habitat complexity, a lack of woody debris in the channel, a lack of shading from riparian vegetation, the loss of surface water storage, and degraded water quality and biotic integrity in much of the basin.

To replace functions impacted by the Master Plan Update improvements and to restore and enhance aquatic and wetland functions in the Miller Creek basin, the Port proposes the following specific mitigation:

- Restore natural channel morphology, habitat complexity, and instream habitat along an approximately 1.4-mile reach of Miller Creek extending from south of Lora Lake to Des Moines Memorial Drive.
- Restore floodplain, floodplain wetlands, and riparian areas along the upper reaches of Miller Creek, and re-integrate floodplains and adjacent wetlands with the stream.
- Restore, replace, and enhance wetland and aquatic habitat functions to the currently degraded lacustrine, stream, floodplain, and riparian wetland system along the upper reaches of Miller Creek.
- Maintain wetland hydrology and base flow functions in wetlands adjacent to the embankment fill by providing surface water drainage features to convey groundwater and surface water runoff from the new embankment to downslope wetlands.
- Restore and enhance wetland and aquatic functions, and protect the long-term viability of these systems by establishing native forested buffers around wetlands and aquatic systems from Lora Lake to Des Moines Memorial Drive.
- Restore habitat connectivity in the upper reaches of the Miller Creek basin by providing a continuous forested wetland and riparian corridor connecting currently fragmented wetland, aquatic, and riparian habitats between Lora Lake and Des Moines Memorial Drive.

To accomplish these objectives, mitigation projects will be concentrated in two areas along the upper reaches of Miller Creek: (1) Lora Lake and the Vacca Farm and (2) Miller Creek and its riparian zone between Lora Lake and Des Moines Memorial Drive.

In addition to these projects, the Port will establish watershed trust funds to promote local stream restoration projects in the Miller Creek basin.

4.1.1.2 Des Moines Creek Basin

Mitigation projects for the Des Moines Creek basin are designed to mitigate unavoidable project impacts to wetlands and aquatic resources by restoring wetland and stream functions, and by providing mitigation for potential indirect effects to wetland hydrology. Mitigation actions in the Des Moines Creek basin will increase infiltration adjacent to the stream, reduce pollutant runoff, increase sediment retention, and improve nutrient cycling functions in the wetland adjacent to Des Moines Creek. To replace functions impacted by Master Plan Update improvements and to restore and enhance aquatic and wetland habitat in the Des Moines basin, the Port proposes the following specific mitigation:

- Restore and enhance wetland and aquatic habitat by replacing the existing turf grass wetland with a native shrub wetland at the Tyee Valley Golf Course, adjacent to Des Moines Creek.
- Enhance water quality and fish habitat, and restore stream conditions in Des Moines Creek by establishing a forested buffer along at least 1,600 linear feet of the west branch of Des Moines Creek.
- Avoid, minimize, and mitigate potential indirect hydrology impacts to wetlands adjacent to the borrow areas by directing groundwater seepage and/or surface water runoff to wetlands near the borrow areas.

In addition to these projects, the Port will establish watershed trust funds to promote local stream restoration projects in the Des Moines Creek basin.

4.1.1.3 On-site Stormwater Mitigation

The Port will construct the necessary stormwater conveyance, detention, and treatment facilities to manage runoff from both newly developed project areas and existing airport areas. These facilities will not only mitigate new construction impacts, as required by current stormwater regulations and mitigation goals identified during the environmental review process, but they will also help to reduce flood peaks in these basins to further mitigate the impacts of airport stormwater discharges.

On-site stormwater facilities will be constructed in Miller, Walker, and Des Moines Creek basins at 14 separate locations and provide approximately 344 acre-ft of new storage. The following sections describe specific mitigation to reduce stormwater impacts from Master Plan Update improvements. Detailed information on mitigation for stormwater quantity and quality is included in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a).

Stormwater Detention Based on Higher Stormwater Standards

Detention storage provided for Master Plan Update improvement projects will exceed that normally required by local regulations, and result in additional mitigation of stormwater impacts from project areas, including reduced peak stormwater runoff impacts on Miller, Walker, and Des Moines Creeks.

Reduce Runoff from Existing Airport Areas With Stormwater Detention

To control runoff from areas of the airport developed prior to 1994, stormwater detention will be provided to mitigate existing runoff impacts. Proposed detention facilities in Miller, Walker, and Des Moines Creeks include stormwater detention to mitigate impacts of pre-1994 development. In the retrofit analysis, the pre-development flow rates assumed that existing land cover is 10 percent impervious area, 75 percent forest, and 15 percent grass (also known as the pre-development "target flow regime"). Stormwater detention designs for Miller, Walker, and Des Moines Creek basins are based on the Level 2 flow control.

Provide Infiltration at Stormwater Detention Facilities

Further improvements to low stream flows will be achieved by infiltrating stormwater at the detention facilities. Because site conditions must be favorable for infiltration to be feasible, the Port has evaluated infiltration for stormwater detention facility design. Ponds in the Miller Creek Basin will use infiltration where practicable.

Water Quality Mitigation

The STIA Master Plan Update improvement projects are not expected to impact existing water quality because:

- The quality of STIA runway stormwater has been shown to be comparable to or better than regional urban stormwater.
- In contrast to existing land uses, all Master Plan Update improvements will be served by BMPs in compliance with the *Stormwater Management Manual for Western Washington* (Ecology 2001b) (e.g., bioswales, filter strips, wet vaults, infiltration).

Since Miller, Walker, and Des Moines Creeks drain urban watersheds, they have been subject to cumulative impacts of heavy metals, oils, and grease from nearby urban highways; fecal coliform from failing residential septic systems and adjacent farms; and suspended solids and litter carried in urban runoff. They also receive increased levels of phosphorus and nitrogen from fertilization of landscaping or cultivated areas. These impacts are typical of an urban environment supporting an assortment of residential, commercial, and industrial activities. Sources of many of these pollutants will be removed as part of the Master Plan Update improvements within the approximately 258-acre acquisition area. Because actions to mitigate impacts to water quality will be in place, the quality of stormwater runoff in the future will be equal to or better than current stormwater quality. A detailed discussion of water quality benefits and mitigation is included in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a).

4.1.2 Off-Site Mitigation

Off-site mitigation is proposed because FAA regulations generally prohibit the siting of potential wildlife attractants (including wetland mitigation) within 10,000 ft of active runways.[13] The Port

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[13] For the Master Plan Update, FAA has specified off-site wetland mitigation as a requirement of Federal funding (FAA 1997a).

searched for wetland mitigation sites in the Des Moines and Miller Creek watersheds that could be used to provide replacement wildlife habitat; however, these watersheds are almost totally within the 10,000-ft exclusion area for wildlife habitat mitigation. Areas within these two watersheds that are more than 10,000 ft from existing runways were found not to be suitable for mitigation due to their small size, developed nature, forested condition, or the lack of hydrologic conditions necessary to support wetlands.

To mitigate for the loss of wildlife habitat due to the Master Plan Update improvements, the Port will construct wetland mitigation off-site on a 65-acre parcel in the City of Auburn. This wetland mitigation area will replace lost wetland functions at a minimum 2:1 replacement ratio. This mitigation provides the opportunity to create, restore, and enhance high-quality, diverse forested, shrub, emergent, and open water wetland habitats and functions to a site where these functions are currently absent or degraded. Approximately 17.2 acres of forested wetland, 6.0 acres of shrub wetland, 6.2 acres of emergent wetland, 0.60 acre of open water habitat will be created or restored. On about 19.5 acres of emergent wetland dominated by non-native pasture grasses, native wetland forest communities will be restored. Overall habitat functions will be enhanced by providing approximately 11.9 acres of forested buffers around the perimeter of the site and approximately 4.0 acres of upland habitat within the interior portion of the site. Replacing habitat currently dominated by pasture grasses with native forested, shrub, and emergent wetland plant communities will enhance wetland functions in existing wetlands.

4.2 ECOLOGICAL FUNCTIONS PROVIDED BY THE MITIGATION

The mitigation sites have been designed to replace and enhance the ecological functions provided by wetlands and streams impacted by the MPU projects at STIA. Mitigation also includes the establishment and enhancement of protective buffers where none are present today. The establishment and enhancement of these buffers at the on- and off-site mitigation areas improve the ecological condition above baseline (or pre-project) conditions, as the buffer areas are currently developed or otherwise degraded by various land uses. The specific functions replaced at each of the mitigation sites are discussed below. The value of the buffers in protecting ecological functions of the mitigation sites is also discussed below.

4.2.1 Vacca Farm Restoration and Miller Creek Relocation

Mitigation at this site focuses on replacing the Miller Creek stream channel, replacing riparian habitat functions, replacing lost floodplain functions, improving water quality functions, improving organic matter export functions, and reducing the habitat value of the area to waterfowl and flocking birds. These functional changes will be achieved as described in the following paragraphs:

- **Fish and Aquatic Habitat**
  The new stream channel will provide improved fish and other aquatic habitat because it is designed with a number of beneficial features to cutthroat trout and other organisms that are lacking in the present stream (see Appendix K). The primary characteristics provided by the design are LWD, woody riparian vegetation, and substrate variability. Each of these features will enhance fish and aquatic habitat. Increased amounts of woody riparian vegetation will result in increased shade, allochthonous inputs (food sources in the form of coarse particulate organic matter [CPOM] and terrestrial invertebrates), and sources of woody debris. Increased

LWD generally provides habitat complexity, including small plunge pools, fish cover, invertebrate substrates, variable water depths and velocities, etc. These conditions will provide nesting, resting, and forage habitat for fish and other aquatic life. Increased streambed variability in the form of gravel, wood, and CPOM will also increase the diversity of invertebrate habitat. [Note that the role of LWD and riparian conditions on aquatic systems is extensively reviewed in Allen (1995), Bisson and Bilby (1998), Bisson et al. (1987), Gregory et al. (1986), Harmon et al. (1986), Hershey and Lamberti (1998)].

The shallow water along the margin of Lora Lake will be improved aquatic habitat compared to existing conditions. The replacement of fill, lawns and riprap coupled with restored wetlands, and plantings of riparian tree and shrub vegetation will improve aquatic habitat by providing shade and organic matter input (woody debris, leaf matter, and insects) that will support fish and other aquatic life.

- **Amphibian Habitat**
  In Puget Sound, amphibian species using non-flooded wetland and riparian areas typically prefer habitats dominated by woody plant communities (Brown 1985; Johnson and O'Neil 2001; Kauffman et al. 2001; Rose et al. 2001). Thus, converting farmland to shrub and forested wetlands and buffers will improve habitat conditions for amphibians. The restored floodplain wetlands will provide habitat for adult amphibians and breeding habitat (logs and forest soils) for species that breed in non-aquatic habitat (e.g., red-backed salamander, ensatina). The mitigation site will also improve amphibian dispersal because of the new South 154th Street bridge that will span the floodplain of Miller Creek, and removal of the existing bridge, which prevents movement of amphibians through riparian areas. The mitigation will also improve connections to upstream, forested wetlands (Wetlands 1 through 9).

  The removal of riprap and fill from the margin of Lora Lake will and provide breeding habitat for amphibians that require surface water for breeding. Removing fill and restoring shrub wetlands along the lake margin will provide non-aquatic habitat for amphibians.

- **Small Mammal Habitat**
  Planting of vegetation in riparian areas and restoring wetlands will improve habitat for small mammals by creating a diversity of forage and cover habitat for them. Logs and woody vegetation added to the site will provide denning and forage areas (Brown 1985; Johnson and O'Neil 2001; Kauffman et al. 2001; Rose et al. 2001). The new South 154th Street bridge and demolition of the existing bridge will improve habitat connectivity for small mammals, because the new bridge will span the floodplain and allow unimpeded passage of small mammals. The restoration also improves habitat connectivity to Wetlands 1 through 9 that are located north and east of the site.

  Removal of fill and restoration of shrub wetlands along the margin of Lora Lake will provide small mammal habitat for wetland and non-wetland dependent species.

- **Nutrient Retention and Sediment Trapping (Water Quality)**
  The new channel is designed to have overbank flow during the 1-year and higher storm events. Smaller storms will flood portions of the floodplain through backwater flooding. In each case, floodwater flows into shrub and forested riparian areas will promote sediment trapping and

retention of nutrients in the restored wetland (see Mitsch and Gosselink 2000 and Belt et al. 1992). In the riparian wetlands, planting woody vegetation will allow this function to occur at higher levels than currently exists on the farmland or lawn areas (adjacent to Lora Lake). The replacement of herbaceous vegetation with woody plant communities would promote storage of nutrients in organic matter (wood) which decomposes slower than herbaceous vegetation (Harmon et al. 1986). Removal of farming and residential land use activities will remove activities that degrade water quality (Horner et al. 1994; Los Angeles County Department of Public Works 2000; Steur et al. 1997; Bannerman et al. 1999; Minnesota Pollution Control Agency 2000).

- **Organic Matter Export**
  The new channel is designed to have overbank flow during the 1-year and higher storm events. Smaller storms will flood portions of the floodplain through backwater flooding. As floodwaters recede, export of dissolved and particulate organic matter from the floodplain to the stream is likely, and will occur at higher levels because greater amounts and types of organic matter (leaves, twigs, branches, etc.) will be on site and available for export.

  Replacing of grass-dominated riparian plants adjacent to the stream and Lora Lake with native woody riparian vegetation will increase the amount and diversity of organic matter (i.e., readily decomposable leaves and woody debris that is slower to decompose) available to the stream and aquatic habitat of Lora Lake.

  The high productivity expected in forest and shrub wetlands will result in accumulations of organic matter in the saturated soil of the restored wetland. Groundwater movement through the site and flooding will transport dissolved organic matter to Miller Creek (Fieberg et al. 1990; Emmet et al. 1994; Dosskey and Bertsch 1994). Placement of logs in Miller Creek and development of a natural riparian zone will help trap organic debris in the stream channel (Bisson and Bilby 1998; Speaker et al. 1988; Bisson et al. 1987), where it will be available for processing by aquatic invertebrates, thus benefiting the food chain.

  Removal of plowing and soil drainage systems will reduce the potential loss of peat soils through oxidation, which occurs in better-drained soils (Ford 1993). Restoring natural hydrology and natural plant communities will provide a carbon cycle where greater amounts of organic matter decomposes anaerobically with subsequent export from the site as dissolved organic carbon, and accumulation on-site as organic soil.

- **Groundwater Exchange**
  The mitigation area is predominantly a groundwater discharge area (as indicated the historical presence of peat soils (Rigg 1958; Paulson 1953). Enhancement activities will not alter this hydrology pattern. Restoration as wetland, including removal of some agricultural drainage systems, would reduce the velocity of some groundwater that moves across the site.

- **Flood Storage**
  The Vacca Farm mitigation site is designed to replace floodplain filled by the project (8,500 cubic yards) and provide a small net increase (9,600 cubic yards). The overall significance of the wetlands and farmland in providing this function will not change.

- **Waterfowl Habitat**
  As directed by FAA, waterfowl habitat functions are not proposed at this mitigation area. The current farmland will be planted with trees and shrubs to provide a complete canopy cover that will prevent ground foraging by waterfowl. Additionally, while portions of the site will flood during 1-year and greater storm events, the presence of standing water on the site will be for a short duration and obscured by vegetation. Thus, it will not attract wildlife.

  The pond margin along Lora Lake will be modified to reduce use by waterfowl. Replacing lawns with riparian tree and shrub vegetation will eliminate forage and resting areas used by waterfowl.

- **Passerine Bird Habitat**
  Planting tall shrubs and trees on the site will reduce foraging by flocking birds. The plant species to be planted do not provide direct food sources (i.e., fruits, nuts, seeds, berries, etc.) for avifauna. The vegetation will produce insects that a variety of passerine birds will forage upon. The combination of these elements will limit bird use, and shift use from flocking birds to forest species. Planting trees and shrubs around Lora Lake could increase forage opportunity for some birds such as kingfisher.

4.2.2 Miller Creek Buffer Wetland Enhancement

Enhancing the riparian zone along Miller Creek, including the enhancement of instream habitat, buffers, will provide the following functions:

- **Fish and Aquatic Habitat**
  The instream enhancements will improve habitat for fish and other aquatic organisms because of the new beneficial features that will be added to the stream that are currently lacking. The primary features provided are LWD, woody riparian vegetation, substrate variability, and removal of riprap. Each of these features will enhance fish and aquatic habitat (see Cederholm et al. 1997). Increased amounts of woody riparian vegetation will result in increased shade, allochthonous inputs (food sources in the form of CPOM and terrestrial invertebrates), and sources of woody debris. Increased LWD generally provides habitat complexity, including small plunge pools, fish cover, invertebrate substrates, variable water depths and velocities, etc. These conditions provide nesting, resting, and forage habitat for fish and other aquatic life. Increased streambed variability in the form of gravel, wood, and CPOM will also increase the diversity of invertebrate habitat. Removal of riprap will provide more natural channel banks that improve invertebrate habitat and forage areas for fish. Buffer enhancement will increase the types and amounts (terrestrial insects, plant detritus, etc.) of organic matter inputs to the stream, thus increasing forage resources for fish and invertebrates. The role of riparian conditions and LWD on aquatic systems is extensively reviewed in Allen (1995), Bisson and Bilby (1998), Bisson et al. (1987), Gregory et al. (1986), Harmon et al. (1986), Hershey and Lamberti (1998), Harmon et al. (1986), and Lassettre (1999).

- **Amphibian Habitat**

  The wetland and buffer enhancements that replace lawns and homes will improve conditions for amphibians by enhancing vegetated habitat in riparian wetlands. This enhancement will provide improved habitat for adult terrestrial amphibians. Improved habitat for terrestrial breeding amphibians (e.g., red-backed salamander, ensatina) will be provided by increased amounts of forest vegetation and woody debris in the Miller Creek buffer and riparian wetlands (Brown 1985; Johnson and O'Neil 2001; Kauffman et al. 2001; Rose et al. 2001). The mitigation site will also improve amphibian dispersal because of improved connections to habitat at Vacca Farm, Lora Lake, and other riparian wetlands.

- **Organic Matter Export**

  Replacing grass-dominated riparian areas with native woody riparian vegetation will increase the export of organic matter to the creek. In many places, lawn vegetation will be replaced with tree and shrub vegetation. The higher productivity and greater structural diversity expected in the riparian wetlands will increase the amount and diversity of organic matter (i.e., insects, leaves, branches, trees, etc.) reaching the stream. Accumulations of organic matter in the saturated soil and increased export to the stream as detritus and woody debris or as dissolved carbon are likely to occur. Where riparian vegetation consists of blackberry, its replacement with a multi-storied forest and shrub canopy will also increase the type and diversity of organic matter reaching the stream.

  Placing LWD in the stream channel and removing residential land uses, as part of mitigation, will result in restoration of natural patterns of organic matter storage and cycling in the stream channel (Bisson et al. 1987; Harmon et al. 1986). For example, under residential land use, many residents clear the riparian buffer of trees or shrubs, reducing delivery of organic matter to the stream channel. When trees or branches do fall into the creek, they are typically removed by the landowner. Removing these logs and branches prevents trapping of organic matter in the channel, and promotes its conveyance downstream. Placement of logs in the stream as mitigation will promote trapping and storage of organic matter in the mitigation site, where its ultimate decomposition will benefit aquatic organisms.

  Groundwater movement through the riparian wetlands will transport dissolved organic matter (Ford 1993) to Miller Creek. Removing artificial bank armoring and placing in-channel woody debris will improve overbank flow in some sections. This overbank flow, coupled with overhanging riparian vegetation, will provide additional sources of organic matter export into the stream channel. Where riparian wetland vegetation is currently pasture or blackberry, planting tree and shrub communities will increase the amount and diversity of organic matter available to the stream and wetlands.

- **Nutrient Retention and Sediment Trapping (Water Quality)**

  Water quality functions of the buffer and riparian wetlands will improve for several reasons. Many impacts to wetlands and the stream will be removed as a result of the project and mitigation. For example, several dozen houses and buildings, lawns, driveways, etc. will be removed from the mitigation area, thus removing features and land uses that contribute to the degradation of water quality (Horner et al. 1994; Los Angeles County Department of Public Works; 2000; Steur et al. 1997; Bannerman et al. 1999; Minnesota Pollution Control Agency 2000). Several septic systems will be removed from the mitigation area, as will one or more horse pasture, which also contribute to degradation of water quality. Outside of the mitigation area, removing streets and residential land use will reduce the amount of pollutant loading to the wetland and stream system. Restoration of these disturbed areas will increase their capacity to provide water quality functions by establishing natural nutrient cycling pathways.

- **Groundwater Exchange**

  The mitigation area is a predominantly groundwater discharge area and enhancement activities will not alter this hydrology pattern (Hart Crowser 2000c; Pacific Ground Water Group 2000, 2001). Design of the embankment and the hydrologic function of the embankment will protect this function.

- **Small Mammal Habitat**

  Planting riparian vegetation in riparian areas and restoring wetlands will improve habitat for small mammals by creating a diversity of forage and cover habitat for them. Increased woody vegetation and debris will provide denning and forage areas (Brown 1985; Johnson and O'Neil; 2001; Kaufman et al. 2001; Rose et al. 2001). The new 154th Street bridge and demolition of the existing bridge will improve habitat connectivity for small mammals using the Miller Creek buffer.

- **Passerine Bird Habitat**

  The buffer plants will provide limited direct food sources (i.e., fruits, nuts, seeds, berries, etc.) for avifauna, but will produce insects that a variety of passerine birds forage upon. While not a specific goal of the mitigation, the increased amounts of woody and forest vegetation will provide additional and improved habitat for forest-dwelling bird species.

Buffering Miller Creek and associated riparian wetlands with 100-ft average buffers will improve the function of the stream compared to baseline. For most functions of concern, the buffers will ameliorate temperature control and provide/protect instream habitat. The 100-ft buffer width, in some locations,[14] is somewhat less than the width that would maximize recruitment of large woody debris (Table 4.2-1). At this width, some reduction in delivery of woody debris to the stream compared to a mature forested buffer in an undisturbed area will occur.[15] Delivery of wood above the current baseline will be substantial because much of the buffer is currently landscaped and homeowners remove woody debris.

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[14] In many locations, the combination of forested riparian wetlands, buffer-averaging areas, and 100-ft stream buffers exceed widths recommended for this function. Where buffers are less than recommended distances, hazard trees can be cut to fall into the buffer to supplement delivery of wood to buffers and creeks.

[15] In many areas, trees are absent from areas farther than 100 ft from the stream (the buffer averaging approach has incorporated several forested areas beyond the 100-ft buffer into the mitigation). Since these areas currently lack trees, the reduction of this function will occur in future years, when planted trees have grown to heights greater than 100 ft. This could occur after 50 to 75 years.

Table 4.2-1. Riparian habitat buffer widths needed to protect riparian habitat functions (modified from Knutsen and Naef [1997]).

Riparian Habitat Function	Buffer (Ft)	Literature Sources	Evaluation for Master Plan Update Mitigation
Water Temperature Control			
60-80% shading	35 to 125	Brazier et al. 1973	The 100 ft vegetated buffer would provide full shade of the narrow stream channels and thus provide water temperature control function. In limited areas where the buffer is reduced to 50 ft, full shading is also expected to occur because of the dense multi-layered planting approach. Since several buffer areas are currently disturbed, shading will increase over time, and is not currently optimal in all locations.
	35 to 120	Johnson and Ryba 1992	
	39	Corbett and Lynch 1985	
	49 to 100	Hewlett and Fortson 1982	
	59	Moring 1975	
50-100% shading	60 to 125	U.S. Forest Service et al. 1993	
	100	Lynch et al. 1985	
	100	Beschta et al. 1987	
	100	Johnson and Ryba 1992	
	100 to 141	Jones et al. 1988	
80% shading	151	Steinblums et al. 1984	
Large Woody Debris			
	100	Murphy and Koski 1989	The mitigation places a substantial amount of LWD in the stream at construction. The stream buffer mitigation will substantially improve recruitment of LWD over existing conditions. When trees in the buffer reach mature heights in 60 to 120 years, recruitment will be somewhat reduced (5 to 15%) from levels expected if buffers were 150 ft. Recruitment could be increased to natural levels (and accelerated over time) by placing any trees that have fallen outside the buffer within the buffer and by felling hazard trees inward toward the creek.
	103	Bottom et al. 1983	
	148	Harmon et al. 1986	
	150	McDade et al. 1990	
	150	Robison and Beschta 1990	
	165	Van Sickle and Gregory 1990	
	180	Thomas et al. 1993	
Filter Sediments			
75% sediment removal	100 to 125	Karr and Schlosser 1977	This function will occur as a result of the 100-ft average stream buffers. Where buffers are reduced to a minimum of 50 ft, the function will also be realized because there will be no areas of bare ground or erosion near the creeks. Permanent and temporary stormwater management facilities and other BMPs (which collect sediment from impervious and construction surfaces) provide this buffer function.
90% of sediment removal at 2% grade	100	Johnson and Ryba 1992	
Sediment removal	100	Erman et al. 1977; Moring et al. 1982; Lynch et al. 1985	
	200	Terrell and Perfetti 1989	

Table 4.2-1. Riparian habitat buffer widths needed to protect riparian habitat functions (modified from Knutsen and Naef [1997]) (continued).

Riparian Habitat Function	Buffer (Ft)	Literature Sources	Evaluation for Master Plan Update Mitigation
50% deposition	289	Gilliam and Skaggs 1988	
Effective control of non-channelized sediment flow	200 to 300	Belt et al. 1992	
			Larger buffers to remove sediment are recommended for land use conditions that are not relevant to the Master Plan Update mitigation sites, such as agricultural, forestland, mining, or other land uses. Studies that identify buffer needs in excess of 100 ft have not considered TESC and extensive stormwater management facilities to control runoff.
Filter Pollutants			
Nutrient reduction	13	Doyle et al. 1977	The stream buffers are large enough to provide this function. They are generally not intended to do so because BMPs and the IWS route pollutants from pollution-generating surfaces through the stormwater management system for treatment. High levels of nutrient and chemical loading associated with agricultural land uses will not occur. The larger buffers recommended for removal of nutrients, fecal coliform, and pesticides from agricultural land uses are not relevant to the Master Plan Update mitigation sites.
Minimum	33	Petersen et al. 1992	
	49	Castelle et al. 1992	
	52	Jacobs and Gilliam 1985	
Nutrient removal using the multi-species riparian buffer strip system	66	Schultz et al. 1995	
Remove fecal coliforms	100 to 141	Jones et al. 1988	
	100	Grismer 1981	
	100	Lynch et al. 1985	
Nitrates removed to meet drinking water standards	100	Johnson and Ryba 1992	
Nutrient pollution in forested riparian areas	100	Terrell and Perfetti 1989	
Nutrient removal	118	Young et al. 1980	
Pesticides and animal waste	200	Terrell and Perfetti 1989	
Nutrient pollution in herbaceous or cropland riparian areas	600	Terrell and Perfetti 1989	

Table 4.2-1. Riparian habitat buffer widths needed to protect riparian habitat functions (modified from Knutsen and Naef [1997]) (continued).

Riparian Habitat Function	Buffer (Ft)	Literature Sources	Evaluation for Master Plan Update Mitigation
Erosion Control			
Bank erosion control	100	Raleigh et al. 1986	Full erosion control potential of the buffer will be realized. There are no high mass wasting areas present in the stream buffer. Specific mitigation is planned to improve bank stability and natural channel morphology.
High mass wasting area	125	Cederholm 1994	
Microclimate Influence			
In forested ecosystem	200 to 399	Chen et al. 1990	These recommendations are made for old-growth forest ecosystems and are not relevant to urban conditions found in the Master Plan Update mitigation sites.
	525	Harris 1984, Franklin and Forman 1987	This function is lost from urban areas as there is no longer a forested ecosystem. However, the stream buffer mitigation will increase the microclimate influence of the buffer above existing baseline. It is unlikely any negative impact to aquatic or terrestrial organisms will result.
Aquatic Habitat			
Aquatic insects	100	Erman et al. 1977	This function will be fully realized where 100-ft buffers are present. In limited areas, the function may be sub-optimal due to 50-ft buffers. However, aquatic habitat conditions at the mitigation sites will improve above baseline due to the instream and buffer enhancement projects, and buffer averaging is included to mitigate reduced buffer widths.
Benthic invertebrates food supply	100	Erman et al. 1977	
Macroinvertebrate density	100	Newbold et al. 1980	
	100	Gregory et al. 1987	
Riparian invertebrates	100	Erman et al. 1977; Roby et al. 1977; Newbold et al. 1980	
Brook trout	100	Raleigh 1982	
Chinook salmon	100	Raleigh et al. 1986	
Cutthroat trout	100	Hickman and Raleigh 1982	
Rainbow trout	100	Raleigh et al. 1984	
Reptiles and amphibians	100	Rudolph and Dickson 1990	The stream buffers, enhanced riparian wetlands, buffer averaging areas, and riparian wetland buffers will provide suitable habitat for amphibian populations. Habitat conditions will exceed the baseline condition due to enhancement of the stream and buffer.
Instream Habitat			
Minimal	50 to 100	Johnson and Ryba 1992	

Table 4.2-1. Riparian habitat buffer widths needed to protect riparian habitat functions (modified from Knutsen and Naef [1997]) (continued).

Riparian Habitat Function	Buffer (Ft)	Literature Sources	Evaluation for Master Plan Update Mitigation
maintenance of most functions			
Mean Buffers [a]			
Temperature Control (90 ft)		Filter Sediments (138 ft)	
Large Woody Debris (147 ft)		Filter Pollutants (78 ft)	
Instream Habitat (50-100 ft)			

[a] Where a range of values was reported in the literature, the median of that range was used to calculate a mean.

The enhanced buffer is expected to provide nutrient and sediment removal functions from stream water during high-flow conditions when portions of it flood. The buffer is not expected to perform significant water quality treatment functions for urban runoff or runoff from adjacent uplands. Urban runoff from adjacent developed areas is treated by the stormwater management system, and not directed to the stream buffers for water quality treatment. Likewise, sources of sediment are not directed to the stream buffers for removal/filtration prior to discharging to the creek.

Since the buffer is not planned to support wildlife habitat, buffer widths for various wildlife species (Knutsen and Naef 1997) are not relevant to the desired mitigation functions.

4.2.3 Des Moines Way Nursery Wetland Restoration

Mitigation goals for this site focus on restoring riparian habitat functions, restoring water quality functions, restoring organic matter export functions, and reducing the habitat value of the area to waterfowl and flocking birds. These functional changes will be achieved through wetland restoration, wetland and riparian enhancement, buffer restoration, and stream channel enhancement. The benefits of the mitigation to these functions are described in the below:

- **Fish and Aquatic Habitat**

  The instream enhancements will improve habitat for fish and other aquatic organisms because of the new features that will be added to the stream that are currently lacking. The primary features provided are LWD and woody riparian vegetation. Each of these features will enhance fish and aquatic habitat (see Cederholm et al. 1997). Increased amounts of woody riparian vegetation will result in increased shade, allochthonous inputs (food sources in the form of CPOM and terrestrial invertebrates), and sources of woody debris. Increased LWD generally provides habitat complexity, including small plunge pools, fish cover, invertebrate substrates, variable water depths and velocities, etc. These conditions provide nesting, resting, and forage habitat for fish and other aquatic life. Increased streambed variability in the form of gravel, wood, and CPOM will also increase the diversity of invertebrate habitat. Buffer enhancement will increase the types and amounts (terrestrial insects, plant detritus, etc.) of organic matter inputs to the stream, thus increasing forage resources for fish and invertebrates. The role of riparian conditions and LWD on aquatic systems is extensively reviewed in Allen (1995), Bisson and Bilby (1998), Bisson et al. (1987), Gregory et al. (1986), Harmon et al. (1986), Hershey and Lamberti (1998), Harmon et al. (1986), and Lassettre (1999).

- **Amphibian Habitat**

  Restoring developed land to wetland conditions will improve conditions for amphibians by increasing the quality of vegetated habitat available to them. The wetland and buffer enhancements that replace lawns and buildings will improve conditions for amphibians by increasing and enhancing vegetated habitat available to them. This enhancement will provide improved habitat for adult terrestrial amphibians. Improved habitat for terrestrial breeding amphibians (e.g., red-backed salamander, ensatina) will be provided by increased amounts of forest vegetation and woody debris in the Miller Creek buffer and riparian wetlands (Brown 1985; Johnson and O'Neil 2001; Kauffman et al. 2001; Rose et al. 2001).

- **Small Mammal Habitat**

  Planting riparian vegetation and restoring wetlands will improve habitat for small mammals by creating a diversity of forage and cover habitat for them. Increased woody vegetation and woody debris will provide denning and forage areas (Brown 1985; Johnson and O'Neil 2001; Kaufman et al. 2001; Rose et al. 2001). Restored wetlands and buffers will provide new habitat and resources wetland and upland dependent species.

- **Passerine Bird Habitat**

  Planting tall shrubs and trees on the site will reduce foraging habitat for ground feeding birds. The buffer plants will provide limited direct food sources (i.e., fruits, nuts, seeds, berries, etc.) for avifauna, but will produce insects that a variety of passerine birds forage upon. While not a specific goal of the mitigation, the increased amounts of woody and forest vegetation will provide additional and improved habitat for forest-dwelling bird species.

- **Nutrient Retention and Sediment Trapping (Water Quality)**

  Water quality functions of the buffer and riparian wetlands will improve for several reasons. Impacts to wetlands and the stream will be removed as a result of the demolition of commercial properties, removal of nursery areas, lawns, and parking areas. Removal of these land uses would remove activities that contribute to water quality degradation (Horner et al. 1994; Los Angeles County Department of Public Works, 2000; Steur et al. 1997; Bannerman et al. 1999; Minnesota Pollution Control Agency 2000).

  The removal of development, fill, and detrimental land uses, coupled with the replacement of these areas with shrub and forest dominated wetland and riparian communities will promote nutrient uptake and storage in vegetation and soil organic matter. Establishing natural nutrient cycling pathways on the site will support water quality functions.

- **Organic Matter Export**

  Replacing grass-dominated wetlands, fill, developed property, and managed riparian areas with wetlands dominated native woody vegetation will increase the export of particulate and dissolved organic matter from wetlands to the stream. In many places, lawn vegetation will be replaced with tree and shrub vegetation. The higher productivity and greater structural diversity expected in the riparian wetlands will increase the amount and diversity of organic matter (i.e., insects, leaves, branches, trees, etc.) reaching the stream. Accumulations of soil organic matter due to slower decomposition of wood in the saturated soils are likely. The partial decomposition of organic matter in wetland environments would increase export to the stream as detritus and as dissolved carbon. Where riparian vegetation consists of lawn, its replacement with a multi-storied forest and shrub canopy will also increase the type and diversity of organic matter reaching the stream.

Placing LWD in the stream channel and removing riprap will result in the restoration of natural patterns of organic matter retention and cycling in the stream channel (Bisson et al. 1987; Harmon et al. 1986), as described in other sections above. This will support stream invertebrates and downstream fish communities.

Placing in-channel woody debris will improve overbank flow in some sections. This overbank flow, coupled with overhanging riparian vegetation, will provide additional sources of organic matter export into the stream channel. Where riparian wetland vegetation is currently lawn or blackberry, planting tree and shrub communities will increase the amount and diversity of organic matter available to the stream and wetlands.

The high productivity expected in forest and shrub wetlands will result in accumulations of organic matter in the saturated soil of the restored wetland. Groundwater movement through the site and flooding will continue, and would transport dissolved organic matter to Miller Creek (Fieberg et al. 1990; Emmet et al. 1994; Dosskey and Bertsch 1994).

- **Groundwater Exchange**

  The mitigation area is predominantly a groundwater discharge area (as indicated the historical presence of peat soils [Rigg 1958; Paulson 1953]). Enhancement activities will not alter this hydrologic pattern. Restoration of portions of the site as wetland by removing fill will allow groundwater to support additional wetland habitat.

- **Flood Storage**

  No changes to this function are planned at the site. Over time, the Miller Creek channel could migrate or meander through wetland restoration areas and it could expand its floodplain and flood storage capacity.

- **Waterfowl Habitat**

  As directed by FAA, waterfowl habitat functions are not proposed at this mitigation area. The current lawn will be planted with trees and shrubs to provide a complete canopy cover that will prevent ground foraging by waterfowl. If any short duration flooding occurs on the site, a tree and shrub canopy that would prevent substantial waterfowl use would cover it.

4.2.4 Functions Planned for the Tyee Valley Golf Course Mitigation Site

- **Fish and Aquatic Habitat**

  Enhancement of floodplain wetlands and stream buffers will improve fish and aquatic habitat. Increased amounts of woody riparian vegetation planted in the wetland and buffer will result in increased shade and organic matter inputs to the stream, including food sources and woody debris that improves habitat (see Table 4.2-1). These conditions improve the quality of the stream for nesting, resting, and forage habitat for fish and other aquatic life. Restoration of floodplain wetlands (converting golf course vegetation to shrub wetland) will increase carbon production, some of which will be exported to the stream during flood events, rainy periods, or through movement in groundwater (in the form of dissolved organic carbon).

- **Amphibian Habitat**

  The wetland and buffer enhancements that replace golf course turf grass will improve conditions for amphibians by restoring floodplain wetlands that provide habitat for terrestrial adult amphibians. Improved habitat terrestrial breeding species (e.g., red-backed salamander, ensatina) will be provided by the increased amounts of shrub vegetation and woody debris. The mitigation site will also improve amphibian dispersal because of improved connections to other riparian wetlands and Wetland 28.

- **Small Mammal Habitat**

  Planting vegetation in riparian areas and restoring wetlands will improve habitat for small mammals by creating a diversity of forage and cover habitat compared to the existing turf grass. Increased woody vegetation and debris will provide denning and forage areas. The mitigation site will also improve amphibian dispersal because of improved connections to other riparian wetlands and Wetland 28.

- **Nutrient Retention and Sediment Trapping (Water Quality)**

  Removing turf grass management from the wetland and buffer areas will remove sources of nutrients and pesticides. Planting shrub and forest vegetation will provide natural pathways for nutrient cycling.

- **Organic Matter Export**

  Organic matter export functions will increase because currently organic matter is cut and removed from the floodplain as part of golf course activities. After enhancement is in place, organic matter could be exported from the wetland and riparian buffer during flooding and rainy periods. New woody vegetation and eliminating mowing of grass in the riparian zone will allow leaf-fall, herbaceous plants, and insects to reach es Moines Creek at levels higher than would be expected from gold course turf.

- **Waterfowl Habitat**

  As directed by FAA, a waterfowl habitat function is not sought at this mitigation area. The current turf grass will be planted with trees and shrubs to provide a complete canopy cover that prevents ground foraging by waterfowl. Additionally, while portions of the site will flood during 1-year and greater storm events, the presence of standing water on the site will be for short duration, and obscured by vegetation. Thus, it will not attract wildlife.

- **Passerine Bird Habitat**
  The wetland and buffer plants will provide limited direct food sources (i.e., fruits, nuts, seeds, berries, etc.) for avifauna to limit bird use, and restrict use by flocking birds. The buffers will produce insects that a variety of passerine birds will forage upon. While not a specific goal of the mitigation, the increased amounts of woody and forest vegetation will provide additional and improved habitat for forest-dwelling bird species.

Buffering Des Moines Creek and associated riparian wetlands with 100-ft average buffers will improve the function of the stream compared to baseline. For most functions of concern, the buffers will ameliorate temperature control and provide/protect in-stream habitat. In forested situations, WDFW recommends a width of 150 ft for maximum wood recruitment for streams. Project constraints do not allow for that width; therefore, some reduction in future delivery of woody debris to the stream compared to a mature forested buffer in an undisturbed area will occur.[16] Delivery of wood above the current baseline will be substantial because the current buffer is largely turf grass.

The enhanced buffer is expected to provide nutrient and sediment removal functions from stream water during high-flow conditions when portions of it flood. The buffer is not expected to perform significant water quality treatment functions for urban runoff or runoff from adjacent uplands. Runoff from adjacent developed areas is treated by the stormwater management system, and not directed to the stream buffers for water quality treatment. Likewise, sources of sediment are not directed to the stream buffers for removal/filtration prior to discharging to the creek. Since the buffer is not planned to support wildlife habitat, buffer widths are not relevant to the desired functions.

4.2.5 Wetland Mitigation in Auburn

Functions planned for the wetland mitigation site in Auburn are:

- **Waterfowl Habitat**

  The Auburn mitigation site will create open water, submergent aquatic bed vegetation, and seasonally flooded emergent vegetation. These areas will provide a a diversity of cover and food sources that will provide habitat for waterfowl, including feeding, resting, and nesting habitat.

- **Passerine Bird Habitat**

  The Auburn mitigation site will provide multi-canopied forested, shrub, and emergent wetland communities. The complex vegetation structure and plant communities (containing vertical diversity, snags, debris structures, and food sources) will provide high quality habitat to a variety of forest and wetland bird species. These elements will provide resting, nesting, and foraging habitat for passerine birds.

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[16] Since most areas located between 100 and 150 ft from the stream that are not currently included in the buffer lack tall trees, the reduction of this function would occur in future years, when any planted trees have grown to heights in excess of 100 ft in height. This could occur after 50 to 75 years.

- **Fish and Aquatic Habitat**

  The Auburn mitigation area is not designed to provide fish habitat. Some warmwater fish may use the open water and flooded emergent portion of the wetlands.

- **Amphibian Habitat**

  Creation of open water ponds with flooded emergent vegetation will provide breeding and rearing habitat for several amphibian species. The open water will provide habitat for the adult phases of aquatic species. Forested wetlands and upland buffers will provide habitat for terrestrial adult life phases. Mitigation includes placement of logs and other woody debris, and topographic diversity that will provide habitat structure for amphibians.

- **Small Mammal Habitat**

  The existing tall grasses on the site provide good habitat for a variety of small mammals. Conversion of the area to forest and shrub wetlands will improve habitat for forest and wetland-associated mammals. The increased vegetation structure will provide a greater variety of denning areas, a greater diversity of food sources, and greater cover.

- **Nutrient Retention and Sediment Trapping (Water Quality)**

  Mitigation consists of depression wetlands with a surface flow outlet. The large size of the wetland basins and relatively small amount of discharge water expected during most conditions will result in high retention rates for sediment and nutrients. The site will have a surface water connection to the Green River floodplain during flow events that exceed 8,500 cubic ft per second. At these flow levels, the wetland area will flood as a result of backwater conditions from the Green River. During flood events the wetland is expected to remove nutrients and sediments from floodwaters.

- **Organic Matter Export**

  As the flood waters drain, fine particulate organic matter (FPOM) and dissolved organic matter will be exported to downstream systems via the ditch systems.

- **Groundwater Exchange**

  The topographic variability of the mitigation area will provide areas of seasonal groundwater discharge.

- **Flood Storage**

  The Auburn mitigation site design connects it hydrologically to the Green River floodplain via a series of ditches. The site is designed to store approximately 50 acre-ft of floodwater during 100-year flood events.

The specific wildlife species targeted for the mitigation site are listed in Section 7.2.5.4. The habitat conditions at this site, including the 100-ft buffers, provide suitable habitat for all these species. The quantity and quality of the approximately 50 acres of wetland and over 15 acres of protective buffer exceeds that of the 18.37 acres of wetland habitat impacted at STIA. While some species do not frequent the affected wetlands near STIA and may require buffers in excess of 100 ft for optimal habitat, the mitigation site will accommodate their use. On the Auburn site, more wildlife species most sensitive to disturbance are expected to use the interior portions of the site that are most secluded (about 37 acres of interior habitat are more than 200 ft from the perimeter of the site). Regardless, for the species of birds using wetlands near STIA, improved habitat functions will occur because wetland buffers of the impacted wetlands are generally absent or much less than 100 ft.

4.3 MONITORING PLAN AND CONTINGENCY MEASURES

Effective monitoring, adaptive management, maintenance, and contingency actions are planned to evaluate and assure performance standards are met, and to correct deficiencies if needed. Monitoring and reporting monitoring results for agency review and concurrence will assure that appropriate contingency actions are taken and ecological benefits are ultimately achieved. This section describes mitigation site monitoring that will occur over a 15-year period to verify that each project is meeting established performance standards and permit conditions. The monitoring approach for all mitigation projects is described here and will be performed in accordance with all conditions of the *401 Water Quality Certification* (Ecology 2001a). Specific monitoring requirements for individual projects are included in Section 5 (on-site mitigation) and Section 7 (off-site mitigation). If monitoring demonstrates that performance standards are not met, then contingency actions will be evaluated and implemented to assure that the desired wetland functions are ultimately provided by the mitigation projects.

4.3.1 Monitoring Approach

The monitoring plan describes steps that the Port will take to ensure that the mitigation projects meet design goals, objectives, performance standards, and permit conditions. Monitoring will be used to evaluate conditions at each mitigation site relevant to mitigation success, including overall site conditions, site hydrology, vegetation, wildlife, invasive species, and when applicable for specific projects, channel morphology and instream habitat features. Parameters commonly used to predict ecological functions (such as percent cover of native vegetation, percent survival of planted stock, channel bed material size distribution, channel profiles, density of LWD in streams, and frequency and size of pools in streams) will be measured. These measurements will be used to quantify site conditions and allow comparisons with performance standards.

Performance standards will be measured using standard field techniques, and thus will be enforceable by permitting agencies. Performance standards developed for the Port's mitigation plan reflect reviews made by ACOE and Ecology.

Monitoring results will be used to evaluate appropriate contingency measures in cases where performance standards are not met. Contingency measures will be implemented following an adaptive management approach, described in Section 4.3.2. The adaptive management approach depends on monitoring data to:

- Evaluate the locations and need for contingency measures.
- Develop appropriate contingency measures.
- Adapt contingency measures as necessary to meet performance standards.
- Evaluate the success of contingency measures following implementation.

If at any point during the monitoring period the results of monitoring show that the success criteria established in the plan are not being met, Ecology may require corrective action, additional monitoring, and additional mitigation.

Ecology or ACOE may require contingency measures and additional monitoring of the mitigation areas if wetland monitoring reveals that vegetation establishment or wildlife use of the wetland is not sufficient to meet the success standards. Additional monitoring may be required beyond the 15-year period if mitigation success is not achieved within the monitoring period.

4.3.1.1 Monitoring Periods

Pre-construction Monitoring

Mitigation sites will be monitored before, during, and after mitigation construction. The Port has conducted regular monitoring of the acquisition area during the acquisition and mitigation design phases to ensure that no wetlands or aquatic resources are impacted by nearby construction or survey activities. Pre-construction monitoring includes steps such as ensuring that wetlands and/or stream boundaries are clearly marked or fenced, inspecting sediment and erosion control measures, and conducting regular site inspections to ensure that construction or survey operations are avoiding wetlands and streams. In addition, groundwater hydrology monitoring will be initiated in wetlands near the new embankment and borrow areas prior to project construction to allow the Port to evaluate any potential indirect impacts. This monitoring will meet all conditions of the *401 Water Certification* (Ecology 2001a). The monitoring will allow the Port to detect potential indirect hydrology impacts that may affect wetland functions. If needed, appropriate contingency measures to maintain hydrology in wetlands will be implemented.

The Port shall monitor hydrologic conditions of all wetlands downslope of the Third Runway embankment in the Miller, Walker, and Des Moines Creek sub-basins. Hydrologic monitoring using piezometers and shallow hand dug soil pits in undisturbed wetlands downslope of the Third Runway embankment shall be conducted with sufficient frequency to determine wet season trends. The Port will conduct twice monthly hydrologic monitoring during the wet season, November through May, and will continue such monitoring for at least three (3) years after completion. Maps of sample locations and vegetation in the surrounding areas, observations of stressed vegetation, any adaptive management actions implemented in the surrounding areas, a comparison to baseline data, and conclusions will be documented and submitted to Ecology on a monthly basis during that period. At the end of each water year, the Port will complete a trends analysis with proposed contingency measures identified to supplement wetland hydrology, if such is required. A schedule for completion of proposed contingency measures, if any are required, will be provided.

A similar groundwater-monitoring program will be completed in wetlands near Borrow Areas 1 and 3. In Borrow Area 1, Wetlands 48, B15, 32, B12, B4, and B1 will be evaluated. In Borrow Area 3, all wetlands will be avoided, but special emphasis shall be given to the area near where the drainage swale discharges into Wetland 29, to provide an early indication of hydrologic changes, if any to the wetland.

Construction Monitoring

The Port will also monitor all mitigation sites during construction. Construction monitoring is essential to ensure that mitigation designs are implemented according to plans and specifications in this mitigation plan, and in the final construction documents. Construction monitoring will also ensure that construction activities are consistent with federal, state, and local permit conditions. Construction monitoring will include regular and periodic inspections of the project site, regular meetings with contractors, and site visits during implementation of critical design elements (e.g., diverting flows to the new Miller Creek channel). Inspection activities during regular visits will, for example, verify that appropriate sediment and erosion control measures are in place, plants are being installed correctly and consistent with the plans, and habitat features are installed consistent with the plans. If changes to the planting design or plant schedule are required (as a result of new information about site conditions), they will be reviewed and approved by the wetland scientist or landscape architect appointed by the Port prior to implementation. Any modifications that affect the ability of the project to meet performance standards will be presented to ACOE and/or Ecology for approval prior to implementation.

Construction monitoring will also ensure that elements of mitigation construction are coordinated with other site activities. Because mitigation construction will often be coordinated with Master Plan Update improvement construction activities, construction monitoring will also ensure that Master Plan Update construction-related activities do not result in impacts to mitigation sites. For example, mitigation planting zones that are adjacent to Master Plan Update construction sites (e.g., Miller Creek relocation and South 154th Street relocation) will be protected and monitored to ensure that plants installed on the mitigation sites are not damaged or disturbed by Master Plan Update construction.

Post-construction Monitoring

Baseline monitoring data will be collected following completion of mitigation construction. The baseline monitoring report will include a summary of site conditions immediately following mitigation construction, as well as documentation of the protocol to be used to monitor the mitigation sites (e.g., sampling methodology, locations of all monitoring wells, photo points, vegetation sampling plots). Post-construction monitoring methods, parameters to be measured, and specific monitoring schedules for each of the mitigation projects are included in this document in the individual sections describing each mitigation project (Sections 5 and 7).

All mitigation projects will be monitored for a 15-year period following completion of mitigation construction and approval of Record drawings (i.e., 'record' drawings) by the agencies. Monitoring will take place during years 0 (baseline), 1, 2, 3, 5, 7, 10, 12, and 15. Monitoring reports will be submitted to ACOE and Ecology each year that monitoring is conducted.

Consistent with condition D1 s of the *Water Quality Certification* (Ecology 2001a), the Port shall notify Ecology and ACOE a minimum of 3 days in advance of field monitoring work. Ecology or its designee will be allowed access to all mitigation sites during the 15-year monitoring period.

4.3.1.2 Monitoring Reports

The Port will prepare and submit annual monitoring reports to ACOE and Ecology's Federal Permit Manager, SeaTac Third Runway, Northwest Regional Office, no later than December 31st of each year following the first year of the mitigation site work. These and other reporting requirements are discussed further in this section.

Construction Monitoring

Construction monitoring by wetland ecologist and the project engineer will occur to ensure the mitigation is constructed according to the approved plans and specifications provided in this document. Also during construction monitoring, mitigation sites will be examined for yard and other waste, including hazardous waste[17], that may have been left by previous landowners. Small amounts of waste occur on some sites (e.g. wood debris, concrete blocks, tires, etc.), and as these items are encountered during implementation, they will be removed from the mitigation area and disposed of in appropriate upland areas.

Consistent with condition D1-q of the *Water Quality Certification* (Ecology 2001a) construction monitoring shall also include field inspection by a qualified wetland consulting biologist during construction and planting to ensure proper installation.

Baseline Monitoring Report

On completion of construction for each mitigation project, record drawings and baseline (record) monitoring report will be submitted to EPA, USFWS, Ecology, and ACOE. These will document the final design of the mitigation sites and any minor changes to mitigation plans that may have occurred during construction.

A baseline monitoring report will also be prepared to document initial post-mitigation site conditions for hydrology, wildlife, vegetation, invasive species, channel morphology, and instream habitat features for each mitigation project as they apply. These baseline conditions will allow the Port and agencies to evaluate changes on the mitigation site over time, progress toward meeting mitigation objectives, and final performance standards.

The baseline report documenting the final design of all wetland mitigation sites shall be prepared when the initial planting is completed. The report shall include discussions and record drawings of the following:

- Site boundaries
- Location of perimeter fencing and signs
- Photographs of the area taken from established permanent reference points (see Appendix I)
- A planting plan showing species, densities, sizes, and approximate locations of plants, as well as plant sources and the time of planting

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[17] Sites have been evaluated for hazardous wastes during the acquisition and demolition phases of the project and all known hazardous wastes have been appropriately removed.

- Habitat features (snags, large woody debris, etc) and their locations
- Drawings in the report shall clearly identify the boundaries of the project
- Locations of sampling and monitoring sites
- Any changes to the plan that occurred during construction, and
- Plans showing locations of all monitoring transects

Monitoring reports shall show all sampling locations, discuss trends and changes, discuss success in achieving performance standards or other implementation difficulties, provide remedies to address implementation problems, and set forth a timeline for their resolution. Supporting data and calculations shall be maintained by the Port and made available to Ecology and ACOE upon request.

The As Built Report shall be sent to Ecology's Federal Permit Manager, SeaTac Third Runway within sixty (60) days of completing the mitigation site.

Any proposed changes to the wetland mitigation and monitoring protocol established in this report and the Water Quality Certification (Ecology 2001a) must be approved in writing by Ecology and/or ACOE prior to implementation of any changes.

A report including the record drawings of the mitigation site and locations of monitoring sampling locations will be submitted within 60 days of completion of the final planting for a given mitigation site. The baseline monitoring report will be submitted within 120 days of the completion of the final planting for a given mitigation site.

Post-construction Monitoring Reports and Reporting Schedule

Monitoring of all mitigation sites (including temporary impacts that involve fill or clearing of vegetation in wetlands) will be conducted for a period of not less than 15 years, consistent with the monitoring plans, methods, and schedules described in this document and required by the *401 Water Quality Certification* (Ecology 2001a). Regular monitoring periods for post-construction monitoring will be in years 0 (baseline), 1, 2, 3, 5, 7, 9, 10, 12, and 15. Monitoring reports will summarize the data collected during each monitoring period. Reports will also compare results from each monitoring period to baseline conditions, previous monitoring year results, and performance standards, and discuss any recommended contingency actions. Monitoring reports will be submitted by the end of the year (i.e., December 31st) of each monitoring period, or at a time mutually agreed upon by the Port and agencies. Monitoring schedules specific to each mitigation project are included in the individual project descriptions in Sections 5 and 7 of this document.

Each monitoring report shall include photographic documentation of the projects taken from permanent reference points (see Appendix I). Existing wetland and mitigated wetland boundaries (including all areas down slope of the Third Runway embankment, Vacca Farm, the borrow sites, and the Auburn mitigation site) will be delineated at years 5, 10, and 15. A licensed survey crew will survey and map the wetland delineation points established. The delineation map and comparisons to previous delineation maps will be furnished to Ecology and ACOE by December

31st in each of the year that a delineation is required. If the delineation shows the wetland boundaries have decreased then additional on-site mitigation may be required by Ecology.

Reporting of Hazard Wildlife Monitoring Results

In addition to performance monitoring that will be conducted specifically for the mitigation sites, the Port conducts regular monitoring as part of the WHMP. Monitoring activities and results regarding hazard wildlife in the area of the mitigation projects will be included as an attachment to the mitigation monitoring reports. The purpose of this attachment will be to document the status of the mitigation projects near the airport with regard to hazard wildlife.

4.3.1.3 Monitoring Methods

Hydrology

Groundwater and/or surface water hydrology will be monitored at mitigation sites for a 15-year period following completion of all mitigation construction. The hydrology in wetlands located adjacent to the runway embankment, SASA, Borrow Area 1, and Borrow Area 3 will also be monitored. The primary purpose of monitoring groundwater levels in mitigation areas is to verify that groundwater, which maintains wetland conditions on most of the mitigation sites, is present and continues to support wetland conditions. The evaluation will include determining that groundwater levels and periods of saturation are sufficient to support the wetland plant communities present on each site. Wetland hydrology in wetlands adjacent to the Master Plan Update improvements will be monitored to verify that indirect impacts to wetland hydrology do not occur, and to implement contingency actions if they are found. Permanent groundwater monitoring wells will be installed to monitor seasonal groundwater levels at each site. Monitoring wells will be installed by a licensed well driller and recorded with Ecology. Groundwater hydrology will be measured in each planting zone and in all wetlands at each mitigation site. Well locations will be surveyed and included on site base maps. Well locations will be shown on the record drawings.

Depths to groundwater will be measured monthly during the first 3 years following completion of grading and then seasonally (i.e., four times a year) thereafter. These data will be used to evaluate the depth, frequency, and duration of inundation and/or soil saturation on the mitigation sites, and determine whether wetland hydrology performance standards are met. These data will also be used to determine appropriate contingency measures if performance standards are not met, and to evaluate adaptive management or maintenance needs.

Groundwater monitoring will also be used to evaluate any potential indirect impacts to wetland hydrology in wetlands between the new third runway embankment and Miller Creek, and wetlands downslope of the borrow areas. Master Plan Update improvements have been designed to avoid and minimize any indirect impacts to wetland hydrology, and hydrology in these wetlands will be monitored to verify that indirect impacts have not occurred.

Surface water levels and/or flows will be monitored at selected mitigation sites where flow rates or the extent, frequency, or duration of inundation are important components of the mitigation (e.g., Miller Creek channel relocation, replacement drainage channels, Auburn open water habitat, Wetland 30 near Borrow Area 3). Surface water levels will be evaluated using staff gages. Surface water depths and/or flow rates will be measured during regular monitoring visits. Flow rates will be measured using depth and velocity methods.

Wetland Indicators

Wetlands at each mitigation site will be evaluated to verify that these areas continue to meet jurisdictional wetland criteria following mitigation. Methods consistent with ACOE 1987 Manual (Environmental Laboratory 1987) for delineating wetlands will be used to verify that hydric soils, hydrology indicators, and hydrophytic vegetation are present in the wetland areas.

Vegetation

Vegetation monitoring will be used to determine if native plant communities are established in accordance with the specific performance standards for each site, and to provide guidance for the implementation of contingency measures when necessary. A range of variables will be evaluated, including percent survival, canopy cover by strata, height by strata, number of vegetation strata, species composition and richness, evidence of herbivore damage or disease, recruitment (i.e., the number of newly establishing individuals), canopy cover, and number of invasive, non-native species.

Immediately after completion of plant installation, the landscape architect or wetland scientist will inspect the site to evaluate the planted stock for overall health. If necessary, re-planting will be recommended to ensure that the site has been planted according to the plans and specifications. Following this inspection, record drawings will be completed to show the location of the installed plant material, the species composition, density and spacing of plants in each planting zone, and average height of each strata in each zone. Permanent vegetation photo points, sampling plots, and/or transects will be established in the field and shown on the record drawings. Vegetation data will be collected to establish baseline conditions on the monitoring site. Record drawings and baseline conditions establish a benchmark against which future changes in the vegetation can be compared. The photo points will provide a visual representation of plant cover, species composition, and general health.

The timing of the baseline monitoring will depend on construction schedules, and subsequent monitoring visits will be scheduled such that at least one full growing season occurs between monitoring dates. Vegetation sampling should occur in the late spring or early summer (June through early July). A combination of plot and plotless vegetation sampling techniques will be used following standard vegetation sampling protocols (e.g., Elzinga et al. 1998; Kent and Coker 1994). Vegetation sampling plots and/or transects will be located to ensure a representative sample of the entire mitigation site (i.e., in each planting zone, in representative locations throughout the site).

Plant survival is a key indicator of the success of native vegetation establishment and of the maintenance of target densities on the mitigation sites. A minimum survival rate of 80 percent for planted stock (calculated as percent of original individuals planted) will be required for the first 3 years of the monitoring period.

Due to the difficulty in locating and tracking individual plants over time, plant cover rather than survival or density will be evaluated following year 3. After year 3, cover of native species will more accurately reflect the ultimate habitat conditions desired on the mitigation sites. After year 3, performance standards will target a density and/or cover measure so that plant abundance can be evaluated even if plant numbers cannot be accurately estimated. Vegetation cover performance standards have been developed from observations of plant growth at various wetland and non-wetland locations in King County, and from monitoring data presented in *Auburn Racetrack-Year Four Monitoring Report* (Shapiro and Associates 2000). The performance standards for vegetation cover at all mitigation sites increase throughout the monitoring period, as listed in Table 4.3-1.

Table 4.3-1. Performance standards for vegetation cover (minimum percent) by vegetation zone and monitoring year.

	Vegetation Zone				
			Emergent		
Monitoring Year	Forest[a]	Shrub[a]	Hydroseed	Planted	Invasive Species
0	-	-	0	0	<10
1	-	-	50	10	<10
2	-	-	60	20	<10
3	10	10	70	30	<10
5	25	40	80	50	<10
7	40	65	80	70	<10
10	80	80	80	80	<10
12	80	80	80	80	<10
15	80	80	80	80	<10

[a] Vegetation cover will not be monitored in forest and shrub plant communities during monitoring year 0, 1, or 2. During these years, plant survival performance will be monitored and at year 3, survival must be 80 percent of the original numbers planted. Invasive plant species cover will be monitored during all monitoring years.

Natural colonization on the mitigation site is an important measure of the success of the mitigation. Plants that colonize the site (i.e., recruitment) following mitigation construction will be included in several of the variables used in the vegetation monitoring (e.g., density, species composition and richness measures, and percent cover).

Wildlife

Port wildlife managers will monitor the mitigation sites near STIA to determine hazard wildlife use (USDA 2000). Mitigation areas will be monitored according to the Port's WHMP. Information obtained from the hazard wildlife studies will be used to determine hazard wildlife use of the mitigation area and any conflicts with FAA requirements regarding wildlife attractants near airports. Monitoring activities may include seasonal bird counts to determine levels of use and presence/absence of specific avian species. If results of the monitoring activities suggest that hazard birds are using the mitigation site, corrective actions regarding planting schemes and/or hydrologic regimes may be implemented following procedures identified in the WHMP. Any measures to control hazard wildlife that are recommended as a result of this monitoring will be reported to the agencies in the regular post-construction monitoring reports to ACOE and Ecology.

Mitigation sites will also be monitored for non-hazard wildlife (e.g., amphibians) during annual monitoring visits. Wildlife will be evaluated by assessing wildlife habitat components (i.e., vegetation structure, diversity, and cover, or habitat elements such as coarse woody debris), and to determine if performance standards are met. There are no performance standards that require monitoring wildlife use or populations. However, during monitoring visits, observations of wildlife will be made and reported rather than directly sampling wildlife populations.

Channel Morphology and Instream Habitat

Channel morphology and instream habitat will be evaluated using standard methods of stream ecology (e.g., Bain and Stevenson 1999; Hauer and Lamberti 1996). These methods will be used to measure variables such as channel profiles, cross sections, substrate size, type and amount of LWD, canopy cover from riparian vegetation, and type and number of habitat features (e.g., undercut banks, side channels, pools). Channel morphology and instream habitat features will be evaluated during regular monitoring visits, as well as following storm events. In addition, biological monitoring will be conducted in Miller Creek to evaluate changes in the Benthic Index of Biotic Integrity (BIBI) over the 15-year monitoring period (Karr and Chu 1999). Visual inspections and photo documentation will also be used to evaluate channel morphology, the stability of habitat features, and evidence of erosion or scouring.

Sample Data Sheets

Sample data sheets in Appendix I show the general format and type of information to be recorded during regular monitoring visits. These data sheets reflect typical measurements of hydrology, wildlife, photographic documentation, plant cover, and plant growth that will be measured during monitoring visits.

4.3.2 Adaptive Management Approach

Implementation of contingency actions and other management activities on the mitigation sites will be based on an adaptive management strategy using performance standards to trigger contingency and management actions. "Adaptive Management" recognizes that since the best contingency and management actions cannot always be predicted in advance and for all potential site deficiencies; they are determined on a case-by-case basis. Monitoring results will be used to identify any areas in which mitigation sites are not meeting performance standards, evaluate the reason(s) performance standards are not being met, and design and implement appropriate contingency actions.

If necessary, the first step following monitoring will be to determine why performance standards are not being met, and to identify key contributing factors (e.g., unusual drought, inadequate hydrology, invasive species, or animal damage). Once contributing factors are identified, appropriate contingency measures to remove or ameliorate the contributing factors will be designed and implemented. Effects of contingency measures will be monitored to ensure they have the desired result. The results of monitoring the efficacy of contingency measures will be used to fine-tune or adjust contingency measures to increase their effectiveness. Any planned contingency actions, as well as the results of implementing specific contingencies, will be fully documented and reported in the regular post-construction monitoring reports. Additional information is provided in the following sections on the weed management strategy for all mitigation sites and the relationship of the WHMP (USDA 2000) to the mitigation sites in the Miller and Des Moines Creek basins.

The Port will provide Ecology and ACOE with written documentation of the implementation of any of the contingency measures and adaptive management measures that have been taken. Adaptive management measures must include temporary erosion and sedimentation measures approved by

Ecology. Any problems identified throughout the mitigation sites shall be immediately corrected. Implementation of corrective actions shall be done within the confines of the contingency measures identified in this report. All contingency measures shall be implemented with adequate TESC measures such that state water quality standards are not exceeded.

4.3.2.1 Maintenance

The mitigation projects are designed to be self-sustaining over the long term and are not anticipated to require significant routine maintenance following the 15-year monitoring period. However, during the monitoring period, some maintenance actions will be required on the mitigation sites. Both routine maintenance tasks (e.g., maintaining irrigation systems) and adaptive management/contingency measures (e.g., weed management, replacing plants) will be required during the monitoring period to ensure that overall objectives and goals are met.

Routine maintenance will include maintaining temporary irrigation systems, repairing or maintaining TESC measures, removing trash, repairing fences and signs, replacing dead plant material, maintaining herbivore deterrents (e.g., geese exclusion devices, herbivore collars), and methods for control of invasive plant species. For the first year following planting, the landscape contractor will be responsible for ensuring the health of planted material and replacing dead or severely stressed plant material. After the first year, the Port will be responsible for maintaining plants and will replace plants as needed based on performance standards and consistent with specified contingency measures. Additionally, if any of the trees planted in mitigation projects within 10,000 ft of STIA runways create prime roosting habitat for starlings, blackbirds, crows, or raptors, the Port may remove these trees to conform with FAA mandates regarding aircraft safety and bird hazards. In this eventuality, the Port will replace these plants with small trees or shrubs, consistent with the WHMP.

Routine invasive plant species control includes removing weed growth from areas of mulch or weed fabric around or between planted stock. Contingency measures that may be needed to meet the invasive species performance standard for re-vegetated areas (no more than 10 percent cover at monitoring year 15) are discussed below under contingency measures.

Routine maintenance, including weeding, removal of invasive species, and watering, shall occur at least twice a year in all mitigation areas and more often as needed. The maintenance crew shall be overseen by a wetland biologist to assist with identifying invasive species and other problems.

The need for maintenance is anticipated to decline during the monitoring period, as the mitigation has been designed to be self-sustaining in the long term. Maintenance will continue as needed for the monitoring period (i.e., at least 15 years).

4.3.2.2 Phasing of Conifer Plantings

The landscape plan for each mitigation area where coniferous trees are specified shows that the planting of these trees is phased (see landscape design sheets in Appendices A-F). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be extended for 1 year to reduce mortality and promote growth during the June to September period.

4.3.2.3 Wildlife Hazard Management

Monitoring and maintenance/contingency actions for the on-site mitigation areas adjacent to STIA will be coordinated with the Port's WHMP. The results of monitoring for hazard wildlife at the mitigation sites will be included in the mitigation monitoring reports submitted to regulatory agencies.

The mitigation and implementation plans have been designed to be consistent with the FAA-approved WHMP, while providing for the restoration of wetland and stream functions potentially impacted by the project. Because the specific requirements of the WHMP (e.g., choice of plant species) were incorporated into the mitigation designs to avoid wildlife hazards at the mitigation sites, it is not anticipated that alterations to the mitigation sites will be necessary to comply with the requirements of the WHMP. The Port will monitor the mitigation sites regularly as part of its routine hazard wildlife-monitoring program. Activities on the mitigation site for the purposes of wildlife hazard management would be consistent with permit conditions. The mitigation monitoring reports will identify hazard wildlife management activities (if any) on the mitigation sites.

In the event that the FAA determines that mitigation measures have created a wildlife hazard to aircraft based on information obtained from the wildlife-monitoring program, the wildlife hazard will be addressed according to the WHMP. The process will be as follows:

- The FAA will consult with the United States Department of Agriculture – Wildlife Science Division (USDA-WSD) regarding the problem
- The USDA-WSD will recommend a list of strategies that can be used to eliminate the problem
- The Port and USDA-WSD will implement the strategies to eliminate the hazard
- Implementation will be consistent with the wildlife hazard, and depending on the nature of the action, agencies will be properly notified

The on-site mitigation areas are not planned as mitigation for impacts to avian or other wildlife species[18] that pose aircraft safety concerns. A critical need of the mitigation projects is to restore wetland and stream buffer functions in a manner that avoids creating new avian wildlife hazards and reduces existing avian wildlife hazards.

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[18] As discussed in this document, wildlife habitat functions will be replaced by creating and restoring wetland habitats at an off-site location in WRIA 9, in Auburn. Non-avian wildlife using mitigation sites may be a hazard to aircraft safety if they attract avian predators, or move onto active runways.

As discussed in this plan, airport property is subject to a variety of potential wildlife management actions (regulations affecting wildlife management are explained in Sections 4.5 to 4.9 of the WHMP, and wildlife management control is discussed in Section 6 of the WHMP). In nearly all cases, these management actions can be successfully implemented without interfering with the ability of the on-site mitigation projects to provide the planned ecological functions. In nearly all cases, management actions at the on-site mitigation sites will involve hazing or removal of wildlife and minor habitat modification. These actions are consistent with the planned mitigation and require no wetland-related permits or approvals.

The wildlife management control actions presented in the WHMP attempt to balance the Port's, FAA's, and USDA WSD's role in protecting aviation safety with the goal of non-wildlife wetland mitigation and enhancement. Although the Port must retain ultimate authority to identify and respond to wildlife threats to aviation safety, the WHMP requires that:

- The Port secure permits and approvals for any control actions that would result in a significant reduction in mitigation functions, except where immediate action is required to ensure air safety.
- Any control action that results in a significant reduction in mitigation functions must be compensated for and mitigation functions must be restored as soon as practicable.

Regarding the mitigation sites, the WHMP contemplates two levels of wildlife management actions: those that may have a de minimus reduction in mitigation function, and those that may cause a significant reduction in mitigation functions.

Minor Vegetation Management Activities

This level of management activity includes vegetation management in mitigation sites that will not result in a significant reduction of mitigation functions, will not require a permit, and will not require a change to an existing permit condition. As a rule of thumb, this will generally include actions that do not alter the ability of a mitigation site to meet performance standards for vegetation, as identified in the mitigation plan. These actions will be exempt from pre-consultation with the permitting agencies. Examples of such management actions include:

- Selective trimming of vegetation. If selective trimming of vegetation within mitigation sites is required, it can occur without disruption of the desired functions of the mitigation. Removal of small quantities of vegetation can also occur when mitigation functions are not significantly altered.
- Increase vegetation density. Adding new non-attractive native plants to mitigation sites would increase plant density and reduce poorly vegetated areas. This action would reduce wildlife use of more open areas and increase the rate of canopy closure over periodically flooded floodplain areas.
- Replant or replace one type of vegetation with another native plant species. If one vegetation type is observed to be a wildlife attractant, it shall be replaced with another type. Replacement could occur through physical removal (cutting, up rooting, etc.) or by replanting areas with faster growing species that may out-compete less desirable plants.

Generally, replacement can occur without significant soil disturbance and without affecting the planned wetland functions.

- Removal of channel obstructions. Various debris blockages (including beaver dams) could increase the presence of standing water at the mitigation sites. To reduce standing water areas and habitat for waterfowl, it will be necessary to remove these obstructions.

The above vegetation management actions, if performed, will be reported in the mitigation monitoring reports, required for the Master Plan Update Clean Water Act Section 404 and Section 401 permit. Reporting will include a description of the action taken, an explanation of why the action was taken, an analysis of the effect of the action on the mitigation site properties, performance standards, and ecological functions. Photographs of the mitigation site prior to and following the management action will be included. An analysis of the effectiveness of the management action in eliminating or reducing the wildlife hazard will also be reported.

Potentially Significant Management Activities

This level includes wildlife management activities that require permits from agencies regarding Clean Water Act Section 404 and Section 401 compliance, ESA review, Hydraulic Project Approval (HPA) review, and other applicable laws, or changes to conditions of existing permits and approvals. In the unlikely event that wildlife management activities result in significant modifications to non-habitat wetland functions, the Port would apply for the required permits or permit changes prior to conducting these activities, unless immediate action was required to ensure aircraft safety. If the Port determines that immediate action is required to ensure air safety, the Port will notify ACOE, Ecology, and other agencies with permitting jurisdiction at the earliest practicable date to consult with them on the actions taken and to be taken. This consultation would also determine the appropriate mitigation(s) necessary to restore the lost or impaired mitigation functions.

Recognizing that activities that would result in a significant reduction in mitigation functions should be employed only as a last resort, the Port will be required to restore the lost or impaired mitigation functions at a ratio of at least 1.5 acres of mitigation to 1.0 acre of impact and to secure any required permits for the mitigation.

Examples of such management activities include:

- **Netting of habitat**. A potential management strategy to reduce bird use is to use a pole-supported net system that would reduce bird access to habitat. Placement of physical structures in wetlands, such as support posts, cable anchors, etc. could be subject to HPA and Section 404 permitting.

- **Drainage of wetlands.** Alteration of soil saturation or the extent of jurisdictional wetlands on mitigation sites through excavation of drainage channels, grading, or other hydrologic modification.

- **Significant removal/replacement of vegetation** such that planned mitigation functions could be altered. This could occur if larger scale removal/replanting affected riparian conditions, reduced shading of creeks, or changed other factors important to the mitigation function. As a rule of thumb, significant removal/replacement of vegetation will generally include actions that result in removal of vegetation cover in a mitigation area such that the vegetation performance standards for the mitigation site cannot be met.

4.3.2.4 Integrated Weed Management

An integrated weed management strategy will be used at all mitigation sites to allow successful establishment of native vegetation and prevent long-term dominance of the site by invasive and non-native plants.[19] The goal of the weed management plan can be accomplished by a combination of the following steps:

- Reducing existing on-site sources of invasive non-natives by measures such as stripping the soil surface to remove above and below-ground plant parts, mowing, and/or applying herbicide consistent with the *Biological Opinion* for the Master Plan Update (FWS 2001).
- Planting rapidly growing native species that will quickly establish cover and shade on the mitigation site to reduce weed invasion in the short-term.
- Using hydroseed to establish an initial "weed barrier" and to provide initial plant cover on the site, and reduce colonization by invasive species.
- Monitoring the site for new weed invasions and controlling or removing invasive species before they are allowed to dominate the site.

Control of invasive plants will be most important during the initial years (i.e., years 1 through 7) of the monitoring period while the native vegetation is becoming established. Control methods include, but are not limited to, using manual/mechanical methods to mow, cut, grub, or girdle plants, and selective use of EPA-approved herbicides.[20] Use of herbicides will be minimized. However, limited herbicide use in combination with other control methods may be necessary to control some of the aggressive invasive species likely to occur on the site (see Table 4.3-2).

Table 4.3-2. Invasive plant species that will be monitored and controlled on the mitigation sites.

Scientific Name	**Common Name**
Convolvulus sepium	Hedge bindweed
Cytisus scoparius	Scot's broom
Lythrum salicaria	Purple loosestrife
Phalaris arundinacea	Reed canarygrass
Polygonum cuspidatum	Japanese knotweed
Polygonum sachalinense	Sachaline
Rubus discolor	Himalayan blackberry
Rubus lacinatus	Evergreen blackberry

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[19] The plan assumes that complete eradication of non-native plants, especially invasive non-native plants, is not possible because the mitigation sites are surrounded by large sources of non-native seeds. A variety of bird species are also expected to import native and non-native plant species to the sites. The presence of non-native species will likely be a permanent feature of the mitigation sites.

[20] Herbicide used will be EPA approved, and applied by licensed applicators. Herbicides will be limited to those that are non-toxic to aquatic organisms. The most likely candidate for application to kill blackberry and reed canarygrass is glycophosphate. This herbicide has been evaluated by Ecology (2000) and others (Extoxnet 1996) and found to be protective of aquatic life for this purpose (FWS 2001).

4.3.2.5 Fencing and Signage

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet and/or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The locations and types of fencing is shown in Appendix P.

4.3.2.5 Contingency Measures

Specific contingency measures have been developed for each performance standard at each mitigation site. Contingency measures will be implemented following the adaptive management approach in cases where performance standards are not being met. Proposed contingency actions will be fully discussed in monitoring reports submitted to the agencies, and all contingency measures will be monitored and evaluated to verify that they are achieving the desired result. Project-specific contingency measures are included with the individual project descriptions in Sections 5 and 7 of this document. The Port will consult with ACOE and Ecology prior to implementing any additional contingency measures that may be required, but that are not included in this document.

Control of invasive non-native plant species will likely require contingency measures on most of the mitigation sites during the first several years following construction. Specific control measures will depend on the invasive species of concern and site conditions. The Port will use an integrated, adaptive weed management strategy to control invasive non-native species on the mitigation sites. This strategy is explained in Section 4.3.2.4.

Independent of the potential for temporary netting to reduce wildlife hazards (Section 4.3.2.3 and the WHMP), temporary netting may be needed to reduce damage by grazing waterfowl. Temporary netting or other temporary enclosure systems could be supported 1 to 2 ft above the ground surface in emergent wetland areas to reduce damage by geese or other waterfowl.

Miller Creek Relocation/
Vacca Farm Restoration

5. ON-SITE MITIGATION PROJECTS

This section describes on-site mitigation projects that are designed to restore and enhance physical and biological functions in Miller and Des Moines Creeks and nearby wetlands. The Port will provide on-site mitigation in both the Miller Creek and Des Moines Creek basins, a part of WRIA 9, to compensate for unavoidable project impacts to wetland, stream, and hydrologic functions. In developing this plan, the Port utilized agency guidance to identify on-site mitigation activities that will compensate for project impacts to wetland and stream functions. Elements of the mitigation plan are specifically targeted to restore on-site functions that will be impacted by the project. These include sediment and nutrient retention (water quality), organic carbon production and export, surface water storage (floodwater detention and storage), and aquatic habitat functions (e.g., instream aquatic habitat and riparian habitat).

The mitigation plan will result in increased functional performance of the wetlands, streams, and buffers in the mitigation sites relative to their degraded existing conditions. For example, wetlands currently dominated by non-native ornamental vegetation and turf grasses will be restored to forested systems containing a greater diversity of native species and habitats. Along Miller and Des Moines Creeks, water storage, nutrient and sediment retention, instream habitat, and non-avian wildlife habitat functions will all be improved relative to existing conditions.

The on-site mitigation projects are described below.

Miller Creek Basin

- Vacca Farm Mitigation: Miller Creek Relocation (Section 5.1.1), Vacca Farm Wetlands and Floodplain Restoration (Section 5.1.2), and Lora Lake Shoreline Enhancement (Section 5.1.3)
- Miller Creek Wetland and Riparian Buffer Enhancement (Section 5.2.1)
- Miller Creek Instream Habitat Enhancements (Section 5.2.2)
- Drainage Channel Replacement (Section 5.2.3)
- Restoration of Temporary Construction Impacts (Section 5.2.4)
- Miller Creek Basin Trust Fund for Waterhed Rehabilitation (Section 5.2.5)
- Des Moines Way Nursery Wetland Restoration (Appendix N)

Des Moines Creek Basin

- Tyee Valley Golf Course Wetland Enhancement (Section 5.3.1)
- Des Moines Creek Buffer Enhancement (Section 5.3.1)
- Des Moines Creek Basin Trust Fund for Watershed Rehabilitation (Section 5.3.2)
- Preservation of buffer and wetlands near Borrow Area 3 (Section 5.3.3)

The section provide descriptions and plans for each on-site mitigation project. Section 5.1 describes relocation and restoration of a portion of the Miller Creek channel; restoration and enhancement of the Lora Lake shoreline; and restoration of wetlands, floodplain, and buffers on the Vacca Farm site. Section 5.2 describes mitigation projects to restore and enhance wetlands and riparian buffers along a 6,500-ft reach of Miller Creek, and to enhance instream habitat along this reach. In addition, mitigation actions to restore wetlands temporarily impacted by construction of the design and replacement drainage channels (Section 5.2) that mitigate for filling of existing ditches and drainage channels are described.

The restoration projects in the Des Moines Creek basin (Section 5.3) are designed to enhance existing wetlands on the Tyee Valley Golf Course and the riparian buffer along sections of Des Moines Creek. Plans to minimize and mitigate potential indirect hydrologic impacts to wetlands near the borrow areas are also provided.

For each mitigation project described in this section, the mitigation plans are organized following Ecology guidance (Ecology 1994a). The mitigation plan, goals, and objectives are introduced first, followed by a description of the project site, existing ecological conditions, the rationale for selecting the project, and any constraints on the proposed mitigation. Next the mitigation design is described in detail, with reference to figures and the plan sheets in Appendices A-F. Performance standards, monitoring schedules, and maintenance and contingency measures necessary to ensure mitigation success are described next. The final section for each project describes the specific construction steps, methods, and sequencing required to implement the mitigation design.

5.1 VACCA FARM MITIGATION

Mitigation actions at the Vacca Farm site are designed to enhance or restore approximately 19 acres of aquatic and riparian habitats. Mitigation actions restore natural channel morphology to Miller Creek, integrate the channel with its floodplain, remove bulkheads along the Lora Lake shoreline, remove fill from wetlands, restore functions to degraded wetlands and restore natural vegetation to poorly vegetated riparian and upland buffers (Table 5.1-1; Appendix A). These actions will enhance fish habitat in Miller Creek, improve water quality (provide shade, ameliorate elevated water temperatures, increase dissolved oxygen, provide inputs of organic matter, improve sediment retention, and remove potential sources of fertilizer or pesticide inputs), provide no net loss of floodplain storage, and enhance the diversity and complexity of wetland habitats. Mitigation projects in the Vacca Farm area have also been designed to reduce the potential wildlife hazards that currently exist on the site, consistent with FAA Advisory Circular 150/5200-33. The major mitigation elements for the Vacca Farm site include the following:

- Relocation of a channelized portion of Miller Creek
- Restoration of natural channel morphology and instream habitat to the relocated reach
- Restoration and enhancement of riparian buffers along Miller Creek
- Restoration and enhancement of floodplain wetlands on the Vacca Farm site
- Restoration and enhancement of upland buffers around the Vacca Farm site

- Restoration and enhancement of wetland areas and upland buffers along the Lora Lake shoreline
- Removal of fill and bulkheads from the Lora Lake shoreline, and restoration of a more natural shoreline along the lake

Table 5.1-1. Summary of wetland and buffer mitigation areas at Vacca Farm.

Mitigation Area at Vacca Farm	Wetland Area (acres)
Wetland Restoration (prior converted and filled wetland near Lora Lake)	**7.60**
Wetland Enhancement	
Wetlands (A1, A1a, A2, A3, A4)	1.59
Farmed Wetlands (1, 2, 3, 9, 10, 11)	0.73
Lora Lake shoreline	0.32
Lora Lake aquatic habitat	3.06
Subtotal	**5.70**
Buffer Enhancement	
Buffer (Des Moines Memorial Drive)	1.54
Stream Buffer (South 154th Street)	3.04
Lora Lake Buffer	1.81
Subtotal	**6.39**
Total Restoration Area	**19.69**

5.1.1 Miller Creek Relocation and Channel Restoration Plan

To accommodate the embankment for the third runway, the RSAs, and the relocation of South 154th Street, approximately 980 ft of Miller Creek will be realigned and relocated. The new stream channel will be constructed approximately 200 ft west of the existing channel, through the Vacca Farm site. The channel reach to be relocated has been dredged and straightened, lacks complexity (e.g., straight uniform channel bed, no undercut banks, no side channels, no pool/riffle morphology, uniform silt substrate), has few instream habitat features (e.g., no LWD, no pools or backwater areas), and the riparian vegetation provides little shade or organic matter to the channel.

Relocating the stream will increase the channel length to approximately 1,080 ft. A low-flow channel will meander within a larger high-flow channel, and the new channel will include instream habitat features (e.g., LWD). The channel will be designed to be connected to the floodplain by overbank flooding with approximately a 1-year return interval. Channel banks will be planted with native shrub plant communities and the new channel will have a native forested riparian zone to ameliorate water quality and provide shade and LWD.

5.1.1.1 Goals, Objectives, and Design Criteria

The overall goals of this plan are to provide a new, longer stream channel with enhanced habitat features and a more natural channel morphology compared to the existing channel, which will be filled. The channel design is constrained by the existing high- and low-flow conditions in Miller Creek and the very gradual slope of the channel through this reach. The goals of the design are focused on the need for the relocated channel to continue to convey base flows, to maintain sufficient depths during summer low-flow periods for fish passage, to prevent deposition of fines and scouring to maintain fish habitat, and to allow flood flows greater than annual peak flows to overtop the channel banks and flow onto the floodplain. Specific goals for the design of the relocated channel are:

- The stream continues to provide base flow conveyance
- Minimum flow velocity remains high enough to minimize fine sediment deposition
- The new channel accommodates peak flows up to the 100-year flow with no net reduction of 100-year floodplain storage or floodway conveyance
- The new channel provides improved fish habitat
- The new channel replaces or enhances riparian habitat function
- The channel does not attract wildlife (such as waterfowl or flocking birds)

The goals are prioritized from the most critical hydrologic functions that the existing channel provides to enhancements that will improve channel and riparian habitat.

To implement the general goals identified above, specific objectives and design criteria were developed (Table 5.1-2). Specific performance standards, monitoring approach, and contingency measures for the channel relocation are discussed in more detail in Section 5.1.1.10.

Table 5.1-2. Mitigation goals, design objectives, and design criteria for the Miller Creek relocation project.

Goals and Design Objectives	Design Criteria
Goal 1: The stream will continue to provide base flow conveyance	
Provide flow depths to allow fish passage, prevent fish stranding, and provide habitat.	Construct low flow channel 8 ft wide with 1:1 slopes and 0.5 ft deep to convey summer base flows. Construct high flow channel 32 ft wide with side slopes of 2:1 (typical) from depths of 0.5 to 1.0 ft to provide capacity for wet season base flow.
Goal 2: Low-flow velocity should minimize fine sediment deposition	
Minimize sedimentation with minimum flow velocity.	The channel cross section will provide an average dry season base flow velocity that is greater than the silt transport velocity (0.7 ft/sec). Design a natural channel with stable gravel bottom.
Minimize channel scouring at the maximum design flow velocity.	Channel flow velocity cannot exceed the gravel movement velocity (4 ft/sec) for the 100-year flow.

Table 5.1-2. Mitigation goals, design objectives, and design criteria for the Miller Creek relocation project (continued).

Goals and Design Objectives	Design Criteria
Goal 3: The channel will accommodate peak flows, including the 100-year flow	
Accommodate the 100-yr peak flow.	Flows greater than the annual peak flow will overtop the channel and inundate the adjacent floodplain restoration area.
Goal 4: The new channel will provide enhanced fish habitat	
Provide enhanced fish habitat without fish passage barriers.	Provide a natural channel configuration. Increase channel length by about 10 percent and create a meandering low-flow channel.
	Provide habitat features, including instream features such as deflectors and overhanging logs as needed to maximize available habitat.
Goal 5: The channel will replace and enhance riparian habitat function	
Provide riparian habitat.	Provide a minimum 50-ft vegetated buffer on the east side of the channel.
	Establish native vegetation along channel banks and the riparian zone of the new channel.
Goal 6: The channel will not attract wildlife	
	Densely plant woody vegetation along the new channel to cover open water and reduce use of the area by waterfowl.

5.1.1.2 Ecological Assessment of Miller Creek at Vacca Farm

Overall conditions in the Miller Creek basin are described in Section 2. In this section, existing conditions at the Vacca Farm site relevant to the mitigation design are described in more detail. Miller Creek originates north of SR 518, flows south through the Miller Creek detention facility along the southeast side of Lora Lake, and then south along the eastern edge of the Vacca Farm site. The Miller Creek detention facility detains and stores floodwaters from the upper reaches of the Miller Creek basin during periods of high flow. Vacca Farm sits in a broad, flat valley of alluvial sands, silts, and peat soils located south of Lora Lake. Portions of Miller Creek have been channelized through the Vacca Farm site and straightened to improve drainage on the site. From the Vacca Farm site, Miller Creek continues south and west through residential areas and ultimately empties into Puget Sound (see Figure 2.1-2 and 2.2-1).

The Miller Creek channel between the Miller Creek detention facility outlet to South 156th Way has been dredged and straightened to drain wetlands for farmland reclamation. Topographic conditions, peat soils, and seasonally high water tables along this reach indicate that this area was historically a wetland. The channel currently overflows its banks with at least a 2-year frequency with full flow velocity of 1.7 ft per second (FAA 1996). Frequent flooding is primarily the result of limited channel capacity, in part due to channel slope.

Miller Creek is approximately 4 to 10 ft wide and 2 ft deep below the outfall of the Miller Creek detention facility. The bank is lined with large rocks in the upper segments near Lora Lake, and the channel has a very silty substrate. The section of the stream within the Vacca Farm site that will be relocated is a ditched reach with a silty bottom substrate. Downstream of South 156th Way, the channel contains natural meanders that vary from approximately 5 to 10 ft in width and the substrate consists of areas of sand and gravel with some silt.

A side channel (ditch) in the Vacca Farm site runs parallel to and west of the main channel. The side channel does not drain runoff from a distinct subbasin area, nor does it provide additional channel capacity to the main channel. Rather, it provides positive drainage for a portion of the relatively flat farmland located west of Miller Creek.

Hydrology

Urbanization and development of the watershed have led to increased runoff rates and volumes that have contributed to erosion and downcutting. Increased erosion and downcutting have also resulted in sedimentation and habitat degradation in the low-gradient areas (FAA 1996). In 1990, King County constructed the Miller Creek detention facility to alleviate some of these impacts (see Figure 1.3-1).

Since 1982, King County Surface Water Management (KCSWM) has monitored flow rates at the outlet of the Miller Creek detention facility (KCSWM 1994). The available flow data provide a good record of base flows, normal wet and dry season flows, and annual peak flows. Streamflow rates are typically highest between October and April and lowest between May and September (FAA 1996). Montgomery Water Group (1995) modeled hydrologic characteristics in the basin and found that in some years no flow occurs in the upper watershed areas during portions of the summer (i.e., 1 in 10-year low flow). They also reported that summer flows are 0.5 cfs less than about 10 percent of the time. Flows during the dry season and wet season are shown in Table 5.1-3. Table 5.1-4 summarizes data for flood frequency estimates in Miller Creek at the Miller Creek detention facility.

Table 5.1-3. Estimated base flow rates at the Miller Creek detention facility outlet structure.

Season	Flow Rate (cfs)
Dry (May – September)	0.5
Wet (October – April)	5.0
Approximate Annual Peak	40.0

Source: KCSWM (1994)

Table 5.1-4. Flood frequency estimates for Miller Creek at the Miller Creek detention facility control structure.

Return Period (years)	Peak Flow Rate (cfs)
1.01	21
1.11	40
2	75
10	125
20	141
50	161
100	175

Source: Montgomery Water Group (1995)

Existing Fish Habitat

Historically, Miller Creek supported anadromous fish runs of coho salmon, chum salmon, and sea-run cutthroat trout, as well as resident populations of pumpkinseed sunfish (*Leponis gibbosus*), sculpin, and cutthroat trout (FAA 1996). A qualitative electrofishing survey conducted in August 1996 identified cutthroat trout, pumpkinseed sunfish, and three-spine stickleback in reaches between South 160th Street and the outlet of Lake Reba (Aquatic Resource Consultants 1996). One coho smolt was captured downstream of the culvert under South 160th Street during a 1996 electrofishing survey. In addition, three cutthroat trout were found north of a natural waterfall above South 160th Street during another electroshocking study on November 10, 1998 by Parametrix, Inc.

The stream currently supports a small coho salmon run maintained by annual releases of hatchery-reared fingerlings raised by the Des Moines Section of Trout Unlimited (FAA 1996; Hillman et al. 1999). No spawning activity was observed during surveys conducted in 1996 by WDFW. However, the Des Moines Section of Trout Unlimited reported 91 coho spawners in a recent survey. The Port has prepared a Biological Assessment that evaluates the effect of the Master Plan Update improvement projects on fish species recently listed under the ESA (Parametrix 2000c).

Residential development in the watershed has resulted in a general deterioration of fish habitat due to removal of native riparian vegetation, stream channelization and bank armoring, filling of riparian wetlands, reduction of the availability of LWD, and increased runoff rates and non-point source pollution loading. Expansion of impervious surface area in the basin has caused increased volumes and velocities of stormwater runoff (resulting in increased bank erosion) and downcutting. These factors have contributed to a general lack of (1) instream cover, (2) available low- and high-flow habitat or refuge, (3) available spawning habitat in the basin, (4) habitat complexity, and (5) high-quality water (KCSWM 1987; and FAA 1996).

Natural, unaltered stream reaches in the Miller Creek basin are essentially nonexistent, while major portions of the main stem and associated drainage ditches are channelized or otherwise modified (KCSWM 1987). The portion of the stream crossing the Vacca Farm site has been channelized, lacks woody debris, and provides limited habitat complexity. This reach is dominated by low-velocity flows and excessive sedimentation, which appears to be partially caused by agricultural runoff. FAA (1996) estimated that 10 tons of sediment are transported to the stream annually from approximately 11 acres of adjacent agricultural land. These factors contribute to the lack of pools, and therefore a lack of refugia (resting places) for fish during high-flow events.

Several natural and man-made barriers appear to limit fish access to the upper basin; however, they are not barriers under all flow conditions. The most prominent barrier on Miller Creek is a natural 8-ft-high waterfall about 0.2 mile upstream of South 160th Street that restricts upstream fish passage. Several corrugated metal and concrete box culverts, such as a culvert located at South 160th Street, appear to be barriers under certain flow conditions.

These barriers, combined with habitat availability, likely contribute to the current fish distributions in Miller Creek; salmonids occupy primarily downstream reaches while other species occur upstream. Recent studies (FAA 1996; Hillman et al. 1999) have found that suitable coho salmon spawning habitat and evidence of coho salmon spawning are limited to the area downstream of First Avenue South, while suitable cutthroat trout spawning habitat is scattered in small patches between South 156th Way and First Avenue South. Areas upstream of First Avenue South consist predominantly of a fine silt and sand substrate, which is more suitable habitat for the non-salmonid fish species that occur there.

Existing Riparian Vegetation

Downstream of the Miller Creek detention facility, about 200 linear ft of the stream is bordered by small tree and shrub riparian vegetation. Riparian vegetation consists of stands of red alder saplings (*Alnus rubra*) with an understory of hardhack (*Spiraea douglasii*), Himalayan blackberry (*Rubus discolor*), and field horsetail (*Equisetum arvense*).

Throughout most of the Vacca Farm site, riparian vegetation associated with Miller Creek is typically a narrow band less than 50 ft wide. Riparian vegetation is dominated by reed canarygrass (*Phalaris arundinacea*), climbing nightshade (*Solanum dulcamara*), and introduced grass species. Scattered throughout this area are black cottonwood (*Populus trichocarpa*) and willow (*Salix* spp.) trees and saplings. This narrow band of low-quality riparian vegetation separates the stream from the adjacent cultivated farmland.

5.1.1.3 Ownership

Property at the Vacca Farm site and along Lora Lake needed for the stream relocation has been purchased by the Port as part of the larger property acquisition program for the proposed Master Plan Update improvements.

5.1.1.4 Rationale for Selection

The Miller Creek relocation mitigation provides the opportunity to restore both high-quality stream habitat and floodplain wetland habitat that will result in on-site, in-kind replacement for stream and wetland functions impacted by the Master Plan Update projects. The existing portion of Miller Creek that will be relocated was moved from its original location within the floodplain at the Vacca Farm site to increase the amount of floodplain suitable for farming. The original channel was moved to the east, straightened, and dredged to facilitate drainage and increase agricultural land on the site. As a result, although the channel still floods, it lacks the connection with its floodplain and floodplain wetlands that it historically had. The channel does not meander across the floodplain and there are no side channels, sloughs, or backwater areas. The existing channel lacks complexity (e.g., straight uniform channel bed, no undercut banks, no side channels, no pool/riffle morphology, uniform silty substrate), there are few instream habitat features (e.g., no LWD, no pools or backwater areas), and the riparian vegetation provides little shade or organic matter to the channel.

Relocation and restoration of channel morphology therefore provides the opportunity to restore both aquatic habitat and floodplain wetland functions on the site. The mitigation plan for the channel relocation will restore channel morphology and instream habitat. In addition, the connection between channel and floodplain wetlands will be restored to the extent possible, while avoiding the creation of new hazard wildlife attractants near the airport. Integration of channel and floodplain will be designed to allow the channel to flood periodically, but to avoid standing water in floodplain wetlands.

5.1.1.5 Constraints

Relocation of Miller Creek must occur on-site in proximity to the existing channel. The Vacca Farm site is nearly level, with only a few feet of grade change from north to south. The alignment for the new channel has been designed to facilitate meeting design criteria for flow and velocity given the existing site topography. Meeting these criteria requires that the stream relocation reach be as short as possible to ensure that the maximum channel slope is maintained. The length of the relocated stream reach cannot be increased and still meet the minimum gradient for required flow velocities and depth. As a consequence of constraints on channel length, the new channel will remain fairly close to the re-aligned roadway and the embankment. The buffer width between the relocated stream and South 154th Street is constrained by the maximum length of the new stream channel (Figure 5.1-1). Constraints on the channel design are described in detail in Section 5.1.1.6, Channel Relocation Mitigation Design.

No other apparent constraints outside of the Port's control could affect the success of the stream relocation. No plans exist to change the Miller Creek detention facility's operation procedure. Stormwater management is now planned to occur in new facilities (i.e., vaults and/or ponds located in upland areas) that are independent of the Miller Creek detention facility (for details, refer to the *Comprehensive Stormwater Management Plan,* Parametrix 2000a, 2001a*)*. However, even if the existing detention facility were enlarged to provide more flood storage, this would not be expected to change flow rates in Miller Creek. The detention facility could be enlarged to provide greater stormwater storage without increasing the maximum elevation of water storage or peak discharge rates. This could be accomplished by excavating uplands that are located south of the facility to an elevation within the operating range of the facility to provide new storage. This will not affect the mitigation design because stream hydrology, specifically base flow and normal seasonal flow, will not be significantly modified, and it is unlikely that peak flows will be increased.

5.1.1.6 Channel Relocation Mitigation Design

The goals of the design are focused on the need for the relocated channel to continue to convey base flows, maintain sufficient depths during summer low-flow periods for fish passage, prevent deposition of fines and scouring to maintain fish habitat, and allow flood flows greater than annual peak flows to overtop the channel banks and flow onto the floodplain.

Channel Design

The channel design process evaluated and adjusted design variables and constraints (e.g., channel depth, width, flow velocity, channel slope, etc.) to meet the design goals and criteria. The critical variables in new channel design are channel slope, flow velocities (i.e., dry and wet season base flows, annual peak flows, and flood flows above annual peak flows), maximum design flow, channel depth and bottom width, channel roughness, and channel length. Initial channel slope was determined using the available drop in elevation along the new reach. The corresponding channel bottom width was determined and adjusted until the minimum flow depth (0.25 ft) was achieved. The slope was then adjusted until the base flow velocity was high enough to move sediment particles smaller than sand to reduce siltation and fining of the bed (Figure 5.1-2). Using the adjusted slope, the channel was then designed to convey peak flows (in connection with maximum depths and channel configurations described in the following sections). Channel widths and flow depth were then adjusted to assure that peak flow velocities were less than the transport velocity for gravel.

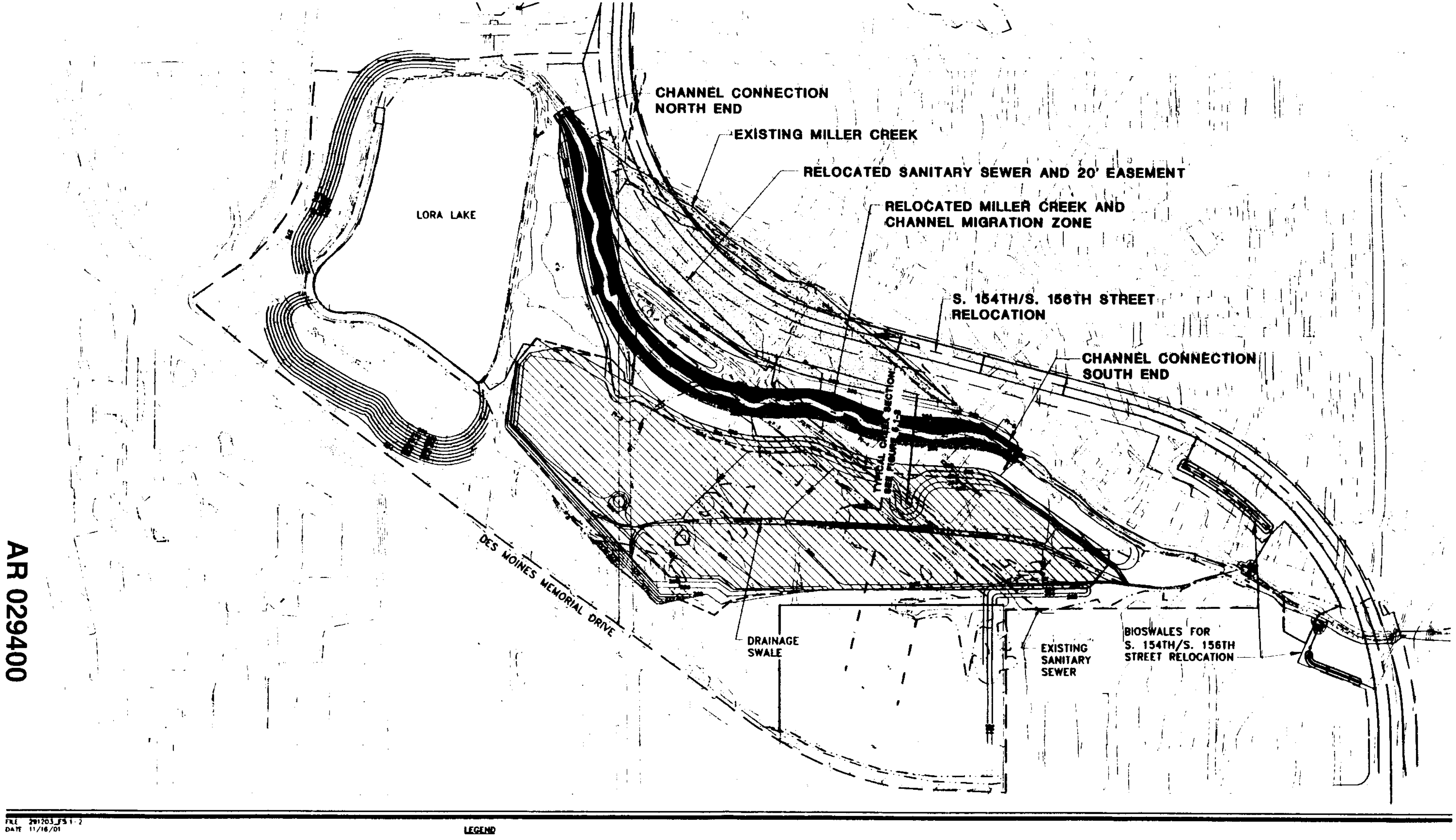
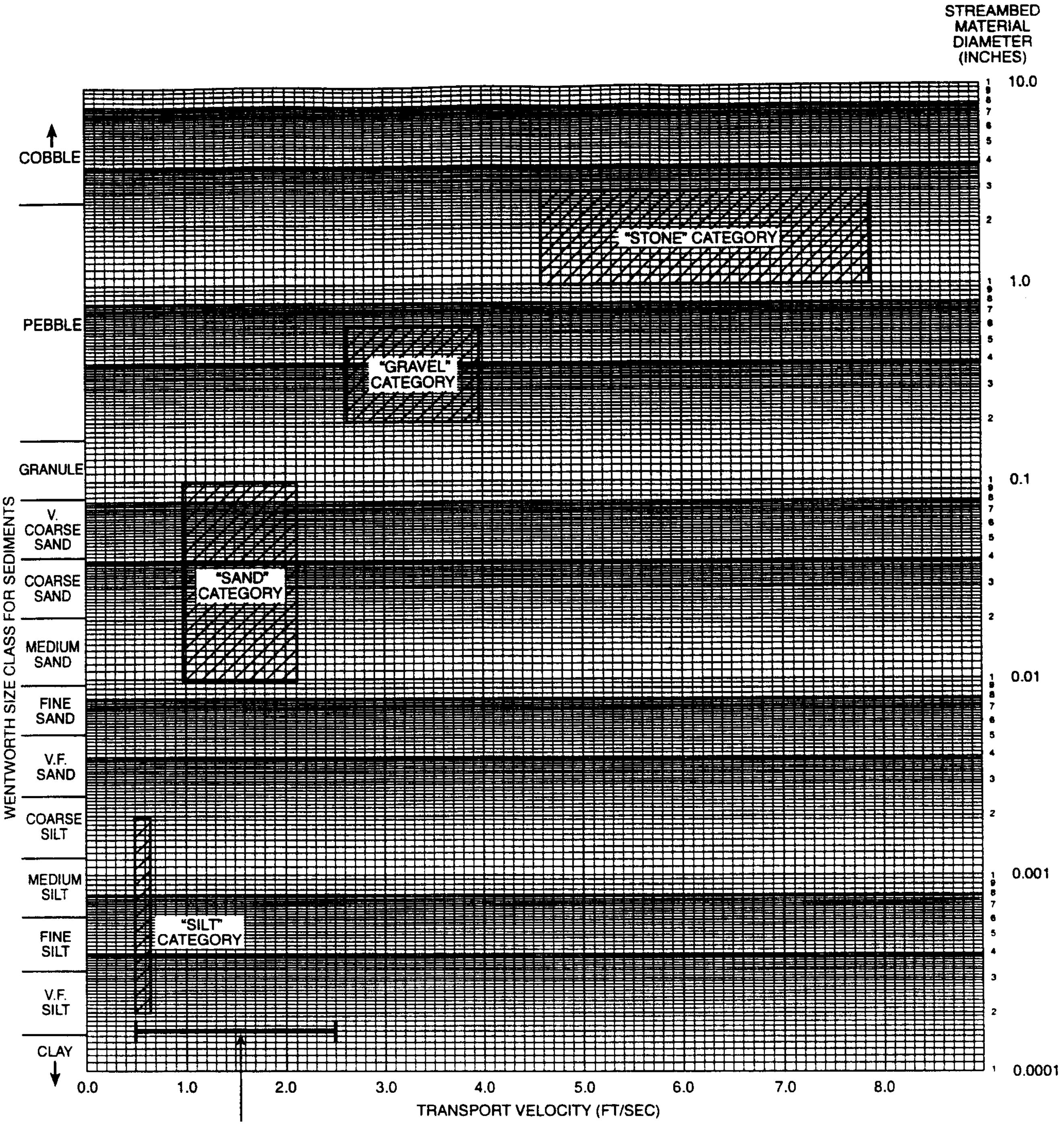


Figure 5.1-1
Vacca Farm Wetland Restoration
Grading Plan



Approximate range of velocities expected
in relocated Miller Creek channel

Source: Fisheries and Oceans (1980)

Figure 5.1-2
Sediment Transport Velocity vs. Sediment Diameter

The channel design (Figure 5.1-3 and Sheets C5 and C8 of Appendix A) includes a geotextile fabric liner for the relocated segment of Miller Creek. The geotextile will facilitate constructability of the channel in the peat soils, allowing placement of channel substrates other features with out excessive mixing with the underlying peat soils.

The proposed geotextile fabric is highly permeable, and is designed to permit groundwater exchange[21]. Because the geotextile fabric will be permeable, the stream will be hydrologically connected to the high groundwater table that is typically present in the underlying peat soils.[22] The high water table that is present on the site, the elevation of the new stream channel at or below the elevation of the groundwater, and the relative low permeability of the peat compared to the channel substrate will assure that the creek flows are maintained at the surface and not lost to groundwater.

Particles of the underlying peat soils and overlying stream substrate are expected to mix within the geotextile fabric. Thus, over time the permeability of the liner will match that of the adjacent strata. Particles from the underlying peat soils (typically under hydrostatic pressure) would be most likely to migrate into the liner and thus, the liner's permeability would eventually be expected to match or exceed the permeability of the peat soils.

The material specifications for spawning gravel (see below) is suitable for cutthroat trout and includes some fine sands and silts. These finer particles will reduce the permeability of the substrate such that during low flow periods the stream flow will remain as surface flow, and not flow laterally through the channel substrate. The lack of significant substantial clay sized particles in the spawning gravel mix will allow water to move from the underlying peat, through the geotextile liner, and into the stream bed materials.

Spawning gravels for the stream channel are specified to be naturally occurring, granular material. They will not be not crushed or fractured, and must be free of roots, wood, organic material, and any other deleterious substances. They must meet the following size gradation:

Sieve Size	Percent Passing	Sieve Size	Percent Passing
4" square	100	¼" square	25-50
2" square	80-100	U.S. No. 4	20-40
1" square	80-100	U.S. No. 10	10-20
¾" square	70-90	U.S. No. 100	5-10
½" square	50-70	U.S. No. 200	5 max.

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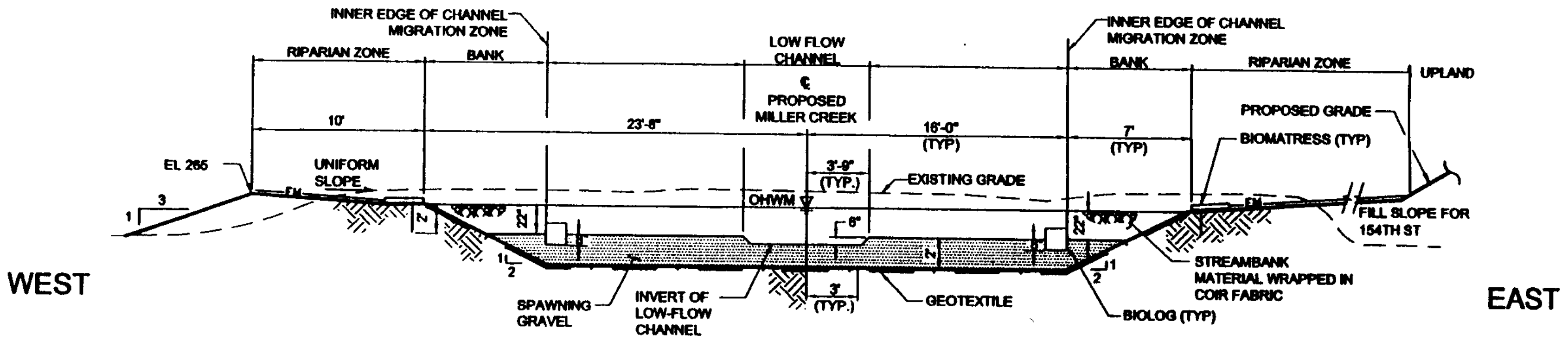
[21] Geotextile liners are by definition permeable, unless identified as "impermeable geomembrane liner". The geotextile liner's permeability of 60 to110 gallons per minute per square foot is much greater than that of the underlying peat.

[22] This design approach represents an improvement over the existing condition, as the existing stream channel consists of a ditch excavated in inorganic soils that are peripheral to the peat. Groundwater that currently surfaces in the peat flows through an agricultural ditch before entering the stream at the extreme south end of the site. The new design allows groundwater to discharge to the stream channel itself throughout the mitigation site.



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SCALE: HORIZONTAL 1"=10'
VERTICAL 1"=10'

Figure 5.1-3
Channel Cross Section
Miller Creek Location

Hydrology

The hydrologic design criteria for the Miller Creek relocated channel design are listed in Table 5.1-2. Design criteria for determining base flow, annual peak flow, and 100 year flow conditions were established from data gathered by KCSWM. These flow rates were determined from data gathered at the outlet of the Miller Creek detention facility (which includes Lake Reba), which is several hundred feet upstream of the mitigation site. Data have been gathered at this location since 1988 (KCSWM 1994). These flow data provide a good record of normal base flows, seasonal peak flows, average flows by season, and extreme flows during near-record events. Design criteria for base flow and annual peak flow conditions were established from these data (Table 5.1-5). Statistical analysis of the flow monitoring data was not conducted.

Table 5.1-5. Estimated flow rates for Miller Creek channel design.

Flow Regime	Flow Rate (cfs)
Dry season base flow	0.5
Wet season base flow	5
Stormflow	10
Annual peak flow	40
2-year peak flow	75
10-year peak flow	125
100-year peak flow	175

Source: Montgomery Water Group (1995), with additional data compiled by Parametrix.

In addition to monitored flow rate data, a detailed hydrologic modeling study was prepared (Montgomery Water Group 1995) that calculated peak flow rates for flood frequencies up to the 100-year flood (Table 5.1-6). The flood return frequencies were calculated assuming that the Miller Creek detention facility and control structure are in place. The calculated flow rates appear to be consistent with the flow monitoring data. The peak monitored flow rate (225 cfs) on November 24, 1990 was in excess of the current predicted 100-year flood flow. The control structure was constructed after the 1990 storm; it is likely that the peak flow rate of November 1990 would have been reduced by the detention system. Because stormwater runoff will be mitigated in separate stormwater management facilities, this plan does not increase channel capacity for increased flows.

Table 5.1-6. Flood frequency estimates for Miller Creek at the Miller Creek detention facility control structure.

Return Period (years)	Peak Flow Rate (cfs)
1.01	21
1.11	40
2	75
10	125
20	141
50	161
100	175

Source: Montgomery Water Group (1995).

Stream Hydraulics

Stream hydraulics are the existing or proposed physical conditions that influence the direction, depth, and flow velocity in the proposed relocated stream. Several factors influence hydraulics, including flow rates, channel slope, channel cross section, channel roughness, and flow depth. While several of these features will be designed, factors such as flow rate or average channel slope cannot be modified. The following sections discuss the design parameters that apply to all channel segments, and the proposed channel configuration for each segment.

Flow Velocity

Channel flow velocity is the primary variable influencing channel design and fish habitat. The low-flow goal is to minimize fine-grained (sands and finer) material sedimentation in the proposed channel during normal dry season base flows. Conversely, the flow velocity at peak flows must not exceed rates that would erode the channel banks or scour loose substrate larger than small gravel.

The relationship between flow velocity and sediment transport velocity is shown in Figure 5.1-2. If the flow velocity equals or exceeds that shown for each grain size, the sediment can be expected to move until the velocity decreases. If the maximum velocity of a specific section of a stream channel is known, an estimate of the size of the bed material that would be relatively stable can be determined. These relationships are used to determine the size of stream substrate materials and their long-term stability. The Miller Creek channel design thus balances a minimum base flow velocity designed to prevent sedimentation with a maximum peak flow velocity designed to prevent scouring. Using Figure 5.1-2, the channel parameters were adjusted to maintain base flow velocity greater than the silt movement velocity, but less than the gravel movement velocity for peak flow. Preventing gravel movement in the new reach will prevent scouring of the substrate.

Channel Slope

The average channel slope in the relocated reach is determined by physical constraints (i.e., topography) of the Vacca Farm site. The proposed channel drops 2.5 ft in approximately 1,118 ft for an average channel slope of 0.22 percent. The approximate elevation at the point where the relocated stream rejoins the existing channel is 260.0 ft. However, the natural land slope along the proposed stream channel does not drop continuously. Due to the small vertical drop over the relocated segment, a relatively uniform grade is proposed for Miller Creek.

Channel Flow Depth

Given the goals for fish habitat, desired substrate characteristics, and stream hydrology, flow depth standards have been determined. These flow standards are: (1) a dry season water depth of at least 0.25 ft; (2) a wet season water depth of 1 ft; (3) a maximum depth of 2 ft at the mean annual flow rate, and (4) flows greater than the annual maximum flow rate (40 cfs) will overflow the streambanks, flooding the Vacca Farm site.

Maximum Design Channel Flow

The topography and available channel slope in the project area limit constructing a large channel that can convey the 100-year storm while maintaining a minimum flow depth for dry season base flows. Therefore, the channel will overflow onto the floodplain at flows greater than approximately 40 cfs. The floodplain and floodway are designed to convey the 100-year flows of 175 cfs.

Channel Bottom Width

The relocated channel bottom width is largely controlled by the minimum low-flow depth of 0.25 ft. During the dry season, the water depth must average at least 0.25 ft to provide minimum depth for fish movement. To determine the channel bottom width, the base flow rate, slope, roughness, and side slopes were fixed, and the bottom width was adjusted until the flow depth was at least 0.25 ft. The results were checked to ensure that no other design criteria were changed to exceed design parameters. Results indicate that a channel bottom width ranging from 4 to 10 ft meets the design criteria for minimum flow depth. Thus, a low-flow channel between 4 and 10 ft wide will maintain a minimum flow depth of 0.25 ft during summer low flows to allow fish passage while conveying wet season base flows (see Figure 5.1-3).

Channel Roughness and Side Slopes

Channel roughness, described by using Manning's roughness factor (n), is a key factor in determining channel capacity. The Manning's channel roughness factor for a natural stream channel with a gravel or stony bottom and limited instream vegetation is 0.0035. This factor was used for calculating channel capacity for the relocated reach. The Miller Creek relocated channel will consist of a high-flow (or bench area) and a low-flow channel. The low-flow channel will have an 18- to 24-inch-deep gravel streambed, and will be generally 4 to 10 ft wide by 6 inches deep. It will meander within the 32-ft-wide high-flow channel, forming a channel migration zone (see Figure 5.1-3). The low-flow channel is designed to convey base flows and to overtop its banks approximately once a year during annual peak flows (i.e., between approximately 20 and 40 cfs). The annual peak flows will be accommodated within the 32-ft high-flow channel. Flood flows greater than the annual peak flows (i.e., greater than 40 cfs) will overflow the streambanks onto the floodplain.

The new channel is located in an area with peat soils; however, the channel will not be constructed directly in peat soils without bank stabilization (see Figure 5.1-3). The streambanks will be constructed using blended soils and gravels wrapped in an erosion control fabric. The toe of the channel banks will be protected by installing prefabricated logs made of dense coconut fibers wrapped in erosion control fabric. This construction method provides immediate erosion protection as well as a rooting substrate that will facilitate revegetation of the banks. The area adjacent to the channel banks will be sloped toward the channel at 2 to 10 percent grade for positive drainage.

The side slopes of the low-flow channel will be 1:1, which is required to maintain minimum flow depths of 0.25 ft for fish passage. This design will also allow some minor undercutting of channel banks over time to increase shelter for fish. Low-flow channels of natural streams in the Puget Sound region typically have vertical side slopes (Rosgen 1994; Montgomery and Buffington 1993), and the design thus mimics natural stream channels. The side slopes of the new channel will be stabilized with bioengineering and by planting native vegetation (i.e., primarily willow stakes). The low channel gradient and design of the low-flow channel to overflow into the larger channel during storms greatly decrease the likelihood of erosive flows.

Channel Alignment

The channel will be constructed to meander within the limits of the stream corridor as shown in plan and cross section in Figures 5.1-1 and 5.1-3. The extent of meandering is limited by the need to maintain a minimum channel slope to meet flow velocity goals.

Sewer Line Relocation

Relocation of Miller Creek (design and construction) will be coordinated with realignment of the sewer line required by relocation of South 154th Street. The sewer line will parallel the new road alignment (outside of the mitigation site boundary) and will cross under the new channel (see Figure 5.1-1). The sewer line will be approximately 4 ft below the invert of the new channel. The trench in which the sewer line lies will be backfilled with compacted fill material that will provide a stable surface over the sewer line. The Port has analyzed the need for additional stabilization below the new channel to protect the sewer line and the channel. This analysis indicates that because of the depth of the sewer line, the flat topography of the site, and the small size of the channel, no extra measures will be required to stabilize the channel over the sewer line. The new channel will be located in a portion of the Miller Creek floodplain that is more or less flat; stream velocities are low in this portion of the stream, and there is no potential for significant downcutting within the new channel reach. During periods of high flows, the channel is designed to overtop its banks and flow onto the floodplain, which further reduces any potential for downcutting.

The 20-ft easement for the relocated sewer will be located outside of the mitigation site boundaries, except where the line crosses under the stream. A maintenance access road will be located within the easement along the east side of the mitigation site; however, the access road will not go through the mitigation site (Appendix A, Sheet C2).

Wildlife Considerations

Design and implementation of mitigation for STIA must meet flight safety issues and FAA requirements. Collisions between birds and aircraft are a serious safety issue. Open-water areas, wetlands, and tall trees can create an aviation hazard by attracting waterfowl, small flocking birds (such as European starlings), and raptors. Fish can also attract birds, such as raptors or herons, that pose hazards to aviation. When these habitat features are within 10,000 ft of airport runways, the potential for collisions with aircraft can be serious. For these reasons, mitigation projects within 10,000 ft of STIA runways are designed, where feasible, to reduce existing wildlife hazards and avoid creating new hazards. At the Vacca Farm area, hazardous wildlife currently use the site and are periodically controlled. Wildlife use of the mitigation site will be monitored and managed according to the WHMP (USDA 2000).

Fish habitat design standards for Miller Creek were developed based on the habitat requirements of cutthroat trout.[23] The planned features include:

- Shading to minimize temperature increases during the summer
- Higher velocity riffles to maintain oxygen levels and reduce sedimentation

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[23] While coho salmon may find suitable rearing habitat in this area, flow conditions are not anticipated to be suitable for spawning coho.

- Placement of logs, rocks, or other structures to provide refuge
- Shading of the channel with native vegetation

Channel shading will enhance the stream habitat and also decrease the stream's visibility to birds of prey (e.g., herons, raptors) that would use the stream to collect food. Riparian vegetation will thus help reduce potential wildlife hazards along the channel. The following sections describe how the stream design will meet cutthroat trout habitat criteria and FAA requirements for aviation safety.

Instream Habitat

The instream habitat criteria used in the relocated channel design are based on general habitat requirements of the resident salmonid cutthroat trout and coho salmon, which could potentially use the site. Although anadromous salmonids have not been observed in the proposed impact areas, resident cutthroat trout are present. These criteria are used to provide the highest quality fish habitat possible. Designing the relocated stream to meet habitat requirements of salmonids helps ensure that the best possible fish habitat is created.

In general, salmonids require cool, well-oxygenated water; spawning gravel that is free of accumulated silt; and abundant instream cover for habitat. In addition, because habitat requirements vary as life stages change, habitat complexity within the stream is also necessary. General physical habitat requirements include access to critical habitat features, stable flows, appropriate stream substrate, and riparian and instream cover.

Salmonids require cover provided by such features as undercut banks, logs, boulders, deep pools, and overhanging riparian vegetation for feeding, hiding, and resting. In addition, these features help stabilize streambanks and substrate during high-flow periods. The relocated channel, which is designed with vertical banks in the low-flow depth range, will encourage minor undercutting to provide cover during low-flow periods. LWD (e.g., deflector logs, angle logs, and root wads) and boulders will be used to stabilize the substrate, protect the upper banks from excessive erosion, and provide hiding and holding habitat for fish during higher flow periods (Figure 5.1-4).

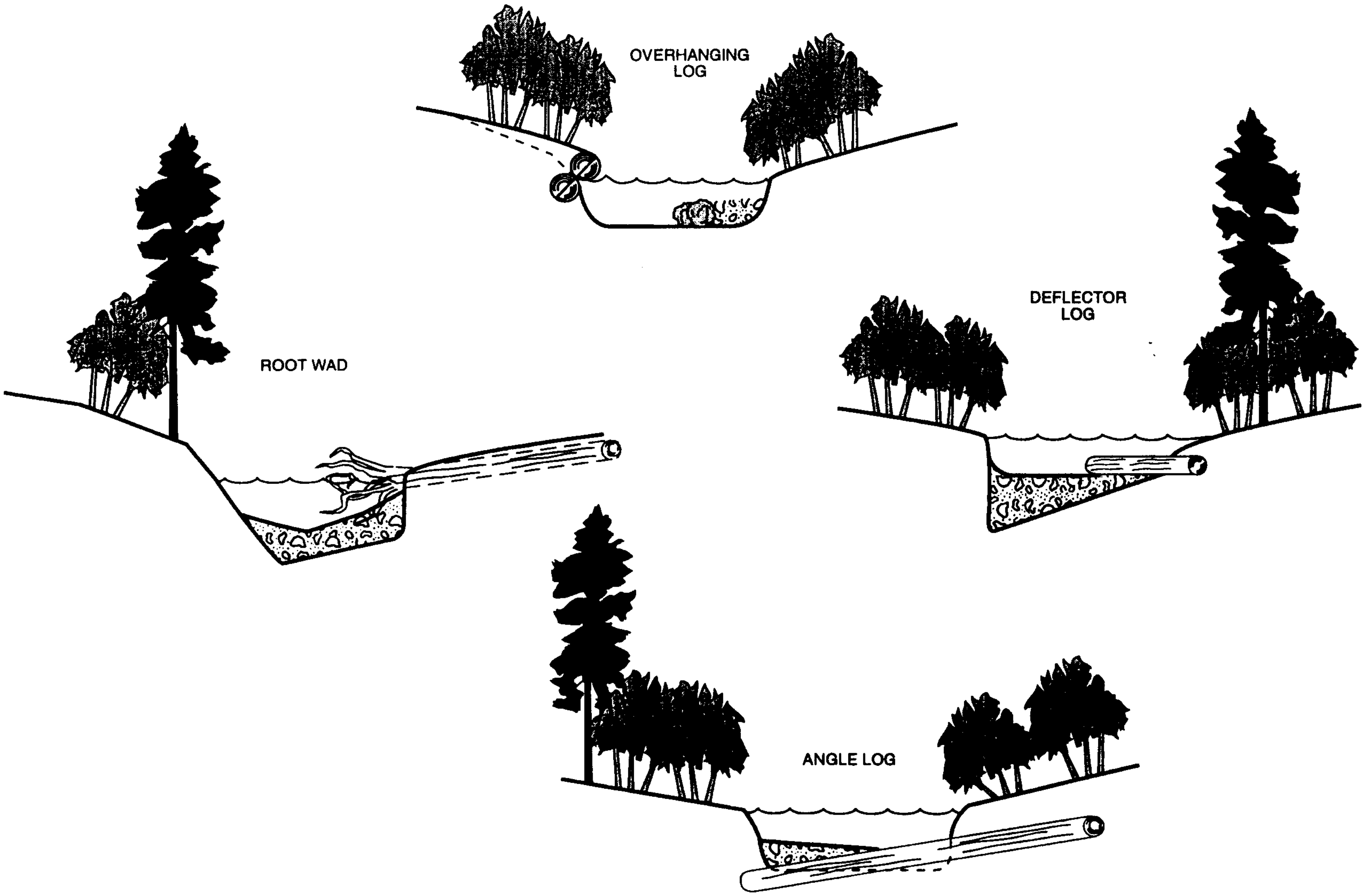
Fish Access

Adequate fish access throughout the entire relocated stream section will be provided by the minimum design depth requirements (i.e., 0.25 ft during dry season base flows). Accessible habitat includes protected areas (i.e., low-velocity pockets) during high flows. The channel is also designed to avoid habitat features that could cause stranding problems during low-flow conditions.

This minimum depth requirement should allow fish access to habitat throughout the length of the channel, thus limiting stranding problems during low-flow periods.

Stable Flow

Stable flows ensure habitat access and protect the habitat against erosion or scouring; they also minimize fish displacement to less preferred habitats. The channel width and bank slope criteria incorporated in the design will help maintain relatively stable flow velocities throughout the range of flows expected in the new channel.



Data Compiled by Parametrix

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

Figure 5.1-4
Representative Fish Habitat Enhancement Features

Stream Substrate

Cutthroat trout require stable gravel and sand substrates largely free of accumulated silt for spawning and during early rearing life stages. This also contributes to the optimum production of desired prey. Substrate in the relocated channel will consist of primarily of gravel, coarse sands, and cobble material substrate (see specifications provided earlier) to provide stable spawning and rearing habitat. However, portions of the channel will naturally accumulate sand over time. The flow velocity criteria for the channel were set to maintain suitable substrate for fish by minimizing the accumulation of fine-grained material in the channel during low-flow periods and preventing excessive scouring of the substrate during high flows. Since flow velocities are not constant along the entire channel, sedimentation is expected to occur on the inside of bends and in deeper pools during low-flow periods. However, these sediments will flush out during higher flows.

Floodplain Conveyance

The 100-year floodplain elevation and floodway delineation in the proposed project area were determined by FEMA when the Flood Insurance Rate Maps (FIRM) were prepared. The proposed channel capacity was checked to assure it could convey the 100-year peak flow. Since the floodplain storage capacity on the Vacca Farm site does not decrease (see Section 5.1.2), no increase in future conveyance capacity of the channel is necessary. During flood events, the stream would overtop the channel banks and flood the existing and regraded floodplain. The floodplain itself is broad and nearly level, and it has adequate storage and conveyance capacity to prevent increases in the 100-year flood elevation upstream of the site.

Channel Planting and Riparian Buffer

The new channel banks will be stabilized and cover will be provided to the stream by planting the banks with native willows. Shade cloth will be used to provide shade over the channel during the summer months until 40 percent cover of riparian vegetation is reached. Use of shade cloth (between Stations 2+00 and 13+00 [see Appendix A]) will ameliorate stream temperatures while riparian vegetation is becoming established. A forested buffer will also be planted along the stream riparian zone to maximize stream shade and provide overhanging cover as habitat. These planting plans are described in Section 5.1.2.7. Upland trees and shrubs will also be planted on the roadway slope east of the new channel. These plantings will buffer the stream from the road, but no mitigation credit will be sought for this area (Appendix A, Sheet C1.1).

5.1.1.7 Implementation

Construction of the third runway, which requires the relocation of Miller Creek, is currently scheduled as part of the first phase of the proposed Master Plan Update implementation. Channel relocation construction is currently anticipated to begin the first construction season (i.e., summer) following granting of the permits for the project. After the new channel is complete, Miller Creek will be diverted and monitoring will begin. Instream work associated with new channel construction must occur during low-flow periods and be consistent with HPA permit conditions as specified by WDFW. Construction of the channel relocation will be coordinated with construction of the third runway, South 154th Street/South 156th Way relocation, the sewer line relocation, and construction of Vacca Farm floodplain projects. A detailed description of implementation, construction methods, and construction steps for the Vacca Farm projects, including the stream relocation, is included in Section 5.1.4.

5.1.1.8 Monitoring and Performance Standards

The Miller Creek relocation project will be monitored consistent with the approach and schedule outlined in Section 4 of this document. Detailed performance standards and contingency measures for the Miller Creek channel are included in Table 5.1-7, which summarizes performance standards and monitoring methods and parameters for all of the Vacca Farm mitigation projects. The general monitoring schedule for the Vacca Farm projects is provided in Table 5.1-8. Monitoring the new channel includes routine inspections and emergency inspections following major floods.

Hydrology and Hydraulics

The effectiveness of the relocated stream will be evaluated in several ways. Because erosion and sedimentation are the primary indicators of stream hydraulic conditions, they are the critical criteria to be included in the proposed monitoring plan. The following activities will be included in the stream monitoring plan to determine whether specific performance standards are being met (see Tables 5.1-7 and 5.1-8):

- Inspect the constructed habitat features (log weirs, root wads, etc.) to ensure they have not been damaged or displaced (to the extent that they are not providing habitat)
- Inspect the substrate to ensure that sedimentation and erosion prevention goals are met
- Inspect for erosion or scouring
- Evaluate substrate material to determine if particle sizes remain stable, and there is no evidence of excessive siltation or scouring
- Inspect stream structures and channel after major storms, as monitored by the KCSWM gage
- Inspect for adverse flooding impacts and ponding water

Fencing along the perimeter of the mitigation area will protected the area from public access and illegal dumping. Where feasible from security and wildlife management concerns, it will be designed to promote wildlife movements. Permanent signs that clearly designate the area as a protected wetland mitigation site will also mark site perimeters. Signs will be inspected regularly and maintained in good condition by the Port.

Channel Bank and Riparian Buffer

Vegetation along the new channel will be monitored to ensure that channel and riparian plantings meet design goals and become successfully established along the relocated stream. Performance standards, variables to be evaluated (e.g., survival, cover), and specific contingency measures for riparian vegetation are included in Table 5.1-7.

The landscape shows that the planting of conifer trees is phased (see landscape design sheets in Appendix A). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm.

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
I. Relocation of Miller Creek (relocated portion of stream (1080 ft) on Vacca Farm)			
1. The channel cross section will provide an average dry season base flow velocity that is greater than the silt transport velocity (0.7 ft/sec).	Average flow velocities will exceed 0.7 ft/sec at flows of 0.5 cfs or greater. Observable surface flow must be in the channel at all times.	Measurements of stream velocity.	Alter velocities in low-flow channel using woody debris or boulders. Narrow portions of channel using LWD, boulders, or gravel bars to increase velocity.
2. Design a natural channel with stable gravel bottom in riffle sections suitable for spawning of cutthroat trout.	Substrates will contain less than 20% fine sediments (i.e., sand or smaller) in riffle sections.	Riffle areas will be delineated as part of the as built plans. A volumetric assessment of substrate (using McNeil cores or bulk samples) will be performed to document substrate conditions.	If fine sediments are present, evaluate sources; if sources are on Port property, implement stabilization measures to control or eliminate fine sediments. Alter velocities in low-flow channel using woody debris or boulders to adjust channel width.
3. Channel flow velocity is less than the gravel movement velocity (4 ft/sec) at the 100-year flow (175 cfs).	Bed material size will not change compared to record conditions.	A volumetric assessment of substrate (using McNeil cores or bulk samples) will be used to document substrate conditions. Channel surveys will be performed to evaluate the presence of scouring or erosion.	Adjust width of channel, replace spawning gravels, and/or repair any eroded channel banks with bioengineering or additional streambank plantings.
4. Flows greater than the annual peak flow will overtop the channel and inundate the adjacent floodplain restoration.	Flows greater than the annual peak (40 cfs) will overtop the streambanks and flow into the floodplain.	Measure water elevations in the stream channel and floodplain and relate to streamflow and as built topography (e.g., floodplain elevation and berm height).	Adjust bank height, channel morphology, or roughness to alter amounts of overbank flow. Regrade channel banks if necessary.
5. Provide instream habitat features such as deflectors and overhanging logs as needed to maximize available habitat.	A minimum of 20 instream habitat features (e.g., LWD, overhanging logs, deflector logs, or root wads) will be present during monitoring years 3, 8, and 15. (LWD is woody material greater than 10 cm in diameter and 2 m in length (Cederholm et al. 1997).	Measure abundance, sizes, and location of LWD in the new channel.	If losses of LWD occur, evaluate factors contributing to reduction in LWD (e.g., high flows) and address. Add LWD to channel as necessary.

Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
6. Provide approximately 3.0 acres of vegetated buffer on the east side of the channel. Establish native vegetation along channel banks and the riparian zone of the new channel.	Establish 3.0 acres of native shrub/forested riparian zone and upland buffers with an average tree density of at least 280 stems/acre and shrub density of at least 2,100 individuals per acre in monitoring years 3, 8, and 15. At Year 1, survival of planted stock will be 100%. Average survival of planted trees and shrubs in the first 3 monitoring years shall be at least 80%; cover of native species will be 80% by year 15[b]. Cover of non-native invasive[c] species will be no greater than 10% during any monitoring year. In monitoring years 3, 8, and 15, the numbers of plant species in the mitigation area shall not decline by more than 10 % from the number originally planted.	Vegetation sampling (plots, transects, or plotless techniques) to measure stem density plant cover, count live and dead plants, and measure cover of non-native invasive species.	Install additional plants if necessary. Identify substitute native species that are adapted to site conditions. Eliminate or reduce the abundance of non-native invasive species. Install protective collars to reduce herbivore damage.
7. Densely plant woody vegetation along the new channel to cover open water and reduce use of the area by waterfowl.	Canopy cover extending over the low flow channel will be 80 percent by the end of the monitoring period[d].	Vegetation sampling to determine tree and shrub cover over the portion of the channel below the ordinary high water mark (OHWM).	Add additional plants if areas of exposed stream channel are present.
II. Wetland Enhancement and Restoration on Vacca Farm			
1.[a] Provide for approximately 5.94 acre-ft of flood storage on Vacca Farm to compensate for approximately 5.24 acre-	Provide 5.9 acre-ft of flood storage to compensate for 5.2 acre-ft filled for the embankment. The floodplain area will slope toward drainage swales that connect to Miller	Record drawings and hydrologic monitoring to verify necessary flood storage is present	Regrade area if not excavated to specifications. Modify design of swales to improve drainage conditions if necessary.

Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
ft filled for the embankment. Excavate drainage swales to provide positive drainage from the floodplain and prevent standing water during non-flood periods.	Creek.		
2. Use excavated material from grading the floodplain to create topographic variation in the floodplain.	Topographic features (mounds, ridges)[c] will be constructed at a density of 4 per acre. Dimensions of these features will range between 4 and 8 ft wide; 8 and 16 ft long, and 1 and 2 ft high.	Determine density from record survey.	Construct additional features if project has not been built to specifications.
3. Plant native trees, shrubs and herbaceous (see Table 5.1-11, Table 5.1-12) species in these areas at tree densities of greater than 280 trees per acre (trees include willow species) and shrub densities of greater than 2,100 per acre. Intersperse scattered native conifers in this area.	At year 1, survival of planted stock will be 100%. Shrub and tree survival will average at least 80% in the first 3 monitoring years. In monitoring years 3, 8, and 15, at least 280 trees per acre (including willow species) and 2,100 shrubs/acre will remain. Percent cover of native species will be at least 80% by year 15[b]. In newly planted or enhanced areas, non-native invasive[c] species cover will be no more than 10% in all monitoring years. In monitoring years 3, 8, and 15, the numbers of plant species in the mitigation area shall not decline by more than 10 % from the number originally planted.	Vegetation sampling (plots, transects, or plotless techniques) measure vegetation cover and diversity.	If standards are not met: • Select species that are better adapted to existing hydrologic conditions. • Install additional plant material. • Install protective collars to reduce herbivore damage. • Control/reduce non-native invasive species.
4. Plant the floodplain with native trees, shrubs,	Percent cover of native herbaceous species will be at	Vegetation sampling (plots, transects, or plotless techniques) to estimate canopy	See above.

Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
and grasses to deter water fowl.	least 80% by year 15[b].	cover.	
5. Enhance existing forested wetland south of Lora Lake with native shrubs to provide a diverse understory. Total density of native shrubs will be at least 1,700 individuals per acre.	At Year 1, survival of planted stock will be 100%. Average survival of planted stock will be at least 80% in the first 3 monitoring years. In monitoring years 3, 8, and 15, shrub density will be at least 1,700 shrubs per acre.	See above.	See above.
	In areas where existing wetland is being enhanced, percent cover of non-native invasive[c] species in the understory will be no more than 10% during any monitoring year.		
	In years 3, 8, and 15, the number of plant species present will not decrease by more than 10% from the number installed at baseline.		
III. Lora Lake Buffer Enhancement			
1. Plant buffer and restoration areas with native trees and shrubs. Plant native tree species at densities of greater than 280 per acre (total of at least 168 trees). Plant native shrub species at densities of greater than 2,100 (total of at least 1,260) per acre.	At Year 1 survival of planted stock will be 100%. Average survival of planted stock will be at least 80% in the first 3 monitoring years. During monitoring years 3, 8, and 15, at least 168 trees and 1,260 shrubs will be present in the buffer.	Vegetation sampling (plots, transects, or plotless techniques), as described above.	Contingency measures for vegetation performance standards are described above.
	Percent cover of native species will be at least 80% by year 15[b].		
	In years 3, 8, and 15, plant diversity will not decrease by		

Table 5.1-7. **Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).**

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
	more than 10% from the number and type of plants installed at baseline. Non-native invasive[c] species cover will be no more than 10% by year 15 in newly planted or enhanced areas.		
2. Restoration areas will meet wetland hydrology criteria	At the upland edge of the restoration area, the minimum criteria for wetland hydrology (see Environmental Laboratory 1987) will be present. In the interior portions of the site, groundwater will be within 12 inches of the soil surface for at least the period of March through May during years of average rainfall.	Groundwater monitoring.	Evaluate hydrologic monitoring data and determine site grades that provide the desired hydrologic regime.
3. Concrete bulkhead will be removed and shoreline graded to a stable slope configuration.	Record drawings and photo documentation verify that the concrete bulkhead has been removed. New shoreline of Lora Lake will have a slope of 3:1 or gentler.	Record drawings to verify removal and bulkheads and slope of shoreline.	Remove all structures and bulkhead areas to be consistent with design. Re-grade as necessary to be consistent with design.

[a] Compliance with this performance standard will be determined from the record drawing, and will generally not require ongoing monitoring.

[b] See Table 4.3-1 for interim cover targets (i.e., from year 3 to year 15).

[c] See Table 4.3-2 for list of invasive, non-native species to be monitored and controlled on the mitigation site.

[d] During the first few growing seasons following establishment of the new channel, shade will be provided over the channel with the use of nursery shade cloth to shade out about 75% of the ambient solar radiation. Interim cover standards for vegetation (i.e., for monitoring years 1 through 14) are provided in Table 4.3-1)

[e] See Appendix A for design details.

[f] Normal rainfall will be based on the definition for 'most years' given in the ACOE manual (Environmental Laboratory 1987) (i.e., annual precipitation in a normal year must be the same as or greater than precipitation in 5 years out of 10) or the average precipitation for a time period plus or minus 1 standard deviation of the mean.

Table 5.1-8. Miller Creek relocation mitigation monitoring methods and schedule.

Feature	Activity	Duration	Years Following Construction												
			0	1	2	3	4	5	6	7	8	9	10	12	15
Habitat Structures	Visual inspection, photodocumentation	Annually (May), or after flows in excess of the 2-year peak flow (during the first 3 years)	X	X	X	X		X		X			X	X	X
Channel Morphology	Measured cross sections, longitudinal profiles, photodocumentation	Annually (May) or after flows in excess of the 2-year peak flow (during the first 3 years)	X	X	X	X		X		X			X	X	X
Substrate	Pebble counts	Semi-annually (February/August)	X	X	X	X		X		X			X	X	X
Erosion or Scouring	Evaluate materials and scouring	Annually (May) or after flows in excess of the 2-year peak flow (during the first 3 years)	X	X	X	X		X		X			X	X	X
Adverse Flooding	Inspect floodplain for ponded water	Twice yearly (February/ November)	X	X	X	X		X		X			X	X	X
Channel Plantings	Vegetation sampling	Semi-annually (May/June & September/October)	X	X	X	X		X		X			X	X	X
	Wetland Delineation	Early spring						X					X		X

Instream Habitat

Instream habitat conditions in the relocated channel section will be described based on a variety of monitoring data collected using standard methods for ecological evaluations of streams. Hydrologic conditions important to habitat that will be described include water depths, velocities, profile, and area of wetted channel. Substrate conditions (size and type) will be evaluated and described by site observations and pebble counts. The amounts and types of LWD in the stream channel will be described, including the special habitat conditions (undercut banks, side channels, and pools) this LWD creates. The influence of riparian vegetation on instream habitat will be described based on surveys of plant cover overhanging the high- and low-flow channels. Methods for collecting and evaluating this information are provided in Table 5.1-8.

5.1.1.9 Site Protection

The Port will execute and file restrictive covenants on the mitigation projects at the Vacca Farm site. Copies of restrictive covenants that have been approved by ACOE, Ecology, FAA, and USDA-WSD are included in Appendix G.

5.1.1.10 Maintenance and Contingency Plans

A key design objective for the stream channel is that it shall function as a natural channel, requiring little or no maintenance. To ensure that this goal is achieved, the monitoring plan and contingencies have been designed to allow the channel to perform within a range of conditions. If the performance standards indicate that the channel is not within this acceptable range, periodic maintenance may be required to change or remove the factors responsible. Specific contingency measures for the channel relocation are included in Table 5.1-7.

The proposed channel configuration has two basic conveyance criteria that need to be maintained to meet performance standards: (1) maintain minimum flow depths and velocity for fish passage, water quality, and sedimentation; and (2) provide flow capacity for peak flows. If there were to be future changes in flow rates in Miller Creek compared to design flows, contingency measures may be required for the project to continue to meet goals and objectives. The Port does not anticipate that contingency measures will be needed due to future changes in flow rates for the following reasons. Flow rates are unlikely to differ from the design flows used to develop this plan because the design flows were derived from detailed data (including a calibrated Hydrologic Simulation Program FORTRAN [HSPF] model), and because of the extensive BMPs developed for the project (see Section 6 and Parametrix 2000a, 2001a). Possible contingency measures that would be implemented in the case of altered flow rates could include:

- Widening the base flow channel to reduce velocities and improve capacity
- Narrowing the base flow channel with logs or boulders to increase base flow depth and velocity
- Widening the flood flow portion of the channel (above 0.5 ft) to improve capacity and reduce velocity
- Adding log weir steps to flatten stream slope, reducing velocity and increasing base flow depth
- Adding a bypass flow channel to convey peak flows past the main channel.

5.1.2 Vacca Farm Floodplain and Wetland Restoration Plan

To mitigate the loss of floodplain storage (approximately 5.24 acre-ft) and wetland impacts in the Miller Creek basin, the floodplain and wetlands in the Vacca Farm area will be restored (see Table 5.1-1). Restoration of the historic floodplain and wetlands will include providing a minimum of 5.94 acre-ft of flood storage, restoring wetland hydrology, and re-establishing native vegetation in approximately 12 acres of existing cultivated farmland and aquatic habitat of Lora Lake. Replacing non-native vegetation with native plant communities will enhance existing degraded wetlands on the Vacca Farm site. Planting forested upland buffers around the perimeter of the Vacca Farm site (Figure 5.1-5) will further enhance functions in the restored wetlands. Approximately 5 acres of upland buffers will enhance and protect the floodplain wetlands by increasing infiltration and supporting wetland hydrology and stream base flows, removing sediments and nutrients, and providing physical protection and visual screening from adjacent properties. The Vacca Farm mitigation allows significant wetland functional restoration to occur in proximity to, and in the same basin as, project impacts.

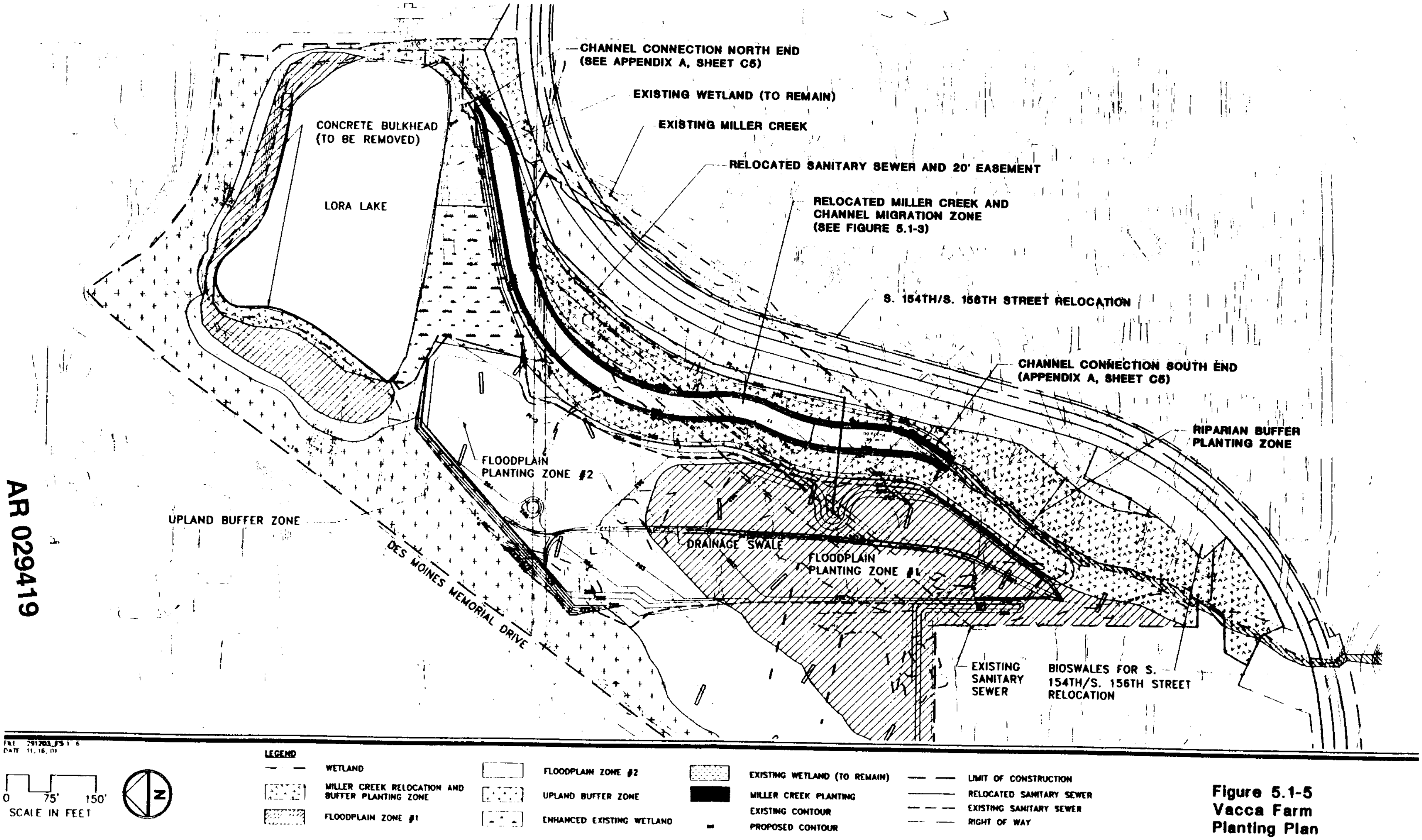


Figure 5.1-5
Vacca Farm
Planting Plan

Vacca Farm contains areas which historically were wetland but have altered hydrology due to prior agricultural activities. Historic wetlands north and west of Lora Lake have been filled. The floodplain and wetland restoration will restore wetland hydrology to the site by removing existing drainage features and excavating part of the floodplain to bring seasonal groundwater levels closer to the surface, and removing fill from the perimeter of Lora Lake. Native wetland plant communities will be restored to the floodplain wetlands and existing degraded emergent wetlands will be enhanced to forested or shrub wetlands (see Figure 5.1-5). These actions will enhance hydrologic (i.e., surface water storage) and water quality functions at the Vacca Farm site, as well as reduce the volume of eroded soil, pesticide, and fertilizer runoff reaching Miller Creek.

To protect aquatic habitat in Miller Creek and protect and enhance functions of floodplain wetlands, forested buffers will be established and enhanced. An upland buffer area will be established along the east side of the relocated Miller Creek between the riparian zone of the stream and the relocated roadway for South 154th Street (Figure 5.1-6, see Figure 5.1-5). The buffer will reduce human intrusion into the riparian zone, screen riparian habitats from human activity, and protect water quality and aquatic habitat. A second upland buffer will be established between the floodplain enhancement area and Des Moines Memorial Drive on the west side of the Vacca Farm site (see Figure 5.1-5). The forested buffer in this area will provide a physical buffer between the road and the enhanced shrub floodplain wetlands and restored stream.

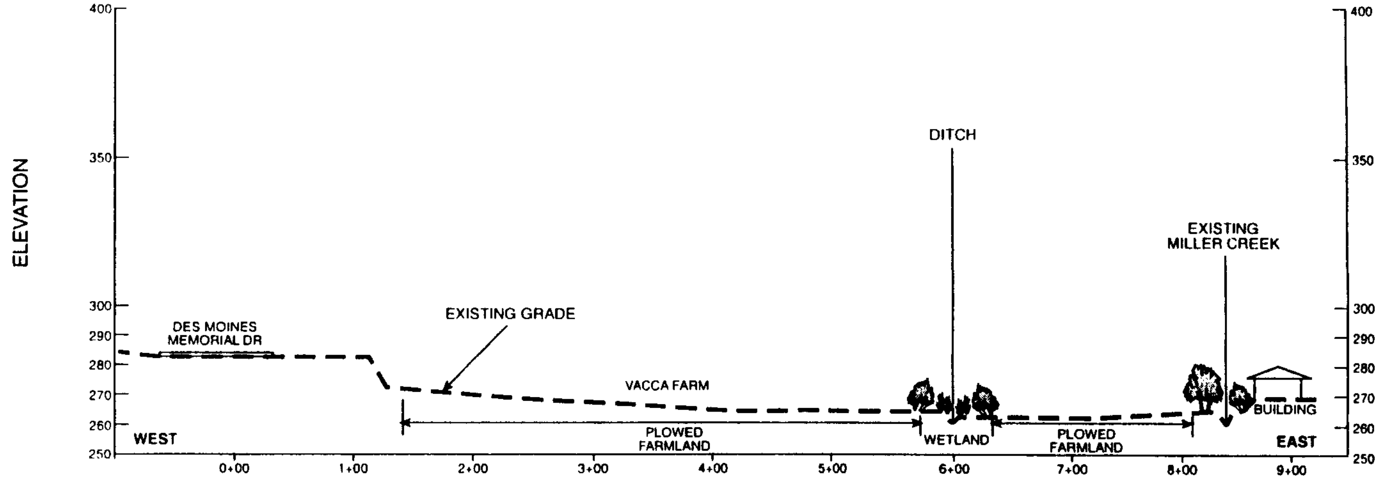
5.1.2.1 Goals, Objectives, and Design Criteria

Three specific goals have been identified for the Vacca Farm floodplain and wetlands mitigation:

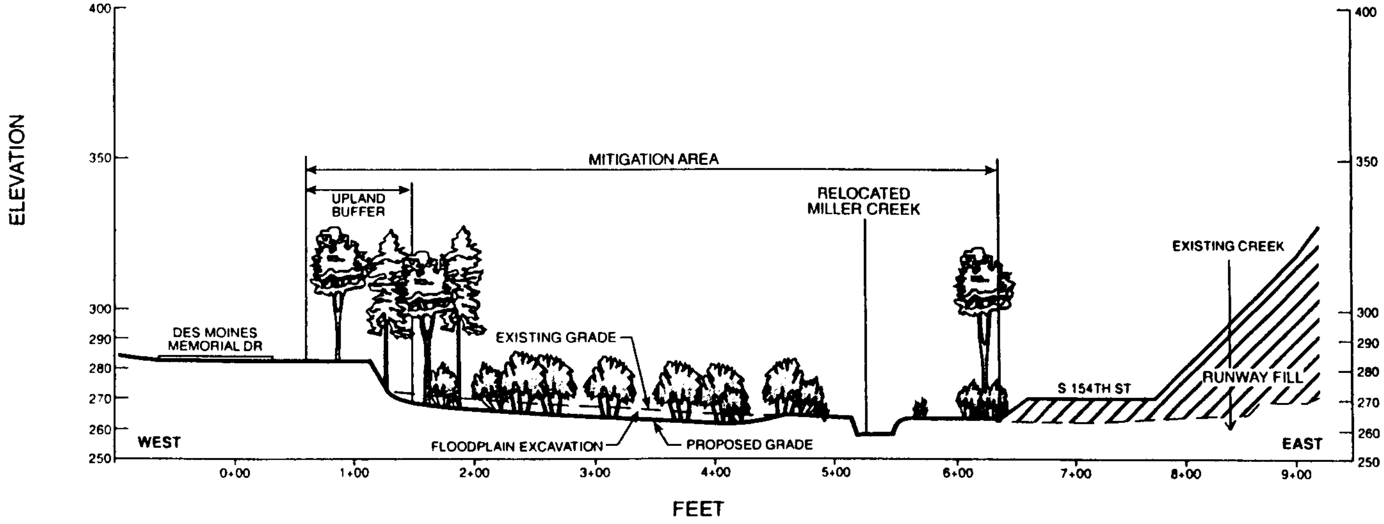
- Compensate for loss of riparian flood storage and wetlands in the Miller Creek basin.
- Restore and enhance floodplain and wetland functions adjacent to Miller Creek in the Vacca Farm site by restoring historic floodplain and wetland hydrology and vegetation. Enhance floodplain, wetland, and stream functions by providing forested riparian and upland buffers.
- Grade the floodplain and create a planting area for the wetland community in the floodplain area that does not attract waterfowl and flocking birds, and reduces existing wildlife hazards.

Specific objectives and design criteria to achieve these wetland mitigation goals are listed in Table 5.1-9.

Existing Conditions



Post-Mitigation



Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 9/01 (K)

Figure 5.1-6
Typical Cross Section of Miller Creek Floodplain Enhancement

Table 5.1-9. Mitigation goals, design objectives, and design criteria for the Vacca Farm wetland restoration project.

Goals and Design Objectives	Design Criteria
Goal 1: Compensate for loss of floodplain and floodwater storage	
Provide additional floodplain area by excavating approximately 9,600 cy on the Vacca Farm site.	Excavate approximately 9,600 cy of soil between elevation 262 ft and 266 ft.
	Drainage swales to provide positive drainage from the floodplain and prevent standing water during non-flood periods.
	Use excavated material from grading the secondary swales to create topographic variation in the floodplain.
Goal 2: Increase functional linkages between historic wetlands and Miller Creek	
Remove existing agricultural uses from the floodplain area on the Vacca Farm site.	Eliminate farming activities and remove existing structures from restoration site.
Restore wetland hydrology to farmed wetlands and prior converted croplands.	Remove ditches and drains. Grade floodplain to elevations that restore wetland hydrology.
Plant floodplain with native trees and shrubs.	Restore 11 acres of floodplain (see Table 5.1-1) with native vegetation.
	Plant native shrub species in the floodplain and intersperse native trees in this area. Shrubs will be planted at a density greater than 2,100 per acre.
Goal 3: Establish native wetland communities in the mitigation area that does not attract waterfowl and flocking birds	
Deter flocking waterfowl from using the site.	Plant the floodplain with native trees, shrubs, and tall grasses to deter waterfowl.

5.1.2.2 Mitigation Site Description

The Miller Creek floodplain and wetland restoration project will be located at the Vacca Farm site, northwest of the existing airfield. The Vacca Farm site includes Lora Lake and the area to the south of Lora Lake between the existing Miller Creek channel and Des Moines Memorial Drive (see Figures 2.1-2 and 2.1-4). Vacca Farm contains upland areas around the perimeter of the site; agricultural fields; some scattered farm structures; a system of drainage ditches and tile drains; FWs; and forested, shrub, and emergent wetlands (Parametrix 2000c). A large ditch runs through the middle of the Vacca Farm site, parallel to the existing Miller Creek channel, flowing into Miller Creek at the south end of the site (see Figure 2.1-4).

5.1.2.3 Ownership

The Port owns all of the property on the Vacca Farm site.

5.1.2.4 Rationale for Selection

The Vacca Farm site allows significant wetland functional restoration to occur in proximity to, and in the same basin as, project impacts. Mitigation at this site provides the opportunity to restore wetland hydrology and wetland habitat to areas that historically were wetlands, but have altered hydrology due to prior agricultural activities. In addition, because the site has been farmed, non-native plants dominate the site, there are no extensive areas of existing forest or invasive species, and the site is relatively flat. Therefore, minimal grading would be required, and no natural vegetation communities would be disturbed by mitigation activities. The floodplain and wetland restoration will also reduce wildlife hazards near the airport by replacing emergent wetlands with forested and shrub wetlands. These actions will enhance hydrologic (surface water storage) and water quality functions at the Vacca Farm site, as well as reducing the volume of eroded soil, pesticide, and fertilizer runoff reaching Miller Creek.

5.1.2.5 Constraints

No constraints have been identified that would preclude implementing this plan.

5.1.2.6 Ecological Assessment of the Vacca Farm Mitigation Site

Ecological conditions important to the mitigation design and implementation are summarized below. Historically the Vacca Farm site likely was a mosaic of forested and shrub wetlands. These wetlands developed on peat soils that formed in a wide floodplain along a low-gradient, frequently flooded reach of Miller Creek. The site currently consists of uplands; agricultural fields; FWs; and forested, shrub, and emergent wetlands.

Miller Creek Floodplain

The 100-year floodplain in the vicinity of the Vacca Farm is quite extensive (see Figure 2.2-2). The wetland area and poor drainage that existed prior to agricultural drainage activities are evident from the 100-year floodplain estimated by FEMA. The approximate 100-year flood elevations, determined by FEMA as part of its study, vary from 266 ft at the Miller Creek detention facility outlet to approximately 265 ft at the downstream end of the Vacca Farm site. A floodway has also been delineated and mapped in a portion of the floodplain on the Vacca Farm site.

Hydrology

Wetland hydrology on the Vacca Farm site is supported primarily by high local groundwater levels, and secondarily by precipitation and overbank flooding in Miller Creek. Four groundwater monitoring wells were installed at the Vacca Farm site on May 14, 1997 to evaluate site hydrology. Groundwater levels were then measured during 16 separate site visits between May 30, 1997 and November 12, 1997 (Table 5.1-10). During this period, groundwater levels averaged approximately 1.5 to 2 ft below the ground surface. The largest fluctuation occurred at monitoring well P-1, located in the existing forested and shrub wetland. At this well, the groundwater table was lowest during the dry summer months, and, as expected, higher groundwater levels occurred in the spring and fall. For the past several years (1996 to 2000) during the winter and early spring months, the Vacca Farm site was temporarily flooded and soils were saturated to the surface. These data were used to estimate hydrologic conditions expected to occur in the floodplain restoration site once drainage ditches are removed and excavation in the floodplain area is complete.

Table 5.1-10. Groundwater monitoring well data[a] on the Vacca Farm site.

	Well Numbers and Surveyed Elevation (ft)[b]			
Sampling Date	**P-1 (263.7)**	**P-2 (265.1)**	**P-3 (262.9)**	**P-4 (273.1)**
5/30/1997	-0.9	-2.0	-1.3	-2.5
6/05/1997	-0.5	-1.5	-0.4	-2.3
6/11/1997	-0.8	-1.8	-0.6	-2.3
6/19/1997	-1.0	-1.9	-0.7	-2.4
7/03/1997	-	-2.0	-0.6	-2.4
7/10/1997	-0.5	-1.6	-0.4	-2.3
7/25/1997	-2.0	-2.2	-1.3	-2.5
7/31/1997	-	-2.3	-1.6	-2.5
8/07/1997	-2.6	-2.4	-1.8	-2.5
8/14/1997	-2.7	-2.6	-2.1	-2.5
9/04/1997	-	-2.4	-1.8	-2.5
9/18/1997	-0.1	-1.1	-0.5	-2.2
9/26/1997	-1.0	-1.7	-0.5	-2.3
10/03/1997	-0.6	-1.2	-0.3	2.2
10/16/1997	-0.8	-1.6	-0.3	-2.2
11/12/1997	-0.5	-1.4	-0.2	-2.2

[a] Data are represented as depth to groundwater in ft.

[b] Elevations are represented as ft above mean sea level.

Soils

The Soil Survey for King County Area Washington (Snyder et al. 1973) has not mapped soils within the project area. However, Parametrix, Inc. and HWA GeoSciences, Inc. (1998) have evaluated existing soil conditions on the Vacca Farm site. Results of these investigations revealed that most of the soils on the site are underlain by soft, saturated peat that overlies layers of alluvial sands, silts, and dense, glacially deposited material. These conditions indicate that the area was largely a historic wetland that has now been partially drained and highly modified. Typical soil profiles in peat-dominated areas on the Vacca Farm site are shown in Appendix A, Sheet C6.1. Soils in the upland areas on the Vacca Farm site are predominantly silty loams with scattered inclusions of sandy loams.

Upland Vegetation

Upland areas on the Vacca Farm site primarily consist of recently cultivated cropland; no native plant communities are present. Limited areas on the edge of the cultivated fields on the south and west side of the site are dominated by Scots broom (*Cytisus scoparius*), Himalayan blackberry, Canada thistle (*Cirsium arvense*), and various grass species such as orchardgrass (*Dactylis glomerata*) and common velvetgrass (*Holcus lanatus*).

The upland area in the southern portion of the site contains a gravel fill pad covered with various grass species and a dense Himalayan blackberry thicket. Some of the upland areas surrounding Miller Creek and drainage swales were created from side-cast material from past dredging and maintenance activities in the stream and swales. Cultivated areas have been ditched and drained.

Farmed Wetland Vegetation

Nine farmed wetlands are present on the Vacca Farm site (FWs 1, 2, 3, 5, 6, 8, 9, 10, and 11; see Figure 2.1-4). Farmed wetlands are areas that contain wetland hydrology and soils, but lack wetland vegetation because of farming activities. Additional descriptions of the these wetlands can be found in the *Wetland Delineation Report* (Parametrix 2000b). Due to the site's agricultural history, an extensive network of drainage ditches and tile drains exists on the site.

These areas have hydric soils and soil saturation within 12 inches of the soil surface for more than 15 consecutive days during the growing season. It is likely that these areas were wetlands before being converted to active farmland. However, these areas lacked inundation for at least 15 consecutive days during the early growing season and therefore do not meet the criteria for FWs according to the Food Security Act (Section 514.22).

Forest, Shrub, and Emergent Wetland Vegetation

A single large wetland (Wetland A1, approximately 4.66 acres) occurs in the central portion of the Vacca Farm site (see Figure 2.1-4). Wetland A1 is a forested, shrub, and emergent wetland complex located south of Lora Lake and extending south through the center of the Vacca Farm site. The northern portion of this wetland contains red alder and black cottonwood in the tree canopy with willow, hardhack, and common cattail (*Typha latifolia*) in the understory. A narrow band of Wetland A1 continues south and contains scrub-shrub and emergent wetland habitat that bisects the farmed agricultural fields. This wetland area is associated with a large north-south drainage ditch that parallels Miller Creek and ultimately drains into the stream to the south (see Figure 2.1-4). Dominant species in wetlands associated with the ditch include Pacific willow (*Salix lucida*), Himalayan blackberry, common cattail, and reed canarygrass.

Wetlands A2, A3, and A4 are seasonally saturated shrub wetlands located in the center of the Vacca Farm site, in tilled farmland. These wetland islands are dominated by Himalayan blackberry with creeping buttercup (*Ranunculus repens*) around the edges.

5.1.2.7 Vacca Farm Floodplain and Wetland Restoration Design

This mitigation plan will replace lost flood storage by excavating approximately 9,585 cy of soil that is currently above the 100-year floodplain on the Vacca Farm site. This action will compensate for lost floodplain storage and wetland impacts from construction activities for the third runway fill embankment and portions of relocated South 154th Street. The farmed fields at the Vacca Farm site will be regraded to restore wetland hydrology and planted with native tree, shrub, and herbaceous plant species to restore the historic riparian/floodplain wetland. In addition, a portion of an existing forested, shrub, and emergent wetland (Wetland A1) will be enhanced by planting native shrubs in the area currently dominated by non-native blackberry species. Key elements of the mitigation design are presented below. Specific details on construction sequencing and construction methods for the project are included in the implementation section for Vacca Farm projects (Section 5.1.4).

Grading Design

Prior to grading, existing structures and fences will be removed from the site and existing ditches and drains will be filled or removed to restore site hydrology. The mitigation design objectives for the floodplain grading will be achieved by excavating and grading approximately 6 acres of the Vacca Farm site between elevations 262 and 266. An initial step will be to remove the top 6 inches of topsoil where floodplain grading will occur to remove potential pesticide residues from past farming activities. This soil will be disposed of off-site at an approved upland disposal facility.

To prevent water from accumulating on the new floodplain surface and potentially attracting waterfowl, a drainage swale with secondary side channels will be graded through the middle of the floodplain. The primary channel will be centrally located and approximately 1 to 2 ft wide and 1 to 2 ft deep. Excavation for the channel will add a minor amount of floodstorage capacity to the site, but the channel will not affect the overall functions of the floodplain. During flood events the channel will become inundated by floodwater that backs up as a result of restrictions located downstream (south) of the site.[24] Additional floodwater will enter the site from the north, as the stream overtops its banks. As floodflows abate, and the channel south of the site can accommodate the stream within its channel, the floodplain will drain. The rate of drainage, however, remains controlled by the downstream channel, and not by the on-site drainage channel. The on-site channel simply assures that water is not stored for long periods (i.e., dead storage) on the site.

Side-cast material from creating these channels will be incorporated into the site grading plan to create microtopographic relief. Microtopography will consist of mounds and ridges at a density of approximately 4 features per acre. Depressional areas will not be created due to the potential for attracting hazard wildlife. This microtopographic relief provides habitat complexity that will increase the diversity of plant species that can be supported on the site (Appendix A, Sheet C7.1). LWD will also be added to the floodplain to increase habitat complexity and increase organic matter on the floodplain (Appendix A, Sheet C1.1).

Immediately after grading, the two floodplain wetland planting zones (see Figure 5.1-5) will be hydroseeded with a native grass mix to establish understory plants in these zones. All other areas that have been graded will be hydroseeded with a seed mixture designed to prevent soil erosion and sedimentation to Miller Creek and/or Lora Lake (Table 5.1-11). The seed mixture will stabilize any exposed soils that will not be brought to final grade or permanent vegetation cover within 30 days of exposure. This seed mix should be applied during the period between April 1 through June 30 and September 1 through October 31. If seeding occurs between June 1 and September 30, irrigation may be required to ensure germination and establishment.

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[24] Because of these downstream restrictions, the floodplain becomes a backwater area, and the drainage channel and the floodplain as a whole is not a floodway or "flow-through" system. The downstream channel restrictions will not be modified, and therefore downstream flow and flood conditions will not change.

Table 5.1-11. **Proposed seed mix for erosion control.**

Scientific Name	Common Name	Percent by Weight
Agrostis alba	Redtop	10
Lolium multiflorum	Annual rye	40
Festuca rubra var. *commutata*	Chewings red fescue	40
Trifolium repens	White clover	10

All soils left exposed for greater than 48 hours from October 1 through March 31 (or greater than 7 days from April 1 through September 30) will be covered with jute matting or other appropriate BMPs.

As described above, soils at the Vacca Farm site consist primarily of peat and some mineral topsoil. Therefore, it is anticipated that soil amendments will not be necessary after grading activities occur. To the extent practicable, existing organic soils (below the top 6 inches) and sands from the site will be used to create a suitable planting medium and match the proposed final graded surface (Appendix A, Sheet C6). Where use of existing organic soils is not practicable, a prepared topsoil will be tilled into the subgrade prior to planting. Newly graded slopes will be tracked at right angles to the contour to reduce soil erosion.

Temporary irrigation will be installed following grading to provide flexibility in plant installation and to maximize successful establishment, survival, and early growth of hydroseeded cover crops and plant stock. The irrigation system is used to provide suitable wetland hydrology (see below), but to ensure success during the initial critical stages of plant establishment. The system will be designed so that above-ground portions can be removed after a few years, when the option to use irrigation will no longer be needed. Irrigation will use municipal water purchased by the Port. Application rates will be less than agronomic rates, but sufficient to reduce plant mortality and to promote growth during dry periods. Use of the irrigation system is described more fully under Implementation, Section 5.1-4.

Expected Hydrology

The high groundwater table throughout the Vacca Farm site suggests that post-construction hydrology will result in soils that are saturated to the surface from the onset of autumn rains through early summer (early to mid July). Standing water, ranging in depth from 2 to 6 inches, is also expected to occur for short periods during the fall, winter, and spring months. To deter waterfowl from using areas of standing water, dense shrub plantings will be located throughout the site. The upland zones may become saturated during some winter months in years of normal rainfall, but would likely be dry by early summer. Because of a high water table on the site, dewatering may be necessary before grading activities occur (see Implementation, Section 5.1.4).

Wildlife Considerations

Flocking birds, raptors, and waterfowl pose the greatest concern for aircraft safety at STIA. Therefore, a landscape planting approach has been developed to aid in deterring these species from using the new mitigation sites as foraging areas or roost sites. Guidance obtained from Port wildlife managers and information gathered through literature searches have directed development of the planting plan. For example, Lyon and Caccamise (1981) found that roost stands for European starlings were generally composed of deciduous trees 18 to 35 years of age with stem densities greater than 290 trees per acre (average of about 700 trees per acre). The minimum roost size was 0.32 acre, although the average was about 4.5 acres. Conclusions from this study indicate that these birds typically select roost sites composed of dense stands of young trees that allow the birds to roost in a compact formation, and also provide some thermal protection after leaf fall.

Waterfowl typically prefer to forage in open areas, such as open water, emergent marshes, or mowed lawn, because their view of potential predators is unobstructed. An obstructed view is perceived as dangerous and waterfowl will not typically forage in such an area. Therefore, the planting plan will focus on installing dense shrubs with scattered small trees to obstruct views and landing paths. This strategy will also exclude waterfowl during the winter by creating a dense barrier of stems to cover standing water that is likely to be present.

Geese or waterfowl exclusion measures will likely be necessary during the initial years of the mitigation because the site will be dominated by low vegetation and will be fairly open. Geese exclusion measures will include dense planting of trees and shrubs on the restoration site and the elimination of areas of open, ponded water. During the monitoring period, geese exclusion may also include physical barriers to prevent geese from landing or entering the site.

Landscape Plan

Planting Plan

Six planting zones will be created in the Miller Creek floodplain enhancement and wetland restoration area: Upland Buffers, Existing Wetland Enhancement, Floodplain Zone 1, Floodplain Zone 2, Miller Creek Riparian Buffer, and Miller Creek Channel Planting (see Figure 5.1-5; and Table 5.1-12; Appendix A, Sheets L4 and L5). To minimize wildlife hazards, all the planting plans for the on-site mitigation actions are designed to be unattractive to flocking birds and waterfowl. Plants used in the on-site mitigation areas produce few fruits, berries, or nuts (see Table 5.1-12).

The landscape plan for the area shows that the planting of conifer trees is phased (see landscape design sheets in Appendix A). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

Upland Buffers

Upland buffers (see Figures 5.1-5 and 5.1-6; Appendix A, Sheets L4 and L5) are located east and west of the floodplain area, and will be planted with species adapted to seasonally wet, upland soil conditions. Upland buffers will typically be located above the 100-year floodplain (approximately at the 265-ft elevation). The landscape plan for the upland area will focus on planting trees and shrubs in a dense vegetated buffer to protect the floodplain enhancement area from surrounding land uses. Installed tree densities will be at least 280 stems per acre. Trees will be installed according to the

Table 5.1-12. **Proposed plant list for mitigation projects in Miller and Des Moines Creek basins.**

Scientific Name	Common Name	Size and Condition [a]	Approximate Spacing (ft/on center)[b]	Upland Zone	Floodplain Zone 1	Floodplain Zone 2	Riparian Zone
Trees							
Abies grandis	Grand Fir	3 – 4' B&B	10 to 15	X			
Acer macrophyllum	Bigleaf maple	3 – 4' B&B	10 to 15	X		X	X
Alnus rubra [c]	Red alder	3 – 4' B&B	10 to 15	X			X
Fraxinus latifolia	Oregon ash	3 – 4' B&B	10 to 15		X	X	X
Picea sitchensis [c]	Sitka spruce	3 – 4' B&B	10 to 15	X		X	
Populus trichocarpa	Black cottonwood	3 – 4' B&B/live stake	10 to 15			X	X
Pseudotsuga menziesii [c]	Douglas fir	3 – 4' B&B	10 to 15	X			
Rhamnus purshiana	Cascara	3 – 4' B&B	10 to 15			X	X
Thuja plicata	Western redcedar	3 – 4' B&B	10 to 15	X		X	
Tsuga heterophylla	Western Hemlock	3 – 4' B&B	10 to 15	X			
Shrubs							
Acer circinatum	Vine maple	2 gal	4 to 6	X			X
Philadephus lewisii	Mock Orange	2 gal	4 to 6	X			
Physocarpus capitatus	Pacific ninebark	2 gal	4 to 6			X	X
Rosa nutkana	Nootka rose	2 gal	4 to 6	X		X	
Rosa pisocarpa	Clustered rose	2 gal	4 to 6			X	X
Salix hookeriana	Hooker willow	live stake [d]	4 to 5		X	X	X
Salix lucida	Pacific willow	live stake [d]	4 to 5		X	X	X
Salix sitchensis	Sitka willow	live stake [d]	4 to 6		X	X	X
Salix scouleriana	Scouler's willow	live stake [d]	4 to 5			X	X
Spiraea douglasii	Hardhack spirea	2 gal	4 to 5		X	X	
Grasses							
Agrostis exarata	Spike bentgrass	Seed			X	X	
Beckmannia syzigachne	Sloughgrass	Seed			X		

Table 5.1-12. Plant list for mitigation projects in Miller and Des Moines Creek basins (continued).

Scientific Name	Common Name	Size and Condition [a]	Approximate Spacing (ft/on center)[b]	Upland Zone	Floodplain Zone 1	Floodplain Zone 2	Riparian Zone
Calamagrostis canadensis	Canada reed	Seed			X	X	
Deshampsia cespitosa	Tufted hairgrass	Seed			X	X	
Sedges and Rushes							
Carex amplifolia	Ample-leafed sedge	Seed			X	X	
Carex practicola	Meadow sedge	Seed			X		
Carex stipata	Sawbeaked sedge	Seed			X	X	
Scirpus cyperinus	Wool-grass	Seed			X	X	
Herbaceous							
Aster subspicatus	Douglas aster	Seed				X	X
Solidago canadensis	Canada goldenrod	Seed				X	

[a] Depending on availability and season, plant condition may be substituted. B&B refers to ball and burlap.

[b] All shrub plantings for the Miller Creek floodplain wetland restoration, Miller Creek drainage channel replacement, and Tyee Valley Golf Course will be planted 3 to 4 ft on center

[c] These species will not be a dominant component of the planting plan in order to limit the potential to attract flocking birds.

[d] Live stake material will typically be used in the Miller Creek relocation buffer planting and in other buffer/floodplain plans, where appropriate. Spacings for line stakes may range from 18 inches to 3 ft on center.

planting plan and field locations will approved by the landscape architect or wetland biologist. Installed shrub densities will be greater than 2,100 individuals per acre (see Table 5.1-7). The planting scheme in the upland areas will place coniferous and deciduous tree species in patches to create a broken canopy.

Existing Wetlands to be Enhanced

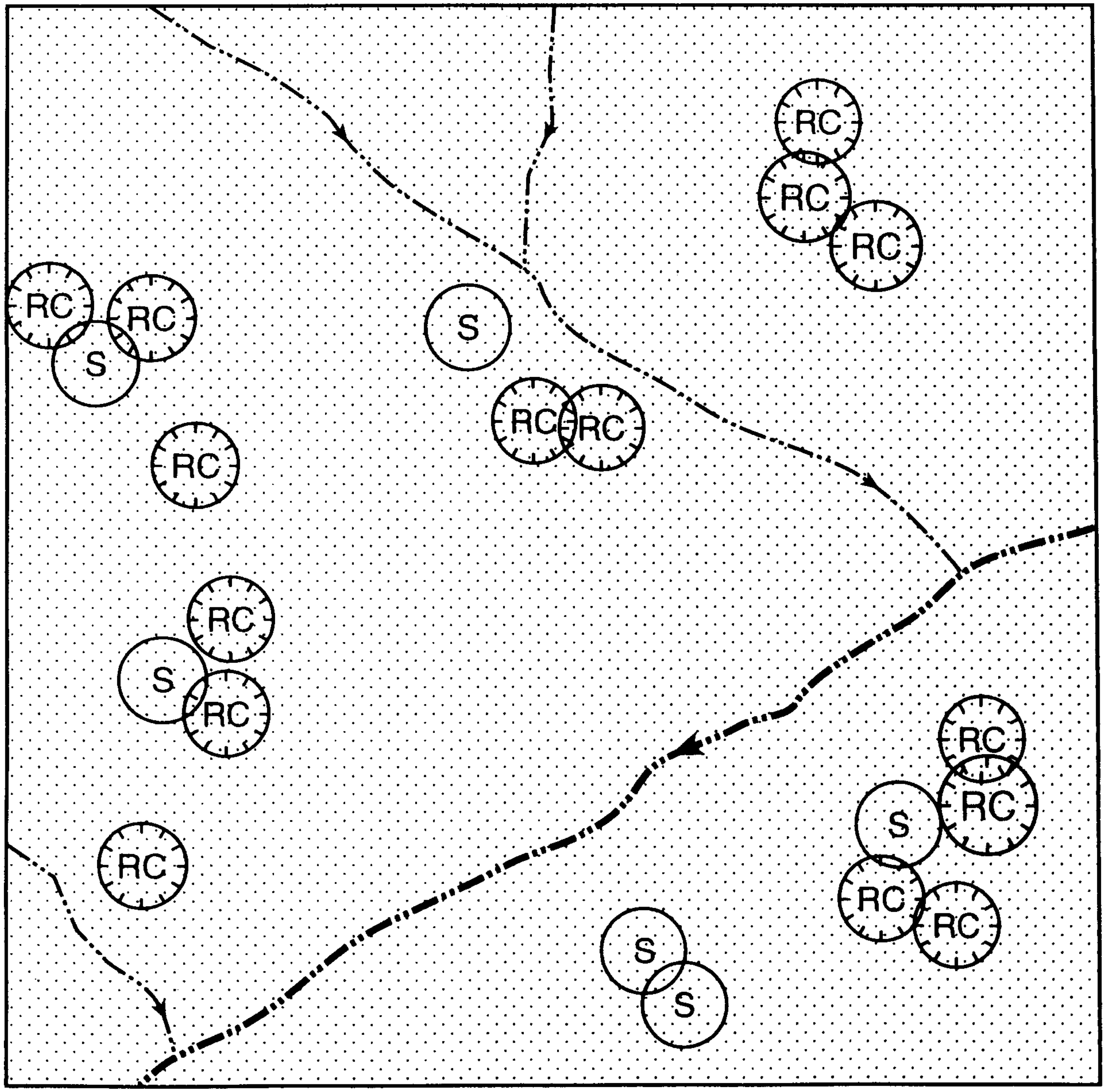
Removing non-native invasive species in selected areas and infill planting with native tree and shrub species will enhance existing wetlands on the Vacca Farm site. A portion of Wetland A1, south of Lora Lake, contains an area that historically has been disturbed by agricultural and other activities. As a result of this disturbance, non-native invasive species such as Himalayan blackberry have become dominant in this portion of the wetland. Therefore, an enhancement plan has been developed for this area to promote a native wetland vegetation community. Patches of blackberry will be removed and the wetland will be planted with native small tree and shrub species (primarily willows) to create a native shrub/tree community and to reduce cover of non-native species. Planting densities for infill tree planting will be greater than 250 stems per acre and for shrub planting will be greater than 1,700 individuals per acre. Infill planting densities are slightly lower than planting densities in cleared and/or graded areas because some native vegetation already exists in areas to be infill planted.

Floodplain Wetlands (Planting Zone 1 and Planting Zone 2)

Floodplain wetlands will be restored to native small tree and shrub wetland plant communities following grading. The landscape plan for the wetland floodplain restoration area will be similar to that described above with regard to wildlife attractants. Shrubs will be planted in dense patches to provide continuous shrub cover, with western redcedar (*Thuja plicata*) and some deciduous trees on microtopographic high points interspersed in the shrub planting (Figure 5.1-7). Floodplain Zone 1 is the wettest zone on the floodplain and will be planted with species tolerant of the prolonged saturation and periods of inundation that will occur below elevation 262.5 ft. Floodplain Zone 2 will be slightly drier than Zone 1 and will consist of wetland plant species tolerant of the wet and saturated soil conditions that occur between elevations 262.5 and 265 ft. Figure 5.1-6 and Sheet C1.2 in Appendix A show a typical cross section of the Vacca Farm floodplain following grading and planting.Figure

Installed tree densities will be at least 280 stems per acre. Trees will be installed according to the planting plan and field locations will approved by the landscape architect or wetland biologist. Installed shrub densities will be greater than 2,100 individuals per acre.

Herbaceous understory species will be established in the two floodplain wetland zones by hydroseeding a native grass/sedge/forb mix in these zones in early fall, following grading (see Table 5.1-11). The hydroseed mix will contain seeds and a wood fiber mulch and tackifer to stabilize soils and enhance germination. Plant species included in the mix are designed to provide for rapidly germinating species that can provide initial cover, as well as later germinating species that will add to the cover and species diversity of the herbaceous vegetation of the floodplain communities.



Note: See Appendix A Sheets L1 and L2 for details

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Figure 5.1-7
Typical Planting Plan for the Miller Creek Floodplain, Zone 2

Miller Creek Riparian Buffer and Channel Planting

In addition to the upland buffers along the northwest and east sides of the site, riparian buffers will be established along Miller Creek and around Lora Lake (see Figure 5.1-5; Appendix A, Sheets L4 and L5). Species proposed to be planted in the riparian buffer include black cottonwood, Pacific willow, Sitka willow (*Salix sitchensis*), Scouler's willow (*Salix scouleriana*), bigleaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), red alder, Pacific ninebark (*Phsocarpus capitatus*), and vine maple (*Acer circinatum*). An average 50-ft buffer will be established on both sides of the relocated segment of Miller Creek, although in some areas the buffer will be less than 50 ft wide due to the location of the embankment and South 154th Street/South 156th Way. The immediate channel banks of the newly relocated channel will be planted with live willow stakes (Appendix A, Sheets L4 and L5). A typical cross section of the proposed buffer area around Miller Creek appears in Figure 5.1-6 and in Appendix A, Sheet C1.2.

Planting Approach

Planting will occur whenever possible in late fall (October to November) or early spring (March or April), when soil moisture and plant conditions are optimal for installing plants. However, it may not always be possible or desirable to plant only during the winter months. For example, soils could be frozen or too wet at times during the winter months, limiting the amount of planting that can take place. Irrigation will be installed on the site to make it possible to plant during times of the year other than winter or early spring. Trees of varying heights (between approximately 36 and 48 inches) will be planted to provide height diversity, and trees and shrubs will be planted in a mosaic of species and heights to simulate natural patchiness. Trees and shrubs will be planted at densities (see Table 5.1-12) sufficient to attain the performance standards in Table 5.1-7. A landscape architect or wetland scientist will be on-site to observe placement and installation of the plant material to ensure that plants are installed according to the planting plan and specifications.

To reduce potential competition with non-native species, mulch or landscape fabric will be placed around the base of trees and shrubs. Girdling or other damage from small or large mammal grazing will be reduced or prevented through the use of collars, or the stems of installed plant material may be painted with a mixture of pruning wax and a natural deterrent such as cayenne pepper.

5.1.2.8 Monitoring and Performance Standards

The Vacca Farm floodplain and wetland mitigation site will be monitored consistent with the approach and schedules outlined in Section 4 of this document. Specific performance standards and contingency measures for the Vacca Farm floodplain are included in Table 5.1-7. The general monitoring schedule for the Vacca Farm projects is provided in Table 5.1-8. Monitoring objectives specific to the Vacca Farm site are designed to evaluate the functioning of the relocated channel (discussed above in Section 5.1.1.8), floodplain hydrology, wetland indicators, and the establishment of the upland and wetland plant communities (Table 5.1-13). Monitoring for hazard wildlife will also be conducted at the Vacca Farm site, as described in Section 4.

Floodplain Hydrology

Floodplain groundwater hydrology will be monitored at the Vacca Farm site for at least a 15-year period following completion of all mitigation construction. The primary purpose of monitoring groundwater levels is to verify that shallow groundwater continues to support wetland hydrology on the site, and that seasonal groundwater levels are sufficient to support the wetland plant communities on the site. Groundwater hydrology will be monitored at the Vacca Farm site consistent with the methods and approach outlined in Section 4 of this document.

Vegetation Monitoring

Vegetation will be monitored in all planting zones at the Vacca Farm site to verify that performance standards are being met, and to develop contingency measures as necessary (see Table 5.1-7, Table 5.1-13). Vegetation monitoring will be consistent with the approach, methods, and schedules provided in Section 4 of this document.

5.1.2.9 Site Protection

The Port will execute and file a restrictive covenant for the mitigation area. Copies of proposed restrictive covenants are included in Appendix G.

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

Table 5.1-13. Monitoring schedule for wetland restoration and floodplain enhancement at Vacca Farm.

			Data Collection Year												
Feature	**Activity**	**Timing**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**15**
Floodplain Storage	A topographic survey of the site.	Immediately after grading is complete	X												
Hydrology	Measure the maximum depth and approximate duration of inundation.	Monthly	X	X	X	X									
		Once during winter, late spring/early summer, and fall					X	X	X	X	X	X	X	X	X
	Measure depth to groundwater.	Monthly	X	X	X	X									
		Once during winter, late spring/early summer, and fall					X	X	X	X	X	X	X	X	X
Establishment of Vegetation	Calculate percent plant survival.	Once late spring to early summer	X	X	X	X									
	Vegetation mapping.	Once in late spring to early summer	X	X		X		X		X			X	X	X
Achieve an early successional wetland plant community	Measure tree/shrub cover.	Once in late spring to early summer in year 3, 5, 7, 10				X		X		X			X	X	X
	Photographic documentation and walk-through survey.	Once in spring	X	X	X	X		X		X			X	X	X
	Wetland delineation	Early spring						X					X		X
Reports			X	X	X	X		X		X			X	X	X

5.1.2.10 Maintenance and Contingency Plans

Routine maintenance tasks (e.g., maintaining irrigation systems, removing trash, mulching, mowing) and adaptive management contingency measures (e.g., re-planting, weed control) will be implemented consistent with the approach outlined in Section 4. If the Vacca Farm site does not meet performance standards during the monitoring period, contingency measures will be implemented using the adaptive management approach outlined in Section 4. Specific contingency measures are provided for each performance standard in Table 5.1-7.

Meeting the performance standards for non-native invasive species at Vacca Farm will likely require implementation of contingency measures during the 15-year monitoring period. Potential invasive species of concern at the Vacca Farm site include, but are not limited to, reed canarygrass, Himalayan blackberry, Japanese knotweed (*Polygonum cuspidatum*, and *P. sachalinense*), and purple loosestrife (*Lythrum salicaria*). These species are a concern because they already occur at Vacca Farm and may be difficult to eliminate, or because propagules of these plants are likely to continuously re-invade the site from upstream aquatic sources or from the surrounding area. Successfully establishing native vegetation on the site will be a key component in reducing and controlling invasive species in the long term at the mitigation site. In the short term (i.e., during the 15-year monitoring period), contingency measures specified in Table 5.1-7 will be implemented as necessary to control invasive species on the site.

Possible contingency measures that may be implemented to reduce hazard wildlife attractants specific to Vacca Farm are included in Table 5.1-7. Contingencies include eliminating areas of standing water on the floodplain by planting shrubs or minor regrading to eliminate depressions. Measures to control wildlife hazards will be consistent with the Port's WHMP approach described in Section 4.

Examples of the types of contingency actions that may need to be implemented at Vacca Farm include:

- If topographic surveys reveal inadequate floodplain storage capacity, additional grading will be undertaken to replace the lost floodplain area.
- If standing water persists on the site for extended periods such that waterfowl use of the site is regular, then corrective actions will be taken to plant densely with shrubs or create positive flow of surface water off the site to Miller Creek.
- If invasive species cover is greater than specified in the performance standards, or if native plant survival is reduced by competition with non-native invasive species, then invasive species removal and/or control will be implemented.
- Replacement plants will be installed if survival is less than 80 percent in the first 3 years.
- If plant species exhibit greater than 20 percent mortality within the first 3 years, site conditions would be re-evaluated to determine whether the conditions could support the species. If the site cannot support the original plant species, then those species may be replaced with species of similar form and function and tolerance to hydrologic conditions on the site.

5.1.3 Lora Lake Shoreline Enhancement

Mitigation at Lora Lake includes removing a concrete bulkhead, removing residential structures, and removing wetland fill from the west and north perimeters of the lake. These disturbed areas will be planted with wetland shrub communities. A forested buffer will be planted around the lake (Figure 5.1-8; Appendix A, Sheet C3.2) (see Table 5.1-1).

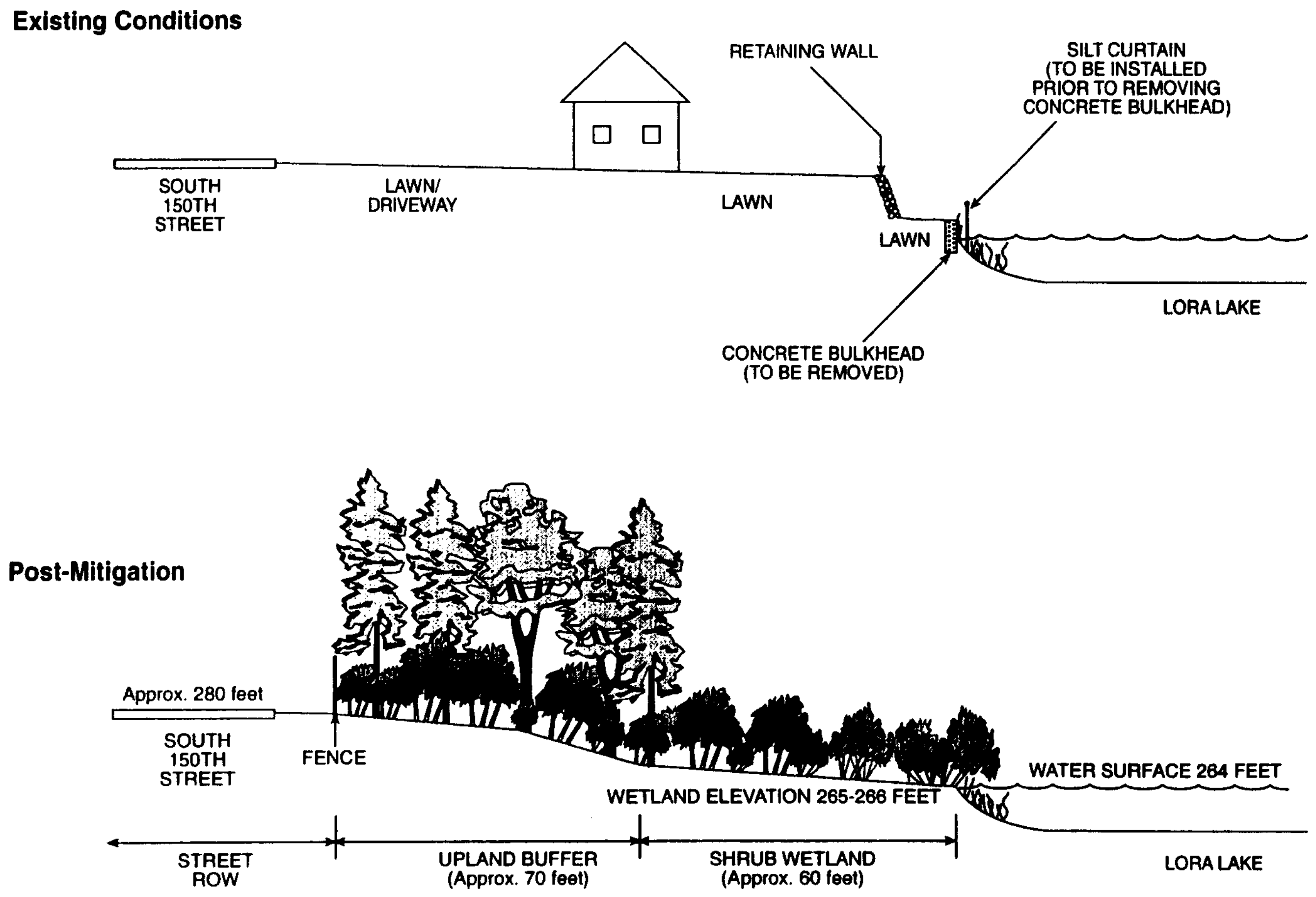
Replacing concrete bulkheads with a vegetated shoreline and establishing forested buffers around Lora Lake provide the opportunity to enhance water quality and habitat in the lake. Restored wetlands and buffers around Lora Lake will also enhance the aquatic habitat functions of the lake and the overall function of the restored wetlands in the Vacca Farm floodplain. In particular, the buffer restored wetlands, and bulkhead removal will increase the amount of organic detritus source to the lake for the benefit of aquatic insects. Increased insect production will improve habitat conditions for fish and amphibians. Additionally, the restored wetlands and vegetated shoreline will provide improved habitat for amphibians. Removing existing residences, lawns, and structures will eliminate sources of nutrients and pollutants to the lake and stream. Mitigation at this site also provides an opportunity to reduce existing hazard wildlife attractants near the airport by reducing habitat for waterfowl that graze on the existing lawn around the lake.

5.1.3.1 Goals, Objectives, and Design Criteria

The goal of the buffer enhancement project is to protect and enhance the aquatic habitats in Lora Lake for aquatic insects, fish, and amphibians by removing shoreline bulkheads and planting native vegetation around the shoreline. Specific design objectives are described in Table 5.1-14.

Table 5.1-14. Mitigation design objectives and criteria for the buffer enhancement projects at Lora Lake.

Goals and Design Objectives	Design Criteria
Restore more natural shoreline to Lora Lake and improve ecological function of the Lora Lake shoreline to the aquatic habitat of the lake.	The concrete bulkhead will be removed and shoreline graded to a stable slope configuration.
	Remove 1-acre of wetland fill along the north and west side of the lake to restore historic wetland conditions.
Protect and enhance mitigation actions by providing protected upland buffers.	All structures within the 25-ft buffer will be demolished and failing septic systems (if present) will be removed.
	Plant upland buffer areas (1.81 acres) around Lora Lake with native trees and shrubs.
Vegetate all disturbed areas with native plant communities.	Plant native tree species at densities of approximately 280 per acre.
	Plant native shrub species at densities of approximately 2,100 per acre.



VERTICAL SCALE 1" = 40'
HORIZONTAL SCALE 1" = 40'

Figure 5.1-8
Typical Cross Section of Lora Lake Buffer Enhancement

5.1.3.2 Mitigation Site Description

Lora Lake is a man-made pond excavated from a natural wetland and located in the northern portion of the Miller Creek floodplain. Lora Lake flows into Miller Creek via a 12-inch concrete culvert on the southeast corner of the lake or via flow at several points over the earthen berm that forms the southern shore of the lake.

Lora Lake was excavated after 1961 and prior to 1970. The residential development along the north and west shore of the lake is partially built on wetland fill that was placed on farmland similar to that occurring on the Vacca Farm site. Cement block bulkhead and riprap retaining walls are located around most of the shoreline on the north and west sides of Lora Lake. Upland areas are located behind the retaining wall and consist of single-family residences, outbuildings, landscaping, mowed lawn, and impervious surfaces such as roads and driveways. Existing septic systems, runoff from roads and rooftops, lawn fertilizers, and pesticides are potential sources of pollutants to Lora Lake, Miller Creek, and associated wetlands. Residential lawns along the lake can also attract waterfowl that graze on the turf grasses.

A narrow band of emergent wetland extends around Lora Lake between the cement bulkhead and the riprap retaining wall, and along the south shore of the lake. Just south of Lora Lake is a large deciduous forested wetland (Wetland A1). Detailed descriptions of Lora Lake and Wetland A1 are included in the *Wetland Delineation Report* (Parametrix 2000b).

5.1.3.3 Ownership

The Port owns all of the parcels within the mitigation area surrounding Lora Lake.

5.1.3.4 Rationale for Selection

Enhancing the shoreline and buffers around Lora Lake provides the opportunity to restore wetlands, enhance water quality in Lora Lake and Miller Creek, and to enhance the function of the restored wetlands in the Vacca Farm floodplain. Removal of existing residences, lawns, and structures will eliminate sources of nutrients and other pollutants to the lake and stream. Wetland functions on the Vacca Farm site will be enhanced by providing buffer protection around the lake and the upper reaches of Miller Creek. Mitigation at this site also provides an opportunity to reduce existing hazard wildlife attractants near the airport.

5.1.3.5 Constraints

There are no constraints associated with implementing this mitigation action. Grading has been avoided in an area where a drainage pipe is present. There is a drainage easement on about 0.01 acre of property for a drainage pipe. The easement also includes maintenance of a rock weir near the Lora Lake shoreline.

5.1.3.6 Ecological Assessment of the Lora Lake Shoreline

Vegetation

Cement block and riprap bulkheads are located around most of the shoreline on the north and west sides of the excavated lake. Most of the area surrounding Lora Lake on the north and west is impervious surface (i.e., turf grass lawn or buildings and roadways). Vegetation is predominantly non-native turf grasses and ornamental landscaping.

A vegetated berm is located along the southern shore of the lake, with a deciduous forested wetland located south of the berm (Wetland A1). An upland shrub area is located to the east. Dominant species on the vegetated berm include red alder, Himalayan blackberry, and various grass species. The forested wetland contains a prevalence of red alder, black cottonwood, willow, Himalayan blackberry, hardhack, and common cattail. The upland shrub area consists of some Douglas fir (*Pseudotsuga menziesii*), with red alder and dense thickets of Himalayan blackberry.

Soils

Soils in the wetland areas surrounding Lora Lake and Miller Creek are composed of organic peat deposits from 3.5 ft to 10 ft thick, with lenses of alluvial sands and silts. Fill material associated with buildings around Lora Lake comprises most of the soils in the upland areas. Soils in the area immediately south of Lora Lake have been altered to contruct the dike on the south side.

5.1.3.7 Lora Lake Shoreline and Wetland Restoration Design

To enhance the aquatic functions of Lora Lake the concrete bulkhead lining the shoreline will be removed. Existing wetlands fringing the Lake will be enhanced, and about 1 acre of filled wetland will be restored. Upland areas between Des Moines Memorial Drive, South 150th Street and Lora Lake will be restored with native tree and shrubs. These changes are illustrated in Figure 5.1-8.

Demolition and Grading

Residences and various outbuildings, the majority of which are located around Lora Lake, will be demolished prior to implementing this plan. The design includes necessary BMPs to be used throughout demolition activities to prevent sediment from entering the lake or associated wetlands.

Grading activities associated with removing the bulkhead and wetland fill will result in a nearly level wetland area 1-acre in size and about 0.5 to 2 feet above the elevation of the lake. The upland slope on the north and west side of the lake would be established at about 3:1. The restored wetland area would be established near the elevation of buried natural soils. If the peat soils that were historically mapped on the site were removed prior to fill, peat removed from other construction projects will be used to establish wetland soil with high organic matter content.

Prior to planting the buffer areas, grading activities may include roughening the surface, removing portions of lawn, or tilling soil that has been compacted during grading, demolition activities or construction staging. During and following grading, standard TESC measures such as tracking soil surfaces on slopes parallel to the contours will be implemented to prevent erosion.

Expected Hydrology

The areas located below elevation 266 ft feet would be expected to meet the wetland hydrology parameter and support restored wetlands. The groundwater table is high adjacent to the lakeshore, and groundwater seepage emanated from the rock retaining walls on the north and west sides of the lake. Some ground water emanates at about 265-266 ft and is present during the late fall to early summer period. Observations of water leaving Lora Lake throughout the summer months suggest these seep areas are perennial. Wetland areas below about 265.4 ft will become inundated for brief during 100-year flood events.

Wildlife Considerations

The landscape plan has been designed to be consistent with the WHMP and to avoid attracting flocking birds, raptors, and waterfowl. Dense plantings of shrubs broken by scattered trees will discourage use by flocking birds and waterfowl. To deter raptor use of the mitigation sites, deciduous and coniferous trees with stiff branches (such as Sitka spruce (*Picea sitchensis*) or Douglas fir) will be planted in limited quantities. These species will also break up the deciduous tree canopy. This will limit roosting habitat for raptors such as red-tailed hawks. The primary coniferous tree species used in the upland and transitional zones will be western redcedar because its limp branches do not provide ideal raptor perching habitat.

Landscape Plan

Species to be planted in the Lora Lake buffer and wetland restoration areas are identified in Table 5.1-12. The planting plan for the buffer is shown in Figure 5.1-5 and included in the Landscape Plan sheets in Appendix A. The Lora Lake buffer includes species such as black cottonwood and willows for the wetland restoration areas, as well as species such as big-leaf maple and red alder for the drier areas in the buffer.

The landscape plan for the area shows that the planting of conifer trees is phased (see landscape design sheets in Appendix A). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

5.1.3.8 Implementation

Implementation details for Lora Lake are included with the descriptions for the Vacca Farm projects in Section 5.1.4.

5.1.3.9 Monitoring and Performance Standards

Monitoring for the Lora Lake buffers will follow the overall approach described in Section 4. Detailed performance standards and contingency measures for the Lora Lake buffer are included in Table 5.1-7. Post-construction monitoring will occur for 15 years after installation of the plant material consistent with the schedule in Table 5.1-13.

Monitoring Lora Lake will focus primarily on vegetation to evaluate establishment of native vegetation, consistent with the approach described in Section 4. The Lora Lake site will also be monitored for hazard wildlife, consistent with the monitoring approaches described in Section 4.

5.1.3.10 Site Protection

The Port will execute and file restrictive covenants for the mitigation area. Copies of proposed restrictive covenants are included in Appendix G. The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

Fencing will protect the site from illegal dumping, human use, and may also serve as a security fence for portions of the airport. Where security or wildlife management concerns allow, fencing will allow passage of wildlife.

5.1.3.11 Maintenance and Contingency Plans

A maintenance plan will be developed for the Lora Lake buffers, as described in Section 4, to guide routine maintenance tasks. Specific contingency measures will be implemented as necessary, consistent with the adaptive management approach. Contingency measures for Lora Lake are listed in Table 5.1-7.

A special monitoring need for this site is to evaluate the several drainage paths that water follows when it exits over the berm of Lora Lake and enters Miller Creek or the Vacca Farm wetlands. Beaver, uprooting of trees, or erosion could alter these hydrologic flow paths which could affect water levels in the lake or the distribution of water to downstream areas. While over time the establishment of greater amounts of tree and shrub vegetation on the berm should create increased stability, in the short term, some changes could create new wetland management opportunities. Evaluation of this feature will provide a basis for adaptive management if needed.

5.1.4 Implementation of the Vacca Farm Mitigation Projects

Construction associated with building the proposed third runway, including relocation of the South 154th Street/South 156th Way roadway and sewer line, will be part of the first phase of the proposed Master Plan Update implementation. Relocation of Miller Creek must occur prior to embankment construction, which will fill a portion of the existing channel. The new stream channel must be constructed and stabilized before stream flow can be diverted from the existing channel and before the existing channel can be filled. Construction of the Vacca Farm mitigation projects is therefore currently scheduled to begin during the first construction season (i.e., early summer) following issuance of permits for the project. A general schedule for implementation of the Vacca Farm projects is provided in Table 5.1-15. Detailed plan sheets for the Vacca Farm projects are included in Appendix A; design details for the grading and restoration of the banks of Miller Creek at the South 154th Street/South 156th Way bridge relocation are included in Appendix B, Sheets P1 and P2.

Table 5.1-15. Proposed Implementation Timeline for Vacca Farm Mitigation Projects[a].

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Miller Creek Relocation																																				
Pre-construction meeting		■	■																																	
TESC, Site Preparation				■	■	■																														
Excavate new stream channel						■	■	■																												
Install instream habitat features and stream gravels							■	■	■																											
Produce record drawings of new channel										■																										
Install stream diversion measures at tie-ins								■																												
Trap and relocate fish in existing stream channel								■																												
Excavate channel tie-ins							■	■																												
Construct new channel banks, install bioengineering and plant channel banks								■	■																											
Divert water to new channel									■																											
Monitor new channel									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Vacca Farm Floodplain and Lora Lake Buffers																																				
Preconstruction meeting			■	■																																
TESC, Site Preparation				■	■	■																														
Implement dewatering						■	■	■																												
Mass grade floodplain					■	■	■	■																												
Fine grade floodplain							■	■	■																											
Install irrigation system								■	■																											
Install monitoring wells																																				
Hydroseed graded areas																																				
Closeout (remove construction debris and equipment, staging areas, access roads, etc.)																																				
Produce grading record drawings																																				

Table 5.1-15. Proposed Implementation Timeline for Vacca Farm Mitigation Projects (continued).

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Install plants in Vacca Farm floodplain and buffer, and along Miller Creek riparian zone[b]								■	■																											
Install plants in Lora Lake buffer[b]										■	■																									
Produce planting plan record drawings															■	■																				
Conduct baseline monitoring																	■	■	■	■	■															
Begin maintenance/monitoring period																						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

[a] Year one starts with the first construction season following issuance of permits. Implementation of mitigation projects may vary from this proposed schedule depending upon coordination with other Master Plan Update projects, contract obligations, or final approval.

[b] Plant procurement for all projects will be started 6 to 12 months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Planting will be phased such that coniferous species will be planted following the third year of monitoring.

5.1.4.1 General Construction Sequencing

Construction of the Vacca Farm projects are currently scheduled to begin during the 2002 construction season (see Table 5.1-15), but the actual schedule is dependent on receipt of federal, state, and local permits. Excavation and grading for the floodplain and stream channel are expected to occur during the driest time of the year, taking approximately 15 weeks, beginning in late June and ending by early October. Instream work associated with the channel relocation will be subject to permit conditions associated with the HPA, and will likely occur between July 15 and September 15.

Construction of the mitigation site will be coordinated with the embankment construction, the South 154th Street relocation (including South 156th Way bridge relocation), and relocation of the sewer line to ensure that these projects do not impact the mitigation site. In particular, prior to commencing with plant installation, contractors will be required to complete all other work on the site to ensure that plants are not damaged once they are installed.

Construction of Vacca Farm projects will likely take place in several phases. Phase 1 will include most of the earthwork for the Miller Creek channel relocation and floodplain. During Phase 1, the Vacca Farm floodplain will be graded and the irrigation system installed, the new channel will be excavated, and the channel banks stabilized with bioengineering and planted with live stakes. After the new channel grading is complete, tie-ins will be constructed at either end of the new channel where it connects with the existing channel (Appendix A, Sheets C1.1 and C5). Connecting the new channel to the existing channel will require installing water control devices to divert water to the new channel, and implementing measures to protect fish in the existing channel during construction. Connecting the existing stream channel to the new channel, and the diverting water into the new channel, and stabilizing will occur during the first construction season. Grading the Miller Creek floodplain adjacent to the new channel will occur concurrently with channel excavation. Removal of Lora Lake bulkheads and grading of the Lora Lake shoreline may also be included in Phase 1 (Appendix A, Sheet C2), although this work is not dependent on the Miller Creek relocation.

Following completion of Phase 1 earthwork, all open areas on the site (i.e., the channel, floodplain areas, and Lora Lake buffers) will be hydroseeded to provide weed barrier and erosion control prior to winter rains and plant installation. Hydroseed should be applied by mid-September to ensure that the site is adequately stabilized before the rainy season.

During Phase 2, the old channel will be filled for construction of the runway embankment, and planting floodplain wetlands and buffers during the first fall and/or winter following completion of grading. Completion of buffer planting east of Miller Creek will be coordinated with roadway relocation and will likely not be completed until roadway construction is complete. Phase 2 planting includes enhancement planting of the existing wetlands, planting the newly graded areas of the floodplain and riparian zone of Miller Creek, and planting new and enhanced buffer areas along Lora Lake and the east and west sides of the mitigation site (Landscape Plan sheets in Appendix A, Sheets L1 and L2). Plant installation in these areas may require more than one construction season to complete.

Phase 1: Site Preparation, Grading, and Channel Relocation

Earthwork for this phase includes site preparation, installation of sediment and erosion control measures, dewatering if necessary, grading, installation of irrigation, and site stabilization following grading.

Site Preparation and Erosion Control

No work will begin until the TESC plan is implemented (Appendix A, Sheets TE1 and TE2), nor until any protected or restricted access areas (e.g., wetlands or streams) have been flagged and/or fenced. The TESC plan includes installation of silt fences around the existing wetlands to be enhanced southeast of Lora Lake, and the Lora Lake shoreline, to prevent sediment from the construction site entering these waters (Appendix A, Sheet TE1). A temporary berm will be constructed and a silt fence installed to protect adjacent properties to the south of the mitigation site and prevent water from the construction site from entering the drainage ditch that runs through the center of Wetland A1.

Water from the construction site will likely be directed to the temporary sediment settling pond at the lowest (i.e., southern) end of the proposed floodplain (Appendix A, Sheet TE1). Water from this pond will be allowed to settle until particulates and sediment have settled out. Water from the site can then be discharged via the outlet, quarry spalls, and straw bale filters to Miller Creek (Appendix A, Sheet TE2). Alternatively, construction stormwater runoff may be diverted or pumped to TESC Pond C. Water in the sediment ponds and discharge will be monitored to ensure that turbid water is not discharged to the stream.

Additional TESC measures include placing silt fence around work areas and staging areas, and placing straw bales at key locations within the project limits. Clearing and brush removal will be limited to only those work areas that the contractor is scheduled to begin within the following 2 weeks.

Prior to the start of grading, construction access, staging, and stockpile areas will be set up, and dewatering may be necessary. Temporary access routes and staging areas identified on the western side of the site will be set up and flagged (Appendix A, Sheets C2, TE1). The site will be cleared of debris (e.g., existing tile drains, storm drains and piping, trash, structures).

Construction sequencing of the mitigation site and the roadway/embankment will be carefully coordinated to prevent impacts to the completed mitigation site from roadway construction. Measures to protect the mitigation site from adjacent construction may include orange barrier fencing, sediment and erosion control fencing, and possibly temporary installation of ecology blocks or rock gabions to prevent the intrusion of construction machinery into the mitigation site.

Dewatering

Due to the high groundwater table throughout the Vacca Farm site, excavation of the floodplain and new channel will likely require dewatering. The dewatering pumps, temporary storage ponds, and sediment and erosion control measures will be installed prior to the start of new channel excavation or floodplain grading. The dewatering system may include excavating dewatering trenches and installing French drains or sumps. The exact location of dewatering trenches and temporary storage ponds will be determined by the contractor. The location of these dewatering features may change as the excavation and final grading of the floodplain proceeds; however, all dewatering wells, temporary storage ponds, and/or trenches will be within the area to be excavated for the floodplain grading (Appendix A, Sheets C2, TE2). In addition, all water from dewatering areas will be directed to sediment settling ponds and any sediment will be allowed to settle prior to being discharged via a quarry spall outfall and straw bale filters to Miller Creek (see Appendix A, Sheet TE2). All dewatering features will either be removed as a consequence of the ongoing excavation (e.g., trenches, drains) or removed and the area graded once they are no longer needed (e.g., temporary storage ponds).

New Channel Excavation and Floodplain Grading

New channel construction includes excavation of the new channel, stabilization of channel banks, installation of stream gravels and woody debris, implementation of fish protection measures, construction of the tie-ins to the existing channel, diversion of water to the new channel, and filling in the old channel. Construction in the existing channel will likely take place between July 15 and September 15, consistent with conditions in the HPA.

The new channel will be excavated and water diverted from the existing channel within the same construction season. The new channel banks will be adequately stabilized to carry dry and wet season flows using bioengineering (e.g., coir lifts with live stakes, erosion control fabric) (Appendix A, Sheets C5 and L2). Channel banks will be planted densely with willow stakes to provide additional stabilization and channel roughness. The dry and wet season base flows in this portion of Miller Creek are typically low (< 5 cfs) and the new channel slope is very gradual. Therefore, even during storm events, flows in Miller Creek through this reach will not have large amounts of energy. Furthermore, the channel has been designed with a low-flow channel inside a wider channel meander zone, which can accommodate up to annual peak flows (Appendix A, Sheet C5). Flows greater than annual peak flows will flood onto the floodplain, rapidly attenuating the energy and erosive force of high flows.

The sequence of steps required to divert existing flows to the new channel will be consistent with HPA permit conditions and will be conducted to reduce stress and impacts on aquatic organisms. Prior to constructing tie-ins and diverting Miller Creek to the new channel, the section of the existing channel to be diverted will be closed off, and fish within the existing channel will be captured and relocated to a point downstream of South 160th Street where suitable habitat exists. Fish capture and relocation will be done under the supervision of a qualified fish biologist with a collection permit from the WDFW.

Immediately following fish capture, the tie-ins will be constructed, and flow from the existing channel will be intermittently introduced to the new channel section to allow the streambed gravels to sort and stabilize. Flows will be intermittently introduced to the new channel with a gate valve or other control structure to allow flows to be metered. During this time a collection sump located at the downstream end of the new channel will collect water. Turbid water will be conveyed to a sediment pond until the new channel flows clear. After diversion of stream flow has been successfully completed, the existing channel will be filled during embankment construction.

Excavation of the floodplain grades at Vacca Farm may occur concurrently with the new channel excavation. Floodplain grading will begin as soon as the contractor can control the groundwater sufficiently for excavation. Grading will occur on all areas of the mitigation site with the exception of the existing wetland to the east of Lora Lake (i.e., between Lora Lake and Miller Creek) and the area of upland buffer along the western portion of the site (Appendix A, Sheets C1.1 and L1). Existing drainage ditches on the site will be filled and removed during grading to restore site hydrology. A swale will be constructed through the floodplain to allow it to drain gradually to the south and prevent standing water (Appendix A, Sheet C2). Cross sections in the plan sheets show the proposed site elevations following grading (Appendix A, Sheets C1.2 and C4). In addition to floodplain grading, existing bulkheads along the north and west shoreline of Lora Lake will be removed and a more gradual slope will be restored to the lake shoreline. Removal of the bulkheads prior to planting buffer vegetation will enhance the function of the buffer to be planted along Lora Lake.

Installation of Temporary Irrigation and Site Stabilization

Once the new wetland, buffer, and floodplain grades have been established and verified by field survey, the temporary irrigation system will be installed (Appendix A, Sheets L1 through L3). This system will be used to provide flexibility in the planting schedule, provide contingencies against periods of dry weather during the first few growing seasons, and to maximize plant survival and growth during the first years following planting. Allowing for maximum plant growth during the first years of restoration will expedite establishment of cover and shade on the site, production of biomass, vertical habitat structure, and organic litter. This will help reduce temporal impacts.

Irrigation is a standard feature of wetland mitigation construction in the Puget Sound Lowlands due to the region's pronounced summer drought. Irrigation will be designed for the entire area to be graded at Vacca Farm; however, it may not be necessary in some areas. If, following grading, the wetland scientist determines that irrigation is not needed in some areas, it will not be installed.

Municipal water will be used for irrigation. It is anticipated that the irrigation system would be used for the months of June through September, but actual timing will be dependent on weather and soil moisture conditions. Application rates will be sufficient to reduce plant mortality and promote growth during dry periods. In upland buffers that contain well-drained soils, earlier and more frequent use may be required. The irrigation system will be decommissioned and all aboveground parts removed at the direction of the wetland scientist once plant survival standards have been met.

The site will be stabilized following completion of grading and prior to the onset of winter rains. A hydroseed mix designed to provide temporary erosion control and a weed barrier will be applied to the graded floodplain areas by mid-September.

Phase 2: Establish Native Vegetation in the Miller Creek Channel, Floodplain, and Buffer

The channel area will be planted as soon as channel excavation is complete. In areas with irrigation, planting will not be limited to fall or winter planting seasons; in areas lacking irrigation, planting will occur only during the fall and/or winter months. The stream buffer and adjacent floodplain can be planted after site grading and irrigation installation is complete and hydroseed has become established.

It is anticipated that floodplain and buffers, stream riparian zone and buffers, and Lora Lake buffer planting will begin the first fall (i.e., October or November) following grading and irrigation installation. Planting the entire site will likely require more than 1 year to complete. Immediately following plant installation, the area between plants will be mulched or covered with a weed control fabric to reduce establishment of weeds. Stem collars or other herbivore deterrents may be installed on plants to reduce damage from rodents and other herbivores.

Soils on the Vacca Farm site are a mix of inter-bedded peat, sand, silt, and gravel. Following excavation and grading, the material exposed at the surface will likely vary from predominantly peat to a mix of sands, gravels, and silts. To ensure a medium suitable for plant establishment, 12 to 14 inches of prepared topsoil will be spread over the surface following grading. Where feasible, the prepared topsoil will be comprised of native materials from the site, mixed to obtain a topsoil with a 3:1 mineral to organic material mix. Where not feasible, prepared topsoil will be a 3:1 mix of clean sand with organic compost that is free of weed seed or other unsuitable material.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic sources. Plant material used for mitigation will be grown in the area that is bounded on the north by the Fraser River Valley of British Columbia, on the east by the 1,000-ft elevation of the Cascades, on the west by the 1,000-foot elevation in the Olympic or Coast ranges, and on the south by the Willamette Valley.

5.1.4.2 Construction Steps

The following sections outline the construction and post-construction steps necessary to implement the Mitigation Plan for the Vacca Farm site.

General Conditions

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscape work.
- Areas where any landscape work has been completed will be off limits to all vehicular traffic, and pedestrian traffic will be strictly limited.
- All site work will be performed in accordance with permit conditions; any instream work or work below Ordinary High Water (OHW) will take place only during the allowable work times, consistent with HPA permit conditions (i.e., July 15 to September 15).

- Plant procurement shall be coordinated with the grading and irrigation installation schedules and be completed 6 to 12 months prior to the scheduled planting season to ensure that plants are available in the quantities and species required by the planting plan.

Site Preparation

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas and temporary access/haul roads.
- Implement TESC plan; install TESC measures for all projects, including the Miller Creek channel relocation, floodplain grading, Lora Lake buffer planting, and Miller Creek buffer enhancement areas.
- Identify and flag sewer manholes and sewer easement.
- Install fencing (orange barrier) around areas to be protected (e.g., existing wetlands, outlet ditches, sewer manholes).
- Maintain security of the site through construction.
- Establish temporary access/haul roads.
- Establish staging and stockpile areas.
- Implement a spill control plan and identify fueling areas.
- Install site dewatering equipment and structures (e.g., pumping wells, manifold piping, temporary storage ponds, discharge structure).

Clearing, Excavation, and Grading

- Clear and grub the site.
- Implement dewatering for new channel construction, if necessary.
- Fill in or remove drainage ditches.
- Excavate new channel subgrades (except at tie-in areas).
- Confirm new channel subgrades with field survey.
- Install log weirs and quarry spalls.
- Place streambed material and grade low-flow channel.
- Confirm new channel finish grades.
- Construct new channel banks; install coir fabric-wrapped streambank material.
- Install coir logs and coir mattresses.
- Install instream habitat features in new channel.
- Install channel plantings and bioengineering.

- Install shade cloth.
- Remove weeds (e.g., grub out blackberry and reed canarygrass; apply herbicide if appropriate per specifications) and clear brush in wetland buffer enhancement areas.
- Mass and fine grade floodplain.
- Install microtopography/LWD on floodplain.

Construct New Channel Tie-Ins to Existing Channel

- Implement fish-protection and erosion control measures for tie-in construction.
- Install sheeting and base flow stream diversion sumps at tie-in areas.
- Excavate new channel grades at tie-in areas.
- Install transition area log weirs and quarry spalls at tie-in areas.
- Place streambed (spawning) gravel and grade low-flow channel at tie-in areas.
- Confirm new channel finish grades.
- Construct new channel banks.
- Install coir logs and coir mattresses at tie-in areas.
- Install bioengineering.
- Divert water into new channel.
- Place fill in existing channel at tie-in areas.
- Prepare grading record drawings for new channel and floodplain; modify planting plans as needed to match as-built grades and site conditions

Irrigation and Landscaping

- Install and test irrigation system in floodplain.
- Apply hydroseed to graded portion of the floodplain.
- Winterize irrigation system.
- Begin planting in fall/winter following grading.
- Plant riparian/buffer zone of new channel.
- Plant Miller Creek floodplain and other wetland enhancement areas.
- Plant upland buffer adjacent to floodplain and Lora Lake buffers.

Closeout

- Complete site cleanup by removing temporary haul/access roads, TESC berm, and staging areas.
- Remove construction equipment and debris.

- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.

Record Drawings, Monitoring, and Maintenance

- Produce record drawings (including grading, instream habitat, and planting) for all project areas (e.g., Lora Lake buffers and shoreline, Miller Creek floodplain, relocated channel, and Miller Creek buffer between new channel and South 154th Street/South 156th Way bridge).
- Complete a baseline report, including record drawings and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring during the first growing season after all grading and planting are complete; submit annual monitoring reports for 15-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

Miller Creek
Enhancement Projects

5.2 MILLER CREEK RIPARIAN AND INSTREAM ENHANCEMENT PROJECTS

Mitigation along Miller Creek from the Vacca Farm site to Des Moines Memorial Drive is designed to establish a large, contiguous habitat corridor extending approximately 6,500 ft along the stream, connecting habitats that are currently fragmented by urban land uses. Within this corridor, instream, wetland, and non-wetland riparian habitats will be restored and enhanced. Removing channel armoring, restoring more natural channel morphology, and installing habitat features at selected areas will restore instream habitat in Miller Creek. Removing structures, impervious surfaces, and non-native vegetation and planting with native wetland vegetation will be enhanced many of the riparian wetlands along Miller Creek. Non-wetland riparian buffers along Miller Creek will be enhanced to stabilize soil; retain sediments and nutrients; and provide shade, organic matter, and woody debris to the stream.

Mitigation measures along Miller Creek will also be implemented to compensate for filling existing drainage channels, maintain the hydrology of wetlands between Miller Creek and the new runway embankment, and mitigate temporary construction impacts to wetlands. These mitigation actions are designed to prevent indirect hydrologic impacts to wetlands downslope of the embankment. Replacement drainage channels will be constructed to maintain inputs from surface water runoff and groundwater seepage to wetlands downslope of the new embankment, and wetlands temporarily impacted by construction will be restored to pre-construction conditions.

To compensate for unavoidable project impacts to wetlands and streams, the Miller Creek buffer and instream enhancement projects include the following specific mitigation actions:

- Restoring and enhancing functions in approximately 7.4 acres of riparian wetlands along both sides of a 6,500-ft reach of Miller Creek, between the Vacca Farm site and Des Moines Memorial Drive (Section 5.2.1)
- Restoring and enhancing a native, forested riparian buffer corridor along the east and west sides of this 6,500-ft section of Miller Creek to protect and improve aquatic habitat in the stream, associated drainage channels, and riparian wetlands (Section 5.2.1)
- Establishing a large, contiguous, protected riparian habitat corridor connecting the upper and lower reaches of Miller Creek (Section 5.2.1)
- Restoring fish and aquatic habitat to degraded, highly modified reaches of Miller Creek by adding LWD and boulders, reconstructing natural stream channels, removing man-made obstructions, and reshaping or stabilizing streambanks (Section 5.2.2)
- Replacing approximately 1,290 linear ft of drainage channels near 12th Avenue South to compensate for existing drainage channels that will be filled by the third runway embankment (Section 5.2.3)
- Restoring wetland and upland plant communities to Wetland A17 to mitigate for the temporary impacts of construction (temporary impacts will also be restored as described in Section 5.2.4, and this mitigation thus reduces duration of these impacts).
- Improve channel conditions in Water D (1,830 linear feet) through riparian plantings and wood placement.

- Encouraging and promoting additional local stream restoration efforts in the basin; the Port will create a $150,000 trust fund to be used for stream restoration projects in the Miller Creek basin (Section 5.2.5)

5.2.1 Miller Creek Riparian Corridor Wetland and Buffer Enhancement Plan

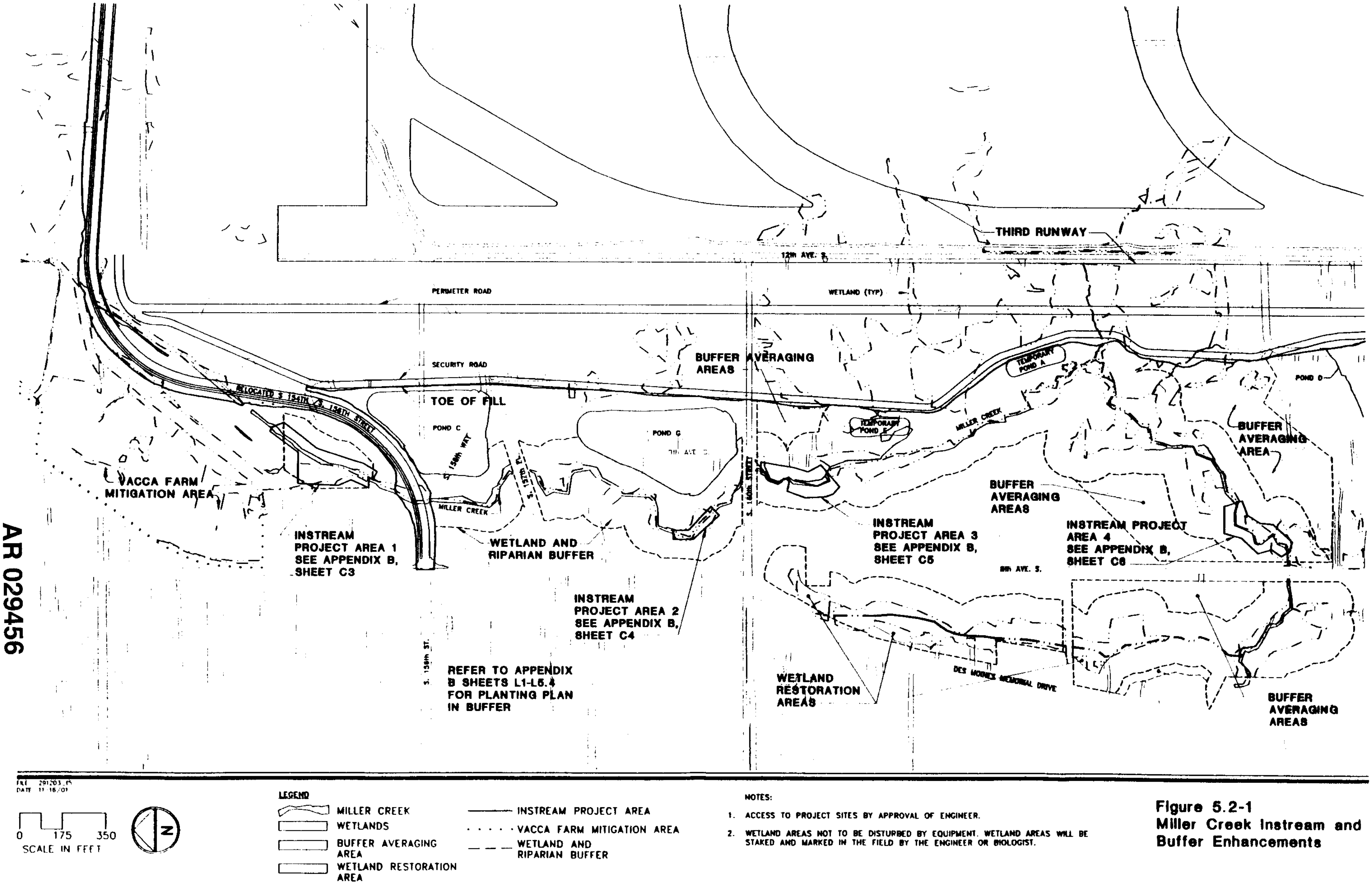
Physical and biological functions will be enhanced along approximately 6,500 ft of Miller Creek. Protection and enhancement of the riparian area will enhance the physical functions forested buffers provide, including reducing stream water temperatures, reducing erosion and suspended sediment releases to streams, influencing channel morphology by contributing LWD to the channel, and stabilizing the banks. Riparian restoration will also enhance biological functions of stream buffers, such as increasing nutrient cycling and retention, increasing organic carbon export to the stream, and providing habitat and food resources to aquatic organisms.

As a consequence of past development in the Miller Creek watershed, buffers have been removed or degraded along much of the stream. Native forested vegetation has been replaced by impervious surfaces, ornamental turf grasses, or landscaping. These alterations reduce the ability of the existing buffer to support the biological and physical functions necessary to maintain quality habitat in adjacent streams.

To restore functions to aquatic resources, riparian wetlands, and buffer along Miller Creek, a buffer area that averages a minimum of 100 ft wide on both banks of the stream (approximately 40 acres) will be enhanced (Figure 5.2-1; Appendix B). Approximately 10.25 acres of riparian wetland habitat and approximately 40.86 acres of buffer will be enhanced. Buffer and wetland enhancement activities along Miller Creek include removal of all residential structures and associated impervious surfaces, underground oil storage tanks, and septic systems. Non-native, invasive species will be removed from wetlands and riparian areas where they would prevent the establishment of native vegetation, and where removal will not destabilize stream banks or result in increased sedimentation.

These specific areas are shown as shaded zones on the landscape sheets in Appendix B. The wetlands and riparian buffer will be enhanced by planting areas of existing lawn, predominantly non-native vegetation, or disturbed areas (i.e., from which structures or impervious surfaces have been removed) with native, predominantly forested vegetation (Figure 5.2-2 and on the Landscape Plan sheets in Appendix B). Wetland or riparian buffer areas, which currently are predominantly forest or shrub vegetation, will be enhanced with in-fill planting of native trees or shrubs.

Design of the Miller Creek wetland and riparian buffer enhancements has been coordinated with the design and location of stormwater detention ponds, the South 156th Way bridge replacement, location of airport security roads and utility easements, and replacement drainage channels (see Section 5.2.3). Appropriate BMPs will be implemented and construction activities sequenced to ensure there are no impacts to buffer enhancement projects from other mitigation or Master Plan Update improvements construction activities (see Implementation, Section 5.2.2.10 for details).

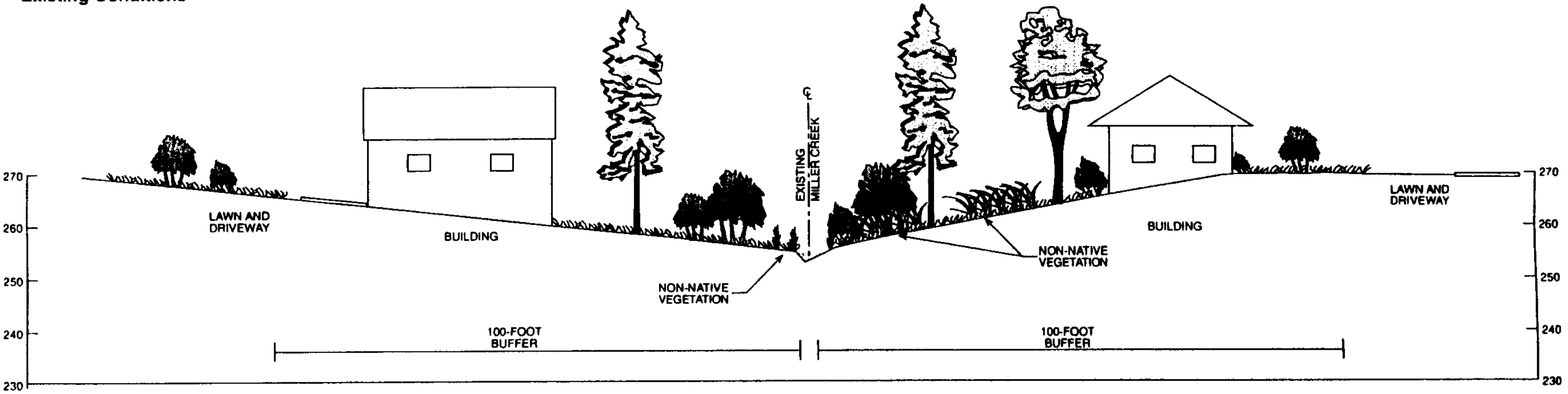


NOTES:

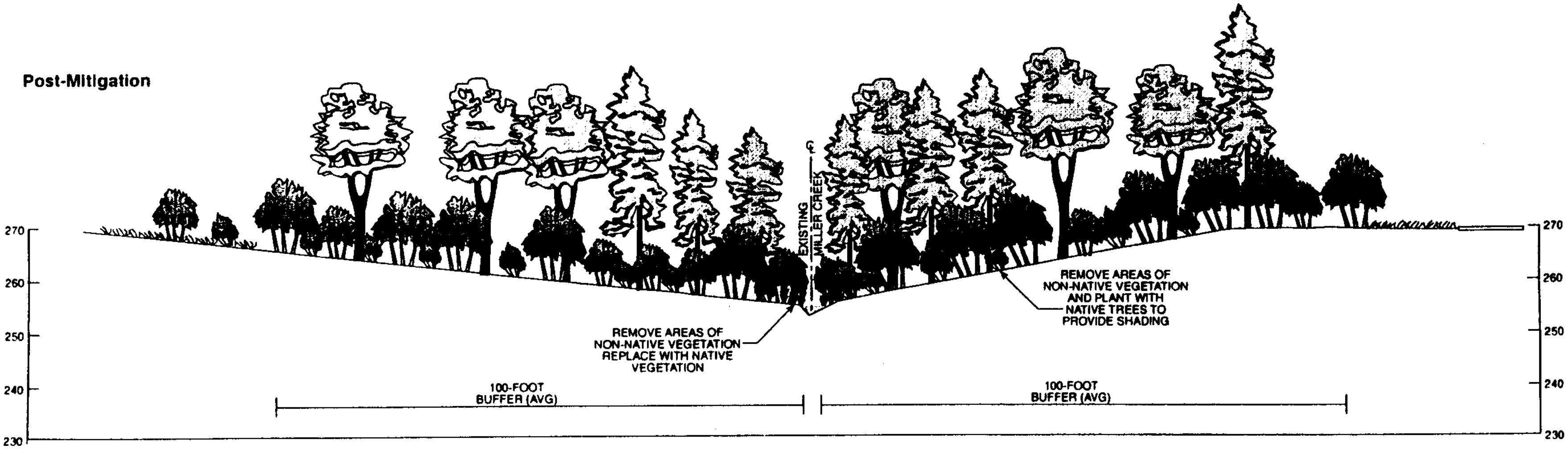
1. ACCESS TO PROJECT SITES BY APPROVAL OF ENGINEER.
2. WETLAND AREAS NOT TO BE DISTURBED BY EQUIPMENT. WETLAND AREAS WILL BE STAKED AND MARKED IN THE FIELD BY THE ENGINEER OR BIOLOGIST.

Figure 5.2-1
Miller Creek Instream and Buffer Enhancements

Existing Conditions



Post-Mitigation



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VERTICAL SCALE 1" = 30'
HORIZONTAL SCALE 1" = 30'

Figure 5.2-2
Typical Cross Section of Miller Creek Stream Buffer Enhancement

5.2.1.1 Goals, Objectives, and Design Criteria

The primary goals of the buffer enhancement plan are to enhance functions in riparian wetlands and in aquatic habitat within and downstream of the Miller Creek riparian corridor by restoring a forested buffer along the entire length of Miller Creek in the acquisition area (Table 5.2-1).

Table 5.2-1. Mitigation goals, design objectives, and design criteria for the Miller Creek wetland and buffer enhancement project.

Goals and Design Objectives	Design Criteria
Goal: Enhance aquatic habitat in the Miller Creek by establishing a forested buffer	
Restore approximately 40.86 acres of riparian buffer along Miller Creek.	Demolish existing structures; remove maintained lawn, landscaping, and portions of non-native vegetation located within 100 ft of Miller Creek (or its adjacent wetlands), and buffer averaging areas. Remove potential water quality impacts such as failed septic systems and untreated stormwater runoff from the buffer area.
Enhance wetland and riparian areas.	Riparian buffer areas that are cleared or disturbed during demolition will be planted with native forested and shrub vegetation. Plant native tree species at densities of greater than 280 per acre. Plant native shrub species at densities of greater than 2,100 per acre. Planting native forest vegetation will enhance lawn and other areas dominated by non-native species.
Increase shade, detritus input, and organic matter retention in the aquatic environment.	Densely plant the portion of the buffer adjacent to the stream with native trees and shrubs where applicable to provide overhanging vegetation and provide future sources of LWD to the stream.
Reduce erosion and sedimentation to Miller Creek.	Remove existing structures, such as riprap walls and bridges, to reduce channel scouring. Increase sediment retention in the buffer by planting trees and shrubs.
Provide long-term protection to the Miller Creek Buffer.	Establish restrictive covenants to permanently protect buffer. Install fencing and signs to designate area as protected mitigation site.

5.2.1.2 Mitigation Site Description

The section of Miller Creek includes the riparian enhancement projects is located along both sides of the stream between the southern portion of the Vacca Farm site and where the stream flows under Des Moines Memorial Drive (Appendix B, Sheet C2).

The Miller Creek buffer was established by adding a 100-ft buffer from the Ordinary High Water Mark (OHWM) of Miller Creek or from the edge of riparian wetlands (riparian wetlands are those that are directly associated with Miller Creek). Approximately 4.8 acres of permanent detention ponds, relocated South 154th Street/South 156th Way, and the third runway embankment will encroach into this buffer. Additionally, an existing 20-ft wide sanitary sewer pipe easement (1.7 acres) was calculated as an encroachment. Buffer averaging was applied at three locations along the stream to compensate for these encroachments. The upland buffers and buffer averaging areas total approximately 40.86 acres (Appendix J).

The riparian buffer vegetation consists primarily of turf grass lawns, areas of ornamental non-native landscaping, or non-native invasive plant species such as Himalayan blackberry, English ivy (*Hedera helix*), and Japanese knotweed (see Figure 5.2-2). Existing land uses in the buffer area include residential structures (such as houses and outbuildings), roads, small stock farms, and horse pastures. In small patches along the channel and in several wetland areas adjacent to the stream, native tree and shrub species occur such as red alder, black cottonwood, Pacific and Sitka willow, hardhack, lady fern (*Athyrium felix-femina*), horsetail, and various native and non-native grasses.

Twenty-five wetlands are present within the Miller Creek buffer and buffer averaging areas (see Table 3.1-4). These wetlands are 18, 37, A1, A9, A10, A11, A13, A16, A17, R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15a, and R17. A complete description of these wetlands is provided in the *Wetland Delineation Report* (Parametrix 2000b).

5.2.1.3 Ownership

All parcels within the riparian wetland and buffer enhancement area shown in Figure 5.2-1 are owned by the Port.

5.2.1.4 Rationale for Selection

Restoring the riparian habitat along this reach of Miller Creek provides on-site and in-kind mitigation opportunities to replace wetland and stream functions impacted by the project. Despite past degradation, the downstream reaches of Miller Creek contain habitat for salmonids. Acquisition, permanent protection, and restoration of a significant portion of Miller Creek have the potential to significantly enhance wetland and aquatic habitats in the Miller Creek basin, including downstream segments not within the project area. Removing residential land uses and associated non-point source pollution and physical impacts, such as clearing and dumping, will enhance the wetland and riparian plant communities, as well as water quality and aquatic habitat within the stream.

The planned restoration and enhancement of the Miller Creek riparian corridor provide an exceptional opportunity to remove anthropogenic impacts, and to establish a large, contiguous riparian habitat corridor within a highly urbanized watershed. Few such opportunities exist to perform habitat restoration at this scale on significant salmonid-bearing streams in urban environments.

5.2.1.5 Constraints

There are no constraints to implementing the mitigation as proposed. Specific mitigation actions have been limited in portions of the mitigation area affected by steep slopes or existing native vegetation. For example, in areas that cannot be accessed without causing increased erosion, or disturbance to desirable vegetation, enhancement actions are not planned.

A concern identified for this mitigation area has been the presence of an existing sewer line easement owned by the Southwest Suburban Sewer District. Occasional maintenance of this line would be required within the 20-foot easement, and this maintenance[25] could prevent mature vegetation from developing within the easement (see Landscape Plan Sheets in Appendix B). For these reasons, this area of the easement is removed from the mitigation buffer, and an equivalent area that can be fully protected from future disturbance has been added to the mitigation area. The presence of the sewer line will not reduce or alter the ecological functions derived from the mitigation. Its presence has, in fact, increased the area of land set aside for protection.

A water main and easement are present in the mitigation site near Wetland A17.

5.2.1.6 Ecological Assessment of the Mitigation Site

Ecological conditions relevant to the mitigation design and implementation are discussed in this section.

Hydrology

The majority of the proposed buffer zone contains uplands and areas of riparian and non-riparian wetlands. Seasonal soil saturation can occur in some of the upland areas near the stream. Inundation of some riparian wetlands occurs during the high-flow periods that may occur in late fall, winter, and spring. Soils in most of the riparian wetlands remain moist during the summer months, and portions of some wetlands (e.g., Wetlands 18 and 37) remain perennially saturated. Non-riparian wetlands in the buffer area are typically saturated during the late fall through early summer period.

Evaluations of project impacts to wetlands (Parametrix 2001b) demonstrate that, with the proposed mitigation, groundwater will continue to be available to support wetlands protected by the Miller Creek buffer. Mitigation to further protect and monitor these wetlands is discussed in Section 5.2.3.

Soils

The project area has not been mapped by the Soil Survey of King County Area Washington (Snyder et al. 1973). However, various soil test pits were dug during field investigations for wetland delineations within the Miller Creek area. Alluvial soils with high organic matter were found in the small riparian wetlands. Soils throughout the remainder of the Miller Creek riparian corridor, south of the Vacca Farm site, are disturbed due to residential development, but appear to be typical Alderwood soils (Snyder et al. 1973). Alderwood series are primarily made up of moderately well

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[25] Sewer lines generally have a design life in excess of 50 years, and rarely require maintenance or fail. Therefore, the potential for disturbance of the easement area is small and infrequent. Furthermore, if leaks were to develop in the line, there are methods to repair and rehabilitate sewer lines in-situ with no disruption of surface soils. These methods employ installation of new pipe sleeves or pipe liners within the existing pipe. Installation is done through existing manholes without soil excavation. These are the preferred methods for rehabilitating sewer lines, and are routinely used by large and small sewer utilities. The easement width of 20 ft provides sufficient construction area for maintenance, repair, or rehabilitation needs.

drained soils forming on glacial till. In some areas, soils were predominantly a sandy loam, with a soil profile that corresponds to Indianola soils (Snyder et al. 1973).

Vegetation

South of the Vacca Farm site, between South 156th Way and South 160th Street, the riparian vegetation is a complex mix of types. Areas of residential landscaping, such as lawns and ornamental plantings, and areas of non-native invasive vegetation, are intermixed with areas of native upland and wetland vegetation. Non-native dominant plants include such invasive species as Himalayan blackberry, Japanese knotweed, and English ivy.

Riparian vegetation south of South 160th Street is more often dominated by native plant species than the area between Vacca Farm and South 160th Street. Common species identified in the canopy layer include red alder, western redcedar, English holly (*Ilex aquifolium*), and some Douglas fir. Dominant species in the shrub layer consist of Himalayan blackberry, salmonberry (*Rubus spectabilis*), willow, and Indian plum (*Oemleria cerasiformis*), with horsetail species, lady fern, swordfern (*Polystichum munitum*), and various upland and wetland grasses in the herbaceous layer.

To assess the extent of non-native vegetation located within 100 ft of the stream, a vegetation survey was conducted along each parcel that borders Miller Creek. Detailed descriptions of the vegetation in each parcel within the riparian buffer are provided in Appendix B, Sheets L1 through L6.

5.2.1.7 Miller Creek Wetland and Riparian Buffer Enhancement Mitigation Design

Conditions along Miller Creek vary widely in terms of existing vegetation, presence of structures, and percent cover of non-native invasive species. Due to this variation, a single mitigation design is not appropriate for the entire buffer area. Given the range of existing conditions, four different buffer-enhancement actions will be implemented, depending on site-specific conditions (Table 5.2-2 and on the Landscape Plan sheets in Appendix B, Sheets L1 through L5). Specific performance standards for the buffer enhancement area are provided in Table 5.2-3. Depending on existing conditions in a given part of the buffer, mitigation actions in may include one of the following:

- Removing structures and/or existing non-native invasive vegetation, and re-planting with native vegetation (i.e., clearing and re-planting)
- Controlling and managing patches of non-native invasive vegetation, and re-planting with native vegetation (i.e., invasive management and re-planting
- Retaining the existing native vegetation matrix but infill planting to increase species diversity and habitat structure (i.e., infill planting)
- Retaining and protecting existing native vegetation with the designated buffer (i.e., protection)

Table 5.2-2. Enhancement planting approach along the Miller Creek buffer.

Enhancement Activity	Explanation and Comments
Remove structures and/or non-native invasive vegetation and re-planting.	This enhancement approach includes planting disturbed areas after structures have been removed from the site. Activities may include grading within the existing buffer to remove houses, driveways, and other structures. If necessary, soil will be scarified and/or amended with organic material. Non-native invasive species such as Himalayan and evergreen blackberry), Japanese knotweed, bamboo (*Bambusa* sp.) and English holly (*Ilex aquifolium*) will be removed from certain portions of the buffer; these areas are shaded on the Landscape Plan sheets in Appendix B. Removal of non-native invasive plants will depend upon vehicular access, the potential risk of sedimentation in wetlands or Miller Creek from vegetation removal, and whether or not invasive species can be controlled adequately without removal. Areas of non-native invasive species will be wholly removed only where there is appropriate access and if existing desirable vegetation will not be adversely affected. Re-vegetation will consist of planting native trees and shrubs in areas, such as lawns associated with residences, that do not currently have an overstory of vegetation. Understory planting will occur in forest areas that lack understory shrubs. Native trees and shrubs to be used in these enhancements are listed in Table 5.1-12.
Invasive vegetation control and/or management, and re-planting with native vegetation.	Non-native invasive species such as Himalayan and evergreen blackberry, Japanese knotweed, bamboo, and English holly will be controlled and managed in certain portions of the buffer where removal is not necessary or possible. For example, invasive species within the buffer may be left in place if removal could cause erosion or sedimentation to the stream or adjacent wetlands. In some areas, patches of invasive species may be treated with herbicide and/or physically removed. These patches may range in size from approximately 200 to 600 ft^2. Coniferous tree species will be planted in the open area to promote reforestation that would eventually shade out invasive species. These plantings will also provide diversity, seed stock, and recruitment of LWD into the riparian buffer. Native trees and shrubs will be planted to increase (1) the amount of shade over Miller Creek, (2) LWD recruitment, and (3) colonization of native trees.
Infill planting in existing native/non-native vegetation.	Native trees and shrubs will be planted to increase (1) the amount of shade over Miller Creek, (2) LWD recruitment, and (3) colonization of native trees.
No enhancement action needed.	These areas either (1) contain well-vegetated buffer that does not require enhancement activities, or (2) are inaccessible or cannot be enhanced without causing harm to desirable vegetation.

Table 5.2-3. **Final performance standards, evaluation approach, and contingency measures for wetland and buffer enhancement along Miller Creek.**

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
1. Riparian buffer areas that are cleared or disturbed during demolition will be planted with native forested and shrub vegetation (these are shaded on the Landscape Plan sheets in Appendix B). Plant native tree species at densities of greater than 280 per acre. Plant native shrub species at densities of greater than 2,100 per acre.	Plant survival will be 100% following year 1. Average survival of planted stock will be at least 80% during the first 3 monitoring years., Tree density will be at least 280 stems/acre; shrub density will be at least 2,100 individuals per acre in monitoring years 3, 8, and 15. During monitoring years 3, 8, and 15, plant diversity will not decrease by more than 10% from the number of plant species installed at baseline. Cover of native species will be at least 80% at monitoring year 15[a]. Cover of non-native, invasive[b] species in newly planted or enhanced areas will not exceed 10% in any monitoring year (see the Landscape Plan sheets in Appendix B for locations where this standard will apply).	Vegetation sampling (plots, transects, or plotless techniques) to estimate native species cover, density, and mortality, and invasive species cover.	If standards are not met: • Select species that are better adapted to existing hydrologic conditions. • Install additional plant material. • Install protective collars to reduce herbivore damage. • Control/reduce non-native invasive species.
2. Lawn and other areas dominated by non-native plant species, will be enhanced by planting native forested vegetation.	Plant survival will be 100% following year 1. Average survival of planted stock will be at least 80% during the first 3 monitoring years. Tree density will be at least 280 stems/acre; shrub density will be at least 2,100 individuals per acre in monitoring years 3, 8, and 15. In monitoring years 3, 8, and 15, plant diversity will not decrease by more than 10% from the number of plant species installed at baseline. Cover of native species will be at least 80% at monitoring year 15[a]. Cover of non-native, invasive[b] species in	See above.	See above.

Table 5.2-3. **Final performance standards, evaluation approach, and contingency measures for wetland and buffer enhancement along Miller Creek (continued).**

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
	newly planted or enhanced areas will not exceed 10% in any monitoring year.		
3. Densely plant the portion of the buffer adjacent to Miller Creek with native trees and shrubs where applicable to provide future sources of LWD to the stream.	Density of trees in buffer is at least 280 stems/acre during monitoring years 3, 8, and 15.	See above.	See above.
4. Install fencing and signs to designate the buffer area as a protected mitigation site.	Signs and/or fencing will clearly mark the buffer edge as a protected mitigation site (see Appendix 0 for fencing specifications).	Check signs and fencing during annual monitoring visits	Repair and/or re-install damaged or missing signs.

[a] See Table 4.2-1 for interim cover targets (i.e., from year 3 to year 15).

[b] See Table 4.2-2 for list of invasive, non-native species to be monitored and controlled on the mitigation site.

Removal of Structures and Impervious Surfaces

All structures, underground storage tanks and septic systems, roads, and driveways within the proposed buffer along the Miller Creek riparian corridor will be demolished and removed. If abandoned underground pipes or other structures do not pose risks to water quality, they may be left plugged and in place.

Demolition will be designed to minimize disturbance to existing native vegetation and soils. The contractor responsible for demolition of structures within the stream buffer areas will follow BMPs to prevent erosion and sedimentation to the stream. The Port has already demolished many residential structures within the stream buffer using sediment and erosion control BMPs to prevent erosion and sedimentation to the stream or wetlands. Standard practice prior to any demolition activity is to install an orange barrier fence and a sediment fence between the demolition site and any wetland or water feature. These standard BMPs will continue to be used throughout the demolition activities associated with the Miller Creek buffer enhancement plan. Materials removed from the buffer area during demolition will be disposed of off-site at an approved upland disposal facility.

Grading and/or Clearing

Grading activities will include removing existing structures, fill material, and driveways in the designated buffer areas. Additional minor grading will remove landscape features such as retaining walls. Clearing of large patches of non-native invasive species from accessible areas along the stream is proposed. On parcels where large areas of blackberry or other invasive species will be removed (such as Parcels 255, 256, and 260), the top 6 to 12 inches of topsoil may be tilled and removed if necessary to remove the root stocks of invasive species.

Expected Hydrology

The hydrologic regime within the buffer area along Miller Creek varies widely because of topography, soil conditions, and proximity to the stream or associated wetlands. Surface grades will be changed as little as possible to retain existing drainage and flow patterns. Therefore, no changes to the existing hydrologic regime are anticipated to occur from implementing this mitigation plan.

Hazard Wildlife Considerations

A landscape planting approach has been developed consistent with the WHMP to aid in deterring flocking birds, raptors, and waterfowl from using the buffer areas along Miller Creek as habitat. Mitigation actions in the buffer, such as replacing the existing open areas (i.e., lawns) along the stream with forested and shrub vegetation, will reduce hazard wildlife attractants by covering and screening open water.

To deter raptor use of the mitigation sites, deciduous and coniferous trees with stiff branches (such as Sitka spruce or Douglas fir) will be planted in limited quantities to limit roosting habitat for raptors such as red-tailed hawks. The primary coniferous tree species used in the upland and transitional zones will be western redcedar because its limp branches do not provide ideal raptor perching habitat.

Landscape Plan

Specific planting plans for each area within the buffer have been designed using the buffer area inventory and the four enhancement alternatives (see Table 5.2-2). Plant communities and specific planting zones are shown in detail on Landscape Plan sheets in Appendix B.

A list of plant species similar to that identified for the Miller Creek floodplain and wetland restoration (see Table 5.1-12) will be used in the Miller Creek riparian corridor buffer enhancement plan. Sun-tolerant species such as Douglas fir and red alder will be planted in open sunny areas, while species that prefer shade, such as vine maple, will be planted in shady areas under existing vegetation. A typical planting plan (Figure 5.2-3) depicts how these planting approaches will be applied.

The landscape plan for the area shows that the planting of conifer trees is phased (see Landscape Plan sheets in Appendix B). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

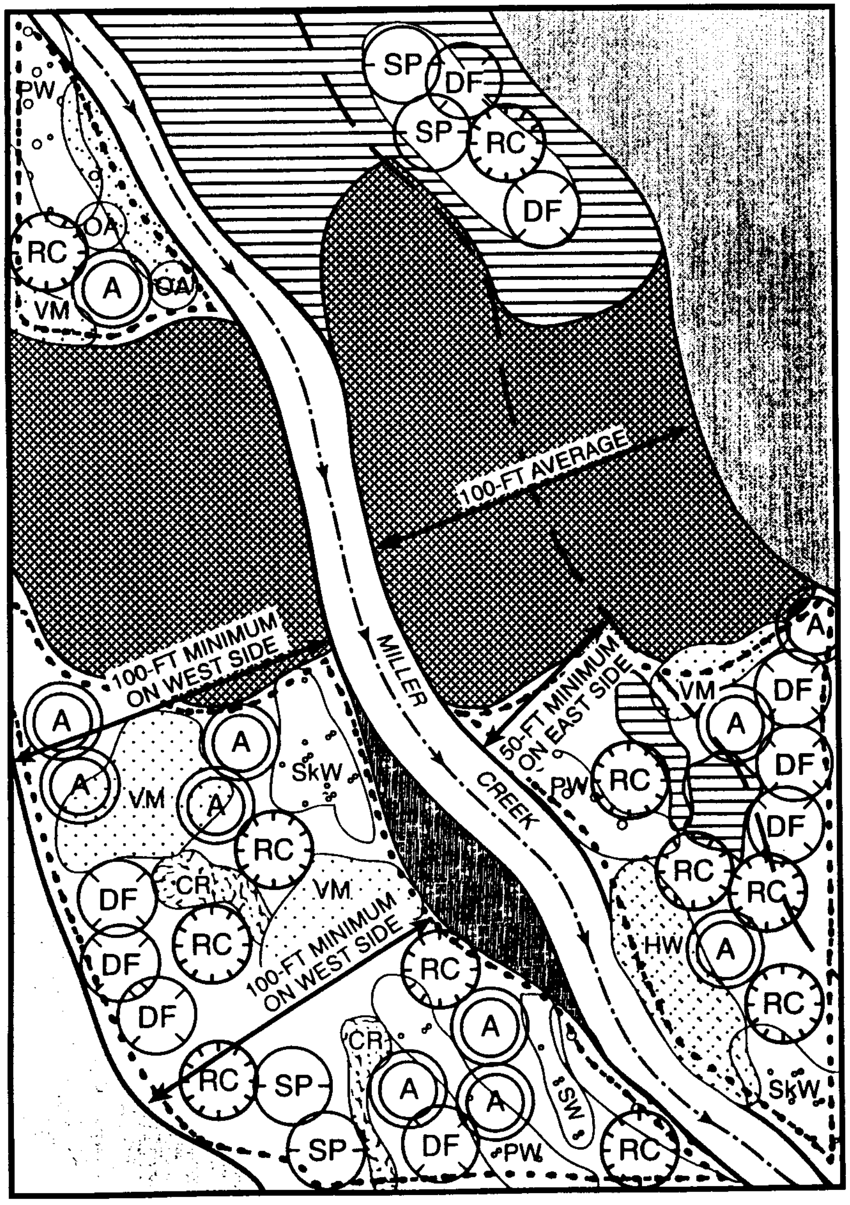
A temporary irrigation system will be provided within the buffer areas. Irrigation will be used only during the plant establishment phase and will be removed after plant survival standards have been met. Irrigation will likely be used during the June through September time period, depending on weather conditions. Application rates are planned to be less than agronomic rates, but sufficient to reduce plant mortality and promote plant growth during the first season following planting.

5.2.1.8 Implementation

Miller Creek buffer projects will be closely coordinated with the instream enhancement projects, as well as related Master Plan Update improvements, such as construction of the embankment. Construction methods, sequencing, and steps necessary to implement both the riparian wetland and buffer enhancement projects and the instream enhancement projects are discussed in Section 5.2.2.10.

5.2.1.9 Monitoring and Performance Standards

Monitoring of the wetland and riparian buffer projects will be consistent with the monitoring approach and schedule outlined in Section 4. Specific performance standards will be evaluated regularly during the monitoring period to ensure that the wetland and riparian buffer enhancement projects are meeting project goals and objectives (see Table 5.2-3). If performance standards are not met, specific contingency measures listed in Table 5.2-3 may be implemented, following the adaptive management approach described in Section 4. Monitoring schedules specific to the riparian buffer are provided in Table 5.2-4.



- ▩ Existing Wetland
- ▨ Existing vegetation to remain
- ⋯ Area of existing non-native invasive plant species to be removed and replaced with native riparian trees and shrubs
- ☰ Areas for partial non-native plant removal. Native coniferous trees will be planted to provide shading

Riparian Floodplain Zone		Upland Zone	
TREES		**TREES**	
RC	Western Redcedar	DF	Douglas Fir
A	Red Alder	SP	Sitka Spruce
OA	Oregon Ash	RC	Western Redcedar
		A	Red Alder
SHRUBS		**SHRUBS**	
SkW	Sitka Willow	VM	Vine Maple
PW	Pacific Willow	CR	Clustered Rose
HW	Hooker's Willow		
○	Hydroseed Mix/ Natural Colonization		

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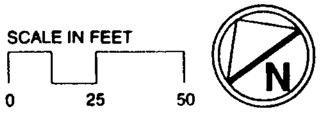


Figure 5.2-3
Typical Planting Plan for the Miller Creek Upland and Streamside Buffer Planting Zones

Table 5.2-4. **Monitoring schedule for the Miller Creek buffer and wetland enhancement project.**

			Data Collection Year								
Feature	**Method**	**Duration**	**0**	**1**	**2**	**3**	**5**	**7**	**10**	**12**	**15**
Plant survival	Calculating plant survival.	Once late spring to early summer	X	X	X	X	X				
Tree and shrub density/cover	Vegetation sampling	Once late spring to early summer	X	X	X	X	X	X	X	X	X
Vegetation structure	Describe from walk-through surveys, incorporating data from above analysis as available.	Once late spring to early summer	X	X	X	X	X	X	X	X	X
Reports			X	X	X	X	X	X	X	X	X

In areas where enhancement tree plantings are added to existing forest vegetation, tree densities of at least 280 trees per acre will be achieved. In these areas, survival of new plants will be monitored for the appropriate performance standards. If mortality of existing vegetation occurs (i.e., through windfall or other damage, they will be evaluated and using adaptive management analysis, replacement planting may be used to supplement these areas.

5.2.1.10 Site Protection

The Port will execute and file a restrictive covenant for the mitigation area. Copies of proposed restrictive covenants are included in Appendix F.

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

5.2.1.11 Maintenance and Contingency Plans

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, replacing plants) will be implemented consistent with the approach outlined in Section 4. Specific contingency actions for each wetland and riparian buffer performance standard are provided in Table 5.2-3.

5.2.2 Miller Creek Instream Habitat Enhancement Plan

Four major instream enhancement projects, as well as general instream habitat enhancements, will restore and improve the quality of fish habitat in Miller Creek. Instream habitat quality is currently degraded as a result of historic residential land uses and overall urbanization in the basin (see Section 2).

The section of Miller Creek between the Vacca Farm site and Des Moines Memorial Drive was surveyed in February and March 1999 to identify areas within the stream channel that would benefit from habitat enhancement. As a result of this survey, four enhancement projects have been identified (Appendix B, Sheet C2). Habitat enhancement in these four projects includes removal of channel armoring, weirs, concrete walls, and footbridges, and installing instream features such as root wads, gravel, and LWD. In addition to these four instream enhancement projects, LWD will be added at selected locations along the 6,500-ft section of Miller Creek to enhance overall channel function and habitat (Appendix B, Sheets C7 and C10). Instream enhancement projects will be coordinated with the wetland and riparian buffer enhancement projects. The streambed and bank of Miller Creek adjacent to the South 156th Way bridge will also be restored after the existing bridge over South 156th Way is removed and reconstructed as part of relocating South 154th Street (see Figure 5.2-1).

5.2.2.1 Goals, Objectives, and Design Criteria

The overall goal of the Miller Creek instream enhancement projects is to alleviate historic human disturbances by increasing the amount, quality, and continuity of instream fish habitat. Specific design objectives in the instream enhancement projects are:

- Enhance instream fish habitat by increasing channel complexity
- Stabilize bed and bank erosion along Miller Creek
- Remove instream man-made debris and channel armoring
- Enhance instream substrate conditions for fish and invertebrates
- Restore the streambed and bank after relocating the bridge over South 156th Way

To implement the goal identified above, specific objectives and design criteria were developed (Table 5.2-5).

Table 5.2-5. Mitigation goals, design objectives, and design criteria for instream enhancement projects in Miller Creek.

Goals and Design Objectives	Design Criteria
Goal 1: Enhance habitat by increasing channel complexity	
Create pools and riffle habitat.	Remove cemented riprap along banks, encourage natural formation of meander bends and cut benches.
Create habitat features for juvenile rearing and high-flow refugia.	Increase the amount of stable, LWD in the channel.
Create instream diversity and enhance organic matter retention.	Place wood in stream to create flow diversity and refugia.
Goal 2: Stabilize bed and bank erosion	
Identify locations of in-channel or bank erosion and stabilize those areas.	Stabilize those areas of excessive erosion by using native vegetation and LWD.
Goal 3: Remove trash	
Channel will be free of trash.	Remove all trash from the channel that could be harmful to fish habitat, aesthetics, and water quality.
Goal 4: Enhance instream substrate	
Enhance substrate.	Add gravel to degraded reaches where natural recruitment is limited.
Goal 5: Restore the bed and bank after relocating the bridge at South 156th Way	
Reduce fine sediment load from Port property.	Reduce upstream erosion by vegetating banks and replanting the Vacca Farm site.

5.2.2.2 Mitigation Site Description

The four instream enhancement projects and the general habitat enhancements are located in Miller Creek between the Vacca Farm site and Des Moines Memorial Drive (see Figure 5.2-1; Appendix B, Sheet C2).

Between Vacca Farm and South 160th Street, the stream channel is less altered than the ditched and channelized reach on the Vacca Farm site; however, it still suffers from the effects of urbanization. South of Vacca Farm, the stream contains some meanders, pools and riffles, and LWD in the channel. The substrate is predominantly silty, mixed with areas of sand and till in the northern portions of this reach. Farther downstream the substrate consists largely of gravel and gravel-sand bars. Unconfined channel widths in this reach range from 7 to 10 ft and gravel bars are approximately 5 ft wide. Because this stream reach has been surrounded by residences and yards, several stream portions are modified with riprap, retaining walls, bridge abutments, footbridges, and other bank-side structures that restrict natural channel morphology. The vegetated upland buffer in this area mostly consists of lawn and some bushes and trees planted by homeowners, but there is very little native riparian vegetation.

The stream channel between South 160th Street and SR 509 is less disturbed than the upstream reaches, with channel widths ranging from 7 to 10 ft. With the exception of a few small stretches within this reach, which have been highly modified with riprap, tire walls, or fences, this reach is characterized by meanders, LWD jams, riparian vegetation (although in much of the area the vegetation is non-native), pools and riffles, and gravel bars. In this section, residential development is generally located farther from the stream than in the upstream reaches. As a result, the streambanks have more intact riparian vegetation, reducing the impact of urbanization. Gravel and sandbars are present in many portions of this reach and substrate in the majority of the channel is gravel.

5.2.2.3 Ownership

The Port owns the entire area to be included in the Miller Creek riparian and instream enhancement mitigation.

5.2.2.4 Rationale for Selection

Mitigation sites for the specific instream enhancement projects were selected based on several criteria. An initial survey of existing conditions was conducted to identify locations where development adjacent to the channel or alterations to the channel were directly impairing habitat and/or water quality in Miller Creek. These sites were then evaluated based on the severity and type of impact and opportunity for restoration. Type of impact included the loss of habitat complexity, channel armoring, erosion, man-made debris in the channel, and unstable or uniform geomorphology. Opportunities for significant improvement at potential enhancement sites were determined based on benefits to upstream and downstream reaches, access to the site, coordination with buffer revegetation projects, and potential negative impacts during construction.

5.2.2.5 Constraints

There are no significant constraints to the implementing the mitigation projects. However, instream work must be performed during low-flow periods, and all work will be designed and performed consistent with conditions of the HPA permit for the projects.

5.2.2.6 Ecological Assessment of the Enhancement Sites

Urban development in the Miller Creek watershed has degraded instream habitat and water quality throughout the basin. Specifically, within the project reach, aquatic habitat has been degraded by altered hydrology; channelization; excess fine sediments; altered water quality due to inputs of pollutants, stormwater discharges, and agricultural and residential herbicides, pesticides, and fertilizers; loss of habitat complexity; and loss of contiguous vegetated buffers (Table 5.2-6). However, Miller Creek continues to support populations of coho salmon, anadromous and resident cutthroat trout, three-spine sticklebacks, white crappie (*Pomoxis annularis*), and pumpkinseed sunfish.

Table 5.2-6. Summary of existing conditions in Miller Creek between South 156th Way and Des Moines Memorial Drive.

Parameter	Description
Fish Habitat	Pool habitat and high-flow refugia quality are relatively poor, which is related to the lack of LWD in the channel. This problem (and other factors) may limit the sizes of resident and anadromous fish populations supported by Miller Creek.
Fine Sediment	High turbidity was observed (and reported) in Miller Creek during winter base flow rates. This problem is primarily found in the upper reaches, where the channel has been straightened and confined by riprap on both banks.
Geomorphic Complexity	Numerous footbridges and riprap confine the stream to a narrow straight channel in many reaches.
Man-made Debris	Man-made debris (tires, shopping carts, metal pipes, and car parts) and fences that restrict upstream and downstream fish movement are common throughout the stream.

Between South 156th Way and the South 160th Street culvert, Miller Creek has been degraded by substantial development adjacent to the banks. Segments of the stream have been straightened and the banks in these reaches are lined with riprap or cement. Substrate in this reach consists of silt and fine sands. Numerous footbridges and weirs influence channel morphology and reduce habitat complexity. Most of the footbridges confine the channel, creating straightened reaches of high-velocity flows and bed scouring. Riparian vegetation consists primarily of lawn and some trees adjacent to the channel; however, the vegetation does not provide shade, bank stabilization, or habitat complexity. A fish survey conducted in 1998 found that sticklebacks were the dominant fish in this reach; white crappies were also found. Although cutthroat trout were found upstream of the waterfall north of South 160th Street during an electroshocking fish survey on November 10, 1998 (Parametrix 1998), they were not found during that survey in the upper reaches of Miller Creek north of South 156th Way.

Specific conditions in each of the four instream project reaches are described in the following section.

Instream Enhancement Project 1

Instream Project 1 is located between the downstream end of the Miller Creek relocation project and South 156th Way (see Figure 5.2-1). The project area includes approximately 650 ft of Miller Creek, which is confined along most of the project length by riprap (Figure 5.2-4). Historically, this area was a wetland that may have lacked a defined streambed. When this area was drained for farmland, Miller Creek was channelized along the eastern edge of Wetland A1. A small side channel, or ditch, draining Wetland A1 flows into Miller Creek at the south end of the wetland (see Figure 5.2-4). This project is located on Parcels 63, 87, 88, 89, 90, 91, 97, 98, 100, and 101.

In this reach Miller Creek is a low-gradient stream, although the valley becomes more confined downstream of the confluence with the side channel. The project site has two distinct areas: upstream of the confluence with the side channel (Parcels 88, 89, and 90), and downstream of the confluence where the valley narrows (Parcels 91, 99, 100, and 101). Substrate in the upstream reach is composed primarily of silt and fine gravel; however, some coarse gravel exists where riprap has fallen into the channel and created a riffle. Substrate in the side channel and downstream of the confluence consists of fine silt. Five footbridges cross Miller Creek upstream of the confluence, and a fence crosses the channel at the upstream end of the project site. Two footbridges and a fence cross the side channel.

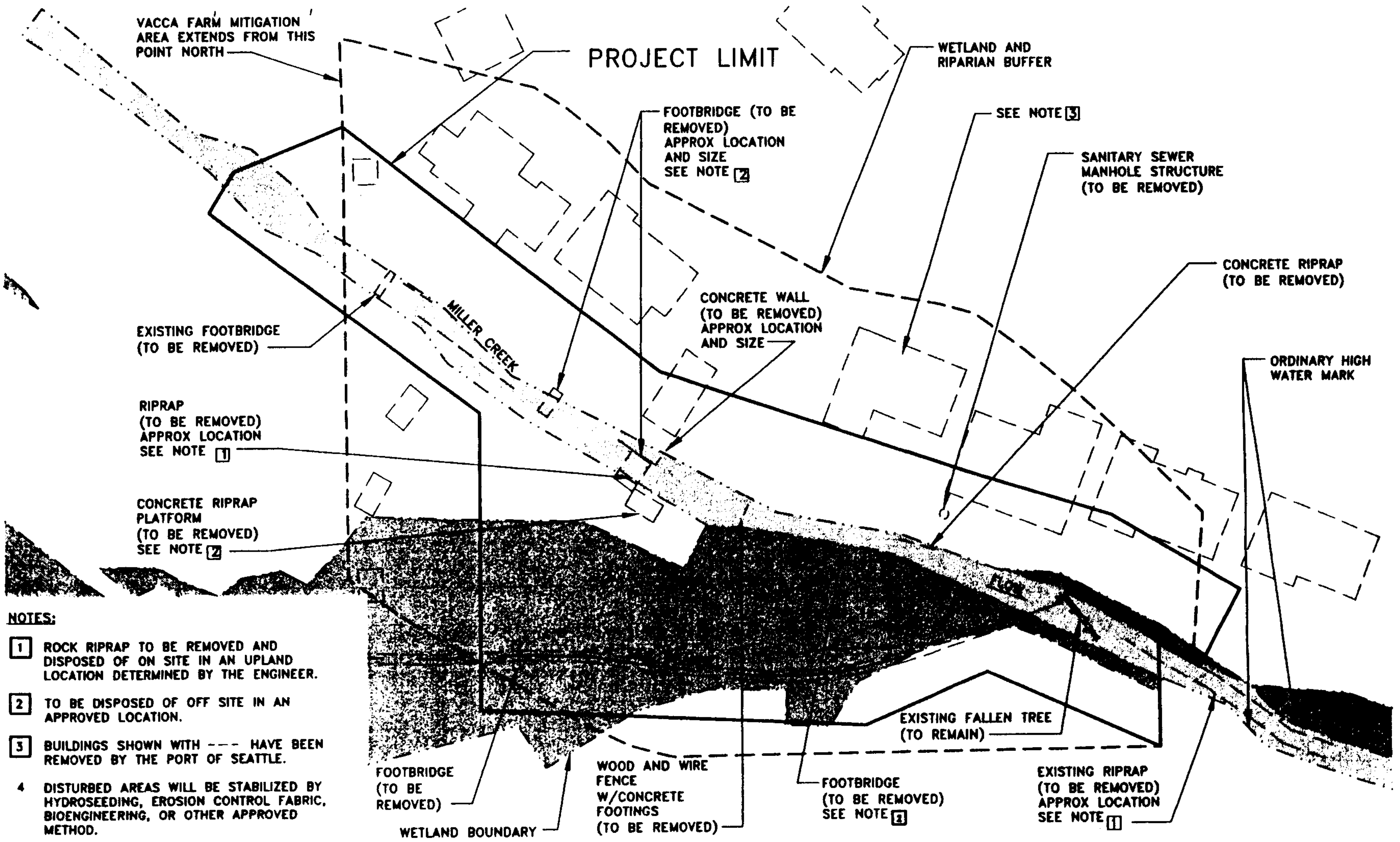
During high-flow events, both Miller Creek and the side channel overtop their banks and flood the adjacent wetland. Vegetation within this reach is predominantly grass; the site also has several large western redcedar trees and some non-native and invasive species. Downstream of the confluence several large trees are located along the channel; however, the remainder of vegetation is lawn and invasive or exotic species.

Instream Enhancement Project 2

Instream Project 2 is located approximately 150 ft upstream of South 160th Street (see Figure 5.2-1). A narrow ravine confines Miller Creek and its floodplain throughout this reach.

Construction of two weirs in this reach has altered the channel profile and resulted in a uniform channel with little habitat diversity (Figure 5.2-5). The first (downstream) weir is approximately 3 ft high and constructed of large boulders. The second (upstream) weir is constructed of cement, located approximately 70 ft upstream of the first weir, and is approximately 2 ft high. A footbridge crosses Miller Creek just upstream of the second weir. Miller Creek is confined by riprap on both banks downstream of the first weir and upstream of the second weir. Both weirs may impede fish passage at summer low flows.

Between the weirs, riprap armors the left bank, while lawn on the right bank is planted to the edge of the channel. During storm events, a pool forms behind the downstream weir and floods the right bank. An emergent wetland lies adjacent to the left bank of Miller Creek throughout the project area.



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OF OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.

FILE: 291203_F5
DATE: 09/05/01

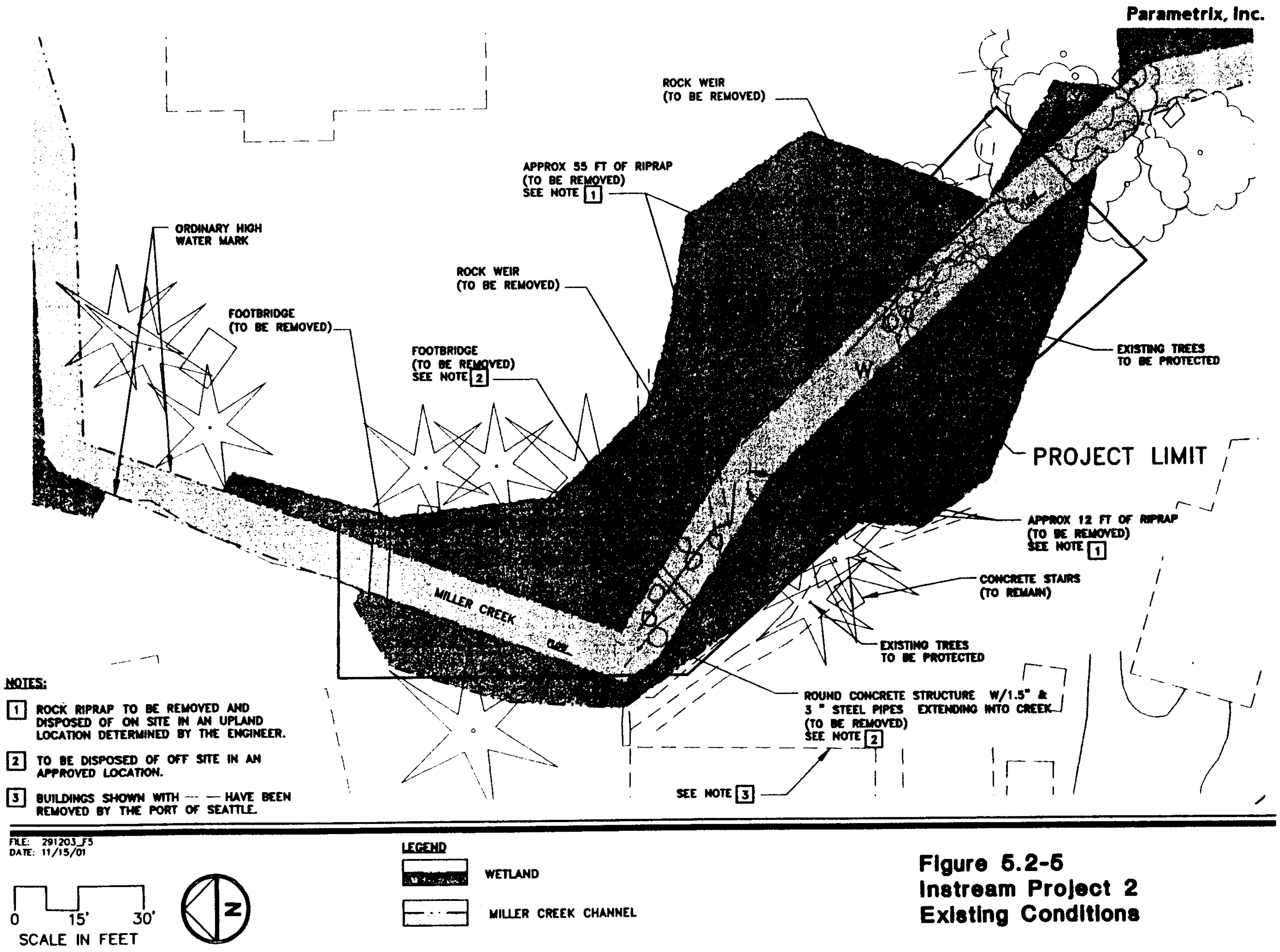
LEGEND

▨ WETLAND

-·-·- MILLER CREEK CHANNEL

Figure 5.2-4
Instream Project 1
Existing Conditions

Parametrix, Inc.



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OF OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.

FILE: 291203_F5
DATE: 11/15/01

Figure 5.2-5
Instream Project 2
Existing Conditions

Vegetation in the project area is predominantly turf grass lawns; however, a stand of large cottonwood trees is located on the right bank near the downstream weir. The project site is easily accessible on the right bank, although heavy equipment access may be limited by a retaining wall on the left bank.

Instream Enhancement Project 3

The site of Instream Project 3 extends from a scour pool and debris area immediately downstream of a culvert at South 160th Street to approximately 600 ft downstream (see Figure 5.2-1). This project is located on Parcels 256, 257, 258, 259, 260, and 276. Miller Creek is confined in the middle and upper portions of this site by a narrow ravine. However, along the lower project reaches, the valley widens and an extensive floodplain and wetland are associated with the stream.

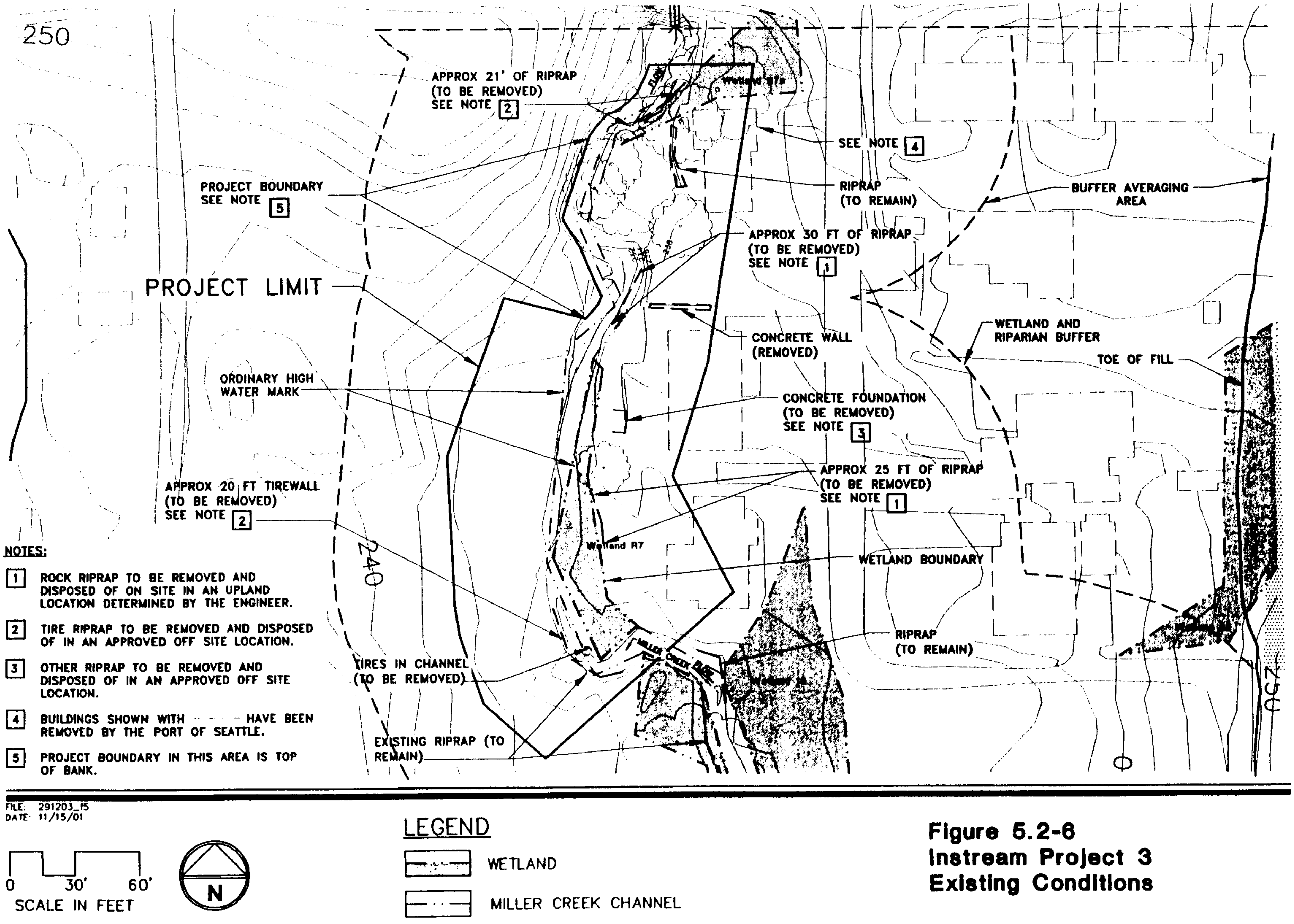
Tire riprap has been placed along the left bank downstream of the scour pool, while the right bank is steep and shows evidence of erosion and downcutting. In the middle of the project site, Miller Creek becomes confined to a narrow channel, the gradient increases to a slope of approximately 3 percent, and the velocity increases. At the lower end of the steep reach, Miller Creek has a sharp meander bend that is protected by riprap (Figure 5.2-6). Tire riprap lines the channel approximately 40 ft upstream of this meander. A deep scour pool with large cobble substrate has formed on the outside edge of the meander. Another meander immediately downstream has also been lined with riprap.

Vegetation throughout this reach is dominated by blackberry species and turf grass lawn, with a few large trees scattered along the banks. Access to the site is limited by steep banks on the right bank immediately downstream of the culvert. However, the project area is easily accessible along the left bank.

Instream Enhancement Project 4

Enhancement Project 4 extends from a point east of 8th Avenue South to a private driveway approximately 820 ft upstream (see Figure 5.2-1). Project 4 is located on Parcels 314, 316, 317, and 321. Many reaches of Miller Creek throughout this project area are unconfined by riprap and have pool and riffle sequences; small pieces of in-channel wood are present throughout this reach as well. Riprap lines the bank downstream of the private driveway (Figure 5.2-7). Large cement pieces line Miller Creek on the right bank, constricting the channel. A collapsed footbridge has created a backwater pool and trapped debris on the upstream side during winter base flow conditions. At the downstream portion of the project area, two rock walls line the stream and a fence spans the channel. The upstream wall, located along the left bank, influences the flow pattern of the stream; however, there is evidence of bank erosion downstream of this wall. Miller Creek is channelized by the second wall, which lines both banks.

Riparian vegetation in the project site includes many large (>30 ft) western redcedar and red alder trees; however, little understory exists, and ground cover is primarily grass, gravel, and invasive species such as blackberry. Steep banks at specific locations on the left bank would limit site access. Miller Creek is easily accessible in most places along the right bank.



NOTES:

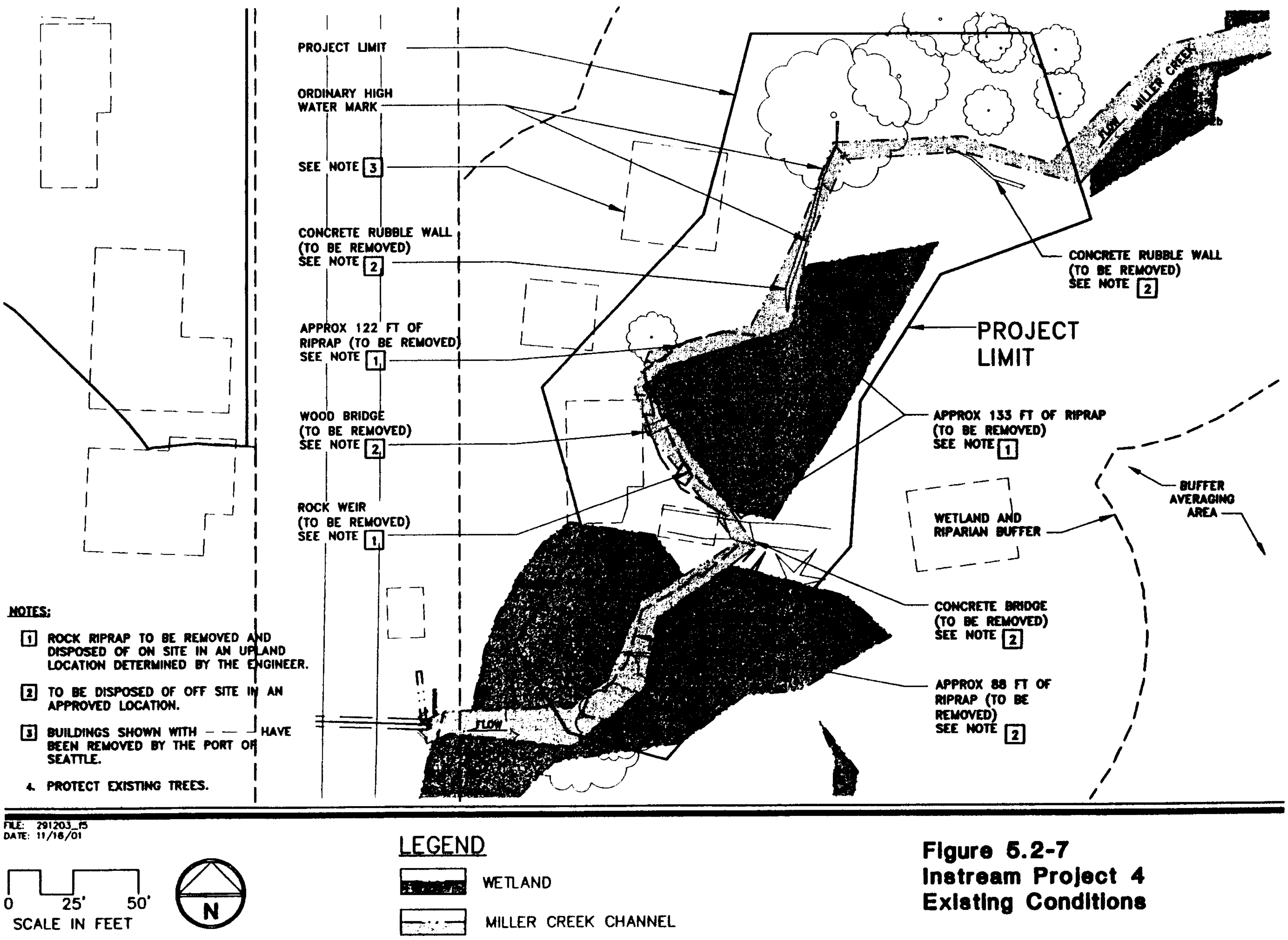
1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TIRE RIPRAP TO BE REMOVED AND DISPOSED OF IN AN APPROVED OFF SITE LOCATION.
3. OTHER RIPRAP TO BE REMOVED AND DISPOSED OF IN AN APPROVED OFF SITE LOCATION.
4. BUILDINGS SHOWN WITH - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
5. PROJECT BOUNDARY IN THIS AREA IS TOP OF BANK.

LEGEND

- ▨ WETLAND
- ▭ MILLER CREEK CHANNEL

Figure 5.2-6
Instream Project 3
Existing Conditions

Parametrix, Inc.



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OF OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. PROTECT EXISTING TREES.

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DATE: 11/16/01

Figure 5.2-7
Instream Project 4
Existing Conditions

5.2.2.7 Instream Habitat Enhancements Mitigation Design

The following sections describe the mitigation actions proposed for the four specific instream habitat enhancement projects, the general in-stream habitat enhancement along Miller Creek, and the restoration of the stream for the South 156th Way bridge relocation.

Most channel armoring, rock walls, weirs, and footbridges along this reach of Miller Creek will be removed. For example, the existing rock weirs located at Instream Project 2 will be removed because they impede fish passage. However, at several locations some riprap will be left in the channel to avoid creating significant erosion or construction impacts (Figures 5.2-8 through 5.2-11; Appendix B, Sheets C3 through C6).

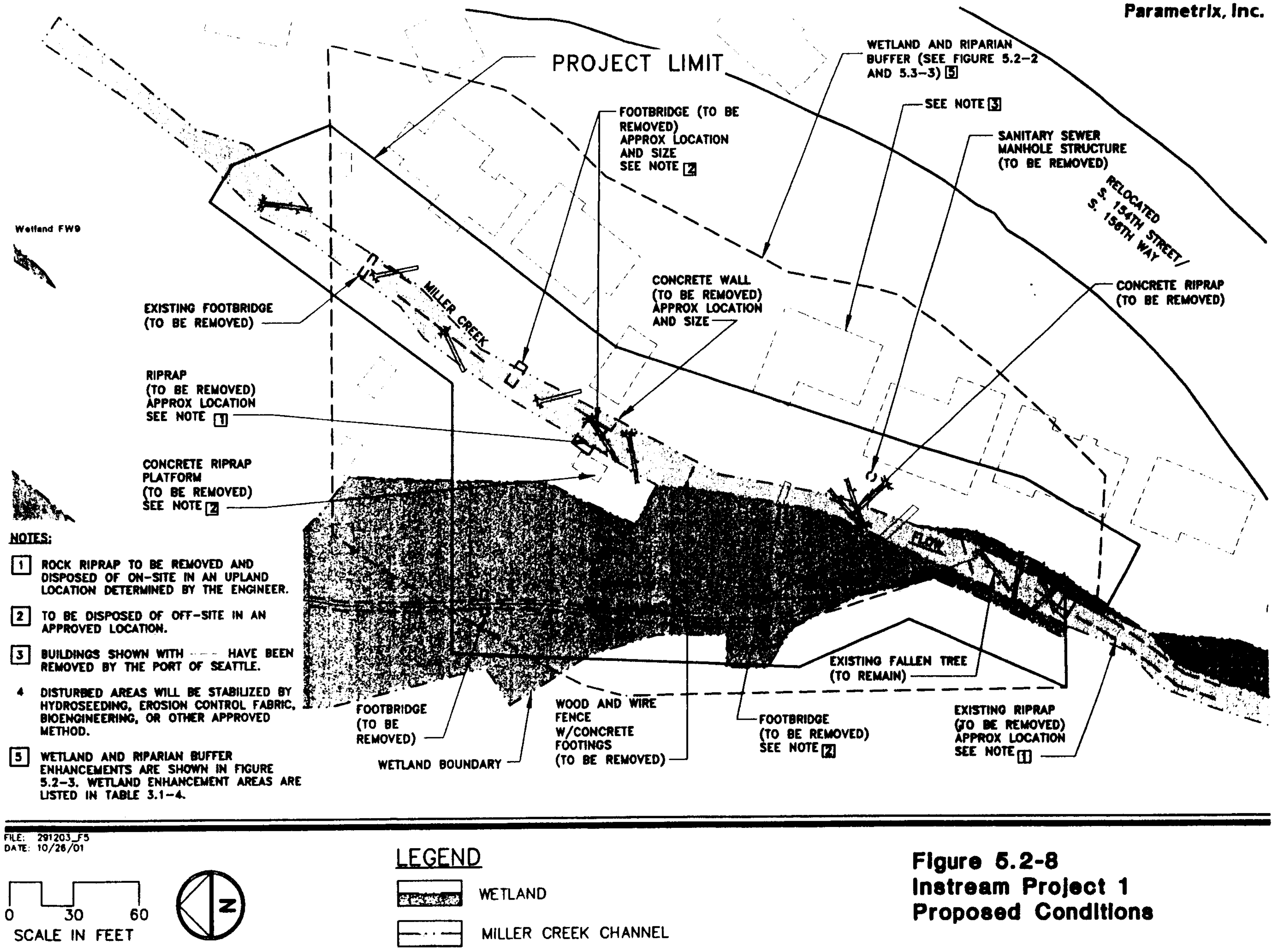
Prior to developing the enhancement designs, cross sections were surveyed in three relatively undisturbed reaches in Miller Creek. These cross sections (Figure 5.2-12) are used as reference sites for proposed instream enhancement projects. The geomorphic and habitat benefits associated with each enhancement feature are summarized in Table 5.2-7.

Table 5.2-7. Habitat and geomorphic benefits of Miller Creek instream enhancement features.

Enhancement Feature	Geomorphic Function	Habitat Function
LWD	Stabilizes banks	Increases habitat complexity
	Promotes deposition of fine sediment	Promotes pool formation Provides instream cover
Riparian Vegetation	Stabilizes banks	Moderates temperature
	Provides a source for LWD recruitment	Provides organic matter
	Increases roughness, promotes deposition of fine sediment	Promotes undercut banks Provides instream cover
Meander Bends	Creates pool/riffle sequences	Increases habitat complexity
	Promotes overbank flows, reduces channel incision	Creates spawning reaches
	Creates variations in flow regime	
	Creates depositional areas	
Boulders	Promotes variation in channel width	Provides instream cover
	Creates variations in flow regime	Creates variations in flow regime
Erosion Control	Reduces sediment loading	Reduces spawning habitat degradation
	Stabilizes banks	Increases macroinvertebrate production
Remove Instream Barriers	Promotes natural geomorphic processes (i.e., widening, meandering, deposition)	Increases habitat availability/continuity
Debris Removal	NA	Enhances aesthetics
		Reduces potential pollutants
Remove Footbridges/Riprap	Allows for natural channel movement (i.e., widening, meandering, deposition)	Increase habitat complexity

NA = Not applicable

Parametrix, Inc.



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON-SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OF OFF-SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
5. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN FIGURE 5.2-3. WETLAND ENHANCEMENT AREAS ARE LISTED IN TABLE 3.1-4.

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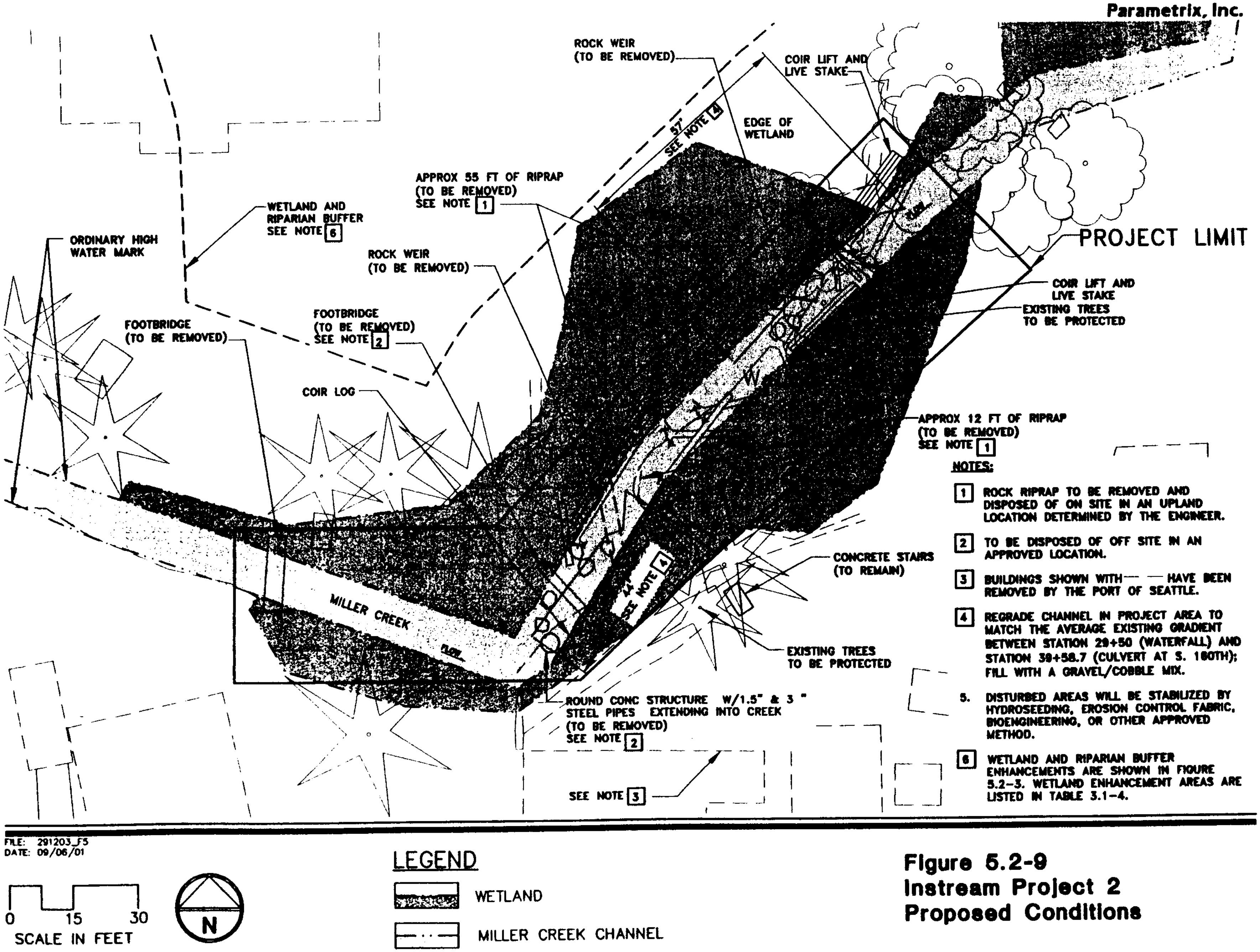
Figure 5.2-8
Instream Project 1
Proposed Conditions



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OF OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. REGRADE CHANNEL IN PROJECT AREA TO MATCH THE AVERAGE EXISTING GRADIENT BETWEEN STATION 29+50 (WATERFALL) AND STATION 39+58.7 (CULVERT AT S. 160TH); FILL WITH A GRAVEL/COBBLE MIX.
5. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
6. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN FIGURE 5.2-3. WETLAND ENHANCEMENT AREAS ARE LISTED IN TABLE 3.1-4.

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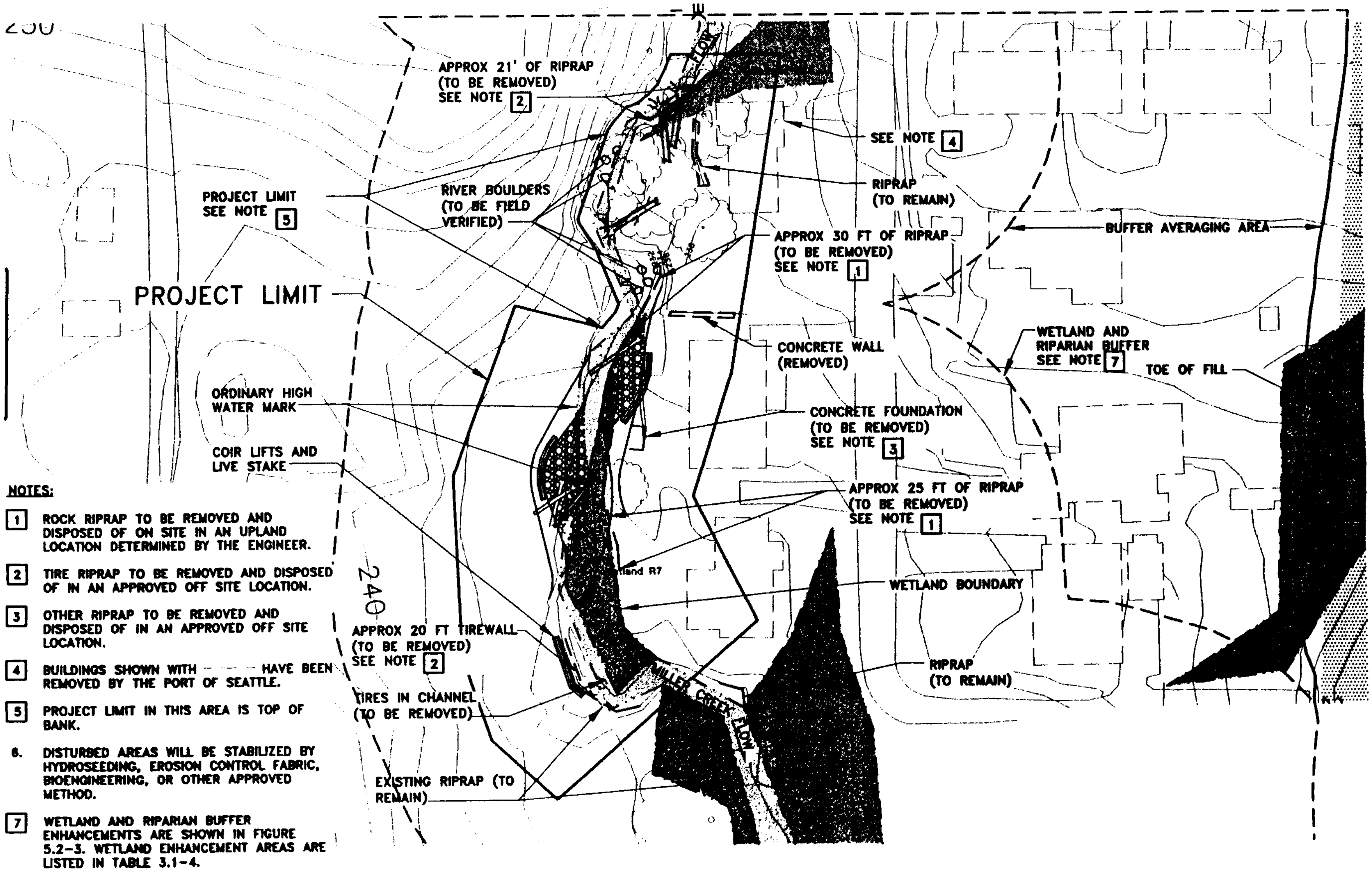
Figure 5.2-9
Instream Project 2
Proposed Conditions

Parametrix, Inc.



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED OF ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TIRE RIPRAP TO BE REMOVED AND DISPOSED OF IN AN APPROVED OFF SITE LOCATION.
3. OTHER RIPRAP TO BE REMOVED AND DISPOSED OF IN AN APPROVED OFF SITE LOCATION.
4. BUILDINGS SHOWN WITH – – – HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
5. PROJECT LIMIT IN THIS AREA IS TOP OF BANK.
6. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
7. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN FIGURE 5.2-3. WETLAND ENHANCEMENT AREAS ARE LISTED IN TABLE 3.1-4.

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DATE: 11/15/01

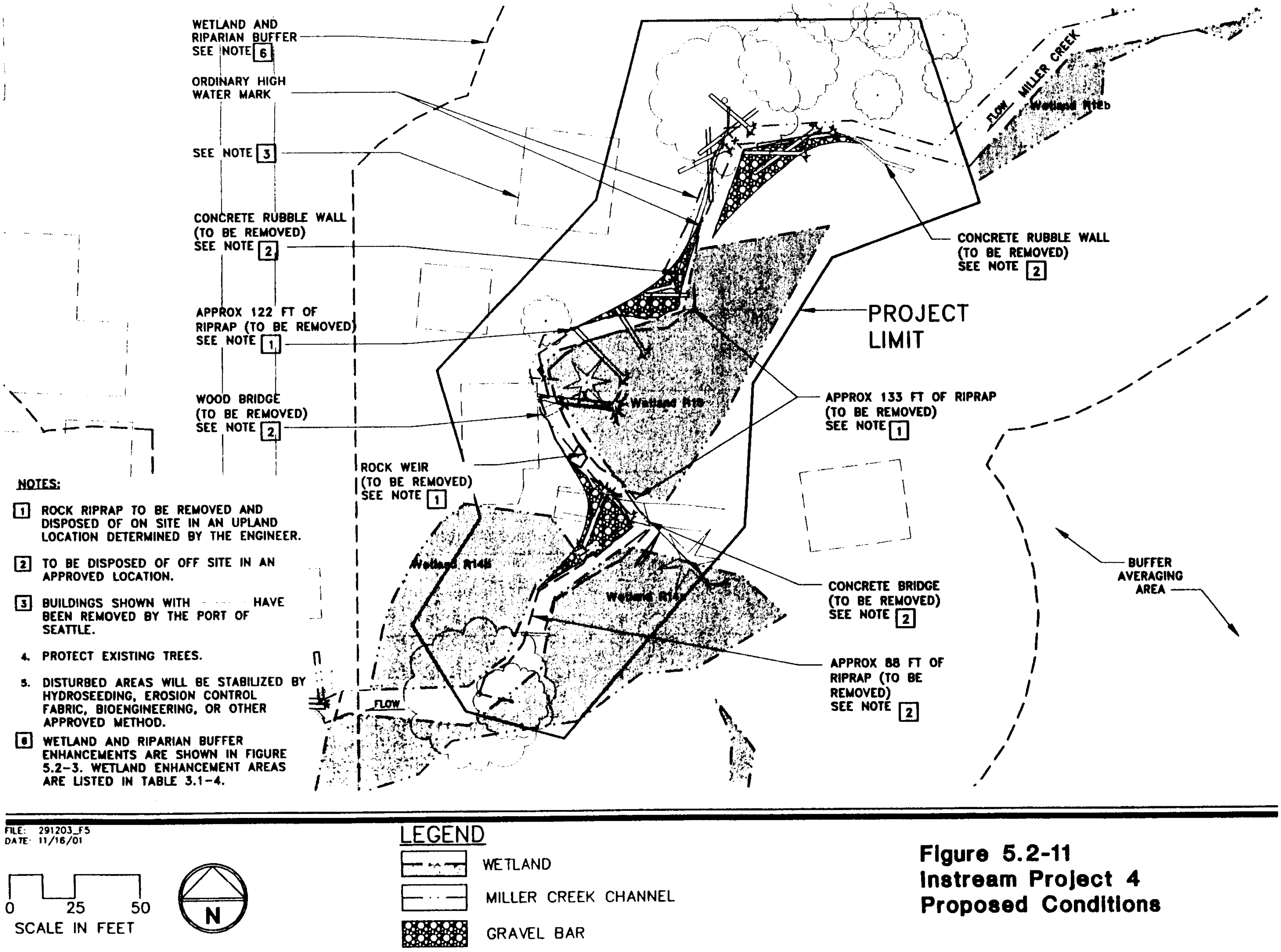
0 30 60
SCALE IN FEET

N

LEGEND

▨ WETLAND
☐ MILLER CREEK CHANNEL
▩ GRAVEL BAR

Figure 5.2-10
Instream Project 3
Proposed Conditions



NOTES:

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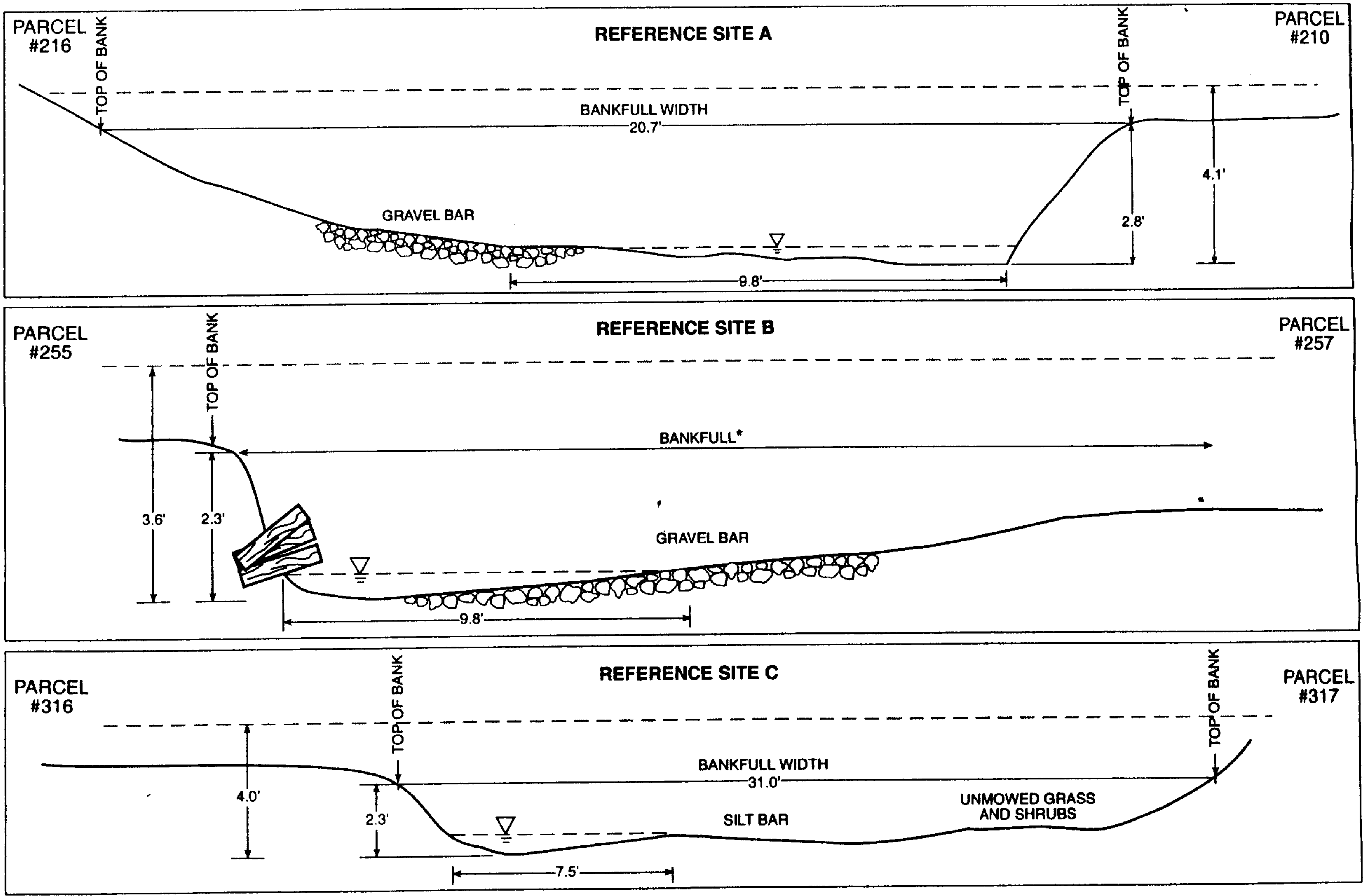
2. TO BE DISPOSED OF OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH - - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. PROTECT EXISTING TREES.
5. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
6. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN FIGURE 5.2-3. WETLAND ENHANCEMENT AREAS ARE LISTED IN TABLE 3.1-4.

FILE: 291203_F5
DATE: 11/16/01

Figure 5.2-11
Instream Project 4
Proposed Conditions



— — — FEMA - 100-year floodplain in elevation

—∇— Water surface elevation at winter base flow (4/28/99)

* Bankfull width not determined for reference site B

NOT TO SCALE

Figure 5.2-12
Representative Cross Sections of Miller Creek Reference Sites (Surveyed at Parcels 210/216-255/257 and 316/317)

Instream Enhancement Project 1

Activities at Instream Project 1 will enhance approximately 470 ft of Miller Creek and 300 ft of a side channel extending from the Miller Creek relocation and Vacca Farm project to the downstream side of the existing South 156th Way bridge (see Figure 5.2-8; Appendix B, Sheet C3). The primary goal of the enhancement features is to create a geomorphically stable, low-gradient stream. Other goals include increasing the frequency of overbank flow for sediment deposition, enhancing instream habitat, and enhancing the side channel.

Project 1 includes removing riprap, footbridges, railroad ties, and fences along Miller Creek and placing woody debris in the channel to increase instream habitat complexity. Riprap currently located upstream of the South 156th Way bridge will be removed as part of the bridge replacement project. Portions of the area may be regraded to match grading associated with the Vacca Farm project and to promote flooding near the confluence with the side channel. The reach currently located under the existing bridge will be restored by adding some wood and large rocks, providing erosion control along the banks, and replanting the riparian area once this bridge has been replaced.

Addition of woody debris and native vegetation to the main and side channel will create more diverse instream habitat for fish and other aquatic organisms. Native riparian and wetland vegetation will be planted along the banks.

The entire project site is easily accessible to people and heavy equipment on both banks. Therefore, construction of instream enhancement features and replanting of riparian vegetation will be unrestricted. Specific access routes will be identified in the field to protect sensitive areas located within the project boundary.

Instream Enhancement Project 2

Proposed enhancements at Instream Project 2 include removing riprap and the two instream weirs, placing LWD and river boulders in the channel, and replanting with native wetland and riparian vegetation (see Figure 5.2-9; Appendix B, Sheet C4). The goal of this project is to improve fish passage and enhance instream and riparian habitat along approximately 234 ft of Miller Creek. Approximately 100 ft of the channel profile will be regraded to match average upstream and downstream gradients.

Approximately 55 ft of riprap will be removed along the left bank between the two weirs and approximately 12 ft of riprap will be removed along the right bank. All of the riprap associated with the two weirs, as well as the two weirs, will be removed from the stream. Two footbridges will also be removed. Coir logs and coir lifts will be used to restabilize areas where riprap is removed (Appendix B, Sheets C4 and C9). Stream gravel will be placed in the channel and LWD and river boulders will be used to stabilize the regraded reach. Native wetland and riparian vegetation will be planted to provide shade and reduce bank erosion.

A temporary diversion of Miller Creek and dewatering of an approximately 120-ft section will be required to remove the instream weirs and install new grade controls in the channel (Appendix B, Sheet TE2). Diversion and dewatering are necessary to prevent sedimentation impacts to downstream portions of the stream during removal of the weirs. Diversion of the stream and construction steps to remove weirs will be implemented only during low-flow conditions and will be consistent with conditions of the HPA permit for the project.

Measures to protect fish (e.g., trapping and relocating fish) in the section of the stream to be dewatered will be implemented prior to diverting flows and will be conducted by a qualified fish biologist consistent with conditions of the HPA permit. To divert the stream, the section of stream to be dewatered will be temporarily blocked with silt curtains, fish trapped and relocated, and the water diverted via a temporary dam, pumps, and pipes. The project area will then be dewatered, weirs and riprap removed and new grade controls installed, banks stabilized, and the stream diverted back into the project area. If necessary, the initial portions of the re-introduced flow would be captured downstream of the project area and pumped into upland areas for biofiltration prior to discharging back into Miller Creek. Diversion of the stream will be conducted only during the work hours when the weirs are being removed (i.e., one or two work days). At the end of each work day, work will be complete enough to allow water to be diverted back into the existing channel.

Instream Enhancement Project 3

Major factors degrading the stream along this reach are erosion and downcutting upstream of a riprapped meander located approximately 300 ft downstream of the South 160th Street culvert. The primary goals of the enhancement are to remove constrictions that channelize flow (i.e., instream tire retaining walls) and stabilize the profile of Miller Creek. Other goals at this site include adding erosion control features along the banks, replanting native riparian and wetland species, removing riprap along both banks, removing a fence along the left bank, and enhancing instream habitat (see Figure 5.2-10; Appendix B, Sheet C5).

All instream tires will be removed throughout this reach, including tires along the left bank immediately downstream of the South 160th Street culvert and those that currently provide erosion control on the right bank upstream of the meander. Erosion control measures and replanting of native vegetation will be used to stabilize the banks where they have been disturbed during construction activities. Upstream of the riprapped meander, the banks will be regraded to create a high-flow channel and two gravel bars (see Figure 5.2-10; Appendix B, Sheet C5). LWD and river boulders will be used to stabilize the channel and reduce velocities. LWD and boulders will also enhance instream habitat. The removal of riprap will allow the stream to naturally meander. The high-flow benches will be planted with native vegetation. Non-native and invasive species will be replaced at the site with native riparian species.

Instream Enhancement Project 4

Gravel bar enhancement features are included in Project 4 (see Figure 5.2-11; Appendix B, Sheet C6). The primary goal of this project is to reduce channel constrictions, which are causing bank erosion and scour, and enhance existing instream and riparian habitat. Two rock walls along the left and right streambanks, as well as an existing driveway, will be removed. Removal of the rock walls and driveway will restore natural channel geomorphology in this reach. Erosion control measures (e.g., sediment fencing and straw bales, erosion control fabric, or other appropriate BMPs) will be used along the banks if needed. LWD will be placed in the channel and on the gravel bars to maintain the existing channel grade, reduce erosion, and enhance instream habitat.

Removal of the two concrete rubble walls in the downstream reaches will enhance stream morphology and create more diverse instream habitat with pools and bars. It will also require erosion control along the banks; placement of woody debris will be used to stabilize gravel bars and promote deposition of suspended sediment.

Native riparian vegetation and wetland vegetation will be planted along the right bank within the project area and along the left bank where the site is accessible. The planted vegetation will provide shade and bank stability, as well as structural and species diversity to the riparian understory and forest. Invasive and non-native species will be removed from the site.

General Instream Habitat Enhancement

In addition to placing LWD within each of the four instream enhancement projects, LWD will be placed at various locations throughout the 6,500-ft stretch of Miller Creek. LWD placement will generally conform to existing WDFW guidelines and be consistent with conditions of the HPA permit. The species (western redcedar, Douglas fir, and western hemlock [*Tsuga heterophylla*]) and size will be determined during the final design. The number and location of woody debris at each project site are shown on the detailed plan sheets in Appendix B (Sheets C3 through C6), and LWD will be field-placed by the project engineer or habitat biologist during construction. LWD will be designed to be stable in the stream. Natural anchoring methods, such as partially burying or locating the woody debris outside the low-flow channel, will be preferred over conventional anchoring methods (Appendix B, Sheet C10). The general locations of LWD will vary from site to site, depending on the design objective. Much of the woody debris can be salvaged from existing forested areas on the Master Plan Update project sites that will be filled by embankment construction. This salvage woody debris will have root wads attached. Table 5.2-8 summarizes final performance standards, evaluation approach, and contingency measures for all the instream habitat enhancements in Miller Creek.

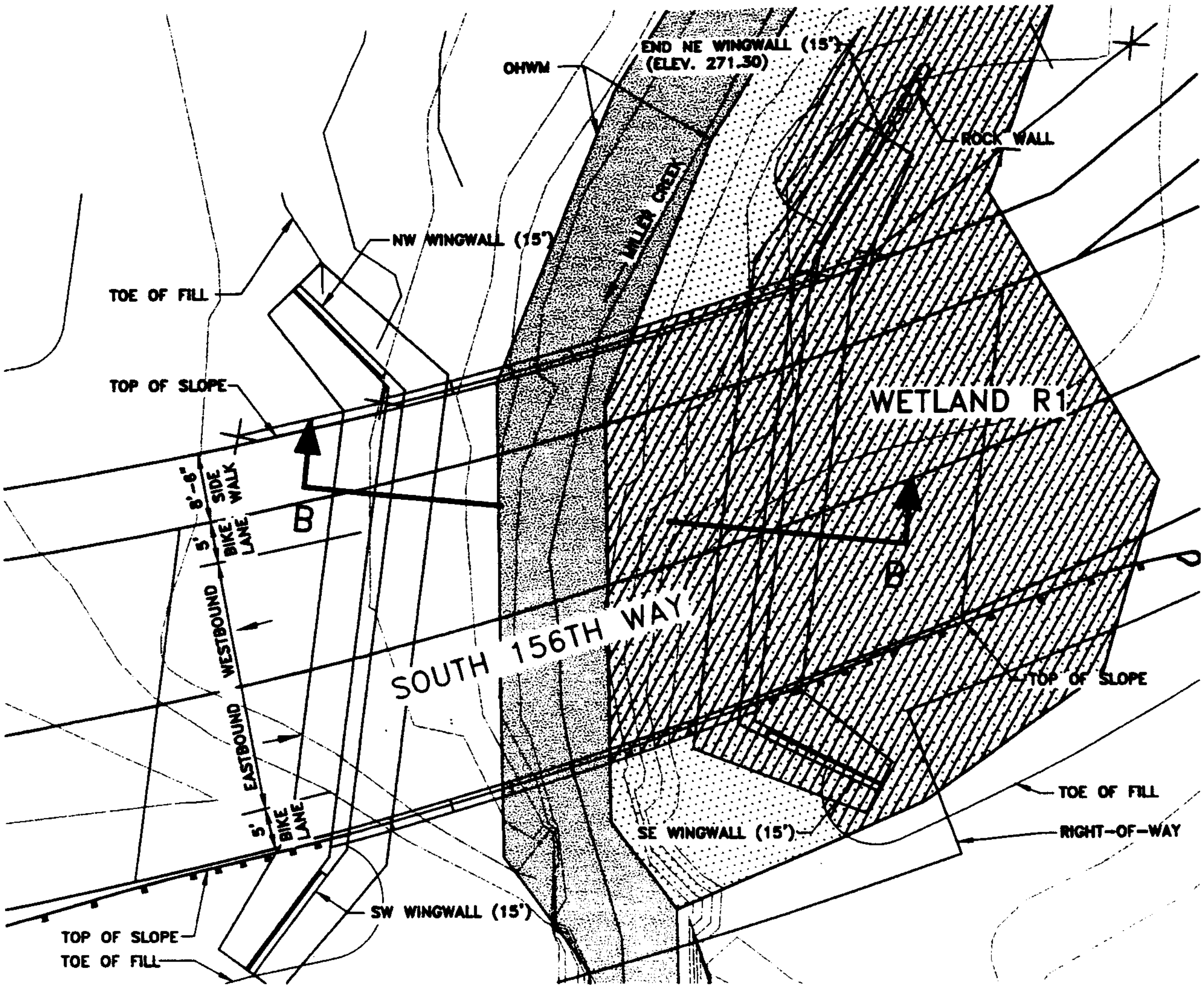
South 154th Street/South 156th Way Bridge Relocation

To accommodate the RSAs for the third runway, it will be necessary to relocate South 154th Street north and west of its current alignment. The existing and proposed alignment of South 154th Street connects with South 156th Way. As a result of relocating this roadway, it will be necessary to replace and relocate the existing bridge over Miller Creek at South 156th Way. The existing timber bridge will be removed and replaced with a new bridge that will span the 100-year floodplain of the stream (see Figure 5.2-1; Appendix B, Sheets L1, L1.1, P1, and P2).

Elements of this bridge relocation will require restoring the streambanks after the existing timber bridge is removed. The existing stream channel under the bridge is armored with riprap and confined by the timber walls of the bridge. As a result of construction for the timber bridge, this segment of the stream was widened, and the channel bed is wider than the segments to the north and south. After removing the bridge, restoration activities will focus on re-establishing the streambanks. To accomplish this, a portion of the channel will be filled to restore the natural channel width (Figure 5.2-13; Appendix B, Sheet P1). Loose riprap will remain along the edge of the stream channel under the bridge segments only to provide stabilization under the bridge (see Figure 5.2-13; Appendix B, Sheets P1 and P2). Streambanks will be planted with native riparian vegetation.

Table 5.2-8. Final performance standards, evaluation approach, and contingency measures for instream habitat enhancements in Miller Creek.

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
1. Add LWD to the creek channel.	During all monitoring years, number of LWD features in stream remains stable or increases compared to baseline (record) conditions (LWD is woody material greater than 10 cm in diameter and 2 m in length).	Record survey and visual inspection of channel	Add LWD to create additional channel complexity.
	During all monitoring years, number and density of habitat features (e.g., pools, riffles, bars, and undercut banks) remain stable or increase compared to baseline (record) conditions.	Record survey and visual inspections. Measure density and number of habitat features	Add LWD to create additional channel complexity and promote formation of pools and riffles.
2. Stabilize areas of erosion by using native vegetation and LWD.	Cover of streambank vegetation in enhancement will meet performance standards for cover provided in Table 4.2-1.	Site inspections and record drawings.	Repair damaged bank if necessary. Stabilize banks with additional LWD, live stakes, or seeding.
	Bank stabilizing LWD, as shown on record drawings, remains in place.		
3. Add gravel to degraded reaches where natural recruitment is limited.	During all monitoring years, substrate is predominantly gravel (>50 percent) on bars and benches, as defined in as-built conditions.	Assess substrate composition with pebble counts. Visual inspection	Evaluate source of sediment and remove/control. Add channel features (e.g., large wood and boulders) to reduce bedload movement.



PLAN

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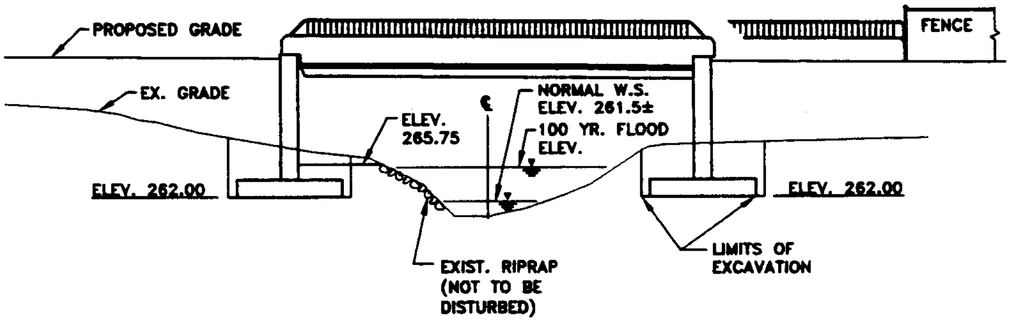

NOTE:
ALL DISTURBED AREAS WILL BE
STABILIZED USING APPROPRIATE BMPS.

SECTION – B

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0 10 20
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N

LEGEND

- ░ WETLAND R1
- ▨ WETLAND IMPACTS

Figure 5.2-13
South 156th Way
Bridge Relocation

5.2.2.8 Monitoring and Performance Standards

The monitoring approach, methods, schedules, and reporting for the instream habitat projects will be consistent with the approach outlined for all Master Plan Update mitigation projects (Section 4). Specific performance standards developed for the instream projects will be evaluated to ensure that the projects are meeting overall objectives and goals (Table 5.2-9).

Table 5.2-9. Monitoring schedule for the instream enhancement projects.

			Data Collection Year								
Feature	**Activity**	**Frequency**	**0**	**1**	**2**	**3**	**5**	**7**	**10**	**12**	**15**
Habitat Structures	Inspection, stability of habitat features	Annually (May) or after flows in excess of the 2-year peak flow during the first 3 years	X	X	X	X	X	X	X	X	X
Substrate	Pebble counts	Semiannually (February/August)	X	X	X	X	X	X	X	X	X
Erosion or Scouring	Visual evidence of erosion or scouring	Annually (May) or after flows in excess of the 2-year peak flow during the first 3 years	X	X	X	X	X	X	X	X	X
Structures	Evidence of cavitation or scouring	Annually (May) or after flows in excess of the 2-year peak flow during the first 3 years	X	X	X	X	X	X	X	X	X
Adverse Flooding	Inspect channel banks and riparian zone for ponded water	Twice yearly (February/November)	X	X	X	X	X	X	X	X	X
Reports			X	X	X	X	X	X	X	X	X

Instream Habitat Conditions

Instream habitat will be monitored and evaluated against performance standards to ensure that these features provide the desired habitat and bank stabilization functions, and that instream LWD is stable, creating pools and meanders as designed. Table 5.2-8 lists specific performance standards, methods/parameters, and contingency measures for ensuring that the instream enhancements are meeting project goals and objectives. Monitoring instream habitat enhancement projects will focus primarily on evaluating parameters related to aquatic habitat quality such as habitat complexity (e.g., pool/riffle morphology, undercut banks), habitat features (e.g., LWD, gravel bars), and overall stream condition (e.g., lack of sedimentation or erosion, lack of man-made debris).

Monitoring methods and schedule for the instream enhancement projects are listed in Table 5.2-9. The schedule includes routine inspections and emergency inspections to be conducted following major flood events.

Biological Conditions

The instream enhancement projects are designed to enhance biological as well as physical functions in Miller Creek and therefore, as part of the monitoring program for the Miller Creek instream projects, biological conditions will be evaluated and compared to existing or baseline conditions in the stream. Biological conditions will be assessed using BIBI (Kerans and Karr 1994; Fore et al. 1996; Kleindl 1995). Aquatic invertebrate populations will be sampled from representative riffles in Miller Creek, and the data will be analyzed to determine the BIBI score. The BIBI score integrates several physical and chemical conditions in the stream and watershed.[26]

Information gathered from this study will be used to evaluate changes in the invertebrate assemblages and relate them to other monitoring parameters and changes at the mitigation sites through the monitoring period. The BIBI scores obtained each year during the monitoring period will be compared to baseline values obtained from Miller Creek prior to mitigation, as well as to values obtained in other urban streams in the Puget Sound region. Since this methodology has not been widely applied to mitigation, BIBI data will be used to generally assess how the mitigation projects affect biotic integrity, but will not be linked to performance standards.

Vegetation

Riparian and channel vegetation installed as part of the instream projects will be monitored and evaluated against the performance standards for the wetland and riparian buffer plantings described in Table 5.2-3. Monitoring methods and a schedule for evaluating riparian vegetation at the instream projects are listed in Table 5.2-4.

5.2.2.9 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented consistent with the approach described in Section 4. A design goal for the instream enhancement features is that each enhanced reach function as a natural channel, requiring little or no maintenance. As indicated in Tables 5.2-8 and 5.2-9, periodic maintenance may be required to correct a variety of detrimental conditions to ensure that the projects meet performance standards.

In the event that contingency measures are necessary, the Port will use an adaptive management plan, as outlined in Section 4, to assess factors contributing to poor performance and design appropriate measures to change the contributing factors. Specific contingency measures for each of the performance standards for the instream projects are listed in Table 5.2-8.

All of the proposed enhancement projects have similar basic criteria for performance standards: (1) maintain minimum flow depths and velocities for fish passage, water quality, and sedimentation; (2) provide capacity for peak flows; and (3) reduce erosion of the bed and banks. The enhancement

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[26] The BIBI is a numerical analysis of stream invertebrate data that assesses the degree to which macroinvertebrate populations have been altered by human disturbance. A strong correlation between levels of urbanization and BIBI scores exists (Fore et al. 1996; Horner et al. 1996). While BIBI measurements will monitor changes in the invertebrate assemblages in the stream, the values will also reflect activities in the watershed upstream of the mitigation, and thus cannot be used to unequivocally determine the effect of mitigation actions.

features were designed to meet these criteria; however, if flow rates and stream hydraulics differ substantially from the design flows used to develop the enhancement features, these features may not function as designed. If this occurs, reaches with enhancement features can be modified by:

- Modifying channel widths to reduce velocities and improve capacity
- Adding additional bank stabilization and erosion control methods
- Adding or modifying channel profile structures (e.g., log weirs) to reduce velocities

5.2.2.10 Implementation of Buffer and Instream Enhancement Projects

Implementation of the buffer and instream projects along Miller Creek will be coordinated with each other, and will be constructed in a manner consistent with federal, state, and local permits (e.g., CWA 404, HPA). In addition, construction of the mitigation projects will be coordinated with construction of the third runway embankment, security roads, utility relocations, South 156th Way bridge relocation, and stormwater management facilities to ensure that implementation of the mitigation projects is not impacted by other construction activities. A proposed implementation time line is presented in Table 5.2-10. Details regarding implementation steps, construction methods, and sequencing are included in this section.

General Construction Sequencing

Landscaping for the buffer enhancement will be coordinated with the instream enhancement projects. Wetland and riparian enhancements will start with installing TESC measures, demolishing of existing structures (e.g., buildings, driveways, fences), clearing and grubbing the site to remove non-native vegetation, and preparing the site for planting.

Temporary irrigation may be installed for some enhancement areas if necessary. Wetland and riparian vegetation will be planted in the fall immediately following site preparation (see Irrigation Plan sheets in Appendix B). BMPs for sediment and erosion control during these activities will minimize impacts to the stream and adjacent wetlands (Appendix B, Sheets TE1 through TE6). Measures include placing silt fence around work areas and staging areas, and placing straw bales or other BMPs at key locations within the project limits. Clearing and brush removal will be limited to only those work areas that the contractor is scheduled to begin within the following 2 weeks. The disturbed areas will be stabilized immediately after work in that area is completed. TESC measures will remain in place and be maintained until the entire site has stabilized.

Instream work will be scheduled during dry weather, when base flows are at a minimum, and will be restricted to allowable work times consistent with the HPA (i.e., July 15 to September 15). Prior to the start of any other construction activities, the TESC plan for the instream projects will be implemented and the TESC elements will be in place (Appendix B, Sheets TE1 through TE6). Once the temporary facilities are in place, the contractor will implement a plan for controlling water in areas requiring instream work. This may include excavating dewatering trenches, French drains, and sumps.

Table 5.2-10. Proposed Implementation Timeline for Miller Creek In-Stream, Wetland, and Riparian Buffer Enhancements Projects

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Miller Creek In-Stream Enhancements																																				
Preconstruction meeting			■																																	
TESC, site preparation					■	■																														
Install silt curtains and silt fencing							■																													
Clear site and grade per plan							■	■																												
Remove bridges, channel riprap, or other structures per plan							■	■																												
Install LWD, stream gravel, bioengineering									■																											
Hydroseed/implement planting plan										■	■	■	■																							
Remove silt curtain and TESC measures																		■	■	■																
Produce record drawings, conduct baseline monitoring										■	■	■	■	■	■	■	■	■	■	■																
Begin compliance monitoring																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Wetland and Riparian Buffer Enhancements																																				
Preconstruction meeting				■												■																				
TESC, site preparation					■	■	■										■	■	■																	
Remove debris and structures per plan						■	■	■										■	■	■																
Remove non-native plants per plan								■	■											■	■															
Install plants per planting plan[b]										■	■	■	■									■	■	■	■											
Produce record drawings													■	■											■	■										
Conduct baseline monitoring															■	■	■	■	■	■							■	■	■	■	■	■				
Begin maintenance and compliance monitoring																																	■	■	■	■

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[a] Year one starts with the first construction season following issuance of permits. Implementation of mitigation projects may vary from this proposed schedule depending upon coordination with other Master Plan Update projects, contract obligations, or final approval.

[b] Plant procurement will begin 6 to 12 months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Planting will be phased such that coniferous species will be planted following the third year of monitoring.

Temporary berms (using sandbags or other structures that would not be driven into the channel) may be used to divert flows around bank work. Silt curtains will be installed prior to any LWD placement except for channel spanning LWD (Appendix B, Sheet TE5). Silt curtains will extend completely around the project site. Any turbid water inside the silt curtain will be pumped out and directed through settling ponds and straw bale filters prior to being discharged back into the stream. All instream work will be performed in a manner to protect fish and other aquatic organisms, consistent with the HPA permit conditions.

Excavation and partial burial (Appendix B, Sheet C10) will anchor LWD. LWD will be excavated and placed by hand tools or from the streambanks using equipment with extendable arms (e.g., backhoe). No equipment will be allowed to drive into or cross the stream channel. Access to project sites will avoid wetlands where possible. If access through non-wetland areas is not feasible, protective plywood mats will be placed over access paths and work areas to protect wetlands and the stream. Silt fences will be installed along all access routes. Vegetation clearing will be limited, and vegetation will be mowed rather than removed wherever possible to gain access to project sites. Access routes will be stabilized and revegetated immediately following construction.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic source. Plant material used in the mitigation will be grown in the area bounded on the north by the Fraser River Valley, British Columbia; on the east by the 1,000-ft elevation of the Cascades; on the west by the 1,000-ft elevation in the Olympic or Coast ranges; and on the south by the Willamette Valley.

Construction Steps

Construction steps required to implement the instream and buffer enhancement projects are described below. General construction steps, as well as construction steps for each of the four instream projects and placement of LWD in the stream within the project area, are included.

General Conditions

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscaping.
- Areas where landscaping has been completed will be off-limits to all vehicular traffic, and pedestrian traffic will be strictly limited.

- Construction will take place during the dry season; any instream work or work below the OHWM will take place only during the allowable work times, consistent with HPA permit conditions (i.e., July 15 to September 15).
- Plant procurement shall be coordinated with the grading and irrigation installation schedules. Plants will be secured 6 to 12 months prior to the scheduled planting season to ensure that plants are available in the quantities and species required by the planting plan.

Site Preparation

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas and temporary access/haul roads.
- Implement TESC plan and install TESC measures.
- Install fencing (orange barrier) around areas to be protected (e.g., stream channel, existing wetlands, vegetation/trees to be retained).
- Maintain security of the site through construction.
- Establish temporary access/haul roads.
- Establish staging and stockpile areas.
- Implement a spill control plan and identify fueling areas.

Clearing, Excavation, and Grading

- Clear and grub portions of the site as specified; clear structures and impervious surfaces and existing non-native vegetation in selected areas.
- In selected areas, grade per specifications.
- Install irrigation as specified in selected areas.

Instream Project 1 (Appendix B, Sheets C3, C9, C10, and TE1)

- Install silt curtains and silt fencing per specifications. This can be done in phases as approved by the engineer.
- Remove riprap, footbridges, railroad ties, and fences identified on plan sheet.
- Regrade portions of the area as needed to meet grading from Vacca Farm projects.
- Install LWD in the main channel and side channel.
- Implement planting plan for the main channel and side channel.
- Seed disturbed areas (including any access roads and staging areas).
- Maintain TESC measures adjacent to restored stream bank until adjacent riparian buffer has been planted and stabilized.

- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

Instream Project 2 (Appendix B, Sheets C4, C8 through C10, TE2)

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove two footbridges identified on plan sheet.
- Remove riprap associated with two weirs; remove the two weirs.
- Install coir logs and coir lifts to stabilize areas where riprap is removed.
- Install LWD, boulders, and stream gravel.
- Seed disturbed areas.
- Implement planting plan for stream banks, wetland, and riparian areas adjacent to project site.
- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

Instream Project 3 (Appendix B, Sheets C5, C8 through C10, TE3)

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove instream tires lining left and right banks; remove riprap.
- Construct high-flow benches and gravel bars.
- Install LWD, boulders, and stream gravel.
- Install coir lifts, coir logs, and plant banks with live stakes to stabilize new banks.
- Seed disturbed areas.
- Implement planting plan for channel banks, wetland, and riparian areas adjacent to the project site.
- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

Instream Project 4 (Appendix B, Sheets C6, C8 through C10, TE4)

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove riprap rock walls and existing driveway.
- Construct three high-flow benches and gravel bars; construct new channel banks.
- Install LWD, river boulders, and stream gravel.
- Place geotextile over new banks.

- Seed disturbed areas.
- Implement planting plan for new channel banks, wetland, and riparian areas adjacent to the project site.
- Remove silt curtain and TESC measures on the east bank once the site is stabilized and approved by the engineer and wetland scientist.

Closeout

- Complete site cleanup by removing temporary haul/access roads and staging areas.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in any temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.
- Install permanent fence and/or signs along buffer boundary.

Record Drawings, Monitoring, and Maintenance

- Produce grading record drawings for instream enhancement projects and planting plan record drawings for wetland and buffer enhancement areas.
- Complete a baseline report, including record drawings, buffer boundaries along Miller Creek, and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring during the first growing season after planting is complete. Submit annual monitoring reports for the 15-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

5.2.3 Drainage Channel Replacement Plan

Three small intermittent drainage channels (Drainage Channels A, B, and W) are located in the acquisition area on the west side of the existing runway (see Section 2, Figure 2.1-2).[27] These drainage channels currently convey water (groundwater and surface water) from the hillside on the western edge of the airport to Miller Creek and the wetlands adjacent to Miller Creek. Channel A is located immediately east of 12th Avenue South in a roadside drainage ditch. Channel B originates in Wetland 37f and is located west of 12th Avenue South. Channel B provides a surface water connection between Wetland 37f and Wetland R9. Channel W is located east of the existing perimeter road within the current Airport Operation Area (AOA). This channel originates in Wetland 20b and flows northwest through a culvert and under the perimeter road; it ultimately empties into Channel A.

Approximately 1,290 linear ft of the existing drainage channels will be filled as a result of third runway construction (Section 3). The Port proposes to mitigate for filling these channels by

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[27] Ditches on the Vacca Farm (see Section 3.4) are not included in this mitigation because their functions are enhanced as part of the Vacca Farm restoration projects (see Section 5.1).

replacing and restoring their functions on-site. A subsurface drainage system in the fill embankment will collect water infiltrating the embankment and direct this water to surface water channels at the base of the embankment. Water from the replacement drainage channels will be directed to riparian wetlands along Miller Creek (Figure 5.2-14). The surface water channels will be designed to replace the 100-year flow conveyance capacity of the channel lengths being filled. Replacement drainage channels will be permanent features and their construction will be coordinated with the Miller Creek buffer enhancement projects, embankment construction activities, and stormwater facility construction.

5.2.3.1 Goals, Objectives, and Design Criteria

To replace the functions of existing channels, four replacement drainage channel areas will be designed along the west side of the perimeter roadway at the base of the fill embankment. The goals of this mitigation action are listed below and described in Table 5.2-11.

- The replacement drainage channels will provide adequate (100-year) flow conveyance functions.
- The replacement drainage channels will collect seepage from the embankment to maintain base flows in Miller Creek and hydrology of downslope wetlands.
- The replacement drainage channels will provide open channel lengths equivalent to the existing drainage channel lengths.
- The replacement drainage channels will be planted with a vegetated buffer to provide shade to enhance water quality in Miller Creek and other wetlands.

Table 5.2-11. Mitigation goals, design objectives, and design criteria for replacement drainage channels.

Design Objectives	Design Criteria
Goal 1: The replacement drainage channels will provide adequate (100-year) flow conveyance functions	
Provide channel flow capacity for expected runoff.	Construct the replacement channel to convey the 100-year, 24-hour design storm and seepage flows emanating from the embankment.
	Channel depths will be a minimum of 2 ft deep with side slopes of 3:1 or flatter; or if slopes are steeper, log and rock weirs will protect channel banks.
Goal 2: The replacement channels will collect seepage to maintain base flows and wetland hydrology	
Integrate channel into embankment drainage layer so groundwater can be collected.	Construct channels down gradient and hydrologically connected to the drainage layer of the embankment.
Convey water to riparian wetlands downslope from the embankment.	Direct water in drainage channels to discharge points in or adjacent to riparian wetlands along Miller Creek (Wetlands A13, 18, 37, 39, 44a, and A9).
Goal 3: The replacement channels will provide an open channel of equivalent length as the existing channel	
Construct new channels with equivalent length, substrate, and streamside vegetation.	Construct new channels with a minimum length of 1,290 ft.
	Channel substrate will be stable and have slopes of less than 3:1. Where steeper channel slopes are required, protect from down cutting with log weirs.
Goal 4: Plant a vegetated buffer along the length of channel to provide shade, which will enhance water quality	
Provide a vegetated buffer along the length of the mitigation channel.	Plant native shrubs at greater than 2,100 individuals per acre along channel banks.
	Plant native trees greater than 280 trees per acre along channel banks.

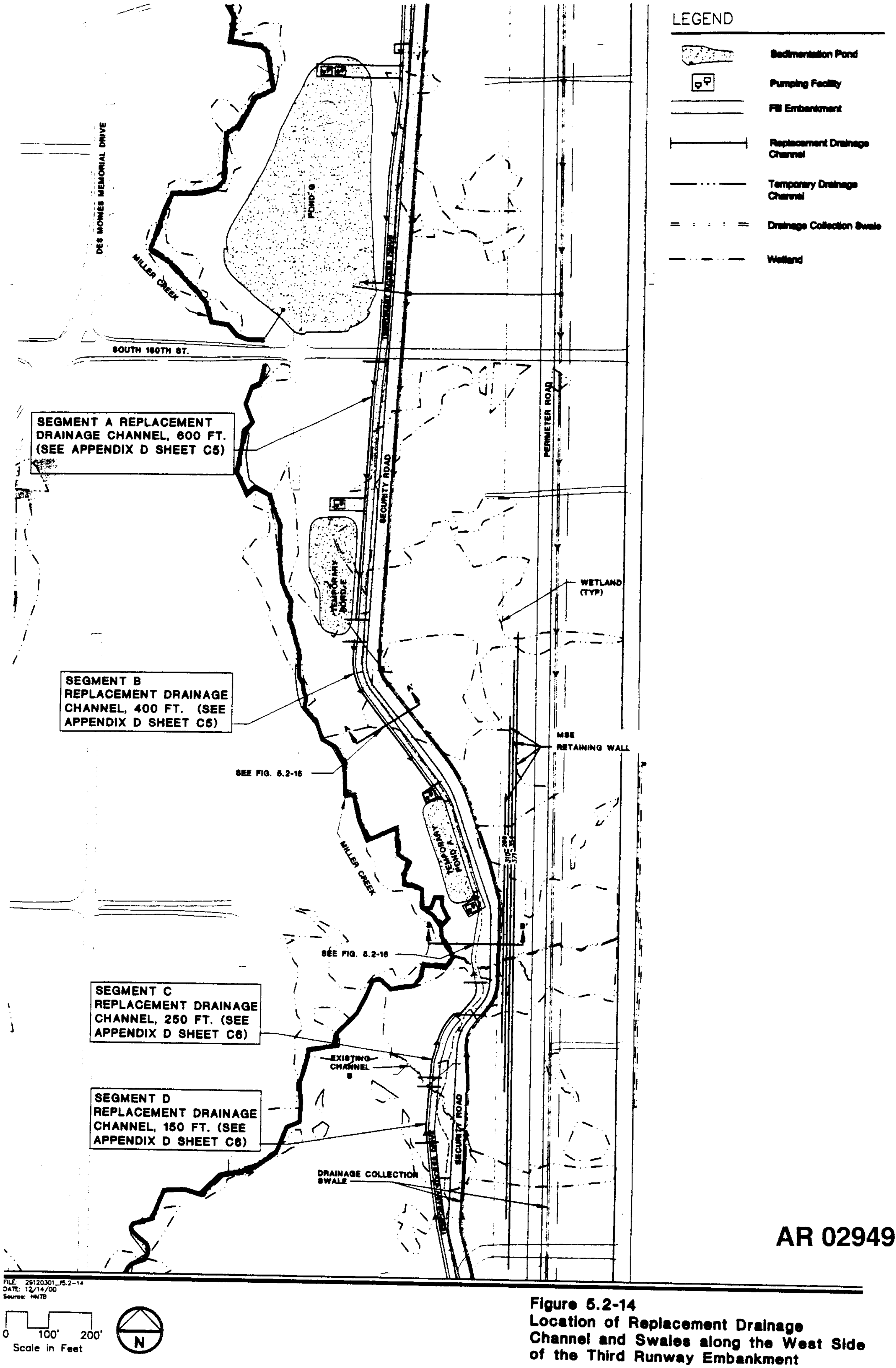


Figure 5.2-14
Location of Replacement Drainage Channel and Swales along the West Side of the Third Runway Embankment

5.2.3.2 Mitigation Site Description

The replacement channels will be located in areas that are currently predominantly residential lawns, upland forest, or emergent wetlands. The replacement drainage channels will be constructed on the west side of the perimeter road that will run immediately west of the new embankment for the third runway (see Figure 5.2-14).

5.2.3.3 Ownership

The Port owns the property where the replacement drainage channels will be relocated.

5.2.3.4 Rationale For Selection

The drainage channel mitigation replaces the water conveyance functions of the channels that will be impacted by the project. Replacement drainage channels will be constructed as close to the original channel location as possible. The existing channels currently convey water from the hillslope to the west of STIA to downgradient wetlands and Miller Creek. The channels are designed to ensure that the discharge of water to wetlands adjacent to Miller Creek continues.

5.2.3.5 Constraints

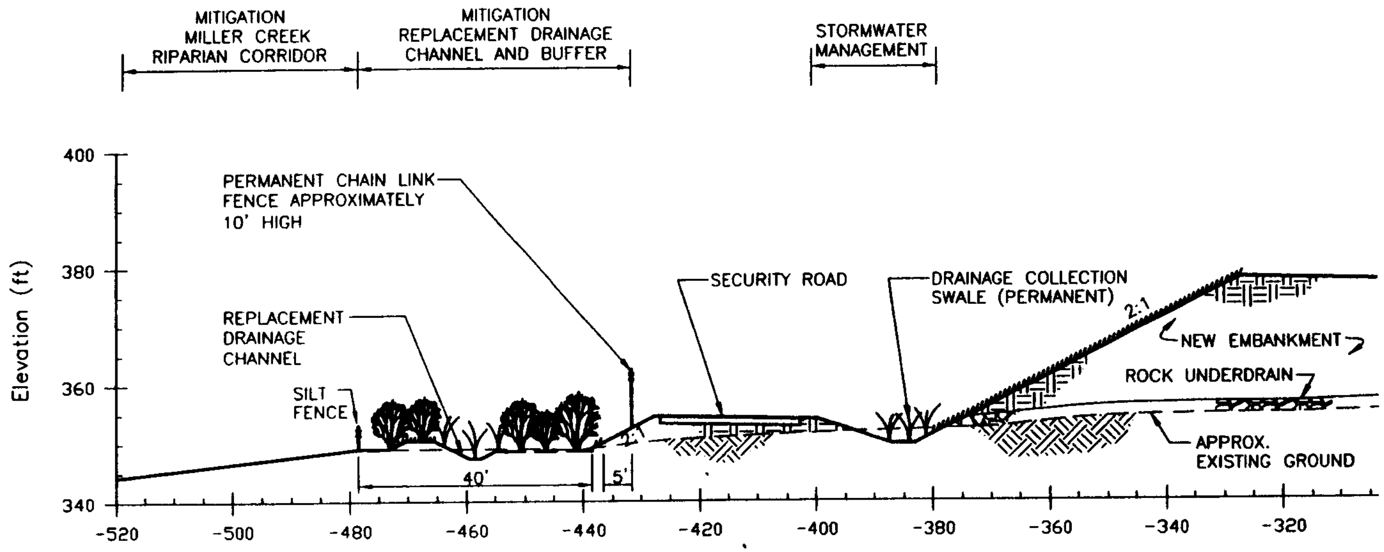
There are no constraints that affect implementation of the planned mitigation action.

5.2.3.6 Ecological Assessment of the Mitigation Site

The replacement channels will be located in areas that are currently residential, upland forest, or emergent wetlands. A detailed description of ecological conditions at these sites is given in the *Wetland Delineation Report* (Parametrix 2000b).

5.2.3.7 Replacement Drainage Channel Mitigation Design

A permanent drainage collection swale will be constructed at the toe of the embankment to intercept surface water runoff from the embankment and security road. The replacement drainage channels located on the west side of the new security road will receive water from the underdrain system the embankment slope, and the non-pollution generating surfaces of the security road. The underdrain system collects water infiltrating into the embankment (see Figure 5.2-14 through 5.2-16; Appendix D, Sheets C5, C6, and C7). The replacement channels will then direct this water to downslope wetlands.



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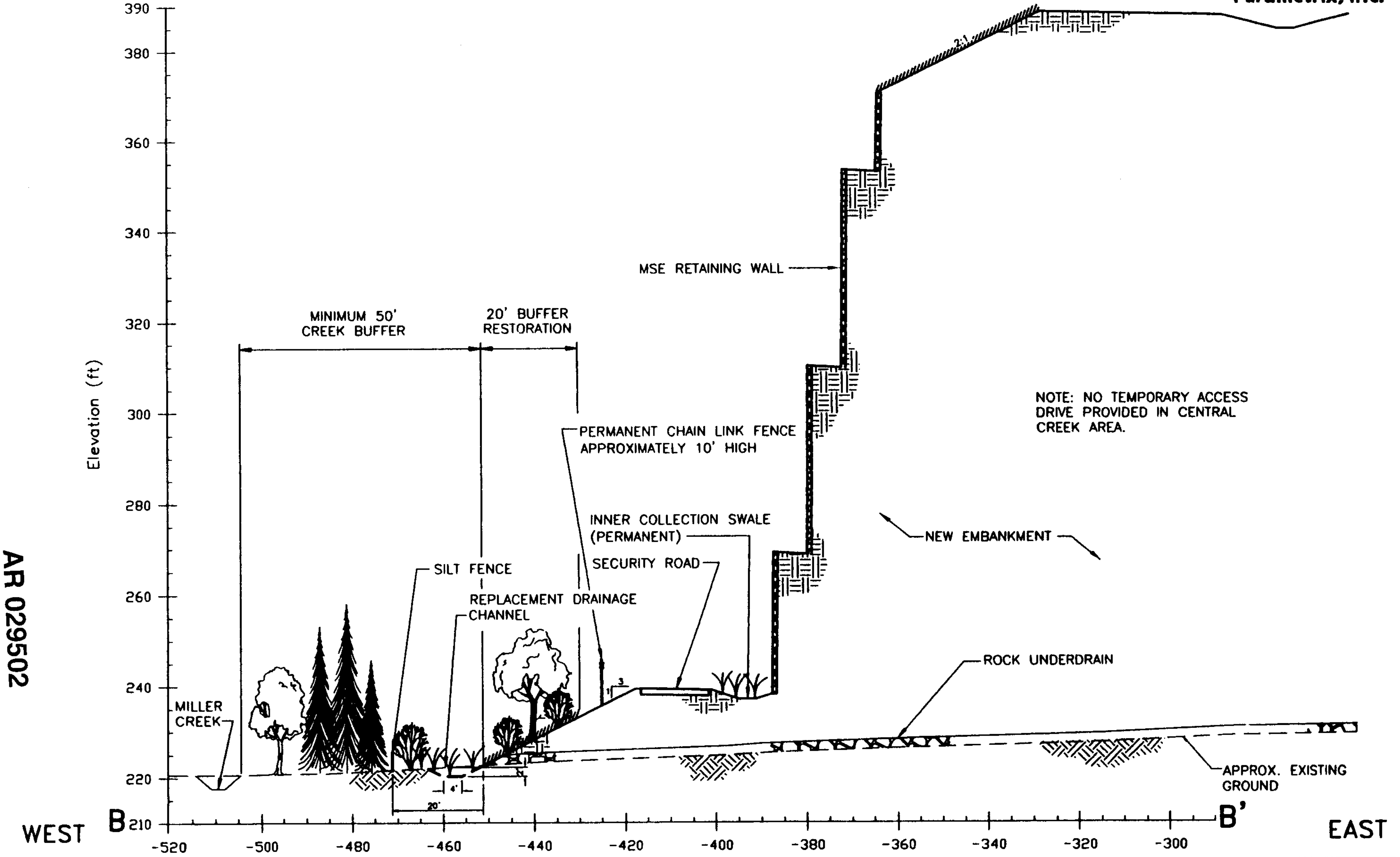
SCALE: HORIZONTAL 1"=30'
VERTICAL 1"=30'

Figure 5.2-15
Typical Cross Section of the Replacement Drainage Channel, Drainage Collection Swale and Third Runway Embankment

Parametrix, Inc.



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SCALE: HORIZONTAL 1"=30'
VERTICAL 1"=30'

REFERENCE: NRMP 2000

Figure 5.2-16
Cross Section B-B' of the Replacement Drainage Channel, Drainage Collection Swale, and Third Runway Retaining Wall

During construction of the embankment and retaining wall, west of the third runway, the collection swale will collect construction runoff from the outermost portion of the embankment and route the water to a sedimentation and water treatment facility. After construction of the embankment and retaining walls is complete, the collection swale will be retained to intercept surface water runoff from the embankment and direct it to the replacement drainage channels via culverts under the perimeter road. The replacement drainage channels (a minimum of 1,290 linear ft of the collection swale) will convey groundwater and seepage from the embankment and runoff water to adjacent wetlands (see Figure 5.2-14; Appendix D, Sheet C3, and Sheets C4 through C8).

Channel Size and Slope

The drainage channels will be designed to convey the 100-year peak flow rate for runoff and groundwater collected by the swale. The maximum flow depth in the channel will be determined by anticipated flow conditions; the channel depth will range from 2 to 4 ft with up to 3:1 side slopes. The bottom width will be controlled by the flow minimum design depth (0.5 ft) and channel slope, but will be a minimum of 3 ft wide. Flow contraol weirs, used to prevent erosion, sedimentation, scouring, and downstream deposition impacts.

Discharge Points

The drainage channels will discharge into downslope wetlands to maintain wetland hydrology, disperse runoff, and to provide base flows to Miller Creek (i.e., Wetlands A13, 18, 37, 39, 44a, and R9; Appendix D, Sheets C4 through C7). At the discharge points, the channels will be designed to prevent erosion or scouring impacts by utilizing the design standards for flow spreaders identified in the *Stormwater Management Manual for Western Washington* (Ecology 2001b) in the receiving channel or wetlands through the use of dispersal trenches or similar construction. The dispersal trenches will include installing weirs and/or soil stabilization (i.e. live stakes, branch packs) at discharge points to prevent erosion. Flow rates at each dispersal trench will generally range between 0.1cfs for two-year storms and less than 0.5 cfs for 100-year storms. Dispersal trenches and weirs are designed to spread and discharge these flows over a 50 – 100 foot zone.

Groundwater Seepage and Hydrology

Existing channels convey seepage and stormwater to downstream wetlands and Miller Creek. The replacement drainage channels will collect seepage water that discharges from the embankment and distribute it to downslope wetlands using rock berms or infiltration swales. The hydrology of wetlands downslope of the new embankment will be monitored following construction to ensure that wetland hydrology is maintained.

5.2.3.8 Implementation

The replacement drainage channel will be constructed as part of the stormwater facilities for the third runway embankment. Channel construction and planting of the vegetated buffers will be coordinated with construction of the embankment and stormwater facilities, the Miller Creek riparian wetland and buffer enhancements, and temporary restoration of wetland impacts. Implementation of the replacement drainage channel is described in Section 5.2.4.12

Landscape Plan

The landscape plan for the replacement channels has been designed to be consistent with the Port's WHMP. The side slopes and buffers along the channels will be planted with native vegetation to provide shade. The vegetation will also contribute organic matter to the drainage channels and ultimately to Miller Creek. The vegetated buffer will extend from the edge of the channel to approximately 10 ft west of the security road (see Figures 5.2-15 and 5.2-16; Appendix B, Sheets L2 through L5; Appendix D, Sheets C5 and C8). This distance is designed to provide a minimum of 5 ft of unvegetated area on either side of the perimeter fence as required for airport security. Native plant species that will not attract hazard wildlife (see Table 5.1-12) will be planted adjacent to the channel.

Monitoring and Performance Standards

The drainage channels will be monitored consistent with the monitoring approach, methods, schedules, and reporting outlined in Section 4. Hazard wildlife will be monitored consistent with the Port's WHMP (USDA 2000). Monitoring and performance standards for the replacement drainage channels will evaluate not only the functioning of the drainage channels (flow conveyance, stability of substrate, evidence of erosion) and the vegetated buffers, but the hydrology of downslope wetlands as well. Specific performance standards, types of parameters to evaluate, and contingency measures for the replacement drainage channels are provided in Table 5.2-12. Replacement drainage channels will be monitored following the schedule and methods provided in Table 5.2-13.

Hydrology

The replacement drainage channel design provides surface water to support the hydrology of downslope wetlands to ensure that existing wetland functions are maintained. The depth and duration of soil saturation will be monitored periodically during the 15-year monitoring period in wetlands between the embankment and Miller Creek (i.e., Wetlands 18 and 37). Groundwater monitoring will use standard groundwater monitoring wells installed in the wetlands between the embankment and Miller Creek. Groundwater levels will be monitored monthly for the first 5 years of the monitoring period, and then every other month for the remainder of the monitoring period. Specific performance standards and contingency measures for maintaining hydrology in downslope wetlands are included in Table 5.2-12.

Vegetation

Vegetation in the drainage channel buffers will be monitored to evaluate plant survival, native plant cover, invasive species cover, plant density, and overall health and vigor consistent with the approach outlined in Section 4.

5.2.3.9 Site Protection

The channels will be protected from adjacent airport development by fencing and signs that designate the area as permanently protected mitigation sites. The area will be covered by the restrictive covenants drafted to permanently protect the mitigation sites (Appendix G).

Table 5.2-12. Final performance standards, evaluation approach, and contingency measures for replacement drainage channels.

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
1[a]. Construct the replacement channel to convey the 100-year, 24-hour design storm, and seepage water collected by the embankment drain layer and adjacent areas.	Channel depths will be a minimum of 2 ft deep with side slopes of 3:1 or gentler with log and rock weirs to protect channel banks.	Monitor stability by examining for scour, bank erosion, etc. once per year and following storm events greater the and the ten year storm.	Enlarge channel if conveyance is inadequate.
2. Direct water in drainage channels to discharge points in or adjacent to riparian wetlands along Miller Creek (Wetlands A13, 18, 37a, 39, 44a, R9).	Flowing water will be present in Segment B and Segment C from December to June in years of normal[b] rainfall. Groundwater in wetlands with predominantly organic soils (Portions of Wetland 18, 37a, R14a, A14b, and 44a) will be within 10 inches of the soil surface at least between March and mid-June in years of normal[b] rainfall. Other wetlands with predominantly mineral soils will have soils saturated in the upper part to mid-April in years of normal[b] rainfall. Wetland indicator status (WIS) of the dominant non-invasive plant species will not differ from pre-project conditions during or at the end of the monitoring period. Each vegetation strata (trees, shrubs, and emergents) shall be assessed separately, and have separarte conclusions. Statistically valid sampling procedures will be employed to monitor these potential changes, in all areas where there is a potential to change the post construction hydrology (downslope of the embankment and the borrow sites). WIS status of the vegetation will be calculated as in the 1987 USACE wetland delineation manual.	Measurements of channel baseflow by installing weirs that allow quantity of water flowing through channels to be determined. Map organic and inorganic soils; characterize wetland vegetation. Monitor duration and depth to water table in wetlands to determine if wetland hydrology persists. The data will be related to the wetland indicator status of dominant wetland plants, the information on vegetation tolerance of various hydrologic regimes, and the intensity of reducing soil conditions (i.e., iron reduction creating mottled and gleyed soil colors, or organic matter accumulation). This	Modify discharge points from channel to wetlands to meet performance standards. Divert treated stormwater from upslope stormwater ponds to drainage channels. Improve drainage paths to convey water to wetlands. Remove obstructions and/or enlarge channels as needed. Reconfigure drainage channels to maintain flows (i.e., longer drainage channels to collect more water for distribution to wetlands). If wetlands are found to be drier than under pre-project conditions: Divert treated stormwater from upslope stormwater ponds to drainage channels (the source of this stormwater could be from biofiltration swales, filter strips, etc. treating runoff from the perimeter road). Reconfigure discharge (i.e., location, size, and number of discharge points that distribute water to wetlands from drainage channels). If these wetlands are wetter than under pre-project conditions: A portion of the water in the drainage

Table 5.2-12. **Final performance standards, evaluation approach, and contingency measures for replacement drainage channels (continued).**

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
		analysis will be used to determine whether the post-construction hydrology observed through monitoring can reasonably be expected to maintain the wetland soils and vegetation currently present in the wetlands.	channels will be directed to Water W rather than into the wetlands.
3. Plant native shrubs at greater than 2,100 individuals per acre and native trees at greater than 280 trees per acre along channel banks.	Shrub density will be at least 2,100 individuals per acre. Tree density will be at least 280 stems per acre. At Year 1, survival of planted stock will be 100%. Average tree and shrub survival will be at least 80% during the first 3 monitoring years. Average canopy cover of native species will be at least 80% by monitoring year 15.[d] By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. Cover of non-native invasive[e] species will be no more than 10% by monitoring year 15.	Vegetation sampling (plots, transects, or plotless techniques) to estimate cover, density, mortality, and invasive species.	If standards are not met: Select species that are better adapted to existing hydrologic conditions. Install additional plant material. Install protective collars to reduce herbivore damage. Control/reduce non-native invasive species.

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[a] Indicates a key design standard to be determined from the as-built condition. These standards typically do not require ongoing monitoring.

[b] Normal rainfall will be based on the definition for 'most years' given in the ACOE Manual (Environmental Laboratory 1987) (i.e. annual precipitation in a normal year must be the same as or greater than precipitation in 5 years out of 10) or the average precipitation for a time period plus or minus 1 standard deviation of the mean.

[c] Pre-project vegetation and soil conditions are documented in the *Wetland Delineation Report* (Parametrix 2000b).

[d] See Table 4.3-1 for interim cover targets (i.e., from year 3 to year 15).

[e] See Table 4.3-2 for a list of invasive, non-native species to be monitored and controlled on the mitigation site.

Table 5.2-13. Monitoring schedule for the replacement drainage channels.

			Data Collection Year (calculated as years following completion of mitigation)											
Feature	**Method**	**Frequency of Inspection**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**12**	**15**
Substrate	Inspect for evidence of erosion or scouring	Annually (May) or after 2-year storm during the first 3 years	X	X	X	X	X	X		X		X	X	X
Hydrology	Inspect following flood events; measure base flow	Twice yearly (February/November)	X	X	X	X	X	X		X		X	X	X
Downslope Wetlands	Groundwater monitoring	Monthly	X	X	X	X	X	X		X		X	X	X
Buffer Vegetation	Vegetation sampling	Annually (late spring or early summer)		X	X	X	X	X		X		X	X	X

5.2.3.10 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented for the replacement drainage channels consistent with the overall approach outlined in Section 4.

Specific contingency measures for the drainage channels are provided in Table 5.2-12. If flow rates and hydrology are substantially different from the design flows used to develop this plan, the channels may not function as designed and the channel section can be modified by:

- Widening the base flow channel to reduce velocities and improve capacity.
- Narrowing the base flow channel with logs or boulders to increase base flow depth and velocity.
- Widening the flood flow portion of the channel (above 0.5 ft) to improve capacity and reduce velocity.
- Adding log weir steps to flatten stream slope, reducing velocity and increasing base flow depth.
- Adjusting discharge points to Wetlands A13, 18, 37a, 39, 44a, and R9 or other wetlands as necessary.

5.2.4 Wetland Restoration Plan for Temporary Construction Impacts

Construction of the third runway embankment will result in some temporary wetland impacts (described in Section 5.2.4.2). Temporary impacts to wetlands are those that do not involve permanent filling or excavation, and include clearing of wetland vegetation; use of a wetland for temporary construction of access roads, staging areas, or temporary stormwater management ponds; or minor disturbances associated with placement of barrier and sediment fencing. Temporary impacts will last 1 to 5 years[28]. A maximum of 2.05 acres of wetlands (including 1.15 acres of forest, 0.46 acre of shrub, and 0.44 acre of emergent wetland) may be impacted temporarily by construction activities (Table 5.2-14). However, not all of these wetlands will necessarily be impacted by construction activities. During construction, all practicable means will be used to minimize and avoid temporary impacts (for example, reducing staging area or access road footprints, minimizing pond sizes, or re-routing access roads). Therefore, actual temporary construction impacts may be less than 2.05 acres. All wetlands temporarily impacted by construction activities will be restored and monitored to ensure performance standards are met (Table 5.2-15).

Following construction, wetlands temporarily impacted by clearing or filling will be restored by removing all temporary fill material, re-establishing pre-disturbance conditions, and planting with native forested and shrub vegetation. Wetlands with only minor disturbances that do not involve clearing of vegetation or filling (e.g., sediment fencing placed along the edge of a wetland) will be restored by removing sediment fencing, removing any other construction debris, and replacing any wetland vegetation disturbed by these activities.

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[28] The temporal loss of wetland functions that can result from temporary impacts that exceed 1 year is mitigated by provided additional mitigation (at Wetland A17 and other locations).

Additionally, other temporary impacts to wetlands will occur during mitigation activities (see Section 5.2.4.2).

Table 5.2-14. Summary of wetlands subject to temporary construction-related impacts.

Wetland	Classification [a]	Total Temporary Impact Area (acres)	Vegetation Type Impacted (acres)		
			Forest	Shrub	Emergent
Runway Safety Area Extension					
4	Forest [b]	0.20	0.20	0.00	0.00
5	Forest /Shrub [b]	0.20	0.10	0.10	0.00
9	Forest/Emergent	0.16	0.11	0.00	0.05
Third Runway					
18	Forest/Shrub/Emergent	0.22	0.04	0.07	0.11
37	Forest/Shrub/Emergent	0.71	0.50	0.10	0.11
44a	Forest/Shrub	0.28	0.18	0.10	0.00
A1	Forest/Shrub/Emergent [b]	0.05	0.01	0.01	0.03
A12	Shrub	0.03	0.00	0.03	0.00
A13	Forest	0.01	0.01	0.00	0.00
R2	Emergent	0.02	0.00	0.00	0.02
South Aviation Support Area					
52	Forest/Shrub/Emergent [b]	0.17	0.00	0.05	0.12
TOTAL		**2.05**	**1.15**	**0.46**	**0.44**

[a] All wetlands are palustrine, based on USFWS wetland classification system (Cowardin et al. 1979).

[b] Temporary impacts will be limited to installation of sediment fencing and other standard BMPs such as temporary seeding, straw mulch, interception swales, etc.

Table 5.2-15. Mitigation design objectives and criteria for restoration of temporary wetland impacts.

Goal and Design Objectives	Design Criteria
Restore wetlands to pre-construction conditions.	Grade areas to pre-construction elevations if pre-construction grades have been modified, amend soils with topsoil.
Provide wetland hydrology appropriate for each wetland vegetation cover type.	Grade to re-establish pre-construction hydrology.
Re-vegetate impacted wetland areas.	Restore impacted areas with native forest vegetation. Emergent wetland communities will be replanted with forest vegetation to increase wetland functions and reduce potential use by waterfowl.
Stabilize soils in upland areas adjacent to restoration areas.	Disturbed ground within 50 ft of the wetlands will be hydroseeded or otherwise stabilized to prevent erosion impacts to the wetland.

5.2.4.1 Goal, Objectives, and Design Criteria

The primary goal of this plan is to ensure no net loss of wetland functions by restoring wetlands temporarily impacted by construction activities to their pre-construction size with an overall increase in function (e.g., replace non-native emergent vegetation with native forest vegetation).

Design objectives and design criteria were developed (see Table 5.2-15) to ensure that restoration goals have been met at the end of the 15-year monitoring program.

5.2.4.2 Wetlands Site Description

A total of 11 wetlands (see Table 5.2-14) may be temporarily disturbed by Master Plan Update project construction activities (see Figure 3.1-3; Appendix D, Sheets C2 and C3 through C7). These wetlands lie within three general project areas: the RSA and South 154th Street relocation, the third runway embankment, and the SASA. Wetlands subject to temporary construction-related impacts are listed in Table 5.2-14. A complete description of these wetlands is included in the *Wetland Delineation Report* (Parametrix 2000b).

Runway Safety Areas and South 154th Street Relocation

Wetlands 4 and 5 are located near the north end of the existing runways where required RSA extensions will be built. As part of the safety extensions, South 154th Street will be relocated several hundred feet to the north, adjacent to these wetlands. Temporary disturbance to small portions of Wetlands 4 and 5 (about 0.40 acre) could result from placement of silt fences and required temporary erosion and sediment control actions.

Third Runway Embankment

Eight wetlands occur near the edge of fill for the third runway embankment. Temporary disturbance will occur in portions of Wetlands A1 (0.05 acre), A12 (0.03 acre), A13 (0.01 acre), R2 (0.02 acre), and 18 (0.22 acre), outside the area of permanent fill. During the relocation of South 154th Street, portions (0.16 acre) of Wetland 9 will be temporarily disturbed by construction activity. Minor disturbance could occur in limited portions of these wetlands as a result of installing silt fences around the construction area.

In addition to the impacts described above, approximately 0.71 acre of Wetland 37 and 0.28 acres of wetland 44a will be directly disturbed from construction of temporary stormwater management facilities, including a temporary detention pond. The pond will be used to temporarily store construction stormwater that is pumped to an upland sedimentation pond. Design of these facilities has been planned to prevent indirect impacts to Wetland 37 and Wetland 44 as explained in Hart Crowser (2001a; Appendix Q). These stormwater facilities will be removed and the wetland area restored after completion of the third runway. Permanent stormwater facilities will be located outside of wetland areas.

South Aviation Support Area

Wetland 52 (i.e., Tyee Pond) is adjacent to the SASA project. Temporary impacts (approximately 0.17 acre) may occur during construction of the taxiway connecting the SASA to the airfield.

Impacts to the wetland could include minor sedimentation or soil disturbance resulting from construction.

Temporary Impacts Resulting from Mitigation Projects

Approximately 43.34 acres of wetland area (in both on- and off-site mitigation areas) will be subject to enhancement and restoration activities such as grading, weed control, and planting (see Table 3.1-4). In general, these activities occur to Category III or Category IV wetlands that are farmed or dominated by non-native vegetation. For example, approximately 3.74 acres of Wetland A1, a Category II riparian wetland, will be temporarily disturbed by construction associated with the relocation of Miller Creek, floodplain grading, and planting. Two emergent Category III wetlands at or near the off-site mitigation area in Auburn, Washington (see Sections 4 and 7) will be altered by the placement of temporary construction access roads or by excavation to increase the amount of seasonal saturation the wetland experiences. All of these wetlands will be enhanced or restored by the proposed mitigation actions, with an overall increase in wetland function resulting from the mitigation. These actions are described in detail in the sections discussing the individual mitigation projects.

5.2.4.3 Rationale for Selection

Those wetlands temporarily impacted from construction activities will be restored on-site. Mitigation of temporary impacts provides the opportunity to enhance or restore functions in wetlands that are currently degraded. Following mitigation of temporary impacts, these wetlands will be vegetated with native forest and shrub wetland species, and wetlands will be protected by 50-ft-wide upland buffers where possible.

5.2.4.4 Constraints

No significant constraints have been identified that would preclude implementing restoration plans for temporarily impacted wetlands.

5.2.4.5 Ecological Assessment of the Mitigation Sites

Ecological conditions in the temporarily impacted wetlands are discussed in detail in the *Wetland Delineation Report* (Parametrix 2000b). A general description of existing conditions in these wetlands is included in Section 2 of this report.

5.2.4.6 Temporary Impact Mitigation Design

Mitigation of temporary impacts varies on the nature of the impact, and specific mitigation plans are included in Appendix D. On completion of construction, all fill material and any construction material, equipment, or debris will be removed from the wetland.

The area will be regraded if necessary to re-establish pre-disturbance topography. Compacted soils will be loosened and amended with organic matter to obtain a suitable planting media. Soils retained for mitigation purposes that are stockpiled for more than 1 year will be treated with microbial inocculants or through the addition of well decomposed organic matter. Where altered, wetland hydrology will be established in the wetland by directing seepage water to the wetlands via the drainage channels.

Wetlands subjected to minor temporary impacts (i.e., installation of sediment or barrier fencing does not require clearing of vegetation) will be restored by removing construction materials or debris. If any vegetation is disturbed by construction activities in these areas it will be replaced.

Finally, any areas outside of wetlands or wetland buffers that are disturbed by construction will be hydroseeded with an erosion control seed mix to stabilize the soils and prevent erosion. Hydroseeding will also provide ground cover and reduce the amount of habitat available for non-native weedy species that could affect the success of the wetland mitigation sites.

Mitigation plans for temporary wetland impacts will be coordinated as needed with the mitigation actions for the adjacent Miller Creek wetland and riparian buffer enhancement projects (Sections 5.2.1 and 5.2.2).

Wildlife Considerations

Planting plans developed for the temporary impact mitigation are similar to those developed for the Miller Creek wetland and riparian buffer enhancement projects. These plans are consistent with the Port's WHMP and include species that are not likely to attract hazard wildlife (see Table 5.1-12; Appendix D, Sheet L1).

Landscape Plan

Native forest and shrub wetland vegetation will be restored by planting species such as Sitka spruce, black cottonwood, western redcedar, Pacific willow, Oregon ash, Pacific ninebark, and Sitka willow (Figures 5.2-17 and 5.2-18). Landscape plans for restoring temporarily disturbed wetland areas are shown in Appendix D, Sheet L1. A typical planting plan shows how the wetland areas will be replanted after construction is completed.

Expected Hydrology

All temporarily impacted wetlands will be restored to pre-disturbance conditions (including topography) and therefore it is anticipated that hydrology in the restored wetlands will be similar to pre-construction conditions. The replacement drainage channel system is designed to ensure that hydrology in wetlands downslope of the embankment will be maintained. Performance standards and monitoring for wetlands downslope of the embankment are provided in Tables 5.2-11 and Table 5.2-12.

5.2.4.7 Performance Standard and Contingency

Performance standards, types of parameters measured, and contingency measures for temporary impact mitigation are listed in Table 5.2-16. The monitoring schedule for temporarily impacted mitigation sites is provided in Section 5.2.4.9.

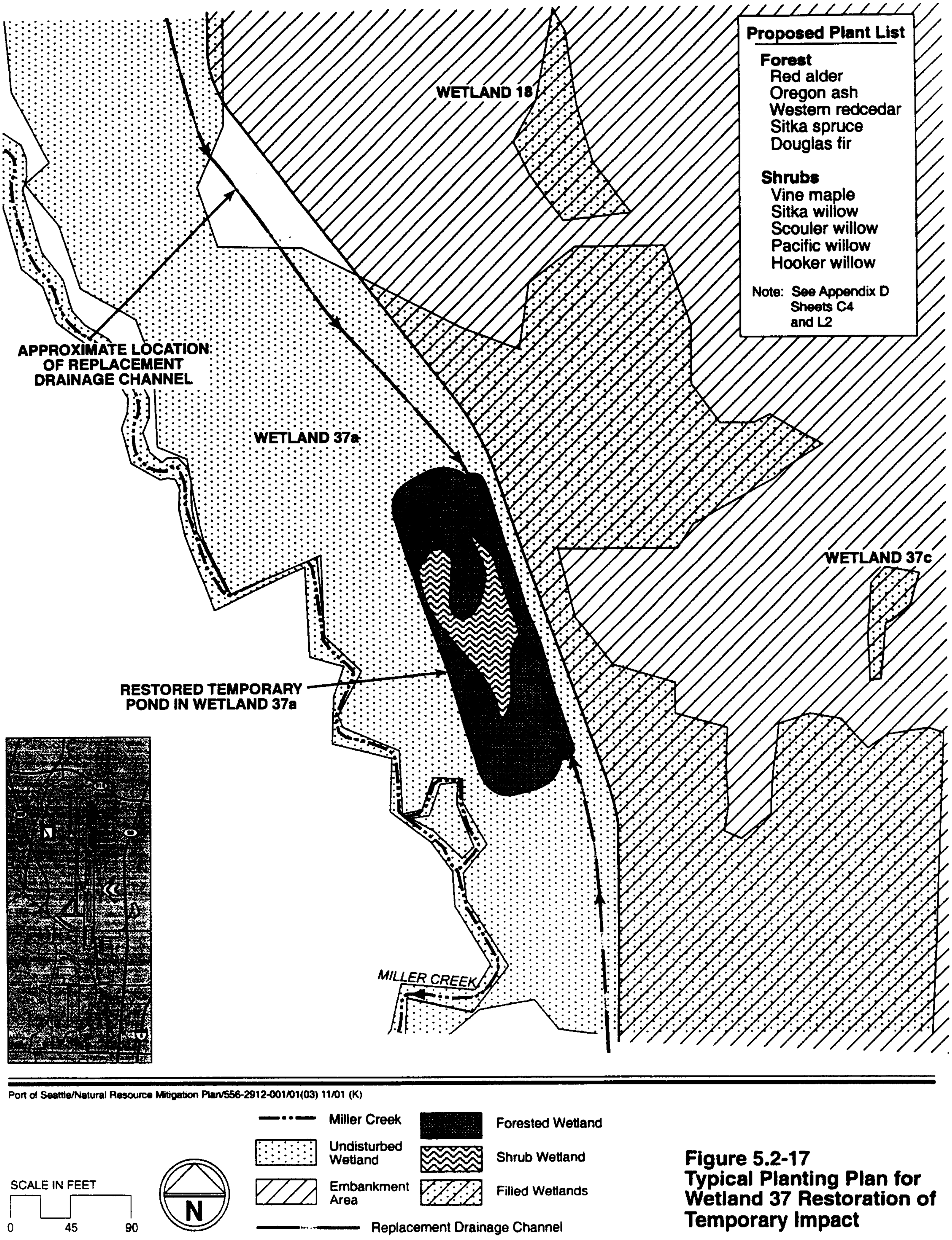

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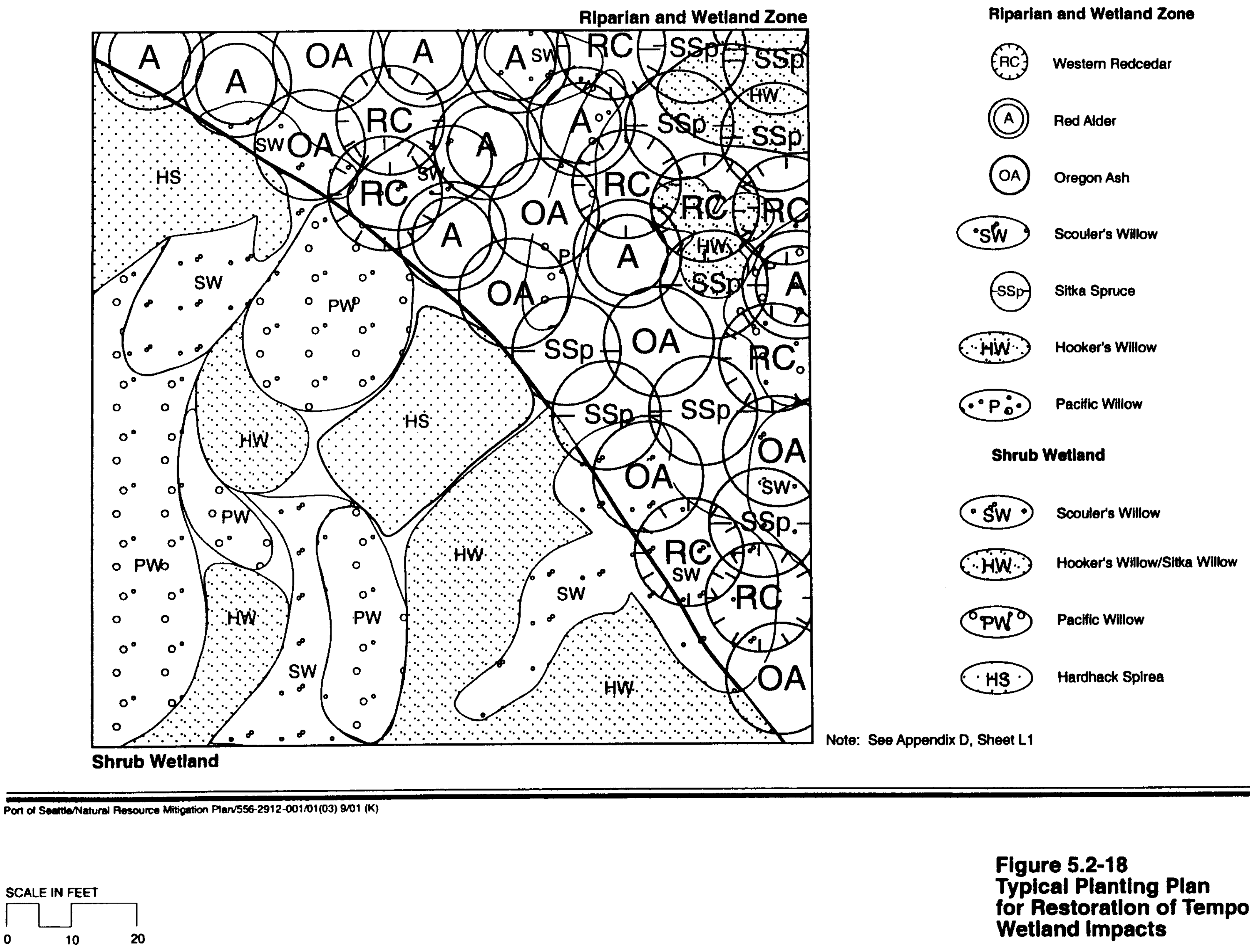
Figure 5.2-17
Typical Planting Plan for Wetland 37 Restoration of Temporary Impact



Note: See Appendix D, Sheet L1

Figure 5.2-18
Typical Planting Plan
for Restoration of Temporary
Wetland Impacts

Vegetation

Temporarily impacted wetlands that are replanted will be restored as palustrine forested wetlands and therefore will be monitored for at least 15 years. Vegetation will be monitored using the approach outlined in Table 5.2-16 and consistent with the requirements of Ecology (2001a).

5.2.4.10 Site Protection

Areas subjected to temporary impacts will be protected as established in the restrictive covenants (Appendix G) and other federal, state, and local regulations that protect wetlands.

5.2.4.11 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented for the temporarily impacted mitigation sites consistent with the overall approach outlined in Section 4.

Contingency measures for each performance standard for the temporary impact mitigation projects are listed in Table 5.2-16. Contingency measures will be consistent with the adaptive management approach outlined in Section 4.

5.2.4.12 Implementation of Replacement Drainage Channel and Temporarily Impacted Mitigation Projects

The locations of the wetlands subject to temporary impacts and drainage channel mitigation sites are shown in Appendix D. Implementation of mitigation activities for temporarily impacted wetlands is dependent on phasing for construction of the third runway embankment and decommissioning of temporary stormwater detention ponds for the runway embankment construction. Drainage channel construction will occur before and during construction of the embankment (approximately 2000 to 2005). Temporary wetland impact restoration will occur immediately after completion of individual projects impacting wetlands (i.e., South 154th Street relocation embankment).

Prior to the start of construction, a pre-construction meeting between the contractor, engineer, and wetland scientist will determine the exact areas needed for construction activities. These temporary construction impact areas will be located to avoid and minimize impacts to wetlands. Construction limits will be clearly marked in the field to avoid impacts to wetlands outside the temporarily impacted areas.

Following construction, all construction debris and equipment will be removed from temporarily impacted areas. Any temporary access roads will be removed. Any fill material will be removed. Temporarily impacted areas will be returned to pre-disturbance conditions and drainage channels will be graded per specifications (Appendix D, Sheets C9 and L1). Soils that have been compacted by construction activities will be deep ripped if necessary, and will be tilled to a depth of 10 to 14 inches to provide suitable conditions for planting. Disturbed areas will be hydroseeded to stabilize the soil and native plant species installed to establish forested wetland vegetation (Appendix D, Sheets C9 and L1). Planting will occur during the early fall following temporary mitigation or drainage channel construction. Sediment and erosion control measures may be removed 1 full year after planting if these sites are stable. Replacement drainage channel buffers will also be planted with native trees and shrubs. Temporarily impacted and drainage channel mitigation sites will be monitored annually for a period of 15 years to ensure they are meeting performance standards.

5.2.5 Miller Creek Basin Trust Fund for Watershed Rehabilitation

To provide opportunities for additional restoration projects in the Miller Creek basin, the Port will establish a trust fund to support watershed rehabilitation projects. The trust fund will focus on portions of Miller Creek not owned by the Port, and where the Port is unable to independently implement stream enhancement projects. The Port will make these trust funds available and defer the selection of appropriate projects to other governmental agencies or interested groups. Restoration or enhancement projects supported by the trust fund are independent of the environmental review and permit process for Master Plan Update projects (e.g., CWA 404/401, HPA), and may require local, state, or federal permits and environmental review.

5.2.5.1 Goal

The goal of this mitigation action is to provide a funding source to local agencies and groups to enhance instream or riparian habitat for salmonids and other aquatic organisms in the Miller Creek basin.

5.2.5.2 Description

The trust fund for watershed restoration will provide $150,000 for restoration projects in the Miller Creek basin. Potential projects eligible for funding by the trust fund are based on information provided in the Stream Survey Report for Miller Creek (Appendix F of the Final EIS for the Master Plan Update Projects [Port of Seattle 1997]). The projects identified in Table 5.2-18 are a preliminary list and are proposed to address habitat problems in Miller Creek identified in the stream survey. Examples of projects eligible for full or partial funding could include instream fisheries habitat improvements similar to those proposed for Miller Creek in this plan (see Figures 5.2-8 through 5.2-11), riparian buffer enhancement, removal of fish passage barriers, and removal of failed septic systems.

While specific projects are not selected, a suite of potential projects is identified with their respective goals, general performance standards, and general monitoring requirements. Additional planning and engineering of selected projects will result in specific project designs, performance standards, monitoring requirements, and contingency measures. Project proponents will be responsible for obtaining any federal, state, or local permits required to implement the projects.

The trust fund will have a sunset period of 5 years, with the 5-year period beginning once permits are issued for the Master Plan Update projects. If after a 5-year period trust fund projects are not designed and environmental permits sought,[29] the Port will use the money to implement projects in the Miller Creek basin that would provide water quality or aquatic habitat benefits. The projects to be implemented will be at the discretion of the Port, but with approval from Ecology and ACOE.

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[29] Project proponents will be responsible for obtaining all federal, state, and local permits required to implement habitat enhancement projects.

Table 5.2-16. **Final performance standards, evaluation measures, and contingency measures for restoration of temporary wetland impacts.**

Design Criteria	Performance Standard	Evaluation Methods	Contingency Measures
1. Grade disturbed areas to pre-construction elevations. and hydrologic conditions.	Pre-disturbance wetland topography is restored.	Comparison of pre- and post-construction topography.	Regrade if necessary.
	Wetland areas will meet wetland criteria (hydrophytic vegetation, hydric soils, hydrology) following restoration (see Table 5.2.12).	Monitor the depth to and the duration of soil saturation (see Table 5.2.12).	Regrade if necessary. Use water collected by drainage channels to supplement wetland hydrology.
2. Restore impacted areas with native forest vegetation. Emergent wetland communities will be replanted with forest vegetation to increase wetland functions and reduce potential use by waterfowl.	In revegetated areas, survival will be 100% at the end of year 1; average survival of planted stock will be at least 80% during the first 3 monitoring years. Cover of native species will be at least 80% by the end of the 15-year monitoring period[a].	Vegetation sampling (plots, transects, or plotless techniques) to estimate mortality, cover, density, and presence of invasive species.	If standards are not met: Select species that are better adapted to existing hydrologic conditions. Install additional plant material. Install protective collars to reduce herbivore damage. Control/reduce non-native invasive species.
	Cover of non-native invasive[b] species in newly planted or enhanced areas will be no more than 10% during any monitoring year.		
	In monitoring years 3, 8, and 15re-vegetated wetlands will have a tree density of at least 280 per acre and a shrub density of at least 2,100 individuals per acre.		
	In monitoring years 3, 8, and 15, plant diversity will not decrease by more than 10% from the number of plant species installed at baseline.		
3. Disturbed ground within 50 ft of the wetlands will be hydroseeded or otherwise stabilized to prevent erosion impacts to the wetland.	Vegetation cover within 50 ft of wetlands will exceed 80 percent within 1 year following restoration.	Measure plant cover using standard vegetation sampling techniques.	Install erosion control fabric. Install additional hydroseed or plants in upland areas.

[a] See Table 4.3-1 for interim cover targets (i.e., from year 3 to year 15).

[b] See Table 4.3-2 for list of invasive, non-native species to be monitored and controlled on the mitigation site.

5.2.4.8 Implementation

Temporary impact mitigation projects will be coordinated with third runway construction activities, as well as with Miller Creek riparian wetland and buffer enhancement projects. Implementation of the replacement drainage channels and the temporary impact mitigation is described in Section 5.2.4.12 below.

5.2.4.9 Monitoring and Performance Standards

The overall monitoring approach for temporary impact mitigation will be consistent with the monitoring approach outlined for all Master Plan Update mitigation projects in Section 4 of this plan. Monitoring tasks specific to the temporary impact mitigation projects are described in this section. Performance standards, methods and parameters, and contingency measures for the temporary impact mitigation are listed in Table 5.2-16. The monitoring schedule for temporarily impacted mitigation sites is provided in Table 5.2-17.

Table 5.2-17. Monitoring schedule for restoration of temporary wetland impacts.

			Data Collection Year												
Feature	**Activity**	**Frequency**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**15**
Wetland hydrology	Groundwater monitoring	Twice Monthly	X	X	X	X									
		Monthly					X	X					X		X
		Once winter, late spring/ early summer, and fall							X	X	X	X		X	X
Vegetation communities	Vegetation sampling	Once late spring or early summer	X	X	X	X		X		X			X	X	X
	Wetland Delineation	Once in spring						X					X		X
Reports			X	X	X	X		X		X			X	X	X

Hydrology

Monitoring of temporarily impacted wetlands, as well as wetlands between the embankment and Miller Creek, will include evaluating wetland hydrology. To ensure that performance standards are met, and to aid in determining appropriate contingency measures, monitoring will include a pre-construction topographic survey and groundwater monitoring. A topographic survey of all wetlands within the temporarily impacted area will be conducted before grading for the runway embankment. This survey will be used as a baseline to re-establish pre-construction contours. Shallow groundwater monitoring wells will be installed within restored wetlands following grading and planting. Groundwater levels will be monitored at least monthly to determine presence of wetland hydrology sufficient to maintain existing or planted vegetation. This monitoring will be consistent with the requirements established by Ecology (2001a).

Table 5.2-18. Potential trust fund projects in the Miller Creek watershed.

Project	Goals	Description	Performance Standards	Monitoring
Pool Habitat Improvements (RM 2.0 to 3.3)	Increase high-flow refugia and over-wintering habitat for resident and anadromous fish species.	Modify stream channel to increase size, depth, and cover of existing pools. Create additional pools through placement of LWD complexes (4 to 6 logs each) in the stream channel.	Established pools and riffles will remain stable, or pool/riffle ratio shall remain within 10% of established value over 10 years.	Assess functions of pool/riffle complex annually at the end of the wet season to determine habitat quality of existing and created pools.
Streambank Stabilization (RM 2.0 to 3.3)	Increase quality spawning gravels and escape cover for juvenile salmonids and habitat for aquatic invertebrates by increasing stability of streambanks prone to slump and landslide activity.	Apply prescriptive stabilization designs to eroding banks, landslide areas, slumps, and debris jams that are major contributors to sediment loading.	Streambank stabilization projects shall remain intact for the 15-year monitoring period.	Assess stabilized streambanks annually at the end of the wet season, noting soil stability, evidence of sediment loading in the stream channel, and potential for sediment loading.
Streambank Re-vegetation (RM 2.0 to 3.3)	Decrease seasonal water temperature fluctuation through shading stream channel with native vegetation.	Install native riparian vegetation to provide overhead cover and shading of stream channel.	Installed plant materials shall have minimum 80% survival after 3 years, and shall provide a minimum of 80% cover of native species by year 10.	Assess installed plant materials and percent cover of non-native invasive vegetation species annually at the end of the growing season.

5.2.5.3 Eligibility

The Port or the designated administrator of the trust fund will consider requests for monies from the watershed trust fund to implement stream habitat enhancement projects. Requests must be made by King County, City of SeaTac, City of Des Moines, City of Burien, City of Normandy Park, special districts, tribal governments, non-profit organizations, or combinations of such governments through inter-local agreements. Organizations requesting funding must comply with general liability insurance requirements established by the Port.

Key criteria to be used to evaluate proposals to implement projects in Table 5.2-18, as well as other projects within the watershed, are:

- A demonstrated benefit to salmon or aquatic habitat without creating significant avian wildlife habitat within 10,000 ft of runways at STIA.
- Consistency with watershed management plans, or with prescriptions/recommendations identified using watershed analysis or stream assessment procedures.
- Clearly defined project goals, implementation plans, performance standards, and post-project monitoring.
- Preference for resolving underlying causes of problems rather than treating symptoms.
- Cost-effectiveness.

5.2.5.4 Implementation

The Miller Creek Basin Committee, the King County Watershed Coordinator, Puget Sound Restoration Fund, or other responsible entity will administer the fund. The administrator will establish eligible project criteria, set project cost limits, and set implementation and monitoring requirements. The Port will review and approve project goals, plans, performance standards, and monitoring requirements to enhance the ultimate success of the projects. The Port or the administrator at the Port's request, will provide status reports to Ecology and ACOE.

5.2.5.5 Site Protection

Site protection measures for enhancement projects will be coordinated with property owners and the fund administrator.

5.2.5.6 Monitoring and Contingency Plans

The fund administrator will review project design, implementation, and as-built plans to verify that intended benefits have been built. Contingency actions associated with establishment or operation of the fund will be reviewed with the Port, ACOE, Ecology, and the fund administrator.

Des Moines Creek
Restoration Projects

5.3 DES MOINES CREEK BASIN RESTORATION PROJECTS

Master Plan Update improvement projects will result in approximately 3.88 acres of permanent wetland impacts in the Des Moines Creek basin (Borrow Area 1, Haul Road, and SASA; see Table 3.1-2). These unavoidable impacts will result from development of the SASA and excavation in the borrow areas. Therefore, to mitigate these impacts in the Des Moines Creek basin, the Port proposes restoration and enhancement projects designed to increase wetland function, enhance aquatic habitat, and improve stream conditions within Des Moines Creek. These mitigation projects are designed to ensure that new wildlife hazards are not created near the airport. This integrated set of projects is designed to meet the following overall objectives:

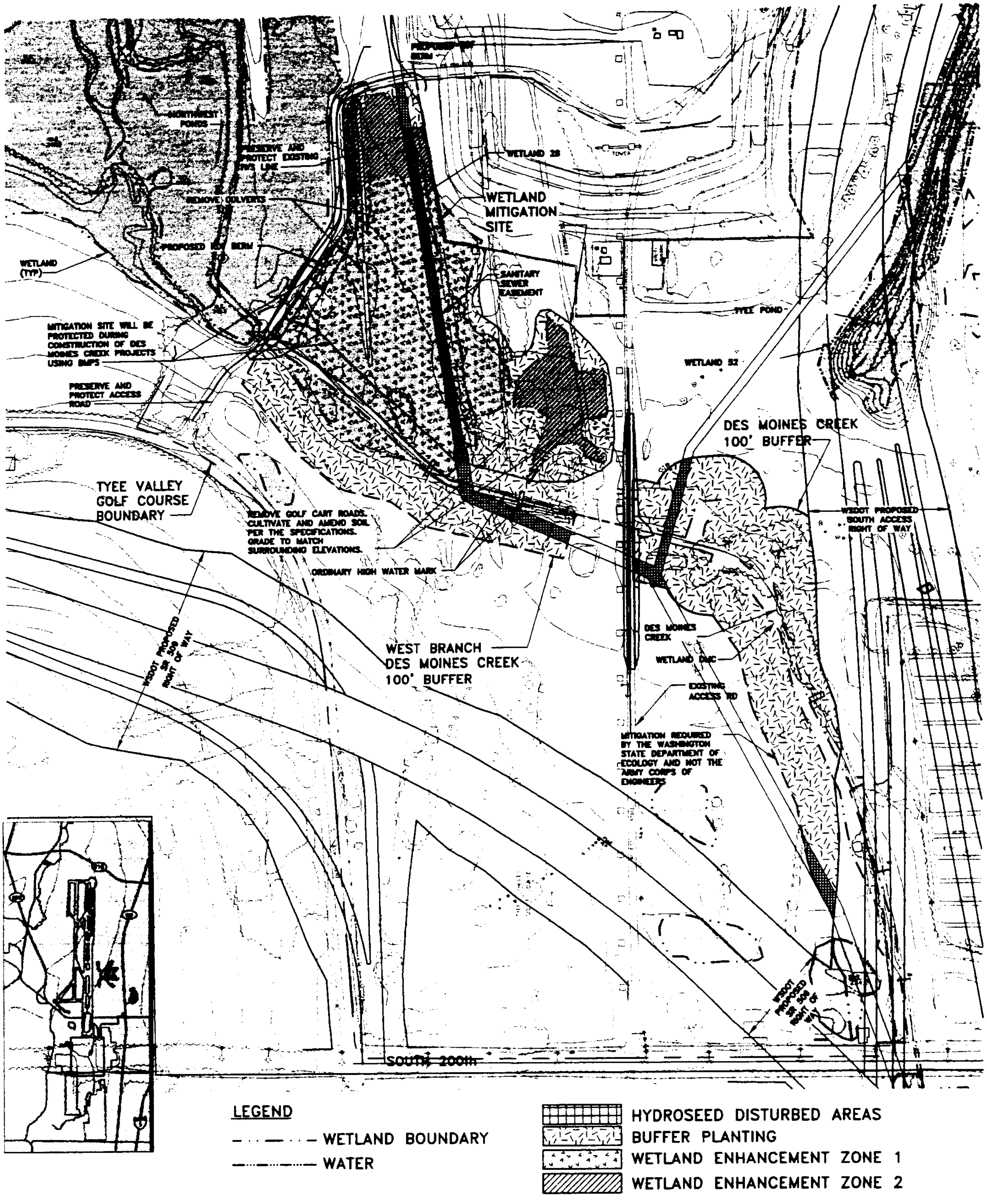
- Restore wetland functions to a portion of the Tyee Valley Golf Course by restoring a native wetland shrub community (Section 5.3.1).
- Enhance aquatic habitat and improve stream functions by restoring a forested riparian buffer along a 870-ft of the west branch of Des Moines Creek, also located on the Tyee Valley Golf Course (Section 5.3.1).
- Establish a $150,000 trust fund for restoration projects located in the Des Moines Creek basin (Section 5.3.2).
- Provide for additional stream enhancement projects and local restoration efforts.
- Provide hydrologic mitigation to wetlands in Borrow Areas 1 and 3 (Section 5.3.3).

To provide additional protection to Des Moines Creek, the Port will plant a 100-ft buffer along Des Moines Creek from the edge of the wetland mitigation site at the Tyee Valley Golf Course south to the proposed South Access Freeway ROW.

5.3.1 Tyee Valley Golf Course Area Mitigation Plans

Projects in the Des Moines Creek basin are designed to mitigate unavoidable project impacts to wetlands and aquatic resources by restoring wetland and stream functions. To mitigate wetland impacts and improve aquatic habitat in the Des Moines Creek watershed, existing emergent wetland at the Tyee Valley Golf Course will be enhanced by establishing a native shrub wetland community (Figure 5.3-1). Approximately 4.5 acres of wetland in the Tyee Valley mitigation area and approximately 1.0 acre in the west branch Des Moines Creek buffer will be enhanced. This mitigation will increase infiltration, reduce pollutant runoff, increase sediment retention, improve nutrient cycling functions in the wetland, and improve water quality and habitat in adjacent Des Moines Creek. Replacing the existing golf course turf grass by planting a native shrub community will also decrease hazard wildlife attractants within 10,000 ft of the airfield (as required by the FAA) by reducing waterfowl use of the golf course.

To enhance water quality and aquatic habitat in Des Moines Creek, approximately 5 acres of buffers will be established along Des Moines Creek at the Tyee Valley Golf Course (see Table 4.1-3). A 100-ft buffer (approximately 3.4 acres) on both sides of the west branch of Des Moines Creek (see Figure 5.3-1) and approximately 1.6 acres within the Tyee Valley Golf Course mitigation area will be enhanced. These buffers will be planted with native forested and shrub riparian vegetation. Species planted in the buffer will be selected to avoid attractants to hazard wildlife, consistent with the Port's WHMP.



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REFERENCE: NRMP 2000

Figure 5.3-1
Location of Wetland Enhancement On the Tyee Valley Golf Course, Des Moines Creek Basin

Enhancement of this buffer will increase infiltration in the buffer area; reduce sediment, nutrient, and pollutant inputs to the stream; and provide shade, LWD, and organic matter inputs to Des Moines Creek.

5.3.1.1 Goals, Objectives, and Design Criteria

The following section describes the goals, objectives, and design criteria identified for the Des Moines Creek projects. Goals identified for this plan include:

- Establish a total of 5.5 acres of native shrub wetland in a currently degraded emergent wetland (i.e., golf course turf). This action will improve water quality, fish habitat, and stream conditions in Des Moines Creek (4.5 acres in Tyee Valley Golf Course mitigation area and about 1.0 acre in west branch Des Moines Creek buffer; see Table 4.1-3).
- Reduce hazard wildlife (e.g., Canada goose and other waterfowl species) use of the golf course area by replacing turf grass wetland with shrub wetland.
- Improve water quality and aquatic habitat in Des Moines Creek by planting a 100-ft forested buffer along both banks of an 870-ft section of Des Moines Creek adjacent to the wetland mitigation.
- Improve water quality and aquatic habitat along other areas of Des Moines Creek that are outside the proposed SR 509 ROW.

Specific design objectives and criteria developed to ensure that the Des Moines Creek projects meet mitigation goals are listed in Table 5.3-1.

Table 5.3-1. Mitigation goals, design objectives, and design criteria for wetland and buffer enhancement on the Tyee Valley Golf Course.

Goals and Design Objectives	Design Criteria
Goal 1: Enhance degraded wetlands to provide improved water quality and aquatic habitat functions to Des Moines Creek	
Enhance existing turf-dominated wetland at the Tyee Valley Golf Course.	Plant 5.5 acres of the golf course wetland with native wetland shrub species (include wetland area on left and right bank west branch Des Moines Creek).
	Shrub and small tree density will be 3,375 individuals per acre.
Goal 2: Reduce waterfowl use of the golf course area	
Reduce habitat value of the mitigation area for waterfowl.	Plant area with shrub vegetation to discourage use of wetland by waterfowl, improving aircraft safety.
Goal 3: Improve water quality and aquatic habitat in Des Moines Creek by restoring riparian buffers.	
Establish and protect 100-ft-wide riparian buffers.	Plant 100-ft-wide riparian buffers on each side of Des Moines Creek (approximately 3.38 acres of buffer area).
	Plant native riparian forested and shrub plant species within the 100-ft buffer along Des Moines Creek.

5.3.1.2 Mitigation Site Descriptions

Tyee Valley Golf Course

The Tyee Valley Golf Course is an active golf course located at the southern end of the STIA runways (see Figure 2.1-1). The golf course occurs in the eastern portion of Wetland 28, an approximately 35-acre wetland complex associated with the Northwest Ponds and the west branch of Des Moines Creek. The portion of the wetland associated with the Northwest Ponds (west of the golf course) contains forest, shrub, emergent, and open-water wetland habitat. The golf course portion of Wetland 28 contains an approximately 9.75-acre emergent turf grass wetland. Wetland enhancement will occur in emergent turf grass wetland (see Figure 5.3-1). A detailed description of Wetland 28 is provided in the *Wetland Delineation Report* (Parametrix 2000b).

Des Moines Creek

The west branch of Des Moines Creek originates at the Northwest Ponds or Wetland 28 (see Figure 2.1-3). The Northwest Ponds, located southwest of the existing runways between South 192nd Street and South 196th Street, were excavated as a source of peat by the previous property owners, and subsequently incorporated into the airport's stormwater management system. The east fork of Des Moines Creek originates in Bow Lake, east of the airport, and flows south, mostly via closed pipes, to the Tyee Valley Golf Course detention pond (Tyee Pond; Wetland 52). From Tyee Pond, the east branch flows through a culvert to join the west branch of the creek southeast of the proposed wetland mitigation site (see Figure 5.3-1). South of the confluence, Des Moines Creek flows through the Tyee Valley Golf Course to South 200th Street and then generally south to Puget Sound.

5.3.1.3 Ownership

The Port owns the property in the Des Moines Creek mitigation areas (i.e., golf course, buffer zone of Des Moines Creek). The golf course is currently leased to a golf course operation, which will cease operations before implentation of the mitigation plan.

5.3.1.4 Rationale for Selection

The Des Moines Creek mitigation projects provide an opportunity to mitigate wetland impacts on-site in the Des Moines Creek basin. Mitigation will occur by restoring portions of a historic peat wetland adjacent to the upper reaches of Des Moines Creek, enhancing riparian buffers along Des Moines Creek, and mitigating potential indirect impacts to wetlands downslope of the project area.

Historic land uses have resulted in converting a native peat wetland to a golf course, as well as replacing forested wetlands and riparian areas along Des Moines Creek with open turf grass areas or areas of non-native invasive species. These alterations have degraded aquatic habitat in Des Moines Creek, increased sediment and nutrient inputs to the stream, and removed the buffering influence of riparian vegetation. Using the Tyee Valley Golf Course as a mitigation site provides a unique opportunity to enhance an existing wetland and restore a native wetland shrub habitat adjacent to a salmon-bearing stream. This mitigation site also provides the opportunity to improve the aquatic habitat of Des Moines Creek by reducing pollutant runoff, increasing sediment retention, and increasing nutrient cycling by restoring both wetlands and riparian buffers along the stream.

Finally, the turf grass and seasonal flooding that occur on the Tyee Valley Golf Course attract a large number of waterfowl (e.g., Canada geese and American widgeon) that forage on the mowed lawn of the golf course. These waterfowl pose a threat to aircraft operation and safety; establishing shrub vegetation will eliminate waterfowl from portions of the golf course and reduce aviation hazards.

5.3.1.5 Constraints

Mitigation design for these projects is constrained by the proximity of the mitigation sites to the airfield and runways. Proximity to the airfield affects the choice of plant species used in the design to ensure that wildlife hazards are not created. The size of buffer areas is constrained by nearby RSAs and embankments. Two separate and unrelated construction projects are also potential constraints that have affected the design and implementation of the Des Moines Creek projects. These projects are the King County RDF proposed at the Northwest Ponds and the Washington State Department of Transportation (WSDOT) SR 509 extension and South Access Freeway.

These constraints will not prevent the plan from being implemented, but they could affect implementation steps (e.g., construction sequencing) or design (e.g., protective barriers around mitigation plantings). In addition, concerns have been raised by ACOE and Ecology regarding the hydrology of the wetland mitigation area. Although this is not a constraint on the mitigation, these concerns are addressed in this section. Finally, there are no constraints on mitigation for indirect hydrology impacts at the borrow areas.

Buffer Size

Site constraints preclude the installation of extensive forested buffers around the wetland mitigation site. Within the wetland mitigation site itself, there are shrub buffers on the north side of the enhanced wetland edge and the surrounding golf course (Appendix C, Sheet C2). On the south side, 100-ft buffers along Des Moines Creek will protect the wetland mitigation site and the stream. Wetland buffers cannot be enhanced east of the wetland mitigation site because these areas are within designated RSAs and runway embankment. In this area, emergency and non-emergency access, flexibility to maintain or modify vegetation, vegetation height limits, and the flexibility to maintain or supplement navigation equipment or other airfield facilities must be retained for the safe operation of the airport. However, these restrictions will preclude high-impact uses near the wetland mitigation site, thereby providing an effective land use barrier.

Wildlife Hazards

The FAA and USDA-WSD staffs have evaluated the mitigation proposed for the Des Moines Creek basin for potential wildlife hazards to aviation. These agencies have determined that the mitigation results in a decrease in wildlife hazards near the airfield. New road construction (i.e., SR 509 extension and South Access Freeway) near the airport is not expected to increase wildlife hazards. Overall, modification of waterfowl habitat by the Port's mitigation (planting of existing emergent wetlands and buffers with shrub and forested vegetation) will reduce wildlife hazards.

Site Hydrology and Relationship to the King County/Des Moines Creek Regional Detention Facility

Hydrology

The Tyee Valley Golf Course wetland mitigation will occur on an existing peat wetland that historically supported forested and shrub vegetation. Existing soils and hydrology on the site would support forested or shrub wetland under existing conditions, in the absence of active measures to maintain the emergent turf grass vegetation of the golf course. Existing wetland conditions at the mitigation site are maintained by high groundwater and by precipitation during the winter months. Grading will not be necessary to create the hydrologic conditions necessary to restore shrub wetlands at the Tyee Valley Golf Course site because the site already has wetland hydrology sufficient to support native shrub wetlands.

Regional Detention Facility

The Des Moines Basin Planning Committee identified a preferred alternative for the RDF in November 1999. The objective of the RDF is to control erosive flows reaching Des Moines Creek and thereby restore salmon habitat (King County Capitol Improvement Project Design Team 1999). The proposal includes increasing storage capacity in the Northwest Ponds and some channel reconstruction in Des Moines Creek to deepen the channel south of the wetland mitigation site.

Wetland hydrology of the mitigation site will not be affected by the operation of the RDF because hydroperiods within the mitigation site will not be significantly affected by the RDF. The Tyee Valley Golf Course currently is inundated by overbank flow from Des Moines Creek to some extent during flood events. The 100-year floodplain of Des Moines Creek (under existing conditions) is entirely within the mitigation site, and within the boundaries of Wetland 28 (Appendix C, Sheet C3). Construction of the RDF will result in a slight decrease in flooding on the mitigation site because of proposed reconstruction of the stream channel adjacent to the mitigation and increased water storage in Wetland 28.

Using data from the King County RDF plan (King County Capital Improvement Design Team 1999), King County compared current water levels on the mitigation site as a result of the 10-year, 25-year, and 100-year floods, with water levels predicted to occur during these flood events after construction of the RDF. In all cases, water levels and the extent of inundation on the site are somewhat lower with the proposed RDF than under current conditions (Appendix C, Sheets C3 and C4). For example, under existing conditions without the RDF, 100-year flood elevations are approximately at the 250.5-ft contour, while with the RDF, the 100-year flood elevations are a foot lower, at the 249.5-ft contour. Under existing conditions, inundation by the 100-year flood at the mitigation site is approximately 3.1 acres, while with the RDF in operation, the 100-year flood would inundate approximately 2.1 acres. Therefore, construction of the RDF will slightly decrease inundation of the site during flood events. However, because wetland hydrology on the site is not driven by flood events, this decrease will not affect implementation of the mitigation plan. Even with the slightly lower levels of inundation during flood events predicted after construction of the RDF, the Tyee site will support the planned wetland shrub vegetation. The site will continue to support wetland vegetation and hydrology because the current wetland is maintained by a high groundwater table that results in saturated soil conditions, and not by overbank flooding.

The preferred alternative for the RDF includes a berm adjacent to the west side of the Tyee Valley Golf Course mitigation site and enhancement of a portion of Des Moines Creek south of the wetland mitigation site (Appendix C, Sheet C2). The Port will protect the wetland mitigation site from RDF construction by placing sediment fencing or other TESC measures, and orange barrier fencing at the edge of the mitigation site to ensure that any potential impacts from construction are avoided. Protection will include ecology blocks or rock gabions to protect the wetland mitigation site during RDF construction to ensure that construction equipment does not enter the wetland mitigation site or riparian buffer.

Riparian buffer enhancement (the area extending a horizontal distance of 100 ft from the OHWM of the stream or from the edge of riparian wetlands, whichever is greater) along Des Moines Creek will be coordinated with construction of the RDF and will be planted by the end of 2004.

SR 509 Extension/South Access Freeway

The WSDOT SR 509 extension and South Access Freeway project will not constrain implementation of the Port's mitigation plan in the Des Moines Creek basin. These two projects involve extending SR 509 south of the proposed RDF and constructing an access road between SR 509 and the airport terminal ramps. All wetland mitigation has been designed to avoid conflicts with the preferred alternative for these projects.

The Port's proposed mitigation at the Tyee Valley Golf Course and along Des Moines Creek avoids the preferred alternative for SR 509 and the South Access Freeway (Appendix C, Sheet C2). Surface water runoff from these roadways can be collected, treated, and diverted to prevent runoff impacts to the mitigation sites. Therefore, these projects will not affect the hydrologic or riparian functions desired for the mitigation site.

Other Utilities

A concern for this mitigation area has been the presence of an IWS discharge line and sewer line easement owned by the Midway Sewer District. Occasional maintenance of this line will be required within the 20-ft easement, and this maintenance[30] could prevent mature vegetation from developing within the easement (see Appendix C, Sheet C2 for location of these lines). For these reasons, the area of the easement is removed from the mitigation buffer, and equivalent area that can be fully protected from future disturbance has been added to the mitigation area. As a result, the presence of the sewer line will not reduce or alter the ecological functions derived from the mitigation. Its presence has, in fact, increased the area of land set aside for protection.

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[30] Sewer lines generally have a design life in excess of 50 years, and rarely require maintenance or fail. Therefore, the potential for disturbance of the easement area is small and infrequent. Furthermore, if leaks were to develop in the line, there are methods to repair and rehabilitate sewer lines in-situ with no disruption of surface soils. These methods employ installation of new pipe sleeves or pipe liners within the existing pipe. Installation is done through existing manholes without soil excavation. These are the preferred methods for rehabilitating sewer lines, and are routinely used by large and small sewer utilities. The easement width of 20 ft provides a sufficient construction work area for maintenance, repair, or replacement activities.

5.3.1.6 Ecological Assessment of the Mitigation Area

Detailed additional descriptions of wetlands, borrow areas, and Des Moines Creek in the mitigation projects area are provided in the *Wetland Delineation Report* (Parametrix 2000b). The following sections summarize the existing conditions of these areas.

Des Moines Creek

The west branch of Des Moines Creek originates at the Northwest Ponds and flows through the golf course to the confluence with the east branch; the main channel then flows south to Puget Sound. The channel and riparian zone of Des Moines Creek upstream of South 200th Street have been significantly altered as a result of golf course development. Des Moines Creek is on the 303(d) list for fecal coliform of unknown origin. The channel substrate in the reach of Des Moines Creek through the golf course is predominantly composed of sands and silts, with some scattered areas of gravels and cobble, and some areas of heavy accumulation of fine sediments. Riparian vegetation along Des Moines Creek in the golf course area is primarily turf grass. Between the confluence and South 200th Street, there is an approximately 25-ft-wide riparian zone vegetated with trees and shrubs. Existing riparian vegetation provides very little shade or organic matter inputs to Des Moines Creek.

Tyee Valley Golf Course Wetland (Wetland 28)

Historically, the Tyee Valley Golf Course was a peat wetland, most of which was farmed until about 1970. At this time, portions of the original wetland were converted to golf course and stormwater management ponds.

Vegetation

The proposed wetland mitigation site is located on an active golf course consisting primarily of fairways, greens, and roughs. Several roadways used for emergency access or golf cart roads are constructed on fill and cross the mitigation site. Vegetation on the Tyee Valley Golf Course is predominantly non-native turf grasses (e.g., *Poa* sp., *Agrostis* sp.), with scattered patches of coniferous and deciduous trees. No native wetland plant communities currently exist on the golf course. Portions of Wetland 28 to the west of the proposed mitigation site are dominated by native shrubs such as Pacific and Sitka willows and red elderberry (*Sambucus racemosa*), with some scattered trees such as black cottonwood and red alder.

Soils

In the golf course area of Wetland 28, the wetland soil is primarily a black or dark brown histic peat to a depth of greater than 18 inches. Small areas of the site consist of very dark gray silty loam mineral soils, or very dark mucks and loams (Parametrix 2000b). Upland soils are very dark grayish brown silty loams.

Hydrology

Hydrology within the wetland is maintained by a high groundwater table, occasional flooding from Des Moines Creek, and precipitation. Wetland hydrology in the western portion of the golf course is supported by groundwater and some overbank flow from Des Moines Creek. Wetland hydrology in the eastern portion of the wetland is primarily maintained by shallow groundwater and precipitation that perches above a relatively impermeable layer of clay. Groundwater seeps are also found along the northern arm and in the southwest portion of the wetland. Soils in these wetland areas are typically saturated to the surface during the fall, winter, and spring months.

5.3.1.7 Mitigation Design

Tyee Valley Wetland Mitigation

The design for the wetland mitigation site is to plant a minimum of 4.5 acres of the golf course area wetland, which is currently dominated by non-native turf grass, with native shrub species (see Figure 5.3-1; Appendix C, Sheets C2 and L1). Additionally, approximately 1.6 acres of upland area adjacent to the wetland will be planted with native shrub species.

Reduced use of the site by geese following conversion of the golf course to shrub wetland will reduce inputs of fecal coliform and nutrients to the stream. In addition, planting the golf course with native shrubs, as well as establishing a forested/shrub buffer along Des Moines Creek, will increase nutrient cycling and retention in the buffer and is likely to further reduce nutrient inputs to the stream.

Clearing and Site Preparation

The design for the wetland mitigation site does not include significant changes to site topography by grading or excavation. Prior to installing plants, culverts and golf cart roads will be removed. Minor grading may take place attendant to the removal of golf course roads and existing culverts. Appropriate TESC measures will be installed prior to site preparation or clearing activities to protect the adjacent wetland and stream.

Expected Hydrology

The wetland enhancement area typically would be saturated to the surface during the fall, winter, and spring months. Soil saturation and wetland hydrology, which is maintained by high seasonal groundwater levels, will not be affected by the mitigation design. As discussed previously under Constraints, if the RDF is constructed, maximum flood levels will be slightly lower than they are now.

Landscape Plan

The planting plan consists of native shrub or small tree species that tolerate water level fluctuations, tolerate saturated soils during the fall-spring months, are typically found growing in peat soils, and are unlikely to attract significant numbers of avian wildlife (see Section 5.1.2.8; Appendix C, Sheet C2 and L1). Species tolerant of such conditions include hardhack and willows (Taylor 1993). Pacific willow, Sitka willow, and hardhack commonly occur in floodplain wetlands and are tolerant of flooding and inundation for prolonged periods. Plants will be installed in patches of varying species compositions and heights to provide the mosaic of vegetation heights that is consistent with reducing hazard wildlife attractants (USDA 2000).

The landscape plan for the area shows that the planting of conifer trees is phased (see landscape design sheets in Appendix C). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

A temporary irrigation system may be installed in the drier portions of the golf course mitigation site to provide flexibility in planting schedules and to optimize growth rates during the initial plant establishment phase. Irrigation would use municipal water purchased by the Port. Irrigation will be used only during the plant establishment phase and will be removed after plant survival standards have been met. Irrigation will likely be used during the June through September time period, depending on weather conditions. Application rates are planned to be less than agronomic rates, but sufficient to reduce plant mortality and promote plant growth during the first season following planting.

Des Moines Creek Buffers

The reach of the west branch of Des Moines Creek south of the Tyee Valley Golf Course wetland mitigation site will be enhanced by planting native riparian trees and shrubs along both banks of the stream (Appendix C, Sheet C2). The riparian buffers will extend 100 ft from the OHWM of the stream or the edge of the riparian wetland, which ever distance is greater. Buffer plants will include black cottonwood, red alder, western redcedar, vine maple, and Nootka rose (*Rosa nutkana*).

A temporary irrigation system will be installed in the Des Moines Creek buffer to provide flexibility in planting schedules and optimize growth rates during the initial plant establishment phase. Irrigation will be provided by municipal water purchased by the Port. Irrigation will be used only during the plant establishment phase and will removed after plant survival standards have been met. Irrigation will likely be used during the June through September time period, depending on weather conditions. Application rates are planned to be less than agronomic rates, but sufficient to reduce plant mortality and promote plant growth during the first season following planting.

5.3.1.8 Performance Standard and Contingency

Performance standards, variables to be evaluated (e.g., survival, cover), and specific contingency measures for Des Moines Creek projects are included in Table 5.3-2. The monitoring schedule is presented in Table 5.3-3.

5.3.1.9 Implementation of Des Moines Creek Projects

The Tyee wetland mitigation and Des Moines Creek buffer enhancements will be coordinated with construction of the RDF. The Port will protect the mitigation sites from RDF construction impacts by placing TESC measures and orange barrier fencing at the edge of the mitigation sites. Ecology blocks will be used to further protect the mitigation sites from RDF construction impacts. Inspections will take place throughout the mitigation construction period to ensure that plans are being implemented as specified, permit conditions are met, and BMPs are installed and operating properly.

A proposed implementation plan for Tyee Wetland Mitigation and Des Moines Creek buffer commencements is presented in Table 5.3-4. Plants in both the wetland mitigation and riparian

Table 5.3-2. Final Performance Standards, Evaluation Approach, and Contingency Measures for the Tyee Valley Golf Course and Des Moines Creek Buffer Mitigation Projects.

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
1. Shrub and small trees planted at combined density of greater than 3,375 stems per acre	Survival of planted stock will be 100% at the end of year 1. Average survival of planted stock will be at least 80% during the first 3 monitoring years. Cover of native species will be at least 80% by monitoring year 15[a]. Cover of non-native invasive species will be no more than 10% by monitoring year 15[b].	Vegetation sampling (plots, transects, or plotless techniques) to estimate mortality, cover, density, and presence of invasive species.	If standards are not met: • Select species that are better adapted to existing hydrologic conditions. • Install additional plant material. • Install protective collars to reduce herbivore damage. • Control/reduce invasive plant species.
2. Plant native riparian tree and shrub plant species within the 100-ft buffer along Des Moines Creek.	Survival of planted stock will be 100% at the end of year 1. Average survival of planted stock will be at least 80% during the first 3 monitoring years. Tree density will be at least 280 individuals per acre and shrub density will be at least 2,100 individuals per acreduring monitoring years 3, 8, and 16. In years 3, 8, and 15, the number of plant species present will not decrease more than 10% from the number installed at baseline. Cover of native trees and shrubs will be at least 80% by monitoring year 15[a]. Cover of non-native invasive species in newly planted or enhanced areas will not exceed 10% during any monitoring year[b].	Vegetation sampling (see above).	See above.

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[a] See Table 4.3-1 for interim cover targets (i.e., from year 3 to year 15).

[b] See Table 4.3-2 for list of invasive, non-native species to be monitored and controlled on the mitigation site.

Table 5.3-3. Monitoring schedule for Des Moines Creek Basin mitigation projects.

			Data Collection Year									
Feature	**Activity**	**Duration**	**0**	**1**	**2**	**3**	**5**	**7**	**9**	**10**	**12**	**15**
Hydrology	Shallow groundwater monitoring wells will be installed in the planting area.	Monthly for the first 3 years; semi-monthly thereafter.	X	X	X	X	X	X	X	X	X	X
Vegetation	Measure plant survival.	Late spring or early summer.	X	X	X	X						
	Vegetation sampling to determine cover.	Late spring or early summer.				X	X		X	X	X	X
	Wetland Delineation	March					X			X		X
Reports			X	X	X	X	X	X		X	X	X

Table 5.3-4. Proposed implementation timeline for Tyee Valley Golf Course and Des Moines Creek Buffer projects.

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Tyee Valley Golf Course and Des Moines Creek Buffers																																				
Preconstruction meeting				■																																
TESC, Site Preparation						■	■																													
Conduct minor site grading as necessary per plans								■	■																											
Install plants per planting plan[b]										■	■	■																								
Produce record drawings													■																							
Conduct baseline monitoring															■	■	■	■	■	■																
Begin maintenance and compliance monitoring																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

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[a] Year one starts with the first construction season following issuance of permits. Implementation of mitigation projects may vary from this proposed schedule depending upon coordination with other Master Plan Update projects, contract obligations, or final approval.

[b] Plant procurement will start 6 to 12 months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Planting will be phased such that coniferous species will be planted following the third year of monitoring.

buffer projects will be installed to reduce hazard wildlife attractants. A landscape architect or wetland scientist will observe plant installation to ensure that plants are installed correctly and according to the plans and specifications.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic source. The appropriate geographic source for plant material used in the mitigation is defined as the area that is bounded on the north by the Fraser River Valley, B.C.; on the east by the 1,000-ft elevation of the Cascades; on the west by the 1,000-ft elevation in the Olympic or Coast ranges; and on the south by the Willamette Valley.

5.3.1.10 Construction Steps

General Conditions

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscape work.
- Areas where any landscape work has been completed will be off-limits to all vehicular traffic, and pedestrian traffic will be strictly limited.

Pre-construction Meeting and Site Preparation

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas, stockpile areas, and temporary access/haul roads.
- Implement TESC plan and install TESC measures.
- Install orange barrier fencing around the site and any vegetation to be protected.
- Install fencing and TESC measures around wetlands to be avoided in borrow areas.
- Maintain security of site through construction.
- Implement a spill control plan and identify fueling areas if needed.

Clearing, Excavation, and Grading

- Clear roads and/or culverts from the wetland mitigation site; clear and grub the riparian buffer site.

- Install hydrology monitoring wells at the wetland mitigation site.
- Prepare grading record drawings; modify planting plans as needed to match as-built grades and site conditions.

Irrigation and Landscaping

- Install and test irrigation (irrigation will be designed for the wetland mitigation and buffers; however it may not be needed at the wetland mitigation site).
- Apply hydroseed to any areas of exposed soils.
- Winterize the irrigation system.
- Plant shrub wetland and forested buffer vegetation in fall/winter following grading.

Closeout

- Complete site cleanup by removing temporary haul/access roads and staging areas.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.
- Install permanent fence and/or signs along mitigation site boundary.
- Install barrier fencing, rock gabions, or ecology blocks at the mitigation site boundary if necessary to protect the site from RDF construction activities.

Record drawings, Monitoring, and Maintenance

- Produce grading and planting record drawings for wetland mitigation site and riparian buffers.
- Complete a baseline report, including record drawings and final monitoring plan (e.g., locations of monitoring plots, baseline conditions), for the wetland site, riparian buffers, and borrow areas.
- Begin compliance monitoring during first growing season after planting (or excavation for borrow areas) is complete; submit annual monitoring reports for 15-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

5.3.1.11 Monitoring and Performance Standards

Monitoring for the Des Moines Creek projects will be performed consistent with the approach, methods, and schedule outlined in Section 4 of this report. The focus of monitoring for the Des Moines Creek basin mitigation projects will be to:

- Evaluate the establishment of native wetland and riparian vegetation in the Tyee Valley Golf Course wetland and the Des Moines Creek buffers.

- Monitor groundwater and surface water levels at the Tyee Valley Golf Course wetland mitigation site.

Hydrology, vegetation, and hazard wildlife monitoring will be conducted consistent with the approach and methods described in Section 4. Groundwater monitoring will be conducted on the Tyee Valley Golf Course mitigation site to evaluate seasonal variation in groundwater levels on the site.

Hydrologic Monitoring

A series of permanent shallow groundwater monitoring wells will be installed in the enhanced wetland area at the Tyee Valley Golf Course to evaluate seasonal variation in groundwater levels on the site. Groundwater levels will be recorded monthly for the first 5 years of mitigation and every other month thereafter. The exact number and location of the wells will be determined after location of the enhancement area has been established. Wells will be installed by a licensed well driller and recorded with Ecology.

Vegetation Monitoring

The plantings at the Tyee Valley Golf Course wetland mitigation site and within the Des Moines Creek riparian buffer will be monitored over a minimum 15-year period that begins when plant installation is complete. Monitoring activities will take place in years 0, 1, 2, 3, 5, 7, 9, 10, 12, and 15 to determine species composition, survivorship, height, percent cover, density, and general health and vigor (see Table 5.3-3). Specific performance standards, parameters to measure, and contingency measures for the Des Moines Creek projects are provided in Table 5.3-2. Vegetation monitoring will follow standard vegetation sampling protocols as described in Section 4.

Wildlife Monitoring

The Port will perform wildlife monitoring in the wetland enhancement area according to requirements of the WHMP (USDA 2000). Based on the results of the wildlife monitoring, alterations to vegetation or hydrologic conditions may be necessary to comply with FAA requirements and the WHMP.

5.3.1.12 Site Protection

The Port will execute and file a restrictive covenant for the Des Moines Creek mitigation area. Copies of proposed restrictive covenants are included in Appendix G.

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

5.3.1.13 Maintenance and Contingency Plan

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, replacing plants) will be required during the monitoring period. Routine maintenance and contingency measures will be implemented consistent with the approach described in Section 4. Specific contingency actions for each wetland and riparian buffer performance standard are listed in Table 5.3-2.

5.3.2 Des Moines Creek Basin Trust Fund for Watershed Rehabilitation

To provide opportunities for additional restoration projects in the Des Moines Creek basin the Port will establish a trust fund to support watershed rehabilitation projects. The trust fund will focus on portions of Des Moines Creek not owned by the Port, and where the Port is unable to independently implement stream enhancement projects. The Port will make these trust funds available and defer the selection of appropriate projects to other governmental agencies or interested groups. Restoration or enhancement projects supported by the trust fund are independent of the environmental review and permit process for Master Plan Update projects (e.g., CWA 404/401, HPA), and may require local, state, or federal permits or environmental review.

5.3.2.1 Goal

The goal of this mitigation action is to enhance instream or riparian habitat for salmonids and other aquatic organisms of Des Moines Creeks on land not owned by the Port.

5.3.2.2 Description

The trust fund for watershed restoration will provide $150,000 for restoration projects in the Des Moines Creek basin. Project information for potential projects eligible for funding by the trust fund is based on information provided in the Des Moines Creek Basin Plan (Des Moines Creek Basin Committee 1997) (Table 5.3-5). The trust fund will be established by the Port to fund watershed projects that result in direct habitat benefits to aquatic life in the streams or to remove documented water quality impacts.

Examples of projects eligible for full or partial funding include instream fisheries habitat improvements (e.g., see Figures 5.2-8 through 5.2-11), riparian buffer enhancement, removal of fish passage barriers, and removal of failed septic systems. Additional planning and engineering of selected projects would result in specific project designs, performance standards, monitoring requirements, and contingency measures. Project proponents will be responsible for obtaining federal, state, or local permits required to implement projects.

The trust fund will have a sunset clause of 5 years following issuance of Master Plan Update permits. If, after a 5-year period, projects are not designed and permits have not been sought,[31] the Port will use the money to implement those project(s) identified in the Des Moines Creek Basin Plan that provide water quality or aquatic habitat benefits. The project(s) to be implemented will be at the discretion of the Port, but with approval from Ecology and ACOE.

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[31] The project proponents will be responsible for obtaining federal, state, and local permits required to implement the projects.

Table 5.3-5. **Summary of potential trust fund projects in the Des Moines Creek watershed (projects are as described in the Des Moines Creek Basin Plan, 1997).**

Project	Goals	Description	Performance Standards	Monitoring	Cost Estimate[a]
Habitat Improvements					
Ravine reach [b] (RM 1.0-1.85)	Stabilize steep channel. Provide channel geometry that responds positively to predicted flows.	Construct 20 rock weirs throughout the reach.	Rock weirs remain secure/intact for 10 years.	Assess function and any movement of rock weirs once a year at end of wet season.	$50,000
Treatment plant [b] (RM 0.4-1.0)	Provide pool habitat. Increase channel complexity. Reduce the risk of bank failure adjacent to sewer line access road by diverting high-velocity flows away from road.	Place 4 LWD complexes (4 to 6 logs each) on outside bends and/or channel spanning; install 15 small rock deflectors, each spanning 40% of channel (half immediately upstream of LWD complexes, half in high-velocity areas diverting flow from bank); place 5 small groups (3 to 5 rocks per group) of fish and turning rocks.	LWD complexes, rock deflectors, fish and turning rocks remain secure/intact for 10 years.	Assess functions of LWD complex, rock deflectors, fish and turning rocks; document shifting or accumulation of debris once a year at end of wet season.	$130,000
Park reach [b] (RM 0.0-0.4)	Increase pool habitat. Increase channel complexity.	Place 1 LWD complex (4 to 6 logs) on outside bend and/or channel spanning; install four small rock deflectors each spanning 40% of channel (half immediately upstream of LWD complexes, half in high-velocity areas diverting flow from bank); install 1 small group (3 to 5 rocks) of fish and turning rocks.	LWD complexes, rock deflectors, fish and turning rocks remain secure/intact for 10 years.	Assess function of LWD complexes, rock deflectors, fish and turning rocks; document shifting or accumulation of debris once a year at end of wet season.	$50,000
Wetland reach (RM 1.85-2.15)	Maintain/enhance natural flood storage function of wetland system.	Add woody debris to stream and/or buffer.	Installed habitat features remain secure/intact instream channel for 10 years.	Assess functions of installed habitat features; document shifting or accumulation of debris once a year at end of wet season.	$10,000
Septic systems [b]					
	Reduce fecal coliform levels and improve other water quality parameters in Des Moines Creek.	Identify houses within areas not connected to sanitary sewer. Connect problem septic systems to sewer lines.	Identified houses are connected to sewers and septic systems are decommissioned.	As-built monitoring to verify completion.	$ 150,000

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[a] This cost estimate reflects 1997 dollars.

[b] Identified as "regional high priority" in the basin plan.

5.3.2.3 Eligibility

The Port or a designated administrator will consider requests for monies from the watershed trust fund to implement stream habitat enhancement projects. Requests must be made by King County, the cities of SeaTac or Des Moines, tribal governments, non-profit organizations, or combinations of such governments through interlocal agreements (ILAs). Organizations requesting funding must comply with general liability insurance requirements established by the Port.

Key criteria to be used in evaluating proposals to implement projects in Table 5.3-5, as well as other projects within the watershed, include the following:

- A demonstrated benefit to salmon or aquatic habitat without creating significant avian wildlife habitat within 10,000 ft of runways at STIA.
- Consistency with watershed management plans, or with prescriptions/recommendations identified using watershed analysis or stream assessment procedures.
- Clearly defined project goals, implementation plans, performance standards, and post-project monitoring.
- Preference for resolving underlying causes of problems rather than treating symptoms.
- Cost-effectiveness.

5.3.2.4 Implementation

The Des Moines Creek Basin Committee, the King County Watershed Coordinator, Puget Sound Restoration Fund, or other responsible entity will administer the fund. The administrator will establish eligible project criteria, application forms, project cost limits, implementation and monitoring requirements, etc. The Port will review and approve the project goals, plans, performance standards, and monitoring requirements to enhance the ultimate success of the projects. The Port, or the administrator at the Port's request, will provide status reports to Ecology and ACOE.

5.3.2.5 Site Protection

Site protection of enhancement projects will be coordinated with property owners and the fund administrator.

5.3.2.6 Monitoring and Contingency

The fund administrator will review project design, implementation, and as-built plans to verify that the project is built as intended. Contingency actions associated with establishment or operation of the fund will be reviewed with the Port, ACOE, Ecology, and the fund administrator.

5.3.3 Preventing Indirect Impacts to Wetland Near Borrow Areas 1 and 3

Mitigation to prevent indirect impacts to wetlands near Borrow Areas 1 and 3[33] is described in this section. Borrow Areas 1 and 3 will be excavated to provide fill material for the third runway and embankment construction (see Figure 4.1-2). Borrow area excavations have been designed to the extent practicable to avoid direct impacts to wetlands. Hydrological studies conducted by Hart Crowser (Hart Crowser 2000b,c, 2001b) indicate that the potential for indirect impacts to the hydrology of wetlands near the borrow areas is low. To further avoid and minimize potential indirect impacts, mitigation actions and monitoring is planned. Mitigation consists of drainage systems that collect surface runoff and/or groundwater seepage and direct this water to the wetlands.

Following construction, groundwater levels will be monitored in wetlands near the borrow areas to verify that wetland hydrology is present and able to maintain existing vegetation (Table 5.3-6).

Actions taken to avoid, minimize, and mitigate potential indirect impacts to wetland hydrology adjacent to the borrow areas are not included in the calculation of mitigation credit for the Master Plan Update projects. Wetlands subjected to hydrologic monitoring are:

Borrow Area 1: Wetlands B1, B4, B12, B15, 32, 48

Borrow Area 3: Wetlands B5, B6, B7, B9, B10, 29, 30.

5.3.3.1 Borrow Area Site Descriptions

The borrow areas are located south of the airfield between 24th Avenue South and 15th Avenue South, and between South 200th Street and South 216th-Street (see Figure 1.3-1). Most of these areas were formerly residential neighborhoods. Between 5 and 20 years ago, the area was acquired and cleared as part of STIA's noise abatement program.

Borrow Area 1 is located east of Des Moines Creek. The area slopes toward Des Moines Creek. Nine wetlands are located in Borrow Area 1 (Wetlands B1, B4, B11, B12, B14, B15a, B15b, 32, and 48).

Borrow Area 3 is located west of Des Moines Creek. The borrow area is bordered on the west by a relatively level plateau that slopes steeply down to a series of depressions in the southeast portion of the borrow area (Appendix H, Figure 1). The northern half and the western edge of the borrow area are high points approximately 40 ft to 120 ft higher than the low point in the southeast corner. Eight wetlands occur in Borrow Area 3 (Wetlands B5, B6, B7, B9a, B9b, B10, 29, and 30).

5.3.3.2 Hydrology of Borrow Area Wetlands

Borrow Area 1 contains wetlands whose hydrology is maintained by both groundwater and precipitation-sources. Wetlands B1, B11, B14, and 32 are depressional wetlands maintained by precipitation and surface water runoff. Wetlands B4, B12, B15, and 48 are slope wetlands maintained by groundwater seepage. Water surfacing in these slope wetlands flows downslope to Des Moines Creek. Surface water hydrology in the general vicinity of Borrow Area 1 has been

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[32] The hydrology in Wetland 28, located north of Borrow Area 4, will also be monitored.

[33] The hydrology in Wetland 28, located north of Borrow Area 4, will also be monitored.

Table 5.3-6. **Final Performance Standards, Evaluation Approach, and Contingency Measures for Monitoring Borrow Area Wetlands.**

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
Maintain wetland hydrology by redirecting surface water runoff to the wetlands near Borrow Area 1.	Soils in wetlands near Borrow Area 1 (Wetlands 48 and B15) will be saturated to the surface from December to April in years of normal[a] rainfall.	Shallow groundwater monitoring wells.	Minor grading to direct surface water runoff to wetlands
Maintain wetland hydrology by directing groundwater seepage and surface water runoff via an interceptor swale to wetlands in and near Borrow Area 3.	Wetland 30 will have shallow standing water up to 24 inches deep during the breeding season for resident amphibians (i.e., December through April).	Shallow groundwater monitoring wells and measurement of surface water depths.	Adjust length and discharge points of interceptor swale system
	Wetland 29 will have soils saturated to the surface from December through April in years of normal[a] rainfall.	Shallow groundwater monitoring wells.	Adjust length and discharge points of interceptor swale system
Wetland vegetation will remain in wetlands adjacent to and downslope of borrow areas 1, 3, and 4.	Wetland indicator status (WIS) of the dominant non-invasive plant species will not differ from pre-project conditions during or at the end of the monitoring period. Each vegetation strata (trees, shrubs, and emergents) shall be assessed separately, and have separate conclusions. Statistically valid sampling procedures will be employed to monitor these potential changes, in all areas where there is a potential to change the post construction hydrology (downslope of the embankment and the borrow sites). WIS status of the vegetation will be calculated as in the 1987 USACE wetland delineation manual.	Vegetation sampling to determine plant cover, dominance, and presence of invasive species.	For Borrow are 3, alter distribution of water from the interceptor swale For other wetlands, review grading and drainage patterns of borrow sites. Regrade to provide additional water to wetlands of concern.

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[a] Normal rainfall will be based on the definition for 'most years' given in the USACE 1987 Manual (i.e. annual precipitation in a normal year must be the same as or greater than precipitation in 5 years out of 10) or the average precipitation for a time period plus or minus 1 standard deviation of the mean.

altered by the system of storm drains, culverts, and drainage ditches constructed when the area was developed. Since clearing the area for the noise abatement program, these surface drainage features have been abandoned and have deteriorated to such an extent that past drainage patterns are changing.

Wetland 29 occurs on the hillside at the west edge of the Borrow Area 3. Hydrology in this wetland is supported by groundwater seeps discharging on the face of the slope from a zone of perched groundwater that extends to the north and west (Hart Crowser 2000b, c; 2001b; Appendix H). Wetlands 30, B7, B6, and B5 occupy a series of depressions in the lower southeastern corner of Borrow Area 3. These wetlands may be supported by some shallow subsurface flow or interflow moving downslope from Wetland 29 (Hart Crowser 2000b,c), and by precipitation. Since these wetlands occur below the main perched groundwater layer on this site, the perched groundwater is available to continue to support wetland hydrology. Water is held in these wetlands by the relatively impermeable soils lining the depressions, promoting shallow perched conditions (Hart Crowser 2000c).

5.3.3.3 Actions to Avoid, Minimize, and Mitigate Indirect Impacts

Borrow Area 1

The excavation in Borrow Area 1 has been designed to avoid direct impacts to Wetlands B1, B4, B15a, B15b, 32, and 48 (see Figure 3.1-2). Indirect impacts to wetlands downslope of the borrow area will be minimized by not excavating portions of the borrow area that lie within the watershed of these wetlands. Hydrology in these wetlands appears to be maintained by seasonal groundwater that perches on the till soils following periods of high rainfall. The existing SDS on 20th Avenue South collects surface runoff and directs it away from these wetlands. This SDS forms the eastern edge of the watershed for Wetlands 48, B15a, and B15b. Since excavation will not occur west of 20th Avenue South, the watersheds of these wetlands will not be altered and indirect hydrologic impacts are not expected to occur.

Wetland hydrology will be monitored in Wetlands 48, B15a, and B15b to verify that wetland hydrology continues to be present in these wetlands (see Table 5.3-6).

Borrow Area 3

A drainage swale will be installed during the excavation of Borrow Area 3 to convey groundwater to Wetland 29 and replace the potential loss of seepage from the perched groundwater zone (Appendix H, Figures 3, 7, and 8). This swale will collect groundwater seepage from the excavated slope face on the north and west sides of Borrow Area 3. Flow in this swale will be collected and conveyed south in a swale that drains into Wetland 29 (Appendix H, Figure 3).

Since the swale will extend for the full length of the seepage face in the borrow area, it may convey flows in excess of those needed to support hydrology in Wetland 29 and downslope wetlands (i.e., Wetland 30, which receives overland flow and shallow interflow from Wetland 29). Two measures will be used to manage excess flows and to optimize the distribution of water to Wetland 29. A flow control structure (weir and diversion structure) will be constructed in the swale just before it flows into Wetland 29 (Appendix H, Figure 9). This control structure will allow a controlled flow rate to be directed into Wetland 29 and enable diversion of other flows away from the wetland and into the base of Borrow Area 3. Diverted flows will either be allowed to infiltrate at the base of Borrow Area 3 or be diverted to stormwater management facilities that will be constructed to manage runoff from the remainder of the borrow area. The length of the collector swale can also be modified (consistent with the adaptive management approach) based on post-construction monitoring to control the amount of seepage and runoff that is collected in the swale and diverted to Wetland 29.

Studies of borrow area hydrology indicate that impacts to the hydrology of the remaining wetlands in Borrow Area 3 (B5, B6, B7, B9a, B9b, B10, and 30) are not anticipated (Hart Crowser 2000a,b,c). Wetlands in Borrow Area 3 will be monitored before, during, and after excavation to verify that wetland hydrology will remain. If Wetlands 29 and 30 do not meet hydrologic performance standards developed for them (see Table 5.3-6), then contingency measures will be implemented. The collector swale system also can be used to divert additional water to Wetlands 29 if necessary.

5.3.3.4 Hydrology Monitoring

Permanent shallow groundwater monitoring wells will also be installed in wetlands near borrow areas to verify there are no indirect hydrologic impacts. Groundwater levels will be recorded monthly for the first 5 years, and then every other month thereafter. In addition, a staff gage will be installed in Wetland 30 to allow monitoring of the extent and duration of surface water ponding that provides habitat for amphibians. Water levels will be monitored according to conditions of the *401 Water Quality Certification*, September 21, 2001 (Ecology 2001).

Evaluation of hydrology in wetlands near Borrow Areas 1 and 3 will be based on shallow groundwater data collected during pre- and post-construction periods. Borrow Area Wetlands 48, B15, 32, B12, B4, and B1 will be evaluated. All wetlands adjacent to Borrow Area 3 will be evaluated.

The Port will collect bi-monthly hydrologic monitoring data during the wet season, November through May, for at least 3 years after completion. Maps of sample locations and vegetation in the surrounding areas, observation of stressed vegetation, any adaptive management implemented in the surrounding areas, comparison to baseline data, and conclusions will be documented and submitted to Ecology on a monthly basis during that period. At the end of each water year the Port will complete and submit to Ecology a trends analysis with proposed contingency measures if needed. A schedule for completion of the proposed contingency measures will also be provided.

In Borrow Area 3, special emphasis shall be given to the area near where the drainage swale discharges into Wetland 29, to provide an early indication of hydrologic changes that may affect vegetation in the wetland. In Wetland 30, the evaluation approach will include measurements of surface water depths taken at least measured monthly during the period from December through April, and the monitoring results compared to pre-construction data.

5.3.3.5 Wetland Delineation

Wetlands in the mitigation area will be delineated in years 5, 10, and 15. A licensed survey crew shall map the wetland boundary, and maps will be provided to Ecology by December 31st of the year the delineation was completed. If wetland boundaries have decreased, additional mitigation may be required.

5.3.3.6 Protection and Maintenance

The drainage swale, downslope wetlands, and the unexcavated southern portion of Borrow Area 3 study area will be placed in restrictive covenents (see Appendix G). Periodic inspection and maintenance of the channel may be required to assure that it continues to perform as designed.

The wetland protection swale will be inspected and maintained at a minimum frequency of 2 times per year. Swale maintenance will include adjustment of flow control weir boards to provide appropriate flows to Wetland 29 and removal of vegetation or fill in the swale which may interfere with the seepage collection and diversion functions of the swale. A weir gage will be installed and calibrated. The gage will be marked with water depth and flow rates as that weir discharges can be determined immediately.

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

Stormwater Management

6. HYDROLOGIC IMPACTS AND MITIGATION

This section describes actions incorporated into the STIA Master Plan Update improvements to mitigate potential impacts to water quantity and quality in the Miller, Walker, and Des Moines Creek basins. Existing water quantity and quality conditions, future changes in land use that affect surface water runoff, and projected future conditions under the Master Plan Update improvements and the proposed mitigation actions are summarized in this section.

Section 6.1 describes the proposed stormwater management program to control stormwater peak flow rates and flow durations from both newly developed project areas and existing airport areas. Proposed facilities, including approximately 344.1 acre-ft of new stormwater detention storage at 14 locations, will mitigate the impacts of new impervious surfaces on flows in Miller, Walker, and Des Moines Creeks. Section 6.2 summarizes actions to mitigate water quality impacts, including water quality treatment using BMPs and source controls, erosion and sediment control, and elimination of existing activities that degrade water quality. The flow control and water quality mitigation activities summarized below are based on stormwater information provided in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a).

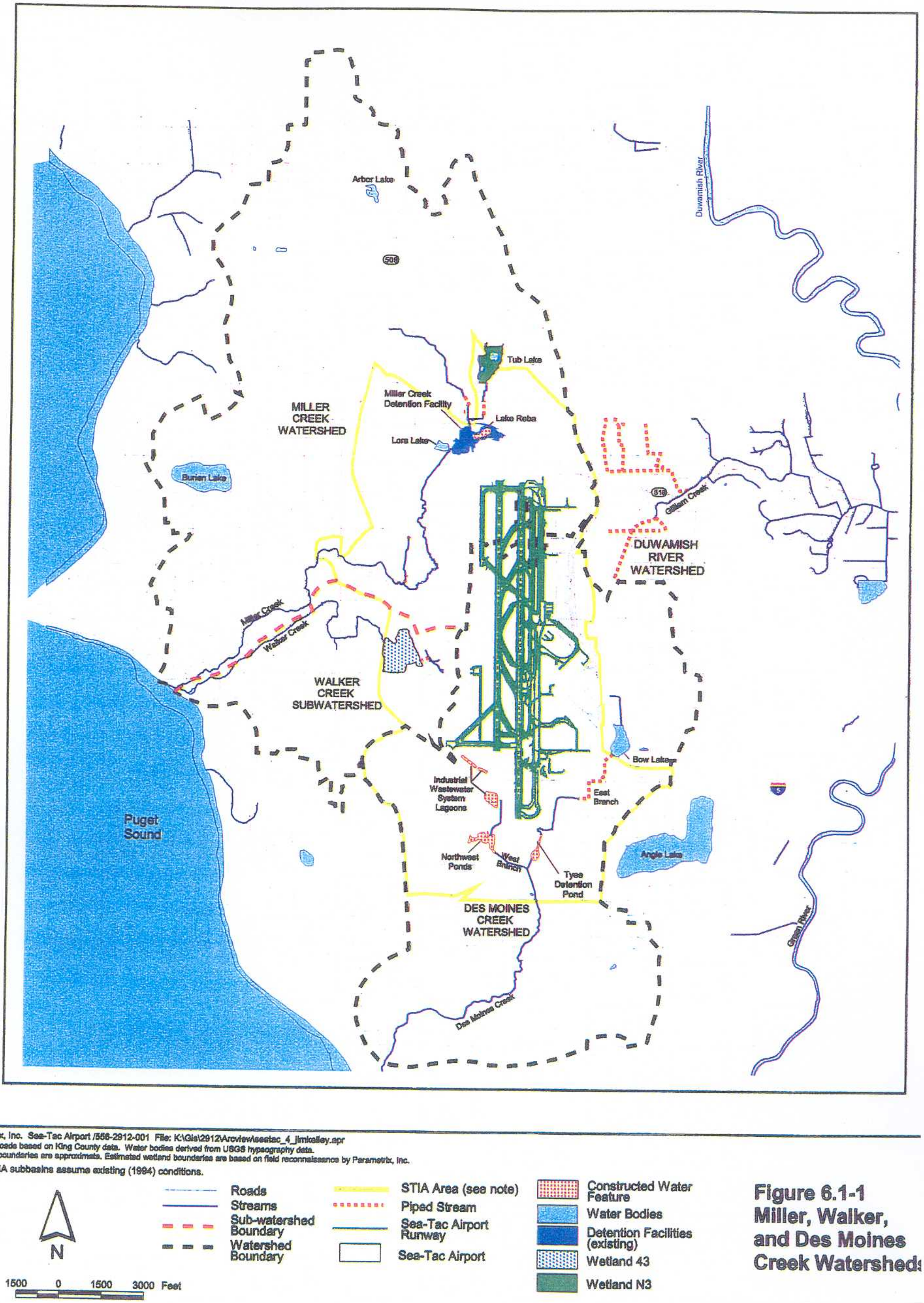
6.1 WATER QUANTITY

The Master Plan Update improvements could increase peak flows and reduce base flows in Miller, Walker, and Des Moines Creeks (Figure 6.1-1), thereby impacting aquatic habitat in these streams. The addition of new impervious area associated with the Master Plan Update improvements affecting the hydrology of these streams is discussed in the following sections, along with associated mitigation measures that compensate for these actions.

6.1.1 Stormflow Impacts

The activities associated with the Master Plan Update improvements will include adding new impervious surfaces (new runways, taxiways, parking, and roadways) and filling wetlands. This action, if unmitigated, could change the hydrologic flow regime of Miller, Walker, and Des Moines Creeks, including increased peak flow magnitude and frequency, and increased elevated flow duration. The potential effects of high-flow impacts in the stream are increased erosion and sedimentation, habitat damage from scouring flows, and impaired habitat use during high-flow periods.

Proposed peak flow mitigation reduces peak flows from existing levels in both streams, which will reduce bank and channel erosion as well as sedimentation in downstream reaches, including estuaries. Additional detail on hydrology and stormwater management are provided in the (Parametrix 2000a, 2001a). The plan includes modeling conducted to estimate the impacts of the project on the Miller, Walker, and Des Moines Creek systems. The HSPF model was used for this purpose.



metrix, Inc. Sea-Tac Airport /556-2912-001 File: K:\Gis\2912\Arcview\seatac_4_jimkelley.apr
ce: Roads based on King County data. Water bodies derived from USGS hypsography data.
tion boundaries are approximate. Estimated wetland boundaries are based on field reconnaissance by Parametrix, Inc.
: STIA subbasins assume existing (1994) conditions.

Figure 6.1-1 Miller, Walker, and Des Moines Creek Watersheds

6.1.1.1 Wetland Fill

The potential impacts to the hydrology of Miller, Des Moines, and Walker Creeks from filling 18.37 acres of wetlands are the loss of stormwater storage, groundwater recharge, and groundwater discharge. These functions are discussed below, and all wetland hydrologic functions are accounted for in the HSPF model, which assesses runoff impacts by various input parameters and calibration.

Stormwater Storage

Most wetlands filled by the project provide limited stormwater storage because they do not occur in closed basins or basins with restricted outlets that would allow water to pond during storms, and release water slowly following storms. Most wetlands occur on moderate to gentle slopes and are free-draining (seldom, if ever, ponding water).

In contrast, flood storage functions are provided by the riparian wetlands located in the 100-year floodplain of Miller Creek. Approximately 8,455 cy of flood storage would be filled at Vacca Farm, and approximately 9,589 cy of new floodplain will be excavated adjacent to the stream. All flood storage, including that provided by wetlands, is accounted for in the calibration of the HSPF model; design of stormwater detention facilities using this model will assure that flow mitigation is provided to account for impacted wetlands.

Groundwater Discharge

Several wetlands are sites of groundwater discharge, and thereby potentially provide base flow support to streams during all or portions of the year. Where fill occurs in these wetlands, the project has been designed to allow these discharge functions to continue. For example, the third runway embankment is designed with an internal drainage system that will collect water that currently infiltrates on the airfield and discharges in wetlands near 12th Avenue South. The drainage system will also collect water that infiltrates into the new embankment, and discharge it to wetlands and Miller Creek (see Section 5.2.3). Drainage systems associated with the retaining wall, which will be constructed to reduce wetland impacts, will also convey groundwater downslope to wetlands and the stream. Groundwater discharge effects on base flow are accounted for in the calibration of the HSPF model.

Groundwater Recharge

Most wetlands affected by fill are unlikely to have significant groundwater recharge functions because they occur on till soils, where layers of till restrict groundwater recharge. These low permeabilities result in poor drainage conditions, which in combination with topography and surface drainage features, promote the development of wetlands. Other wetlands occur in areas of known groundwater discharge (i.e., wetlands formed by local groundwater discharges) and thus cannot recharge groundwater. However, the HSPF model is based on the premise that all wetlands infiltrate; thus the model conservatively accounts for potential impacts to groundwater recharge as a result of filling these wetlands. Overall, development of impervious surfaces from Master Plan Update improvements could reduce groundwater recharge and eventual groundwater discharge to streams. These functions are accounted for in the HSPF model, and mitigation for these effects is included in the activities discussed in Sections 5 and 7 of this document, as well as in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a).

6.1.1.2 Indirect Hydrologic Impacts/ Impact Avoidance

Where feasible and practicable, direct and indirect impacts to the hydrologic functions of wetlands (base flow, groundwater discharge, and stormwater storage) have been avoided (Parametrix 2000a, 2001a,b). For example, within the three borrow areas, direct and indirect impacts to hydrologic functions of wetlands were avoided or minimized by protecting several wetlands and their upslope watersheds from excavation. Wetlands located downslope of excavation or fill areas will continue to receive ground and surface water from upslope areas because BMPs for water quality, site grading, and other surface water management features will allow clean water to continue to discharge to them. Additionally, rainwater will continue to infiltrate on the borrow sites because no impervious surface will be added, and this water will be available to recharge downslope wetlands and Des Moines Creek.

6.1.1.3 Impervious Area

In the Miller Creek Basin, Master Plan Update improvement projects will result in a net increase of 105.6 acres[33] of impervious surface area (Table 6.1-1), increasing the overall impervious area in the basin by about 1 percent above the existing baseline condition (about 23 percent of impervious surface; Parametrix 2000a, 2001a). In the Walker Creek basin, Master Plan Update improvements will result in a net increase of 6.2 acres of impervious surface. In the Des Moines Creek basin, Master Plan Update improvements will result in a net increase of 128.2 acres of impervious surface, increasing the overall impervious area in the basin by about 4 percent above the existing base condition (approximately 32 percent impervious surface; Parametrix 2000a, 2001a).

The new impervious surfaces could increase stormwater runoff rates (FAA 1996) and volumes. Unless mitigated, changes in runoff would be expected to increase flooding and erosion, and degrade instream habitat and water quality in Miller, Walker, and Des Moines Creeks downstream of stormwater inputs from the improved areas. As discussed below, the Port's *Comprehensive Stormwater Management Plan* includes mitigation to manage runoff from newly developed Master Plan Update improvement areas. In addition, existing hydrologic impacts from existing impervious surfaces will be mitigated.

6.1.1.4 Flow Control for New Master Plan Update Improvements and Retrofitting for Existing Airport Areas: Level 2

To protect instream and estuarine habitat, the Port has committed to achieving streamflows that maintain or reduce existing peak flow magnitude and duration in Miller and Des Moines Creeks. The Level 2 flow control standard, as defined by the King County Manual (King County DNR 1998), requires matching or improving post-developed flow duration to pre-developed flow durations[34] for all flow magnitudes between 50 percent of the 2-year event and the full 50-year event.

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[33] The net change in impervious area includes removal of approximately 50 acres of impervious surfaces (streets, driveways, and rooftops) that will result when existing houses and streets are removed in the acquisition area. Demolition in these areas is ongoing and expected to be completed by 2002.

[34] Flow duration control refers to limiting the duration of geomorphically significant flows (i.e., those flows that initiate bedload movement) to baseline (pre-Master Plan Update) conditions.

Table 6.1-1. Summary of Miller, Walker, and Des Moines Creek drainage areas at STIA and change in impervious area between 1994 baseline and 2006 future conditions (acres).

Stormwater	1994 Baseline			2006 Future Condition			Increase in
Outfall[a]	Pervious	Impervious[a]	Total	Pervious	Impervious[a]	Total	Impervious Area
Miller Creek							
SDN1	6.2	9.9	16.1	3.5	12.7	16.1	2.8
SDN1LWR	5.0	0.4	5.4	4.9	0.6	5.4	0.2
SDN1OFF	25.8	10.5	36.3	28.3	8.0	36.3	-2.5
SDN2X	7.2	0.3	7.5	5.3	2.2	7.5	1.9
SDN3	33.4	14.5	47.9	23.6	24.3	47.9	9.8
SDN3A	28.6	1.9	30.5	22.2	8.2	30.5	6.3
SDN3X	25.4	0.0	25.4	25.4	0.0	25.4	0.0
SDN4	27.7	2.6	30.3	18.1	12.3	30.3	9.7
SDN4X	14.1	1.1	15.2	11.0	4.2	15.2	3.1
SDW1A	52.0	0.9	52.8	37.4	15.4	52.8	14.5
SDW1B	92.5	4.3	96.9	69.9	27.0	96.9	22.7
NEPL	41.4	0.9	42.3	10.0	32.3	42.3	31.4
CARGO	7.0	1.1	8.1	0.0	8.1	8.1	7.0
Other STIA[b]	246.5	15.1	261.8	247.8	13.8	261.8	-1.3
Total							**105.6**
Walker Creek							
SDW2	41.3	3.3	44.6	35.1	9.5	44.6	6.2
M8	22.2	6.6	28.8	22.2	6.6	28.8	0.0
M9	76.1	22.5	98.6	76.1	22.5	98.6	0.0
Total							**6.2**
Des Moines Creek							
SDE4	50.7	115.5	166.2	40.1	126.1	166.2	10.6
SDS1	0.9	16.8	17.7	1.4	16.3	17.7	-0.5
SDS2	7.7	1.5	9.2	8.1	1.0	9.2	-0.5
SDS3	165.5	178.0	343.5	144.3	199.2	343.5	21.2
SDS3A	62.7	7.1	69.8	34.6	35.1	69.8	28.0
SDS4	45.4	19.2	64.6	32.1	32.5	64.6	13.3
SDS5	32.1	0.4	32.5	28.3	4.2	32.5	3.8
SDS6	12.5	4.3	16.7	13.5	3.2	16.7	-1.1
SDS7	83.2	8.0	91.3	55.1	36.2	91.3	28.2
SASA	25.3	8.9	34.3	0.0	34.3	34.3	25.4
Other STIA[c]	136.1	57.7	194.4	136.0	57.5	193.5	-0.2
Total							**128.2**
IWS							
NCPS	6.9	28.8	35.7	4.8	30.9	35.7	2.1
NSMPS	6.6	0.0	6.6	4.7	2.0	6.6	2.0
NSPS	0.3	13.5	13.8	0.3	13.4	13.8	-0.1
Primary	24.9	277.6	302.6	13.5	289.1	302.6	11.5
SASA	51.8	6.5	58.3	0.1	58.3	58.4	51.8
Total							**67.3**
TOTAL	**1465.0**	**839.7**	**2305.8**	**1157.7**	**1147.0**	**2304.9**	**307.3**

Note: Rows may not total exactly as shown due to rounding. Source: Geographic Information System (GIS) coverage.

[a] Locations of stormwater outfalls are mapped in the *Comprehensive Strormwater Management Plan* (Parametrix 2000a, 2001a).

[b] Impervious area includes impervious area, lakes, and detention ponds.

[c] This includes outfalls MC6 and MC7.

The Level 2 analysis is more protective than stormwater control standards that have been used in the past. Previous controls allowed using an "event model," which is a hydrologic model that compares pre-development runoff with post-project runoff using a hypothetical design storm; only peak flows were evaluated for compliance with standards. The Level 2 analysis used in the *Comprehensive Stormwater Management Plan* requires that a "continuous simulation" model (HSPF) be used and actual precipitation runoff is modeled. Pre-development runoff is compared with post-project flows over a range of probable flows. Level 2 flow analysis evaluates flow protection and mitigation measures over a wide range of erosive stormflows, whereas Level 1 analysis and event models are only protective of certain peak flows or flooding events. Level 2 is more protective of stream morphology, habitat (such as stream substrate), and hydrologic flow patterns.

The pre-developed condition for the Level 2 standard will be based on a *target flow regime*. The target flow regime used assumes that the existing watershed land cover is 10 percent impervious (or less if the existing impervious area is less that 10 percent impervious), 15 percent pervious "grass," and 75 percent pervious "forest."[37] Basing target flow on theoretical basin development of 10 percent (Miller Creek and Des Moines Creek existing impervious areas are 23 percent and 32 percent, respectively) is expected to reduce existing peak flows and be beneficial in maintaining stable stream channels (Parametrix 2000a, 2001a).

In the Des Moines Creek basin, the target flow regime was determined in a study by the University of Washington (King County CIP Design Team 1999). The flow regime determined for Des Moines Creek coincides with a target flow regime that would occur with an effective watershed impervious area of 10 percent. In studies of several Puget Sound streams, Booth and Jackson (1997) identified an approximately 10 percent impervious area threshold above which stream channel instability and habitat degradation occur.

The net result of flow retrofitting in the watersheds will be to reduce existing stormwater peak flows downstream of STIA in Miller and Des Moines Creeks *before flow impacts and controls for the Master Plan Update improvements are considered*. That is, even though the Miller Creek and Des Moines Creek watersheds have an existing impervious area of about 23 and 32 percent, respectively (Parametrix 2000a, 2001a), the flows from areas draining the airport will be reduced to a level corresponding to approximately 10 percent impervious area.[38]

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[36] Flow duration control refers to limiting the duration of geomorphically significant flows (i.e., those flows that initiate bedload movement) to baseline (pre-Master Plan Update) conditions.

[37] In areas where existing impervious area is less than 10 percent, the impervious area is not changed and the difference between actual percent impervious and 10 percent is assumed to be grass.

[38] The HSPF model was calibrated with recorded flow data and actual basin land use prior to simulation of adding Level 2 flow control retrofits. The calibration accounts for flows attributable to each type of land use, based on existing conditions. Flows for other land use and hydrologic control conditions (such as 10 percent impervious surfaces and the Level 2 flow control retrofit) were then simulated using the HSPF model.

6.1.1.5 Estimated Detention Storage Requirements

Proposed stormwater detention facilities for the Master Plan Update improvements were designed based on the drainage area served by each facility, the detention standard, the detention storage volume required to meet the flow control standards, and potential for waterfowl attraction. Approximately 344 acre-ft of new stormwater detention storage will be needed to mitigate the impacts of increased stormwater runoff (Table 6.1-2) associated with Master Plan Update improvements. The locations of new facilities are shown in Figure 6.1-2.

For sub-watersheds draining to the Des Moines Creek RDF or the Miller Creek detention facility, additional future analysis by the Port or the Basin Committees may show that the target flow and Level 2 standards can be met in the regional facilities. Stormwater detention facilities shown by the Port may be modified, with approval by Ecology, to reflect available detention in the regional facilities. In either case, the objective to meet the target flow using the Level 2 standard for both streams will be achieved.

Pond and Vault Construction and Operation

The feasibility of proposed stormwater ponds and vaults is demonstrated by the recent construction of similar facilities at STIA, including the North Employees' Parking Lot Vault (1997) and the Interconnecting Taxiways Vault (1998). Only the SASA detention pond will displace wetlands, a 0.06-acre shrub wetland. All other on-site detention facilities will be constructed in non-wetland areas. The primary discharge from the detention facilities will be surface discharge (not infiltration). However, infiltration is proposed at two stormwater facilities, SDW1A and SDW1B, to enhance base flows and reduce detention facility size. Detention facilities will consist of dry ponds with live storage[39] and will not include wet ponds with dead storage.[40]

Net Result of Hydrologic Mitigation

The net result of flow controls for the Master Plan Update improvements will be to maintain or reduce peak flows in Miller, Walker, and Des Moines Creeks to a stable flow regime downstream of STIA discharges (Tables 6.1-3 and 6.1-4). Stormwater facilities will retrofit existing flows to the target watershed flow regime pre-development conditions before new development is considered. The net effect of flow controls for Miller, Walker, and Des Moines Creeks (Figures 6.1-3, 6.1-4, 6.1-5, and 6.1-6) will be to maintain stormflows below existing conditions or the target watershed flow regimes following Master Plan construction and peak flow mitigation, whichever is less. The target flow regime will reduce flows in the stream channels, thereby reducing erosion and improving channel stability.

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[39] Live storage is that volume of stormwater stored in a detention facility that drains following the storm. Live storage is used for hydrologic benefit to reduce flow peaks and durations.

[40] Stormwater for supplemental lowstream flow may be stored as dead storage in vaults.

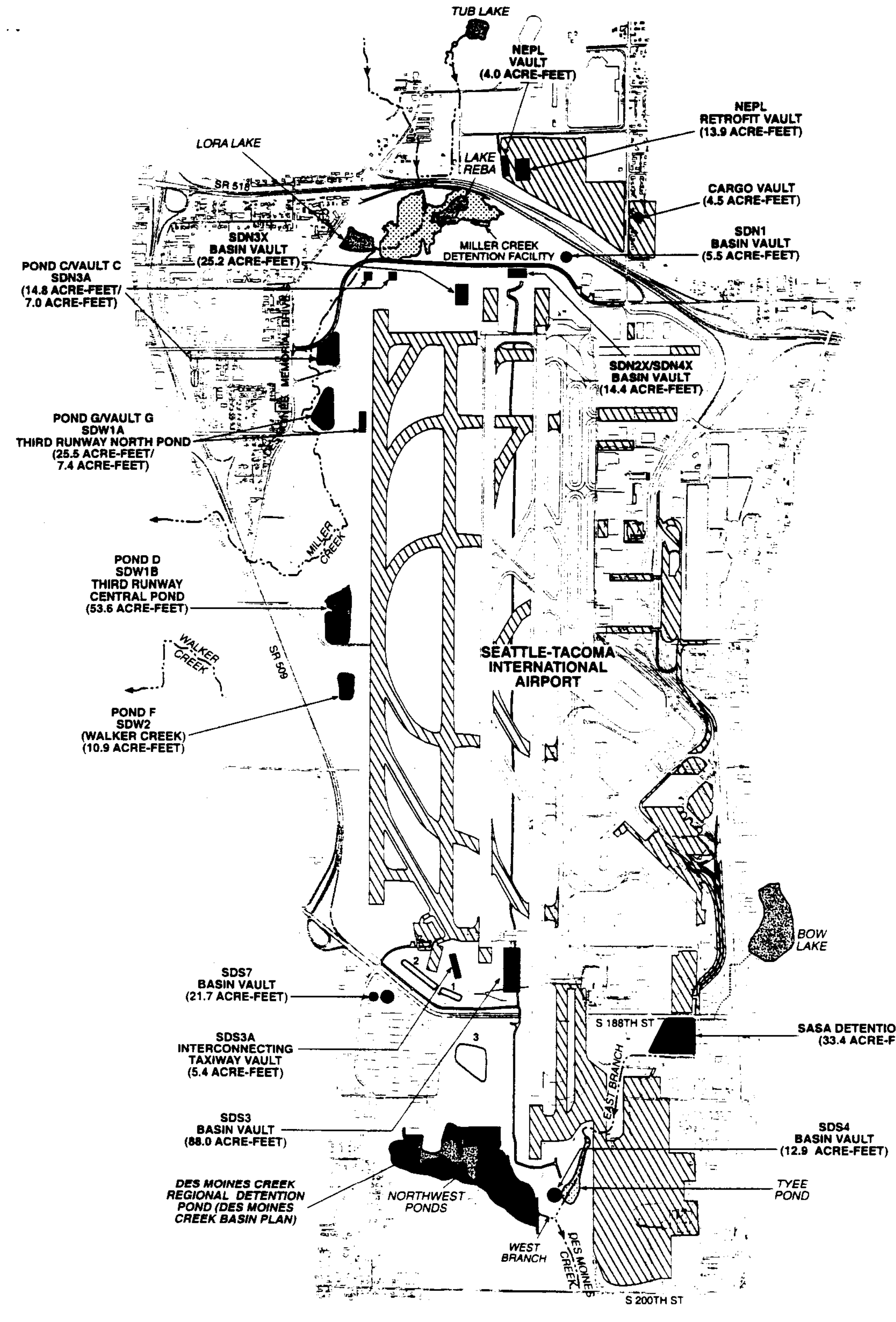
Table 6.1-2. Summary of required detention facility volumes.

Watershed	Hydrologic Evaluation Point	Volume Required (acre-ft)	Type of Facility[a]	Comments
Miller Creek	**NEPL**	**13.9[b]**	**Vault**	**In addition to existing 4 ac-ft**
	CARGO	4.5	Vault	
	SDN2x + SDN4x	44.4	Vault	
	SDN3/3x	25.2	Vault	
	SDN1	5.5	Vault	
	SDN3A	Pond: 14.8 / Vault: 7.0	Pond/Vault	
	SDW1A	Pond: 25.5 / Vault: 7.4	Pond/Vault	Infiltration used
	SDW1B	53.6	Pond	Infiltration used
Total Miller Creek		**171.8**		
Total Walker Creek	**SDW2**	**10.9**	**Pond**	
Des Moines Creek	**SASA Detention Facility**	**33.4[c]**	**Pond**	
	Interconnecting taxiway (SDS3A)	5.5	Vault	
	Third Runway South (SDS7 and 6)	21.6	Vault	
	SDS3	88.0	Vault	
	SDS4	12.9	Vault	
Total Des Moines Creek		**161.4**		

[a] Types of facilities are: Vault – an enclosure with multiple orifice outlets on a vertical riser with overflow spillway; or Pond – open earth construction with netting or other means to provide wildlife deterrent.

[b] This is the volume needed to retrofit the existing facility.

[c] This is the volume required to retrofit the STIA area only.



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▨ Water Features

■ Proposed Stormwater Detention Facilities (With Simulated Maximum Storage Volume)

▧ Master Plan Projects

—·—·— Creek

········ Piped Creek

░ Detention Facility

SCALE IN FEET

0 750 1,500

N

Figure 6.1-2
Proposed Detention Facilities for Master Plan Projects

Table 6.1-3. Summary of flood peak flow frequency results for Miller/Walker Creek subbasins (all values are cfs).

Return Period Peak	NEPL		CARGO		SDW2		SDW1B		SDN3A (Vacca)	
	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	0.61	0.22	0.12	0.05	1.65	0.58	0.68	0.20	0.27	0.09
Q_2	1.22	0.44	0.24	0.09	3.30	1.16	1.35	0.40	0.53	0.18
Q_{10}	1.70	0.73	0.33	0.14	6.22	3.14	2.11	0.71	0.75	0.32
Q_{25}	1.96	0.96	0.38	0.18	7.71	5.06	2.57	1.04	0.87	0.44
Q_{50}	2.16	1.18	0.42	0.21	8.82	7.13	2.96	1.04	0.96	0.56
Q_{100}	2.37	1.46	0.46	0.25	9.92	9.95	3.39	1.89	1.05	0.70

Return Period Peak	SDWIA		SDN3, SDN3X		Combined SDN2X/SDN4/SDN4X		Miller Creek at Detention Facility	
	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	0.15	0.006	0.71	0.25	0.57	0.20	19.66	19.78
Q_2	0.30	0.01	1.41	0.50	1.15	0.39	39.31	39.56
Q_{10}	0.58	0.05	2.01	0.83	1.61	0.68	56.11	56.41
Q_{25}	0.79	0.12	2.33	1.06	1.86	0.95	64.06	64.38
Q_{50}	0.99	0.25	2.58	1.27	2.06	1.22	69.82	70.17
Q_{100}	1.24	0.52	2.84	1.52	2.26	1.57	75.47	75.85

Return Period Peak	Miller Creek at SR509		Walker Creek at South 12th Street		SDN1	
	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	22.81	22.72	1.65	0.58	0.28	0.12
Q_2	45.62	45.44	3.30	1.16	0.56	0.24
Q_{10}	67.23	65.61	6.22	3.14	0.79	0.40
Q_{25}	77.29	74.82	7.71	5.06	0.91	0.54
Q_{50}	84.53	81.38	8.82	7.13	1.00	0.67
Q_{100}	91.58	87.72	9.92	9.95	1.10	0.82

Table 6.1-4. Summary of flood peak flow frequency results for Des Moines Creek subbasins (all values are cfs).

Return Period Peak	SASA[a]		SDS3		SDS3A	
	Pre-Project	Project	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	31.95	13.57	6.03	2.40	1.23	1.52
Q_2	63.90	27.13	12.06	4.79	2.45	3.05
Q_{10}	97.35	44.54	21.07	10.85	4.28	7.80
Q_{25}	116.65	56.20	26.92	16.51	5.47	12.09
Q_{50}	132.17	66.34	31.92	22.46	6.49	16.50
Q_{100}	148.69	77.82	37.52	30.39	7.62	22.26

Return Period Peak	SDS4		SDS - Point of Compliance	
	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	0.86	0.35	8.06	4.35
Q_2	1.72	0.69	16.11	8.71
Q_{10}	2.65	1.29	28.45	18.58
Q_{25}	3.21	1.80	36.55	26.66
Q_{50}	3.67	2.29	43.51	34.51
Q_{100}	4.17	2.92	51.33	44.30

Return Period Peak	SDS7		Des Moines Creek @ South 200 Street	
	Pre-Project	Project	Pre-Project	Project
1/2 Q_2	1.47	0.64	55.72	36.29
Q_2	2.94	1.28	111.45	72.58
Q_{10}	5.23	2.84	184.86	117.11
Q_{25}	6.73	4.45	231.02	145.08
Q_{50}	8.03	6.25	269.81	168.55
Q_{100}	9.48	8.77	312.64	194.44

[a] STIA basins plus non-STIA basins D1 and D2 are routed to pond. Retrofitting is applied only to STIA drainage areas.

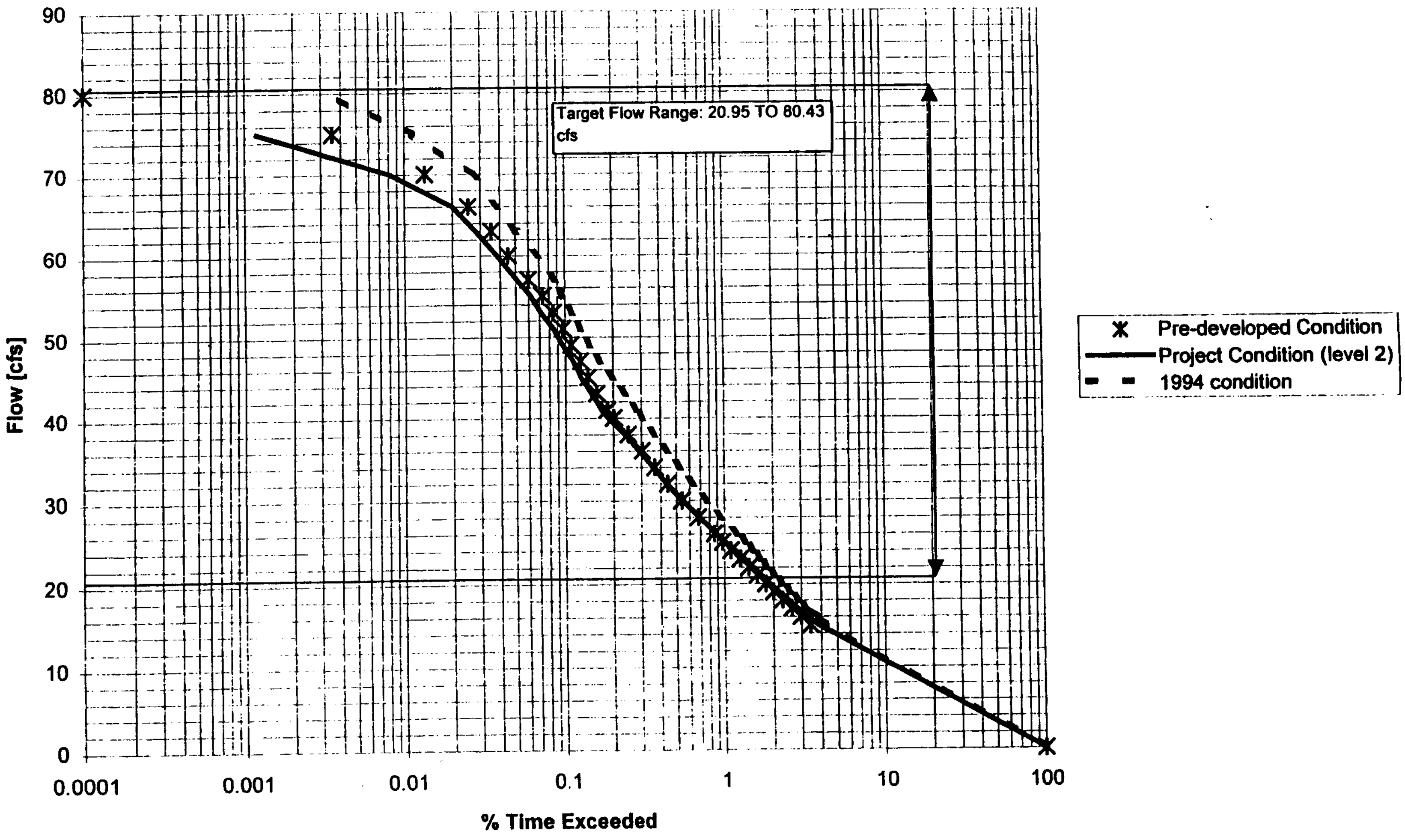

Figure 6.1-3
Flow Duration Curve for
Miller Creek at SR 509

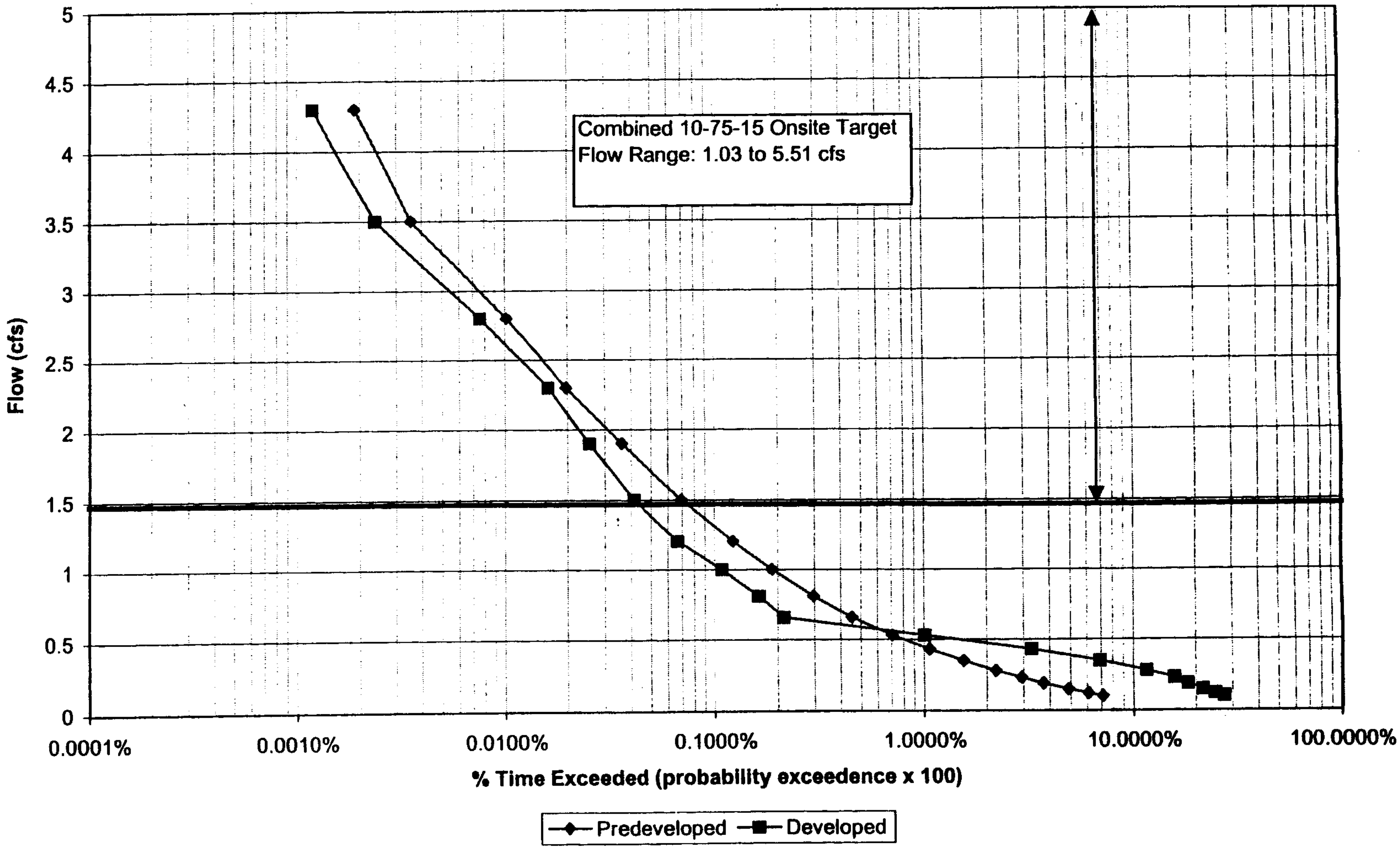

Figure 6.1-4
Flow Duration Curve for
Walker Creek at South 12th Street

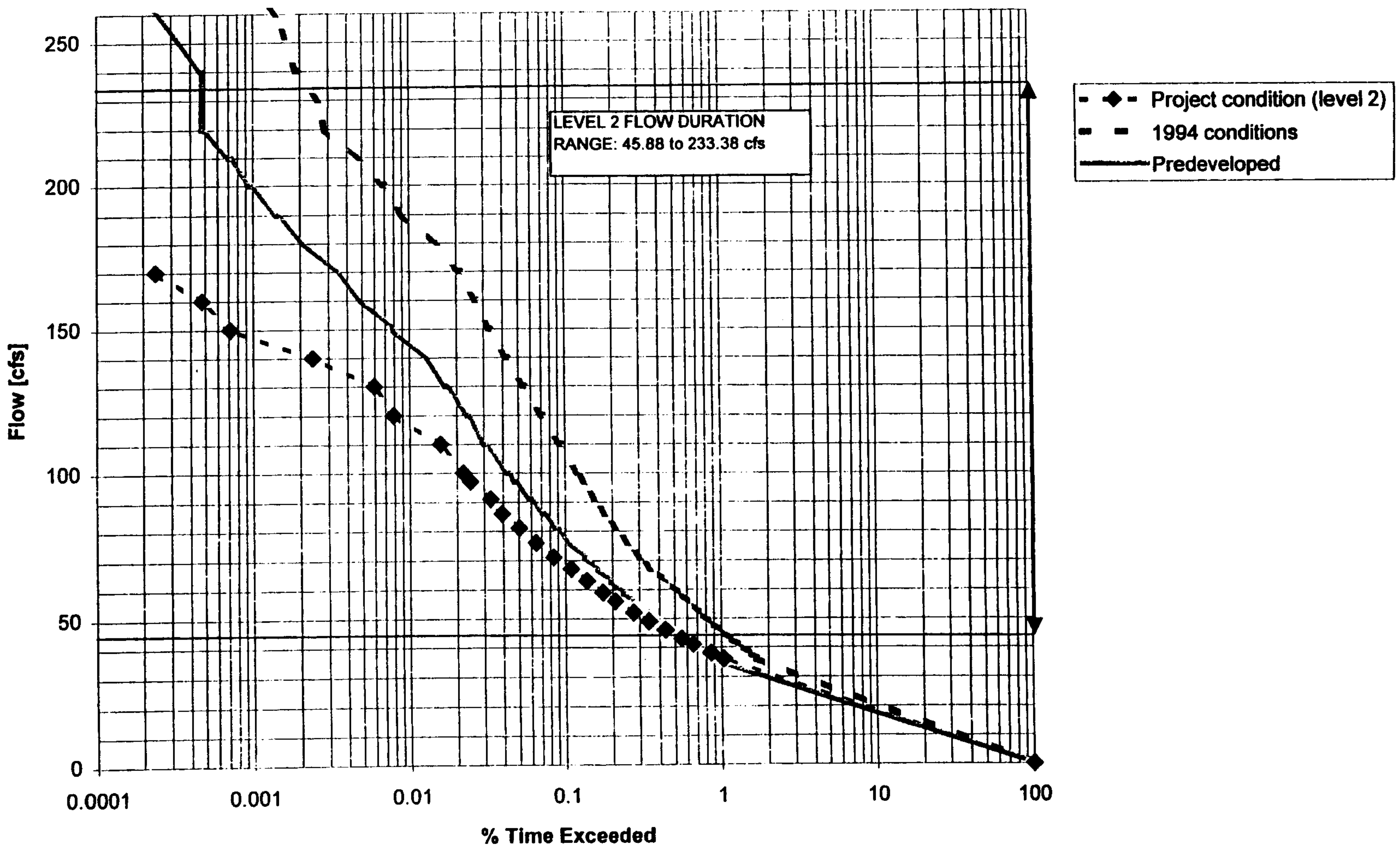

Figure 6.1-5
Flow Duration Curves for Des Moines
Creek at South 200th Street

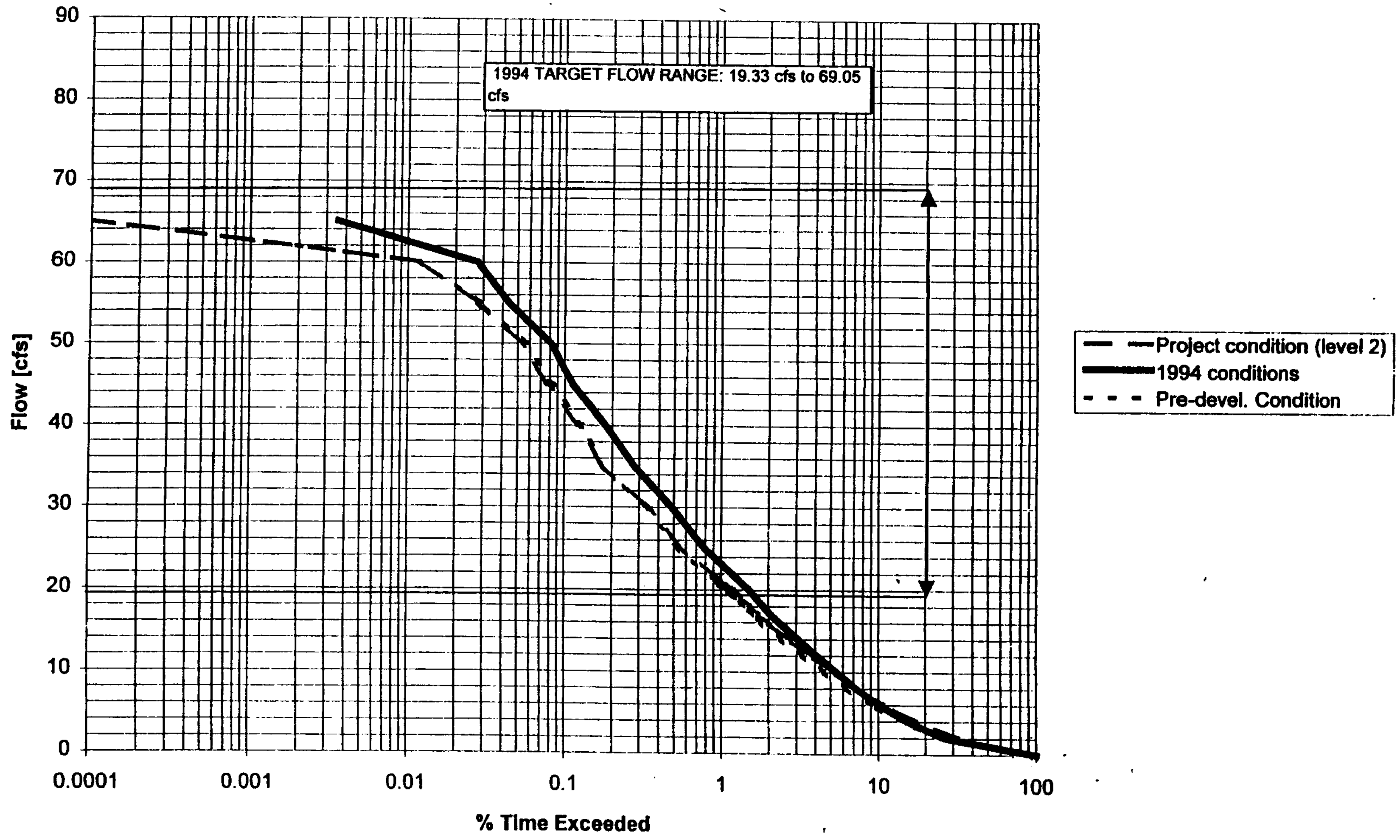

Figure 6.1-6
Flow Duration Curve for Miller Creek at MCDF

6.1.2 Base Flow Impacts

Hydrologic modeling has also demonstrated a potential base flow impact due to the Master Plan Update improvements (Parametrix 2000a, 2001a). The HSPF model was used to analyze the potential hydrologic effects on stream base flow[41] after construction of the project in pervious areas. Results for the pre-project base condition (1994) were compared to the developed project condition (2006) in Miller, Walker, and Des Moines Creeks. Potential base flow changes were evaluated using a comparison between pre-project and project stream flow conditions during the typically driest times of year (August and September). Using HSPF, average changes in streamflow were simulated as shown in Table 6.1-5 (EarthTech 2000).

Table 6.1-5. Estimated Low Streamflow Changes.

	Average Flows (cfs)					
	1994		**2006**		**Change**	
	Aug	**Sept**	**Aug**	**Sept**	**Aug**	**Sept**
Miller Creek	1.27	1.50	1.10	1.40	- 0.17	- 0.1
Walker Creek	0.033	0.035	0.031	0.039	- 0.002	+ 0.004
Des Moines Creek	1.08	1.64	1.07	1.73	- 0.01	+ 0.09

If base flow impacts are large enough, the wetted stream area could be reduced and adversely affect critical habitat. However, base flow impacts estimated for Miller, Walker, and Des Moines Creeks are insignificant and would not measurably change the wetted area of critical habitat.

While the HSPF modeling summarized in Table 6.1-5 indicates reduced low streamflow, some mitigative elements of project hydrology have not been calculated and are beyond the capability of the HSPF model to closely evaluate. For example, stormwater from detention ponds SDW1A and SDW1B in the Miller Creek basin will be infiltrated. Infiltration will offset some low flow reduction, as water will be infiltrated in trenches near Miller Creek to slowly seep through the soil back into the stream long after the rain has stopped. Also, stormwater that infiltrates into the fill embankment (a large soil mass that will collect, store, and transmit water) and slowly leaks out has not been accounted for in the HSPF model due to limitations in the model to simulate these constructed systems. The relatively small reductions in low flow shown on Table 6.1-5 will in fact be even less due to the limitations of the HSPF model to model these positive effects. Additional details on base flow impacts are provided in the *Seattle-Tacoma Airport Master Plan Update Improvements Low Streamflow Analysis* (Earth Tech 2000).

6.1.2.1 Effects of Peat Removal at Vacca Farm

Peat soils are often identified as having the ability to store water during wet periods and then release it slowly during dry periods, thereby augmenting base flows of associated streams. Excavation of peat soils during construction could alter hydrology and potentially affect base flow in Miller Creek.

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[41] Base flow is defined as the streamflow generated by groundwater in undeveloped watersheds. It is sometimes referred to as dry-weather flow.

The peat soil at the Vacca Farm site is identified as "Rifle" peat–afibrous, woody peat. It forms in depressions on top of glacial outwash soils such as the Vashon advance outwash, a medium dense sand soil series mapped in the vicinity of the Miller Creek valley. The Soil Conservation Service (SCS) estimates the permeability of similar peat soils to be on the order of 0.63 to 2 inches per hour (moderate permeability). An estimate of field capacity (the soil water content after gravity drainage from the peat has ceased), based on SCS data, is 0.4 (relatively high soil water retention). In comparison, the underlying dense sand in the outwash material has a permeability estimated at less than 1.4 inches per hour, and an available water capacity of about 0.1. The total porosity of the peat is assumed to be 0.8 (relatively high, thus a conservative assumption of greater maximum water storage).

The quantity of peat removed that could potentially provide water storage is about 10,000 cy. Therefore, the peat could store (10,000 cy) x (27 cf/cy) x (0.8 - 0.4) = 108,000 cubic ft of water. If the release rate to the stream were uniform during the drier months (May through September), the average daily flow would be on the order of (108,000 cubic ft)/(160 days x 24 hours x 60 minutes x 60 seconds) = 0.008 cfs. This estimate is high because it neglects evapotranspiration, which reduces the amount of water actually available to release as streamflow. Furthermore, the timing of the release of water stored in the peat is not likely to be uniform throughout the summer–most release would occur during late spring and early summer (May and June), prior to minimum streamflows. Thus, the potential impact on base flows from peat removal is likely considerably less than 0.008 cfs; this is unlikely to affect aquatic habitat in Miller Creek. In addition, the mitigation actions described in Section 5 include removal of drainage ditches, which will slow soil drainage at the Vacca Farm site.

6.2 WATER QUALITY

The Port's mitigation of potential water quality impacts is described in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a, 2001a). Stormwater quality mitigation elements in the plan include the following:

- BMPs will meet or exceed stormwater quality treatment standards. BMPs will be applied to all new and redeveloped pollution-generating impervious surfaces (PGIS), and BMPs will be retrofitted to treat runoff from existing untreated PGIS where practicable. Upon completion of the Master Plan Update improvements and other anticipated projects (e.g., north terminal expansion), an estimated 499.4 acres (86 percent) of the STIA SDS will have water quality treatment BMPs, out of a total SDS PGIS area of 579.4 acres.

- Source control BMPs will be implemented for all PGIS, and regularly reviewed for additional or improved methods. Source controls are planned and implemented via the Port's SWPPP for airport operations (Port of Seattle 1998).

- A landscape management plan is included in the SWPPP. The landscape management portions of the SWPPP are intended to control water quality impacts from managed vegetated areas, including chemical use, container disposal, integrated pest management, fertilizer application, weeding, pruning, and a prohibition of herbicide application near water courses.

- The IWS, a source control BMP, is designed to treat industrial wastewater from aircraft maintenance, fueling, and de-icing areas. The IWS is being upgraded so that storage overflows do not occur. The upgrade includes expansion of IWS Lagoon 3. The IWS upgrades are not a Master Plan Update project.

- Existing sources of stormwater pollutants will be removed from urban drainage areas. This includes removal of septic tanks, underground fuel storage tanks, untreated flows from lawns, streets, and driveways, and cultivated land located in stream floodplains and buffers.

- Projects will be implemented to enhance water quality such as flow augmentation, wetland restoration, stream restoration, and enhancement of riparian buffer zones within the Miller and Des Moines Creek basins.

- Hydrologic controls (peak flow and flow duration control, discussed in the flow control sections of the *Comprehensive Stormwater Management Plan*) will reduce instream erosion.

- During construction, TESCs will be applied in excess of Ecology Manual (Ecology 2001b) minimum requirements. TESC activities will include planning and implementing construction SWPPPs and monitoring plans for every individual Master Plan Update improvement activity, applying conventional TESC BMPs, providing advanced stormwater treatment where necessary and appropriate, supervising contractor erosion control compliance with an erosion control and stormwater specialist, and funding independent third-party oversight of construction erosion control and stormwater management and compliance.

As demonstrated in the *Comprehensive Stormwater Management Plan*, concentrations of pollutants in STIA stormwater are generally less than those in runoff from other residential, urban, and industrial areas in the region. As the Master Plan Update improvements will consist of similar activities and BMPs, these actions are expected to mitigate or prevent impacts. The Port's ongoing compliance with the Clean Water Act and, in turn, protection of STIA's receiving waters, are demonstrated through compliance with its Section 402 (NPDES) Permit, administered in Washington by Ecology (Ecology 1998). The Fact Sheet for the Port's NPDES Permit states that compliance with the effluent limitations and other conditions in the permit constitutes compliance with the Federal Water Pollution Control Act and the Washington Water Pollution Control Act (RCW 90.48).

Off-Site Mitigation

7. OFF-SITE HABITAT MITIGATION: AUBURN WETLAND MITIGATION

The proposed Auburn wetland mitigation site is a 67-acre parcel of land located within the City of Auburn immediately west of the Green River (see Figure 1.2-1). This mitigation project is in WRIA 9 and designed to restore and enhance forested, shrub, emergent, and open-water wetland habitats on over 65 acres of the 67-acre site to compensate for wetlands unavoidably impacted by the Master Plan Update improvements within the same WRIA. The overall goal is to replace wetland habitat functions (especially for avian species) in an off-site location, in compliance with FAA Advisory Circular 150/5200-33 (FAA 1997b).[42] The Port proposes to restore or enhance existing emergent wetland with diverse forest, shrub, emergent, and open-water wetland habitat, and restore buffer areas at the Auburn site as mitigation for habitat impacts. A summary of wetland impacts resulting from the Master Plan Update projects, proposed compensatory mitigation for each wetland type, and the overall replacement ratios provided by the Auburn mitigation site are provided in Table 7.1-1.

Table 7.1-1. Summary of wetland impacts and off-site compensatory design objectives for the proposed Master Plan Update improvements.

Project Impact	Compensatory Design Objectives	Acreage Provided[1]
Fill of 8.17 acres of forested wetland and loss of associated wildlife habitat.	Provide in-kind replacement of forested wetland functions and increase overall wildlife habitat function by creating/restoring emergent wetlands to create native forested habitat.	17.20 acres of forested wetland
	Enhance existing emergent wetlands to create native forested habitat.	19.50 acres of enhanced forested wetland
Fill of 2.98 acres of shrub wetland and loss of associated wildlife habitat.	Provide in-kind replacement of shrub wetland functions and increase overall wildlife habitat function by enhancing and restoring emergent wetlands.	6.00 acres of shrub wetland
Fill of 7.22 acres of emergent wetland and loss of associated wildlife habitat.	Provide functional replacement of emergent wetlands and increase wildlife habitat function by restoring emergent wetland.	6.20 acres of emergent wetland
	Provide pockets of open-water habitat.	0.60 acre of open-water wetland
Protect the wetland from potential off-site disturbance and provide enhanced upland wildlife habitat.	Protect wetlands with 100-ft buffers that are densely planted with native tree and shrub vegetation.	Approximately 15.90 acres of forested buffer protect the site from potential off-site disturbance and provide upland habitat.

Wetland mitigation immediately adjacent to the existing airport is constrained by the need to avoid creating wildlife hazards (i.e., waterfowl and flocking bird habitat) near the airfield (FAA 1997b). Therefore, the focus of the on-site mitigation projects (Section 5) is to replace and enhance wetland functions, including hydrologic, water quality, aquatic habitat, and riparian support, to the extent

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[42] The ACOE RGL 01-1 (ACOE 2001) recognizes air traffic concerns a factor in siting wetland mitigation.

practicable, while reducing existing wildlife hazards and avoiding the creation of new wildlife hazards. As a consequence, on-site projects will not create or enhance open-water or emergent wetland habitats that could attract waterfowl. Due to this constraint on-site, the Port proposes to include significant additional restoration, creation, and enhancement of palustrine forest, shrub, emergent, and open-water habitats at the Auburn mitigation site to compensate for project impacts to these habitats.

Much of the emergent wetland habitat impacted by the Master Plan Update projects is relatively low quality and has been significantly altered and degraded by development. The Miller and Des Moines Creek basins historically supported forested or shrub wetlands dominated by a diverse native flora. The vegetation in existing emergent wetlands filled or disturbed by the project is generally maintained by ongoing anthropogenic disturbance (i.e., mowing, golf course maintenance). In the absence of this disturbance, these wetlands would develop into forested or shrub wetlands. The emergent wetlands are also relatively low quality habitat for most wildlife species because of ongoing disturbance and a lack of vegetation diversity. Similarly, many of the existing shrub wetlands are dominated by non-native invasive species such as Himalayan blackberry, and in the absence of disturbance would develop into forested wetlands. Existing shrub wetlands also provide lower quality habitat due to frequent disturbance and lack of habitat diversity.

For these reasons, the off-site mitigation has been designed to provide improved avian habitat conditions relative to the existing wetlands lost near STIA. Off-site mitigation emphasizes the development of forested wetlands because, over time and in the absence of ongoing human disturbance, most of the wetlands impacted by the Master Plan Update projects would develop into forested wetlands similar to those historically found in the area. Therefore, the wetland mitigation provided at Auburn (see Table 7.1.1) is not strictly in-kind mitigation of habitat types, and creates a greater amount of generally higher quality forested wetlands compared to the lower quality emergent and shrub wetlands found near STIA.

This section describes the off-site mitigation and monitoring plan. Overall goals and design criteria are described in Section 7.1. The mitigation site and site selection process are described in Section 7.2. Section 7.3 contains a detailed description of the mitigation design, including a description of construction methods and implementation of the mitigation plan. Section 7.4 describes the implementation of the project at the mitigation site. Detailed plan sheets showing design elements are included in Appendix E.

7.1 GOALS, OBJECTIVES, AND DESIGN CRITERIA

Goals, objectives, and design criteria for the Auburn off-site wetland mitigation have been developed to guide the mitigation design and ensure that overall mitigation objectives are met (Table 7.1-2). The wetland mitigation goals and objectives identified are designed to compensate for unavoidable wetland impacts, especially to wildlife habitat, by creating forested, shrub, emergent, and open-water replacement wetland habitat with a net gain in functional value and acreage.

Table 7.1-2. Mitigation goals with associated design objectives and design criteria for the Auburn mitigation site.

Goals and Design Objectives	Design Criteria
Goal 1: Achieve no net loss of wetland acreage by constructing replacement habitats of forest, shrub, and emergent wetland with a forested buffer	
Provide seasonal to permanent wetland hydrology appropriate for each wetland vegetation cover type.	Use a perched water table to establish wetlands at the approximate final grades of: **East Basin** Below 38 ft in open-water wetland 38 ft to 41 ft in emergent wetlands 41 ft to 42 ft in shrub wetlands 42 ft to 46 ft in forested wetlands **West Basin** Below 42 ft in open-water wetland 42 ft to 44 ft in emergent wetlands 44 ft to 47 ft in shrub wetlands 47 ft to 49 ft in forested wetlands
Provide in-kind replacement for impacts to 8.17 acres of forested wetland.	Plant five forested wetland plant associations that are similar in composition to naturally occurring plant associations. Use native deciduous and evergreen species such as black cottonwood, Oregon ash, red alder, western redcedar, and Sitka spruce. Forest communities will have a native shrub understory with species such as salmonberry (*Rubus spectabilis*), twinberry (*Lonicera involucrata*), red-osier dogwood, red elderberry (*Sambucus racemosa*), willows, and vine maple. Plant native tree species at densities greater than 280 per acre. Plant native shrub species in forested communities at densities greater than 1,800 plants per acre.
Provide in-kind replacement for impacts to 2.98 acres of shrub wetland.	Plant an association of native shrub wetland species that is similar in composition to naturally occurring shrub wetlands, including species such as Pacific willow, Hooker's willow, Sitka willow, red-osier dogwood, and twinberry. Plant native shrub species at densities greater than 2,100 plants per acre.
Provide replacement for impacts to 7.22 acres of emergent wetland.	Plant an association of native emergent wetland species similar in composition to native emergent wetlands. Use native species that are suited to seasonally and/or permanently flooded conditions, such as water parsley (*Oenanthe javanica*), hardstem bulrush (*Schoenoplectus acutus*), and common spikerush (*Eleocharis palustris*). Plant native emergent species in approximately 0.05-acre monotypic patches at densities greater than 10,000 plants per acre (approximately 24 inches on-center).
Provide a forested buffer around the mitigation site to enhance functions and protect the wetland mitigation.	Establish a 100-ft-wide forested buffer around the perimeter of the mitigation site.

Table 7.1-2. Mitigation goals with associated design objectives, design criteria, and final performance standards for the Auburn mitigation site (continued).

Goals and Design Objectives	Design Criteria
Goal 2: Provide wildlife habitat replacement outside the 10,000-ft safety radius for aircraft operations	
Provide flooded emergent wetland habitat suitable for waterfowl feeding and resting during the winter and spring months.	Emergent wetlands will satisfy the design criteria for wetland mitigation Goal 1. Additional design criteria for waterfowl habitat include: Provide year-round shallow water with patches of emergent vegetation as feeding habitat for dabbling duck species. Provide ponded water areas for resting habitat.
Provide emergent, shrub, and forested wetland habitat with feeding and breeding for songbirds.	Forest, shrub, and emergent wetlands will satisfy the design criteria for wetland mitigation Goal 1. Additional design criteria for songbird habitat include: Plant forested wetland adjacent to shrub, emergent, and open-water habitats. Plant portions of the forested wetland with shrub understory species to provide a multiple-layered canopy adjacent to the shrub portion of the wetland.
Provide forested, shrub, and emergent wetland feeding and breeding habitat for small mammals.	Forest, shrub, and emergent wetlands will satisfy the design criteria identified for wetland mitigation Goal 1. Additional design criteria for small mammal habitat include: Place LWD (stumps and logs of native species) throughout the forested wetland to provide year-round cover for small mammals. Construct low hummocks in the shrub wetland areas to provide non-saturated soils for burrowing small mammals.
Provide breeding habitat for amphibians.	Forest, shrub, and emergent-wetlands will satisfy the design criteria for wetland mitigation Goal 1. Additional design criteria for amphibian habitat include: Provide attachment substrate for breeding amphibian species in areas of ponded water.
Goal 3: Provide replacement wildlife habitat that increases overall habitat functions	
Consolidate mitigation for impacts to many small, discontinuous wetlands into a single, larger wetland to provide a more diverse aggregate of habitat types.	Construct a contiguous wetland system with forested, shrub, and emergent wetland types and wildlife habitat features that provide in-kind and out-of-kind habitat replacement.
Assure long-term protection of the mitigation site.	Screen the wetland from off-site areas and install fencing around the perimeter. No public trails will be permitted on the mitigation site.
Goal 4: Enhance the existing 19.5-acre emergent wetland at the Auburn site	
Enhance functions of approximately 19.5 acres of degraded emergent wetland.	Plant existing wetland with native trees and shrubs at densities greater than 2,100 individual plants per acre for shrubs and greater than 280 stems per acre for native trees.

7.1.1 Goals and Objectives

The general mitigation goals for the Auburn site are as follows:

- Achieve an overall increase in wetland acreage and functional replacement at a mitigation ratio of at least 2:1.
- Mitigate lost habitat functions of the Master Plan Update improvements outside of the 10,000-ft aircraft operations safety radius of STIA to protect public safety and reduce wildlife hazards to aircraft.
- Create diverse wetland habitats (including forested, shrub, open water, and emergent) as well as upland forested habitat on a large site adjacent to existing habitat corridors along the Green River.
- Enhance wetland functions in the existing degraded wetlands, which are dominated by non-native species, by converting them to diverse, native forested, shrub, and emergent wetlands.
- Provide long-term protection for the mitigation site by providing a 100-ft forested buffer around the perimeter of the site.

7.2 WETLAND MITIGATION SITE

The mitigation site chosen for off-site compensatory mitigation for the Master Plan Update improvements is described in the following sections.

7.2.1 Site Description

The mitigation area is part of a 67-acre parcel located within the City of Auburn immediately west of the Green River (Figure 7.2-1). The site is nearly level but gradually slopes from the eastern (approximately 52 ft in elevation) and southeastern boundaries to approximately 45 ft in elevation in the northwest corner. The undeveloped parcel has been farmed in the recent past, and currently supports a mix of upland and wetland pasture grasses and forbs that are common on abandoned agricultural land in the Puget Sound basin. The mitigation site is located between 100 and 150 ft west of the OHWM of the adjacent Green River.[43]

The site is bounded by a variety of land uses, including active agriculture fields to the north and south; undeveloped land, multi-family housing and a drive-in theater to the west; and the Green River, patches of riparian forest, and undeveloped, forested slopes to the east. The site was previously zoned single-family residential (R2) by the City of Auburn, and the 1995 Comprehensive Plan designation is single-family (Auburn 1995). In 1998, a new section was added to the City's zoning ordinance that allows wetland mitigation to occur in R2 zoning. The mitigation site is located within the Draft Mill Creek Special Areas Management Plan (SAMP) (ACOE 1997). The relationship of this project to the Draft SAMP is discussed in Section 7.2.3.

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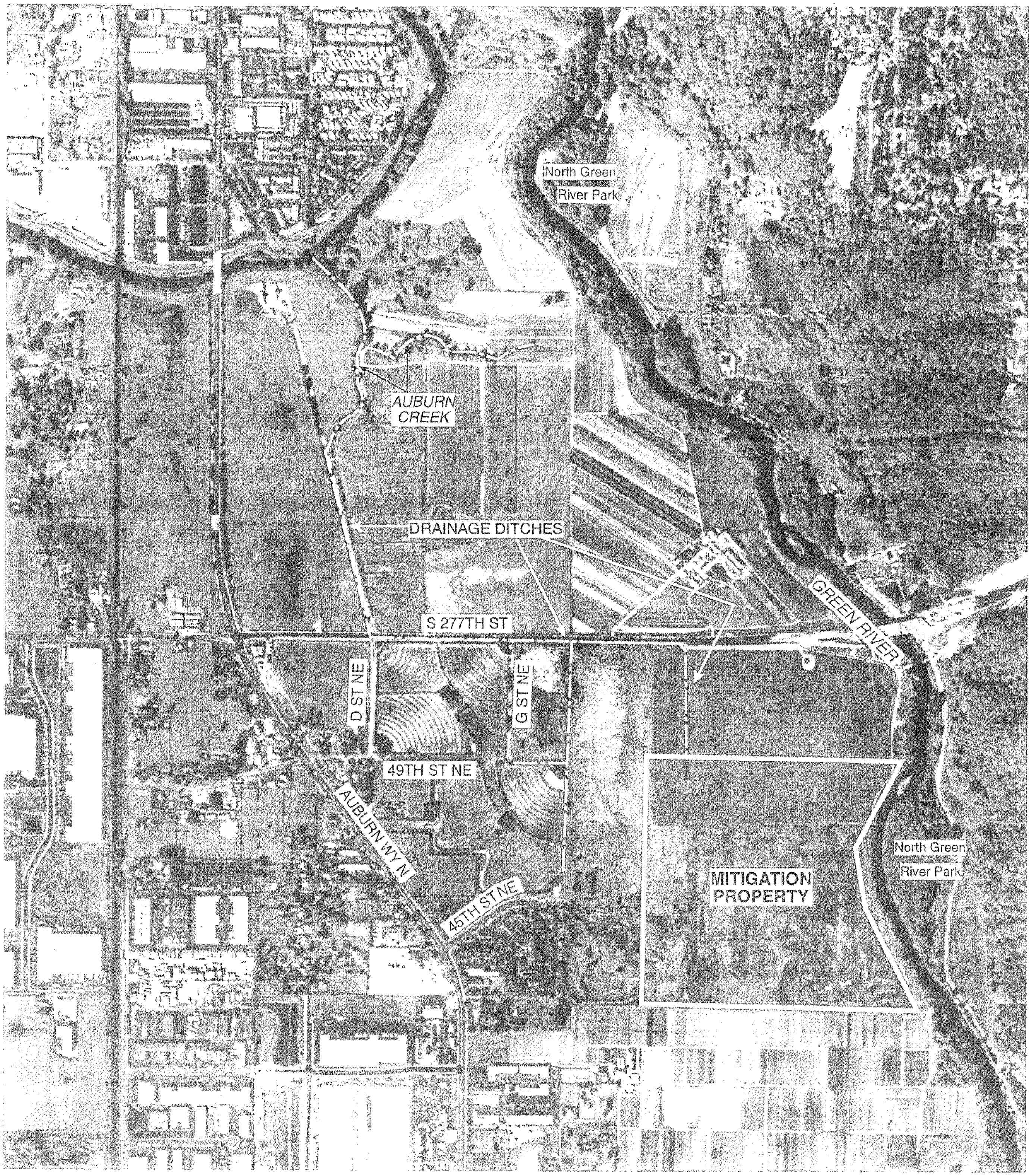
[43] Approximately 1.62 acres along the eastern boundary of the 67-acre site is set aside for potential development as part of a regional trail that may be built by King County.



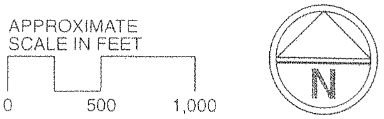


Figure 7.2-1
Aerial Photograph of the Auburn Wetland Mitigation Site (1999)

Three jurisdictional wetlands were delineated on the mitigation site. Wetland 1 extends from the northwest corner to the south-central portion of the site (Figure 7.2-2) and covers 18.89 acres of the site. The wetland also extends off-site to the west, through the access easement for the site. Wetland 2 is adjacent to Wetland 1 in the south-central portion of the site, and is about 0.60 acre in size. Wetland 3 is located in the north-central portion of the site and is about 0.01 acre in size (Parametrix 2000b). Descriptions of site hydrology, soils, and vegetation of the wetland and upland portions of the site are included in the following sections.

7.2.2 Ownership

The Port owns the entire 67-acre site and has a permanent access easement on the western side of the property (Appendix E, Sheet C2). Construction of the mitigation project requires temporary construction access easements, and a temporary drainage and construction easement that will allow the Port to modify an existing drainage ditch for drainage related to construction of the wetlands. A permanent easement allows monitoring and maintenance following construction. The Port has obtained these easements.

7.2.2.1 Construction Access

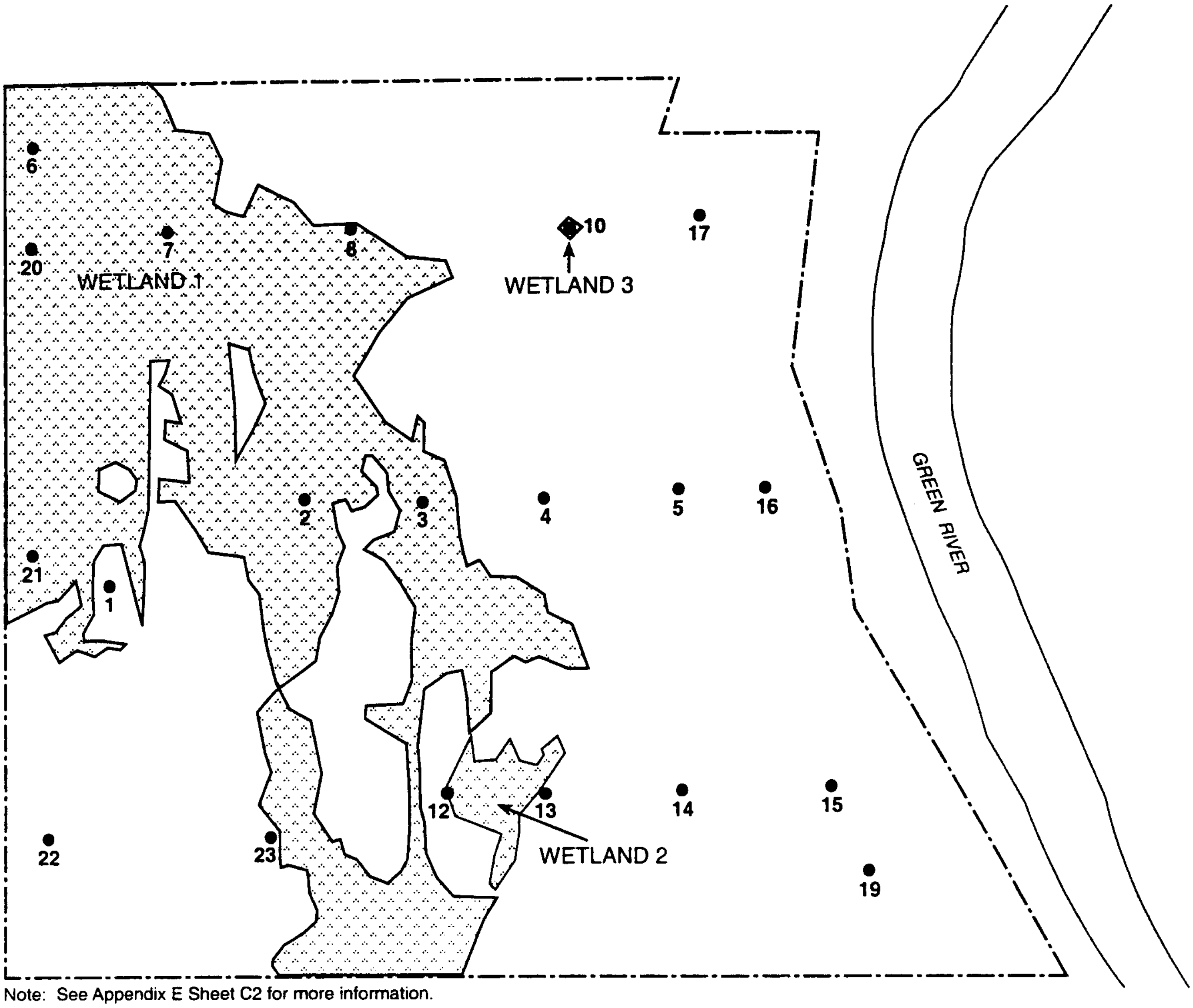
The Port has procured temporary construction and access easements from property owners to the west of the site for construction access to the mitigation project. As of December 2000, the Port had completed easement agreements from two property owners and was in the process of completing negotiations with three other owners.

7.2.2.2 Drainage Easement

The Port has also procured a drainage and construction easement across the property north of the mitigation site (Appendix E, Sheet C2). The purpose of this easement is to grant the Port the right to modify an existing channel for drainage purposes related to construction of the mitigation project. The easement grants the Port the right to use this channel for the temporary discharge of water from dewatering wells to be used during excavation and construction of the mitigation wetlands. During dewatering, drainage water from the Port's property will be temporarily channeled to the existing outfall into the Green River at South 277th Street. Other than during construction dewatering, drainage water from the mitigation site will flow north through existing drainage channels along and under 277th Street, and then north to the Green River (see Section 7.2.2.3). The temporary drainage and construction easement will remain in use until a permanent flood channel is constructed across the property to the north.

7.2.2.3 Permanent Flood Channel

Construction of a permanent flood channel is a condition of the ILA between the Port and the City of Auburn. The ILA requires the Port to construct, or with the consent of the City, to pay the cost of constructing the floodway channel. The ILA requires that the flood channel be located in a mutually agreed upon location across the property to the north of the mitigation site (i.e., the Bristol



Note: See Appendix E Sheet C2 for more information.

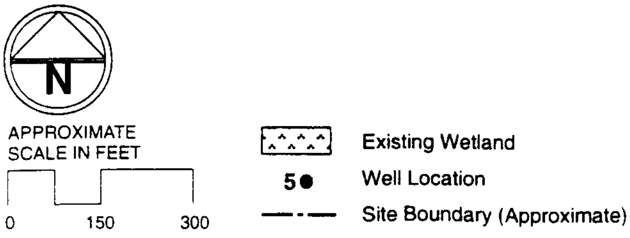


Figure 7.2-2
Wetlands and Shallow Groundwater Monitoring Well Locations on the Wetland Mitigation Site, Auburn, Washington

property). The Port is currently working with the City of Auburn and Bristol on the design and location of the floodway channel. Although a final determination has not been made as of December 2000, the existing channel is the most probable location of the permanent floodway channel (Appendix E, Sheet C2). Widening and deepening the existing drainage channel to construct the permanent floodway will impact a maximum of 2.2 acres of Waters of the U.S.[44], and these impacts have been included in the project's CWA 404 permit application.

7.2.3 Rationale for Selection

Mitigation site selection began with a review of the established goals as outlined in Section 7.1.1. The general site criteria required to meet these goals are similar to those listed by Castelle et al. (1992) and are listed below:

- A large non-wetland site, greater than 50 acres in size, with evidence of a seasonally high water table
- A non-forested site (to allow for significant net habitat improvements) adjacent to a higher quality habitat area (i.e., the Green River riparian corridor)
- A site with relatively flat topography
- A vacant or substantially vacant site
- A site available for purchase by the Port
- A site at least 10,000 ft from proposed or existing runways as recommended by the FAA (FAA 1997b)

The recommended preference for selecting wetland mitigation sites in the State of Washington is as follows: (1) on-site and in-kind; (2) off-site, within the watershed, and in-kind; (3) off-site, out of the watershed, and in-kind; and (4) off-site, out of the watershed, and out-of-kind (Ecology 1990). The Port's mitigation for wetland impacts follows these recommendations and the majority of mitigation for most wetland functions is located on-site, but outside of the STIA operations area to avoid hazards to aircraft. However, creating new wetland habitat within the STIA operations area was eliminated from consideration because the site criteria listed above could not be met. Additional on-site mitigation near STIA was not considered because it could be subject to degradation from wildlife control for safety reasons. Therefore, consideration of off-site mitigation was necessary.

7.2.3.1 Wetland Mitigation and Aircraft Safety

Bird-aircraft collisions (bird strikes) are a significant concern to the Port, the FAA, and the aviation community in general. Bird strikes threaten passenger safety, result in costly aircraft repair, cause passenger delays, and decrease revenue for commercial air carriers (Soloman 1973; Seubert 1977).

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[44] This estimate is based on a drainage channel of about 1,200 linear feet that requires a construction footprint averaging 80 feet in width. It is assumed this channel is constructed in existing drainage ditches or abandoned farmland that are Waters of the U.S.

In the United States, annual costs due to bird strikes have been estimated to be $112 million to military aircraft (Conover et al. 1996). Conover et al. (1996) estimate that for civilian aviation, about 33 percent of bird strikes are unreported, and that the annual rate for civilian aircraft is 6,240 strikes (the cost of these strikes was not estimated). Annual loss of life associated with bird strikes is less than three fatalities for all branches of the military, and 3.7 fatalities for civilian/commercial aviation (Conover et al. 1996). For these reasons, bird control in and around airports has become an important component of airport management.

The reported bird strikes at STIA are summarized in Table 7.2-1. The FAA (as part of the Part 139 Airport Certification Program) requires STIA to maintain and implement a WHMP (USDA 2000) to minimize bird strike hazards. Because of certification requirements and the Port's desire to maintain safe aircraft operations, it is compelled (where feasible) to eliminate bird hazards as part of the management plan. These hazards can be eliminated or reduced by hazing (scaring) birds from problem areas, killing wildlife (per permits issued by the USFWS), or modifying habitat so it is no longer suitable for wildlife creating the hazards.

Table 7.2-1. Summary of reported bird strikes at Seattle-Tacoma International Airport (1979-1999).

Year	Number of Strikes[a]
1979	5
1980	8
1981	14
1982	4
1983	8
1984	3
1985	11
1986	12
1987	11
1988	7
1989	13
1990	35
1991	22
1992	13
1993	14
1994	22
1995	20
1996	27
1997	27[b]
1998	13[b]
1999	21
Average	**14.8**

[a] Some strike events may involve more than 1 bird.

[b] These numbers include carcasses found near the airfield.

FAA policy regarding wildlife attractants near airports includes the position that any activity or land use on or near an airport that threatens aircraft safety by attracting or sustaining hazardous wildlife is not a compatible land use (FAA 1997b). The FAA recommends all new wildlife attractants be 10,000 ft from turbine aircraft movement areas (AMAs) and 5 miles from an airport where wildlife could be attracted to or across the airport's approach or departure airspace. The FAA and the Port believe that wetland mitigation created as habitat for wildlife is a land use that should not occur near STIA.

There are compelling reasons to support decisions to mitigate for wildlife habitat mitigation greater than 10,000 ft from active runways. *Port of Seattle Position Paper re: Off-Airport Mitigation of Wetland Wildlife Habitat Function* (Port of Seattle 1998b) provides detailed explanation of off-airport mitigation needs. The reasons for off-airport mitigation discussed in that paper are summarized as follows:

- Creation of wetland wildlife habitat near the airport would increase the hazards to passenger safety. In the United States, more than 1,700 bird strikes occur each year. Worldwide since 1995, 74 people have been killed as a result of bird strikes and four large aircraft have been destroyed. For these reasons, FAA Advisory Circular 150/5200-33 recommends locating replacement wetlands more than 10,000 ft from runways serving turbine-engine airplanes. The FAA and the Department of Agriculture Animal Damage Control Division believe strongly that wetland wildlife habitat should not be created near STIA.
- If the Port were to create wetland wildlife habitat near the airport, it would be required to manage the wetland to prevent its attraction to birds. These management activities could be directly contrary to the key purpose of creating the habitat.
- The FAA has required, as a condition of its approval of the STIA improvements and as a condition of federal funding, that the Port comply with the FAA Advisory Circular and locate the replacement wetlands in Auburn. If the Port did not follow this requirement, it would likely lose essential federal funding for the airport projects.
- Constructing a replacement wetland in proximity to the airport raises liability concerns for the Port. Federal courts have found airport operators liable for failing to mitigate and warn pilots of wildlife hazards.

Considering the Port's and the FAA's mandate to provide a safe environment for aircraft operations, the construction of wetland mitigation to provide wildlife habitat is not feasible near (within 10,000 ft) an existing or proposed runway. A mitigation project designed to provide forest and shrub wetland (to discourage waterfowl use and replace functions in-kind) could attract additional numbers of birds known to be a strike hazard at the airport. While the mitigation is planned to avoid attracting other birds, it is potential habitat to many species. These include flocking birds (starlings, blackbirds, and pigeons), raptors (owls and hawks), and other common passerine (perching) birds. If increased numbers require management actions by the Port and FAA (such as modification of the mitigation site to discourage wildlife use), management would be contrary to federal and state wetland regulations and policies regarding mitigation.

The Port is attempting to decrease the aircraft/bird strike hazard at STIA as described in the WHMP (USDA 2000). The addition of new wildlife habitat near airport runways could undermine the ongoing effort to maintain and enhance airport safety and would not meet the goals of the Master Plan Update in which landing and takeoff safety is a major consideration.

7.2.3.2 On-site Locations

A GIS database (Puget Sound Regional Council 1994) was used to locate potential mitigation sites within the Miller Creek and Des Moines Creek watersheds. The GIS program identified all undeveloped, non-forested, non-wetland sites with average slopes less than 5 percent. It was assumed that, if available for purchase, these were the minimum criteria necessary for a suitable mitigation site. Based on these criteria, 19 potential mitigation sites were identified (Figure 7.2-3). The suitability of the sites (although all are within the 10,000-ft radius of concern for wildlife hazards to aircraft [FAA 1997b]) for wetland mitigation was evaluated during site visits on August 28, 1996 (Table 7.2-2).

The site selection criteria were altered because undeveloped sites greater than 50 acres were lacking in the two watersheds. For this level of analysis, it was assumed that drainage conditions on each site identified by the GIS program could be modified to retain adequate water to support wetlands, so evidence of high water tables was not considered. For this project, a mitigation site in excess of 50 acres is preferred because it would allow a mitigation ratio of at least 2:1 and allow protection of the site with adequate wetland buffers. In addition, sites greater than 50 acres would combine the functions of several small, isolated wetlands in a single large wetland mitigation project. This approach would enhance the probability of achieving mitigation goals, ensuring long-term protection, and ultimately providing wetland functions to compensate for project impacts (Federal Register 1995; Hurt et al. 1998). However, all sites greater than 10 acres were evaluated because there were few large undeveloped sites on suitable terrain in either watershed.

7.2.3.3 Off-site Locations

The search for off-site mitigation areas began by reviewing over 100 parcels for their suitability as wetland mitigation. The review focused on sites larger than 50 acres because of the acreage needed to mitigate impacts and the ecological and logistical advantages of developing mitigation on a single site. Other constraints identified for off-site areas included:

- Site selected should be in proximity to impact site and not conflict with other planned wetland mitigation projects in the Duwamish watershed
- Land not constrained by development restrictions (such as King County's Farmland Preservation Program)
- Land that is economically feasible for purchase and construction of desired mitigation
- Sites greater than 10,000 ft from proposed or existing STIA runways
- Sites greater than 5,000 ft from general aviation runways (for airports located within the Cities of Auburn and Kent)
- Sites located in WRIA 9

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Figure 7.2-3
Potential Mitigation Sites Evaluated in the Miller Creek and Des Moines Creek Watersheds

Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3).

Site	Watershed	Acres	Existing Conditions	Mitigation Limitations
1	Miller Creek	55	The site is within the direct flight path to the airport. It is within a vacated residential area and has been identified for development as the North SeaTac Park (which includes play fields, a picnic shelter, restrooms, a playground, parking, and trails), pursuant to an agreement between the Port and the City of SeaTac.	Use of the site for wetland mitigation would eliminate use of much of the site as a community park. The site is approximately 6,400 ft north of the existing runways. Enhancement of wildlife habitat in this area would increase wildlife hazards to aircraft.
2	Miller Creek	14	The area is within the direct flight path to the airport. It is in an abandoned residential area with scattered deciduous trees, blackberries, grasses, and weeds. The site drains from east to west into Tub Lake.	Some slopes on the site are steeper than mapped in the GIS database, and only approximately 5 acres of the site are suitable for wetland creation. Therefore, this site is not large enough. The site is 4,500 ft north of the existing runways, and enhancement of wildlife habitat in this area would increase hazards to aircraft.
3	Miller Creek	33	The area is in a vacated residential area in the direct flight path to the airport. Vegetation is largely comprised of blackberries, ornamental trees, grasses, and weeds. The smaller, northern portion of the site connects to the Tub Lake wetland on one side, with an approximate rise in elevation of 30 to 50 ft on other sides. The southern portion of the site is also topographically higher than the Tub Lake wetland.	The site is fragmented by three streets, which could be detrimental to wildlife. The site is approximately 2,600 ft north of the nearest existing runway. Creation of wetland habitat at this site would increase wildlife hazards to aircraft.
4	Miller Creek	17	The area is at a topographic high point in the direct flight path of the airport. There are patches of mixed deciduous and ornamental trees. A large water tower is in the northern portion of the site.	The area is not large enough to mitigate wetland impacts at one site, and there is no wildlife corridor to the other potential sites or other habitat areas. The site is within the fenced airport security area, which would preclude use of the wetland by some forms of wildlife, including deer, coyote, and fox. The site is within the area of proposed Master Plan Update improvements where warehouse and parking is proposed. This site is approximately 2,300 ft north of the nearest runway. Wetland creation would not be feasible due to the proximity of low-flying aircraft and increased wildlife hazards.

Table 7.2-2. **Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).**

Site	Watershed	Acres	Existing Conditions	Mitigation Limitations
5	Miller Creek	11	The site is on a slope within the fenced airport security area. Patches of deciduous and ornamental trees are scattered throughout the site.	Most of the site will be developed as part of the Master Plan Update improvements. Only about 1 or 2 acres will remain after construction. The proximity to existing airport operations (approximately 2,000 ft from existing runways and 1,000 ft from the proposed runway) would result in increased wildlife hazards to aircraft.
6 and 7	Miller Creek	45	These sites are grassy areas between the existing runways and taxiways within the airport operation area.	Locating wetland habitat within the airport operation area is not feasible for safety reasons.
8	Miller Creek	23	This site consists of landscaped yards in a semi-rural residential area west of the airport. Miller Creek flows through portions of the relatively flat site.	The eastern portion of this site is within the fill footprint for the proposed runway. The remaining portion of the site is not large enough to mitigate wetland impacts. The mitigation area would be isolated from other habitat areas by South 154th Street, the airport, and SR 509, which would not be conducive to optimal wildlife habitat. The mitigation area would be 3,100 ft southwest of the end of the nearest existing runway and 2,100 ft southwest of the end of the proposed runway. The site is approximately 1,000 ft directly west of the edge of the proposed runway. The proximity of airport operations increases the wildlife hazard to low-flying aircraft.
9	Des Moines Creek	24	The site is a cemetery.	It is not reasonable to locate wetland mitigation in a cemetery. The proximity of the site (3,600 ft southeast of the end of the nearest runway and 2,600 ft east of the edge of the nearest runway) to runways presents a wildlife hazard to aircraft.
10, 11, 13, and 14	Miller Creek (sites 10 and 13) and Des Moines Creek (sites 11 and 14)	100	These sites are located between and adjacent to the existing runways and taxiways. They are grassy areas mowed and maintained for airport safety reasons.	Locating wetland habitat within the airport operations area is not feasible due to safety reasons.

Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).

Site	Watershed	Acres	Existing Conditions	Mitigation Limitations
12	Miller Creek	16	This relatively flat area consists of large expanses of lawn bordered by roads, houses, and a large scrub/shrub wetland.	Wetland mitigation at this site would require displacement of additional residents. The site is not large enough to mitigate all of the wetland impacts at one location. The area is bordered by major roadways (SR 509 and Des Moines Way South) on two of the three sides, which would not be conducive to optimal wildlife habitat. Mitigation would be about 1,800 ft west of the proposed runway and approximately 4,500 ft from either end of the proposed runway. The proximity of the proposed runway to mitigation would increase the hazard to aircraft.
15	Des Moines Creek	11	Site 15 is a horse pasture surrounded on three sides by steep slopes. A scrub/shrub wetland, which connects to Bow Lake, lies on the western side of the pasture. Single-family homes, a trailer park, and a hotel overlook the site.	Less than half of the site would be available for wetland mitigation due to the surrounding topography and the presence of existing wetland. The proximity of a trailer park, hotel, and single-family homes, and the small size of available upland area, make this site undesirable for wetland habitat mitigation. The site is roughly 5,200 ft east of the ends of the existing runways and 4,700 ft east of the edge of the nearest runway.
16	Des Moines Creek	35	Site 16 is located in the direct flight path and consists of the northern portion of Tyee Valley Golf Course. Currently, a safety area for Runway 34R, which encroaches on the golf course, is under construction.	Much of the area is included in the Master Plan Update improvement area (including the safety area currently under construction and the SASA). If the preferred alternative for the airport expansion is implemented, there would not be enough suitable land remaining for wetland creation. Mitigation at this site may not be protected in perpetuity due to the proximity of airport operations. It is approximately 1,500 ft south of Runway 34R, which would increase wildlife hazards to aircraft.

Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).

Site	Watershed	Acres	Existing Conditions	Mitigation Limitations
17	Des Moines Creek	23	This site is the southern portion of Tyee Valley Golf Course. It is bordered by a mixed forest to the west and south, residential and recreational uses to the east, and the northern portion of the golf course to the north. Des Moines Creek divides the northern and southern portions of the golf course.	The site would be confined by ongoing disturbances or developments, including the airport, the SASA area, and borrow areas for construction of the proposed runway, which is not conducive for wildlife habitat replacement. It is 2,100 ft directly south of the end of Runway 34R, which would result in increased wildlife hazards to aircraft. There is not enough land to mitigate wetland impacts on one site that could be protected in perpetuity.
18	Des Moines Creek	16	This site consists of grass pastures and landscaped yards adjacent to a forested area on the west side and residential areas to the north, east, and south. Most of the site is on a topographically high area.	The necessary acreage required for compensatory mitigation could not be attained at this site. It is fragmented by homes and active roads, and residents would have to be displaced for mitigation. The site is approximately 4,900 ft south of the existing runways and would increase wildlife hazards to aircraft.
19	Des Moines Creek	12	Site 19 consists of landscaped yards and some pasture area with a large forested area to the north. Most of the site is topographically high.	The necessary acreage required for compensatory mitigation could not be attained at this site. It is fragmented by homes and active roads, and residents would have to be displaced for mitigation. Site 19 is approximately 5,200 ft south of the existing runways, and would increase wildlife hazards to aircraft.

Note: Data compiled by Parametrix.

In addition to the above constraints, a preference was given to suitably sized, non-wetland areas that were close to surface water or other riparian habitat areas. The mitigation site would then provide ecological functions to off-site areas.

Of 11 sites larger than 50 acres, five were rejected as unsuitable due to the large amount of wetlands present or because they offered minimal opportunity for habitat improvement. Of the six remaining sites, two were not available for purchase, the development rights of two were owned by King County for farmland preservation, and one site had been purchased by the City of Kent for its own mitigation purposes.

The remaining site, analyzed in this plan, has several attributes that make it favorable for wetland mitigation. It is large enough to accommodate the entire wetland mitigation project and has physical features that could successfully support the proposed mitigation approach. These features include proximity to the Green River and a seasonally high water table.

The mitigation site is within the boundary of the Mill Creek SAMP (ACOE 1997). This mitigation project enhances existing wetlands and creates wetlands from upland areas, enhances the aquatic resources of the basin, and is consistent with the goals and objectives of the SAMP. The Draft SAMP identifies specific wetland areas on which development would be permitted by a Regional General Permit, and other areas where protection and enhancement of wetlands will be required. The overall goal of the Draft SAMP is to provide for aquatic resource protection and economic development in the Mill Creek basin while assuring no net loss of aquatic resource functions and values of the basin.

7.2.4 Constraints

No construction or implementation constraints have been identified that would affect the success of the wetland mitigation at the Auburn site.

7.2.5 Ecological Assessment of the Mitigation Site

The ecological conditions of the upland and wetland areas of the proposed mitigation site are discussed in this section. The existing wetlands are described in more detail in Appendix A of the *Wetland Delineation Report* (Parametrix 2000b).

7.2.5.1 Existing Site Conditions

Vegetation

The mitigation site consists primarily of abandoned agricultural land. Vegetation is a mix of native and non-native herbaceous species, including meadow foxtail (*Alopecurus pratensis*), Canada thistle, quackgrass (*Agropyron repens*), timothy (*Phleum pratense*), orchardgrass, colonial bentgrass (*Agrostis tenuis*), and patches of reed canarygrass (Table 7.2-3). Other non-native species scattered throughout the area include cocklebur (*Xanthium strumarium*), common dandelion (*Taraxacum officinale*), and climbing nightshade.

Table 7.2-3 Plant species observed on the mitigation site and adjacent riparian areas during delineation site visits in October 1995 and 2000.

Scientific Name		Common Name	WIS [a]
Trees	*Alnus rubra*	Red alder	FAC
	Crataegus douglasii	Douglas hawthorn	FAC
	Fraxinus latifolia	Oregon ash	FACW
	Populus trichocarpa	Black cottonwood	FAC
	Prunus emarginata	Bitter cherry	FACU
Shrubs	*Acer circinatum*	Vine maple	FACU
	Cornus stolonifera	Red-osier dogwood	FACW
	Corylus cornuta	Beaked hazelnut	FACU
	Cytisus scoparius	Scots broom	NI
	Populus trichocarpa (saplings)	Black cottonwood	FAC
	Rosa nutkana	Nootka rose	FAC
	Rosa pisocarpa	Clustered wild rose	FAC
	Rosa sp.	Rose	
	Rubus discolor	Himalayan blackberry	FACU
	Rubus laciniatus	Evergreen blackberry	FACU
	Rubus ursinus	Pacific blackberry	FACU
	Salix spp.	Willow	FACW
	Salix scouleriana	Scouler willow	FAC
	Symphoricarpos albus	Snowberry	FACU
Herbs	*Agropyron repens**	Quackgrass	FAC
	Agrostis alba	Redtop	FACW
	*Agrostis tenuis**	Colonial bentgrass	FAC
	Alopecurus geniculatus	Water foxtail	OBL
	*Alopecurus pratensis**	Meadow foxtail	FACW
	*Cirsium arvense**	Canada thistle	FACU
	*Cirsium vulgare**	Bull thistle	FACU
	*Dactylis glomerata**	Orchardgrass	FACU
	Dipsacus sylvestris	Teasel	FAC
	Eleocharis palustris	Creeping spikerush	OBL
	Epilobium ciliatum	Willow-herb	FACW
	Equisetum arvense	Field horsetail	FAC
	*Festuca arundinacea**	Tall fescue	FAC
	Festuca rubra	Red fescue	FAC+
	Geranium spp.	Crane's-bill	FACU
	*Holcus lanatus**	Common velvetgrass	FAC
	Juncus effusus	Soft rush	FACW
	Juncus spp.	Rush	FACW
	Lolium perenne	Perennial rye grass	FACU

Table 7.2-3. **Plant species observed on the mitigation site and adjacent riparian areas during delineation site visits in October 1995 and 2000 (continued).**

Scientific Name	Common Name	WIS [a]
Lotus corniculatus	Birds foot trefoil	FAC
*Phalaris arundinacea**	Reed canarygrass	FACW
*Phleum pratense**	Timothy	FAC
Phragmites communis	Common reed	FACW
Plantago lanceolata	English plantain	FAC
*Poa pratensis**	Kentucky bluegrass	FAC
Polystichum munitum	Sword fern	FACU
Ranunculus repens	Creeping buttercup	FACW
Rumex crispus	Curly dock	FAC
Scirpus acutus	Hard-stem bulrush	OBL
*Solanum dulcamara**	Climbing nightshade	FAC
Symphoricarpos albus	Snowberry	FACU
*Tanacetum vulgare**	Common tansy	UPL
Taraxacum officinale	Common dandelion	FACU
Trifolium pratense	Red clover	FACU
Typha latifolia	Common cattail	OBL
Xanthium strumarium	Cocklebur	FAC

* These species are dominant on portions of the site.

[a] Wetland Indicator Status (Table 7.2-4).

Table 7.2-4. The wetland indicator status (WIS) system for determining a species adaptation to wetland conditions.

Category	Symbol	Definition
Obligate Wetland Plants	OBL	Obligate wetland plants occur almost always (estimated probability >99%) in wetlands under natural conditions, but may also occur rarely (estimated probability <1%) in non-wetlands.
Facultative Wetland Plants	FACW	Facultative wetland plants usually occur (estimated probability 67% to 99%) in wetlands, but may also occur (estimated probability 1% to 33%) in non-wetlands.
Facultative Plants	FAC	Facultative plants with a similar likelihood (estimated probability 33% to 67%) of occurring in wetlands or non-wetlands.
Facultative Upland Plants	FACU	Facultative upland plants usually occur (estimated probability 67% to 99%) in non-wetlands, but also occur (estimated probability 1% to 33%) in wetlands.
Obligate Upland Plants	UPL	Upland plants occur almost always (estimated probability >99%) in non-wetlands under natural conditions.
	+	Used in conjunction with a category to indicate a somewhat greater probability to occur in wetlands.
	-	Used in conjunction with a category to indicate a somewhat lower probability to occur in wetlands.

Source: Environmental Laboratory (1987)

Three emergent wetlands are present at the Auburn site (totalling about 19.5 acres [see Figure 7.2-2]). The wetlands are dominated by non-native pasture grasses that include meadow foxtail, redtop (*Agrostis alba*), colonial bentgrass, quackgrass, tall fescue, common velvetgrass, and patches of reed canarygrass. Other herbaceous species in the wetlands include soft rush (*Juncus effusus*) and creeping buttercup. Along the western edge of the site are scattered black cottonwood and red alder trees.

A variety of shrubs and trees are scattered along a fence line at the southern boundary of the site. Shrubs found along the fence line include Himalayan blackberry, vine maple, roses (*Rosa* sp.), snowberry (*Symphoricarpos albus*), and red-osier dogwood (*Cornus stolonifera*). Tree species present in this area are Douglas hawthorn (*Crataegus douglasii*), Oregon ash, and black cottonwood. The herbaceous community in this area is dominated by reed canarygrass.

In the summer of 1998, the northern one-fourth of the property was plowed and disced by a farmer leasing the land to the north.[45] Pasture grasses such as tall fescue (*Festuca arundinacea*) and perennial ryegrass (*Lolium perenne*) currently dominates this portion of the site, and weedy forbs such as bull thistle (*Cirsium vulgare*) and willowherb (*Epilobium ciliatum*).

Hydrology

There are no natural surface water features on the mitigation site. Two streams, the Green River and Auburn Creek, are located near the mitigation site. The Green River flows from south to north about 100 to 150 ft east of the mitigation site. At this location, the river base elevation is about 12 to 15 ft below the site elevation. The river channel consists of a steep bank, largely vegetated with red alder and black cottonwood saplings. North of the mitigation site and north of South 277th Street, King County sensitive areas maps (King County 1990) shows an intermittent stream, Auburn Creek (see Figure 7.2-1). This stream drains pasture and farmland and flows into the Green River about 1 mile north of the mitigation site. At the confluence of Auburn Creek and the Green River, a small dike, culvert, and flap gate provide flood control.

Overland flow enters the site through a wetland drainageway, or shallow swale, that crosses the middle of the site. For short periods following heavy rainfall, this shallow swale contains surface flows and conveys water from south to north across the site. This shallow drainage swale is connected to the 100-year floodplain of the Green River at the very northwest corner of the site (Figure 7.2-4). The eastern portion of the mitigation site is not within the 100-year floodplain of the Green River because the eastern edge of the site is several feet higher than the 100-year flood elevation of the river (see Figure 7.2-4). A drainage ditch on the mitigation site conveys stormwater and surface water runoff from the northwestern portion of the site to other ditches along South 277th Street. This water eventually flows into the Green River via a series of drainage ditches also called Auburn Creek.

Since September 1995, the groundwater hydrology of the site has been monitored using shallow groundwater monitoring wells (see Figure 7.2-2). Three representative wells are presented in Figures 7.2-5 through 7.2-7. The well data indicate groundwater levels that are within 18 inches of the surface at a number of locations, and generally within 36 to 24 inches of the soil surface for extended periods of time during the late fall, winter, and early spring months. Wetlands on the

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[45] The Port did not authorize this activity and the Port's property was not planted.

mitigation site appear to be largely supported by this seasonally high groundwater table. In addition, wetland hydrology is supported by on-site precipitation that perches in the low permeability soils, resulting in saturated soils and extensive areas of shallow surface water ponding during the rainy season (see Figures 7.2-5 through 7.2-7).

At all well sites, groundwater elevations were lowest in late summer and early fall. Groundwater elevations were highest during and immediately after winter and early spring rains. Groundwater monitoring data show that following early fall precipitation (October, November) and subsequent soil saturation, groundwater elevations on the mitigation site rise by approximately 5 to 8 ft (see Figures 7.2-5 through 7.2-7). Groundwater elevations fall slowly during periods of low precipitation. The changes in groundwater elevation in response to precipitation are largely independent of variations in surface water elevation in the Green River because the river elevation is typically below the groundwater levels observed on the site (Figure 7.2-8).

Well data indicate that groundwater in the mitigation area is perched over a low-permeability clay layer and generally flows northwesterly in the same direction as surface water (Figure 7.2-9 through 7.2-11). A groundwater divide occurs approximately 700 ft west of the Green River (see Figure 7.2-9). East of this divide, groundwater flows eastward toward the river. West of the divide, water flows to the northwest.

Soils

The soils on the mitigation site are alluvial in origin, developed from material deposited on the site by the Green River. The surficial layers of these soils are a complex of silty mineral soils, frequently with lenses of fine sand intermixed. Plowing has mixed the surficial layers of soil, typically to a depth of 9 to 10 inches.

The King County Soil Survey (Snyder et al. 1973) maps soils on the site as the poorly drained Briscot, and Oridia silt loams, and the somewhat poorly drained Renton silt loam (Figure 7.2-12; Table 7.2.5). Briscot, Oridia, and Renton silt loams are designated as hydric soils on the King County, Washington Hydric Soil List (NRCS 2000).[46]

Table 7.2-5. Drainage characteristics of soils occurring on the mitigation site.

		High Water Table			Flooding		
Soil Series [a]	**Drainage Class**	**Permeability (in/hr) [b]**	**Depth (ft)**	**Months**	**Frequency**	**Duration**	**Months**
Briscot	Poorly	0.63-2.0	1 to -1	Nov-Apr	Occasional	Brief	Dec to Feb
Oridia	Poorly	0.20-2.0	1 to 3	Nov-Apr	Occasional	Brief	Nov to Apr
Renton	Somewhat poorly	2.0-6.3	1 to 1.5	Nov-Apr	Common	Brief	Nov to Apr

Source: USDA (1973).

[a] All soils are classified as hydric (wetland); however, evaluation of on-site conditions indicate non-hydric soil inclusions occur throughout the site.

[b] Within the top 20 inches of soil.

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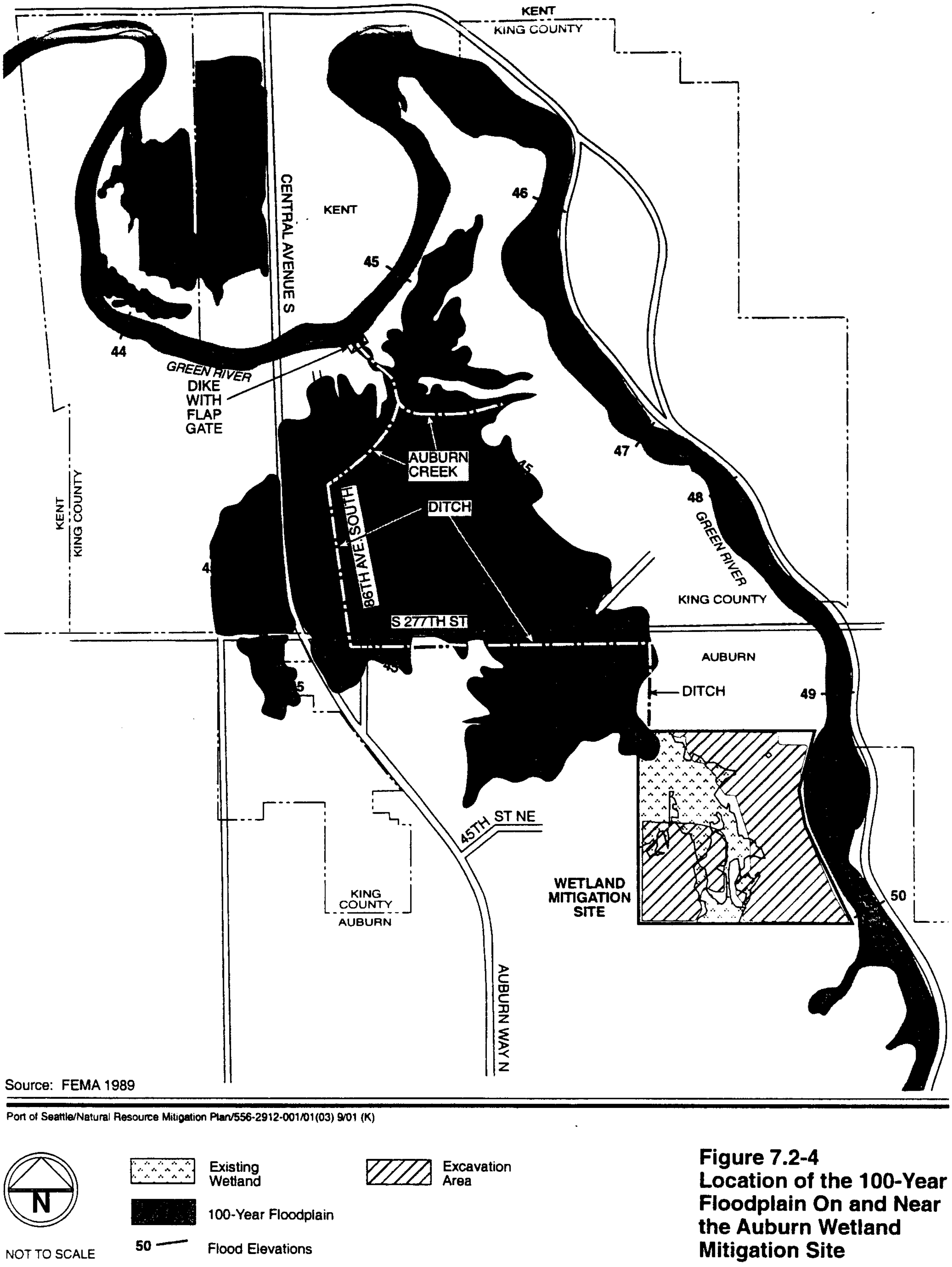
[46] Because the soils on the site are mapped as hydric, and farming activities including ditching have occurred, mitigation on the site could be considered restoration. Because the Port's mitigation establishes some wetland classes that probably did not historically occur on the site, the term "creation" is used for mitigation in upland portions of the site.



Source: FEMA 1989

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 9/01 (K)

Figure 7.2-4
Location of the 100-Year Floodplain On and Near the Auburn Wetland Mitigation Site

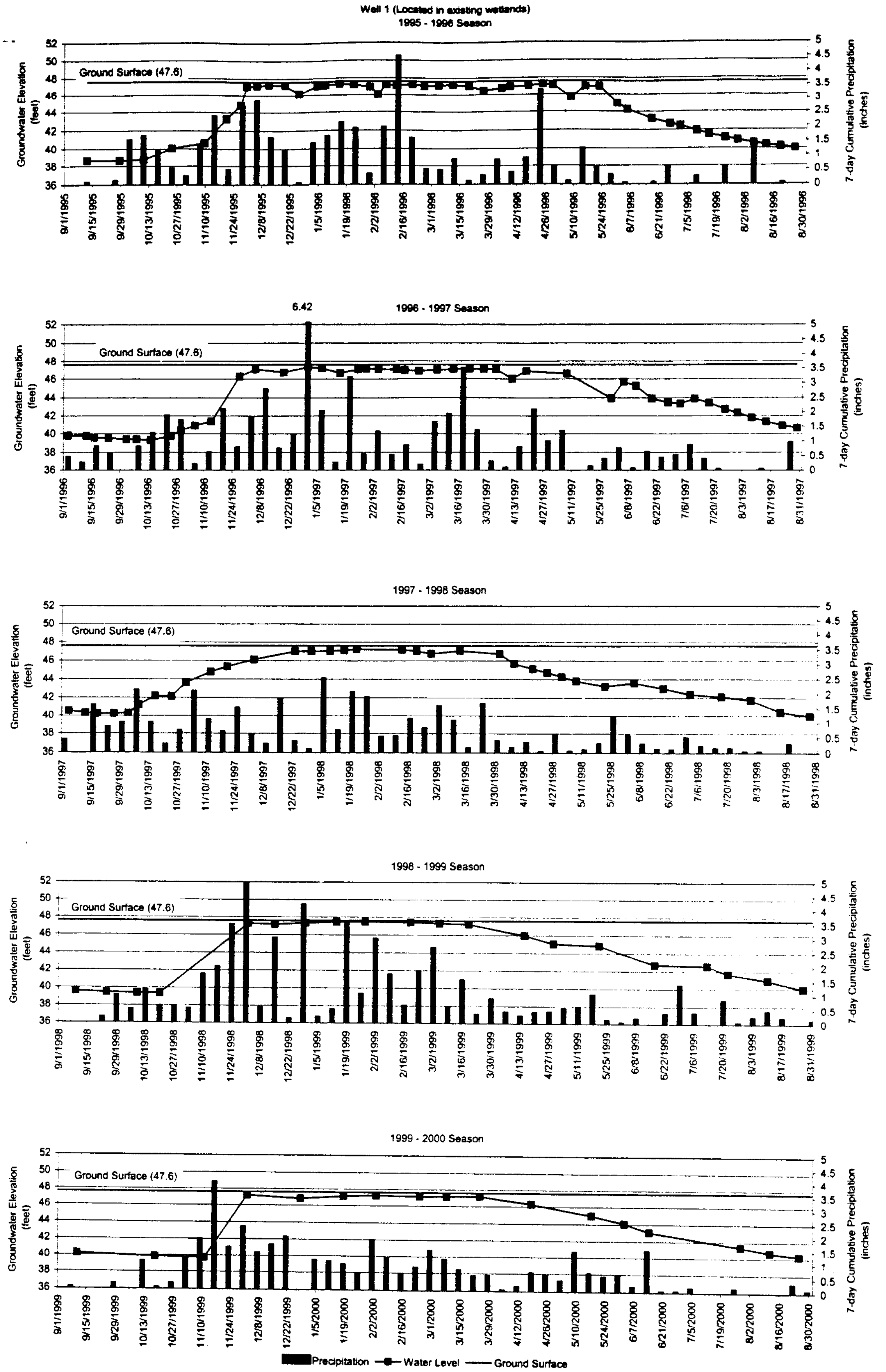


Figure 7.2-5
Variations in Groundwater (Monitoring Well 1) and Precipitation

charts for NRMP.xls

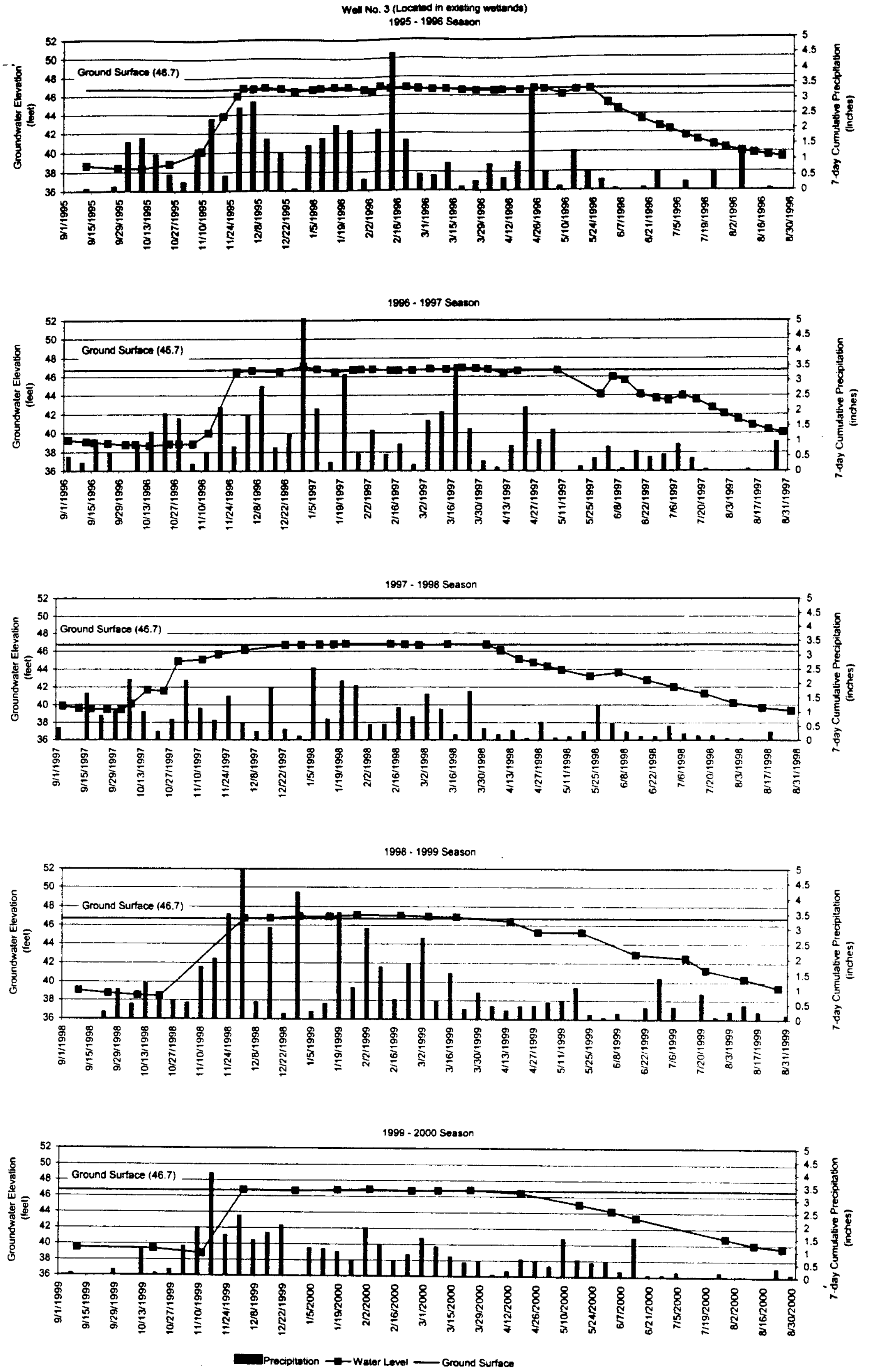


Figure 7.2-6
Variations in Groundwater (Monitoring Well 3) and Precipitation

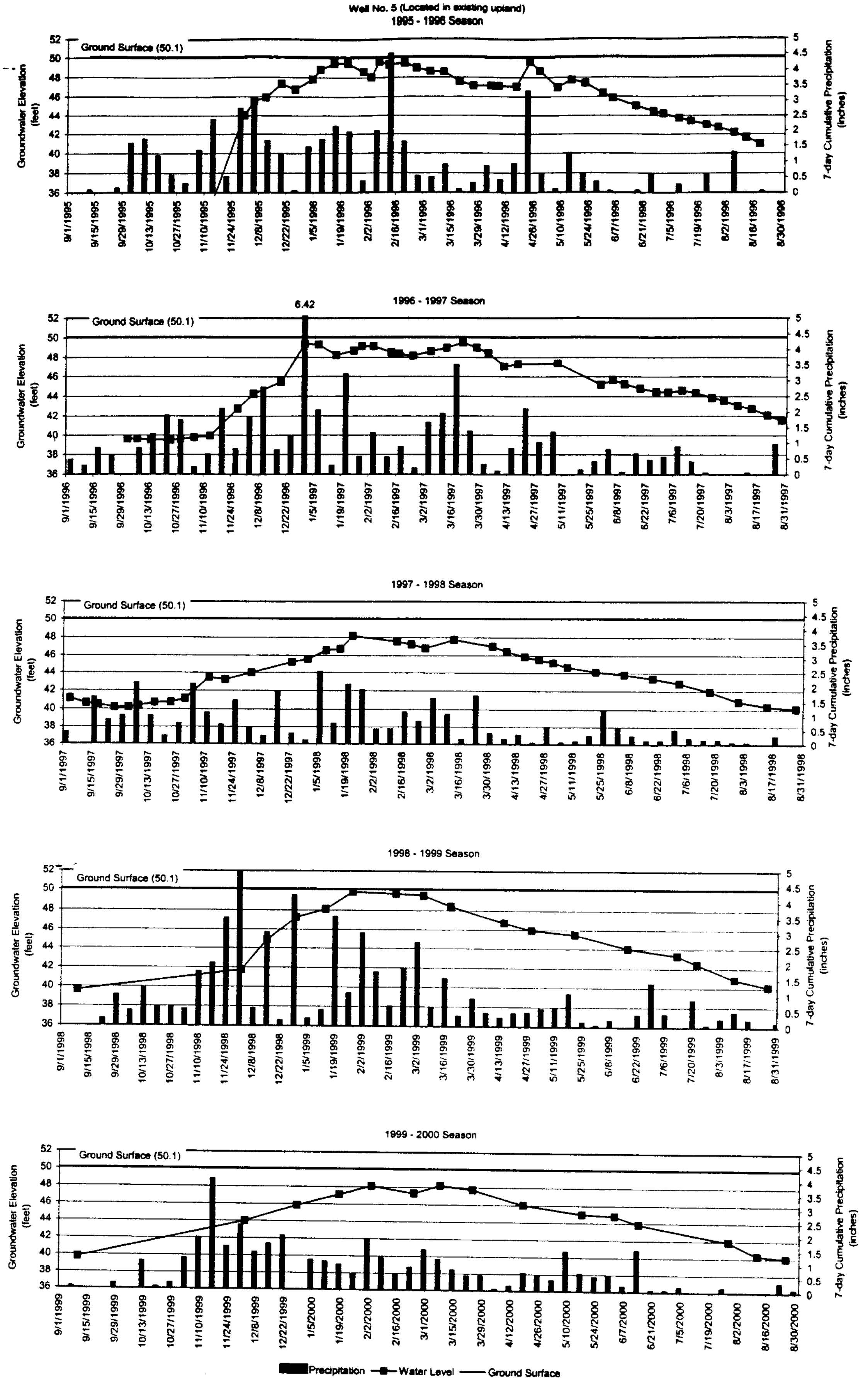
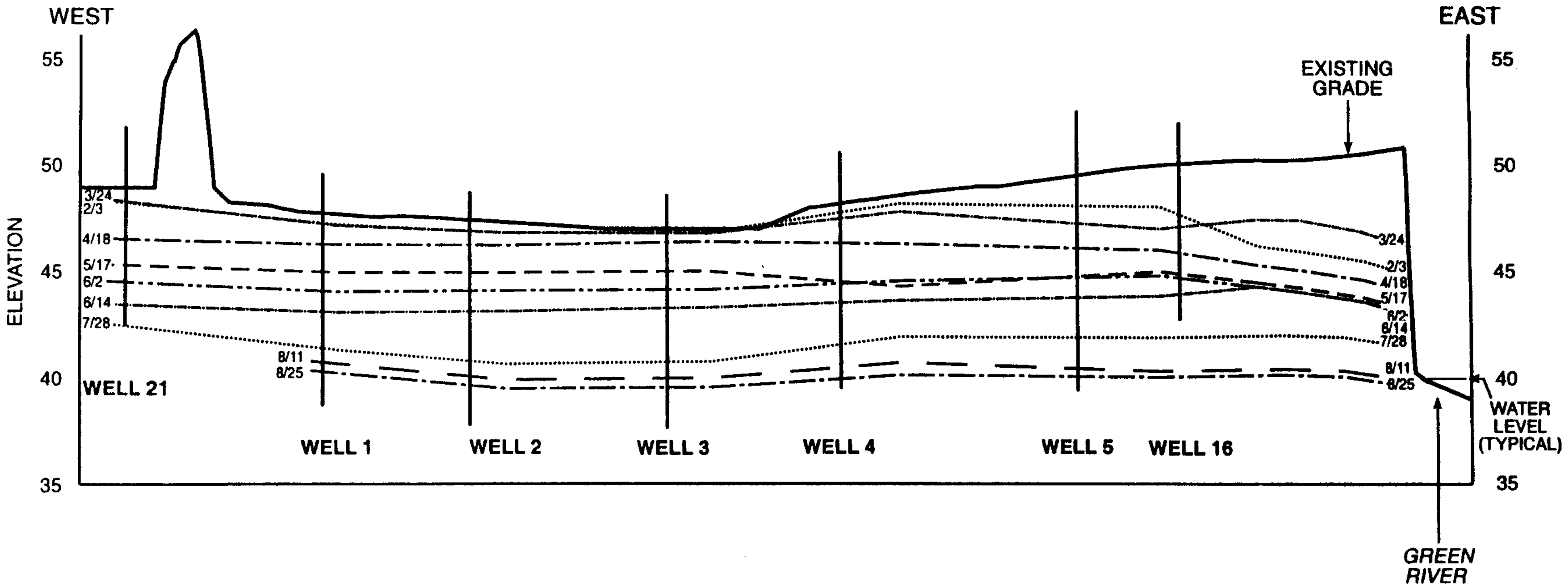


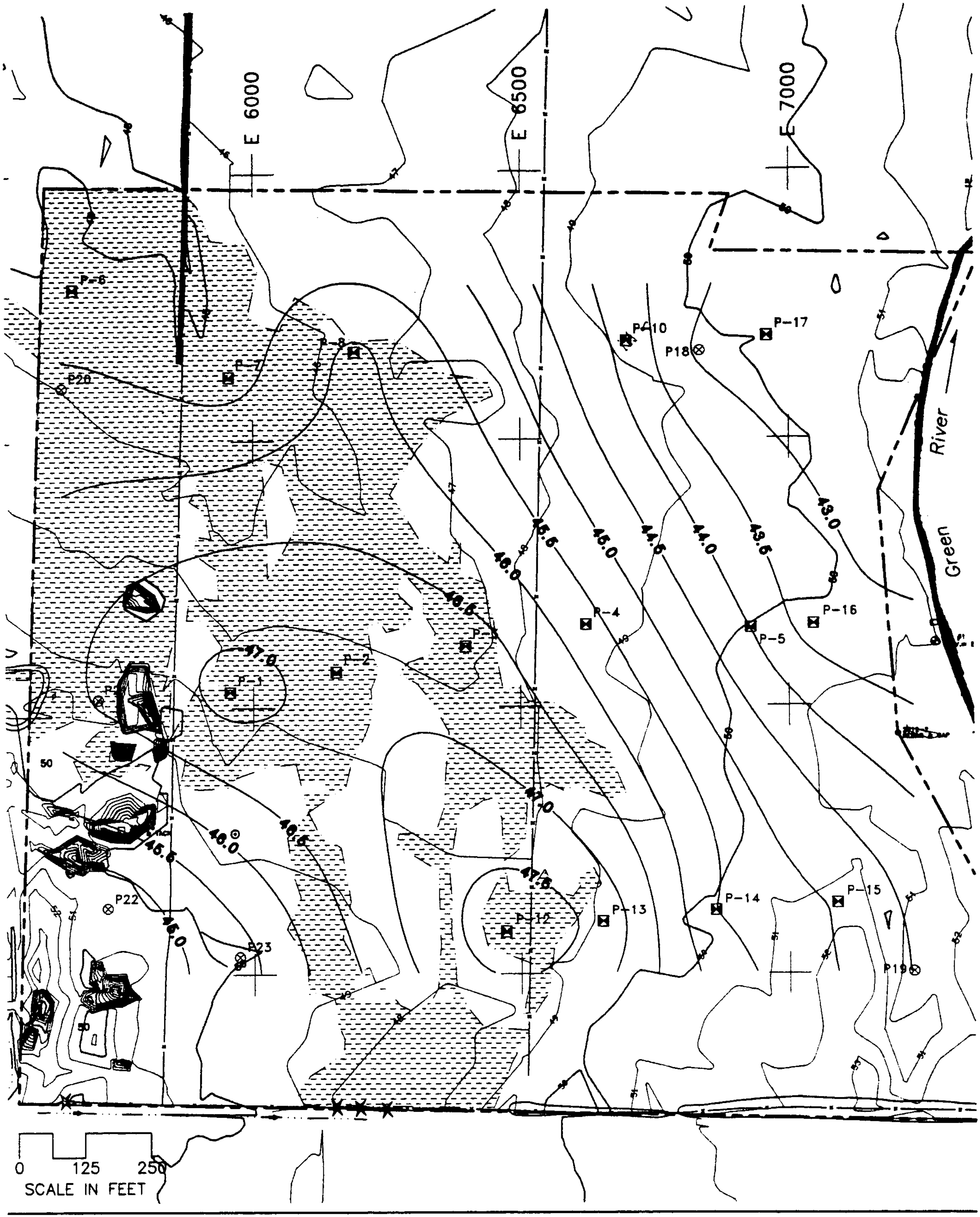
Figure 7.2-7
Variations in Groundwater (Monitoring Well 5) and Precipitation

charts for NRMP.xls



Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 6/01 (K)

Figure 7.2-8
Cross Section of Groundwater Elevations (February-August 2000) at the Wetland Mitigation Site



FILE: 291214040
DATE: 09/06/01

LEGEND:

—45.0— Groundwater Contour and Elevation

Existing Wetland

☒ ⊗P20 Piezometer Locations and Number

——45—— Existing Ground Surface Contour and Elevation

Figure 7.2-9 Groundwater Elevations on the Auburn Wetland Mitigation Site (December 2, 1999)

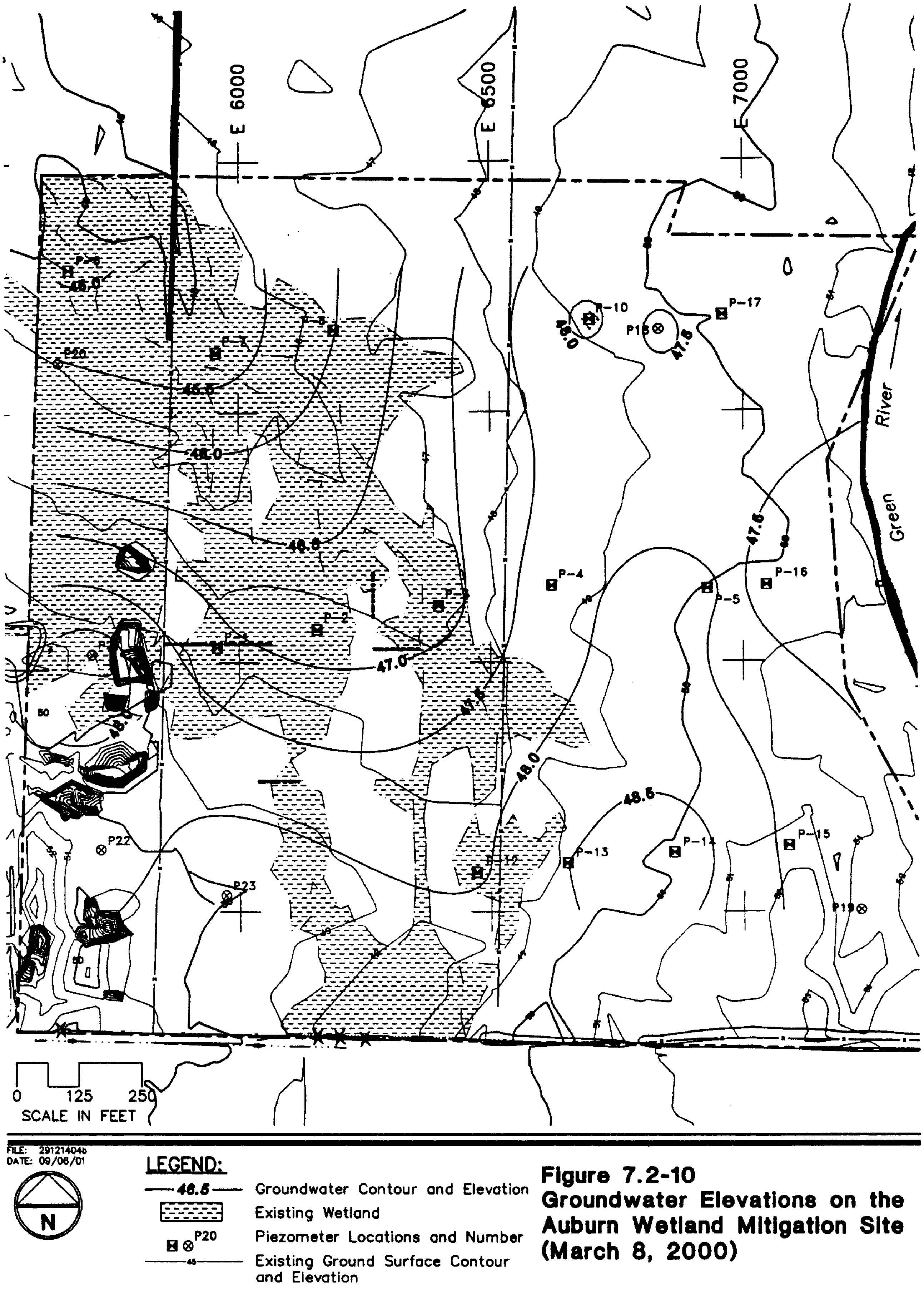
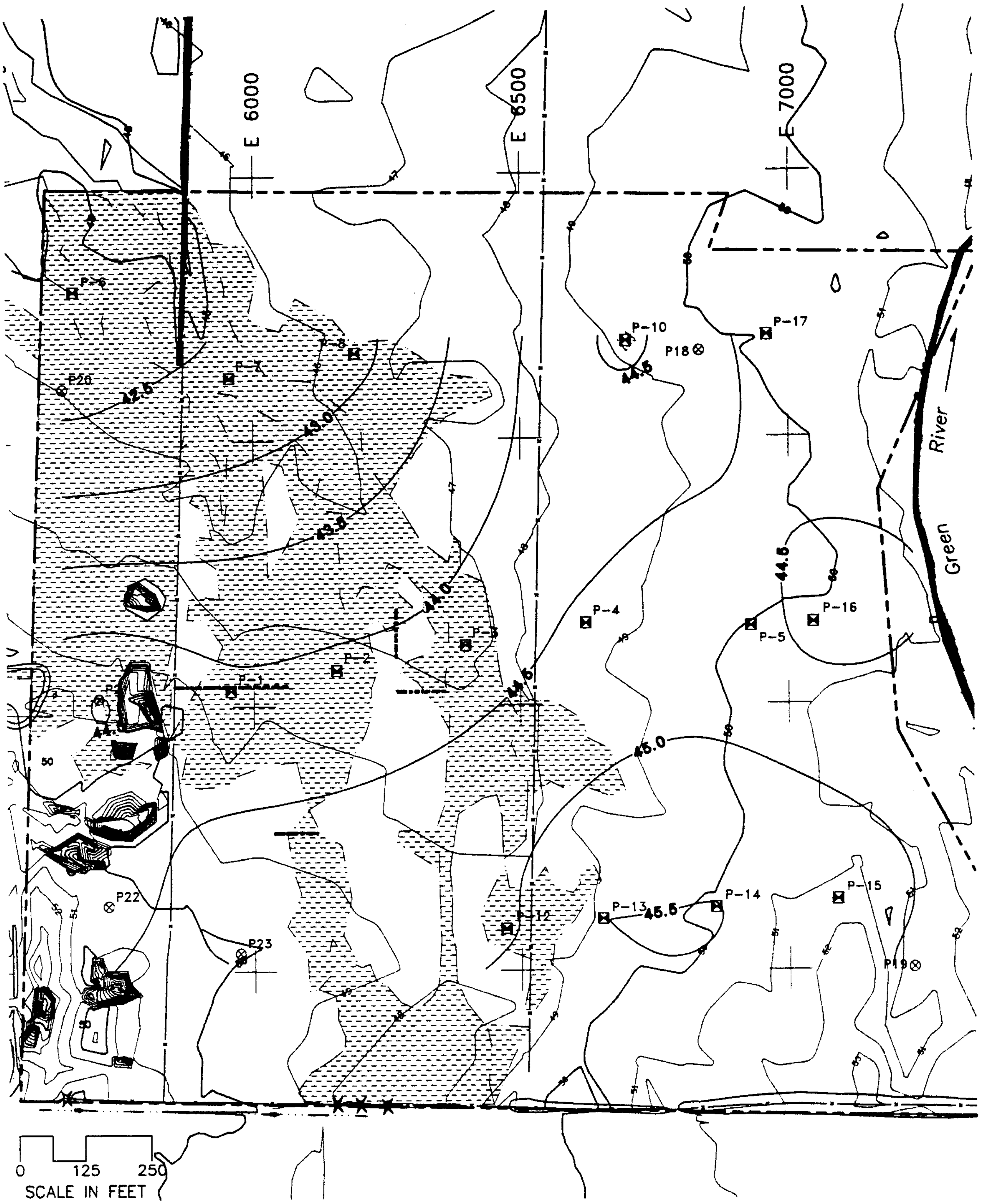


Figure 7.2-10
Groundwater Elevations on the Auburn Wetland Mitigation Site (March 8, 2000)



FILE: 29121404c
DATE: 09/06/01

LEGEND:

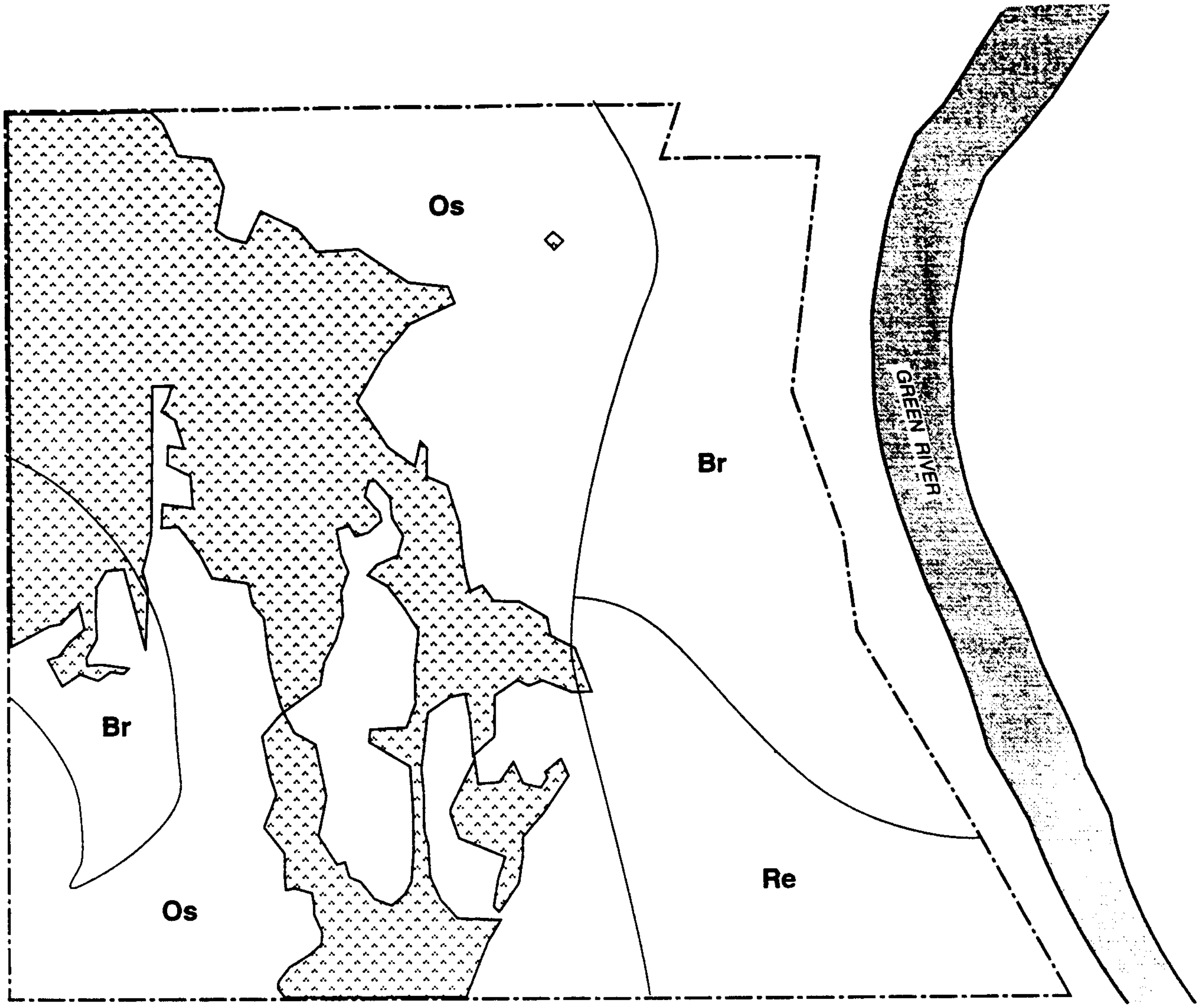
—44.5— Groundwater Contour and Elevation

▭ Existing Wetland

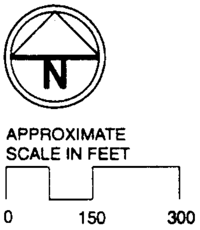
⊠ ⊗P20 Piezometer Locations and Number

——45—— Existing Ground Surface Contour and Elevation

Figure 7.2-11 Groundwater Elevations on the Auburn Wetland Mitigation Site (June 2, 2000)



Source: USDA 1973



Re Renton Silt Loam
Os Oridia Silt Loam
Br Briscot Silt Loam

▨ Existing Wetland
—·— Site Boundary (Approximate)

Figure 7.2-12
Soil Types on the Proposed Wetland Mitigation Site

The published soil descriptions are generally consistent with the results of the laboratory and field analysis of soil performed by Parametrix in October 1995 and soil data collected in the fall of 2000 (Parametrix 2000b). Field observations and analytical test results indicate that two general soil profiles occur on the proposed mitigation site: a wetland soil profile and an upland soil profile (Figure 7.2-13).

The wetland soil profile generally consists of a 6-inch organic layer that covers a 72-inch layer of clayey silt (see Figure 7.2-13). The first 24 inches of the clayey silt are uniform, with mottles dispersed throughout. This uniformity is likely a result of past plowing. Below the uniformly mixed silt, the soil is stratified to layers of gray silt and sandy silt that grades to a sandy silt layer at a depth of about 72 inches. Below the sandy silt are 12 to 16 inches of very compact clayey silt. Below the clayey silt layer, the soil grades to a uniformly fine sand layer. The permeability of the clay silt varies between 0.001 to 0.003 inches/hour (determined at two locations). Because of the thickness of the clayey silt layer and the absence of an underlying fine sand (as found in the adjacent upland soils described below), these soils drain slowly, allowing hydric soil characteristics to develop.

In the upland portion of the site, including the areas outside the existing wetlands that would be graded under the proposed mitigation design, the upper 30 inches of soil is similar to the wetland soils described above (see Figure 7.2-13). A 6-inch topsoil layer is present over a 24-inch, uniformly mixed layer of clayey silt with dispersed mottles. Below 30 inches a 36- to 66-inch layer of uniform gray, fine sand (with some silt) is found. A 6- to 8-inch-thick clayey silt layer was encountered between the 72- and 96-inch depth. Below this clayey silt, the soil returns to a uniform fine sand. The sand layer located near the soil surface and a relatively thin clay silt layer in these soils allow them to drain more rapidly than the wetland soils.

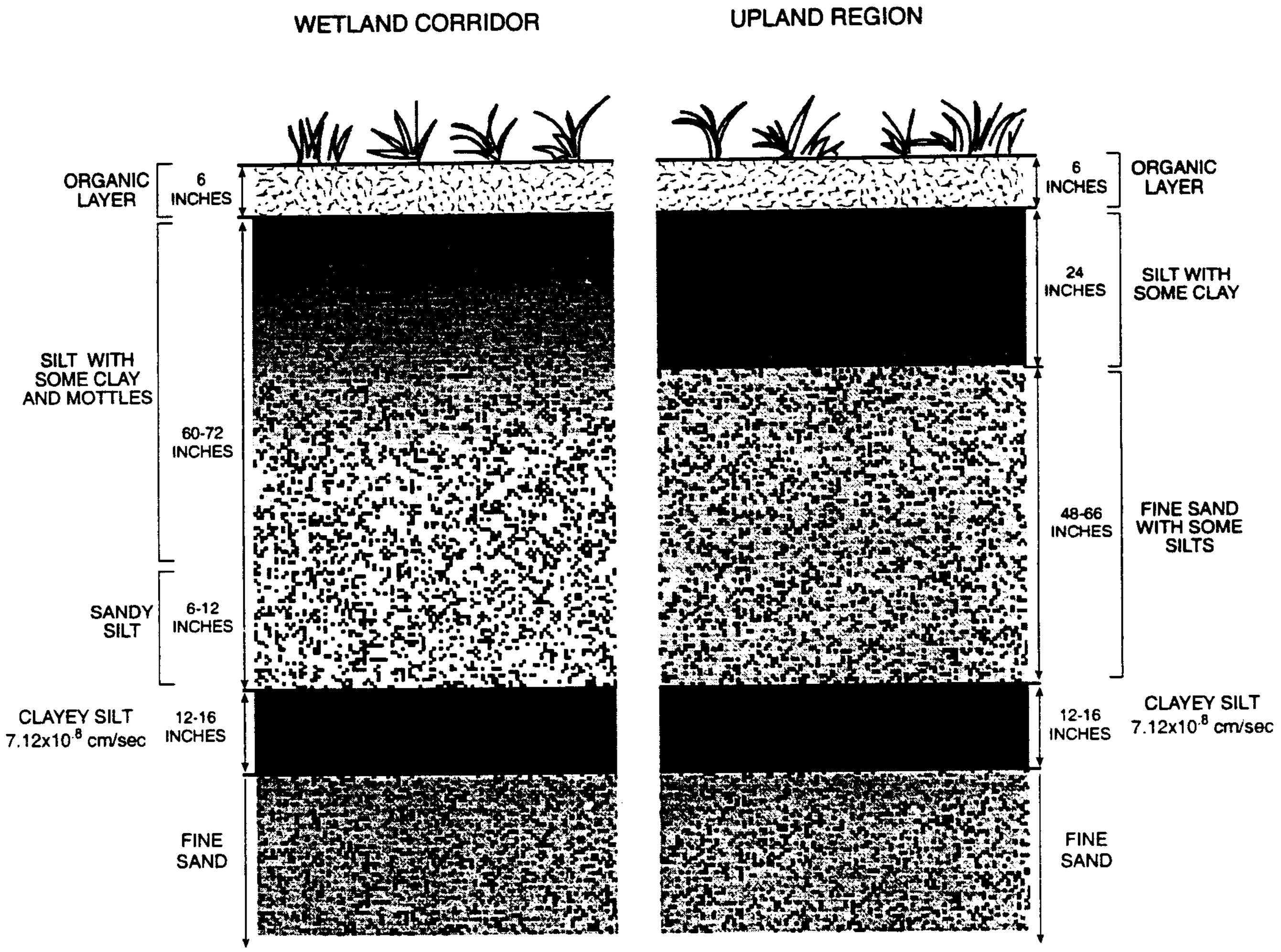
7.2.5.2 Environmental Site Assessment

A Phase I Site Assessment of the mitigation property was conducted in December 1995 (Parametrix 1995). The report was prepared according to guidelines described in *American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM E 1527). The assessment indicates no environmental conditions of concern associated with past or current use of the site and adjacent properties.

7.2.5.3 Wildlife Habitat

The mitigation site consists of abandoned agricultural land that is dominated by grasses and forbs. The properties immediately adjacent to the site to the north and south are actively farmed. West of the site, wildlife habitat has been largely eliminated by residential development. No permanent aquatic habitat is found on the site, although the Green River provides aquatic habitat near the eastern site boundary. Forest slopes along the east bank of the Green River provide habitat connectivity to riparian and other wetland systems, and forested areas. The WDFW Priority Habitats and Species database identifies the palustrine emergent wetland that bisects the site as a priority habitat (all wetlands are considered priority habitat by WDFW).

Habitat quality of the existing wetlands and the adjacent grassy uplands is relatively low due to a number of factors. The relatively uniform pasture grass vegetation is dominated by non-native plant species, lacks structural diversity, has low plant species diversity, and lacks habitat complexity.



Data Compiled by Parametrix

Figure 7.2-13
Typical Soil Profiles at the Wetland Mitigation Site

Small mammals use the area for feeding and breeding. The site may provide foraging habitat for raptors, such as Northern harriers and red-tailed hawks. Apart from the tall pasture grasses there is a general lack of cover from predators, and a lack of habitat complexity (e.g., pits and mounds, LWD) that provides for breeding, resting, and/or thermal cover for small mammals. For most passerine bird species, the site lacks habitat structure for nesting, protection from predators, thermal cover, or perching. A narrow band of shrub vegetation along the southern boundary provides limited forage and perching habitat. Amphibian habitat on the site is currently limited by a lack of seasonally inundated pools, forest cover, and LWD.

Tracks or scat of coyote, mink, deer, and raccoon were observed on or near the mitigation site during the site assessment. Species observed on the site include kingfisher, short-eared owl, barn owl, common snipe, red-tailed hawk, common yellowthroat, and mallard duck. Most of these species appeared to be most abundant in the eastern portion of the site next to the Green River.

7.2.5.4 Functional Changes Anticipated at the Auburn Mitigation Site

The off-site wetland mitigation site is designed to replace wetland habitat functions affected by implementation of the proposed Master Plan Update improvements. The proposed design of the mitigation site will also provide additional mitigation for wildlife species using wetland buffer areas and other upland habitats at the airport. While about 20 acres of the mitigation site contains wetlands, the net result of the proposed mitigation is beneficial to these wetlands in that it restores them to a more natural condition, with higher habitat functions, as discussed below (see Table 4.1-2; also see Table 4-16 in Parametrix 2001b). There would be no adverse changes to the physical or biological functions provided by the existing wetlands on or near the site.

Wildlife Habitat

Construction of the forested, shrub, and emergent wetlands would create conditions that provide habitat for a variety of wildlife species (Table 7.2-6). Habitat structure and availability will change as vegetation matures over the next several decades, and the wildlife species using the site are expected to change over time (Table 7.2-7). Plant species proposed for the wetland mitigation area and their values to various forms of wildlife are presented in Table 7.2-8.

Post-construction habitat structure in forested wetlands would be similar to a regenerating forest, and would develop mature forest habitat attributes after several decades (Figure 7.2-14). The shrub understory would enhance development of habitat structure. Songbird use in early stages of habitat development would include foliage and bark-gleaning species (kinglet, chickadee, bushtit, and vireo) that forage in the area. In later years, Oregon ash, vine maple, willows, redcedar, and western hemlock seed production would be used by additional songbird species. Small mammals would likely forage on the forest floor for seeds and invertebrates, even though optimal habitat conditions would not occur for one or more decades. As a tree canopy begins to develop, it would provide nesting habitat and cover for predator avoidance.

Post-construction habitat structure in shrub wetlands would generally be similar to that of forested systems during the first several years of development (see Figure 7.2-14). However, since shrub communities would periodically be flooded, ground-dwelling animals would be less common. The shrub community would reach functional maturity in 15 to 25 years following planting (see Figure 7.2-14).

Table 7.2-6. Wildlife species expected to occur in the Auburn wetland mitigation site after construction.

	Habitat Type					
Common Name	**Permanently Flooded Emergent Wetland**	**Seasonally Flooded Emergent Wetland**	**Shrub Wetland**	**Forest Wetland**	**Riparian Forest**	**Abandoned Agricultural Land**
Amphibians						
Northwestern salamander	X	X		X	X	
Long-toed salamander		X	X	X	X	
Pacific giant salamander	X			X	X	
Rough-skinned newt	X	X			X	
Ensatina					X	
Western toad	X	X				
Pacific chorus frog	X	X	X	X	X	
Red-legged frog	X	X	X	X	X	
Bullfrog [1]	X					
Reptiles						
Common garter snake	X	X	X	X	X	
Birds						
Great blue heron	X	X	X	X		
Canada goose	X	X				X
Green-winged teal	X	X				X
Mallard	X	X	X			X
Northern pintail	X	X				X
American pigeon	X	X				X
Osprey					X	
Bald eagle					X	
Northern harrier	X	X				X
Red-tailed hawk				X	X	X
Killdeer	X	X				X
Common snipe	X	X				
Herring gull	X					X
Rock dove [a]						X
Western screech-owl				X	X	
Rufous hummingbird					X	X
Belted kingfisher	X					
Downy woodpecker				X	X	
Northern flicker				X	X	
Pileated woodpecker				X		
Willow flycatcher				X	X	
American/northwestern crow	X	X		X	X	X
Black-capped chickadee				X	X	
Bushtit				X	X	

Table 7.2-6. Wildlife species expected to occur in the Auburn wetland mitigation site after construction (continued).

Common Name	Habitat Type: Permanently Flooded Emergent Wetland	Seasonally Flooded Emergent Wetland	Shrub Wetland	Forest Wetland	Riparian Forest	Abandoned Agricultural Land
Bewick's wren			X	X	X	
Winter wren					X	
Marsh wren	X		X			
Golden-crowned kinglet					X	
Ruby-crowned kinglet				X	X	
American robin		X		X	X	X
Varied thrush				X	X	
European starling[a]				X	X	X
Yellow warbler				X	X	
Yellow-rumped warbler				X	X	
MacGillivray's warbler			X	X	X	
Common yellowthroat	X		X			
Wilson's warbler				X	X	
Rufous-sided towhee				X	X	
Fox sparrow				X	X	
Song sparrow	X	X	X	X	X	X
Dark-eyed junco				X	X	
Red-winged blackbird	X	X	X			X
Brown-headed cowbird	X	X	X	X	X	X
American goldfinch				X	X	
House sparrow[a]						X
Mammals						
Vagrant shrew		X	X	X	X	
Pacific water shrew	X	X				
Shrew-mole					X	
Pacific mole						X
Pacific jumping mouse				X	X	
Raccoon	X	X	X	X	X	
Mink	X	X	X	X	X	
Striped skunk					X	X
Coyote			X	X	X	
Red fox			X	X	X	

[a] This is an introduced species.

Table 7.2-7. Potential wildlife use of constructed wetland habitats.

	Years After Planting											
	Emergent Wetland				Shrub Wetland				Forest Wetland			
Wildlife Types	0 to 2	2 to 5	5 to 15	>15	0 to 2	2 to 5	5 to 15	>15	0 to 2	2 to 10	10 to 25	>25
Mammals												
Shrews and mice		F	F	F	F	B/F	B/F	B/F	F	B/F	B/F	B/F
Squirrels						F	F	F	F	F	B/F	B/F
Raccoons and mink		F	F	F		F	F	F		F	B/F	F/M
Fox and coyote		F	F	F		F	F	F		F	F	F
Bats	F	F	F	F	F	F	F					
Deer	F	F	F	F	F	F	F	F	F	F	F	F
Birds												
Shrub-nesting songbirds		F	F/M	F/M	F/M	F/M	B/F/M	B/F/M	F/M	B/F/M	B/F/M	B/F/M
Swallows and swifts	F	F	F	F	F							B/F
Forest-dwelling songbirds						F/M	F/M	F/M	F/M	F/M	B/F/M	B/F/M
Cavity-nesting birds						F	F	F		F	F	B/F
Marsh-nesting songbirds	F	F	B/F	B/F	F	F	B/F	B/F	F	F		
Raptors	F	F	F	F	F	F	F	F	F	F	F	B/F
Wading birds		F/M	F/M	F/M	F/M	F/M						
Dabbling waterfowl		F/M	F/M	F/M	F/M	F/M						
Diving waterfowl		F/M	F/M	F/M								
Herpetofauna												
Reptiles		F	F	F	F	B/F	B/F	B/F	F	B/F	B/F	F
Terrestrial-breeding amphibians		F	F	F	F	F	F	F	F	B/F	B/F	B/F
Aquatic-breeding amphibians		F	B/F	B/F	F	B/F	B/F	B/F	F	F	F	F
Macroinvertebrates												
Aquatic insects	B/F	B/F	B/F	B/F	B/F	B/F	B/F	B/F	B/F	B/F	B/F	B/F
Gastropods			B/F	B/F		B/F	B/F	B/F		B/F	B/F	B/F

B = Breeding
F = Foraging
M = Migration

Table 7.2-8. Plant species to be planted at the Auburn wetland mitigation site.

Plant Species		Wildlife Function	Description
Scientific Name	**Common Name**		
Deciduous Trees			
Acer macrophyllum	Big-leaf maple	Forage	The seeds of big-leaf maple and Oregon ash are eaten by small mammals, songbirds, and game birds.[a] Cascara and western crabapple fruit are persistent and offer good winter forage for pileated woodpeckers, thrushes, band-tailed pigeons, and other songbirds. The female catkins of alder, cottonwoods, and willows are used by foraging songbirds. New growth provides browse for medium and large mammals. Deciduous trees provide foraging habitat for hawking and foliage-gleaning insectivores. The leaf litter provides food for detritivores (which in turn are consumed by small mammals, amphibians, reptiles, and birds).
Alnus rubra	Red alder		
Populus trichocarpa	Black cottonwood		
Rhamnus purshiana	Cascara		
Fraxinus latifolia	Oregon ash		
Malus fusca	Pacific crabapple		
Salix lasiandra	Pacific willow		
		Habitat	Deciduous trees provide nesting habitat for birds, small mammals, and invertebrates; perching and roosting habitat for birds; and escape cover for prey species. Mature Oregon ash are vulnerable to heart rot and subsequent insect invasion, providing cavity nesting and roosting habitat. Leaf litter from deciduous trees is used as cover by amphibians and small mammals.
Coniferous Trees			
Picea sitchensis	Sitka spruce	Forage	These coniferous trees provide seed forage for songbirds, game birds, mice, squirrels, voles, and shrews, as well as foraging habitat for hawking and foliage-gleaning insectivores. Deer, rabbit, and mountain beaver browse on new growth and young bark.
Thuja plicata	Western redcedar		
Abies grandis	Grand fir		
		Habitat	Evergreen vegetation provides breeding and roosting habitat for birds and small mammals. Coniferous heartwood often decays readily when attacked by fungi, resulting in hollow living trees that provide habitat for cavity-nesting and roosting species. The foliage provides year-round escape cover and thermal protection when deciduous foliage is lacking.

Table 7.2-8. **Plant species proposed for the Auburn wetland mitigation area (continued).**

Plant Species		Wildlife	
Scientific Name	**Common Name**	**Function**	**Description**
Shrubs			
Salix sitchensis	Sitka willow	Forage	Willow shrubs may be used as browse by deer and some small mammals. The female catkins provide forage for songbirds. Vine maple seeds are eaten by small birds and mammals.
Salix hookeriana	Hooker's willow		
Salix scouleriana	Scouler's willow		
Acer circinatum	Vine maple		
		Habitat	These shrubs provide dense multi-stem nesting habitat and escape cover for songbirds and small mammals. The leaf litter provides habitat for amphibians and detritivores.
Cornus stolonifera	Red-osier dogwood	Forage	Hazelnut provides a mast crop and winter forage for game birds, deer, and small mammals. Twinberry, red elderberry, snowberry, and Indian plum fruit are an excellent food source for birds and mammals. Rose hips are a food source for songbirds, game birds, deer, small mammals, and rodents. The fruits are persistent and provide forage in the winter months. Salmonberries provide food for songbirds, game birds, small mammals, deer, and some omnivores (fox, raccoon, etc.). Deer browse on the leaves, twigs, and fruit of all of these shrubs.
Lonicera involucrata	Twinberry		
Oemleria cerasiformis	Indian plum		
Physocarpus capitatus	Pacific ninebark		
Rubus spectabilis	Salmonberry		
Rosa nutkana	Nootka rose		
		Habitat	The shrub structure provides nesting and escape cover for birds, mammals, and other prey species.
Herbaceous Species			
Carex rostrata	Beaked sedge	Forage	The seeds of sedges and fruits of rushes are eaten by songbirds, game birds, and waterfowl, especially mallard and ring-necked ducks. Deer and small mammals browse upon the foliage. Bur-reed fruit and the young shoots of most emergent plants are forage for waterfowl and muskrat.
Eleocharis palustris	Common spike-rush		
Scirpus microcarpus	Small-fruited bulrush		
Scirpus acutus	Bulrush		
Scirpus lacustris	Hardstem bulrush		
Sparganium emersum	Narrow-leaf bur-reed		

Table 7.2-8. Plant species proposed for the Auburn wetland mitigation area (continued).

Plant Species		Wildlife	
Scientific Name	Common Name	Function	Description
		Habitat	These species provide nesting materials and cover for songbirds, waterfowl, and small mammals. Shrews, mice, and voles use the ground cover for thermal protection and predator avoidance. In late winter and spring floods, the stems are used for breeding substrate by amphibians and invertebrates.
Oenanthe sarmentosa	Water parsley	Forage	Some herbivores may browse on water parsley and smartweed. Water smartweed fruit provide food for songbirds, game birds, deer, and rabbit. Dabbling and diving ducks feed on the foliage.
Polygonum amphibium	Water smartweed		
Grasses			
Agrostis alba	Redtop	Forage	Songbirds and rodents feed on all these grass seeds, while mannagrass and red fescue are grazed by waterfowl.
Festuca rubra	Red fescue		
Glyceria sp.	Mannagrass		
		Habitat	Grasses provide breeding and escape cover for small mammals. Grasses are used by many species for nest construction and lining.

Sources: Martin et al. (1951); Brown (1961); Payne and Bryant (1992)

[a] Seed production by trees varies with maturity. Red alder and black cottonwood produce seeds at 4 to 10 years of age. Big-leaf maple, Douglas fir, and western redcedar produce seeds after 10 to 12 years of age. Oregon ash, Sitka spruce, and western hemlock produce large seed crops after about 20 years of growth.

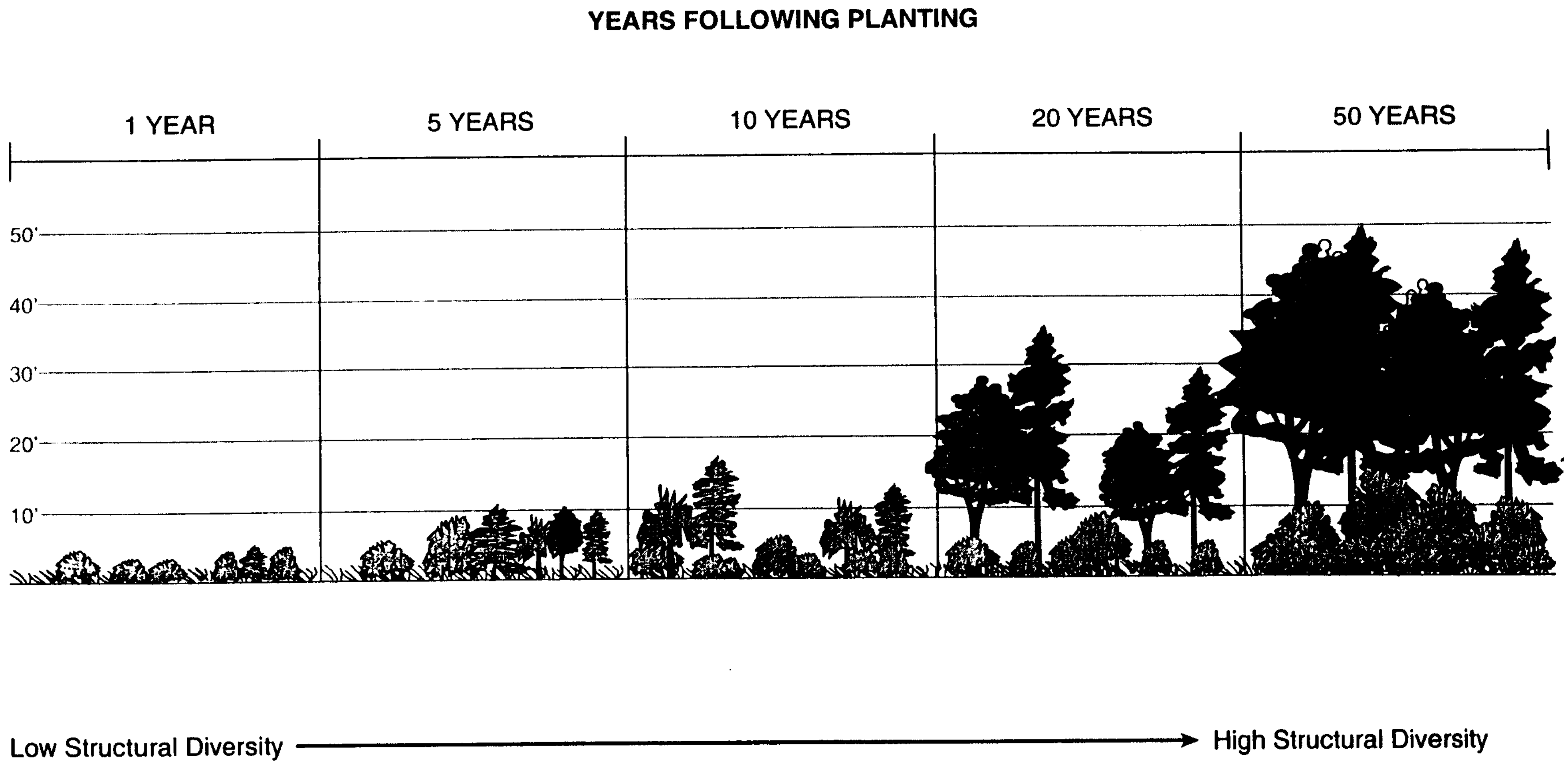


Figure 7.2-14
Typical Successional Changes in Forested Wetland Vegetation Following Planting

Emergent communities would provide resting and foraging habitat for shore and water birds within 1 year of planting. After 2 to 3 years, most of the intended wildlife functions should be present, and in the following 5 to 10 years, relatively mature communities should be present.

Tree-nesting songbirds (such as thrushes, vireos, and warblers) are expected to use horizontal branches for nesting when the canopy closes enough to provide cover. Leaf litter and forest detritus would begin to accumulate, providing habitat for the invertebrates (Pennak 1989) that amphibians (such as ensatina), small mammals, and ground foraging birds feed on. Small mammals, in turn, are likely to become food for predators, such as barred owls. Over several decades, disease or competition for light would result in mortality. Dead and decaying trees would provide woody debris and snag habitat for flickers, woodpeckers, and small cavity-nesting birds.

The shrub and emergent wetlands should achieve stable habitat conditions earlier than the forested wetland community. Shrub wetland communities should produce forage and nesting opportunities within 2 to 10 years. Swainson's thrush and Wilson's warblers use moist shrub habitats for nesting and foraging. Berries produced by salmonberry, red elderberry, and red-osier dogwood are used by several insectivorous songbird species to supplement fall and winter diets (Ehrlich et al. 1988). Mink, shrews, and other small mammals would exploit these insect and aquatic invertebrate food sources. Wading birds, such as great blue herons and bitterns, can feed on small mammals and amphibians.

Amphibian use, however, would likely be limited by immigration rates because of the lack of existing amphibian habitat in the area. Some species, such as Pacific giant salamander, northwestern salamander, and rough-skinned newt, commonly migrate through terrestrial habitats and could use the mitigation site.

Although flooded emergent wetlands can provide substantial forage opportunities for ducks, habitat use would vary with proximity to upland predator cover. Waterfowl, which are wary of dense shrubs (which allow predators to approach undetected), prefer interspersion of flooded emergent vegetation and open water. Slough sedge (*Carex obnupta*), spike-rush (*Eleocharus palustris*), and horsetail are all species preferred by dabbling ducks and geese during migration (Payne and Bryant 1992). Narrow-leaf bur-reed (*Sparganium emersum*) is preferred by dabblers and migrating wood ducks. As decaying vegetation builds up in flooded areas, shovelers, pintails, and other diving species could forage on growing populations of plankton, algae, aquatic insects, and snails.

Over time, portions of properties adjacent to or near the mitigation site may be developed for commercial and/or residential uses. Depending on the nature of any development and its proximity to the mitigation site, some changes to the wildlife habitat functions provided by the mitigation site may occur. The 65-acre mitigation site is large enough to provide key habitat functions for target wildlife species. The proximity of the mitigation site to riparian habitat corridors along the Green River will ensure that the project is connected to other terestrial and aquatic habitats.

If significant areas of farmland near the mitigation site are developed, use of the mitigation area by non-water dependent wildlife (i.e., mammals such as deer, coyote, and red fox) may decrease because these species may be eliminated from adjacent areas. Development of nearby land with residential uses may increase use of the site by dogs and cats. Dogs and cats could affect some wildlife populations on the mitigation site (i.e., ground-nesting birds and small mammals could be subject to increased predation or cats could become a food resource for coyote). Depending on the exact proximity of development to the wetland buffer and the intensity of human use, wildlife use of the buffer could be reduced. Alternatively, wetland protection and restoration on nearby parcels that contain wetlands (likely required by existing regulations) could result in increased habitat for wildlife and enhanced wildlife function of the mitigation site.

Hydrology

Hydrologic conditions and functions at the wetland mitigation site are anticipated to be stable over the long term, even if future development occurs nearby. Hydrologic monitoring on the wetland mitigation site has been ongoing since September of 1995. The monitoring indicates that favorable subsurface hydrology necessary for creating wetlands exists, and the probability of successful wetland mitigation is high. Further, in planning the mitigation project, contingency actions were identified that will be implemented if post-construction monitoring indicates that performance standards for the wetland are not achieved.

Monitoring results indicate that seasonally high groundwater levels on the site are maintained by precipitation. This conclusion is based on observations of rapid increases in groundwater during mid to late fall, often within several days of heavy rainfall. The rates of water level increase are more rapid than one would expect if the high water table were dependent on groundwater movement from off-site areas. Because the site hydrology is largely precipitation driven, off-site development that may occur near the mitigation would have minimal effect on the hydrology in the mitigation wetlands.

Finally, stormwater management (water quality and discharge) standards and/or wetland protection and restoration requirements for development on nearby parcels will protect the hydrology of the site. These standards are likely to prioritize infiltration, and require water quality BMPs and detention to prevent high flow discharges. Wetland protection requirements (required by existing regulations) could result in wetland restoration and further protect hydrologic conditions on the Port's mitigation site.

7.3 MITIGATION SITE DESIGN

The mitigation design is based on design objectives and criteria explained in this section. This section also explains the basis for specific design elements, including the rationale for establishing the wetland mitigation hydrologic water regime, grading plan, and planting plan.

The mitigation design for the site consists of the following elements:

(1) Excavating two new wetland basins;

(2) Establishing native forested, shrub, emergent, and open-water wetland habitats in these basins;

(3) Enhancing the existing emergent wetlands by replacing the non-native plant communities with native forest and shrub communities;

(4) Establishing a forested buffer around the perimeter of the site; and

(5) Post-construction monitoring, adaptive management, and maintenance of the site.

7.3.1 Water Regime

An adequate water regime is the most critical factor in establishing the desired forest, shrub, and emergent wetland vegetation on the mitigation site. The duration and amount of standing water and soil saturation control the wetland classes and plant community types suitable for the site. Evaluation of the hydrology requirements of natural Puget Sound wetland communities (Ecology 1994a; Kunze 1994) and examination of over 5 years of groundwater monitoring data (see Figures 7.2-5, 7.2-6, and 7.2-7) indicate that it is feasible to create the hydrologic conditions necessary to sustain the diverse wetland habitats and plant communities designed for this site.

In the fall of 2000, ACOE evaluated wetland conditions on the mitigation site (Parametrix 2000b) and found additional wetlands, particularly on the west side of the mitigation site. The mitigation design presented in this document reflects the most current understanding of existing wetlands and groundwater hydrology on the site.

Excavating the two basins on the mitigation site to intercept the seasonally high or permanent groundwater table[48] will attain appropriate hydrologic conditions for a variety of native wetland plant communities by providing a range of soil saturation flooding conditions that will support a variety of plants.

Following grading, ground surface elevations on the site will range from approximately 37 to 50 ft, with most of the east basin below approximately 43 ft. Excavation in limited areas will be a maximum of 12 ft deep to create open-water habitat. The approximate elevations, hydrologic regime, and wetland vegetation classes proposed for the mitigation are presented in Table 7.3-1. The relationship of the proposed wetland vegetation zones to anticipated water levels and site topography of the east basin is shown in Figure 7.3-1.

Table 7.3-1. Proposed wetland classes, elevation ranges, and hydrologic regimes.

Proposed Wetland Class	Proposed Elevation Range (ft)	Anticipated Hydrologic Regime
Forest Wetland	East Basin: 42 to 46 West Basin: 47 to 49	Seasonally saturated soil during years of typical rainfall. During a 10-year flood,[a] flooding of up to 3 ft for up to 9 consecutive days would occur. Soil would be unsaturated to at least 18 inches below the ground surface during most summer and fall periods.
Shrub Wetland	East Basin: 41 to 42 West Basin: 44 to 47	Seasonally saturated or flooded with up to 1 ft of water during years of average rainfall. During a 10-year flood, water could be up to 4 ft deep for 9 consecutive days. Soil would generally be saturated within 12 inches of the ground

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[48] Excavation in the east wetland basin will include construction of a flood conveyance channel and water level control structure that will establish typical wet-season water levels at or near 41 ft elevation (see Appendix E, Sheet C8.2). The basin on the west side will be a closed depression, with water elevations and depths maintained by seasonal variations in groundwater hydrology.

Table 7.3-1. Proposed wetland classes, elevation ranges, and hydrologic regimes (continued).

Proposed Wetland Class	Proposed Elevation Range (ft)	Anticipated Hydrologic Regime
		surface during most of the summer and early fall.
Persistent Emergent	East Basin: 38 to 41 West Basin: 42 to 44	Seasonally flooded with up to 4 ft of water during years of average rainfall. The water table would be at or within 6 inches of the ground surface during late summer and early fall.
Open-water/Unvegetated	East Basin: Below 38 West Basin: Below 42	Permanently to semi-permanently flooded during years of average rainfall. Surface water would generally be 6 to 24 inches deep during late summer and early fall, but may not be present during years of extremely low rainfall.

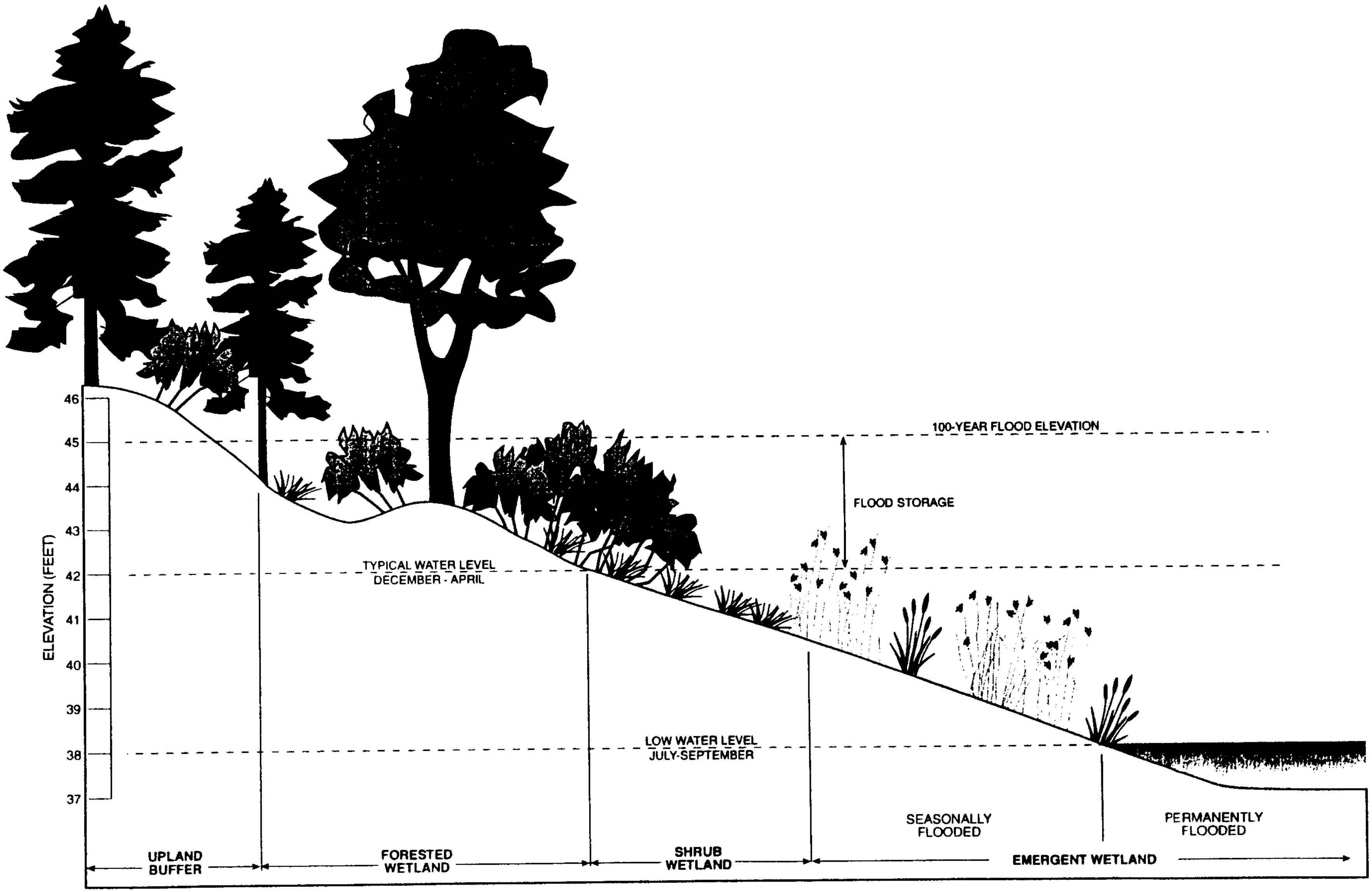
[a] Only the east basin will lie in the floodplain of the Green River. Because of flood control management of the Green River discharge, the peak flows for 10-year and 100-year flood events are equivalent. All recorded flows that could inundate the wetland have occurred between November and early March. In most years, flood inundation would not occur, or would be for periods of one to several days. The maximum period of inundation is less than 9 consecutive days which occurs during cold weather or the dormant period when the common types of wetland vegetation planned for the site are not susceptible to impacts from short duration flood events.

The new wetland areas in the east basin will be connected to the 100-year floodplain of Green River (FEMA 1989) by constructing a vegetated swale from existing ditches located along South 277th Street to the northwest corner of the wetland (see Figure 7.2-4 and 7.2.-1). The ditches along South 277th Street lie within the 100-year flood plain, and also connect to the Green River via a ditch along 86th Avenue South and Auburn Creek. The bottom elevation of the constructed ditch will be at 41 ft, about 3 ft below the elevation of the 100-year flood. The new ditch connecting to the floodplain will allow the east wetland basin to become inundated during 100-year flood events, as backwater flooding from the Green River reaches the site through the ditch system (see Figure 7.2-4).

The wetland mitigation is not, however, dependent on Green River flood events to maintain wetland hydrology, as flooding is too infrequent and for too short of a time period to independently maintain wetland hydrology (see Table 7.3-1). Wetland hydrology will be maintained by the seasonally high groundwater elevations found on the site, and documented in Figures 7.2-9 to 7.2-11.

During the 100-year flood event (when flows exceed 8,500 cfs), water levels in the east basin will increase by up to 3 ft. The frequency of inundation due to Green River flooding is low, with flood events occurring exclusively between November 10 and March 21 (Figure 7.3-2, see Table 7.3-1). The duration of flood events is also short, generally occurring for 1 to several days. Since 1970, two flood events have occurred in March, each about 2 days in duration. The longest period of flooding occurred for 10 days in December 1975.

The hydrologic regimes for the east and west basins will support the vegetation desired to establish wetland functions discussed in Section 7.2.5.4, and required to replace avian habitat functions lost near STIA. Since all plants proposed for the wetland mitigation areas are adapted to a fluctuating water table and periodic inundation (which is common during winter months in floodplain wetlands of western Washington), plant "die-back" as a result of flooding will not occur. All plant species listed in Table 7.2-8 are expected to be tolerant of infrequent and brief periods of inundation during



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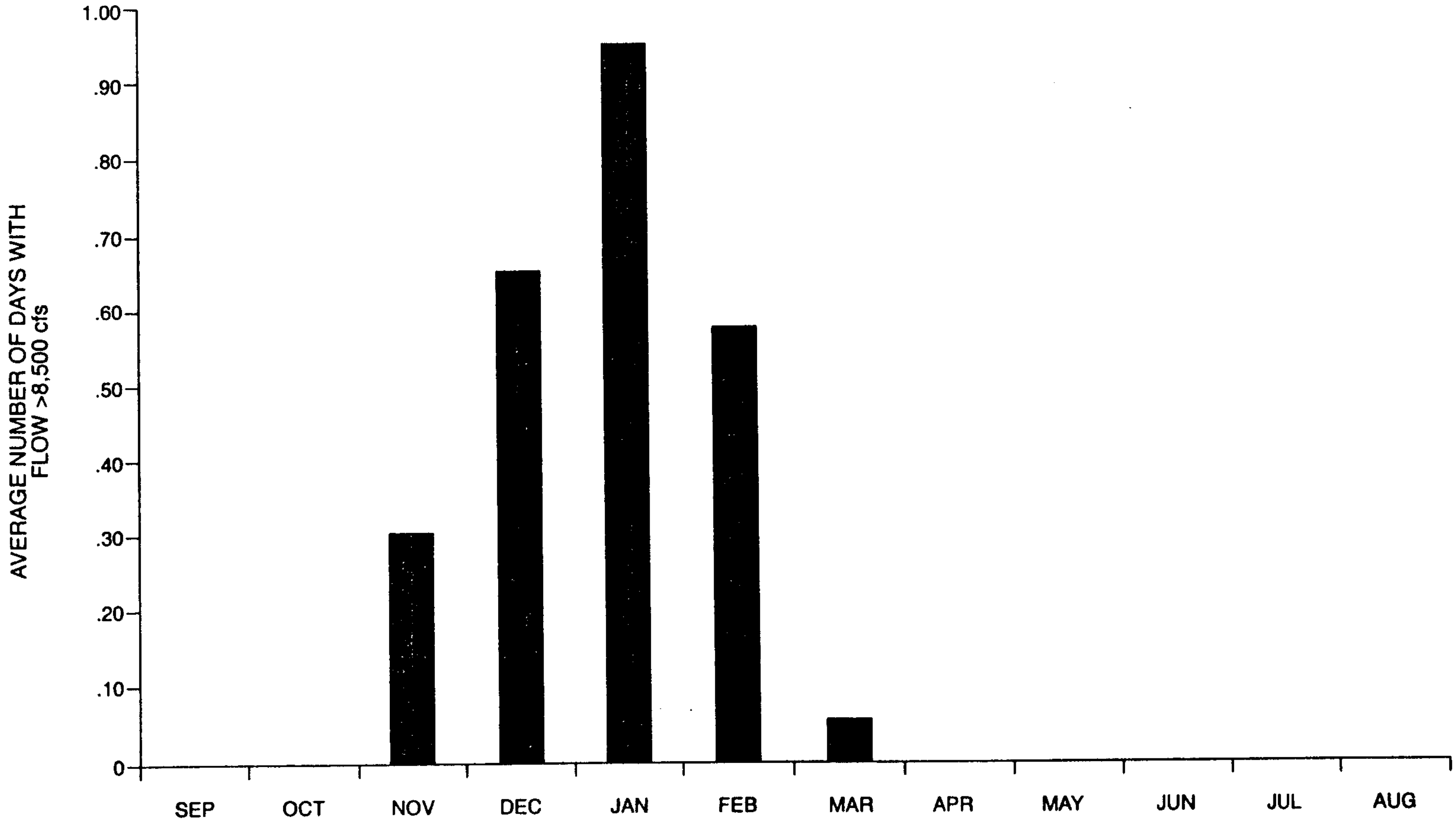
Data Compiled by Parametrix

Figure 7.3-1
Relationship of Seasonal Water Level Variations and Soil Surface Elevations to Proposed Wetland Vegetation Classes



USGS 1996

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

Figure 7.3-2
Green River Flood Frequency by Month
(Based on 1960-1996 Data for Auburn)

the dormant period, and these species are commonly found in uplands and wetlands on the floodplains of northwest rivers. Because of the timing, duration, and frequency of flood events, they are not expected to affect plant survival on the site. Plant survival will largely be a result of each species' tolerance of wet soil conditions, as reflected by their "wetland indicator status" (see Tables 7.2-4 and 7.2-8). To provide additional flexibility in the control of site hydrology in the east basin over the first few years of monitoring, an outlet control structure will be constructed near the northwest portion of the site to regulate water levels in the wetland. The water levels will be adjusted by raising or lowering control gates, thereby raising or lowering water levels (Appendix E, Sheets C3, C5, and C8). However, the weir will be permanently fixed once planting is completed and the site has been monitored for up to several years.

For the east basin, the combination of drainage channels and weir, coupled with the grading plan (described below), will assure that saturated soil conditions (and not long-term inundation) occur in the forest and shrub wetland planting zones (see Table 7.3-1). The weir and drainage channel will result in a free-draining wetland basin that will maintain soil saturation (not inundation) above elevation 41 ft. This soil saturation will be maintained even when the groundwater elevations in surrounding soils exceeded 41 ft, because the drainage channel and weir will prevent inundation of the new ground surface.

For the west basin, the water levels in excavated depressions will be controlled by groundwater conditions on the site since there will be no new channel excavation to connect the basin to the floodplain and other ditches. This grading has been planned to allow vegetation zones to be established as indicated in Table 7.3-1. In the forested zone, the ground surface elevations to be established are based on hydrologic monitoring summarized in Figures 7.2-9 to 7.2-11. The hydrologic monitoring indicated that native vegetation with a wetland indicator status of FAC, FAC+, FACW-, or FACW will be adapted to this hydrologic regime, as shown in Section 7.3.4. Similarly, for other planting zones, the hydrologic regime of the wetland is matched to the tolerance of wetland vegetation to saturated and/or inundated soils. Section 7.3.4 provides additional information regarding plant selection and planting zones.

During the initial plant establishment phase, some control of water levels may be required to optimize establishment and survival of the planted stock. Any necessary adjustments to water regime are anticipated to be minor and short term, and should not be necessary after plants become established. The Port will monitor site hydrology and plant survival carefully during the first few growing seasons and any adjustments to site water levels will be based on these monitoring results. The Port's wetland scientist will adjust outlet control structures, and adjustments will be fully documented in monitoring reports. Following this initial plant establishment period, and based on any water level adjustments made during the first few years, the outlet control structure will be set at a fixed elevation appropriate for the site. No long-term adjustments to the outlet control structure or site water levels are anticipated.

7.3.2 Grading

One basin will be excavated east and another basin southwest of the existing wetlands to create two new wetland areas (Figures 7.3-3 and 7.3-4; Appendix E, Sheets C2 through C7). Excavation will generally be to depths between 1 and 5 ft below the existing ground surface to intercept the seasonally high or permanent groundwater table (see Section 7.3.1 for an explanation of the hydrologic regime to be established by this grading plan). Excavation depths will be less in the west

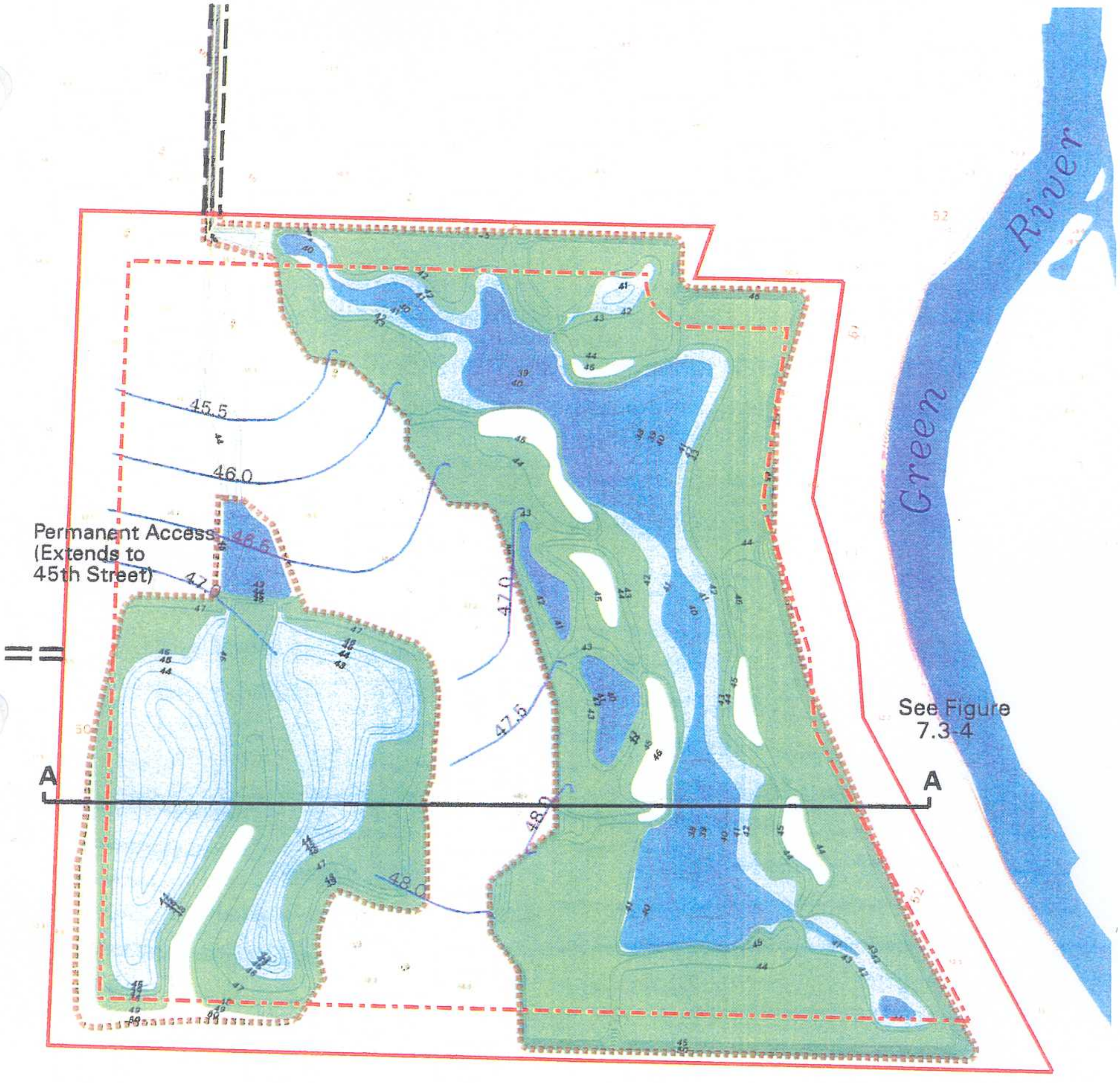


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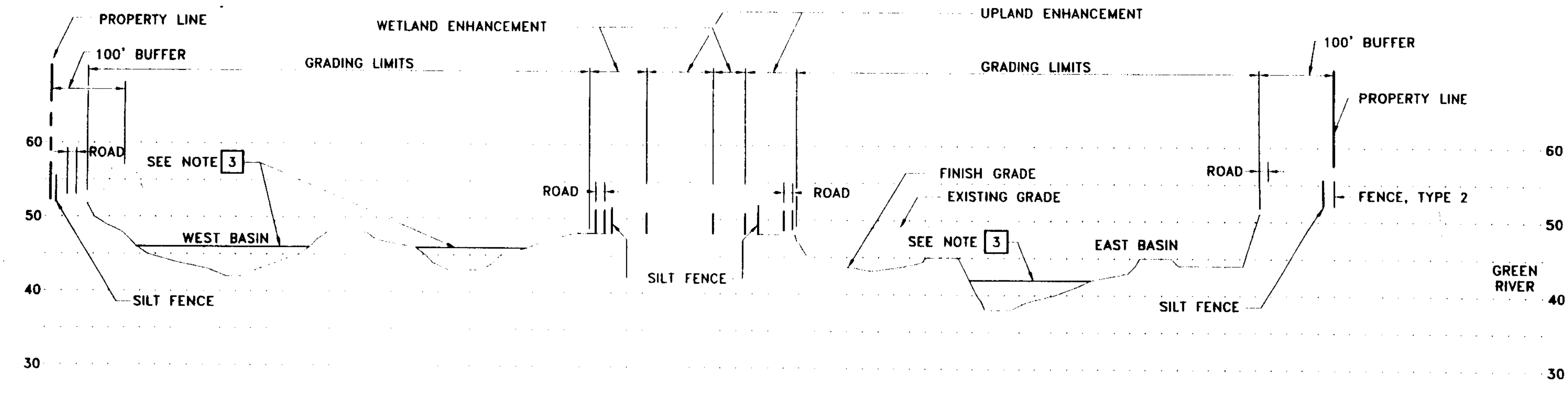
Figure 7.3-3
Wetland Mitigation Grading Plan and Hydrology (Early Spring)



SECTION A–A

HORIZ: 1"=100'
VERT: 1"=10'

NOTES:

1. WETLAND SOIL TYPE 1 SHALL BE USED AT ELEVATION 41.0 AND ABOVE FOR ALL AREAS WITHIN THE GRADING LIMITS. WETLAND SOIL TYPE 2 SHALL BE PLACED BELOW ELEVATION 41.0 WITHIN THE AREA SHOWN ON THE PLAN.
2. GRADE SHOWN AT 3H:1V BUT WILL VARY BETWEEN 3H:1V AND 5V:1V TO PROVIDE VARIATION IN UPLAND/WETLAND BOUNDARY.
3. TYPICAL EARLY SPRING WATER LEVELS.

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Figure 7.3-4
Wetland Mitigation
Cross Section

basin due to higher groundwater elevations, as well as to avoid impacts to the existing wetlands east of this basin. Due to site constraints, an area north of the west wetland basin will be used as a temporary staging area during construction. This area will be restored and enhanced after construction is complete (see Section 7.4.4).

Due to the high water table, the site will be dewatered prior to and during grading. Grading and site work other than planting will take place during the dry season (e.g., June through September). Site grading may take place in phases, if necessary, to ensure that all grading and site stabilization (e.g., hydroseed) can take place in one construction season. If construction of both basins cannot be completed in the same season (i.e., excavation, final grading, site stabilization), then the east basin will be constructed first and the west basin the following year. Construction is currently anticipated to begin during the 2002 dry season. Major construction activities will be limited to the period from October 31 to March 31 to avoid any disturbance to wintering bald eagles that may be in the vicinity of the Green River.

The proposed grading will affect about 11.9 acres of the existing emergent wetland that is described in Section 7.2.5.1 (see Table 3.1-4). In addition, a maximum of 2.2 acres of low-quality emergent wetland and existing wetland drainage ditches (located north of the site) will be widened to connect with the 100-year floodplain and existing ditch systems, which will provide floodwater storage and conveyance functions. Approximately 0.12 acre of existing wetland will be permanently impacted by access roads. However, no net loss of wetland area will result due to the temporary use of access roads, their restoration, and wetland creation actions planned for the remainder of the site.

Temporary maintenance roads will be constructed around each wetland basin to provide access to the site during planting, maintenance, and monitoring. These roads will be removed and the areas restored and enhanced with native vegetation after construction is complete and monitoring.

7.3.2.1 Surface Soil Removal

The first grading step will be to strip off the top 12 inches of soil, which will be disposed of in an approved, upland location off site. Removal of this soil will remove rhizomes, roots, and seeds of the existing vegetation, and minimize re-colonization by non-native plants after native plants are installed. Suitable subsoil material removed during excavation will be stockpiled, amended with composted organic material that is free of weeds, spread to a depth of 12 inches, and disced into the subsoil prior to installing plants. Approximately one-third of the excavated soil will be stockpiled for use as topsoil in the new basins. Soils that become compacted during grading will be ripped and/or disced to break it up and provide a suitable rooting medium for plants.

7.3.2.2 Basin Excavation and Dewatering

Approximately 440,000 cy of soil will be excavated to create the two wetland basins. Excavation depths will range between 1 and 8 ft. Due to seasonally high groundwater levels on this site, dewatering will likely be necessary to allow excavation of the new wetland basins and site grading. Water from site dewatering will be conveyed through a series of sediment/settling ponds and straw bale filters to existing ditches that drain the site at the northwest corner.

Dewatering Plan

All dewatering will be performed according to conditions of the HPA obtained for the project. The Port estimates that the current groundwater table should be lowered approximately 5 ft below the subgrade to facilitate grading. The dewatering plan will use approximately 45 to 50 wells that extend into the shallow groundwater table. To lower the water table sufficiently to allow grading, water will be pumped off site via these wells. Groundwater will be conveyed to the existing ditch that drains the site. It is estimated that dewatering on the project site could discharge up to 4,600 gallons per minute of groundwater while the excavation is occurring. The highest discharge rates are anticipated to occur early in the construction season (May or June), with little discharge occurring in August or September.

Two retention ponds will be constructed to capture runoff from the Phase 1 construction staging area located on the northwest portion of the site. Based on design criteria and runoff modeling, the minimum total storage volume required is 3.65 acre-ft. This volume will contain the 25-year summer storm event, with a 1.5 factor of safety. A smaller pond, able to retain at least 0.77 acre-ft of runoff, will serve the northern section of the staging area. A larger pond, with a minimum storage capacity of 3.65 acre-ft, will collect runoff from the remaining portion of the site as well as the pumped discharge from the smaller pond.

Sediment in the pond water will be removed by an on-site alum treatment facility. The treatment facility will consist of three coagulation tanks and one settling tank. Additional coagulation tanks will be utilized if necessary. While treated water from the facility will be discharged off site, any treatment plant bypass water will be discharged on site. In addition, sediment from the facility will be redeposited on site. Surface water that accumulates during excavation will also be treated prior to being discharged from the site. All water discharged from the site must meet turbidity standards for water quality. These standards are less than 5 NTUs above background when background levels are less than 50 NTUs, and no more than 10 percent above background when background levels are more than 50 NTUs.

Ditches through which dewatering water passes will be evaluated for stability and erosion potential. Where necessary, stabilization (such as hydroseeding or other methods) will be employed.

Drainage Easements for Dewatering

The Port has procured a temporary drainage and construction easement across the property north of the mitigation site that allows use of an existing channel for drainage purposes. The easement also grants the Port the right to use this channel to temporarily discharge water from dewatering wells to be used during construction of the Port's wetlands. During the dewatering process, water will be temporarily channeled to the existing outfall into the Green River at South 277th Street. Other than during the dewatering process, drainage water from the Port's property will flow north through existing drainage channels along and under South 277th Street, and discharge to the Green River north of South 277th Street. The newly constructed wetland basins will generally drain to the northwest at elevations of 42 ft (east basin) and 46 ft (west basin). The temporary drainage and construction easement remains in effect until a permanent flood channel is constructed.

The location of the temporary drainage channel is shown on Appendix E, Sheet C3. A cross-section schematic of the temporary drainage channel (i.e., wetland outlet ditch) is shown on Appendix E, Sheet C8.

Effects of Dewatering on Existing Wetlands

Dewatering activities on the Auburn site are not likely to affect the hydrology or habitat conditions in existing wetlands located on, near, or adjacent to the mitigation site. Dewatering of the site will occur from approximately May through September, over one or two construction seasons.[49] The purpose of dewatering is to accelerate the rate at which the water table falls during late spring, and assure that during construction the water table is below the proposed grades of the site. During the spring months and subsequent summer, the water table in the wetlands normally falls about 6 to 8 ft over a period of 4 to 5 months (see Figures 7.2-5, 7.2-6, and 7.2-7). In May, at the time dewatering starts, the water level in the wetlands is typically 24 inches below the ground surface, and thus below the rooting zone of wetland plants. By late May, it is as much as 36 inches below the ground surface and below the rooting zone of the herbaceous vegetation present on the site. Because the timing of dewatering is such that it will occur after water levels in the wetlands have already dropped below the root zone, wetland vegetation will not be impacted by further lowering of the water table through construction dewatering. Since surface water is not present, dewatering will not remove surface water that could provide special habitat types to wildlife.

Construction dewatering is not proposed to lower the water table below the elevation it normally reaches by late summer. Thus, during the fall, when soil moisture and groundwater recharge begin, recharge rates and requirements in adjacent wetlands will the same as if dewatering had not occurred. Thus, dewatering will not increase the length of time required for the water table to rise again in the fall.

7.3.2.3 Topsoil Replacement and Finish Grading

Native subsoils at the Auburn site are a mix of silts and fine sands, and will be used to construct an amended topsoil for the site. Approximately one-third of the excavated material will be selectively stockpiled either at on-site staging areas, or off site, for use as backfill and to construct topsoil for the excavated areas.

Two types of soil amendments will be used to provide a suitable substrate for wetland plant establishment on the site. The first soil type (Wetland Soil 1) will be a 3:1 mix of suitable native subsoils with organic compost that is free of weed seeds or other unsuitable material. This soil will be used above 42 ft elevation in the east basin and throughout the excavated area of the west basin (Appendix E, Sheet C9). The second soil type (Wetland Soil 2) will be used below 42 ft in elevation in the east basin to provide soil for the emergent planting zone (Appendix E, Sheet C9). Native subsoils on the site are a mix of sands, silts, and clays, and naturally formed layers that are relatively impervious. To ensure that subsoils used in the emergent planting zones maintain this relative impermeability, Wetland Soil 2 will be native subsoil amended with 4 percent bentonite.

Final grades will establish elevation and hydrologic gradients that will allow the planting of the desired native plant community types (see Figure 7.3-4). Fine grading and habitat log placement will also establish a complex microtopography on the site, which will enhance water storage and microhabitat diversity (Appendix E, Sheet 8.2). Habitat log placement and installation of snags will enhance wildlife functions on the site. The landscape architect and/or wetland scientist will place

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[49] If construction were to occur over two seasons, only portions of the site would be dewatered during the second season.

logs, snags, and field direct fine grading. Microtopography will be established by constructing a series of 'pit and mound' features in the forested and shrub wetland areas. Pit and mound features are designed to simulate the microtopography created by windthrow of large trees. Pit and mound features will be constructed at a density of approximately four per acre. Habitat logs will be placed predominantly in forested and shrub wetland classes, with a density of approximately 15 per acre (Appendix E, Sheet C9).

7.3.2.4 Hydroseed

Following completion of fine grading and topsoil placement, the soil surface will be stabilized with a hydroseed mix. Hydroseed mixes have been designed to accomplish several objectives. Hydroseeding is part of the TESC measures and will provide short-term stabilization of the soil surface and erosion control following grading. Hydroseeding will also allow rapid establishment of ground cover and serve as a weed barrier to reduce colonization of the open site by invasive species. In addition, native herbaceous understory species for the forest, shrub, and emergent communities will be provided by hydroseeding prior to planting the overstory vegetation in these zones.

Hydroseeding will use one of three seed mixes, with the mix selected for each zone matched to the site moisture conditions in that zone (Table 7.3-2). A wet zone seed mix consisting of OBL and FACW species will be used below 43 ft in the east basin and below 46 ft in the west basin (see Figure 7.3-4). A transition zone seed mix consisting of FACW, FAC+, and FAC rated species will be used from 43 to 45 ft in the east basin and from 46 to 49 ft in the west basin. A native buffer seed mix consisting of FAC, FAC+, FAC-, and FACU rated species will be used in the forested buffer areas above 45 ft in the east basin and above 49 ft in the west basin. In addition, a low-grow seed mix will be used to vegetate temporary construction access roads and staging areas that are located outside the mitigation area.

Hydroseed mixes will be comprised predominantly of native grass, sedge, and rush species. However, some non-native grasses may be included to provide rapid germination and growth for erosion and weed control. Use of non-natives will be restricted to species that are not invasive, and will not persist once the planted stock becomes established and canopies become closed. The buffer zone hydroseed mix is designed to establish a low-growing ground cover of grasses that will protect the soil and reduce erosion while minimizing competition with the planted stock. The wetland and transition seed mixes are designed to supplement the container stock by increasing ground cover and plant density.

Table 7.3-2. Hydroseed mixtures.

Common name	Scientific Name	% by weight
For use in areas designated as emergent wetland		
Tall mannagrass	*Glyceria elata*	15
Water foxtail	*Alopecurus geniculatus*	10
Water parsley	*Oenanthe sarmentosa*	10
Slough sedge	*Carex obnupta*	10
Beaked sedge	*Carex rostrata*	15
Small-fruited bulrush	*Scirpus microcarpus*	15
Woolgrass	*Scirpus cyperinus*	10
Dagger leaf rush	*Juncus ensifolius*	5
Taper tip rush	*Juncus acuminatus*	5
Slough grass	*Beckmania syzigachne*	5
For use in areas designated as forested or shrub wetland and wet buffers		
Blue wildrye	*Elymus glaucus*	25
Western mannagrass	*Glyceria occidentalis*	8
Tall mannagras	*Glyceria elata*	10
Tufted hairgrass	*Deschampsia cespitosa*	10
Annual ryegrass	*Lolium multiflorum*	15
Chewings red fescue	*Festuca rubra*	10
Meadow foxtail	*Alopecurus pratensis*	10
Bentgrass	*Agrostis tenuis*	10
Alsike clover	*Trifolium hybridum*	2
For use in upland buffer areas		
Barkley's perennial ryegrass	*Lolium perenne*	30
Red fescue	*Festuca rubra*	35
Aurora hard fescue	*Festuca longifolia*	35

7.3.2.5 Temporary Irrigation

An irrigation system will be installed on the mitigation site (Appendix E, Sheets L1 through L3). Irrigation with municipal water purchased by the Port will be used during the initial stages of the restoration to optimize conditions for plant establishment. Irrigation will provide flexibility in the timing of plant installation, increase survival rates, and enhance growth rates of the planted stock. Enhancing plant growth during the first few years will lead to a more rapid establishment of canopy cover and shade on the site, and reduce re-invasion of the site by non-natives.

The irrigation system will be installed, tested, and fully operational before plants are installed. Irrigation in the existing wetland will be installed above ground to minimize ground disturbance. Irrigation in the areas to be excavated and graded will be installed below ground.

The irrigation system will be sufficiently durable to provide irrigation to the site throughout the first 10 years of the monitoring period. However, the system will be used the first few (one to three) growing seasons depending on weather conditions, time of planting, etc. In subsequent years irrigation would be used in limited areas if replanting was required.[50] Irrigation will likely be used during the June through September time period, depending on weather conditions. Application rates are planned to be less than agronomic rates, but sufficient to reduce plant mortality and promote plant growth during the first season following planting. Once the system is no longer needed, the system will be removed and decommissioned.

7.3.3 Landscape Plan

Native species will be planted to establish forested wetland, shrub wetland, and emergent wetland plant communities, as well as a forested upland buffer around the edges of the site (Figure 7.3-5; Appendix E, Sheets L5 through L10). These general community types will include six wetland plant associations (or planting zones) typical of freshwater wetlands and forested uplands in the northern Puget Sound basin (Figure 7.3-6). Choice of plant species, planting densities, and community composition is based primarily on composition and densities of local wetland plant communities (Kunze 1994).[51] In addition, plant species were chosen for their value as food sources or habitat elements for wildlife. For example, the design includes shrubs and emergent plants that are particularly valuable as wildlife food sources (e.g., hazelnut, Indian plum, sedges, and bulrushes).

Forest wetland plant communities include black cottonwood/Pacific willow, red alder/salmonberry, Oregon ash/Pacific willow, and western redcedar plant communities. A dogwood/willow shrub community and a grass, beaked sedge/water parsley emergent community will be planted in wetter portions of the site, surrounding small areas of open water in the centers of the basins. Planting black cottonwood, Oregon ash and red alder will enhance the existing emergent wetland and the forested communities will increase plant diversity and enhance wildlife habitat (Appendix E, Sheets L5 through L10). The upland buffer will be planted with a mix of native trees and shrubs such as Douglas fir, big-leaf maple, vine maple, hawthorn, and Indian plum (Appendix E, Sheet L10).

Along the boundaries of the site, the upland buffers will be planted densely adjacent to the perimeter fence with species likely to discourage intrusion into the site (e.g., tall Oregon grape [*Mahonia aquifolium*], hawthorn, rose). Planting may occur in phases, with an initial planting of rapidly growing plants tolerant of full sun followed by a second planting of species that are more shade tolerant.

The following sections describe the general planting approach for each planting zone. The sections identify the types of plant species, the condition of material planted (container, bareroot, live stakes, seed, or plugs), and the planting approach (density, pattern, and area of coverage). At the time of planting, minor variations in the plantings may occur to account for site-specific factors and the planting season. For example, if an area is planted in late spring or summer, container-grown versus live-stake material will be used. Similarly, during late fall, winter, or early spring plantings, a greater amount of bareroot and live-stake versus container-grown material will be planted.

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[50] Due to performance requirement of 80 percent tree and shrub survival by year 3 and phased planting of conifers in year 3, irrigation in year 4 may also be necessary.

[51] The relation of the wetland zones to the hydrologic conditions is generally discussed in Section 7.3.1. The specific considerations in placing particular species and community types at various elevations are discussed in Section 7.3.4.

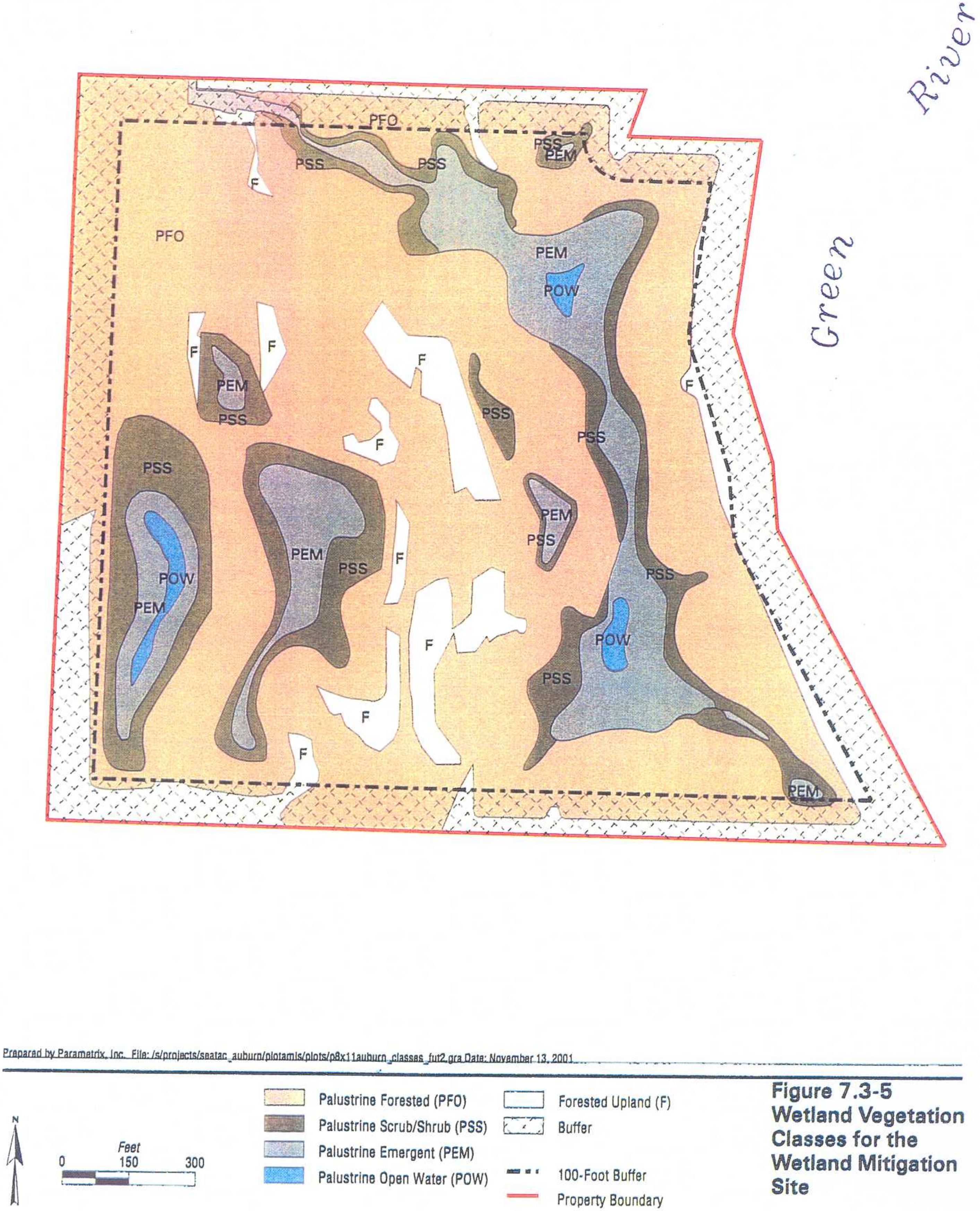

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Figure 7.3-5 Wetland Vegetation Classes for the Wetland Mitigation Site

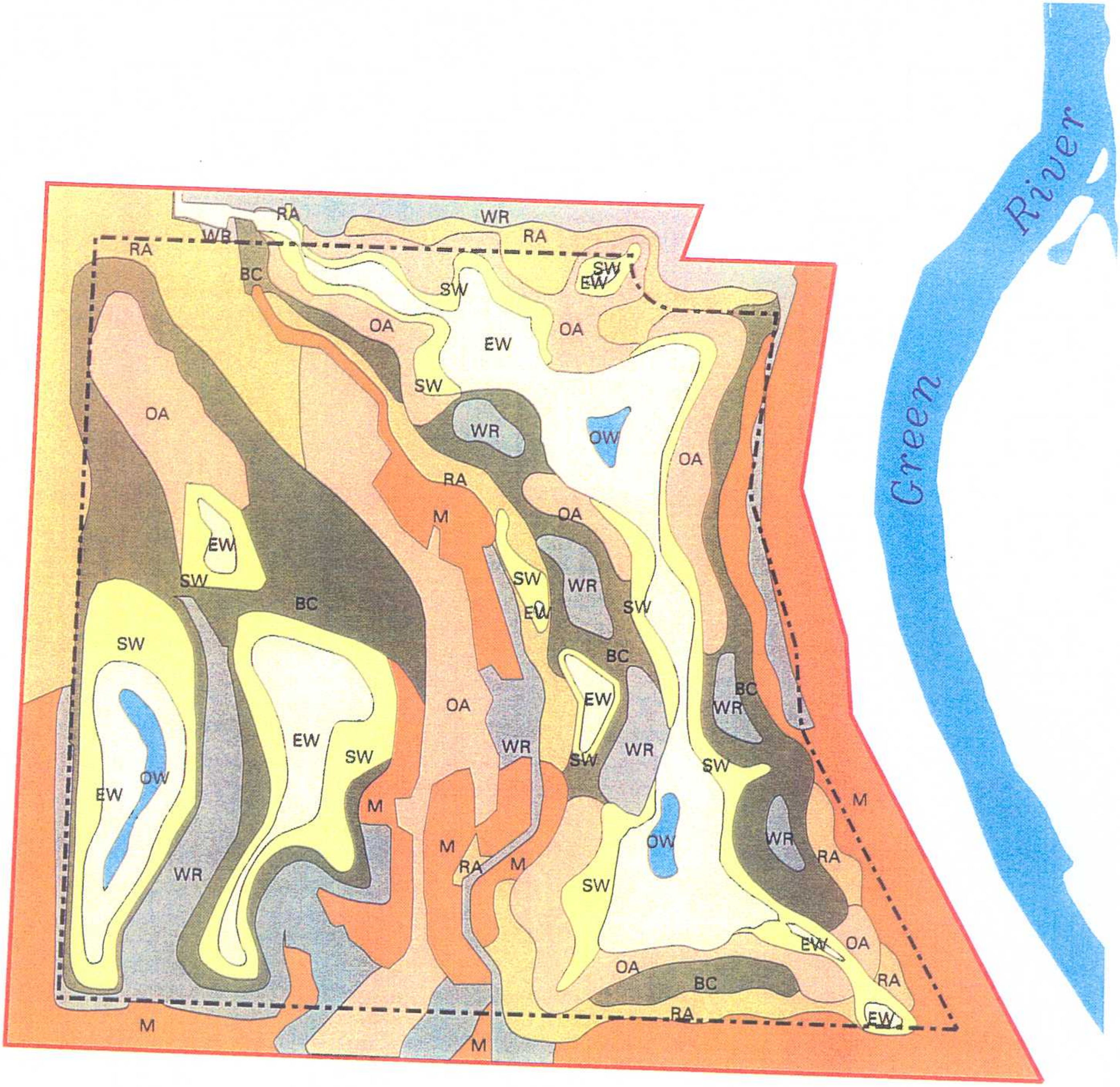

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Figure 7.3-6
Plant Associations for the Wetland Mitigation Site

Figure 7.2-14 depicts the expected growth pattern of the plantings as time progresses. It is anticipated that a mature forested wetland system will develop within 50 years.

The landscape plan for the area shows that the planting of conifer trees is phased (see landscape design sheets in Appendix E). It is anticipated that these conifers would be planted in a second planting phase coincident with replacement plantings that may be required to meet the year three performance standard for plant survival. At this time, the conifer species would be planted. The trees will be positioned such that they receive some shade from adjacent plants (trees, shrubs, and groundcover). For the first growing season following this planting, soil moisture conditions will be examined closely, and the use of the temporary irrigation system may be used to reduce mortality and promote growth.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic sources. Plant material used will come from an area bounded on the north by the Fraser River Valley of British Columbia, on the east by the 1,000-ft elevation of the Cascades, on the west by the 1,000-ft elevation in the Olympic or Coast ranges, and on the south by the Willamette Valley.

7.3.3.1 Weed Control

Invasive non-native species such as reed canarygrass and Himalayan blackberry can reduce successful establishment of desirable native plant species. A variety of weed control strategies are available to treat non-native species prior to and during the native plant installation period (see Section 4.3.2.4). These control strategies are incorporated into the planting design, or will be implemented during the monitoring period to control invasive species. Weed control methods (in order of preference) are:

- Dense plantings of target species that competitively exclude non-native species.
- Application of sterile straw or other biodegradable mulch as a weed barrier.
- Installation of biodegradable weed barrier fabric.
- Mechanical removal using mowers, line trimmers, or hand removal.
- Applications of EPA-approved herbicides by licensed applicators, as necessary.

Several methods for controlling reed canarygrass are currently proposed. An integrated approach relying on a suite of control strategies (listed above) and adaptive management will be used to control reed canarygrass at the Auburn site.

Topsoil containing weed seed, roots, and rhizomes will be removed to establish appropriate wetland hydrology over much of this site. Existing vegetation, including reed canarygrass, may also be removed from the site by application of approved herbicides, plowing, cultivating, and allowing the site to lie fallow. The project has been designed to anticipate some colonization of reed canarygrass by targeting the establishment of forested wetlands that ultimately will shade out this species. Competitive exclusion will be used early in the planting period by seeding areas with a fast-germinating cover crop (see Table 7.3-2). Competitive grass species such as tufted hairgrass (*Deschampsia cespitosa*), sloughgrass (*Beckmannia syzigachne*), bentgrass, or red fescue can be effective in establishing cover and reducing invasion by reed canarygrass. Contingency actions could include repeated applications of herbicides, mowing, or use of weed barriers.

7.3.3.2 Plant Protection from Animals

To deter plant damage by rodents (i.e., herbivory), plants may be installed with protective devices such as plastic stem collars. Depending on the type of community and level of herbivory, deterrence measures may range from plastic collars around individual stems to wire mesh around groups of plants.

7.3.3.3 Perimeter Fencing

Fencing will be installed around the perimeter of the site to clearly mark the mitigation boundary and protect the mitigation site from intrusion and damage from people or domestic animals (see Appendix P. In addition to the fence, signs will be posted along the boundary of the mitigation site, designating it as a wetland mitigation area.

7.3.4 Native Plant Communities

The planting plan will result in establishing five forested communities, one shrub community, and one emergent community on the site. Four of the forested communities, as well as the shrub and emergent communities, are wetlands. An upland forested community will be planted in buffer zones.

7.3.4.1 Forest Communities

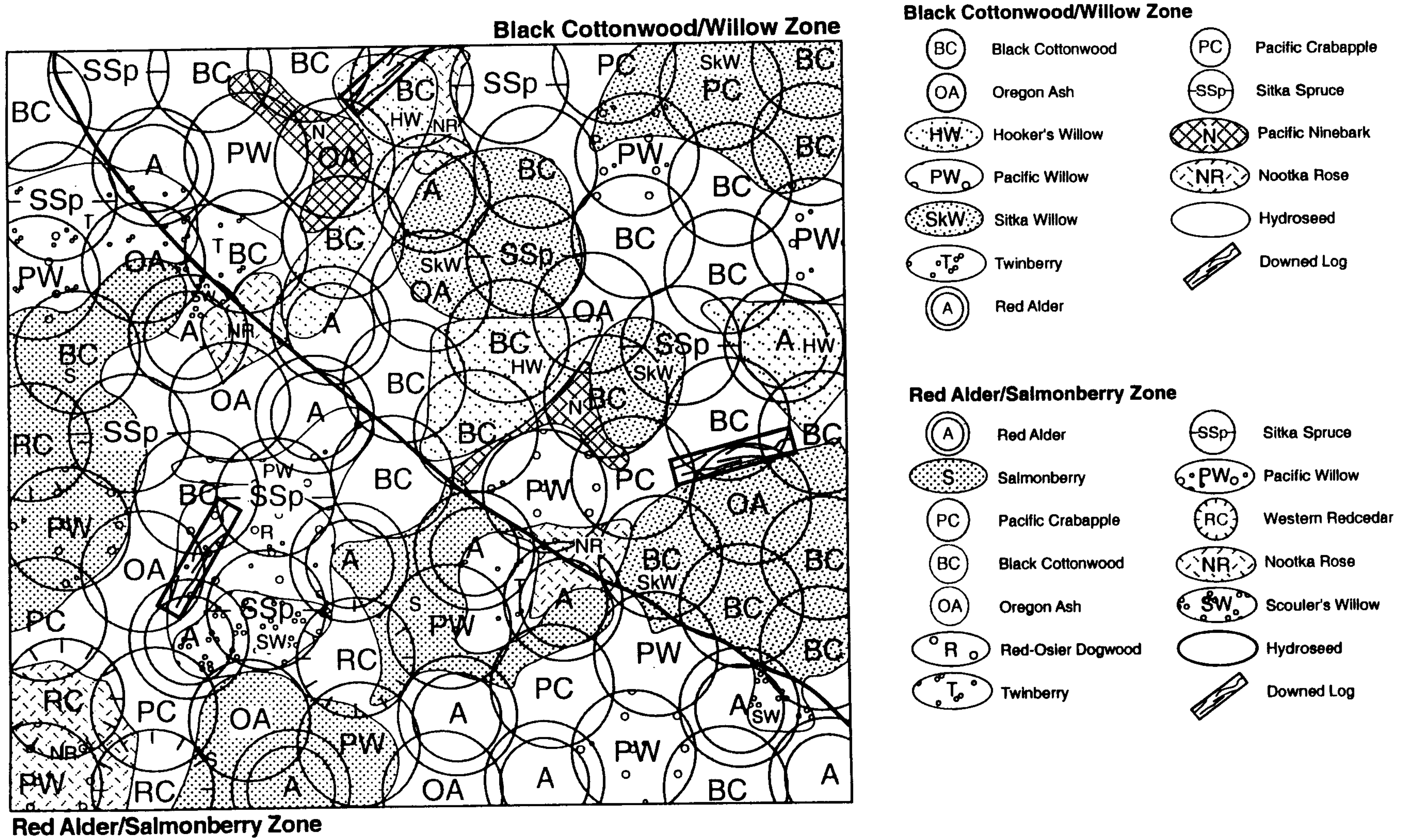
Black Cottonwood/Willow Association

The black cottonwood/willow association is characteristic of many floodplain forested wetlands in western Washington, including the Green River valley. The plants within this association (Table 7.3-3 and Figure 7.3-7) are adapted to large fluctuations in the water table and are tolerant of seasonally dry soils. This zone would be planted above elevation 42 ft on the east side and above elevation 47 ft on the west side.

Table 7.3-3. Proposed plant species for the black cottonwood/willow association.

Scientific Name	Common Name	Indicator Status[a]	Condition
Trees			
Alnus rubra	Red alder	FAC	container
Fraxinus latifolia	Oregon ash	FACW	container
Malus fusca	Pacific crabapple	FACW	container
Picea sitchensis	Sitka spruce	FAC	container/bareroot
Populus trichocarpa	Black cottonwood	FAC	container/ live stake
Salix lasiandra	Pacific willow	FACW+	container/ live stake
Shrubs			
Lonicera involucrata	Twinberry	FAC+	container
Physocarpus capitatus	Pacific ninebark	FACW-	container
Rosa nutkana	Nootka rose	FAC	container
Salix hookeriana	Hooker's willow	FACW	container/ live stake
Salix sitchensis	Sitka willow	FACW	container/ live stake

[a] See Table 7.2-4 for indicator status definitions.



Note: See Appendix E Sheets L5 - L10 for more details

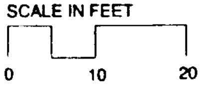


Figure 7.3-7
Typical Planting Plan Example for the Black Cottonwood and Red Alder Planting Zones

Red Alder/Salmonberry Association

The red alder/salmonberry association (Table 7.3-4, Figure 7.3-7) commonly occurs on wet valley floors in seasonally flooded areas (Kunze 1994). This association will be planted above the 42-ft elevation on the east side and above the 47-ft elevation on the west side, where year-round soil saturation would not occur.

Table 7.3-4. Proposed plant species list for the red alder/salmonberry association.

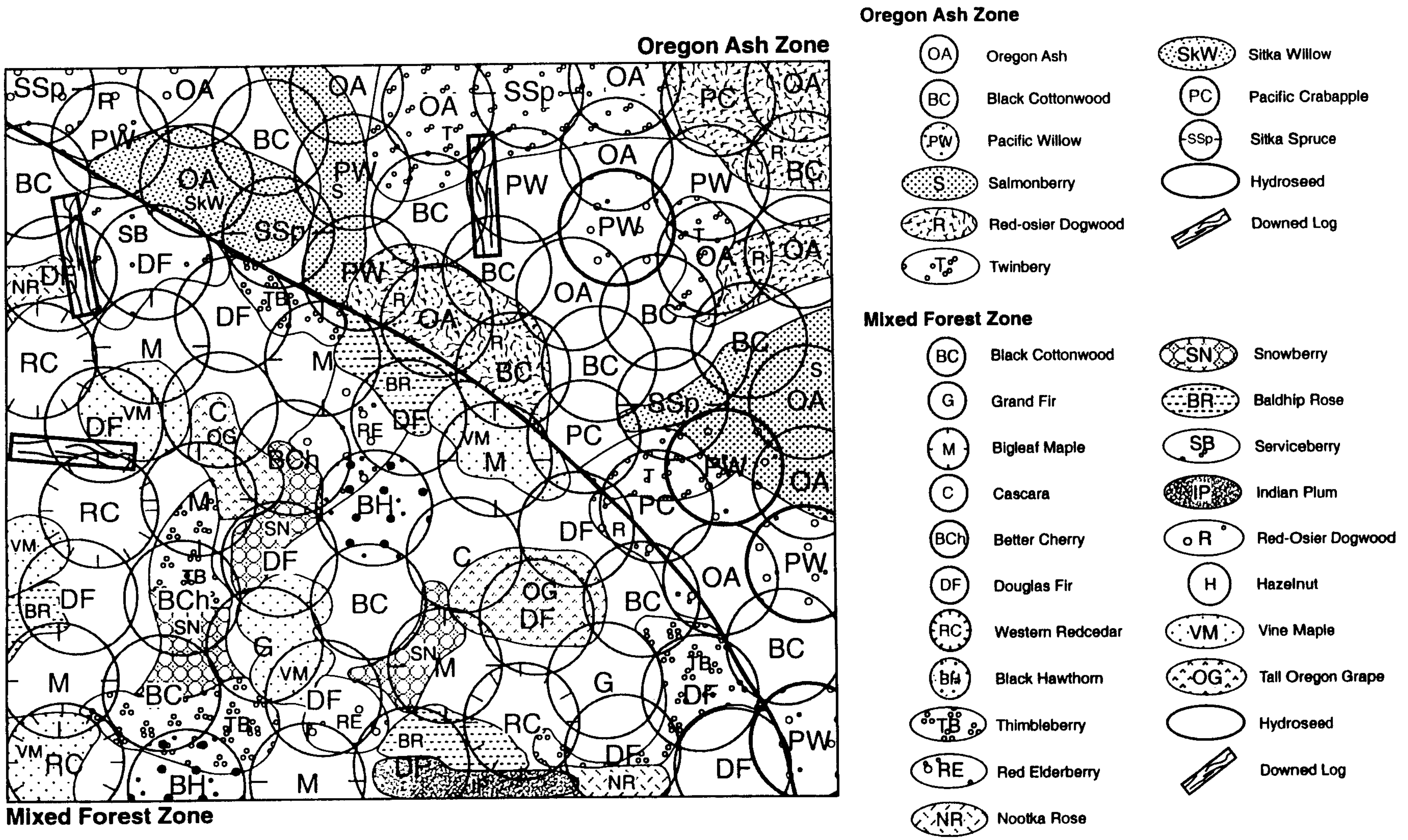
Scientific Name	Common Name	Indicator Status	Condition
Trees			
Alnus rubra	Red alder	FAC	container
Fraxinus latifolia	Oregon ash	FACW	container
Malus fusca	Western crabapple	FACW	container
Picea sitchensis	Sitka spruce	FAC	container
Populus trichocarpa	Black cottonwood	FAC	container/live stake
Salix lasiandra	Pacific willow	FACW+	container/live stake
Thuja plicata	Western redcedar	FAC	container/ bareroot
Shrubs			
Cornus stolonifera	Red-osier dogwood	FACW	container/ live stake
Lonicera involucrata	Twinberry	FAC+	container
Rosa nutkana	Nootka rose	FAC	container
Rubus spectabilis	Salmonberry	FAC+	container
Salix scouleriana	Scouler's willow	FAC	container/ live stake

Oregon Ash Association

The Oregon ash association is most commonly found in floodplains or associated with streams and backwater sloughs (Kunze 1994). This community will be planted in the wetter portions of the forest zone, since most of the associated species are tolerant of soil saturation and inundation well into the spring. Oregon ash will comprise most of the canopy cover, with salmonberry and willow in the shrub layer (Table 7.3-5; Figure 7.3-8).

Table 7.3-5. Proposed plant species list for the Oregon ash association.

Scientific Name	Common Name	Indicator Status	Condition
Trees			
Fraxinus latifolia	Oregon ash	FACW	container
Malus fusca	Western crabapple	FACW	container
Picea sitchensis	Sitka spruce	FAC	container/bareroot
Populus trichocarpa	Black cottonwood	FAC	container/ live stake
Salix lasiandra	Pacific willow	FACW+	container/ live stake
Shrubs			
Cornus stolonifera	Red osier dogwood	FACW	container/live stake
Lonicera involucrata	Twinberry	FAC+	container
Rubus spectabilis	Salmonberry	FAC+	container
Salix stichensis	Sitka willow	FACW	container/live stake



Note: See Appendix E Sheets L5 - L10 for more details

Figure 7.3-8
Typical Planting Plan
for the Oregon Ash and
Mixed Forest Planting Zones

Mixed Forest Association

The mixed forest association includes several coniferous and deciduous tree species as well as an understory shrub component. Some of the tree species in this association are not tolerant of prolonged saturation. Therefore, this association will be planted in the upper zone between wetland and upland, as well as in the upland buffers (Table 7.3-6; see Figure 7.3-8).

Table 7.3-6. Proposed plant species list for the mixed forest association.

Scientific Name	Common Name	Indicator Status	Condition
Trees			
Abies grandis	Grand fir	FACU-	container
Acer macrophyllum	Big-leaf maple	FACU	container
Alnus rubra	Red alder	FAC	container
Crataegus douglasii	Black hawthorn	FAC	container
Populus trichocarpa	Black cottonwood	FAC	container/ bare root
Prunus emarginata	Bitter cherry	FACU	Container
Psuedotsuga menziesii	Douglas fir	FACU	container
Rhamnus purshiana	Cascara	FAC-	container
Thuja plicata	Western redcedar	FAC	container
Shrubs			
Acer circinatum	Vine maple	FAC-	container
Amelanchier alnifolia	Serviceberry	FACU	container
Mahonia aquilifolium	Tall Oregon grape	FACU	container
Corylus cornuta	Hazelnut	FACU	container
Oemleria cerasiformis	Indian plum	FACU	container
Rosa gymnocarpa	Bald-hip rose	FACU	container
Rosa nutkana	Nootka rose	FAC	container
Rubus parviflorus	Thimbleberry	FAC-	container
Sambucus racemosa	Red elderberry	FACU	container
Symphoricarpos albus	Snowberry	FACU	container

Western Redcedar Association

The western redcedar association includes deciduous as well as coniferous tree species, with an understory of FAC and FACW shrub species (Table 7.3-7; Figure 7.3-9). Tree species such as western redcedar and big-leaf maple are not tolerant of prolonged soil saturation. Therefore, this association will be planted in the upper portions of the wetland zone, or above approximately elevation 47 ft in the west basin and about 44 ft in the east basin.

Table 7.3-7. Proposed plant species list for the western redcedar association.

Scientific Name	Common Name	Indicator Status	Condition
Trees			
Abies grandis	Grand fir	FACU-	container/ bareroot
Acer macrophyllum	Big-leaf maple	FACU	container
Alnus rubra	Red alder	FAC	container
Populus trichocarpa	Black cottonwood	FAC	container/ bareroot
Rhamnus purshiana	Cascara	FAC-	container
Thuja plicata	Western redcedar	FAC	container
Shrubs			
Acer circinatum	Vine maple	FAC-	container
Oemleria cerasiformis	Indian plum	FACU	container
Physocarpus capitatus	Pacific ninebark	FACW-	container
Salix scouleriana	Scouler's willow	FAC	container/ live stake

Existing Wetland Enhancement

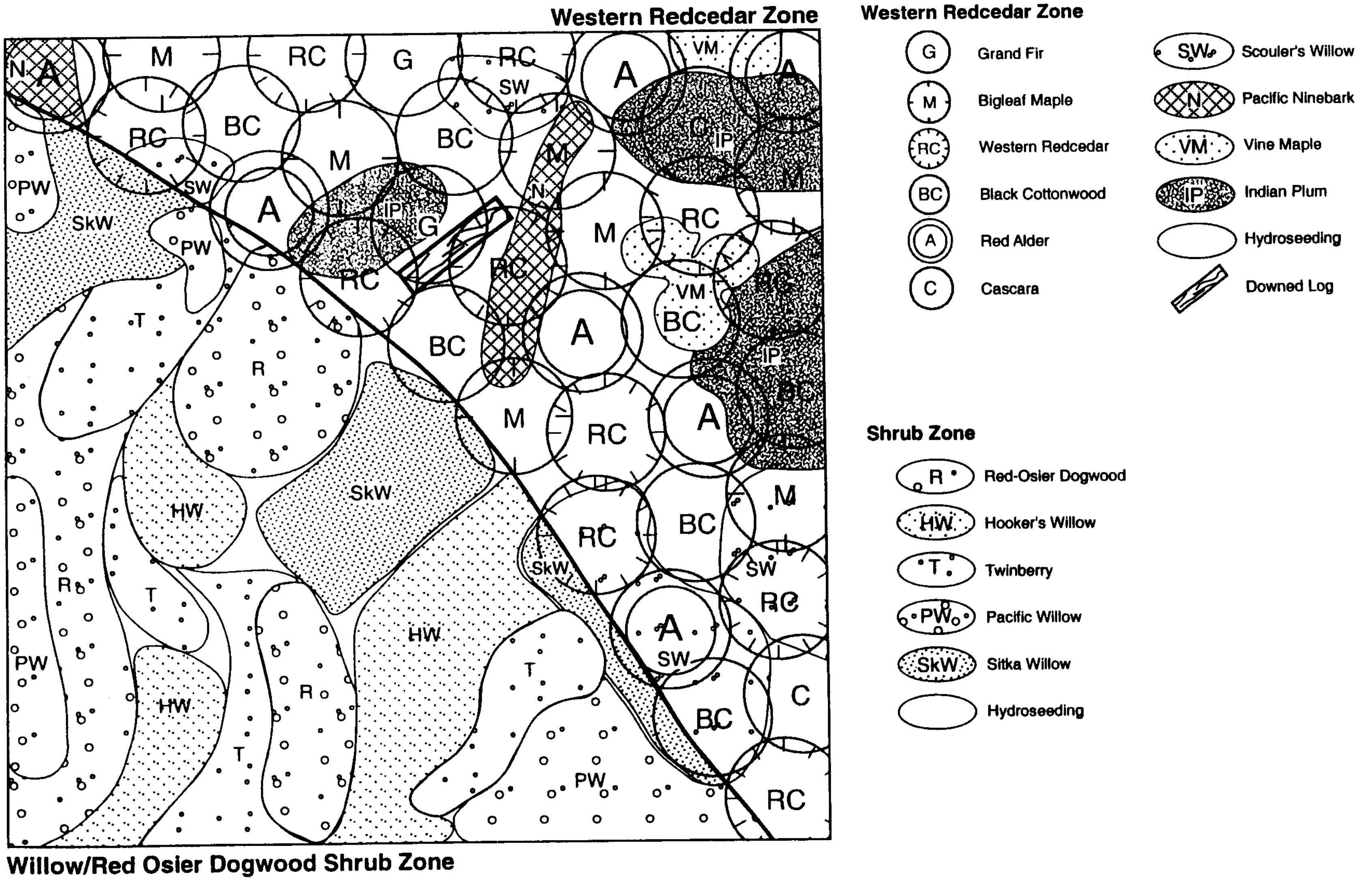
The existing emergent wetlands will be enhanced by planting them with various forested and shrub communities, including black cottonwood/willow, red alder/salmonberry, Oregon ash, and willow/red osier dogwood plant associations (see Tables 7.3-3 through 7.3-5 and 7.3-8). Trees and shrubs included in these associations will be infill-planted into the existing wetland vegetation. Wetland enhancement communities will be planted at the existing ground elevations, between elevations 45 and 49 ft.

Forest Buffers

A 100-ft forested buffer along its boundaries will protect the mitigation site from off-site disturbance and provide additional wildlife habitat. In addition, upland forest between the existing wetland and the newly created wetlands will create an upland/wetland mosaic to increase habitat diversity (Appendix E, Sheets L5 through L10). Approximately 15.9 acres of forested buffer and upland will be established.

Buffer areas on the site range from moist upland areas to wetter transitional areas between uplands and wetlands. Transitional areas between uplands and wetlands will be planted with the western redcedar association (see Table 7.3-7), while upland areas will be planted with the mixed forest association (see Table 7.3-6).

Upland areas disturbed during wetland construction will be seeded using a mix of low-growing grass species (see Table 7.3-2) prior to planting. Trees and shrubs will be planted at densities sufficient to attain the stem density and canopy cover performance standards identified for forested wetland habitat (see Table 7.1-2).



Note: See Appendix E Sheets L5 - L10 for more details

Figure 7.3-9
Typical Planting Plan
for the Western Redcedar
and Shrub Planting Zones

7.3.4.2 Shrub Wetland Community

Willow/Red Osier Dogwood Association

The shrub wetlands will be planted with a willow/red osier dogwood association (Table 7.3-8, see Figure 7.3-9). Shrubs will be planted approximately 4 to 6 ft on-center. This association will occupy wetter areas of the site that are inundated during the winter months and have saturated soils into the summer. Shrub wetlands will be planted between elevation 44 and 47 ft in the west basin, and between 41 and 42 ft in the east basin (Appendix E, Sheets L5 through L10).

Table 7.3-8. Proposed plant species list for the willow/red osier dogwood shrub zone.

Scientific Name	Common Name	Indicator Status	Condition	Comments
Cornus stolonifera	Red-osier dogwood	FACW	container/ live stake	Shrubs will be planted in approximately 85% to 90% of the shrub zone at spacings ranging from 5 to 8 ft on-center.
Lonicera involucrata	Twinberry	FAC+	container	
Salix hookeriana	Hooker's willow	FACW-	container/ live stake	
Salix lasiandra	Pacific willow	FACW+	container/ live stake	
Salix sitchensis	Sitka willow	FACW	container/ live stake	

7.3.4.3 Emergent Wetland Community

Emergent wetlands in the excavated basins will be planted with native emergent species common in the Green River valley and the northern Puget Sound region. Since wetland hydrology is designed to create both seasonally and permanently flooded areas, plants that are tolerant of extended flooding and soil saturation will be established in these areas. The emergent zones will be planted with an herbaceous community dominated by native sedge and rush species such as beaked sedge, slough sedge, water parsley, small-fruited bulrush, and narrow-leaved bur-reed (Table 7.3-9; Figure 7.3-10; Appendix E, Sheets L5 through L10). Emergent communities will be planted in the wettest portions of the site with year-round soil saturation and some areas of permanent standing water. Emergent communities will be planted below between elevation 42 and 44 ft in the west basin between 38 and 41 ft in the east basin.

Where emergent marsh plants are specified, they will be planted with rhizomes or stems spaced 12 inches on center. Areas that are designated for hydroseeding but have visible surface water on them at the time of planting will be planted with marsh plants (rhizomes, rooted stems/seedlings, plugs, etc.

Table 7.3-9. Proposed species list for the beaked sedge/water parsley emergent zone.

Scientific Name	Common Name	Indicator Status	Condition
Carex rostrata	Beaked sedge	OBL	plug/container
Eleocharis palustris	Common spike-rush	OBL	plug/container
Oenanthe sarmentosa	Water parsley	OBL	container
Polygonum amphibium	Water smartweed	OBL	container
Scirpus acutis	Hardstem bulrush	OBL	plug/container
Scirpus microcarpus	Small-fruited bulrush	OBL	plug/container
Sparganium emersum	Narrow-leaf bur-reed	OBL	plug/container

The typical growth pattern for emergent marsh plants is in monotypic patches with some interspersion in open, less densely vegetated areas, and proposed planting would mimic this pattern (Figure 7.3-10). Planting shoots with rhizomes 12 inches on-center in monotypic stands of varying size, in combination with seeding a mix of emergent species (see Table 7.3-2) in the areas between patches, should achieve that result. Because ponding in emergent areas is expected well into the early summer, planting of emergent species will occur during the fall months when soils are becoming saturated, but before water levels reach their winter maximum.

7.4 IMPLEMENTATION

The following sections describe the general implementation sequence for the Auburn site. Table 7.4-1 presents a proposed implementation timeline for Auburn mitigation projects.

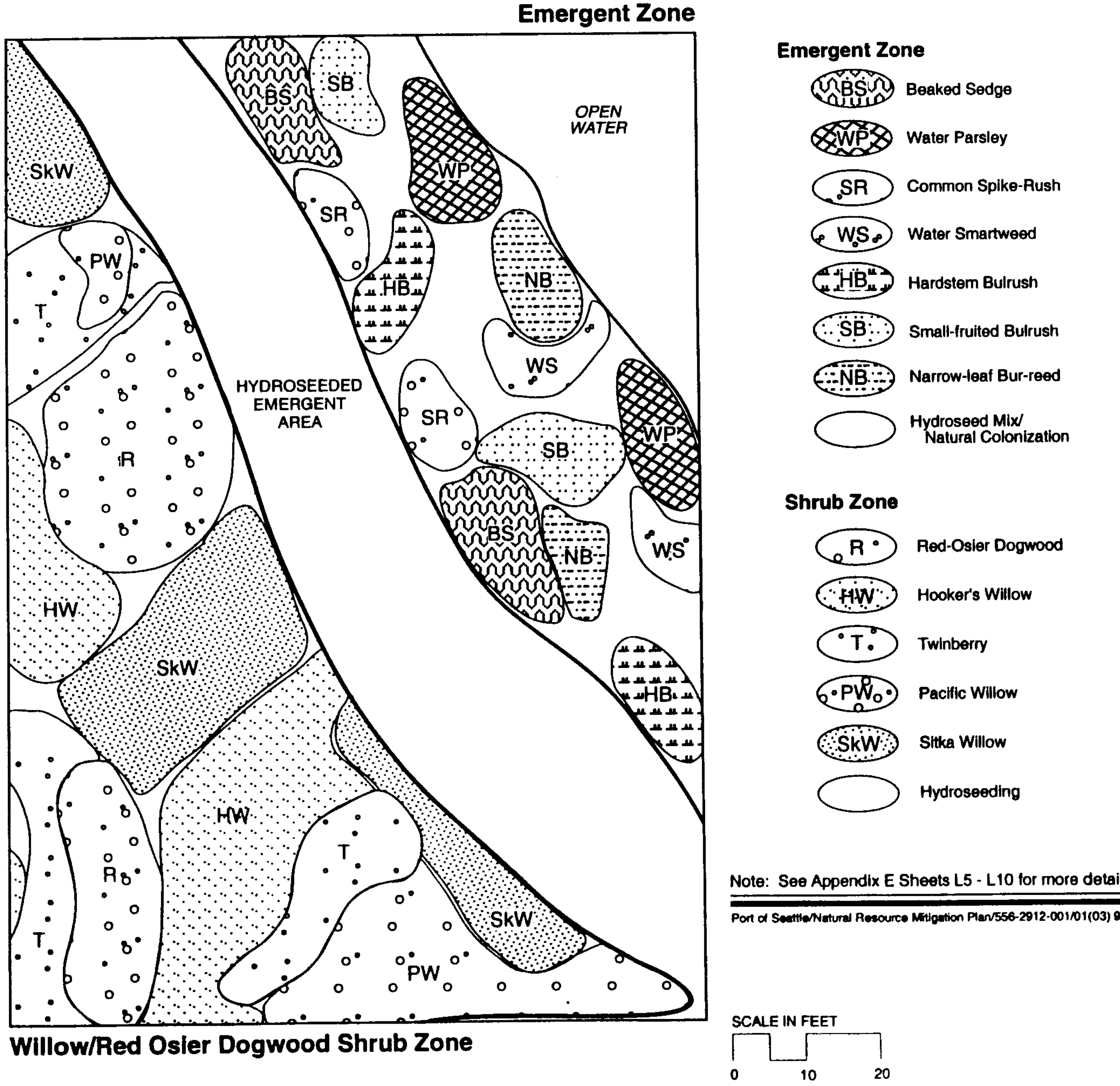
7.4.1 Pre-construction Meeting

Oversight during construction of the wetland mitigation will be required to ensure that the contractors follow the plans and specifications. Prior to any site work, a pre-construction meeting will be held with the Port, general contractors, engineers, landscape contractors, landscape architects, and biologists to ensure that the work is constructed as designed, and that contractors understand and comply with all environmental permit conditions. Both a civil engineer and wetland ecologist will be available for on-site inspections and approval of all work during construction.

7.4.2 Site Preparation and Planting

7.4.2.1 Existing Wetlands

The majority of the existing wetlands will not be cleared of vegetation or graded during site grading and excavation (Appendix E, Sheets C3 through C6). Non-native vegetation in the existing wetlands will be managed before installing native plants to reduce competition, and to control weeds. Management will include reducing cover and vigor of existing non-native vegetation. Plant installation will occur between March and October, and weed management should occur immediately prior to installing plants.



Note: See Appendix E Sheets L5 - L10 for more details

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Figure 7.3-10
Typical Planting Plan
for the Emergent and
Shrub Planting Zones

Table 7.4-1. Proposed implementation timeline for Auburn wetland mitigation projects.

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Auburn Wetland Mitigation																																				
Pre-construction meeting			■																																	
TESC, site preparation					■	■																														
Begin dewatering						■	■	■	■																											
Excavate and mass grade east basin						■	■	■																												
Fine grade east basin, place wetland soil							■	■	■																											
Mow and herbicide buffer								■																												
Construct water control structure and connection to east basin							■	■																												
Install irrigation in east basin and buffer							■	■	■																											
Install groundwater monitoring wells and staff gages and begin hydrology monitoring									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Hydroseed graded portions of site									■																											
Produce grading record drawings									■																											
Install Phase I plants in east basin and buffer[b]																■	■	■	■	■	■															
Produce planting plan record drawing																						■														
Excavate and mass grade west basin																		■	■	■																
Fine grade west basin, place soils																			■	■	■															
Mow existing wetland; mow, herbicide, and disc buffer																				■	■															
Install irrigation in west basins, existing wetland, and buffers																				■	■															
Construct water control structure																				■	■															
Install groundwater monitoring wells and begin compliance monitoring																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Hydroseed open areas																					■															

Table 7.4-1. Proposed implementation timeline for Auburn wetland mitigation projects (continued).

Project/Activity	Year 1[a]												Year 2												Year 3											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Produce grading and irrigation record drawings																					■	■														
Install Phase I plants in west basin, existing wetland, and buffers																												■	■	■	■	■	■			
Closeout of temporary access roads, staging areas																												■	■	■						
Produce planting plan record drawings, conduct baseline monitoring for entire site																													■	■	■	■	■			
Begin compliance monitoring[c]																																		■	■	■

[a] Year one starts with the first construction season following issuance of permits. Implementation of mitigation projects may vary from this proposed schedule depending upon coordination with other Master Plan Update projects, contract obligations, or final approval.

[b] Plant procurement for all projects will be implemented 6 to 12 months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Sensitive coniferous species will be planted in a Phase II planting to occur 3 years following the initial planting.

[c] Compliance monitoring begins once grading is complete.

Prior to the scheduled plant installation in the existing wetlands, existing vegetation will be mowed and maintained at a maximum height of approximately 6 to 12 inches. Enhancement plantings will be installed per the planting schedule (Appendix E, Sheets L5 through L10). Native trees and shrubs will be installed in clumps of 5 to 10 individuals. Mowing may occur periodically to maintain the grasses at a height of 12 inches or less. Mowing between the planted areas may be necessary for the first 3 to 5 years of the monitoring period to minimize competition between the planted stock and existing pasture grasses or to control invasive plants.

This weed management strategy is expected to maximize the success of plant establishment. Over time, the areas in between the planted clumps will fill in with native wetland trees and shrubs through the increase in cover from the initial planted stock, as well as colonization of new areas.

7.4.2.2 Protective Buffers

Buffers at the Auburn site will be established in a 100-ft-wide zone around the perimeter of the mitigation site, as well as in the areas between the existing wetlands and newly created wetlands (Appendix E, Sheets C3 through C6). The existing upland areas, including the buffer around the wetlands, are currently dominated by non-native pasture grasses and forbs. To reduce competition from existing vegetation and to control weeds prior to planting, the cover of existing vegetation will be reduced, and soils will be disced to prepare a substrate for the hydroseed mix and the planted stock. During early to mid summer, existing vegetation will be mowed to a maximum height of approximately 6 to 12 inches. The vegetation will be allowed to grow for about 2 weeks to produce new shoots and leaves, and then herbicide will be applied per the specifications. Approximately 2 weeks after the herbicide application, the area will be thoroughly disced to mix the upper soil profile, irrigation will be installed, and a hydroseed mix applied. The following spring and summer, plants will be installed in the buffer planting zones.

7.4.3 Erosion Control

Prior to any site preparation and grading, sediment and erosion control measures will be implemented to protect on- and off-site aquatic systems from sedimentation. Generally, construction of the wetland basins will not be prone to off-site migration of sediments due to the level topography of the site and the lack of surface water features in or adjacent to the site. In areas where fine sediments could potentially occur in surface waters, adjacent properties, or existing wetlands due to construction activities, a variety of erosion control measures will be employed. Staging areas and existing wetlands will be protected with silt fencing. Stockpiled soil left in place for more than 3 weeks will be stabilized with an approved native hydroseed mixture, tarp, or appropriate BMP. In addition, a native erosion control grass seed mixture will be used to stabilize the soil in the graded portions of the site until native vegetation can be installed.

To reduce tracking of mud onto paved roads, the site entrance roads will be stabilized using a pad constructed of quarry spalls. Vehicles and/or their tires will be washed or brushed prior to leaving the site during periods when track-out of mud could occur.

7.4.4 Excavation and Grading

Prior to excavation and grading, the extent of all grading activities will be surveyed by a professional surveyor and staked in the field. The contractor will establish vertical and horizontal site controls and maintain them throughout the construction period. The limits of work will be identified and flagged in the field, wetlands and surface water features will be identified with orange barrier fencing, and the TESC measures will be installed.

Approximately 440,000 cy of soil will be excavated to form the new wetland basins to the east and west of the existing wetlands. The top 12 inches of soil will be stripped and removed from the site. This surface material, as well as the majority of the excavated material, will be transported off site and disposed of at an approved upland location. A portion of the excavated subsoils, which are composed of silts, clays, and fine sands, will be blended with composted organic matter and used as topsoil to be placed after the new site grades are established. The topsoil blending operation will require temporary stockpiling and processing at either an on-site or off-site location.

The existing drainage channel, located north of the site, will be widened to connect the mitigation site with the 100-year floodplain and an existing ditch system near South 277th Street (Appendix E, Sheet C8 Section 5).

Final grading and habitat log placement will be performed under the direction of the wetland scientist or landscape architect. If subsoils have become compacted during preliminary grading, the soil surface will be ripped and/or disced prior to spreading the amended topsoil mix. The topsoil mix will be placed to a depth of at least 12 inches.

7.4.5 Construction Access Roads, Staging Areas, and Maintenance Roads

In addition to any temporary access and/or haul roads, temporary construction and maintenance roads will be required on the mitigation site. Temporary maintenance roads will be constructed around each wetland basin to provide vehicular access during planting, and for the early site maintenance and monitoring period. Temporary gravel paths will provide foot and small vehicle access to the interior of the site during the planting period.

7.4.5.1 Staging Areas and Temporary Haul and Access Roads

On completion of earthwork and planting phases, temporary staging areas and access and haul roads will be removed, prepared for planting, and planted. Staging areas and/or access roads that are not within the mitigation site boundaries will be cleared of construction equipment and debris and soils will then be ripped or disced to break up compacted layers and prepare a suitable substrate for planting. Except for where these areas cross wetland, they will be hydroseeded with the low-grow erosion control seed mix specified for the upland buffers (Table 7.3-2). Where they cross wetlands, the wetland hydroseed mix will be used.

Temporary staging areas or access roads within the mitigation site will be removed and planted. These areas will be cleared of construction equipment and debris, road materials will be removed, and soil surfaces will be prepared for planting and planted according to the planting plan. For example, where a temporary haul road occurs in an area designated as western redcedar on the planting plans (Appendix E, Sheets L5 through L8), the area will be planted with the western red cedar association once the road is removed. Preparation of these areas for planting may include deep ripping or discing, depending on the degree of soil compaction, and the addition of organic mulch.

7.4.5.2 Gravel Paths and Maintenance Roads

Temporary gravel paths in the mitigation area will provide access for planting, initial maintenance, and monitoring. These access paths and roads will help assure that:

- The initial planting can be readily completed in a reasonable timeframe.
- If phased plantings are desired, latter phases can be implemented without damaging plants installed in previous phases.
- If replacement plantings are needed, they can be installed without damaging other vegetation.

The gravel paths will be decommissioned after five complete growing seasons following completion of planting if the areas have met plant cover and survival performance standards for 2 consecutive years. If the areas are not meeting cover performance standards at the end of 5 years, the gravel paths will be decommissioned when basins have met plant cover and survival performance standards. Decommissioning will include removing path materials, preparing the soil surface for planting (e.g., ripping and/or tilling), and planting according to the planting plan.

The temporary maintenance roads will be removed after five growing seasons if the areas they serve meet cover performance standards for 3 consecutive years. The road materials will be removed and soil surfaces treated to provide a suitable medium for plant growth (i.e., ripping and/or discing). The road area will be planted with fast-growing species from the mixed forest plant schedule (i.e., Douglas fir, red alder, black cottonwood, bald-hip rose).

Maintenance roads along the west, north, and south sides of the site may be retained throughout the 15-year monitoring period for maintenance and security for the site (i.e., to manage weed control, support any necessary replanting, prevent dumping, etc.). At the end of the 15-year monitoring period, the Port will consult with regulatory agencies to determine if the maintenance roads should be decommissioned, or if they should be retained to allow for on-going maintenance, adaptive management, or security needs. If it is determined the maintenance roads should be removed, they will be planted as described above for the construction haul and access roads.[52]

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[52] If the maintenance roads were left in place, the canopies of adjacent trees would cover the road. There would be a minor reduction in habitat for small mammals and ground nesting birds. According to Ecology (1999) infrequently used gravel or paved roads can be ignored as a disturbance (see data sheets for Riverene Flow through wetlands)

7.4.6 Temporary Irrigation

After all grading activities have been completed a temporary irrigation system will be installed throughout the site. Installation of the temporary irrigation system will be coordinated with grading and planting steps to ensure that irrigation is installed prior to plant installation. Installation of the temporary irrigation system will be below ground in all areas that will be cleared and graded; however, the system will be installed above ground in the existing wetlands.

The temporary irrigation system will remain in place and functional until the plants become established, which is anticipated to take 2 to 5 years (depending on any phasing requirements or needs to replant to meet 80 percent survival requirements).[53] The temporary systems will be decommissioned and above-ground parts of the system will be removed. The below-ground lines will be abandoned in place to prevent any need for soil or vegetation disturbance from equipment and pipe removal.

7.4.7 Establish Native Wetland and Upland Buffer Vegetation

All planting zone boundaries will be surveyed by a professional surveyor, and staked and flagged in the field according to the planting plan. A landscape architect or wetland scientist will observe plant installation to ensure that plants are installed properly and according to the plans and specifications. The contractor will be responsible for ensuring that plants are not damaged during transport, staging, or installation, and will be responsible for plant survival and health during the first year following planting.

Due to the large number of plants required to cover the entire buffer, planting may occur in phases. An initial planting of rapidly growing plants tolerant of full sun will be followed by a second planting of more slowly growing species that tolerate or require shade. Planting activities will most likely occur during the spring and fall months to avoid potential disturbance to wintering bald eagles in the vicinity of the Green River.

To further protect the site from people and pets, the fence line will be densely planted with species from the mixed forest community type to provide a physical and visual screen. Dense planting along the fence line will include Douglas fir, black hawthorn, tall Oregon grape, bald-hip rose, and big-leaf maple (Appendix E, Sheet L10, Detail 6).

7.4.8 Record Report and Monitoring

On completion of earthwork, site topography will be surveyed and a report containing record drawings for the earthwork phase will be prepared and submitted to regulatory agencies. The planting plan will be reviewed and adjusted if necessary to match constructed grades and site conditions. Adjustments may include moving the boundaries of planting zones or adjusting species compositions to ensure successful establishment of the plant communities. Any necessary

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[53] Use of temporary irrigation during the establishment phase follows wetland mitigation design recommendations of King County (Mockler 1999b) and Ecology (personal communication with Erik Stockdale, February 2000) for improving the success of mitigation projects.

adjustments to the planting plan will be submitted to regulatory agencies with the earthwork record drawings and report.

Upon completion of planting (i.e., completion of all planting phases), a complete set of record drawings (including both earthwork and planting record drawings) documenting the constructed mitigation site will be prepared and submitted to regulatory agencies. Baseline monitoring (year 0 monitoring) will be conducted on completion of planting to document baseline ecological conditions on the site. Compliance monitoring consistent with the monitoring plan outlined in Section 4 of this document will begin during the first growing season after submittal of the complete set of record drawings (i.e., monitoring year 1). Monitoring reports will be submitted to the regulatory agencies consistent with the schedule described in Section 4 of this document.

7.4.9 Construction Steps

The following sections provide a general outline of the construction and post-construction steps necessary to implement the mitigation plan.

7.4.9.1 General Conditions

- All site work will be consistent with permit conditions and City of Auburn grading permit.
- A pre-construction meeting will be held with contractor, architect/engineer, and wetland scientist to review submittals, work plan, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in accordance with all permit conditions and shall maintain a copy of permits on site.
- During construction, hydroseed or mulch will be applied to all open areas after grading consistent with City of Auburn grading permit.
- All areas of exposed soil will be hydroseeded or mulched by September 15th to stabilize the site prior to the start of the rainy season.
- Plant procurement must be coordinated with the construction schedule to ensure that specified plant quantities and species are available when they are needed.

7.4.9.2 Site Preparation

- Establish and maintain vertical and horizontal site controls throughout the construction period.
- Identify and flag limits of work for the mitigation site.
- Install fencing (orange barrier) around existing wetlands and outlet ditches.
- Implement TESC plan.
- Maintain security of the site through construction; install security fence around site.
- Establish temporary site access roads and wetland crossings.
- Establish staging and stockpile areas.

- Implement a spill control plan and identify fueling areas.
- Install dewatering system (pumping wells, manifold piping, and discharge structure).
- Install temporary utilities (e.g., electric power and irrigation mains).

7.4.9.3 Outlet Channel and Outlet Control Structure

- Install temporary sediment and erosion control measures.
- Recontour ditch at the north end of site (as needed), construct water control structure and channel connecting to the east wetland basin.
- Install erosion control matting and hydroseed open areas.
- Install outlet control structure.

7.4.9.4 East Wetland Basin and Buffer

- Clear site of brush and fence, etc.
- Strip top 12 inches of soil material and dispose of off site in an approved upland disposal area.
- Start dewatering activities.
- Excavate east side of wetland basin.
- Mix subsoils with organic compost and stockpile; stabilize consistent with grading permit requirements.
- Complete fine grading of east side of wetland basin.
- Disc soils that are compacted by grading.
- Place amended soils 12 inches deep over entire east side basin and disc into subsoils.
- Mow existing vegetation in upland buffer areas.
- Install habitat logs and snags.
- Install irrigation system in east basin; restore disturbed grades as needed.
- Install irrigation in upland buffer.
- Test irrigation system.
- Install erosion control matting as needed.
- Remove haul roads, access roads, dewatering ponds/pipes, staging areas, etc. not needed for planting of the existing wetland or west basins, return staging areas/access roads, etc. to grade.
- Apply hydroseed to east basin (wet and transition seed mixes) and upland buffer (low-grow mix) per specifications.
- Winterize irrigation system.

- Produce grading record drawings.
- After grading is complete, install plants in east basin; phase planting if necessary.
- Install plants in upland buffer and in the area between the maintenance roads and the fencing.

7.4.9.5 Preparation and Enhancement Planting of Existing Wetland and Buffer

- Mow existing vegetation in wetland and buffer.
- Disc and install irrigation in the buffer area only.
- Hydroseed buffer with transition seed mix.
- Install above-ground irrigation in existing wetland.
- Install additional plants in the existing wetland and surrounding buffer areas.
- Perform maintenance mowing in areas between enhancement plantings in the existing wetland.

7.4.9.6 West Wetland Basin

- Clear site of brush and fence, etc.
- Strip top 12 inches of soil material and dispose of off site in an approved upland disposal area.
- Start dewatering activities.
- Excavate west side wetland basin.
- Mix subsoils with organic compost and stockpile; stabilize consistent with grading permit requirements.
- Complete fine grading of west side basin.
- Disc soils that are compacted by grading.
- Place amended soils 12 to 24 inches deep over entire west side basin.
- Mow existing vegetation in upland buffer areas.
- Install irrigation system and restore disturbed grades as needed.
- Test irrigation system.
- Install habitat logs.
- Install erosion control matting as needed.
- Apply hydroseed to west basin (wet and transition seed mixes) and upland buffer (low-grow seed mix) per specifications.
- Winterize irrigation system.
- Produce grading record drawing ("as-built").

- After grading is complete, install plants.

7.4.9.7 Closeout

- Remove temporary haul/access roads.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.

7.4.9.8 Record Drawings, Monitoring, and Maintenance

- Produce irrigation and plant installation record drawings ("as-builts").
- Conduct baseline monitoring and complete baseline report, including record drawings, results of baseline monitoring, and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring after grading is complete; submit annual monitoring reports for 15-year monitoring period.
- Conduct maintenance (e.g., weed management) and implement any necessary contingency measures to meet performance standards.

7.5 MONITORING AND PERFORMANCE STANDARDS

The mitigation site will be monitored for a 15-year period, focusing on collecting the physical and biological data necessary to determine if the performance standards, and ultimately the ecological benefits, of the mitigation are met (see Table 7.1-2). Monitoring reports will summarize the ecological condition of the site and document compliance with performance standards. If necessary, specific contingency actions and schedules for implementing contingency measures will be recommended. The first phase of monitoring will be to complete record drawings and a baseline monitoring report, as described below in Section 7.5.1. Section 7.5.2 describes specific monitoring activities and schedules for the mitigation site.

7.5.1 Record Drawings and Baseline Monitoring Report

Conditions on the mitigation site following completion of construction will be documented with record drawings and a baseline monitoring report. This report will verify that mitigation has been constructed as designed or document any deviations from the plan. Any significant deviations from the mitigation design will be noted, and submitted to ACOE for approval. The baseline report will also include documentation of all sampling locations for future monitoring activity. A detailed map of the site will be prepared from field surveys, and will include the following information:

- Site topography at 1-ft contour intervals and selected spot elevations.
- Locations of major plant community boundaries.

- Locations of surface water and control structures.
- Locations of vegetation transects, photograph points, groundwater wells, staff gages, and other sampling points.

Baseline monitoring data will be collected to provide the basis for evaluating future changes on the mitigation site, consistent with the approach and methods outlined for all Port mitigation projects in Section 4 of this document. Results of the baseline monitoring will be compared to the established design criteria and performance standards for the mitigation site (see Table 7.1-2).

7.5.2 15-Year Monitoring Plan

Monitoring activities during the 15-year monitoring period will focus on collecting vegetation, hydrology, and wildlife data to determine wetland function and performance, and compliance of the mitigation site with the performance standards. The monitoring schedule and methods for the mitigation site are summarized in Table 7.5-1.

7.5.2.1 Vegetation Monitoring

Vegetation monitoring will measure establishment of native plant communities on the site. The development of native plant communities will be a key indicator of how well wetland and upland functions are being restored and enhanced by the mitigation. Vegetation is also an indicator of wildlife habitat, as well as having a significant influence on hydrologic and water quality functions.

Data describing plant species composition, density, and cover will be collected along permanent vegetation transects or within permanent plots. Walk-through surveys will be made to estimate annual shoot growth, survival rates, and vertical and horizontal vegetation structure. Photographs can provide qualitative documentation of plant community development over time by evaluating variables such as cover, species composition, height, and vertical structure. Therefore, photographs will be taken along transects and at appropriate viewpoints to document the extent and nature of plant cover. Results of the vegetation monitoring will be used to determine if performance standards for plant survival, cover, density, and species composition are met in each monitoring year.

7.5.2.2 Hydrology

Data on site hydrology will be collected to evaluate the duration and extent of flooding and/or soil saturation in each wetland type on the mitigation site. Both surface and groundwater hydrology will be monitored using staff gages or permanent groundwater monitoring wells, and field observations. Wells will be placed within existing wetlands and at representative sites in the newly constructed forested, shrub, and emergent plant communities. Surface water levels at staff gages and depth to groundwater will be recorded monthly for the first 3 years after construction is complete, and at least three times per year thereafter (Table 7.5-1).

The water level control structure will be inspected monthly during the first three years following construction, and three times per year for the remainder of the monitoring period. Adjustments will be made following consideration of whether the current water regime is suitable for the plant zones established and how changes could optimize the water regime for achieving performance standards. Changes to the water regime of the wetlands will not be made without notifying ACOE and Ecology.

Table 7.5-1. Auburn wetland mitigation site monitoring methods and schedule.

Design Objective	Performance Standard	Method	Frequency	Wetland Vegetation Zone	0	1	2	3	4	5	6	7	8	10	12	15
Forest Wetland Vegetation	In-kind replacement ratio	Aerial photographic or ground-based mapping	May	All	X	X	X	X		X		X		X	X	X
	Species composition	Walk-through surveys and vegetation sampling (plots, transects, or plotless techniques) to document all plant species present	July	All	X	X	X	X		X		X		X	X	X
	Plant Survival	Vegetation sampling	July	All		X	X	X								
	Tree and shrub density	Measure by plot sampling method along transects	July	PFO, PSS, Buffer				X		X		X		X	X	X
	Plant growth	Walk-through surveys to estimate annual shoot growth and survival rates	July	All	X	X	X	X		X		X		X	X	X
	Vegetation structure	Describe from walk-through surveys, incorporating data from above analysis as available	July	All	X	X	X	X		X		X		X	X	X
Shrub Wetland Vegetation	In-kind replacement ratio	Aerial photographic or ground-based mapping	May	PSS	X	X		X		X				X	X	X
	Species composition	Walk-through surveys to document all plant species present by vegetation sampling (plots, transects, or plotless technique)	July	PSS	X	X	X	X		X		X		X	X	X
	Plant Survival	Vegetation sampling	July	All		X	X	X								
	Shrub density	Measure by line-intercept method along transects	July	PSS				X		X				X	X	X
	Plant growth	Walk-through surveys to estimate annual shoot growth and survival rates	July	PSS	X	X	X	X		X						

Table 7.5-1. Auburn wetland mitigation site monitoring methods and schedule (continued).

Design Objective	Performance Standard	Method	Frequency	Wetland Vegetation Zone	0	1	2	3	4	5	6	7	8	10	12	15
	Vegetation structure	Describe from walk-through surveys, incorporating data from above analysis as available	July	PSS	X	X	X	X		X		X		X	X	X
Emergent Wetland Vegetation	In-kind replacement ratio	Aerial photographic or ground-based mapping	May	PEM	X	X		X		X		X		X	X	X
	Species composition	Walk-through surveys to document all plant species present	July	PEM	X	X	X	X		X		X		X	X	X
	Herbaceous plant coverage	Measure by plot sampling method along transects	July	PEM	X	X		X		X		X		X	X	X
	Plant growth	Walk-through surveys to estimate annual shoot growth and survival rates	July	PEM	X	X	X	X		X						
	Vegetation structure	Describe from walk-through surveys, incorporating data from above analysis, as available	July	PEM	X	X	X	X		X		X		X	X	X
Wetland Hydrology	Soil saturation	Depth from the soil surface to groundwater measured at permanent sampling stations in forested, shrub, and emergent wetland zones	Monthly February, June, September	PFO, PSS, PEM	X	X	X	X	X	X	X	X	X	X	X	X
	Surface water depth	Water depths measured at permanent sampling stations in shrub and emergent wetland zones	Monthly February, June, September	PFO, PSS, PEM	X	X	X	X	X	X	X	X	X	X	X	X
Wildlife	Habitat structure	Analysis of hydrologic and vegetation data from forested, shrub, and emergent wetlands	February, June	PFO, PSS, PEM	X	X	X	X		X		X		X	X	X

Table 7.5-1. Auburn wetland mitigation site monitoring methods and schedule (continued).

Design Objective	Performance Standard	Method	Frequency	Wetland Vegetation Zone	0	1	2	3	4	5	6	7	8	10	12	15
		Description of habitat structure from walk-through surveys	June	PFO, PSS, PEM	X	X	X	X		X		X		X	X	X
	Wildlife use	Report wildlife species and activities on site	January, April, June, October	All	X	X	X	X	X	X	X	X	X	X	X	X
Long-term Protection	Buffers, adjacent land uses	Description of buffer vegetation and adjacent land uses, including proximity and screening	June	All	X	X				X				X	X	X
		Description of adjacent vegetation and land uses	June	All	X					X				X	X	X
		Delineate Wetlands	March	All						X				X		X

7.5.2.3 Wildlife Habitat

Habitat structure (i.e., vegetation types, flooding, etc.) of the mitigation site will be monitored to evaluate whether performance standards are being met. These data will be supplemented with observations of wildlife using the site. Wildlife surveys will be conducted four times per year to record wildlife species and activities on site.[54] A variety of techniques will be used to evaluate wildlife use and wildlife habitat attributes on the site. Techniques described in Ralph and Scott (1981), Ramsey and Scott (1979), and Reynolds et al. (1980) may be used to monitor bird numbers. Techniques described in Olson et al. (1997) may be used to sample pond-breeding amphibians and Corn and Bury (1990) for terrestrial amphibians.

7.6 SITE PROTECTION

The Port will execute and file restrictive covenants on the Auburn wetland mitigation site to provide permanent protection for the site. Copies of the restrictive covenants are provided in Appendix F. Language and conditions of these restrictive covenants have been revised to reflect discussions between the Port and ACOE, Ecology, FAA, and USDA-WSD.

The boundaries of the mitigation area and buffers shall be permanently marked with stakes at least every 100 feet or with fencing. The marking shall include signage that clearly indicates that mowing and fertilizer/pesticide applications are prohibited within mitigation areas. The details of fencing and signage are provided in Appendix P.

7.7 MAINTENANCE AND CONTINGENCY PLANS

7.7.1 Routine Maintenance

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, replacing plants) will occur during the monitoring period. Routine weed control does not include contingency measures that may be needed to keep invasive species cover below the 10 percent cover standard. These are discussed below under contingency measures.

The mitigation site has been designed to achieve final performance standards without significant ongoing maintenance. The need for maintenance is anticipated to decline during the monitoring period because the mitigation has been designed to be self-sustaining in the long term. Some maintenance will continue for at least as long as the 15-year monitoring period.

Typical maintenance activities will include replacing dead plants and implementing weed control measures. For the first year following planting, the landscape contractor will be responsible for ensuring the health of planted material and for replacing dead or severely stressed plant material. After the first year, the Port will be responsible for maintaining plants and will replace plants as

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[54] Performance standards do not require wildlife surveys. Wildlife surveys will be conducted to obtain additional information that may be useful in making adaptive management decisions or implementing contingency measures.

needed based on performance standards and consistent with specified contingency measures. To achieve relatively rapid overstory development and structural diversity, trees will be planted closer together than would occur in natural, mature stands, and may be fertilized. At the end of the 15-year monitoring period, some trees may be cut or girdled (these would then be left as woody debris for wildlife habitat) to allow better development of some trees. This management activity will allow the remaining trees adequate space to reach full size, while providing additional microhabitat for animals in the downed or standing woody debris.

7.7.2 Contingency Measures

Contingency measures will be implemented consistent with the adaptive management approach if monitoring results show that specific performance standards are not being met. Specific performance standards and contingency measures for the mitigation site are identified in Table 7.7-1. If conditions arise that have not been identified in this table, they will be evaluated on a case-by-case basis, and discussed with ACOE and Ecology. Based on these discussions, appropriate contingency measures will be developed and implemented.

7.7.2.1 Weed Management

If needed, a variety of weed control strategies are available to manage non-native invasive species, and these weed control strategies may be used as appropriate throughout the project (see Section 4.3.2.4). Specific control measures will be determined on a case-by-case basis, depending on the extent of the invasive species problem, the invasive species of concern, and the site condition. Steps in weed control may include (listed in order of preference) any of the following:

- Dense plantings of desired species that competitively exclude non-native species.
- Use of mulch in the form of sterile straw or other biodegradable mulch.
- Installation of biodegradable weed barrier cloth.
- Mechanical removal of weeds by using weed whackers, hoeing, or hand-removal.
- Applications of EPA-approved herbicides, as necessary.

needed based on performance standards and consistent with specified contingency measures. To achieve relatively rapid overstory development and structural diversity, trees will be planted closer together than would occur in natural, mature stands, and may be fertilized. At the end of the 15-year monitoring period, some trees may be cut or girdled (these would then be left as woody debris for wildlife habitat) to allow better development of some trees. This management activity will allow the remaining trees adequate space to reach full size, while providing additional microhabitat for animals in the downed or standing woody debris.

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- Dense plantings of desired species that competitively exclude non-native species.
- Use of mulch in the form of sterile straw or other biodegradable mulch.
- Installation of biodegradable weed barrier cloth.
- Mechanical removal of weeds by using weed whackers, hoeing, or hand-removal.
- Applications of EPA-approved herbicides, as necessary.

Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project.

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
Excavated Areas (East and West Basins)			
1. Use a perched water table to establish wetlands at the approximate final grades of: East Basin Below 38 ft in open-water wetland 38 ft to 41 ft in emergent wetlands 41 ft to 42 ft to in shrub wetlands 42 ft to 45 ft to in forested wetlands West Basin: Below 42 ft in open-water wetland 42 ft to 44 ft in emergent wetlands 44 ft to 47 ft in shrub wetlands 47 ft to 49 ft in forested wetlands	Wetland areas will meet the following hydrology[a] criteria: In forested areas, soils will be saturated within the upper 12 inches for a minimum of 2 weeks during the growing season[b] In shrub areas, soils will be saturated within the upper 6 inches for a minimum of 6 weeks during the March-November period. In emergent zones, soils will be saturated to the soil surface for 6 months, including at least the period of March through June.	Measure hydrology using ground water monitoring wells, soil pits, and staff gages.	Modify surface drainage features or control elevations of drainage channels. Minor grading if necessary.
2. Plant five forested wetland plant associations that are similar in composition to naturally occurring plant associations. Use native[c] deciduous and evergreen species such as black cottonwood, Oregon ash, red alder, western redcedar, and Sitka spruce. Forest communities will have a native shrub understory with species such as salmonberry, twinberry, red-osier dogwood, red elderberry, willows, and vine maple.	Forest wetlands will cover at least 36 acres of the mitigation site. Upland forest habitat will be established on at least 15 acres of the mitigation site.	Measured using record surveys, vegetation monitoring, and mapping. Verify areas available for vegetation zones on completion of grading and prior to planting.	Replant as necessary to achieve desired vegetation. Adjust planting areas to match as-built grades and planned vegetation zones.

Table 7.7-1. Auburn Wetland Mitigation Site monitoring methods and schedule (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
3. Plant native tree species at densities greater than 280 trees per acre. Plant native shrub species in forested communities at densities greater than 1,800 plants per acre.	Forest wetlands will have at least 80% cover[d] of native species by monitoring year 15. Forest wetlands will have no more than 10% cover of non-native invasive[e] species during any monitoring year. At the end of year 1, survival of planted stock will be 100%. Average survival of planted stock will be at least 80% in the first 3 monitoring years. In monitoring years 3, 8, and 15, forested areas will have multiple strata, tree density will be at least 280 trees per acre in forested wetland areas and shrub density will be at least 1,800 individual plants per acre in areas of the forested wetland that are planted with shrubs (i.e., over 25% to 50% of the area). Plant diversity in each stratum will not decrease by more than 10% from the number plant species installed at baseline.	Verify using record surveys and vegetation monitoring. Vegetation sampling (plots, transects, or plotless techniques) to determine plant mortality, density, cover, and presence of invasive species. Vegetation analysis will employ statistically valid sampling and analysis procedures.	Replant as necessary to meet required density. If standards are not met: Select species that are better adapted to existing hydrologic conditions. Install additional plant material. Install protective collars to reduce herbivore damage. Control/reduce non-native invasive species. Implement integrated weed management plan, which may include test plots to evaluate potential control methods, mechanical removal, manual controls (i.e., chopping, digging), mowing, mulching, biological control, and/or herbicides.

Table 7.7-1. Auburn Wetland Mitigation Site monitoring methods and schedule (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
4. Plant an association of native shrub wetland species that is similar in composition to naturally occurring shrub wetlands, including species such as Pacific willow, Hooker's willow, Sitka willow, red-osier dogwood, and twinberry.	Shrub wetlands will cover at least 6.0 acres of the mitigation site. Species composition in the shrub wetland will include at least a 5% cover of each native species planted in monitoring years 3, 8, and 15. At the end of year 1, survival of planted stock will be 100%. Average survival of planted stock will be at least 80% during the first 3 monitoring years. In monitoring years 3, 8, and 15, shrub density will be at least 2,100 plants per acre in shrub wetland areas. Cover of native species will be at least 80% by monitoring year 15[d]. Shrub areas will have no more than 10% cover of non-native invasive[e] species during any monitoring year. In monitoring years 3, 8, and 15, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.	See above.	See above.
5. Plant an association of native emergent wetland species similar in composition to naturally occurring emergent wetlands. Use native species that are suited to seasonally and/or permanently flooded conditions, such as water parsley, hardstem bulrush, and common spike rush.	Emergent wetlands and open-water habitat will cover at least 6.8 acres of the mitigation site. Native emergent wetland species will contribute at least 90% of plant cover in areas planted with emergent species by monitoring year 15[d]. During any monitoring year, no more than 10 percent cover by *Typha latifolia* will be present.	See above.	See above.

Table 7.7-1. Auburn Wetland Mitigation Site monitoring methods and schedule (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
6. Plant native emergent species in approximately 0.05-acre monotypic patches.	Species composition in the emergent wetland will include at least a 5% cover of each native species planted. Emergent areas will have no more than 10% cover of non-native invasive[e] species during any monitoring year. By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.	See above.	See above.
7. Provide year-round shallow water with patches of emergent vegetation as feeding habitat for dabbling duck species.	Permanently flooded wetlands (at least 0.59 acres) will have shallow-water habitat (<12 inches deep during the June to September period) in 20% of their area. Open water, shallow aquatic bed areas will cover at least 0.59 acres.	Hydrologic monitoring and vegetation surveys.	Replant or minor grading as necessary.
8. Provide ponded water areas for waterfowl resting habitat.	Ponded water at least 26 inches deep will occur in open areas of at least 1 acre from December through May.	Hydrologic monitoring.	Minor grading as necessary.
9. Plant forested wetland adjacent to shrub, emergent, and open-water habitats.	Forested vegetation with trees at densities of 280 stems per acre will occur within 50 ft of the edge of flooded emergent wetland areas for at least 200 linear ft	Vegetation monitoring, site mapping.	Replant as necessary.
10. LWD (stumps and logs of native species) placed throughout the forested wetland to provide year-round cover for small mammals. Low hummocks constructed in the shrub wetland areas to provide non-saturated soils for burrowing small mammals.	LWD placed at densities of 50 pieces per acre (approximately 25 ft on-center). LWD pieces will be at least 6 ft in length and at least 1 ft in diameter at the narrowest part; 25% of the LWD will be greater than 10 ft long and greater than 2 ft in diameter at the narrowest end. Root wads will be at least 4 ft long and 1 ft in diameter at the stump end.	As-built surveys for wood placement and topography. As-built surveys to verify grades; vegetation surveys. Wildlife surveys.	Supplement with more wood as necessary.

Table 7.7-1. Auburn Wetland Mitigation Site monitoring methods and schedule (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
	Shrub hummocks (with a minimum area of 150 ft^2 at elevation 43 ft) at least 4 per acre in the shrub zone.		
11. Provide attachment substrate for breeding amphibian species in areas of ponded water.	At least 50% of live and dead stems in ponded emergent wetland areas will be species with stem diameters less than 0.25 inch.	Vegetation surveys.	Replant as necessary.
Existing Wetland			
12. Enhance habitat functions of existing wetland.	Plant sections of the existing wetland with native trees and shrubs at densities of at least 2,100 individual plants per acre for shrubs and at least 280 stems per acre for native trees. At the end of Year 1, survival of planted stock will be 100%. Average survival of planted stock in the enhanced wetland will be at least 80% during the first 3 monitoring years. Cover of native species in the enhanced wetland will be at least 80% by monitoring year 15[d]. Cover of non-native invasive[e] species will be no more than 10% in any monitoring year. In monitoring years 3, 8, and 15, plant diversity in each stratum will not decrease by more than 10% from the number of plant species installed at baseline.	Vegetation sampling (plots, transects, or plotless techniques) to determine plant mortality, density, cover, and presence of invasive species.	If standards are not met: Select species that are better adapted to existing hydrologic conditions. Install additional plant material. Install protective collars to reduce herbivore damage. Control/reduce non-native invasive species. Implement integrated weed management plan, which may include test plots to evaluate potential control methods, use of mechanical removal, manual controls (i.e., chopping, digging), mowing, mulching, biological control, and/or herbicides
Buffers			
13. Establish a 100-ft-wide forested buffer around the perimeter of the mitigation site.	At the end of Year 1, survival of planted stock will be 100%. Average survival of	See above.	See above.

Table 7.7-1. Auburn Wetland Mitigation Site monitoring methods and schedule (continued).

Design Criteria	Performance Standard	Evaluation Approach	Contingency Measures
The buffer will be densely planted with native trees and shrubs to provide site protection and discourage access to the site by people or domestic animals.	planted stock in the buffer will be at least 80% during the first 3 monitoring years. Cover of native species in the buffer will be at least 80% by monitoring year 15[d]. Cover of non-native invasive[e] species will be no more than 10% during any monitoring year. During years 3, 8, and 15, plant diversity in each stratum will not decrease by more than 10% from the number plant species installed at baseline.		

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[a] All hydrologic criteria (water depths, soil saturation, etc.) must be met during years of normal rainfall. Normal rainfall will be based on the definition for 'most years' given in the ACOE Manual (Environmental Laboratory 1987) (i.e. annual precipitation in a normal year must be the same as or greater than precipitation in 5 years out of 10) or the average precipitation for a time period plus or minus 1 standard deviation of the mean.

[b] Growing season as defined by the NRCS: portion of year when soil temperatures at 19.7 inches below soil surface are higher than biological zero (i.e., 5°C. From King County Soil Survey, this period is assumed to begin March 1 and is between 190 to 220 days in portions of the County near Puget Sound.

[c] Native species are those defined as native to the Pacific Northwest per Hitchcock and Cronquist, 1973.

[d] See Table 4.3-1 for interim percent cover targets for the mitigation site (i.e., between years 1 and 15).

[e] See Table 4.3-2 for list of non-native invasive species to be monitored and controlled on the mitigation site.

Reed canarygrass is present in wetland areas on and adjacent to the mitigation site, and this undesirable species could spread into mitigation wetlands via seed dispersal. To control the spread of reed canarygrass and to ensure the success of native plant establishment, contingency measures as well as routine maintenance actions may be required. Potential control measures include periodic mowing, reseeding with native wetland grasses, and/or treatment with an EPA-approved herbicide.

Because of the planting approach taken (hydroseeding, densely planting fast growing species, and very wet emergent areas), the need for long-term control of reed canarygrass on the site is not anticipated. The dense planting of forested vegetation, including a significant conifer component, will provide dense shade over much of the site. Shade from the forest canopy will greatly reduce the likelihood that reed canarygrass can persist on the site over the long term. The emergent wetlands are designed to be too wet for this species, and it is unlikely to out-compete native wetland plants once they are established in the emergent zone. Hydroseeding at the time of construction should also limit the ability of reed canarygrass to become established.

7.7.2.2 Reducing Herbivore Damage

Vegetation at newly planted mitigation sites can be vulnerable to browse by Canada geese, deer, voles, beaver, and other wildlife species. In order to avoid significant loss of planted species, a number of contingency measures may be necessary. Stem collars may be installed around the base of woody species or netting may be placed over some plantings. A combination of cayenne pepper and pruning wax applied to woody stems has been an effective deterrent to herbivory at the Auburn Race Track mitigation site and may be used. Temporary netting or other temporary enclosure system may be supported 1 to 2 ft above the ground surface in emergent wetland areas to reduce damage by geese. These and other contingency measures may be employed on a case-by-case basis.

7.7.3 Performance Standards

In addition to overall goals and objectives, specific design criteria and performance standards (see Table 7.1-2) were developed to achieve the established wetland mitigation goals. Performance standards are measurable criteria that can be evaluated to demonstrate when a mitigation element has been successfully implemented. Performance standards were developed for each design objective (see Table 7.1-2). During the monitoring period, these performance standards will be evaluated to determine the need for contingency or adaptive management actions. At the end of the monitoring period, performance standards will be used to determine if the project has successfully met design objectives and goals.

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Appendices

APPENDIX A-F

MITIGATION DESIGN DRAWINGS

These appendices, which provide detailed engineering designs and planting specifications for each mitigation site are provided under separate cover.

APPENDIX G

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

APPENDIX G

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

This appendix contains draft language for the restrictive covenants that will be placed on the deeds of each mitigation site describe in this report. The restrictive covenants will legally protect the sites from land uses or activities, except as permitted in the covenants, that could reduce their ecological function. The Port of Seattle will record the restrictive covenant for each respective mitigation site with King County within 60 days following the issuance of a Section 404 permit by the U.S. Army Corps of Engineers.

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

1. Miller Creek / Lora Lake / Vacca Farm Wetland and Floodplain Mitigation Area
2. Miller Creek Mitigation Area
3. Tyee Valley Golf Course Mitigation Area
4. Des Moines Creek Mitigation Area
5. Borrow Area 3 Mitigation Area
6. Auburn Wetland Mitigation Area
7. Des Moines Way Nursery Mitigation Area

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	______________________________ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	____________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ______________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Miller Creek/Lora Lake/Vacca Farm Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # _______________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which

shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a floodplain, wetlands, flood storage areas, and/or riparian corridors, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels and outfalls as authorized in writing by the Corps and Ecology, and maintenance of those channels and outfalls.

e. Installation of guy-wires and anchors (to support navigation light towers outside the Mitigation Area) and maintenance of the guy-wires and anchors.

f. Continuation, including maintenance and reconstruction, of the existing underground sanitary sewer line, currently owned and operated by the Southwest Suburban Sewer District; and partial relocation of this line as authorized in writing by the Corps and Ecology.

g. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

h. Continuation, including maintenance and reconstruction, of the existing electrical power line currently owned and operated by Seattle City Light.

i. Vegetation height control to maintain FAA required approach slopes and radar coverage.

j. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

k. Continuation, including maintenance and reconstruction, of the existing stormwater drainage line to Lora Lake and the rock weir in the lake, currently owned by King County.

l. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal
corporation

By: ______________________
Name: ______________________
Its: ______________________

STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ______________________, _____.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ________________
My appointment expires: ________________

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE MILLER CREEK/LORA LAKE/VACCA FARM WETLAND AND FLOODPLAIN MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Miller Creek Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Miller Creek Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	____ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	________________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of _______________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Miller Creek Mitigation Area, which is legally described in <u>Exhibit A</u> attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # ___________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Miller Creek Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Miller Creek Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. <u>Declaration</u>. The Port hereby declares that the Miller Creek Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural vegetative buffer, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels and outfalls as authorized in writing by the Corps and Ecology, and maintenance of those channels and outfalls.

e. Continuation, including maintenance and reconstruction, of the existing underground sanitary sewer line, currently owned and operated by the Southwest Suburban Sewer District; and partial relocation of this line as authorized in writing by the Corps and Ecology.

f. Continuation, including maintenance and reconstruction, of the existing water main, currently owned and operated by King County Water District No. 49.

g. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

h. Vegetation height control to maintain FAA required approach slopes and radar coverage.

i. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

j. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal
corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

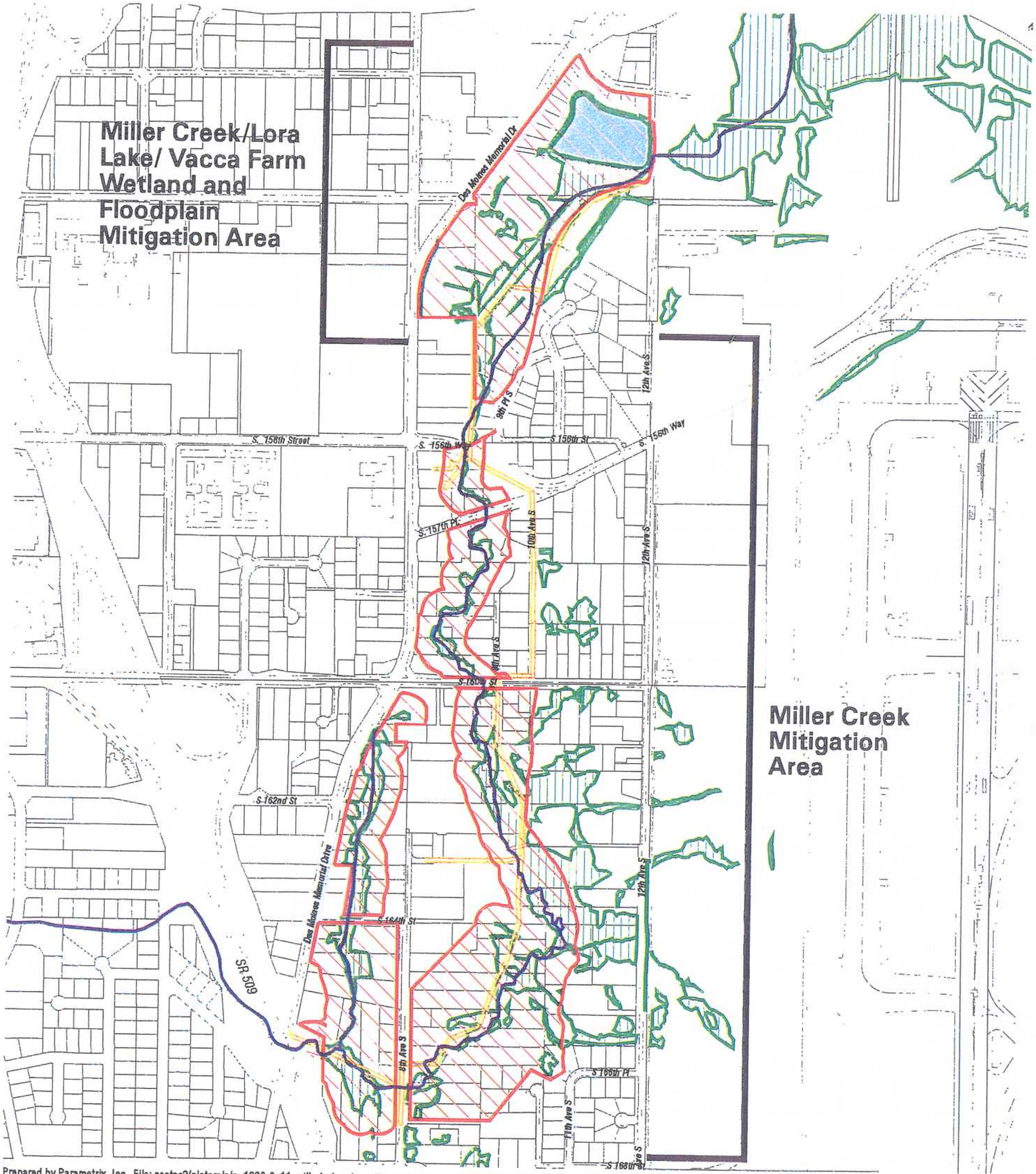
STATE OF WASHINGTON)
) ss.
COUNTY OF _______________)

I certify that I know or have satisfactory evidence that _______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ________________________, ____.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at _________________
My appointment expires:_________________



Prepared by Parametrix, Inc. File: seatac2/plotamls/p_1008-8x11-millerbuf.aml creating p_1008-8x11-millerbuf.gra Date: November 16, 2001

Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

N

🟩 Wetland

▨ Restrictive Covenant Area

— Creek

— Sanitary Sewer

Feet

0 250 500 750 1000

Miller Creek Mitigation Areas to be Protected by Restrictive Covenants

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE MILLER CREEK MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Tyee Valley Golf Course Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Tyee Valley Golf Course Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	______________________________ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	____________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ________________________, ______, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Tyee Valley Golf Course Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # __________________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Tyee Valley Golf Course Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Tyee Valley Golf Course Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Tyee Valley Golf Course Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural wetland area, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels and outfalls as authorized in writing by the Corps and Ecology and maintenance of those channels and outfalls.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

h. Continuation, including maintenance and reconstruction, of the two existing underground sewer lines, one of which is currently owned and operated by the Midway Sewer District, and the other of which is currently owned and operated by the Port (the Industrial Wastewater System line).

i. Activities to implement the Des Moines Creek Basin Plan as authorized in writing by the Corps and Ecology.

j. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ____________________
Name: ____________________
Its: ____________________

STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ________________________, _____.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ________________
My appointment expires: ________________

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE TYEE VALLEY GOLF COURSE MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Des Moines Creek Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Des Moines Creek Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	______________________________ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	____________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of _______________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Des Moines Creek Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # ___________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Des Moines Creek Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Des Moines Creek Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Des Moines Creek Mitigation Area (hereinafter the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural vegetative buffer, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels and outfalls as authorized in writing by the Corps and Ecology, and maintenance of those channels and outfalls.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

h. Continuation, including maintenance and reconstruction, of the two existing underground sewer lines, one of which is currently owned and operated by the Midway Sewer District, and the other of which is currently owned and operated by the Port.

i. Activities to implement the Des Moines Creek Basin Plan as authorized in writing by the Corps and Ecology.

j. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal
corporation

By: ______________________
Name: ______________________
Its: ______________________

STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

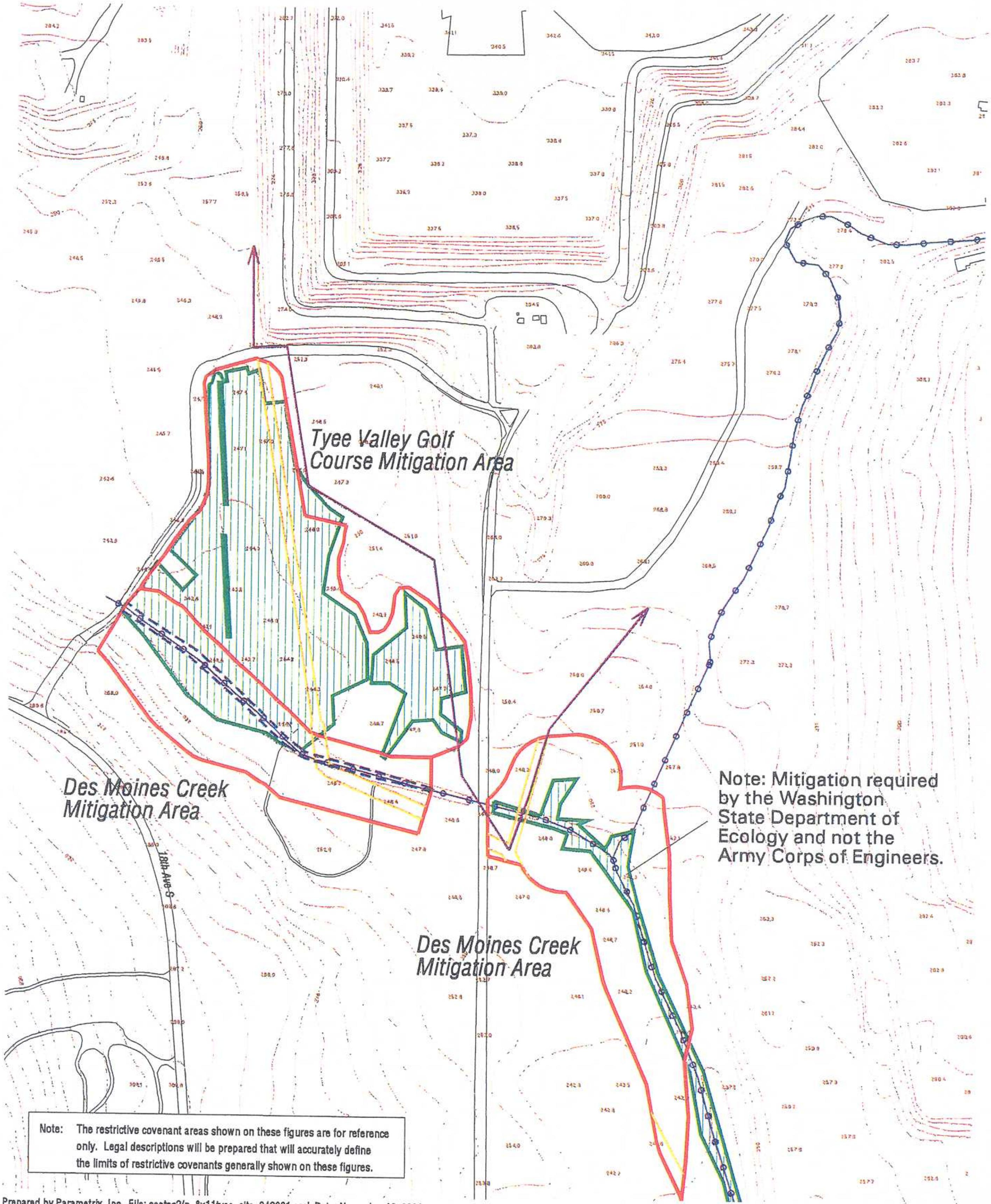
I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ______________________, ____.

c

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ______________
My appointment expires:______________



Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

Prepared by Parametrix, Inc. File: seatac2/p_8x11tyee_site_042001.aml Date: November 16, 2001

Restrictive Covenants on South End of Seattle - Tacoma International Airport

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE DES MOINES CREEK MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Borrow Area 3 Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Borrow Area 3 Mitigation Area)

Grantor: Port of Seattle, a Washington municipal corporation

Grantee: Port of Seattle, a Washington municipal corporation

Legal Description: ______________________________
Official legal description attached on Exhibit A.

Assessor's Tax Parcel ID#: ____________________

Reference # (If applicable): N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this ________ day of ______________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Borrow Area 3 Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order # 1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # ___________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Borrow Area 3 Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Borrow Area 3 Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Borrow Area 3 Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural wetland area, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

e. Vegetation height control to maintain FAA required approach slopes and radar coverage.

f. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

g. Construction and maintenance of a drainage swale to convey water to wetlands in the area, as required by the Corps/Ecology-approved Natural Resource Mitigation Plan.

h. Continuation, including maintenance and reconstruction, of existing stormwater drainage lines.

i. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe,

extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

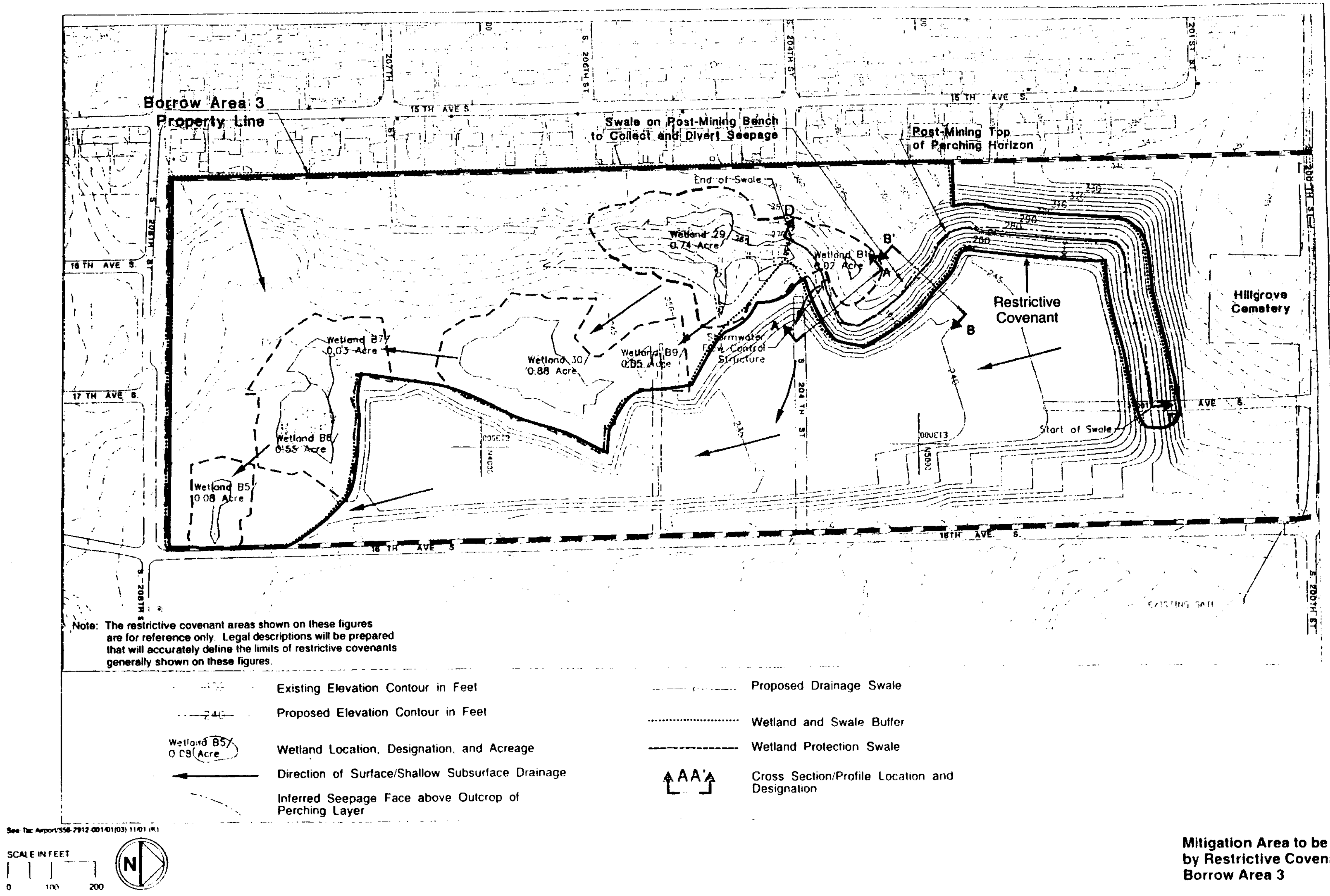
STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the _____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of _______________________, ____.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at _______________
My appointment expires:_______________



Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

Mitigation Area to be Protected
by Restrictive Covenant Near
Borrow Area 3

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE BORROW AREA 3 MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Auburn Wetland Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Auburn Wetland Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	________________________________ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	______________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ________________________, _____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Auburn Wetland Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #1996-4-02325 (Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # ____________________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Auburn Wetland Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Auburn Wetland Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Auburn Wetland Mitigation Area (hereinafter the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used for wetland mitigation. The Mitigation Area shall also be used for floodwater storage in flood events, but it shall not be used for stormwater management for developed areas (i.e., stormwater detention and water quality treatment). No development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Activities necessary for the maintenance and effective functioning of the wetlands and buffers, including but not limited to: (i) monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit; (ii) the removal of exotic, non-native, invasive vegetation; and (iii) maintenance of drainage channels.

c. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

d. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the

Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns, any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal
corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

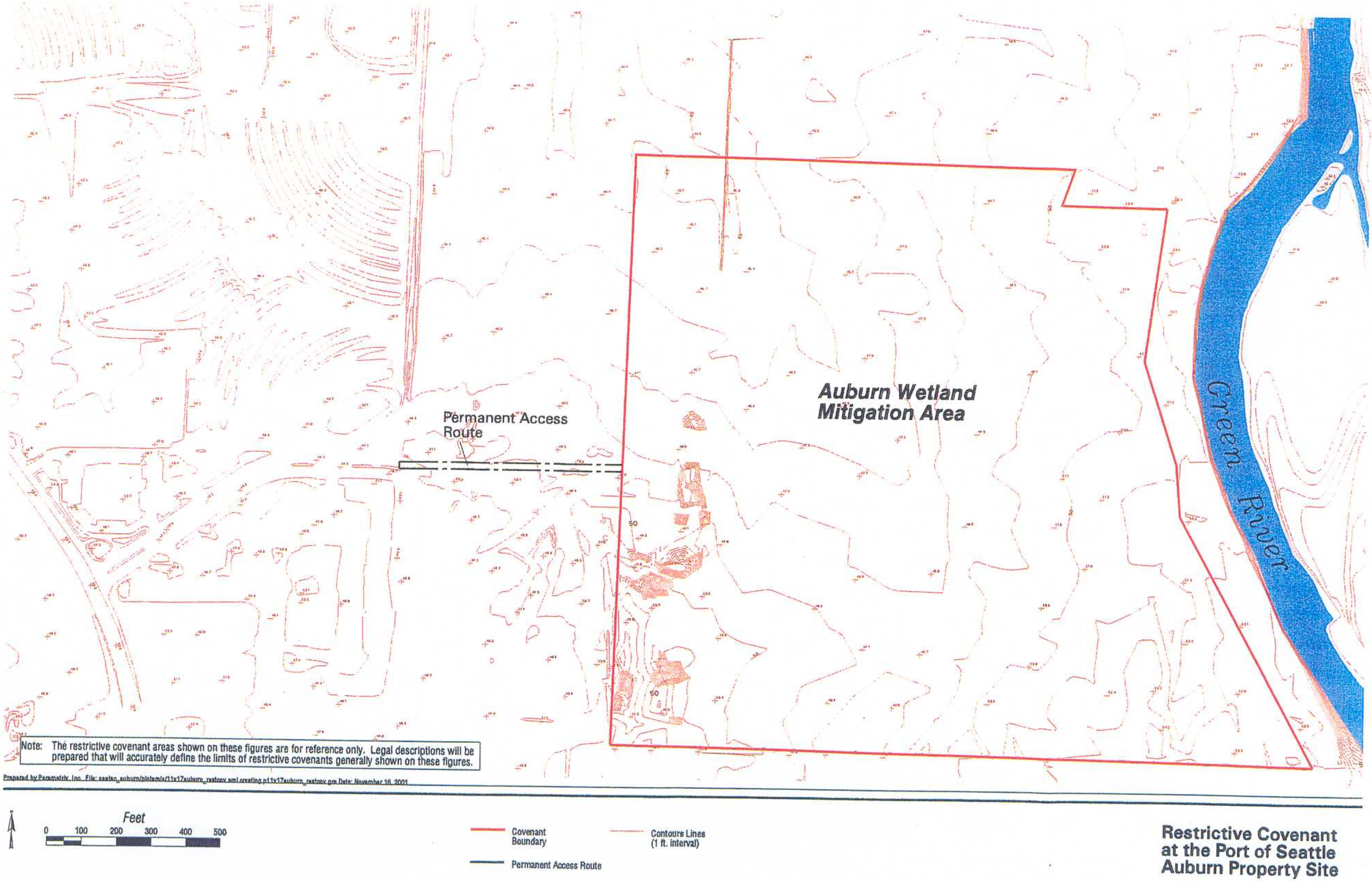
I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of _______________________, _____.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ______________
My appointment expires: ________________

Restrictive Covenant at the Port of Seattle Auburn Property Site



Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

Prepared by Parametrix, Inc. File: seatac_auburn/plotamls/11x17auburn_restcov.aml creating p11x17auburn_restcov.gra Date: November 16, 2001

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE AUBURN WETLAND MITIGATION AREA

RESTRICTIVE COVENANTS FOR MITIGATION AREAS

Des Moines Way Nursery Mitigation Area

DRAFT
11/15/01

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____
____
____
____

DECLARATION OF RESTRICTIVE COVENANTS
(Des Moines Way Nursery Mitigation Area)

Grantor:	Port of Seattle, a Washington municipal corporation
Grantee:	Port of Seattle, a Washington municipal corporation
Legal Description:	____________________________________ Official legal description attached on Exhibit A.
Assessor's Tax Parcel ID#:	________________________
Reference # (If applicable):	N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ________________________, ______, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by a Washington State Department of Ecology ("Ecology") Order and a Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit, each as more particularly described in Recital C, below.

RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); (vi) the real property adjacent to Borrow Area 3 (the "Borrow Area 3 Mitigation Area"); and (vii) the real property at the former Des Moines Way Nursery (the "Des Moines Way Nursery Mitigation Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Auburn Wetland Mitigation Area," the "Borrow Area 3 Mitigation Area," and the "Des Moines Way Nursery Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Des Moines Way Nursery Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order # 1996-4-02325 Amended-1) ("Ecology's Order"), and the Corps Section 404 Permit # ________________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Des Moines Way Nursery Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Des Moines Way Nursery Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Des Moines Way Nursery Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural wetland area, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels and outfalls as authorized in writing by the Corps and Ecology and maintenance of those channels and outfalls.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Felling of trees that a certified arborist has determined to be a hazard to persons or property (e.g., diseased or damaged trees that could fall on adjacent property), as authorized in writing by the Corps and Ecology. Felled trees shall remain in the Mitigation Area as woody debris, and the Port shall replant areas where trees are felled, as appropriate to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan. (This exception does not apply to wildlife management control actions, which are governed by a separate exception above.)

h. Continuation, including maintenance and reconstruction, of an existing underground sanitary sewer line, currently owned and operated by the Southwest Suburban Sewer District.

i. Continuation, including maintenance and reconstruction, of an existing underground stormwater drainage line, currently owned by King County.

j. Other activities authorized in writing by the Corps and Ecology.

Any activity in the Mitigation Area, as authorized above, shall use methods that minimize damage to the Mitigation Area. Where the activity will be carried out by a utility or other non-Port entity, the Port shall provide access over adjacent Port-owned property as necessary to shorten the access route within the Mitigation Area. Following any activity in the Mitigation Area, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. <u>Default; Remedies</u>. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

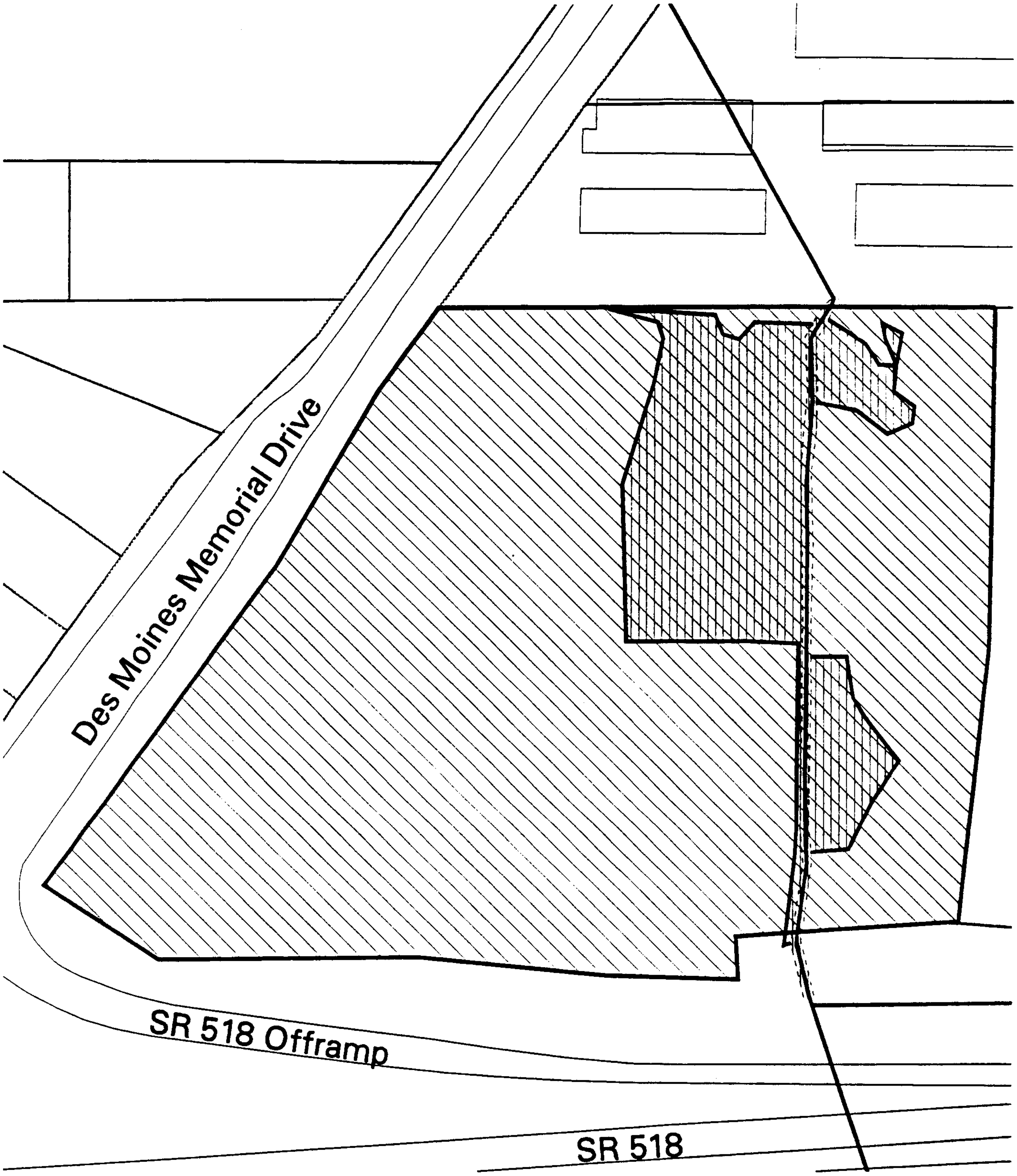
STATE OF WASHINGTON)
) ss.
COUNTY OF ______________)

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ______________________, ______.

____
(Signature of Notary)

____
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ________________
My appointment expires: ________________



Prepared by Parametrix, Inc. File: seatac2/plotamls2001/plots/p_1113-nursery-macov.am Date: November 16, 2001

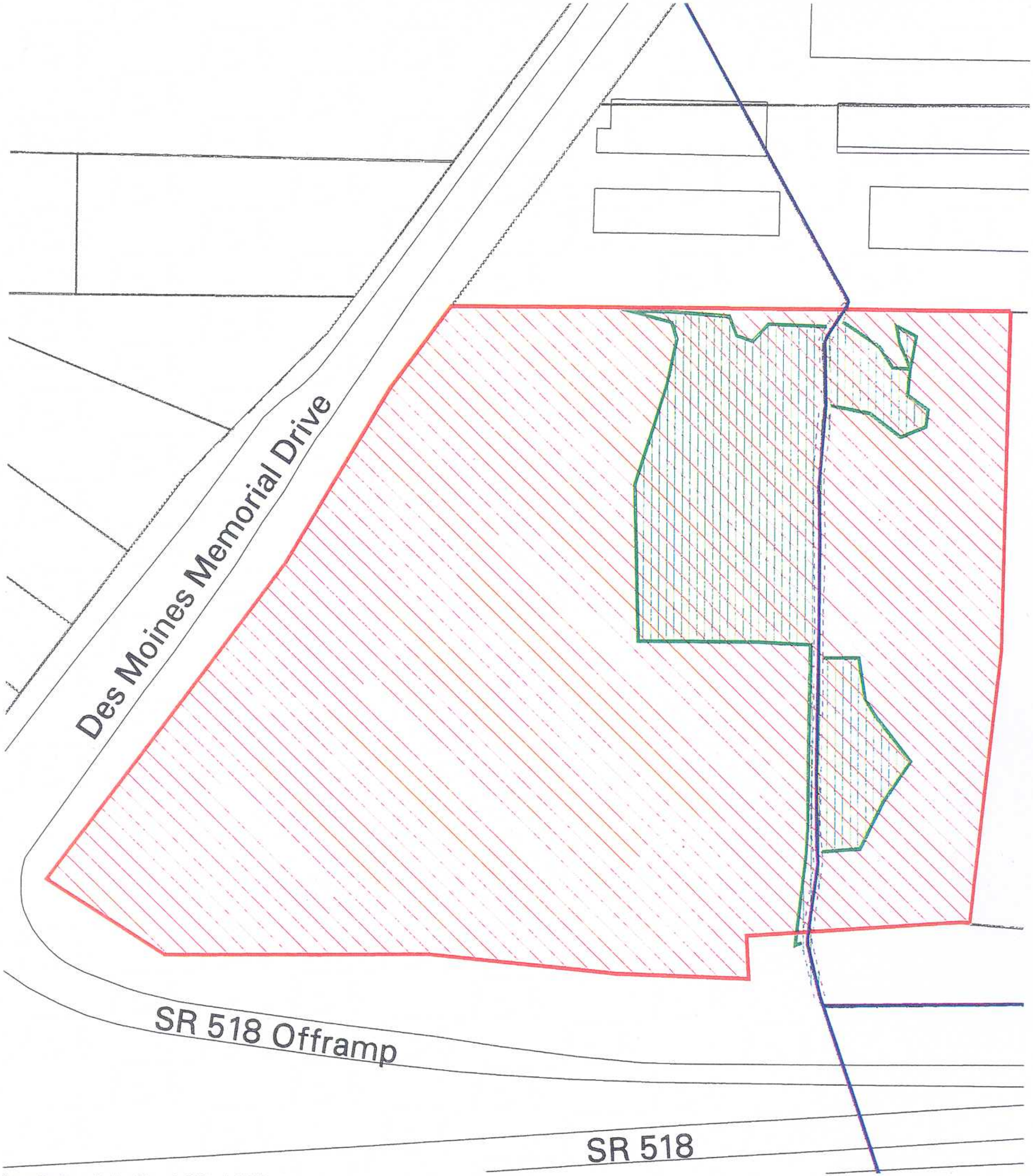
Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

▥ Wetland
▧ Restrictive Covenant Area

— Miller Creek
- - - Surveyed OHWM Miller Creek
— Parcel Boundary

Feet
0 25 50 75 100

Des Moines Way Nursery Mitigation Area Restrictive Covenant



Prepared by Parametrix, Inc. File: seatac2/plotamls2001/plots/p_1113-nursery-rescov.gra Date: November 16, 2001

Note: The restrictive covenant areas shown on these figures are for reference only. Legal descriptions will be prepared that will accurately define the limits of restrictive covenants generally shown on these figures.

N

🟩 Wetland
🟥 Restrictive Covenant Area

Miller Creek
Surveyed OHWM Miller Creek
Parcel Boundary

Feet
0 25 50 75 100

Des Moines Way Nursery Mitigation Area Restrictive Covenant

EXHIBIT A
TO
DECLARATION OF RESTRICTIVE COVENANTS

LEGAL DESCRIPTION OF THE DES MOINES WAY NURSERY MITIGATION AREA

APPENDIX H

SEA-TAC THIRD RUNWAY – BORROW AREA 3 PRESERVATION OF WETLANDS

APPENDIX H

SEA-TAC THIRD RUNWAY – BORROW AREA 3 PRESERVATION OF WETLANDS

This appendix contains information and analysis to show how excavation of the borrow area has been modified to avoid potential hydrologic impacts to the wetlands that occur south and downslope of the excavation footprint. Mitigation explained in the report and illustrated in the revised drawings includes modifications of the excavation footprint, modification of the depth of excavation, and provision of a drainage channel to convey groundwater that will seep into the north and west sides of the embankment to Wetland 29 and other wetlands.

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MEMORANDUM

DATE: October 20, 2000

TO: Jim Thomson, HNTB

FROM: Michael A.P. Kenrick, P.E., and Michael J. Bailey, P.E., Hart Crowser

RE: **Sea-Tac Third Runway – Borrow Area 3**
Preservation of Wetlands
J-4978-06

As requested by the Port of Seattle, this memo and the attached figures provide conceptual design and supporting information for the proposed drainage swale to protect wetlands in Borrow Area 3. We also provide a brief explanation of the hydrology that supports the wetlands, including why excavation of Borrow Area 3 will not drain these wetlands. Figure 1 shows the location of Borrow Area 3 to the south of Sea-Tac Airport.

REVIEW OF BORROW AREA 3 WETLAND HYDROLOGY

The first section of this memo provides a review and explanation of the hydrology that currently supports and sustains wetlands in Borrow Area 3. Understanding these hydrologic factors is important in ensuring the long-term preservation of the wetlands during and after excavation of the fill materials contained in Borrow Area 3.

Factors Promoting Preservation of the Wetlands

Existing wetlands and current topography in Borrow Area 3 are shown on Figure 2; the proposed area of mining and resulting contours for final excavation are shown on Figure 3.

The series of wetlands mapped in Borrow Area 3 follow a line of shallow depressions in the southcentral part of the site, extending to the southeast from Wetland 29 through Wetlands B9, 30, B7, B6, and B5. These wetlands exist in an area of relatively permeable subsoils where the main groundwater table is at a depth of 10 to 15 feet below the wetlands. Depth of the water table indicates the wetlands are supported by other sources of water. The sources of water appear to include surficial runoff and shallow interflow, as well as

910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
Tel 206.324.9530

groundwater seepage occurring from a perched zone above the main water table that discharges in the area of Wetland 29. Observation wells in the area indicate the perched zone does not contribute flow directly to the other wetlands but, by extension, flow from Wetland 29 appears to pass along the line of wetlands, to each wetland in turn.

The key factors for sustaining wetland hydrology in Borrow Area 3 are (1) ensuring the continued supply of water and (2) preventing the undue loss of water from the wetlands. Wetland hydrology is typically sustained by a combination of hydrologic processes, as shown schematically on Figure 4. The processes supporting wetland hydrology include precipitation (P), groundwater flow (GW) and spring seepage (Sp), runoff (RO), and interflow (IF). Other processes such as evapotranspiration (Et) and deep percolation (DP) lead to the potential loss of water from wetlands. Where wetlands exist, it can be assumed that the sources of water exceed the losses, for at least a large part of the year. Maintenance of the water sources, without increasing the losses, should ensure preservation of the wetlands in perpetuity.

One of the main constraints on wetland development in the area is the relatively high permeability of the surficial soils. In agricultural terms, the surficial soils are identified to be part of the Indianola series (USDA, 1973) and are characterized as being "excessively drained" with "rapid permeability." This is consistent with the predominant soil material in Borrow Area 3 being stratified glacial drift, which is primarily sand and gravel outwash with varying amounts of silt in a predominantly granular matrix.

The overall approach for maintaining wetlands in Borrow Area 3 focuses on preserving or enhancing the existing sources of water, and ensuring that no additional loss pathways are created.

Wetland 29

Wetland 29 is unique in that it occurs on a hillside (see Figure 3). Its existence is attributable primarily to a continuous supply of groundwater that seeps from the hillside at this point. Investigation of subsurface conditions at Borrow Area 3 links this area of seepage with a laterally continuous zone of perched groundwater that extends to the north and west, behind Wetland 29 (Hart Crowser, 1999, see reference list following the text of this memo). In hydrologic terms, the wetland occupies part of a surface seepage discharge area for groundwater flowing through the perched zone, as illustrated in the cross section on Figure 4. Part of the seepage from the perched zone flows into Wetland 29, the rest of the seepage from the perched layer does not appear elsewhere on the surface, so is assumed to percolate down into the shallow regional aquifer in the eastern part of the site where the perching layer has been removed by erosion.

The proposed borrow area excavation to the east of Wetland 29 (Figures 3 and 4) will not interfere with the perching layer behind or beneath the wetland and will, therefore, have no direct effect on the continued discharge of groundwater from the west. An analysis of groundwater flow potentially diverted from Wetland 29 (Hart Crowser, 2000) indicates that excavation could change the seepage gradient and result in a decrease in flow to Wetland 29. Mitigation to address this potential change is discussed below.

Although the base of the Borrow Area 3 excavation will be lower in elevation than most of Wetland 29, excavation will occur in predominantly permeable soils that are above the water table. These existing permeable soils already provide a drainage pathway for seepage losses from the wetlands. The persistence of the wetlands despite the presence of permeable soils and a relatively deep water table demonstrates that wetlands will not be drained by the adjacent excavations.

Other Wetlands

Water in Wetland 29 is primarily lost by percolation to the underlying aquifer and evapotranspiration. A portion of the water flowing through Wetland 29 is inferred to move downslope as interflow or shallow subsurface flow to feed successive wetlands that trend southeastward from Wetland 29, occupying a series of shallow depressions (see Figure 3 - note that this flow is out of the plane of the cross section on Figure 4). This inference is based on the topographic position of the adjacent wetlands and the absence of other sources of water. Flow appears to move from one wetland to the next, and some water is likely lost as deep percolation into the permeable subsurface soils that underlie most of the site, including the wetlands. Some additional water probably comes as surface runoff or interflow from the surface catchments feeding each wetland.

According to the Wetland Delineation Report (Parametrix, 1999) and supporting Field Data Sheets, the wetlands in Borrow Area 3 typically feature 10 to 12 inches of "black muck" - a fine-grained richly organic soil that appears to help the ponding of water in the wetland, and likely retains saturation of the root zone rather than allowing much of the water to percolate downward. The concept is illustrated on Figure 5, which is a cross section through Wetland 30.

Note that Wetlands 30, B7, B6, and B5 appear to exist beyond the main perching layer. It is possible that these wetlands formed on locally silty (less permeable) zones in the predominantly granular soil, promoting shallow perched conditions that sustain the wetland hydrology. As evidence of this, Wetland B7 is reported to have a seasonally high water table that would be 10 to 15 feet above the main groundwater table in the underlying relatively permeable shallow regional aquifer. As a result, excavation of the perching layer northeast of Wetland 29 would not have any direct impact on the other wetlands in Borrow Area 3 provided flow into Wetland 29 is maintained as described below.

Proximity of Excavations

The Port proposes that excavations of Borrow Area 3 (see Figure 3) will leave at least a 50-foot buffer around the wetlands. Excavation to the east of the wetlands will proceed to approximate elevation 233 to 235 feet, whereas the wetlands themselves are at approximate elevations 236 feet (Wetland 30) and 235 to 238 feet (Wetlands B6 and B7), see Figures 5 and 6. The hydrology of these wetlands will not be adversely impacted by the excavations because:

- The wetlands already exist over permeable subsoils;
- The buffer will be retained, preventing any lateral "short circuit" flowpath that could divert water from the wetlands and into the borrow site excavation; and
- Base elevations of the proposed excavations are at most only a foot or two lower than the lowest point in these adjacent wetlands.

Wetland B5 is at about elevation 230 feet, well below the proposed excavation. Wetlands B9 and 29 are upslope of the proposed excavation and would be protected against any potential loss of water by the proposed mitigation discussed herein. Wetland B10 is upslope of the perched zone and, therefore, would not be impacted by changes in perched zone flow.

Potential Loss of Surface Flows

In some areas of the buffer zone between the wetlands and the proposed excavation, there may be localized low spots that provide a potential pathway for overland flow to occur from the wetland into the excavation at periods of exceptionally high water levels. If erosion occurs during periods of high water in the wetlands, formation of gullies could divert increased surface flows from the wetlands into the excavations. Erosion will be prevented by preserving existing vegetation in the wetland buffer areas and revegetating the excavated area in accordance with Washington Department of Natural Resources reclamation criteria. However, if erosion threatens the wetland floor, mitigation could easily be accomplished. The Port has proposed a period of wetland monitoring following excavation of the borrow site. If necessary during or after excavations, berms or other erosion protection will be constructed outside the wetland buffer and on the edge of the excavations to prevent overland flow occurring from the wetland depressions into the adjacent excavation. This element of the mine plan will depend on field surveying for elevation control of the land-surface profile along the buffer zone, reclamation of the site to a stable condition, and monitoring after reclamation, which the Port has already committed to.

DRAINAGE SWALE DESIGN

The remainder of this memo addresses the design of a drainage swale that will provide additional water to Wetland 29 to replace the potential loss of seepage from the perched zone.

As described in Hart Crowser (2000), groundwater modeling suggests the possibility that mining will produce a small change in the groundwater flow regime within the perched zone that feeds Wetland 29. Modeling suggests increased drawdown in the perched zone due to excavation in the Borrow Area 3 (see Figure 3) could cause a shift in the seepage gradient. This change in gradient could reduce groundwater flow by a maximum of about 20 percent of the current flow to Wetland 29, or about 400 ft^3/day (roughly 2 gallons per minute). The Port proposes to mitigate this potential indirect impact by collecting groundwater seepage in a swale along the western slope face of the excavation (see Figure 3) and diverting this to Wetland 29.

Overall Concept for Drainage Swale

The proposed drainage swale is designed to collect groundwater seepage from the excavated slope face on the north and west sides of Borrow Area 3, as depicted on Figure 3. The groundwater seepage represents natural flow from the perched zone that is forced to discharge at the cut slope face, as described in detail in Hart Crowser (2000). The flow will be collected and conducted southward in a swale that drains into Wetland 29. Grades along the swale are expected to be between about 1 and 2 percent. A schematic profile along the drainage swale is shown on Figure 7. Modeling shows there is about 2,400 ft^3/day of groundwater flow available compared to projected maximum loss to Wetland 29 of 400 ft^3/day (Hart Crowser, 2000). There is more than enough seepage flow available to make up any loss in the natural perched zone groundwater flow to Wetland 29.

Adaptive Design Approach

The detailed design and construction of the drainage swale will be modified as needed to take account of field conditions revealed during the excavation of Borrow Area 3. For example, the swale could be lined with HDPE (see Figure 6) if needed to prevent loss of flow in the event soils encountered during construction are more permeable than indicated by the borings. Design, construction, operation, and maintenance issues are described under the following headings.

Typical Cross Section

The typical cross section for the proposed drainage swale is shown on Figure 6(a). This cross section presupposes that a sufficient thickness of natural low-permeability soils (the lateral extension of the perching layer) will be present in the upper part of the bench holding the swale.

Prevention of Leakage

To allow for potential variability in the surface elevation or thickness of the perching zone, the design assumes the invert of the swale may extend below the base of the perching horizon in places, in order to maintain the design slope of 1 to 2 percent. If the perching horizon is thin or even be eroded away in places, this will be revealed as excavation of Borrow Area 3 occurs and the intersection of the perching layer with the final cut slope becomes visible. In the event that field mapping during excavation shows insufficient low-permeability soil is present to form the required subgrade for the unlined drainage swale, the swale grade or alignment could be modified, and/or an impermeable lining (protected by gravel) would be used in the base of the swale to prevent seepage loss, as shown on Figure 6(b).

Control of Excess Flows

The position of the drainage swale at mid-slope around the northern and western sides of Borrow Area 3 will cause the swale to collect surface water runoff during high precipitation. Some precipitation upslope of the swale is likely to infiltrate but may appear as shallow interflow or perched water and contribute to seepage in the swale. Also, if constructed to its full length as shown on Figure 3, the swale is expected to collect more than enough groundwater seepage to make up for the projected maximum loss in flow from Wetland 29.

Two measures are available to deal with these anticipated excess flows:

1) A flow-control structure will be constructed in the course of the swale before it enters Wetland 29 (see Figure 9); and
2) The length of the swale can also be modified (at time of construction, or after some period of post-construction monitoring) to control the amount of seepage (and runoff) that is collected and diverted to Wetland 29.

The proposed flow control weir or diversion structure will be designed to provide a consistent low flow of seepage into Wetland 29 and enable diversion of excess flow in the drainage swale away from Wetland 29. The excess flow will be diverted along a channel and into the base of Borrow Area 3, where it will infiltrate and/or be handled by the stormwater facilities for managing runoff from the remainder of the borrow area.

The flow control structure will be constructed of reinforced concrete. As illustrated on Figure 9, it will include a narrow flow slot at the lower elevation to enable a continuous low flow from the drainage swale into Wetland 29. The second part of the flow control structure will include a broad overflow weir that will allow water to spill over into a diversion channel during periods of higher flow in the swale. Flow through both the narrow slot and the broad weir will be controlled with adjustable boards as shown on Figure 9. Flow to Wetland 29 will be fine-tuned during the initial maintenance period (following construction) by adjusting the height of the boards placed in each part of the structure. Final flow levels may then be fixed by replacing the boards with masonry at the end of the monitoring period.

Construction

Construction of the drainage swale will be integrated with the mining and reclamation plan for the excavation of Borrow Area 3. This will prevent over-mining of the perching layer in close proximity to the final slope contours for the excavation. Mining will progress from the highest area of the site in the northwest part of Borrow Area 3, working down the slope and reclaiming the upper part of the final cut slope as excavation proceeds. The perched zone will be encountered as wet areas at the base of the working slope. Mining will then step in approximately 20 feet to allow the bench for the drainage swale to be formed in the perching layer beneath the perched zone.

The next stage will be to excavate within the bench width to cut the swale into the perched zone and underlying perching layer. The bench will be cleaned off and graded to form the swale, which will be constructed per the typical cross section. This will provide the opportunity to determine from field surveying the elevation, profile, and thickness of the perching layer in the area of the final slope. The final design of the swale invert elevations and cross sections will then be adjusted as required to best match subsurface conditions and topography, facilitating final construction the swale at the required elevation on the bench. Mining will then proceed into the lower part of the slope below the drainage swale.

Surface Protection and Reclamation

Reclamation of the borrow area will be accomplished in accordance with Washington Department of Natural Resources criteria and the Port of Seattle landscape plans. Once final grades have been established, the drainage swale and adjacent slopes will be protected from erosion using the same techniques demonstrated to be effective by the embankment construction to date. The excavation slopes will be dressed and hydroseeded with a bonded fiber matrix. The swale will be protected with erosion control matting until grass is established as part of the post-excavation site reclamation.

Operation and Maintenance

Operation of the swale, and particularly the flow control structure, will require monitoring and recordkeeping for an initial period of about two to five years. During this period, the amount of seepage and operation of the flow control weir will be monitored. The weir height may be adjusted to ensure stable and appropriate flows to Wetland 29, which are consistent with plant and ecological requirements of the wetlands.

Long-term operation and maintenance of the swale will be restricted to periodic (annual) inspections of the facility to check the basic integrity of the swale and look for signs of erosion or blockage that could require remedial work by Port grounds maintenance staff.

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Attachments:
References
Figure 1 - Site Location Map
Figure 2 - Pre-Excavation Topography and Wetlands – Borrow Area 3 Perched Zone
Figure 3 - Post-Excavation Topography and Drainage Facilities - Borrow Area 3 Drainage Swale
Figure 4 - Cross Section A - A' through Wetland 29
Figure 5 - Cross Section B - B' through Wetland 30
Figure 6 - Cross Section C - C' through Wetland B6
Figure 7 - Drainage Swale – Profile D-D'
Figure 8 - Typical Cross Sections E-E' - Borrow Area 3 Drainage Swale
Figure 9 - Flow Control Structure Schematic - Borrow Area 3 Drainage Swale

REFERENCES

Hart Crowser, Inc., 1999. Subsurface Conditions Data Report, Borrow Areas 1, 3, and 4, Sea-Tac Airport Third Runway. Prepared for HNTB and the Port of Seattle, September 24, 1999 (J-4978-02).

Hart Crowser, Inc., 2000. Evaluation of Perched Zone Interception and Possible Impacts to Wetland Hydrology, Borrow Areas 3, Sea-Tac Airport Third Runway. Prepared for HNTB and the Port of Seattle, September 12, 2000 (J-4978-13).

Parametrix, Inc., 1999. Wetland Delineation Report, Seattle-Tacoma International Airport, Master Plan Update Improvements. Prepared for Port of Seattle, August 1999.

USDA, 1973. Soil Survey, King County Area, Washington. United States Department of Agriculture, Soil Conservation Service, 100 pp. November 1973.

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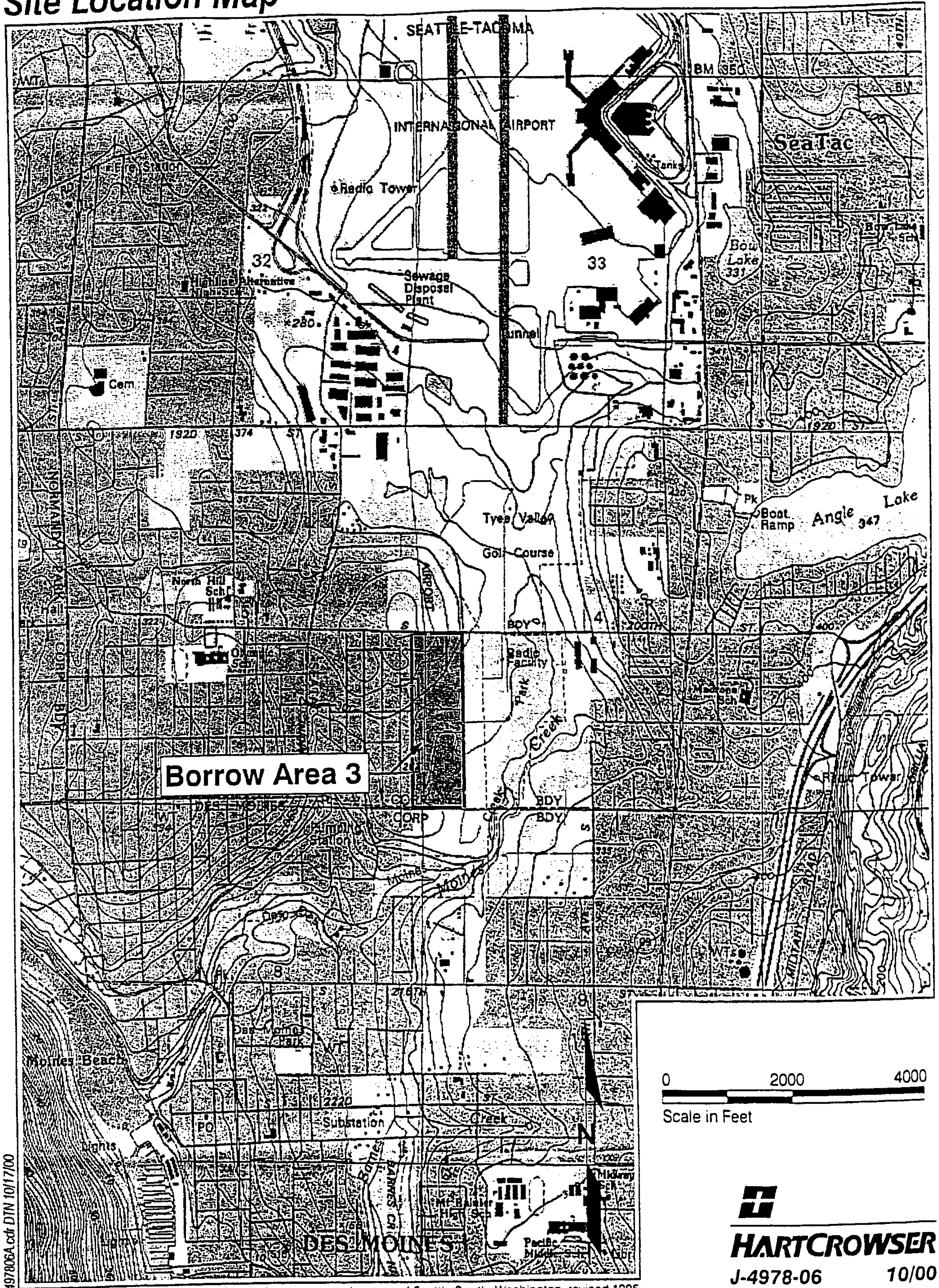
Site Location Map



497806A.cdr DTN 10/17/00

Note: Base map prepared from USGS 7.5 minute quadrangle maps of Seattle South, Washington, revised 1995.

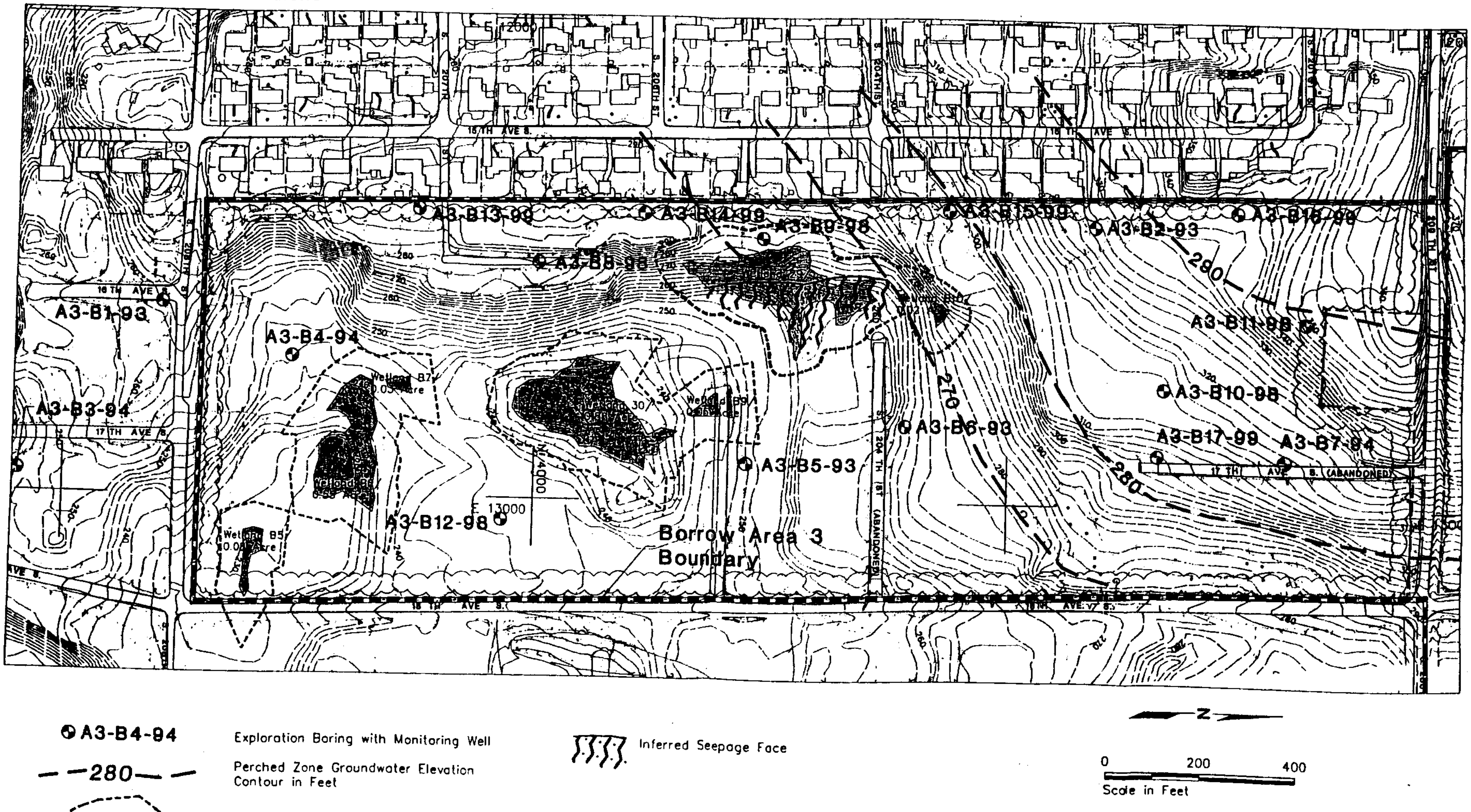
HARTCROWSER

J-4978-06 10/00

Figure 1

AR 029751

Pre-Excavation Topography and Wetlands
Borrow Area 3 Perched Zone



⊕ A3-B4-94 Exploration Boring with Monitoring Well

— —280— — Perched Zone Groundwater Elevation Contour in Feet

Wetland Location, Designation, Acreage, and 50-foot Wetland Buffer (Based on Parametrix, 1999)

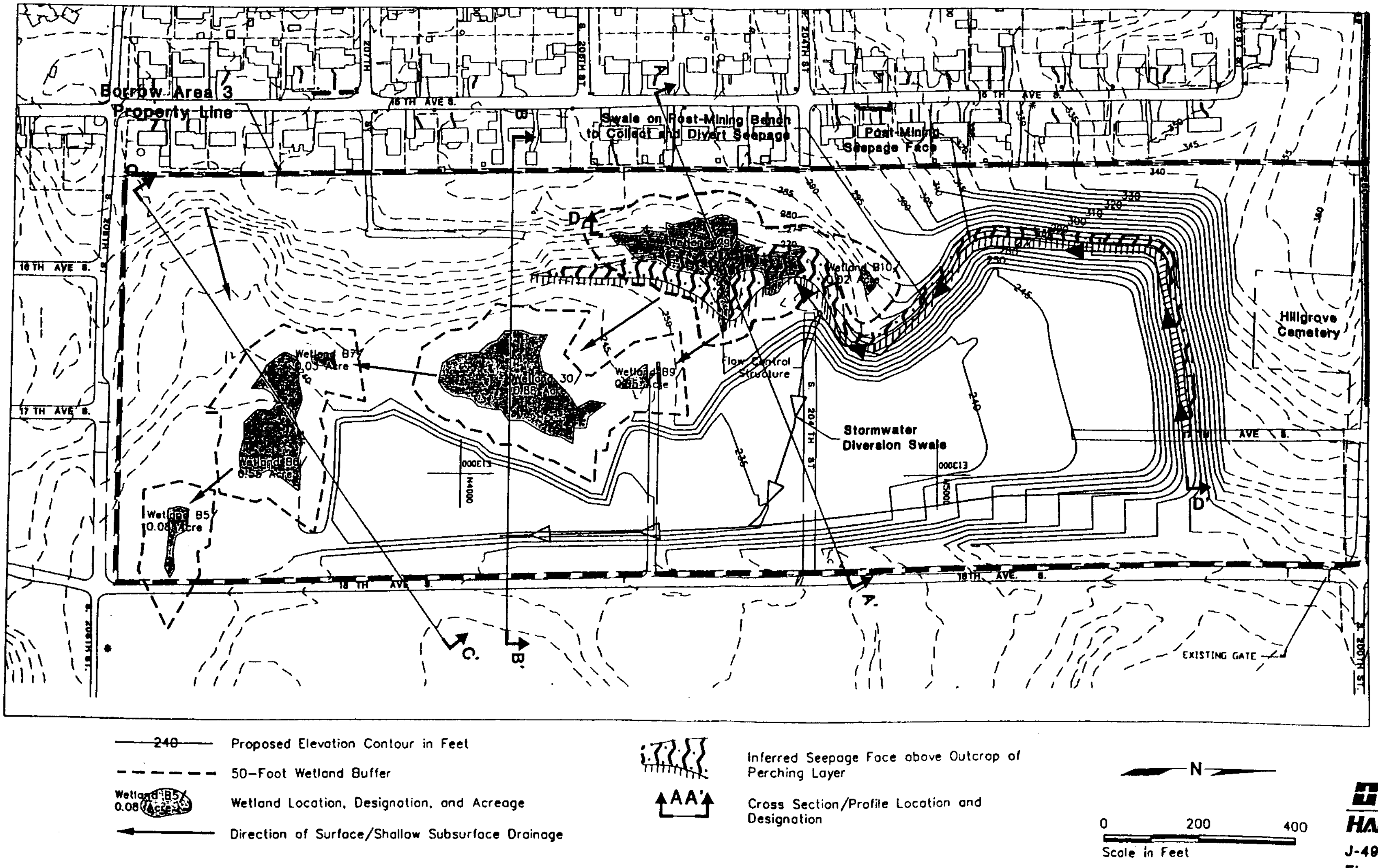
Inferred Seepage Face

HARTCROWSER

J-4978-06 10/00

Figure 2

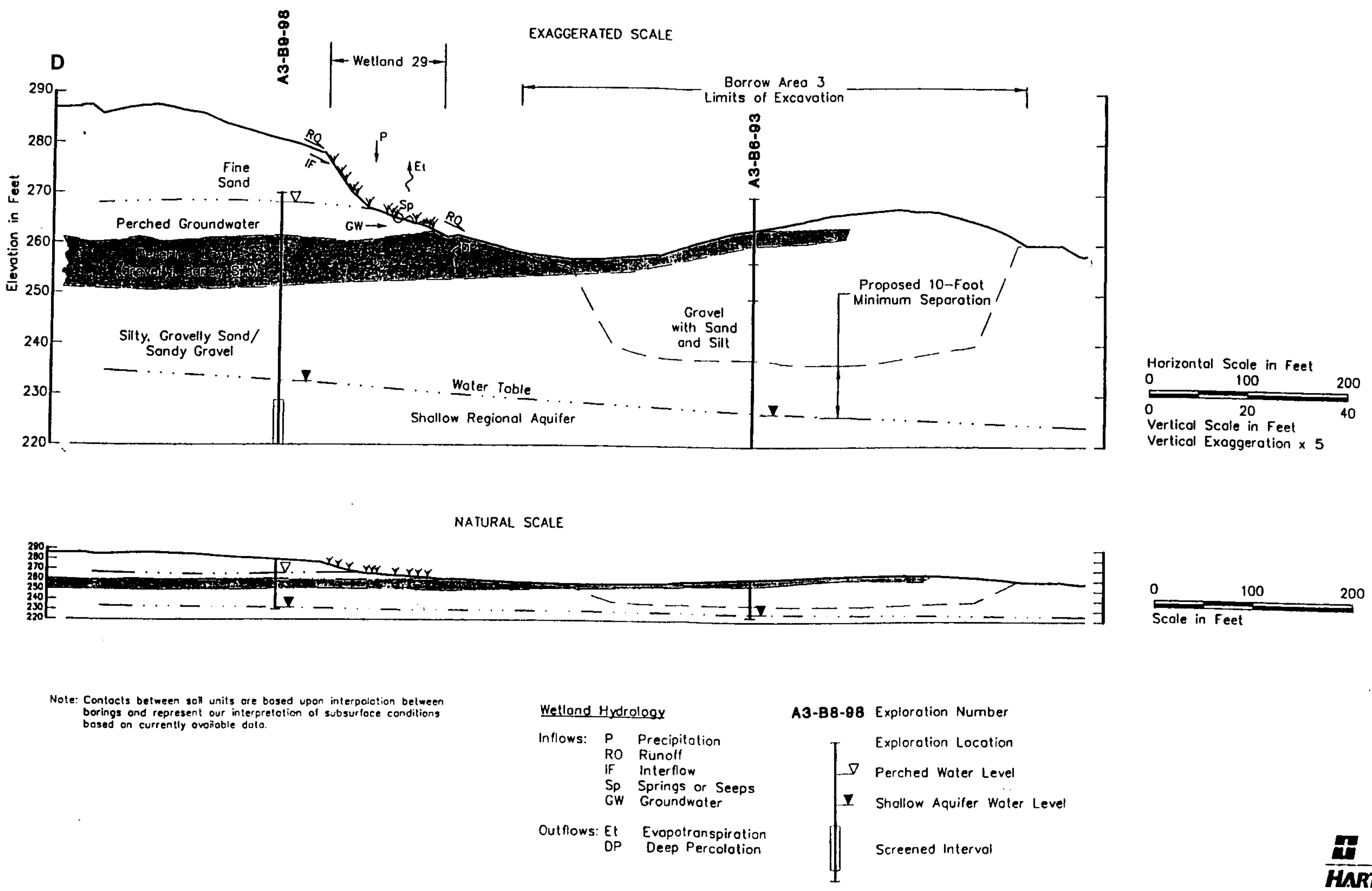
Post-Excavation Topography and Drainage Facilities
Borrow Area 3 Drainage Swale



HARTCROWSER
J-4978-06 10/00
Figure 3

Cross Section A-A' through Wetland 29

Looking North

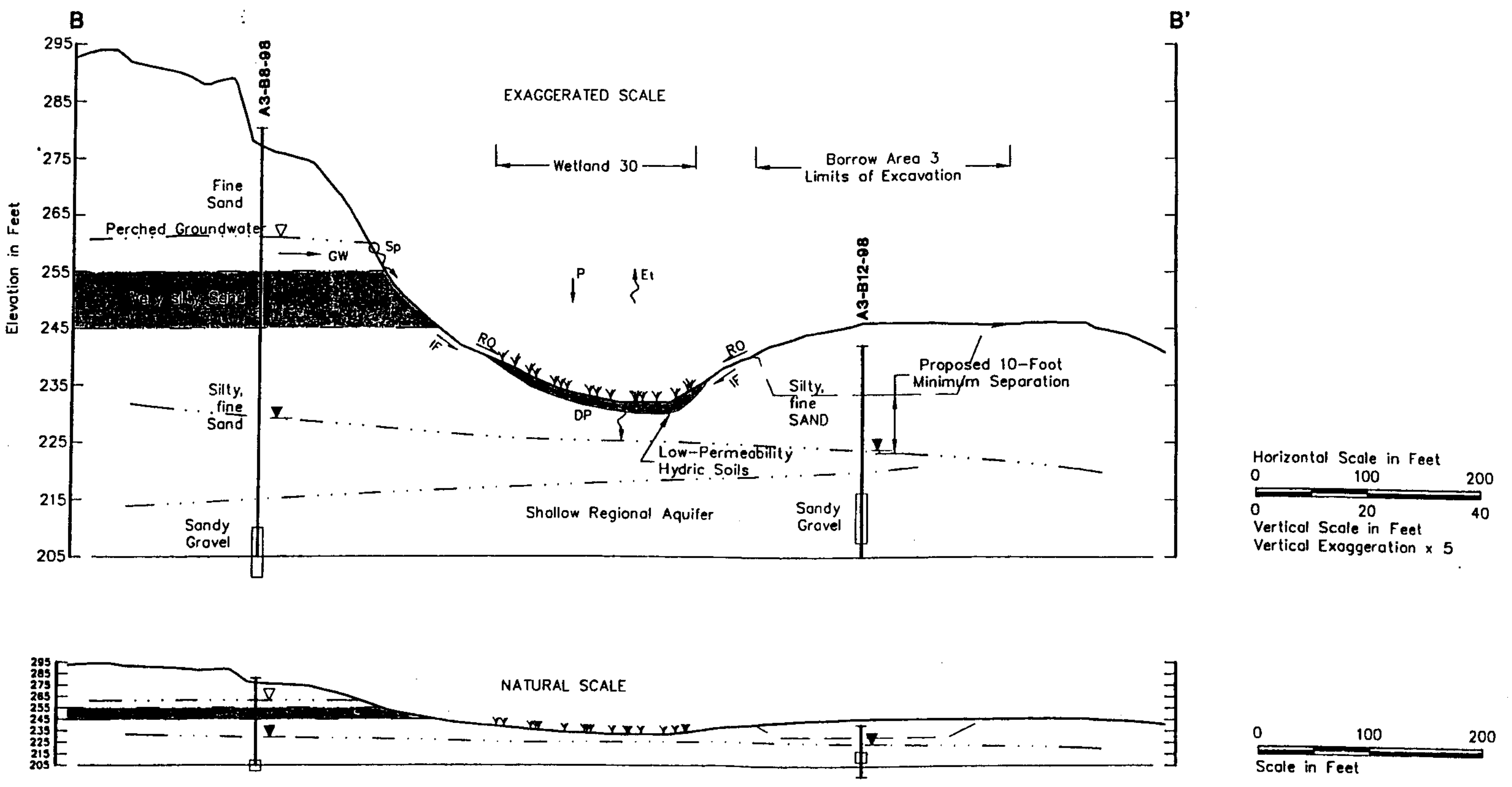


Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

HARTCROWSER
J-4978-06 10/00
Figure 4

Cross Section B-B' through Wetland 30

Looking North



Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

Wetland Hydrology

Inflows:
- P Precipitation
- RO Runoff
- IF Interflow
- Sp Springs or Seeps
- GW Groundwater

Outflows:
- Et Evapotranspiration
- DP Deep Percolation

A3-B8-98 Exploration Number

Exploration Location

▽ Perched Water Level

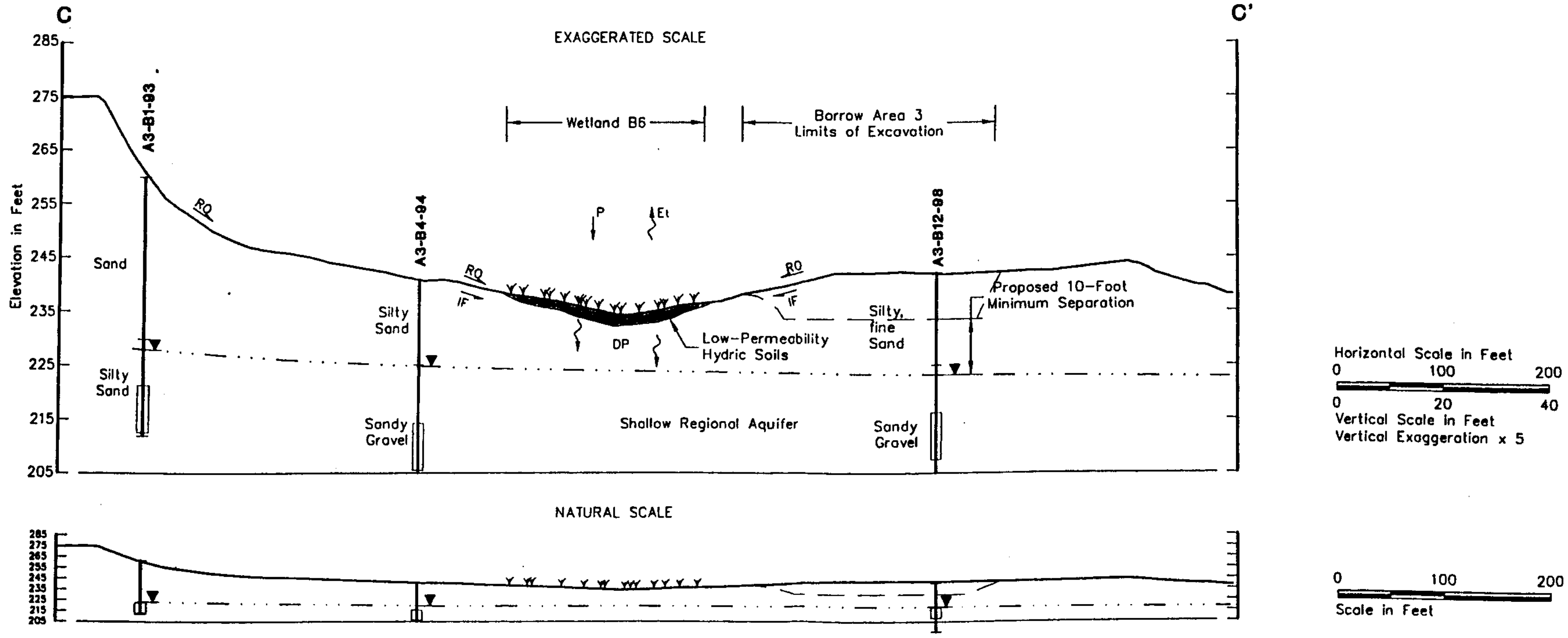
▼ Shallow Aquifer Water Level

Screened Interval

HARTCROWSER
J-4978-06 10/00
Figure 5

Cross Section C-C' through Wetland B6

Looking North



Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

Wetland Hydrology

Inflows:
- P Precipitation
- RO Runoff
- IF Interflow
- Sp Springs or Seeps
- GW Groundwater

Outflows:
- Et Evapotranspiration
- DP Deep Percolation

A3-B8-98 Exploration Number

Exploration Location

▽ Perched Water Level

▼ Shallow Aquifer Water Level

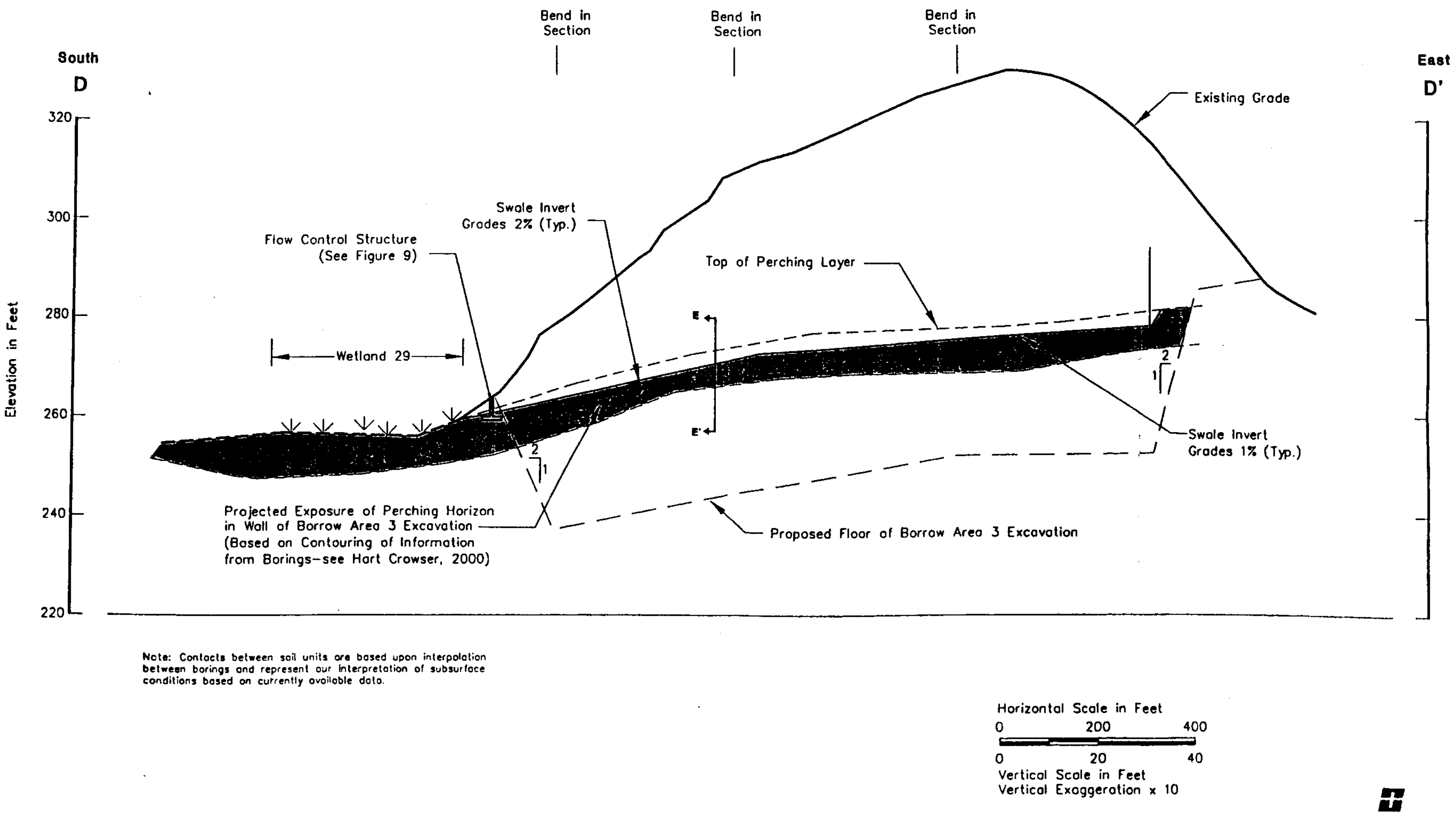
Screened Interval

HARTCROWSER

J-4978-06 10/00

Figure 6

Drainage Swale - Profile D-D'
Borrow Area 3



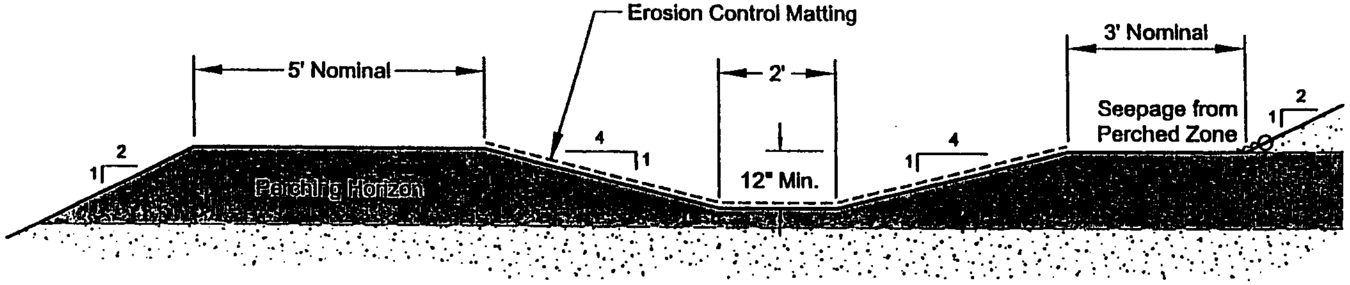
Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

HARTCROWSER
J-4978-06 10/00
Figure 7

DTN 10/18/00 1=1 charlie-8.pc2 49780641.dwg

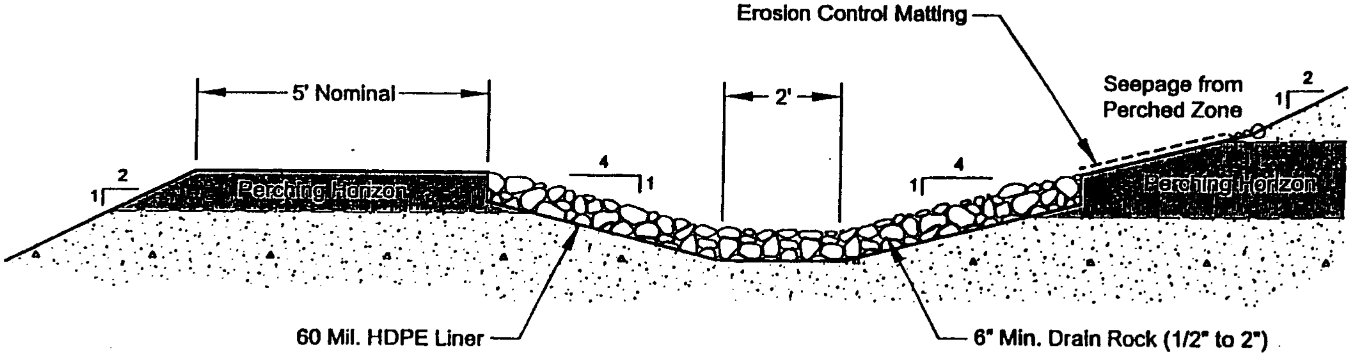
Typical Cross Sections E-E'

Borrow Area 3 Drainage Swale



(a) DRAINAGE SWALE (TYPICAL)

Not to Scale



(b) LINED DRAINAGE SWALE (AS NEEDED)

Not to Scale

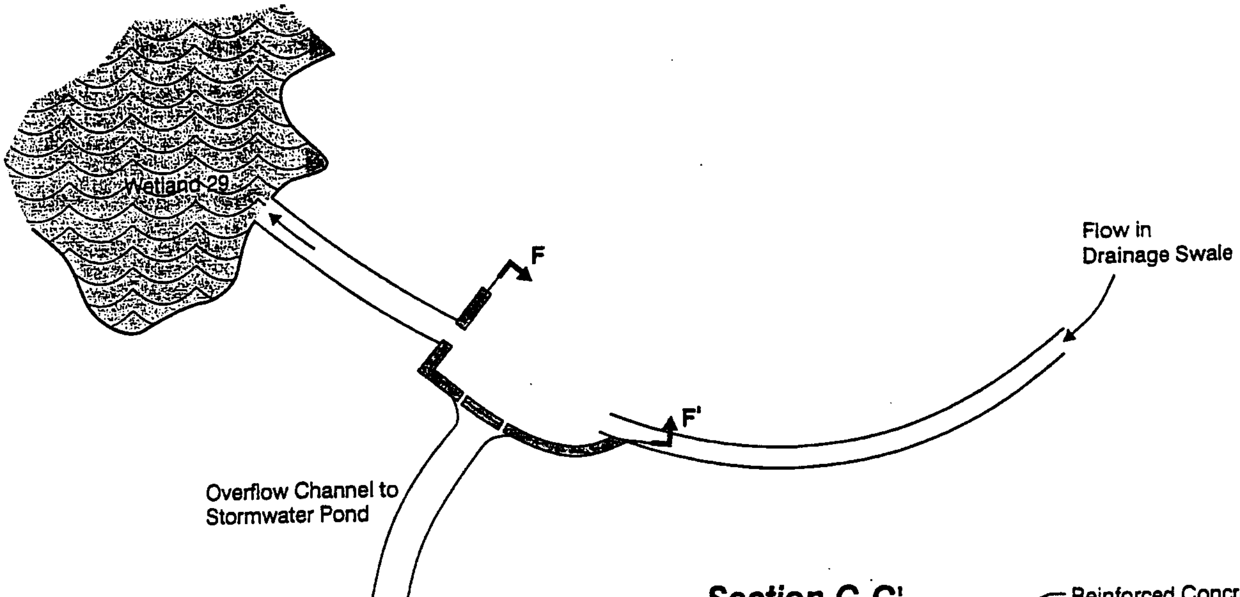
HARTCROWSER

J-4978-06 10/00

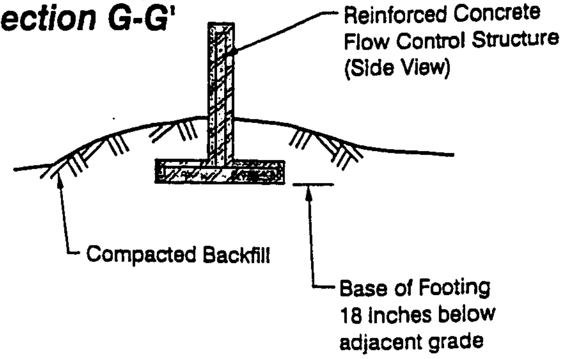
Figure 8

Flow Control Structure Schematic

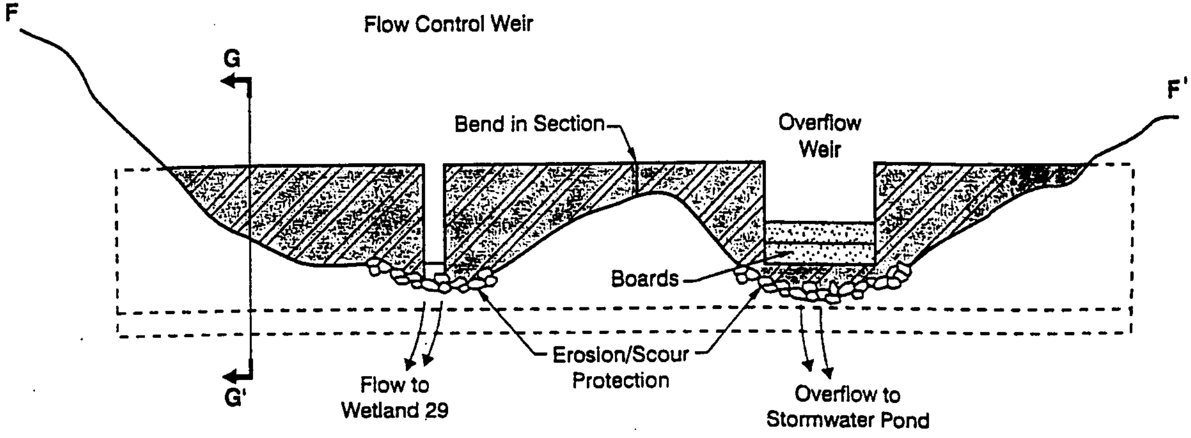
Borrow Area 3 Drainage Swale



Section G-G'



Elevation F-F'



hel 10/18/00 497806B.cdr

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J-4978-06 10/00
Figure 9

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Letter of Transmittal

To: Parametrix
5808 Lake Washington Blvd. NE
Suite 200
Kirkland, WA 98033-7350

Date: June 18, 2001

Job No.: 4978-06

Attn: Jim Kelley

Re: Third Runway Project, Borrow Area 3 Wetland Protection Swale

We are sending the following items:

Date	Copies	Description
6/01	3	Figure 1 Draft Post-Reclamation Topography and Drainage Facilities
6/01	3	Figure 2 - Draft Typical Cross Sections
6/01	3	Figure 3 - Draft Post-Reclamation Topographical Detail
6/01	3	Figure 4 - Draft Proposed Wetland Protection Swale Profile and Cross Section

These are transmitted:

☐ For your information ☐ For action specified below ☐ For review and comment ☒ For your use ☐ As requested

Remarks

Enclosed please find the revised plan and sections for the Borrow Area 3 Wetland protection Swale that provides mitigation of potential seepage changes. Per your request, copies are being sent directly to Ann Kenny at Ecology and Katie Walter at Shannon and Wilson. Pending any comments from the agencies, these draft plans and sections will be incorporated into the Borrow Area 3 excavation plans.

Please call if you have any questions.

By: Michael Bailey, P.E.

Title: Senior Principal

Copies to:
Ann Kenny, Ecology (4)
Katie Walter, Shannon & Wilson (1)
Elizabeth Leavitt, Port of Seattle (1)
Alan Black, HNTB (2)
Jim Thomson, HNTB (1)
Paul Fendt, Parametrix (1)
Ralph Wessels, Port of Seattle (1)

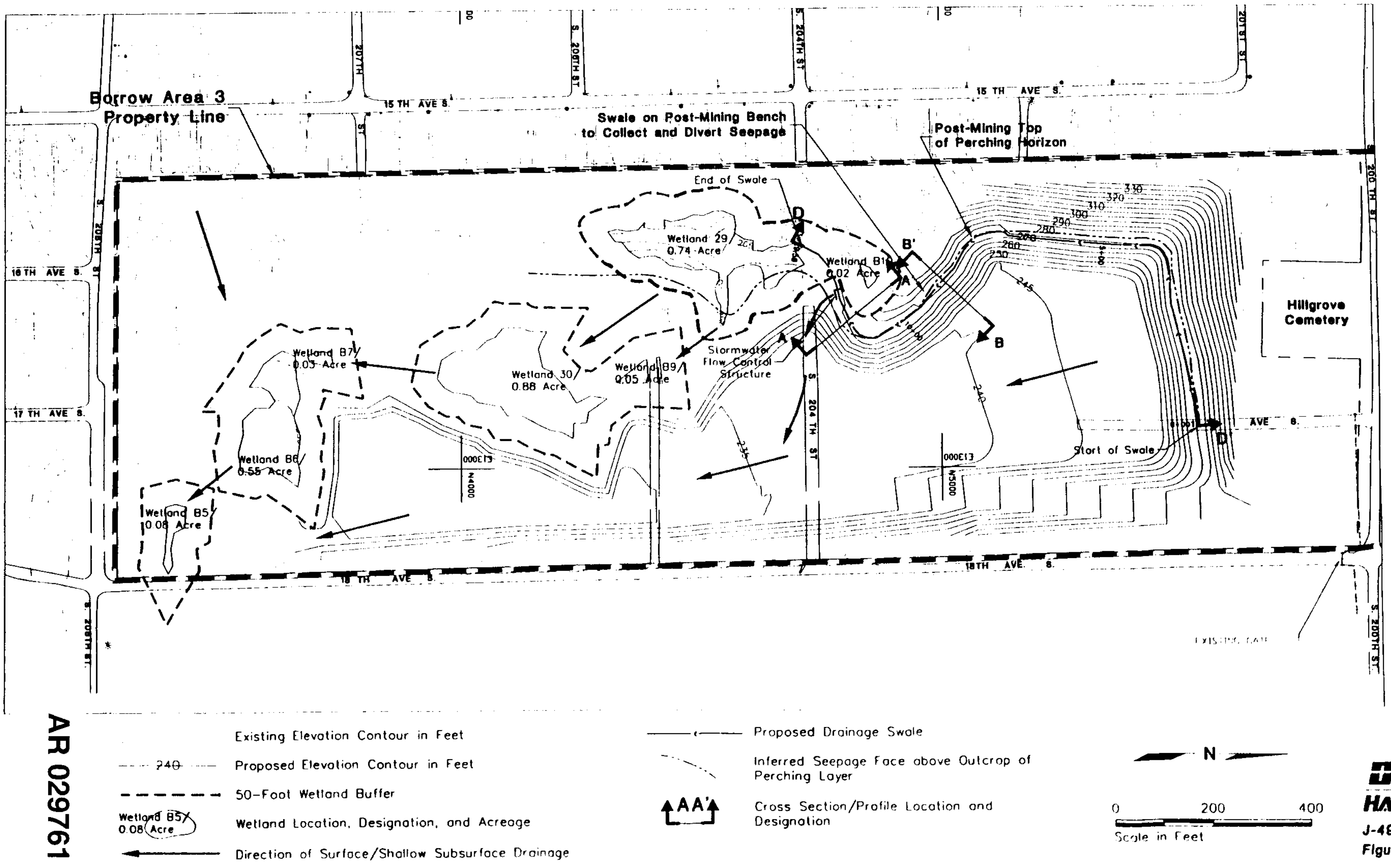
Anchorage
Boston
Chicago
Denver
Fairbanks
Jersey City
Juneau
Long Beach
Portland
Seattle

1910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
Tel 206.324.9530

Post-Reclamation Topography and Drainage Facilities

Borrow Area 3 Wetland Protection Swale

DRAFT

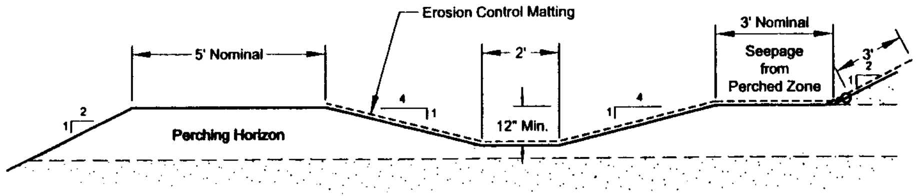


HARTCROWSER
J-4978-06 6/01
Figure 1

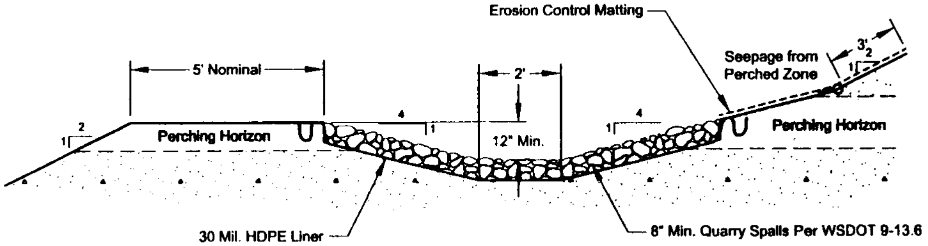
Typical Cross Section

Borrow Area 3 Wetland Protection Swale

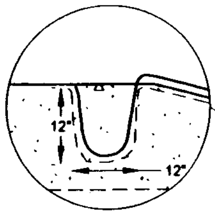
DRAFT



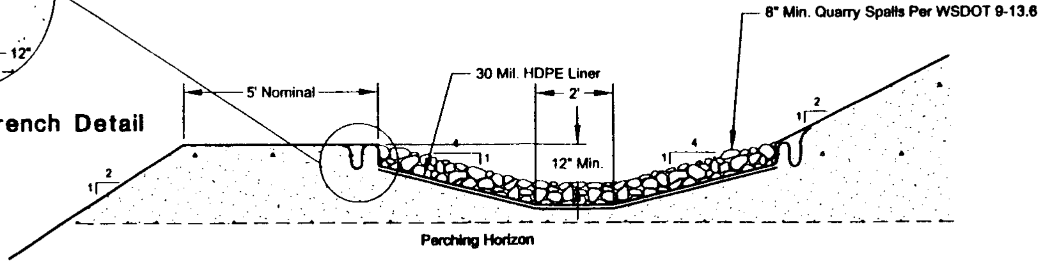
(a) DRAINAGE SWALE (TYPICAL)
Not to Scale



(b) LINED DRAINAGE SWALE (AS NEEDED)
Not to Scale



Typical Anchor Trench Detail

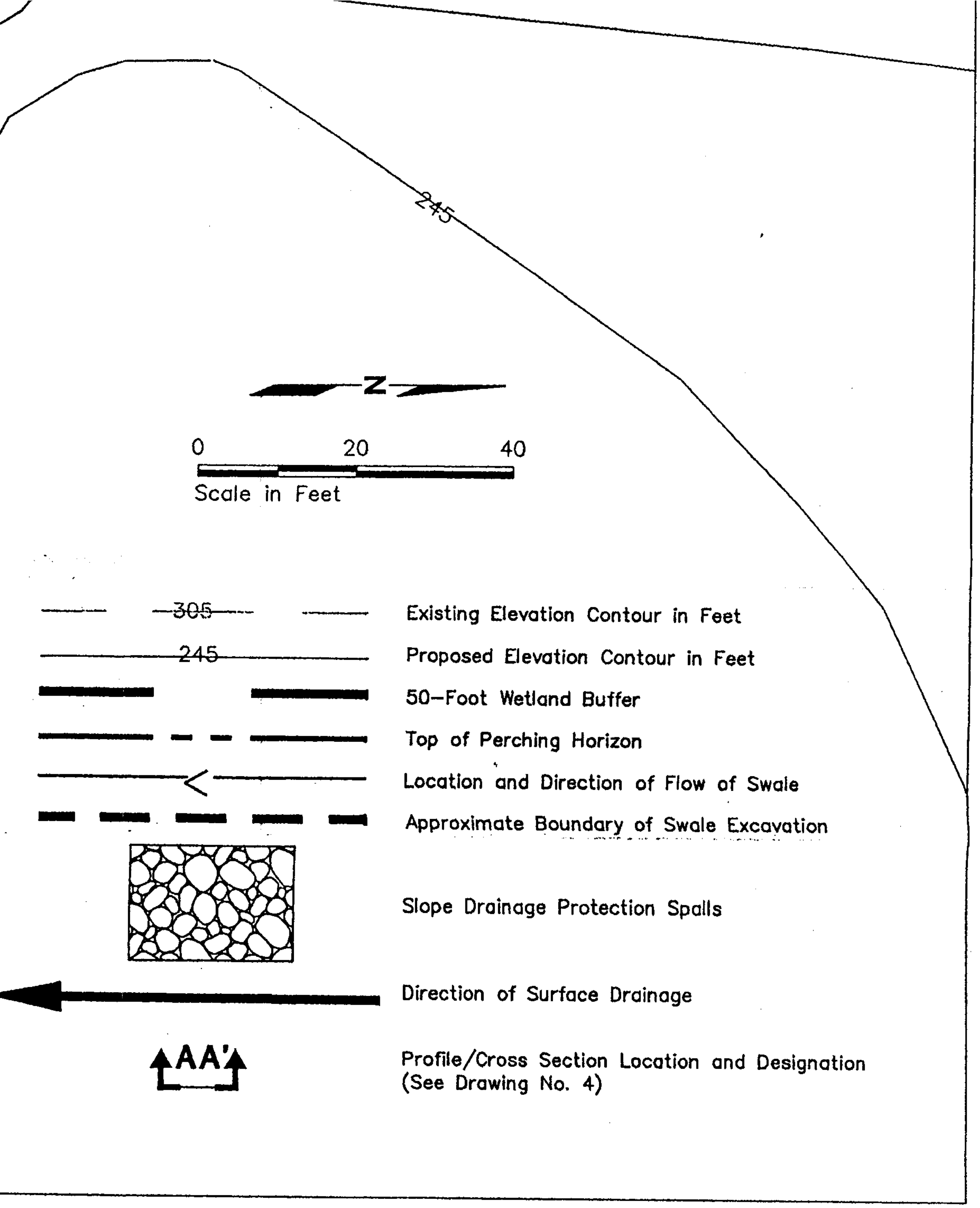


(c) LINED DRAINAGE SWALE (AS NEEDED)
Not to Scale

- Seepage Zone
------ Erosion Control Matting
—— 30 Mil. HDPE Liner
▭ Perching Horizon

Note:
Elevation and thickness of perching horizon and groundwater levels are shown schematically based on existing information. Design grades will be established following field survey during excavation of Borrow Area 3 and exposure of the perching horizon.

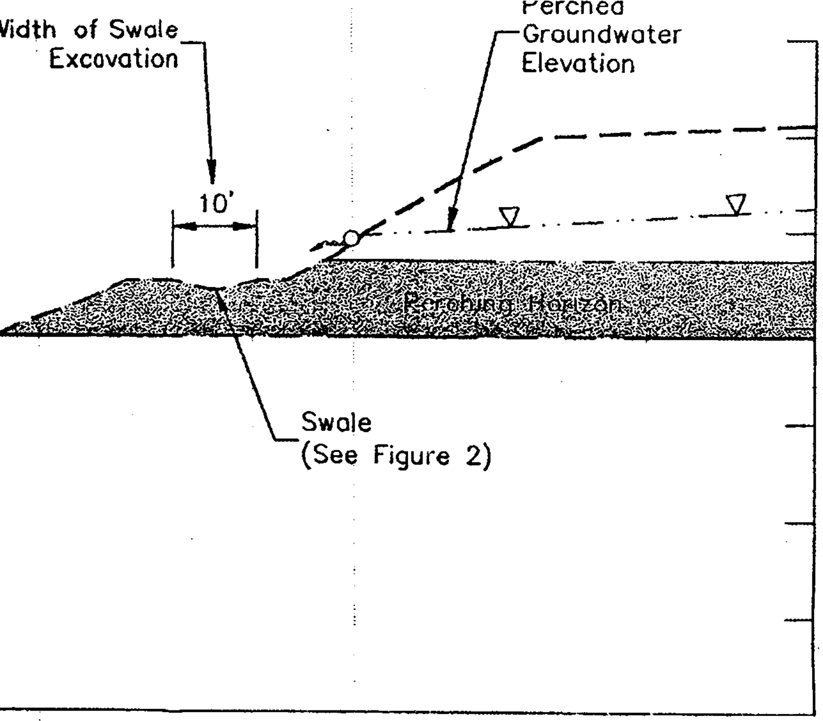
HARTCROWSER
J-4978-06 6/01
Figure 2

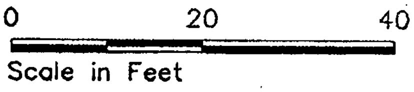


SEA-TAC THIRD RUNWAY

T-RECLAMATION TOPOGRAPHIC DETAIL
W AREA 3 WETLAND PROTECTION SWALE
HNTB REVISION

N	Date Issued: 6/15/01	Drawing Type: DRAFT	Job No.: 4978-06	SHEET: of	Drawing No.: 3





SEA-TAC THIRD RUNWAY

PROPOSED WETLAND PROTECTION SWALE PROFILE AND CROSS SECTIONS BORROW AREA 3

AR 029764

wing : 24x36	Scale: AS SHOWN	Date Issued: 6/7/01	Drawing Type: DRAFT	Job No.: 4978-06	SHEET: of	Drawing No.: 4

APPENDIX I

SAMPLE DATA SHEETS AND PERMANENT REFERENCE POINT LOCATIONS

APPENDIX I

SAMPLE DATA SHEETS AND PERMANENT REFERENCE POINT LOCATIONS

This appendix contains sample data sheets that will be used to collect physical and biological monitoring data specified in this Natural Resource Mitigation Plan and the *Section 401 Water Quality Certification* (Ecology 2001). The appendix also locates permanent reference points that will also be part of the monitoring program. At these locations, photographs, hydrologic, soil morphology, and other ecological data will be collected.

HYDROLOGIC MONITORING
SURFACE WATER DEPTHS – STAFF GAUGE DATA
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Miller Creek Buffer ☐ Tyee Golf Course ☐ Temporary Impacts ☐ Auburn ☐ DMW Nursery Site ☐ Borrow Area #1 ☐ Borrow Area #3

Surveyor(s): ____________________ Weather Conditions[a]: ____________________

Date: ____________ ☐ Ecology/Corp notified a min. of 3 days in advance of field work Page ___ of ___

Station Name/Number	Time	Water Level[b]	Notes[c, d]

[a] Indicate subsurface water levels with a negative sign (-) and standing water with a positive (+) sign.

[b] Record observations of present and preceding weather conditions.

[c] Record species, numbers, and locations of wildlife.

[d] Record algae blooms, odors, or other unusual conditions.

PHOTOGRAPHIC RECORD
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn ☐ Borrow Area #1
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ DMW Nursery Site ☐ Borrow Area #3

Surveyor(s): ______________________ Weather Conditions: ______________________

Date: ______________________ Medium: ☐ Print film - Roll _____ or ☐ Digital Page ___ of ___

☐ Ecology/Corp notified a min. of 3 days in advance of field work

Photo Numbers	Location	Description/Remarks/Wildlife Observations[a]

---

[a] Include species, location, and numbers

VEGETATION COVER DATA
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn ☐ Borrow Area #1
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ DMW Nursery Site ☐ Borrow Area #3

Surveyor(s): ____________________ Weather Conditions: ____________________

Date: ____________________ ☐ Ecology/Corp notified a min. of 3 days in advance of field work

Transect: ____________________ Plot: ____________________

Soil color (at 12-inch depth): ______________ Depth of water table/soil moisture (within upper 18"): ______________

Species (4-letter code)	Non-native, invasive	Estimated Cover (%)	Cover Class (1 to 8)[a]	Height (ft)	Dead/Alive	Remarks

[a] Cover class 1 = <1%, class 2 = 1-5%; class 3 = 6-15%; class 4 = 16-25% ; class 5 = 26-50%; class 6 = 51-75%; class 7 = 76-95%;, class 8 = >95%

WOODY PLANT COVER
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn ☐ Borrow Area #1
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ DMW Nursery Site ☐ Borrow Area #3

Surveyor(s): ____________________ Weather Conditions: ______________________________
Date: ______________________________ ☐ Ecology/Corp notified a min. of 3 days in advance of field work
Transect: ______________________________ Plot:: ______________________________
Soil color (at 12-inch depth): ____________ Depth of water table/soil moisture (within upper 18"): ____________

Species (4-Letter Code)	Record Intercept Lengths by Species and Occurrences	Intercept Total

WETLAND PLANT CONDITION[a]
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn ☐ Borrow Area #1
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ DMW Nursery Site ☐ Borrow Area #3

☐ Ecology/Corp notified a min. of 3 days in advance of field work

Wetland Zone (circle one): Forest Shrub Emergent Open Water Buffer Other: ______________________

Date: ______________________ Observer (s): ______________________

Species (4-Letter Code)	Leaves[b]	%	Shoots[c] (cm)	%	Stems[d]	%	Disease[e]	%	Height (ft)	Diameter (Trees only)

[a] Attach site map of wetland to indicate specific areas examined and reported on this data sheet
[b] Note leaf color, size, and shape abnormalities
[c] Note typical shoot elongation for current season, and abnormalities (including die-back)
[d] Note stem die-back, if any
[e] Record diseases or pests (including insect or animal grazing)

VEGETATION MONITORING DATA SHEET (POINT-INTERCEPT)
SEATTLE-TACOMA INTERNATIONAL AIRPORT
WETLAND MITIGATION MONITORING

Wetland: ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn ☐ Borrow Area #1
☐ Miller Creek Buffe ☐ Temporary Impacts ☐ DMW Nursery Site ☐ Borrow Area #3

Date: ____________________ Wetland Number: ____________ Transect Number/Location: ________________________

Sheet ___ of ____: Lat/Long (beginning or ending):____

Surveyor(s): ______________________________________ ☐ Ecology/Corp notified a min. of 3 days in advance of field work

Sample Point Number	Distance along Transect (feet)	Soil Type O/M Organic/Mineral	Species Present (4 letter code –*Alnus rubra* = ALRU)[a]			Comments[b]
			Tree	Shrub	Herbaceous	

vasive non-native plants will be identified and tallied separately

ote soil saturation at areas along transects (i.e., at beginning, ending, topographic changes, or changes in soil type)

Vegetation Monitoring - Seattle-Tacoma International Airport - Wetland Mitigation Monitoring

Site#______ Site Name____ Surveyor(s) ______________________ Date_____

Photo Roll_________ Photo Numbers_______________

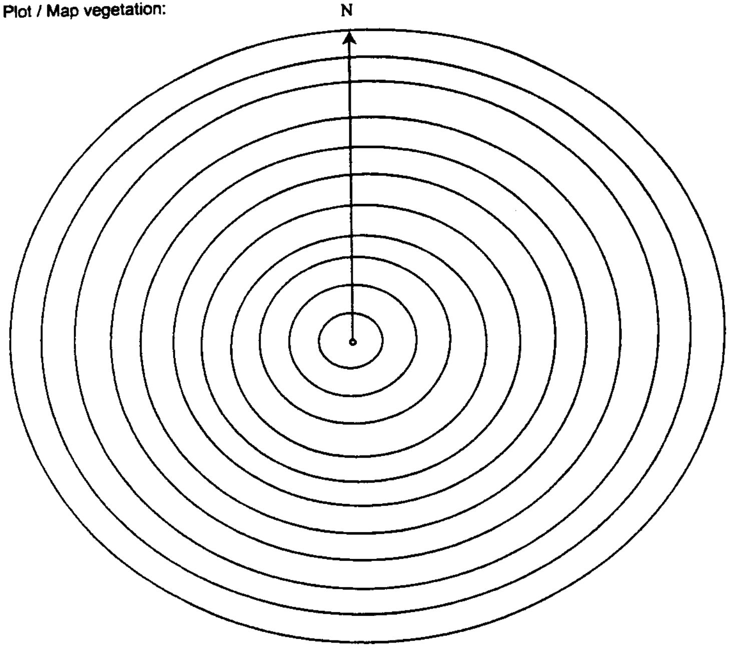
Stratum	Height Range (ft)	Modal Height (ft)	Cover Class Midpoint
Trees (≥10' tall, single stem)			
Snag (≥10', single stem; ≥4" Dia.)			
Small Trees (>3' & <10', single stem)			
Seedlings (</=3', single stem)			
Shrubs (multiple stem)			
Forbs, Graminoids, Ferns & Fern Allies			
Mosses and Lichens			

% Cover	Midpoint
<1	0.5
1-5	3
6-15	10.5
16-25	20.5
26-50	38
51-75	63
76-95	85.5
>95	98

Circle Plot Size	
Acres	Radius
1/100	11.8
1/50	16.7
1/25	23.6
1/10	37.2

Plot / Map vegetation:

Scale:

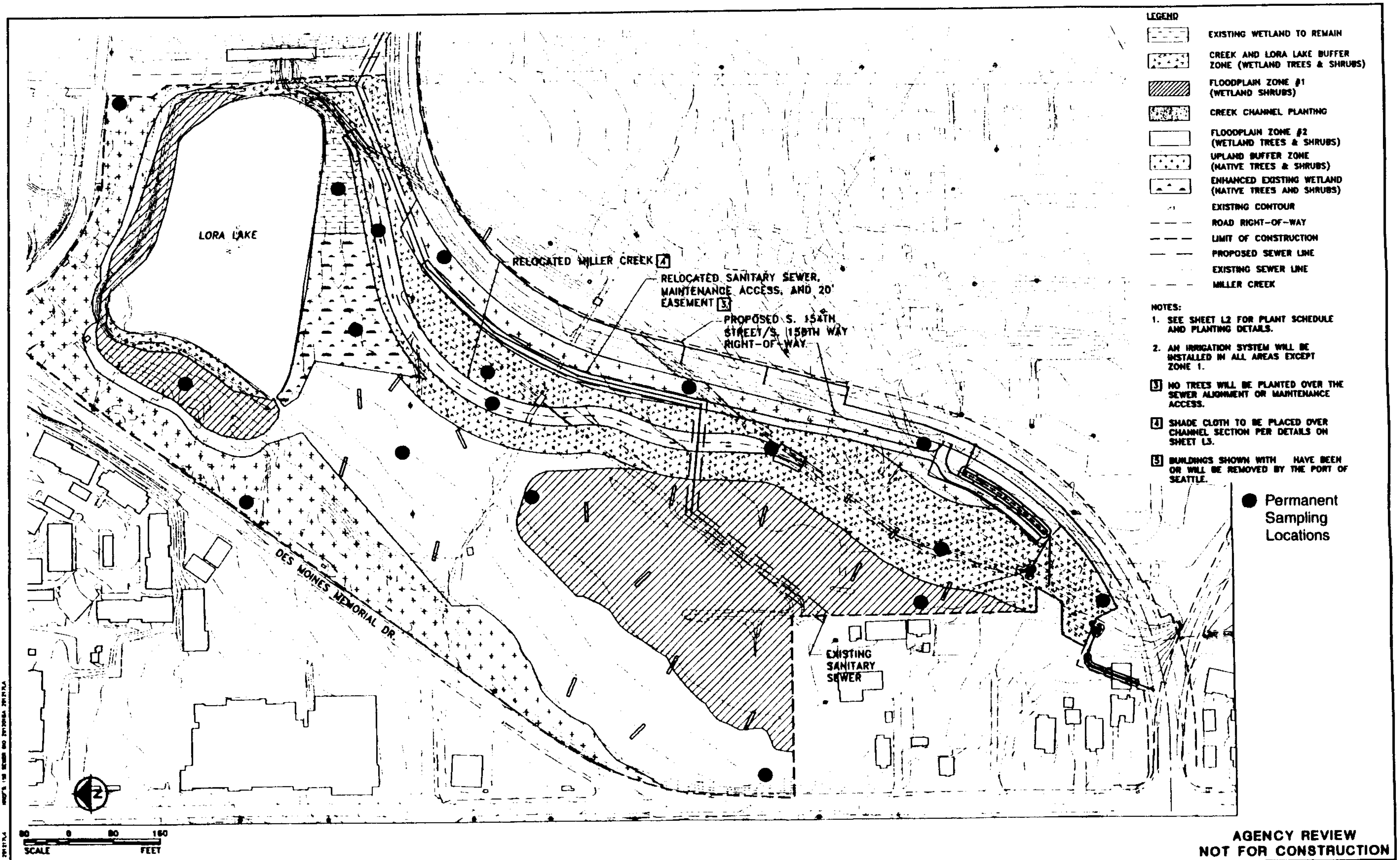


Symbol	Species	Number

Forbs, Graminoids, Ferns & Fern Allies Species	Cover Class Midpoint	Forbs, Graminoids, Ferns & Fern Allies Species	Cover Class Midpoint

Notes:

Parametrix, Inc. Vegetation Data Sheet V1.0 William Kleindl 9/28/00



NOTES:

1. SEE SHEET L2 FOR PLANT SCHEDULE AND PLANTING DETAILS.
2. AN IRRIGATION SYSTEM WILL BE INSTALLED IN ALL AREAS EXCEPT ZONE 1.

3 NO TREES WILL BE PLANTED OVER THE SEWER ALIGNMENT OR MAINTENANCE ACCESS.

4 SHADE CLOTH TO BE PLACED OVER CHANNEL SECTION PER DETAILS ON SHEET L3.

5 BUILDINGS SHOWN WITH HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.

AGENCY REVIEW
NOT FOR CONSTRUCTION

CALL 48 HOURS
BEFORE YOU DIG
1-800-424-5555

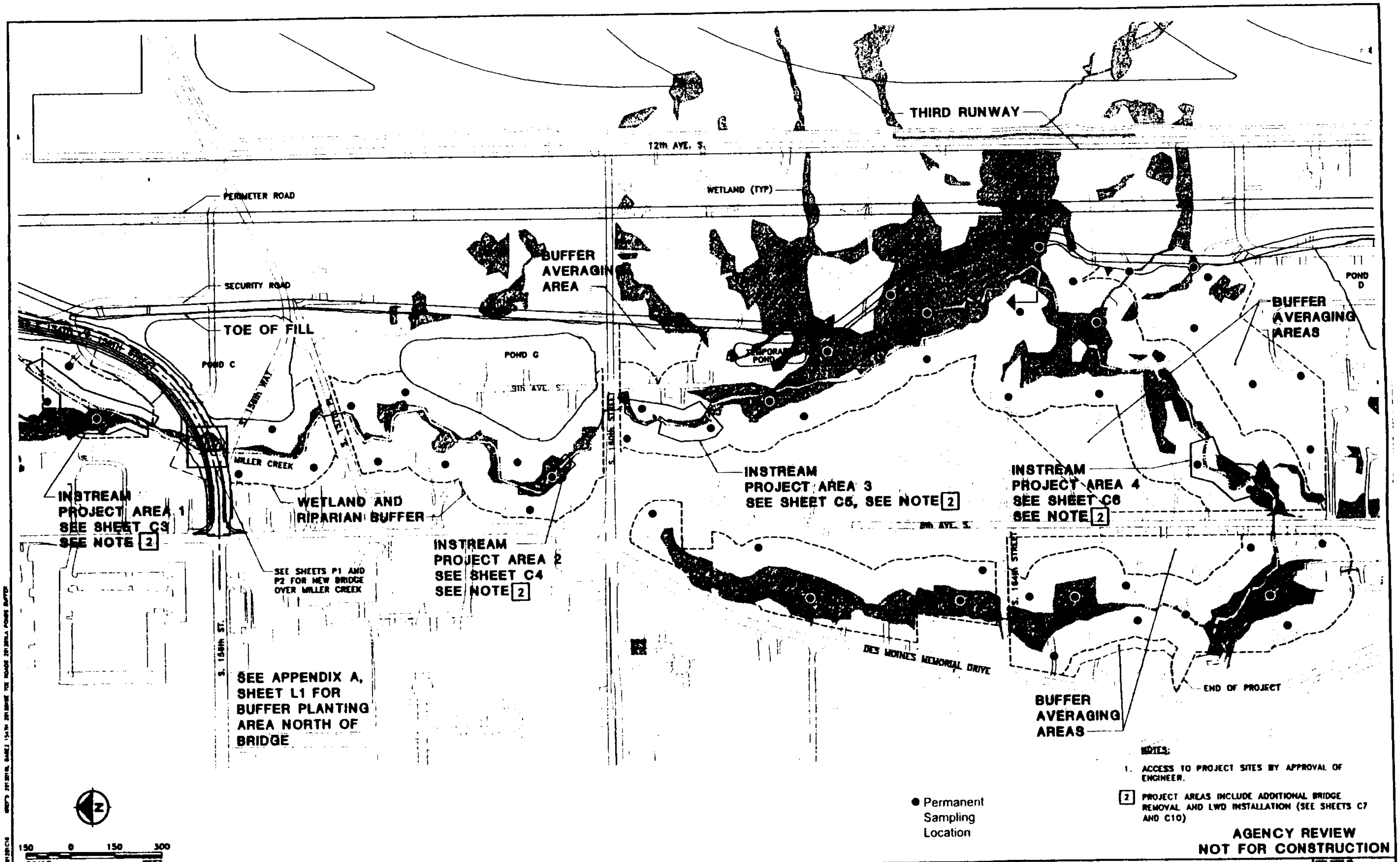
Parametrix, Inc.
5808 Lk. Washington Blvd. NE
Kirkland, WA 98033
Ph: (425) 822-8880
"Quality Service through Employee Ownership"

P. FENDT
M. LOUTHER
1"=80'
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
PLANTING PLAN

100051
291217L4
STIA-9805-L4



● Permanent Sampling Location

NOTES:

1. ACCESS TO PROJECT SITES BY APPROVAL OF ENGINEER.

[2] PROJECT AREAS INCLUDE ADDITIONAL BRIDGE REMOVAL AND LWD INSTALLATION (SEE SHEETS C7 AND C10)

AGENCY REVIEW
NOT FOR CONSTRUCTION

CALL 48 HOURS
BEFORE YOU DIG
1-800-424-5555

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Kirkland, WA 98033
Ph: (425) 822-8880
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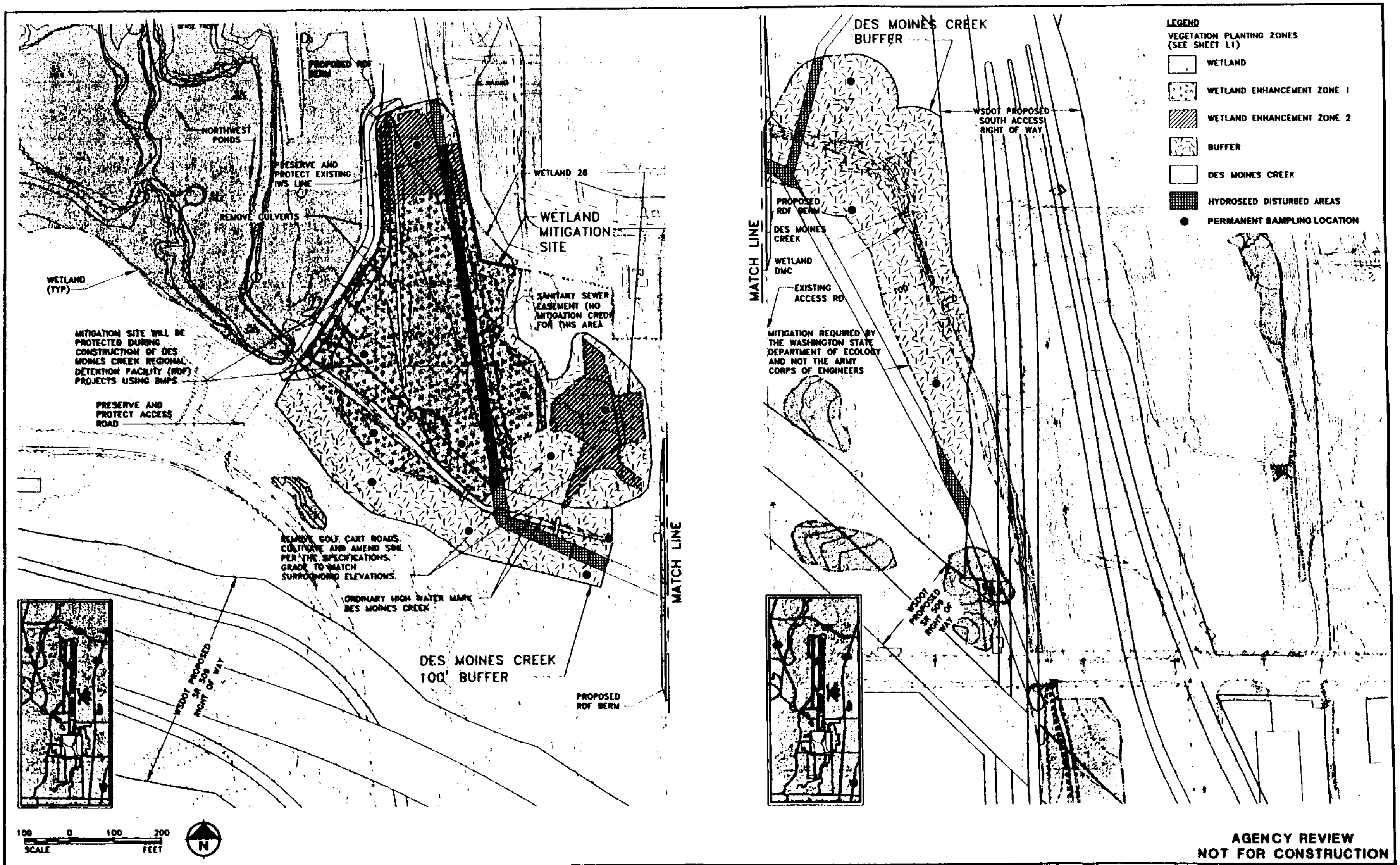
P. FORT
J. LEAVITT/S. UNRH
PJT/SRH
1"=150'
NOVEMBER 2001
-
P. FORT

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
PROJECT PLAN

C3490
291281C16
STIA-9806-C2

APPENDIX 9



AGENCY REVIEW
NOT FOR CONSTRUCTION

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Kirkland, WA 98033
Ph: (425) 822-8880
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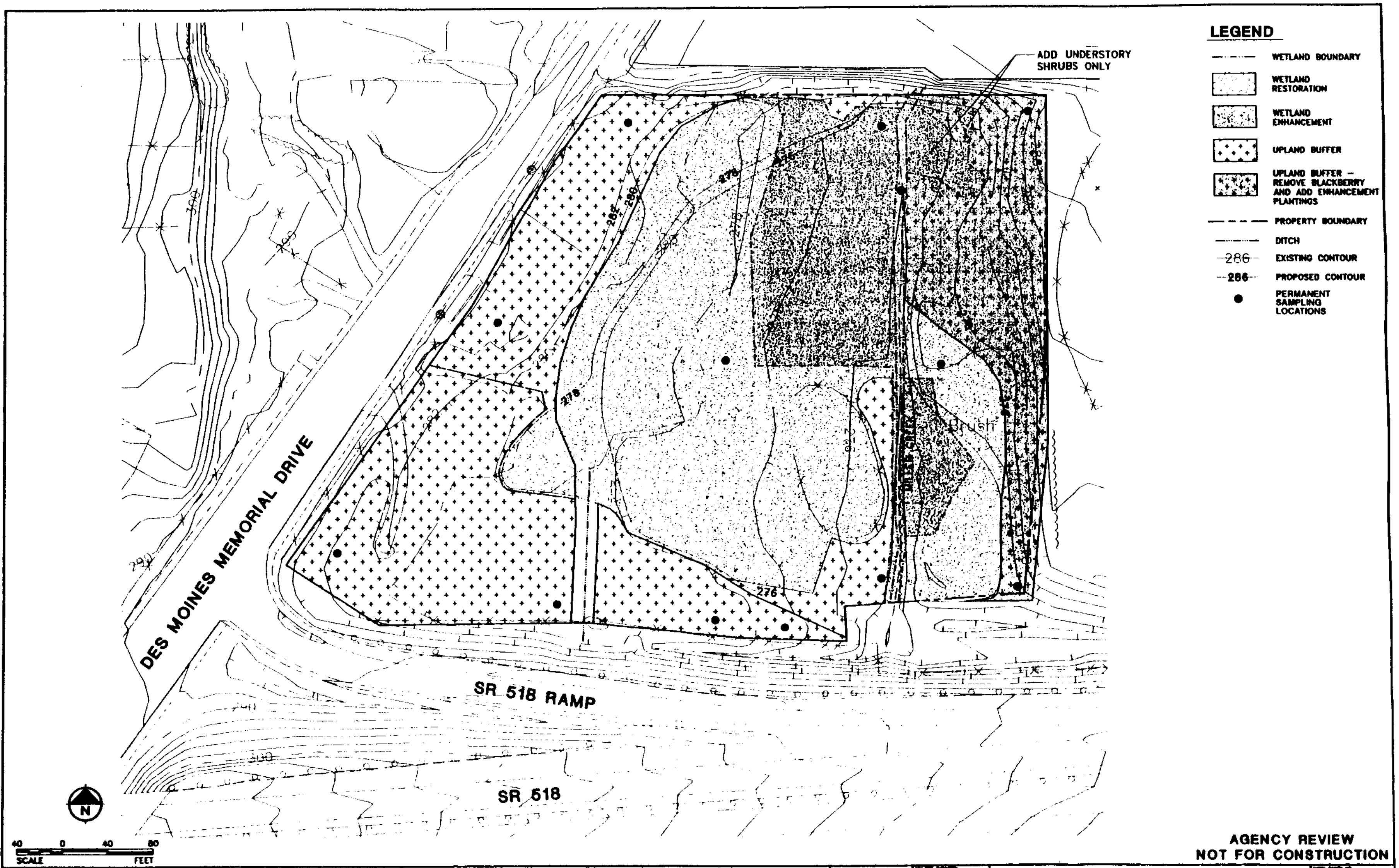
P. FOSTER
J. KELLEY
2/7/2001
1"=100'
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: TYEE VALLEY GOLF COURSE
WETLAND MITIGATION
SHEET TITLE: **PLANTING PLAN**

291282C2
S714-XXXY C2



AGENCY REVIEW
NOT FOR CONSTRUCTION

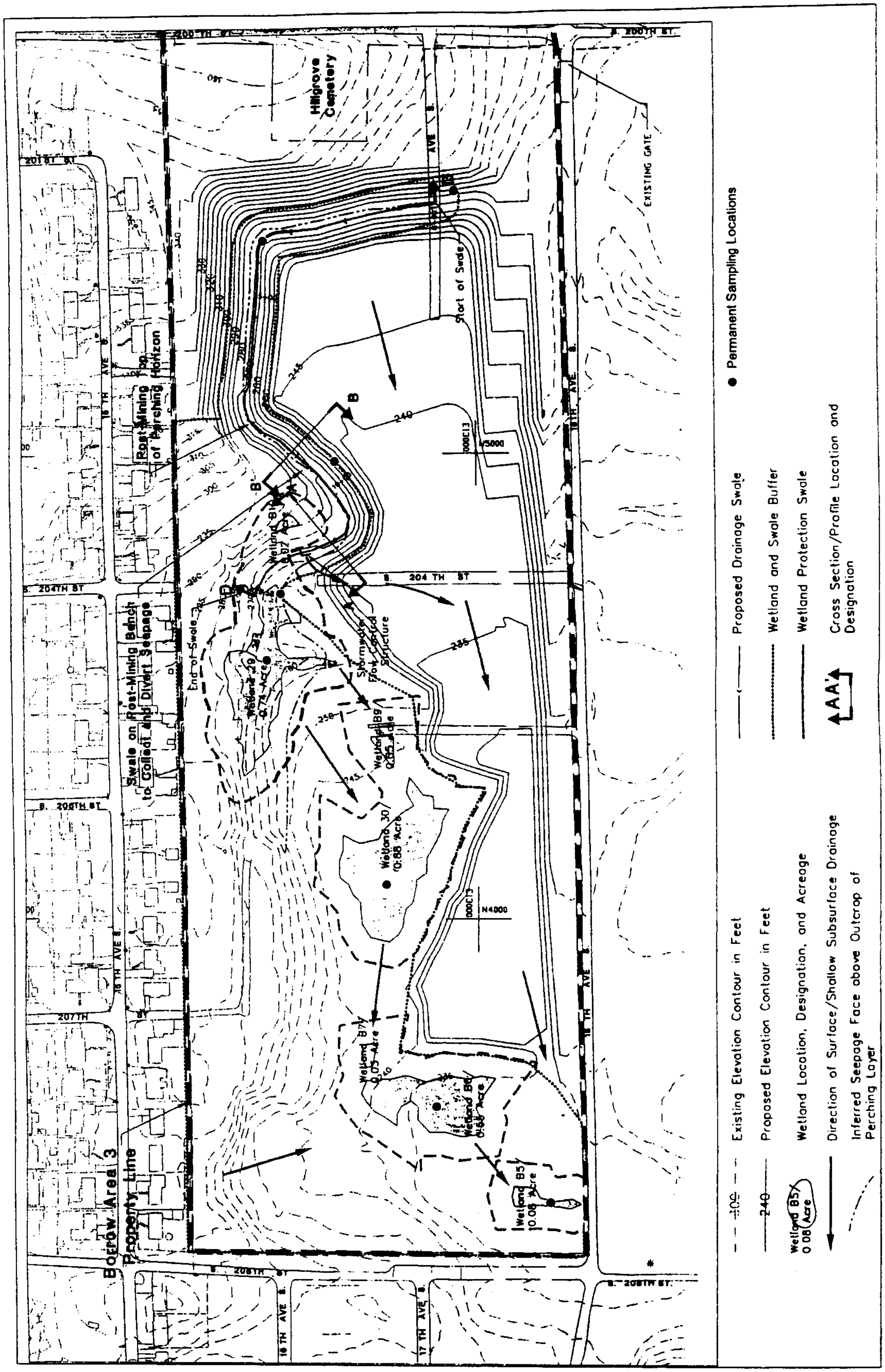
CALL 48 HOURS
BEFORE YOU DIG
1-800-424-5555

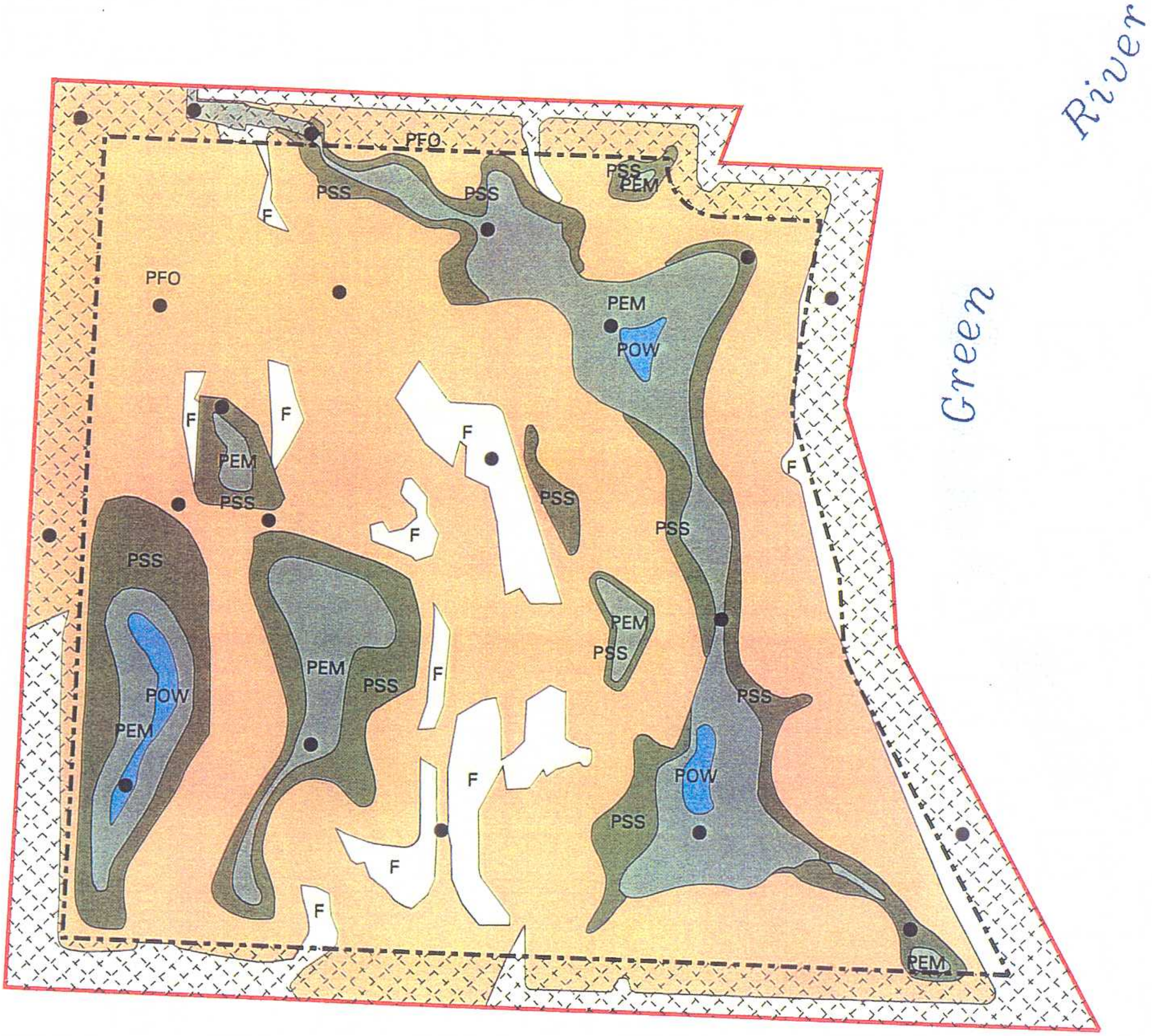
Parametrix, Inc.
5808 Lk. Washington Blvd. NE
Kirkland, WA 98033
Ph: (425) 822-8880
"Quality Service Through Employee Ownership"

P. FENDT
J. KELLEY
S. NEWELL
1"=80'
NOVEMBER 2001
J. HARRIS
P. FENDT

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
DES MOINES WAY
NURSERY WETLAND RESTORATION
LANDSCAPE PLAN

-
29120308L1
STIA-XXXX L1
APPENDIX 1


S. 200TH ST
Hillgrove Cemetery
EXISTING GATE
201ST ST
16 TH AVE S.
Post-Mining Top of Perching Horizon
Start of Swale
B
B'
240
245
Wetland B10 0.02 Acre
S. 204TH ST
S. 204 TH ST
Swale on Post-Mining Bench to Collect and Divert Seepage
End of Swale
Wetland 29 0.74 Acre
Stormwater Flow Control Structure
235
Wetland B9 0.05 Acre
S. 206TH ST
Wetland 30 0.88 Acre
N4000
N5000
E13000
207TH
Wetland B7 0.05 Acre
Wetland B6 0.68 Acre
Wetland B5 0.08 Acre
Borrow Area 3 Property Line
S. 208TH ST
16 TH AVE S.
17 TH AVE S.
18 TH AVE S.
Existing Elevation Contour in Feet
Proposed Elevation Contour in Feet
Wetland Location, Designation, and Acreage
Direction of Surface/Shallow Subsurface Drainage
Inferred Seepage Face above Outcrop of Perching Layer
Proposed Drainage Swale
Wetland and Swale Buffer
Wetland Protection Swale
Cross Section/Profile Location and Designation
Permanent Sampling Locations



Prepared by Parametrix, Inc. File: /s/projects/seatac_auburn/plotamls/plots/p8x11auburn_classes_fut2.gra Date: November 13, 2001

Sea-Tac/Auburn/556-2912-001/01(03) 11/01 (K)

N

Feet
0 150 300

🟧	Palustrine Forested (PFO)	☐	Forested Upland (F)
▨	Palustrine Scrub/Shrub (PSS)	☒	Buffer
▨	Palustrine Emergent (PEM)	●	Permanent Sampling Location
🟦	Palustrine Open Water (POW)	- - -	100-Foot Buffer
		🟥	Property Boundary

Wetland Vegetation Classes for the Wetland Mitigation Site

APPENDIX J

MILLER CREEK MITIGATION AREA – BUFFER AVERAGING ANALYSIS

APPENDIX J

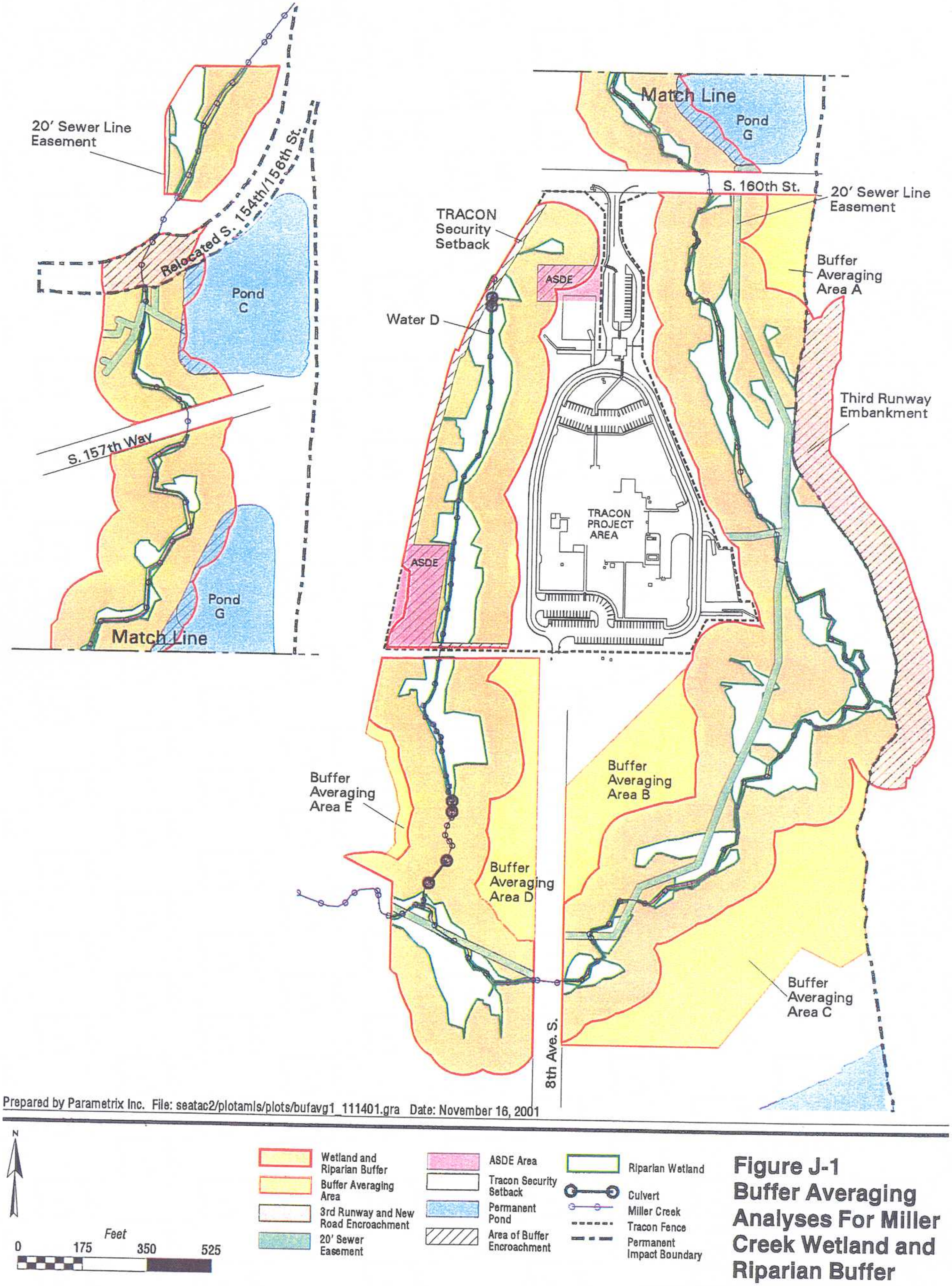
MILLER CREEK MITIGATION AREA - BUFFER AVERAGING ANALYSIS

This appendix contains a map and table showing how buffer averaging calculations were made to account for portions of the desired 100-foot buffers that could not be included in the mitigation area because of unavoidable conflicts with Master Plan Update or other projects that could not be reasonably relocated to avoid wetlands. The buffer averaging also accounts for utility and other easements that pass through mitigation areas. These easements are excluded from mitigation areas, restrictive covenants, and mitigation credits because they cannot be fully protected by the Port.

Table J-1 **Buffer Averaging Analysis for the Miller Creek Mitigation Area**[a]

Wetland and Riparian Buffer Impacts and Mitigation	Area (acres)
ENCROACHMENTS INTO WETLAND OR RIPARIAN BUFFERS	
Sewer line easement	1.71
Stormwater Ponds C and G	0.84
Runway Embankment and South 154/South 156th Street	3.95
ASDE Alternative Sites	0.93
TRACON Security Fence	0.55
	Total 7.98
BUFFER AVERAGING AREAS	
Area A	0.79
Area B	2.37
Area C	5.02
Area D	1.73
Area E	0.33
	Total 10.24
Excess Buffer Averaging Area	2.26

[a] Refer to Figure J-1 for the locations of these areas.



Prepared by Parametrix Inc. File: seatac2/plotamls/plots/bufavg1_111401.gra Date: November 16, 2001

Figure J-1 Buffer Averaging Analyses For Miller Creek Wetland and Riparian Buffer

APPENDIX K

REQUIREMENTS FOR COASTAL CUTTHROAT TROUT AND DESIGN CRITERIA FOR FISH HABITAT ENHANCEMENTS

APPENDIX K

REQUIREMENTS FOR COASTAL CUTTHROAT TROUT AND DESIGN CRITERIA FOR FISH HABITAT ENHANCEMENTS

INTRODUCTION

Stream channel mitigation planned at the Vacca Farm site, as explained in Section 5.1 of the National Resource Mitigation Plan (NRMP). A design criteria for fish habitat is to meet, to the degree feasible given stream and site constrains, is to meet the habitat requirements of coastal cutthroat trout (*Salmo clarki clarki*)[1]. This appendix discusses some of the basic habitat requirements of this fish and how the mitigation is designed to accommodate them.

Cutthroat trout are resilient and nearly ubiquitous in urban streams of the greater Seattle area (Muto and Shefler 1983; Lucchetti and Fuerstenberg 1992; Ludwa et al. 1997; Serl 1999). The habitat requirements of cutthroat trout are well documented and are similar to those of coho salmon (*Oncorhynchus kisutch*)(Glova 1978). Because cutthroat trout and possibly coho salmon use Miller Creek, their habitat requirements were used to develop design criteria for the Miller Creek Relocation and Instream Enhancement projects. Specific fisheries use of Miller Creek within the project area is discussed in Section 4 of the *Biological Assessment* (Parametrix 2000) and Section 5.1 of the NRMP.

REQUIREMENTS OF CUTTHROAT TROUT

Throughout most of the year cutthroat trout fry require low velocity shallow water that is associated with backwater pools, side channels, undercut banks, submerged tree roots or branches, logs, and the margins of pool and riffle habitats (June 1981; Trotter 1989; Giger 1972). In addition, juvenile cutthroat trout prefer water temperatures between 48° and 60° F (Wydoski and Whitney 1979; Trotter 1989; Heggenes et al. 1991; Flosi and Reynolds 1994). During periods of high flows and cold water temperatures, juvenile cutthroat use deeper, low velocity pools or stream substrate. Under these conditions, the young fish are torpid and seek cover under rocks and tree roots and in log jams (June 1981; Trotter 1989; Flosi and Reynolds 1994).

Cutthroat trout also require summer cover, which can be provided by treetops, branches, and other small woody debris (June 1981; Flosi and Reynolds 1994). Cutthroat trout prefer to spawn in substrate that ranges from 5 to 25 mm (coarse sand to walnut-sized gravel) (Cramer 1940; Trotter 1989; Hall et al. 1997).

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[1] Cutthroat trout have not been observed in this section of Miller Creek. The restored channel and enhanced portions of the creek could be expected to support this species in the future.

DESIGN CRITERIA

The Miller Creek Relocation and Instream Enhancement projects have been designed to meet the habitat requirements of cutthroat trout and coho salmon within the limitations of stream hydrology, topography, and soil conditions in the area. The proposed channel depths (0.25 to 2.0 feet) and velocities (0.5 to 2.5 feet per second) reported in the *NRMP* are expected to meet habitat requirements for fry and juvenile trout. Log weirs, large woody debris, and root wads are included in the design to create habitat diversity, provide cover, and create low-velocity pools.

A mixture of coarse sand and small gravel in the range required by cutthroat trout will be placed in the relocated channel and in the enhancement project areas. Although the quality of spawning substrate may be reduced if fine sediments accumulate (Waters 1995) channel widths were designed to maintain velocities that prevent fine sediment deposition in spawning areas. In addition, log jams that develop pools usually improve spawning reaches by trapping gravel, and creating hydraulic conditions that keep fine sediment in suspension (Flosi et al. 1998).

In addition to instream enhancements, the riparian corridor will also be enhanced. Flosi and Reynolds (1994) recommended that the riparian canopy should cover approximately 80 percent of the stream channel to maintain suitable water temperatures and to provide insect or other organic matter inputs. The Miller Creek Relocation and Instream Enhancement projects are designed to provide a multi-storied riparian area to provide shade, woody debris, and organic nutrients to the stream.

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APPENDIX L

GROUNDWATER AND VEGETATION MONITORING FOR INDIRECT IMPACTS

APPENDIX L

GROUNDWATER AND VEGETATION MONITORING FOR INDIRECT IMPACTS

The hydrology, vegetation, and soil conditions in wetlands located near Seattle-Tacoma International Airport (STIA) Master Plan Update improvement areas will be monitored during a 15-year post-construction monitoring period. This appendix summarizes the hydrology data collection effort undertaken by the Port of Seattle to monitor the site. Monitoring well locations and data collected to date are presented. Methods for sampling vegetation as part of the monitoring program are also explained.

INTRODUCTION AND BACKGROUND

At the request of the regulatory agencies, Parametrix began collecting hydrologic data in the downslope wetlands in February 2001. At that time, monitoring consisted of monthly measurements of the depth from the ground surface to the shallow water table in hand-dug holes, as described in wetland delineation procedures (Environmental Laboratory 1987). Measurements of soil saturation were also taken because, as a result of capillary action, soil saturation extends above the water surface. In April 2001, the U.S. Army Corps of Engineers (ACOE) requested that additional monitoring sites be established and these sites were added to the sampling effort.

In September 2001, Washington State Department of Ecology (Ecology) issued the 401 Water Quality Certification (Ecology 2001). The Certification outlines several requirements for monitoring at the site, and specifically states the following requirements in permit Condition D 1:

g. *The Port shall monitor hydrologic conditions of all wetlands downslope of the Third Runway embankment in the Miller, Walker and Des Moines Creek sub-basins. Hydrologic monitoring using piezometers and shallow hand dug soil pits in undisturbed wetlands downslope of the Third Runway embankment shall be conducted with sufficient frequency to determine wet season trends. The Port shall immediately begin conducting twice-monthly hydrologic monitoring during the wet season, November through May, and shall continue such monitoring for at least three (3) years after completion....*

j. *...The Port shall amend the monitoring condition in Table 5.2-12 to read: "Wetland indicator status (WIS) of the dominant noninvasive plant species shall not differ from pre-project conditions during or at the end of the monitoring period. Each vegetative strata (trees, shrubs and emergents) shall be assessed separately, and have separate conclusions. Statistically valid sampling procedures will be employed to monitor these potential changes, in all areas where there is a potential to change the post construction hydrology (down slope of the embankment, and the borrow sites). WIS status of the vegetation will be calculated as described in the 1987 ASACE or Washington State Department of Ecology delineation manuals."*

Performance standards based on comparisons of post-construction vegetation, soil, and hydrology data are more useful than simply comparing pre- and post-construction hydrologic data. This approach is free of the short-term variations and aberrant conditions to which groundwater levels and wetland hydrology are subject (Tiner 1999; Mitsch and Gosselink 2000). The hydroperiod within a particular wetland is not the same each year and can vary according to trends in recent rainfall (quantity and timing), antecedent soil moisture conditions, evapotranspiration rates and other factors. This variability is illustrated by the data presented in Table L-1 where the period of the wetland hydrology during spring months in a groundwater-driven wetland varies by as much as 60 days. Even in years with essentially the same amount of rainfall (Figure L-1, Table L-1), the hydrology parameter varied by as much as 30 days. Thus, relying solely upon hydrologic data to determine whether wetland conditions have been altered by the project is not a valid approach.

Table L-1. Cumulative precipitation and last date of observed wetland hydrology at monitoring Well 3 located at the off-site wetland mitigation project in Auburn.

	Cumulative Precipitation Since October 1				
Water Year	**March 31**	**April 30**	**May 31**	**Departure From Normal**	**Wetland Hydrology**
1995-1996	38.45	43.82	45.89	Above normal	To May 30
1998-1999	41.53	43.02	45.14	Above normal	To May 15
1996-1997	38.11	42.43	44.4	Above normal	To June 15
1999-2000	28.76	30.24	34.00	Normal	To May 15
1997-1998	26.81	27.8	29.78	Somewhat below normal	To April 15
2000-2001	16.28	19.44	20.83	Much below normal	To May 15

Note: The date reported for wetland hydrology is the date in the spring when the depth from the ground surface to the water table exceeded 12 inches, such that the wetland hydrology criteria were no longer met. This wetland lacks hydrology from the reported date until sufficient fall rains once again result in saturated soils. (The date in the fall at which groundwater is again present is also variable, and typically occurs in late November or early December (see Figure 7.2-6) of the NRMP. Precipitation data for STIA is presented in Attachment A.

More importantly, with hydrologic data, there are no scientific standards that could be used to establish an impact threshold[1], and even if there were such standards, it would take many years of post-construction measurements to statistically establish that post-construction conditions were the same or different from pre-construction conditions. While impact criteria for stormwater discharge-related changes to water depths have been developed for the wetland depressions that impound surface water,[2] they have not been developed for the slope wetland or riparian wetland classes that occur at STIA. Since the studies did not measure changes to plant vigor or other factors with respect to hydrologic conditions, and failed to measure groundwater conditions, they cannot be used to evaluate any potential change in groundwater conditions in slope or riparian wetlands.

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[1] See discussion on page 138 in B.Wheeler (1999).

[2] See page 87 of *Wetlands and Urbanization* (Azous and Homer 2001). Because groundwater, not surface water is the controlling hydrologic variable in slope wetlands, it is noteworthy that these studies have only measured surface water conditions. They provide no information relating variations in groundwater conditions to vegetation or vegetation impacts.

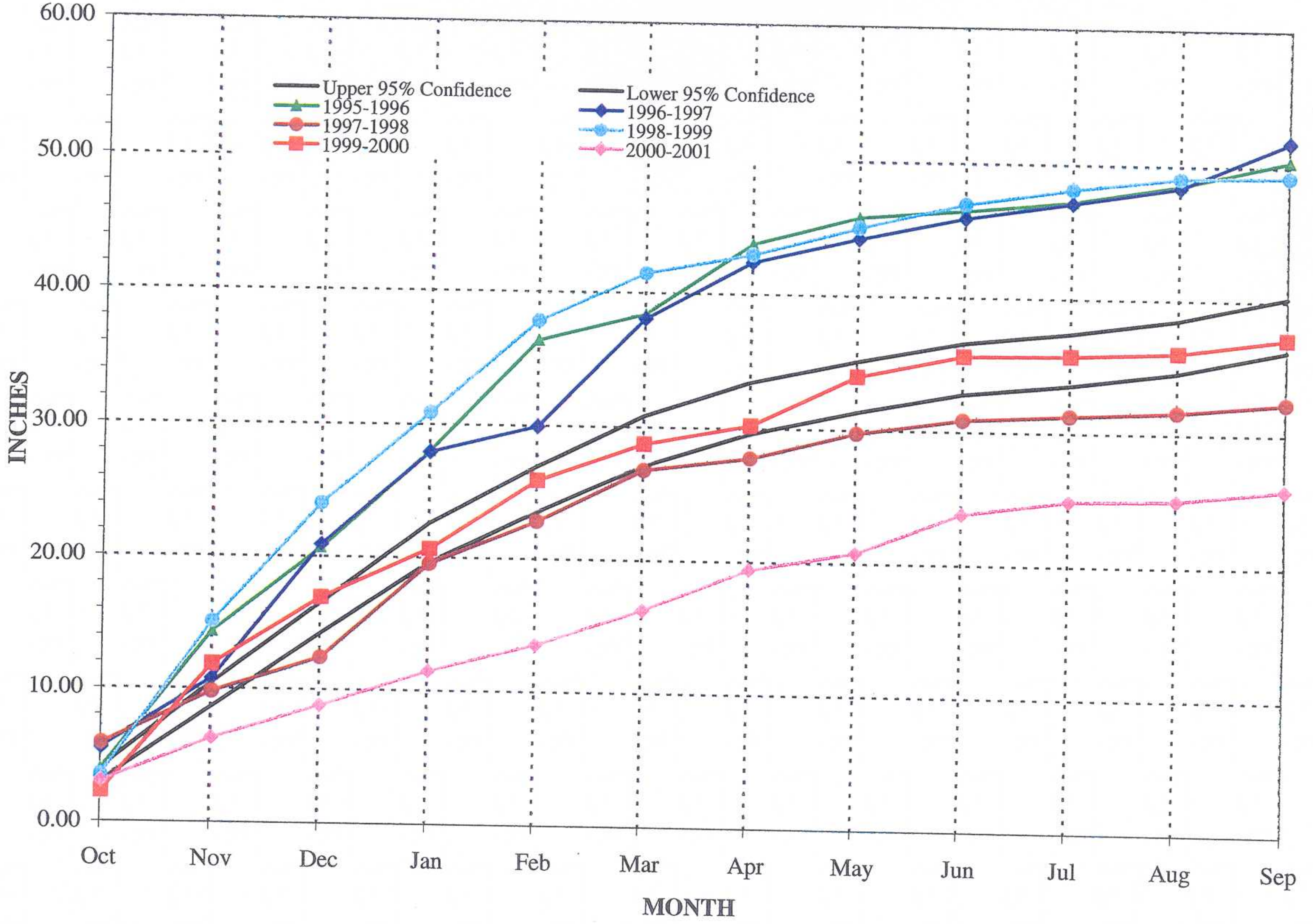

Figure L-1. Cumulative precipitation by water year at STIA.

11/14/2001

Data collected from hydrologic observations can be related to the wetland indicator status of wetland plants, the information on vegetation tolerance of various hydrologic regimes, and the intensity of reducing soil conditions (i.e., iron reduction [creating mottled and gleyed soil colors] or organic matter accumulation). This analysis provides insight into the long-term hydrologic regime under which the wetland has developed, and the nature of any ecological changes that may occur. It provides an objective methodology for determining whether post-construction hydrology can reasonably be expected to continue to support the wetland soils and vegetation. If wetland soils and vegetation are maintained by wetland hydrology, the desired wetland functions will remain also.

The quantitative performance standards for downslope wetlands have been developed based upon observations of existing wetland hydrology, of soil types, and of the wetland plant communities present in these wetlands. The performance standards are as follows:

- The replacement channel shall be constructed to convey all storm events equal to or less than the 100-year, 24-hour design storm and seepage water collected by the embankment drainage layer and adjacent areas (permit Condition D 1 i).
- Wetland areas with predominantly organic soils (portions of Wetland 18, 37a, R14a, A14b, and 44a) will have soils saturated in the upper part to mid-June in years of normal rainfall.
- Other wetlands with predominantly mineral soils shall have groundwater within the upper 10 inches from at least March to mid-April in years of normal rainfall (permit Condition D 1 k).
- The wetland indicator status of the dominant non-invasive plant species shall not differ from pre-project conditions during or at the end of the monitoring period. Each vegetation strata shall be assessed separately, and have separate conclusions.

In addition to determining if the ecological conditions in the wetland have changed as described above, Condition D 1 h of the 401 Water Quality Certification requires a direct measurement of any change in wetland area that may be related to long-term changes in post-construction hydrology. Wetland boundaries adjacent to the embankment and borrow areas will be re-delineated at years 5, 10, and 15 following construction. These data will be used to determine if the wetland boundaries have changed over time, and to evaluate if additional mitigation is required as a result of any changes to wetland boundaries.

HYDROLGIC DATA COLLECTION

The 401 Water Quality Certification requires that hydrologic conditions of all wetlands downslope of the Third Runway embankment in the Miller, Walker and Des Moines Creek subbasins be monitored with sufficient frequency to determine wet season trends. This section describes hydrologic data collection.

LOCATION OF HYDROLOGY MONITORING WELLS

Hydrologic monitoring wells were placed in wetlands located downslope of construction areas. The specific locations of these wells were established based on discussions and review by ACOE and Ecology staff. The monitoring locations include wetlands adjacent to the Runway Safety Area Extensions; wetlands between the Third Runway embankment and Miller Creek, between the SASA footprint and Des Moines Creek; south of the IWS lagoons; and adjacent to borrow site excavations (Figures L-2 and L-3). As part of geotechnical evaluations other hydrologic data have been collected in Wetlands 18 and 37.

WELL INSTALLATION

Installation of groundwater monitoring wells in the wetlands was conducted in accordance with a Clean Water Act Section 404 Nationwide Permit 5 (for scientific measuring devices) that approved installation of 50 shallow groundwater monitoring wells. Prior to well installation, data had been collected at sites in hand-dug soil pits, as described in wetland delineation methodologies (Environmental Laboratory 1987; Ecology 1997), using a shovel or 3-inch soil augur. The soil pits were excavated or bored to a depth of 18 inches.

In August and September 2001, shallow monitoring wells were installed to meet the following specifications:

1. Holes were hand augured to depths of approximately 2.5 feet using a 3-inch bucket or power augur.
2. A 6-inch layer of silica sand was placed in the bottom of the hole.
3. PVC pipe was inserted into but not through the sand.
4. Sand was back-filled around the pipe to within about 6 inches of the ground surface.
5. A 2-inch seal of bentonite clay was placed above the sand and wetted.
6. Grout was placed over the seal.
7. Soil and bentonite clay was mounded around the well to keep surface water from ponding immediately adjacent to the well.

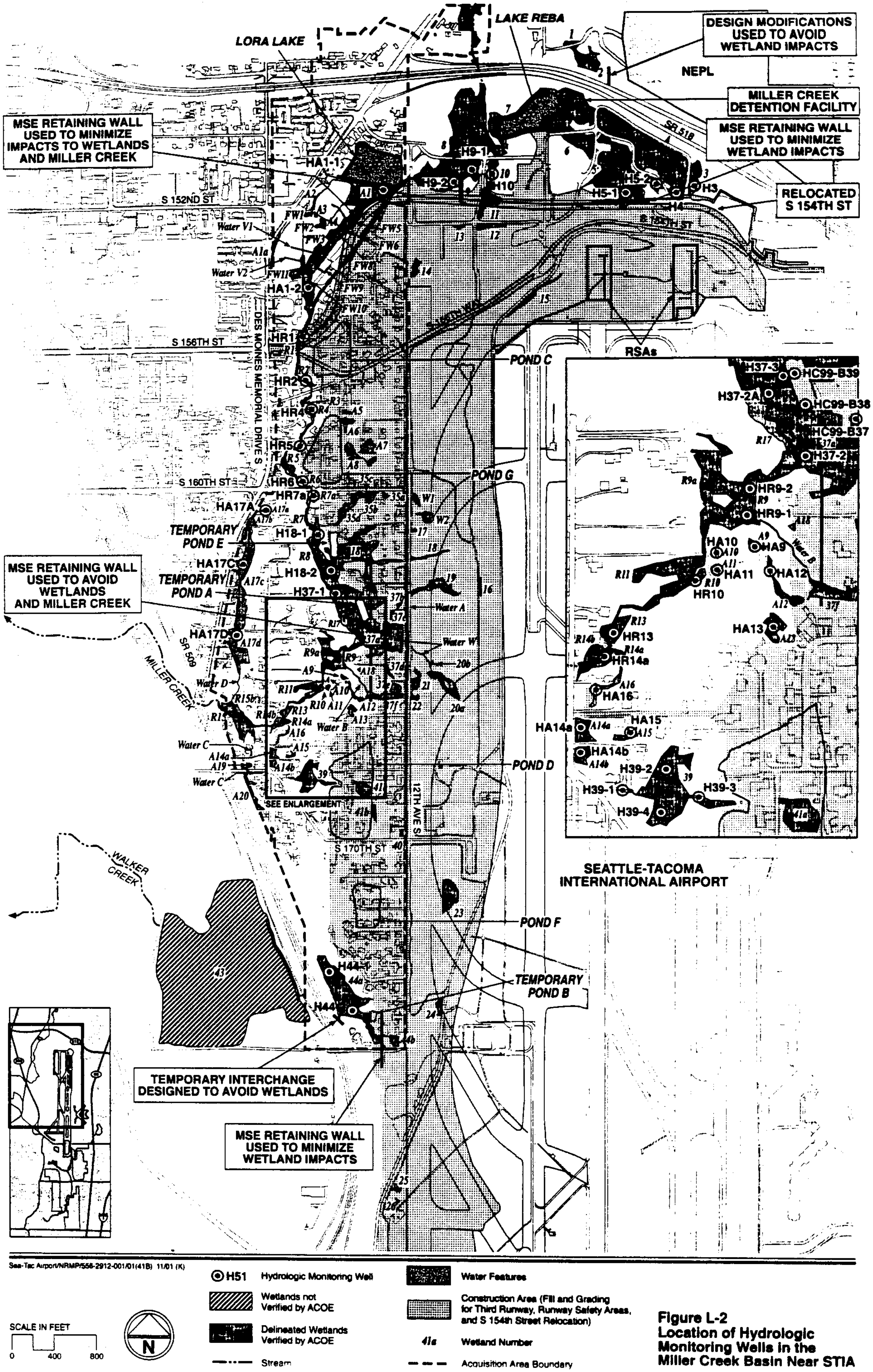

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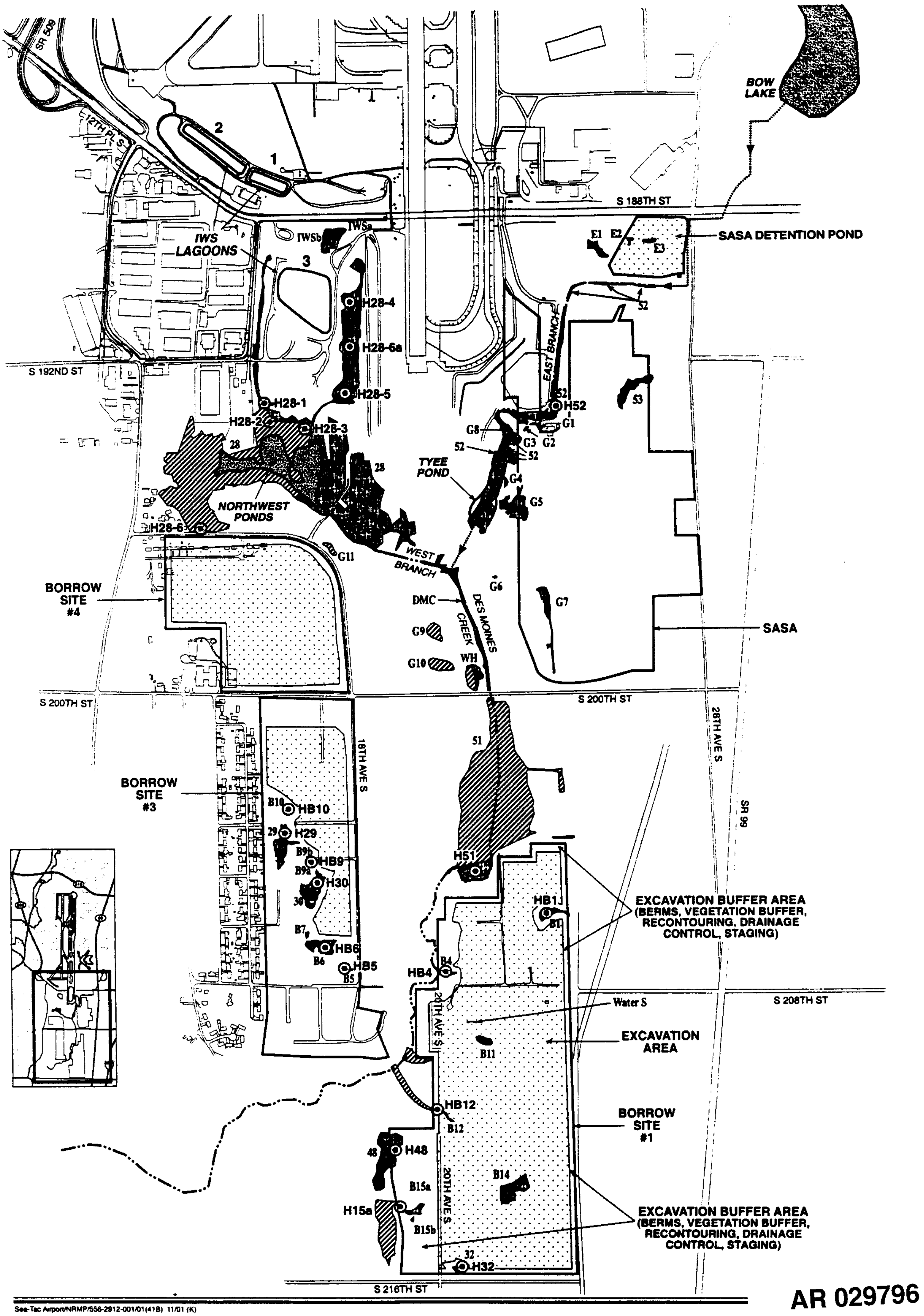
Figure L-2
Location of Hydrologic Monitoring Wells in the Miller Creek Basin Near STIA



Sea-Tac Airport/NRMP/556-2912-001/01(41B) 11/01 (K)

◎ H32 Hydrologic Monitoring Well

▩ Water Features

■ Delineated Wetlands Verified by ACOE

—··— Stream

⬚ Excavation Area

▨ Wetlands not Verified by ACOE

B12 Wetland Number

.... Piped Stream

SCALE IN FEET
0 400 800

N

Figure L-3
Location of Hydrologic Monitoring Wells in the Des Moines Creek Basin Near STIA

PRELIMINARY DATA

The hydrologic data collected from these wells are summarized in graphs in Attachment B. Groundwater data collected in support of geotechnical studies are tabulated in Attachment C. Data will continue to be collected and analyzed during and after project construction to identify potential hydrologic changes that may occur.

Since groundwater measurements are affected by short-term and seasonal trends in precipitation, precipitation data were collected from the National Weather Service STIA records. Daily precipitation data were cumulated for 7-day periods and graphed with groundwater measurements.

VEGETATION SAMPLING METHODS

The 401 Water Quality Certification requires that the wetlands downslope of the embankment and near borrow areas be monitored to determine if there is a change in wetland indicator status (WIS) of the dominant, non-invasive plant species. Specifically, the permit condition states that the wetland indicator status of the dominant, non-invasive plant species shall not differ from pre-project conditions during or at the end of the monitoring period. The condition specifies that each vegetation strata (trees, shrubs, and herbaceous species) be evaluated separately due to the different response times among strata. Each vegetative strata will be assessed separately and have separate conclusions.

Statistically valid sampling procedures will be employed to monitor the vegetation and evaluate if changes have occurred. The WIS of the vegetation will be calculated as described in Environmental Laboratory (1987) or Ecology (1997) wetland delineation manuals.

The Port will monitor vegetation in wetlands downslope of the embankment and near the borrow areas by establishing permanent line transects and using a point intercept sampling procedure along these transects to determine the aerial coverage of each species. Percent cover will be calculated as the number of points along the transect intercepted by a species, divided by the total number of measuring points taken along the transect multiplied by 100 (Elzinga et al. 1998). Tree, shrub, and herbaceous (graminoids, ferns/fern allies, and forbs) strata cover will be recorded separately.

SAMPLING OBJECTIVES

The sampling objectives were to determine if the WIS of dominant plant species change during the monitoring period. Future sampling will be conducted to determine if the WIS of dominant plant species differ from pre-project conditions during any year of the 15-year monitoring period. Finally, future sampling must be conducted to determine if the WIS of the dominant plant species differ from pre-project conditions at the end of the 15-year monitoring period. Wetlands included as mitigation for the projects included in the STIA Master Plan Update are being monitored separately, as described elsewhere in this mitigation plan.

For purposes of sampling, the wetlands were stratified into two types based on geomorphic position and dominant hydrology. The sampling groups are slope and riparian wetland types. In addition, sampling will be further stratified by the major differences in soil types present in the area, i.e., either predominantly mineral soil or predominantly organic soil.

Permanent line transects running perpendicular to the long axis of the wetland will be established in each wetland. Transects will be marked with rebar at both ends, and the GPS position of each end point will be recorded. Where transects are perpendicular to the long axis of the wetlands, sampling will take place along environmental gradients (e.g., slope, soils) that are related to wetland hydrology. Sampling along this gradient may reveal patterns in vegetation change related to position along the slope, and indirectly to any changes in hydrology.

MEASURING CANOPY COVER

Canopy cover will be recorded for all species along the transect using an optical sighting device. Every 5 feet along each transect a sampling point will be established and an optical densitometer will be used to determine if any tree, shrub and/or herbaceous species canopy intercepts that point. Species intercepting the point will be recorded. Species cover will be calculated as:

> Percent cover = number of points where species is recorded/total number of points on transect) x 100.

Plant species along each transect will be identified to species. For any species that cannot be identified in the field during sampling, a voucher specimen will be collected and identified using Hitchcock et al. (1969) or Hitchcock and Cronquist (1973). WIS will be assigned according to ACOE and Ecology wetland delineation procedures.

PERMANENT PHOTOGRAPH POINTS

Photographs will be taken of all transects. Photographs will be taken from each transect endpoint looking toward the opposite endpoint along the length of the transect.

SAMPLING SCHEDULE

Line transects were established and sampled in Wetlands 37 and 18 during October 2001. The remainder of the wetlands will be sampled in 2002. During the initial data collection period, sample sizes will be evaluated and adjusted to ensure adequate sample sizes for statistical comparisons among years (Elzinga et al. 1998; Sutherland 1996).

DATA ANALYSIS

For each wetland in each monitoring year, the data will be summarized by strata. Percent cover for each species in each strata will be calculated using the method described above. Dominant species in each strata will be identified using methods described in the ACOE wetland delineation manual (Environmental Laboratory 1987).

The WIS for all dominants species will be recorded. A weighted score for the WIS of the dominants species for each strata on each transect will be calculated using the method outlined in Atkinson et al. (1993). A wetland indicator score will be assigned for each WIS as follows:

Wetland Indicator	Frequency of Occurrence in Wetlands	Score
OBL	> 99%	1
FACW	66-99%	2
FAC	34-66%	3
FACU	1-33%	4
UPL	< 1%	5

For the dominant species in each strata, an average WIS for the transect will be calculated by summing the product of the wetland scores and relative abundance of each species, and dividing by 100 (Atkinson et al. 1993).

For each wetland, the WIS of all transects will be averaged by strata to get a mean WIS for each strata for each wetland. To determine trends in the vegetation, the mean WIS in a given monitoring year will be compared to the initial baseline monitoring year.

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ATTACHMENT A

MONTHLY CUMULATIVE PRECIPITATION

Attachment A Table 1. Monthly cumulative precipitation at STIA by water year.

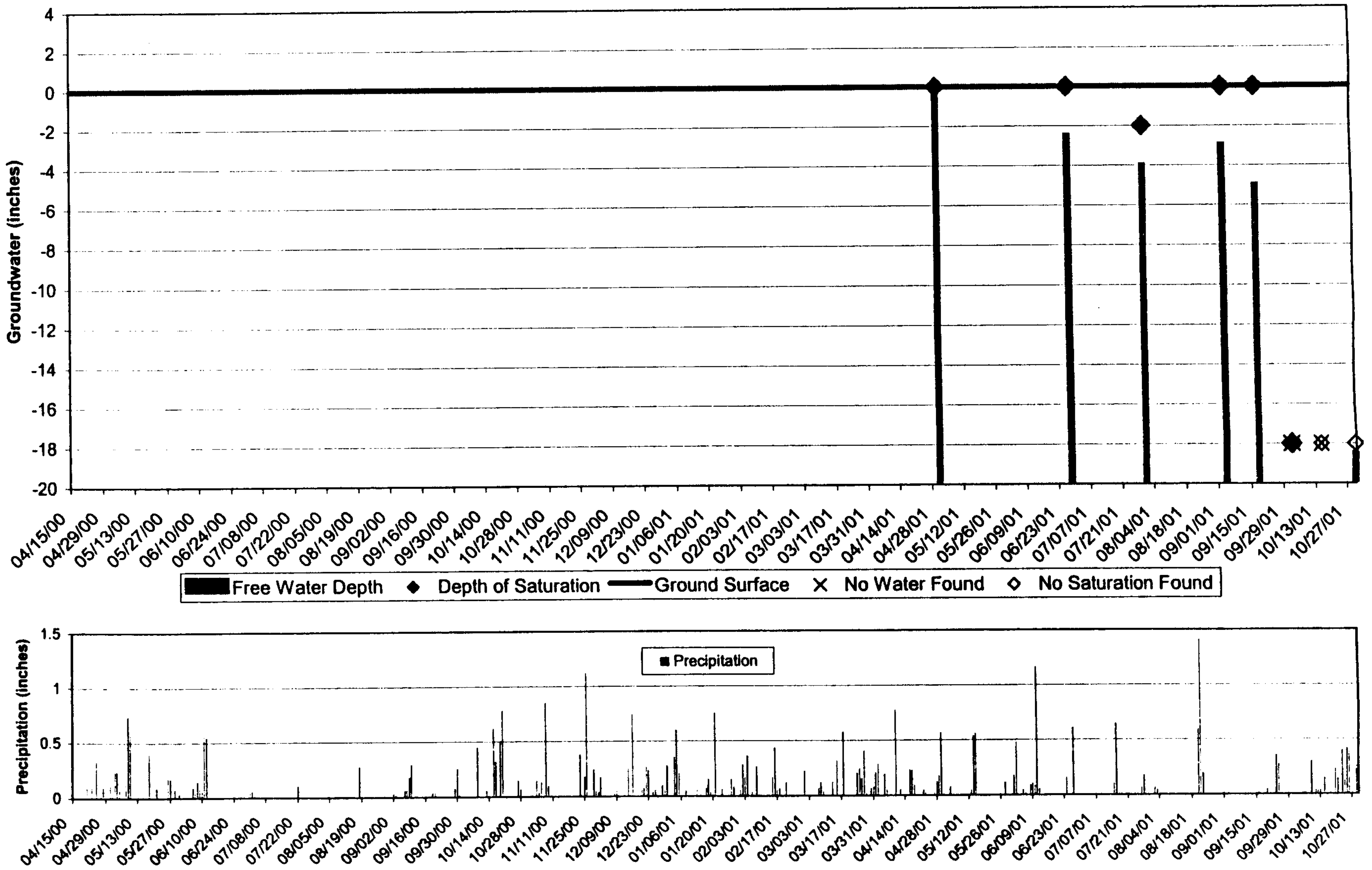
WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1949-1950	3.85	10.63	15.93	24.84	30.58	38.98	41.90	42.68	43.27	44.27	46.44	48.74
1950-1951	6.68	14.66	21.80	28.60	37.36	41.12	41.77	43.38	43.51	43.82	44.84	46.87
1951-1952	5.87	11.31	15.23	20.12	22.58	26.10	28.13	29.12	30.16	30.57	31.27	31.59
1952-1953	1.29	2.40	7.42	20.34	24.04	27.76	29.86	32.37	34.22	34.88	35.99	39.27
1953-1954	4.43	11.65	17.57	25.93	30.31	32.38	35.02	36.91	39.35	40.81	42.38	44.06
1954-1955	1.91	9.58	14.78	18.13	22.43	25.68	29.32	31.27	32.54	34.64	34.81	36.33
1955-1956	6.60	15.56	25.06	33.73	35.90	40.85	41.18	42.01	44.48	44.81	45.57	47.99
1956-1957	6.71	8.30	13.92	16.33	21.90	28.16	30.39	31.56	32.74	33.84	35.48	36.24
1957-1958	3.79	6.79	12.31	21.03	26.39	28.65	32.16	33.10	34.00	34.00	34.31	35.73
1958-1959	3.99	12.06	19.21	27.19	30.83	34.95	38.54	40.14	41.96	42.89	43.49	48.09
1959-1960	2.67	10.81	17.64	23.12	27.13	31.21	34.09	37.13	37.83	37.83	39.75	40.92
1960-1961	4.22	12.25	16.00	23.71	32.82	37.28	39.63	42.70	43.24	43.99	44.81	45.27
1961-1962	3.27	7.94	13.26	15.69	17.98	20.84	22.87	24.69	25.37	26.06	28.02	30.33
1962-1963	4.16	13.50	18.72	20.97	25.33	28.76	31.82	32.72	34.40	35.58	36.31	36.90
1963-1964	5.06	14.75	20.54	30.30	31.96	34.92	36.48	37.39	41.21	42.20	43.43	45.70
1964-1965	1.00	10.65	16.18	21.45	25.33	25.90	29.63	31.26	31.85	32.23	34.41	34.90
1965-1966	2.76	7.74	14.84	20.27	22.58	26.96	28.95	30.30	31.45	32.80	33.22	34.99
1966-1967	2.92	9.77	18.08	27.40	30.12	33.83	36.33	36.71	38.75	38.76	38.78	39.72
1967-1968	6.66	9.22	13.94	20.84	26.92	32.00	33.33	35.00	38.02	38.85	43.43	45.36
1968-1969	4.32	10.18	18.73	24.44	27.60	29.80	33.25	36.18	37.09	37.36	37.81	43.38
1969-1970	1.19	3.40	9.08	17.30	19.56	22.72	26.03	27.20	27.63	28.11	28.43	30.66
1970-1971	2.52	7.55	15.83	21.15	25.51	32.63	35.02	36.45	38.73	39.41	39.98	43.49
1971-1972	3.57	8.88	15.55	22.79	30.90	37.64	41.76	42.45	44.26	45.60	46.73	50.83
1972-1973	0.72	4.10	13.08	17.37	19.26	20.88	22.23	23.83	26.33	26.41	26.68	28.49
1973-1974	3.31	11.30	19.63	27.41	31.42	37.26	39.65	41.02	42.27	43.78	43.79	44.00
1974-1975	1.99	7.05	13.50	19.51	25.31	28.18	30.67	31.80	32.64	32.91	37.50	37.50
1975-1976	7.75	12.82	20.48	26.03	30.77	33.48	35.15	36.76	37.39	38.56	41.27	42.52
1976-1977	2.06	2.80	4.66	6.43	8.01	11.81	12.36	16.06	16.60	17.02	20.61	23.16
1977-1978	2.60	7.87	14.34	18.64	22.23	24.66	28.85	30.64	31.39	32.79	33.98	39.93
1978-1979	0.98	7.03	8.40	10.65	15.97	17.52	18.33	19.21	19.67	20.40	21.42	23.49
1979-1980	3.38	5.32	17.17	21.26	26.30	28.40	31.63	32.60	34.37	34.83	35.47	36.90
1980-1981	1.32	8.48	15.87	18.29	22.74	24.97	26.55	27.88	30.19	31.57	31.82	35.24
1981-1982	6.40	10.47	16.03	21.38	28.95	32.68	34.75	35.38	36.41	37.00	37.62	39.11
1982-1983	4.07	9.38	16.24	23.31	27.88	31.69	32.75	34.85	36.70	39.09	40.99	42.84
1983-1984	1.34	9.31	14.33	17.95	21.86	25.77	28.64	32.02	34.83	35.00	35.13	36.14
1984-1985	2.14	10.23	15.18	15.76	18.39	20.95	22.25	23.10	25.90	26.00	26.55	28.53
1985-1986	5.74	10.00	11.78	20.32	24.73	27.40	28.78	30.49	31.17	32.27	32.37	34.26
1986-1987	4.21	12.19	15.86	21.84	23.89	29.42	32.03	34.41	34.57	34.96	35.25	36.16
1987-1988	0.31	3.52	9.63	13.70	14.41	18.16	21.36	24.37	25.93	26.43	26.71	28.46
1988-1989	2.24	10.67	14.15	16.93	20.36	26.15	28.95	31.73	32.87	33.51	34.40	34.94
1989-1990	2.98	9.11	13.90	23.31	27.03	29.61	32.15	34.13	37.18	37.76	38.47	38.52
1990-1991	5.79	16.50	20.13	24.59	29.28	33.94	40.47	41.86	43.15	43.43	45.60	45.60
1991-1992	1.31	6.64	9.95	17.77	20.86	22.54	26.66	26.78	27.92	28.81	29.47	30.62
1992-1993	2.45	8.02	12.11	16.20	16.55	21.35	25.89	28.75	31.23	32.50	32.66	32.69
1993-1994	1.54	3.74	8.22	10.73	15.20	18.37	20.64	22.07	23.32	23.60	23.90	25.59

Attachment A Table 1. Monthly cumulative precipitation at STIA by water year.

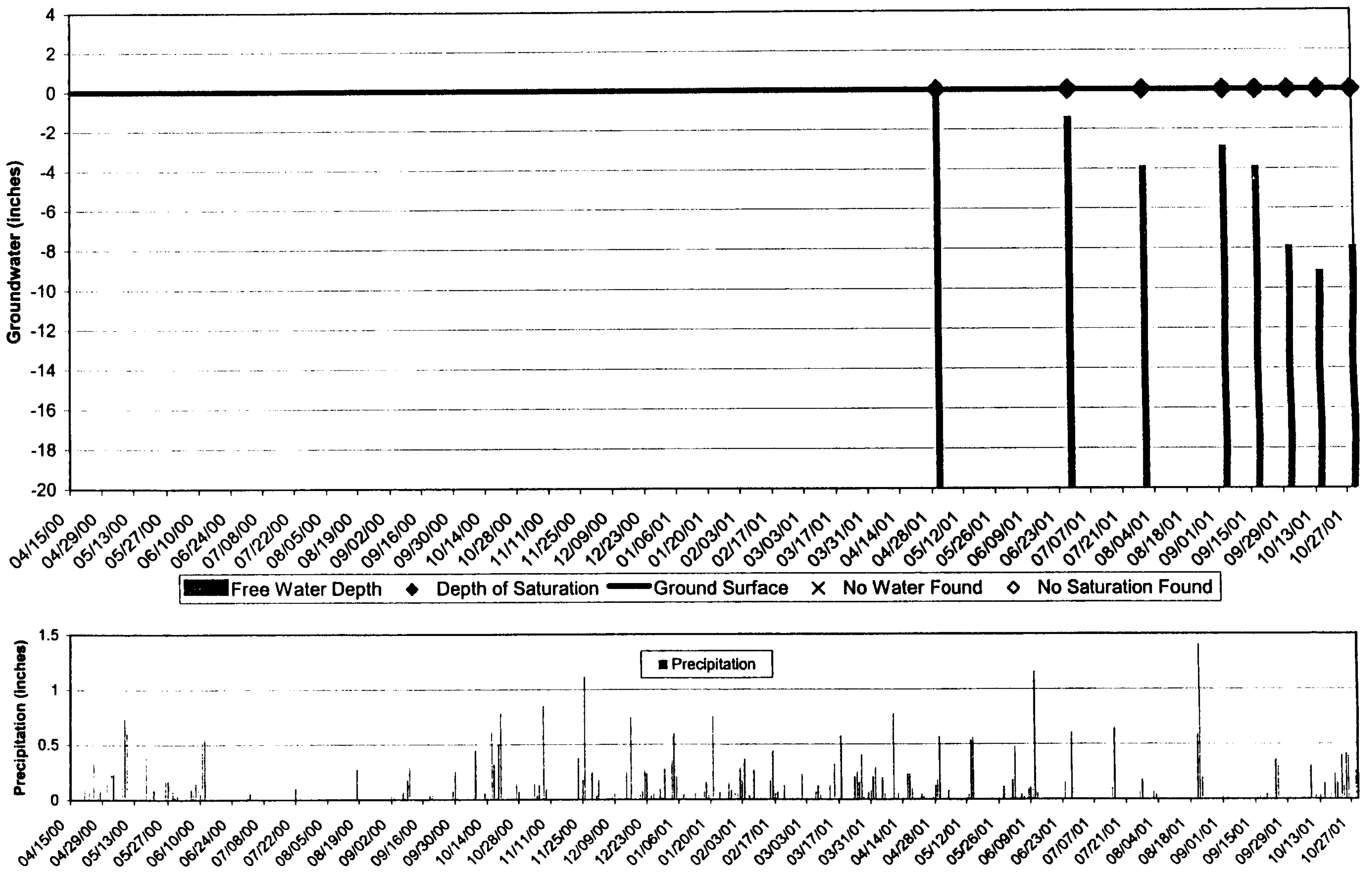
WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1994-1995	3.51	9.30	17.45	21.93	26.90	30.97	33.02	33.83	35.29	36.63	38.44	39.35
1995-1996	3.93	14.33	20.70	28.04	36.39	38.45	43.82	45.89	46.48	47.25	48.57	50.42
1996-1997	5.54	10.77	20.95	27.97	29.96	38.11	42.43	44.30	45.94	47.14	48.41	51.82
1997-1998	5.83	9.76	12.39	19.54	22.85	26.81	27.80	29.78	30.89	31.30	31.65	32.37
98-1999	3.48	15.10	24.08	30.92	37.87	41.53	43.02	45.14	47.00	48.18	49.10	49.27
1999-2000	2.26	11.86	16.92	20.69	25.94	28.76	30.24	34.00	35.65	35.75	36.08	37.20
2000-2001	3.00	6.27	8.78	11.48	13.55	16.28	19.44	20.83	23.88	24.95	25.10	25.95
# of records	52	52	52	52	52	52	52	52	52	52	52	52
MEAN	**3.49**	**9.49**	**15.34**	**21.07**	**25.21**	**28.95**	**31.50**	**33.20**	**34.68**	**35.45**	**36.51**	**38.24**
Std. Dev.	1.85	3.35	4.25	5.42	6.31	6.84	7.04	6.95	6.98	7.09	7.22	7.40
Confidence Value (0.05)	0.50	0.91	1.15	1.47	1.71	1.86	1.91	1.89	1.90	1.93	1.96	2.01
Upper C.I. (0.05)	**3.99**	**10.40**	**16.49**	**22.54**	**26.92**	**30.80**	**33.41**	**35.09**	**36.58**	**37.37**	**38.48**	**40.25**
Lower C.I. (0.05)	**2.99**	**8.58**	**14.18**	**19.60**	**23.50**	**27.09**	**29.58**	**31.31**	**32.78**	**33.52**	**34.55**	**36.23**

ATTACHMENT B

GROUNDWATER MONITORING CHARTS



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland 3, Well 3.



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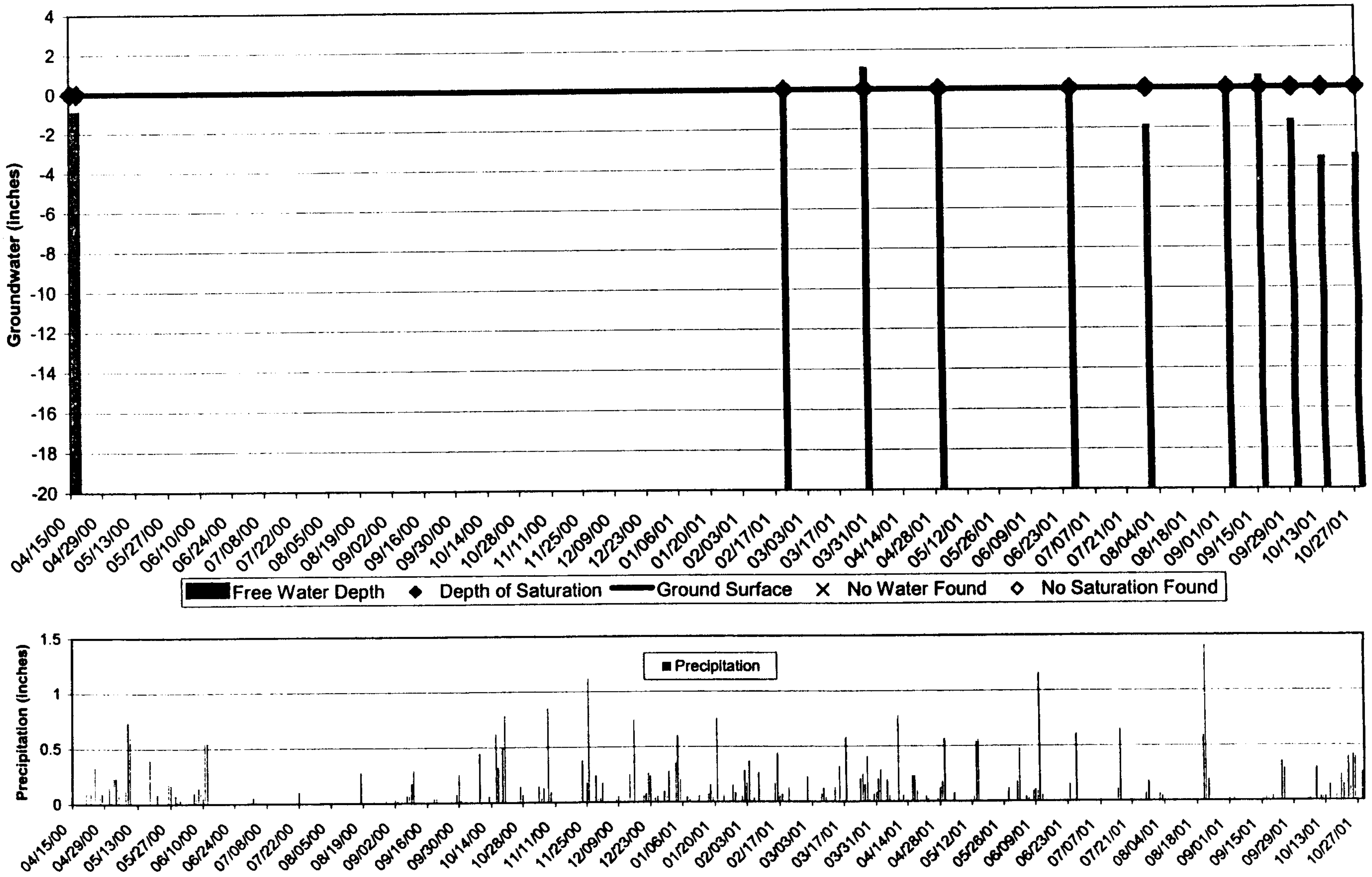

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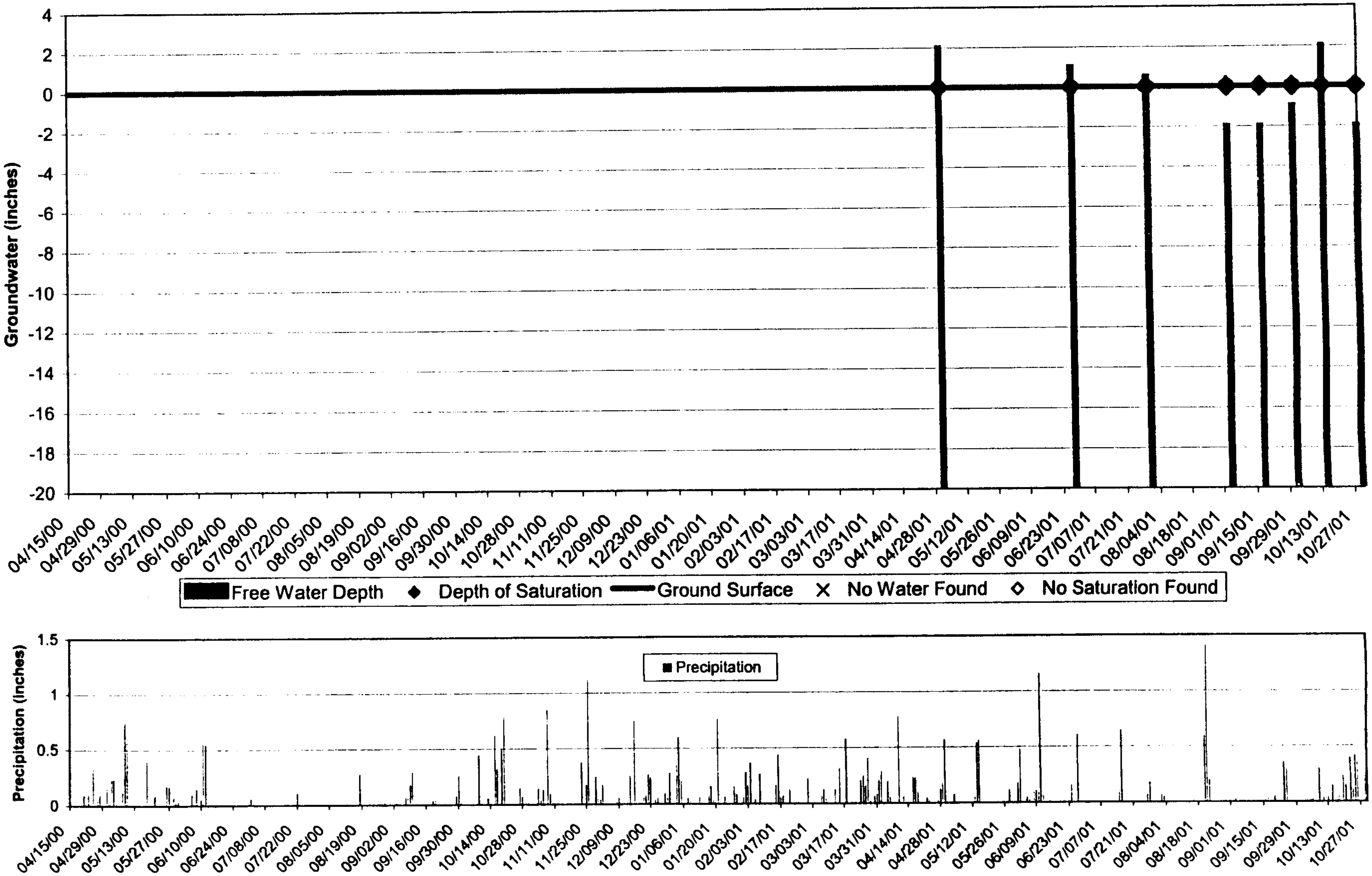

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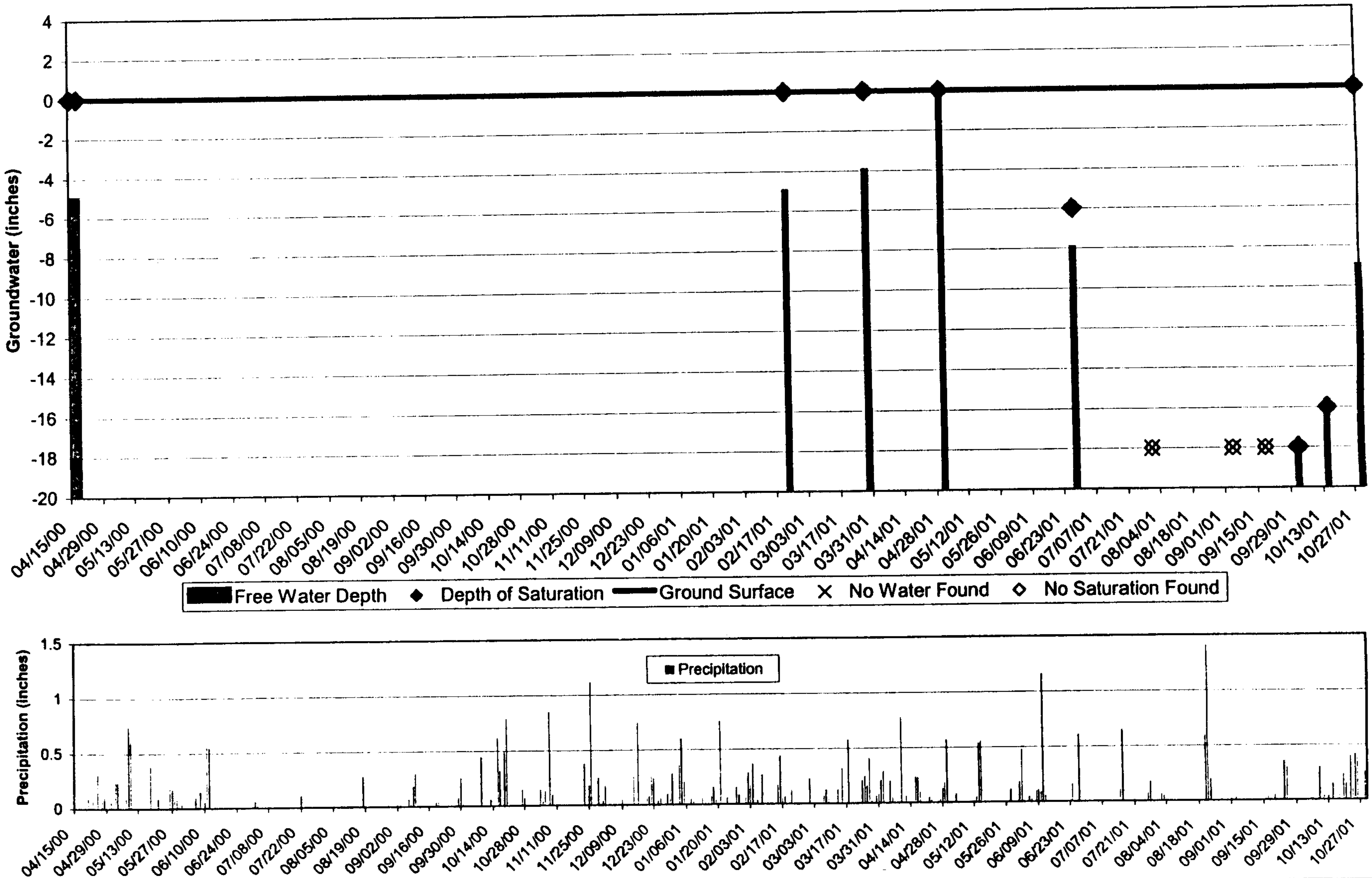

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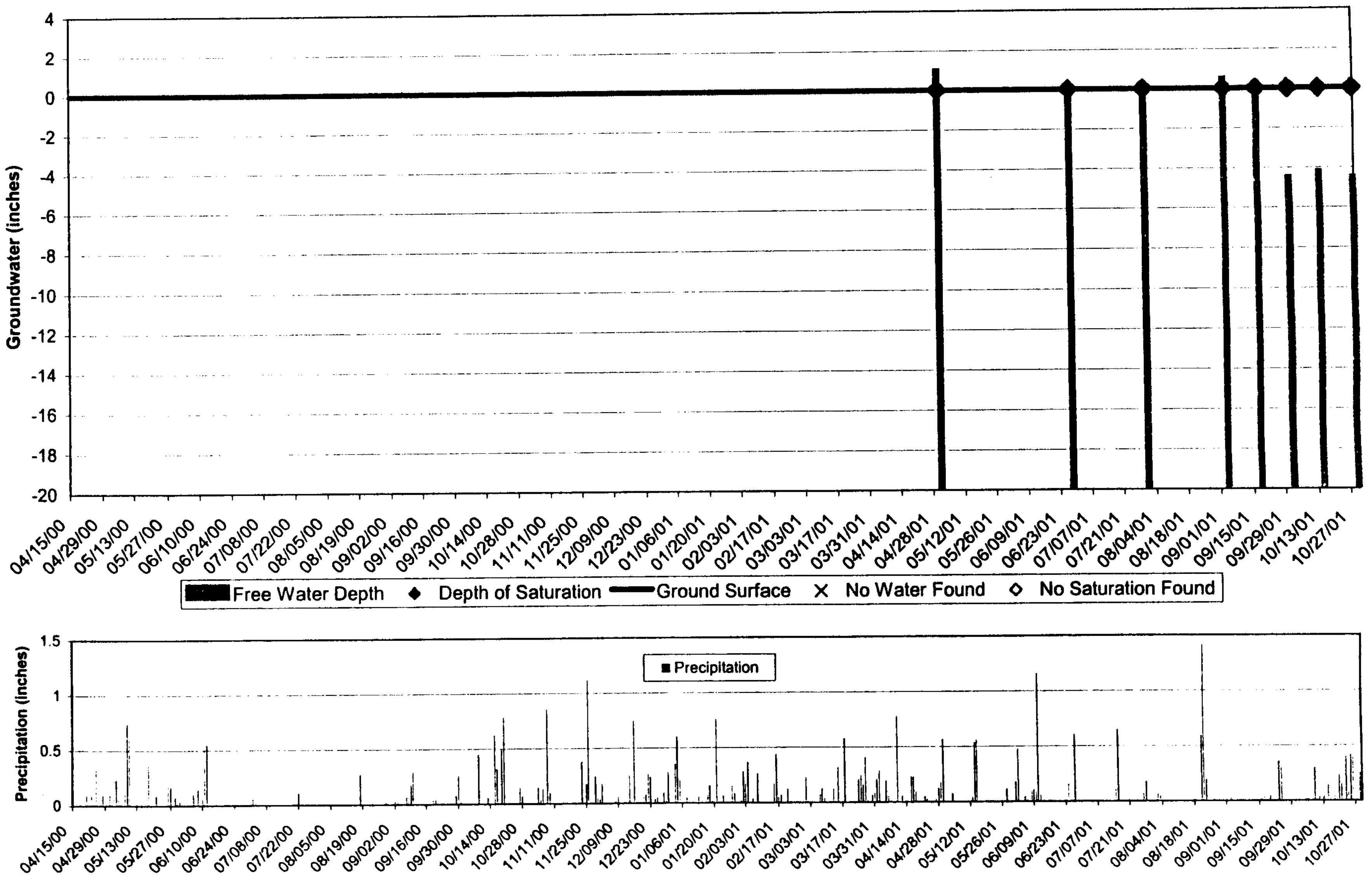

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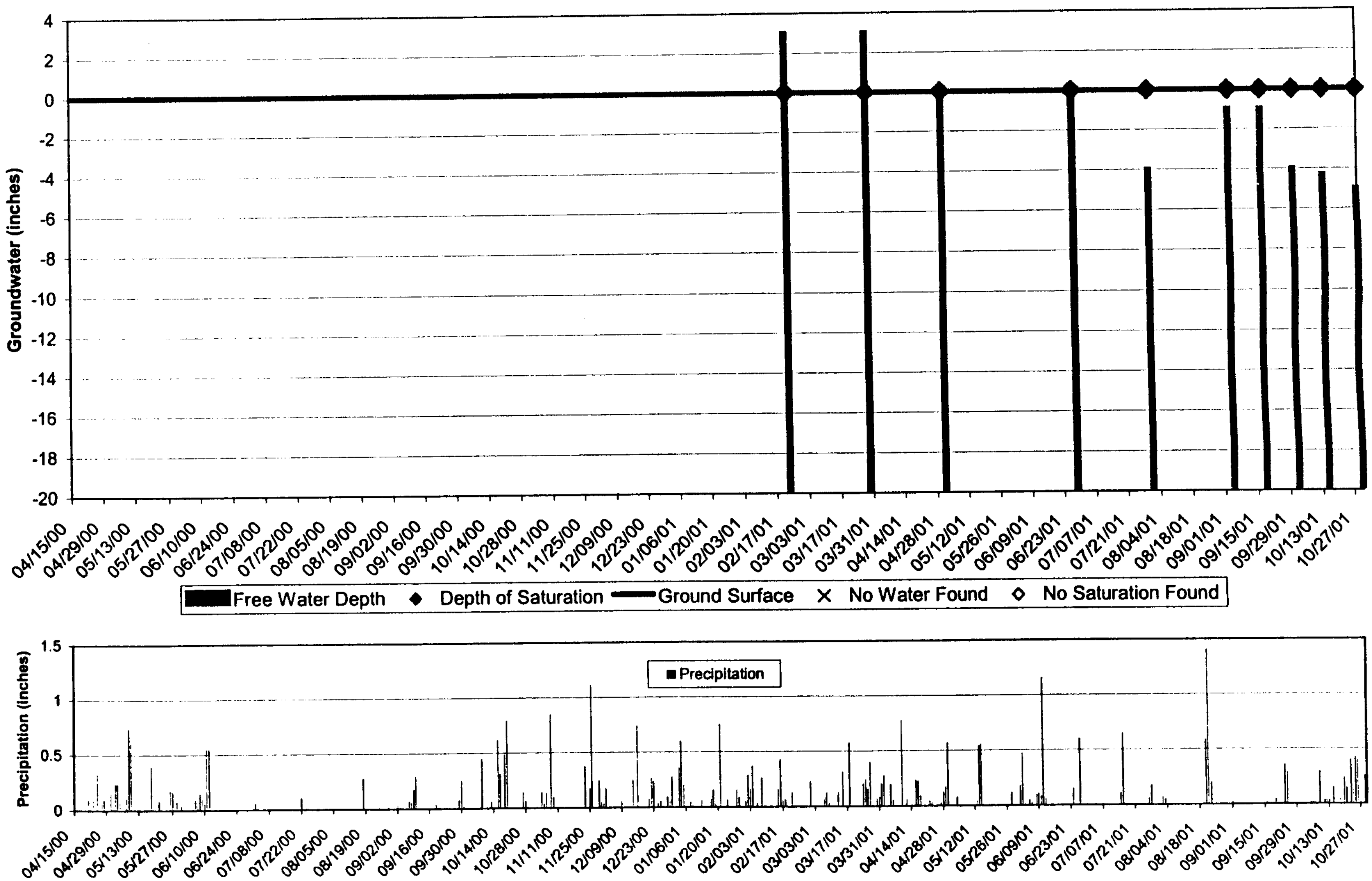

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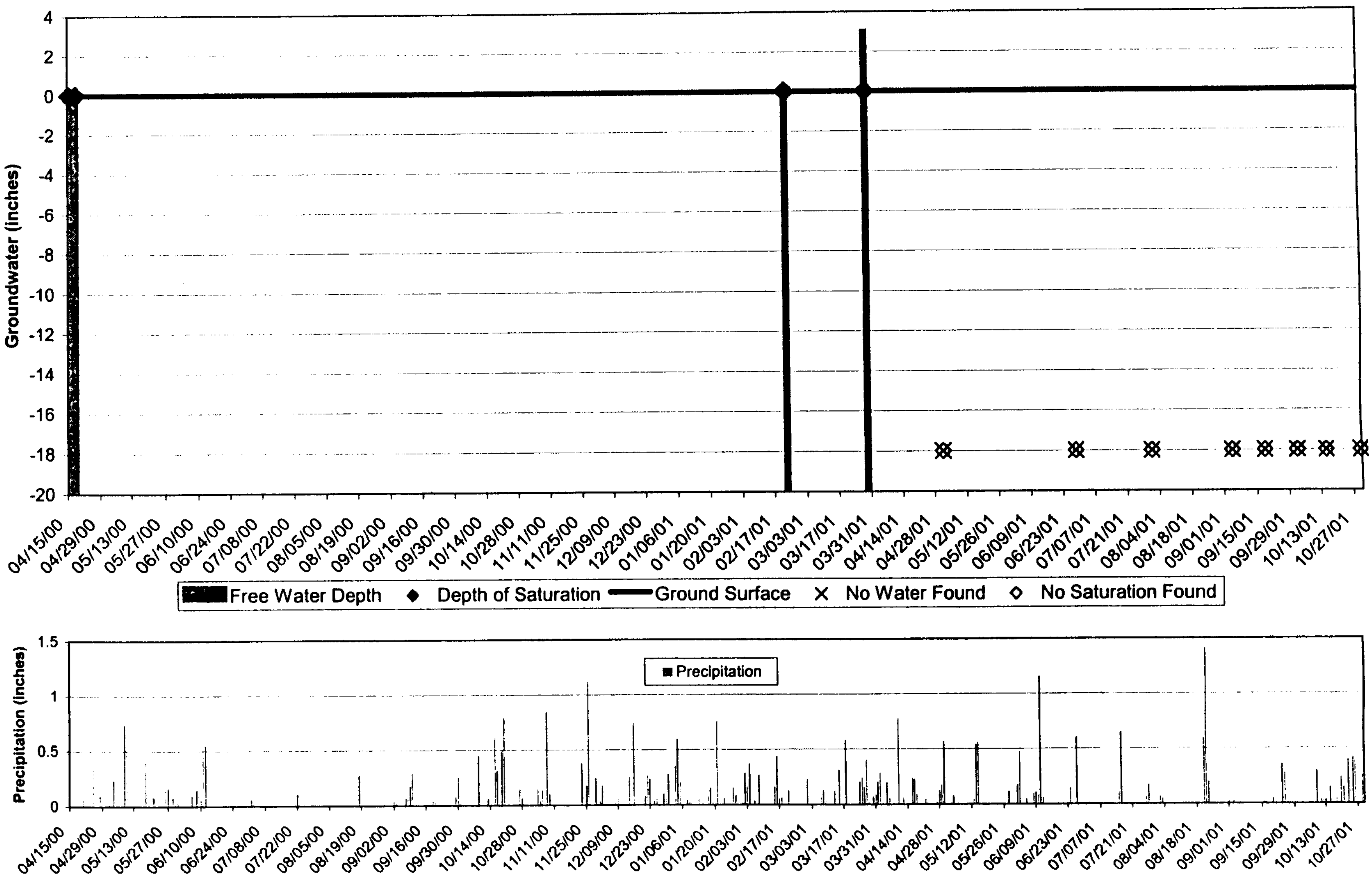

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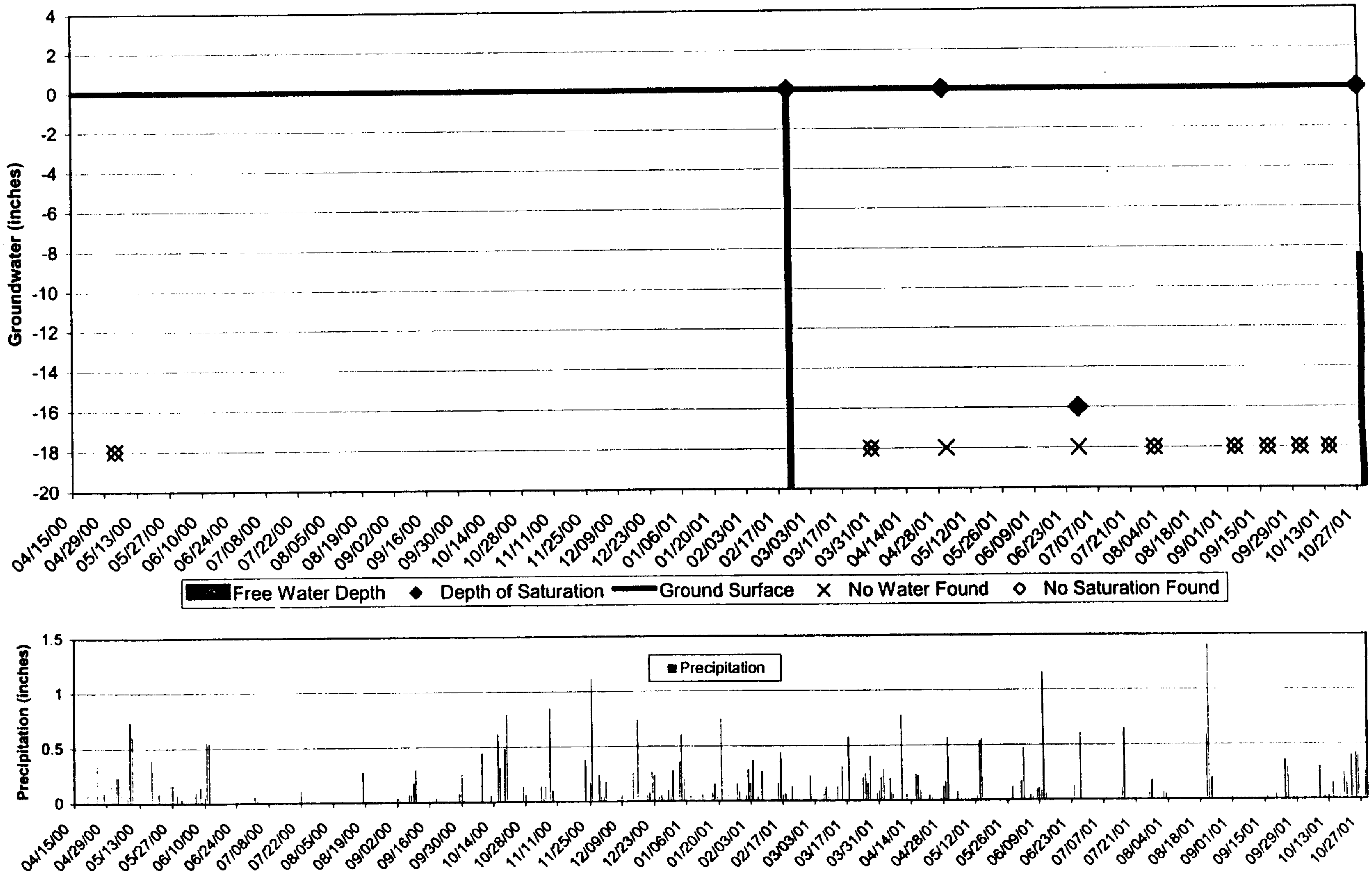

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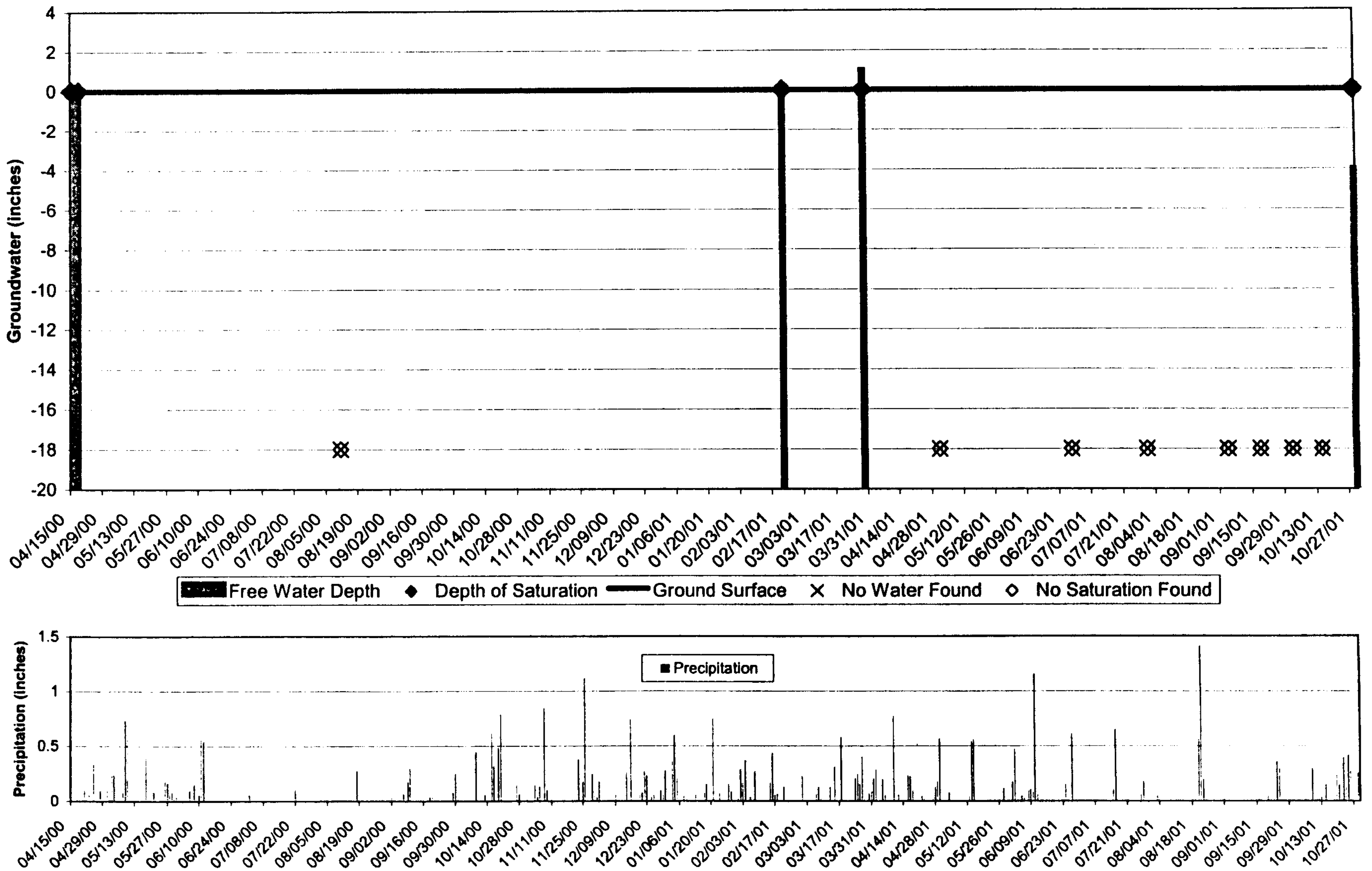

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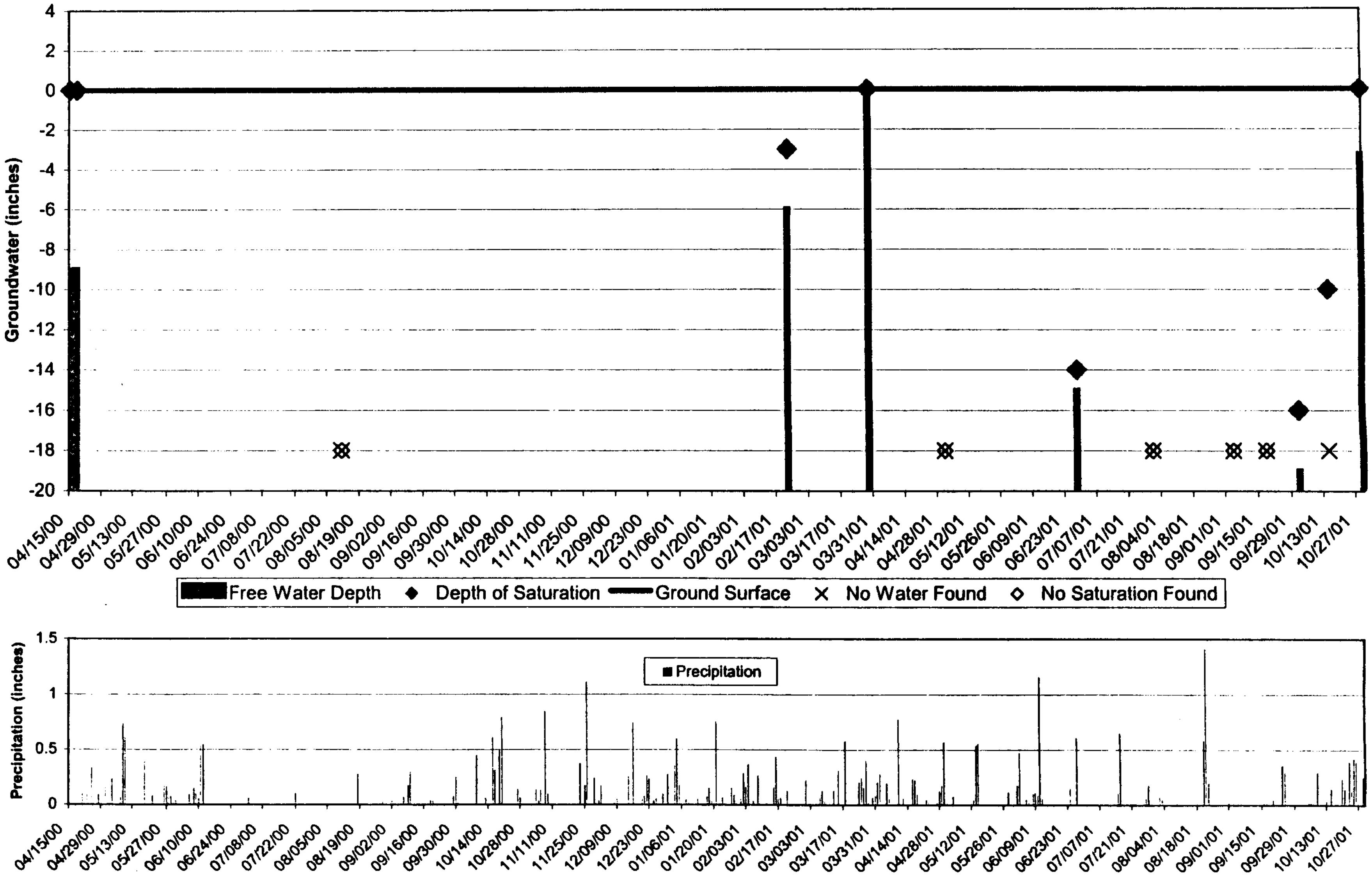

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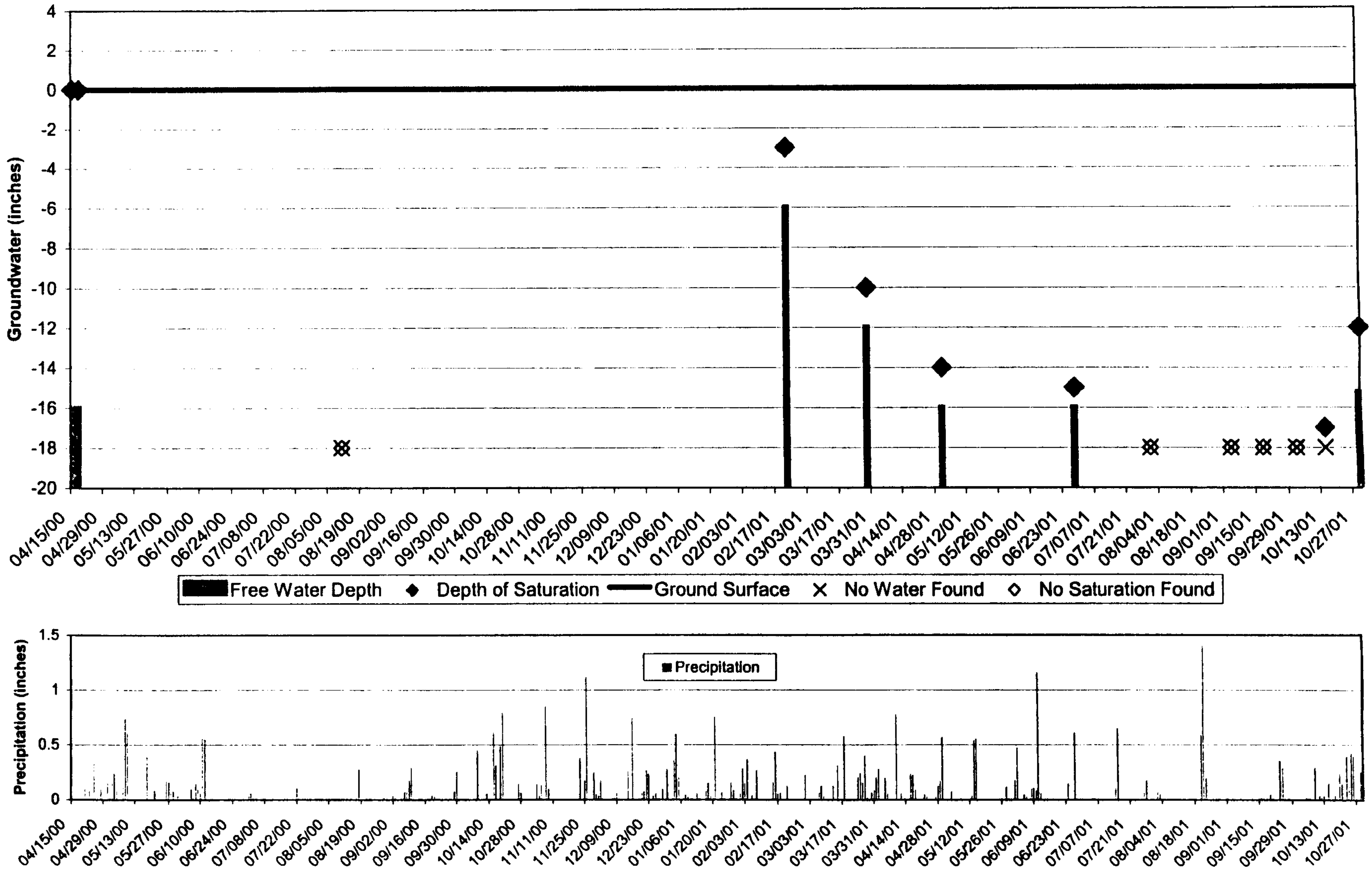

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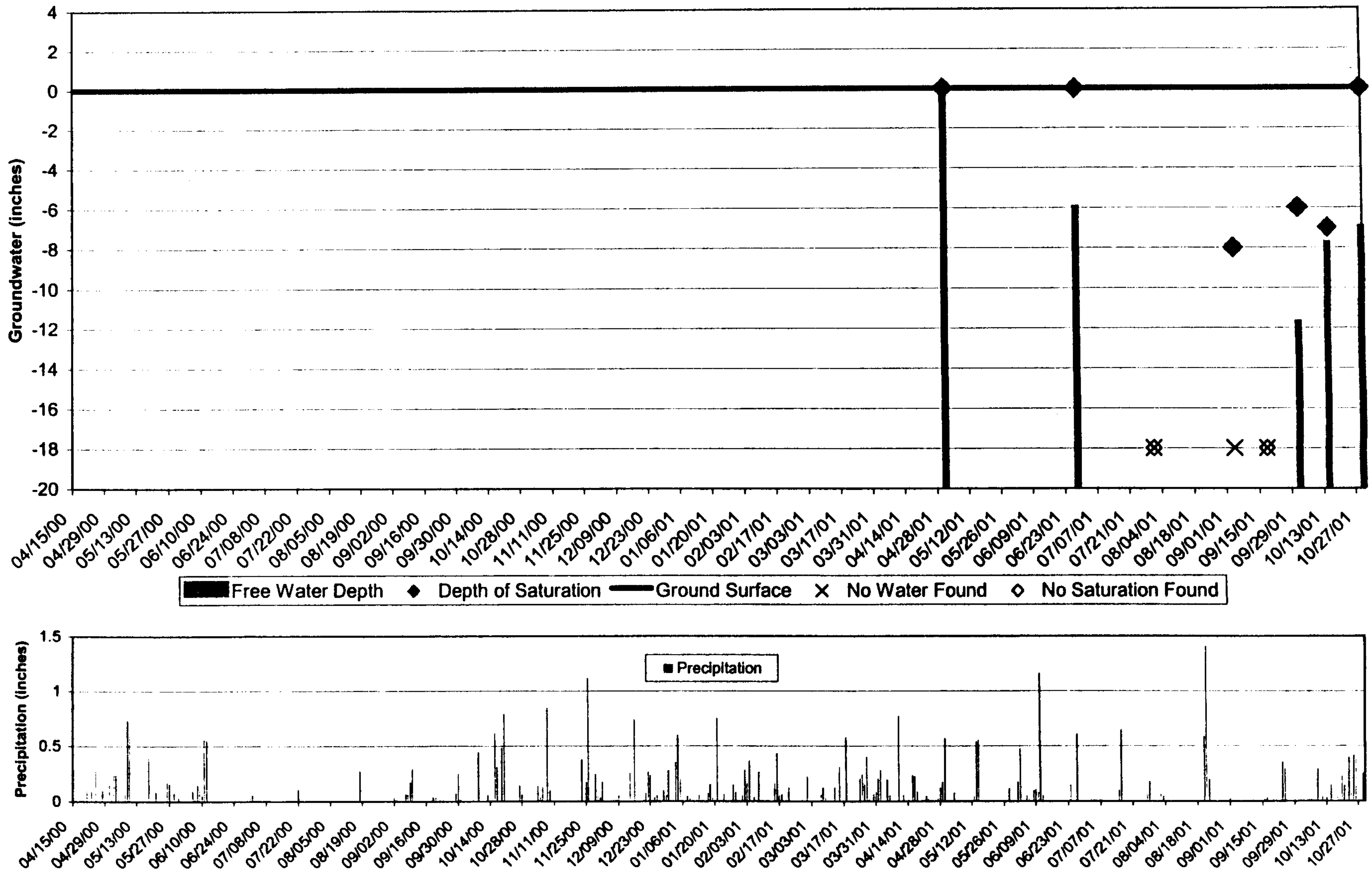

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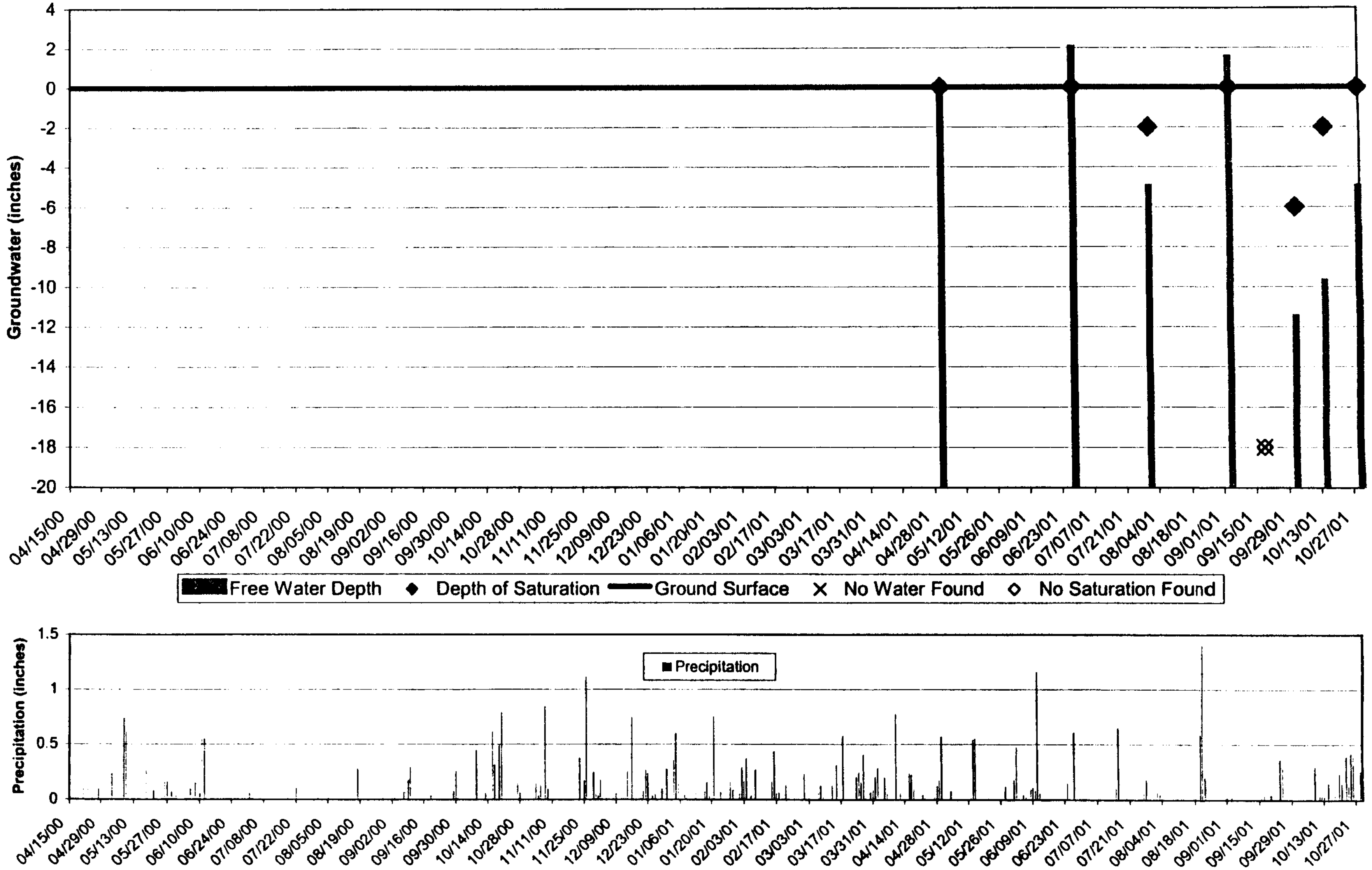

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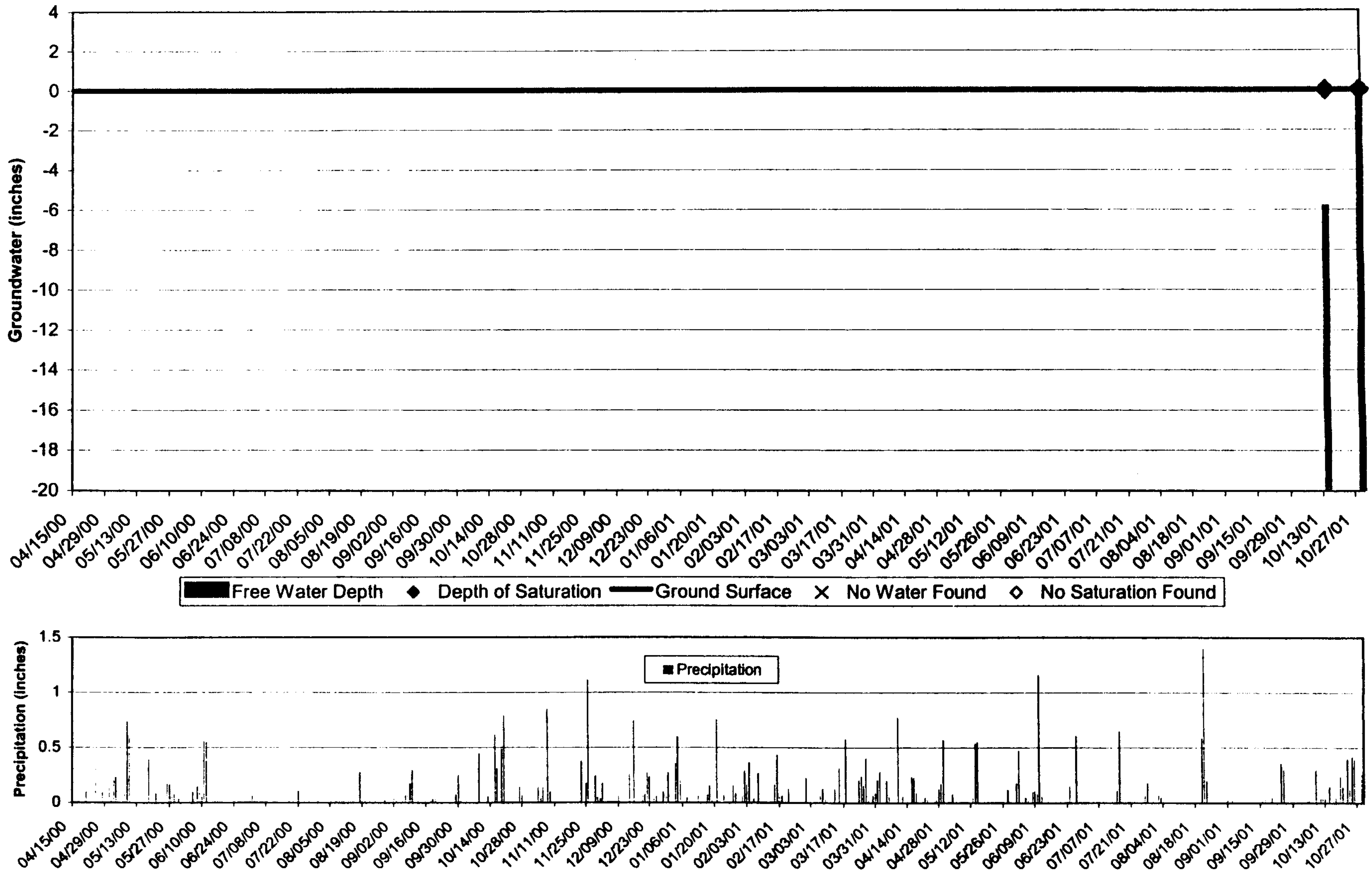

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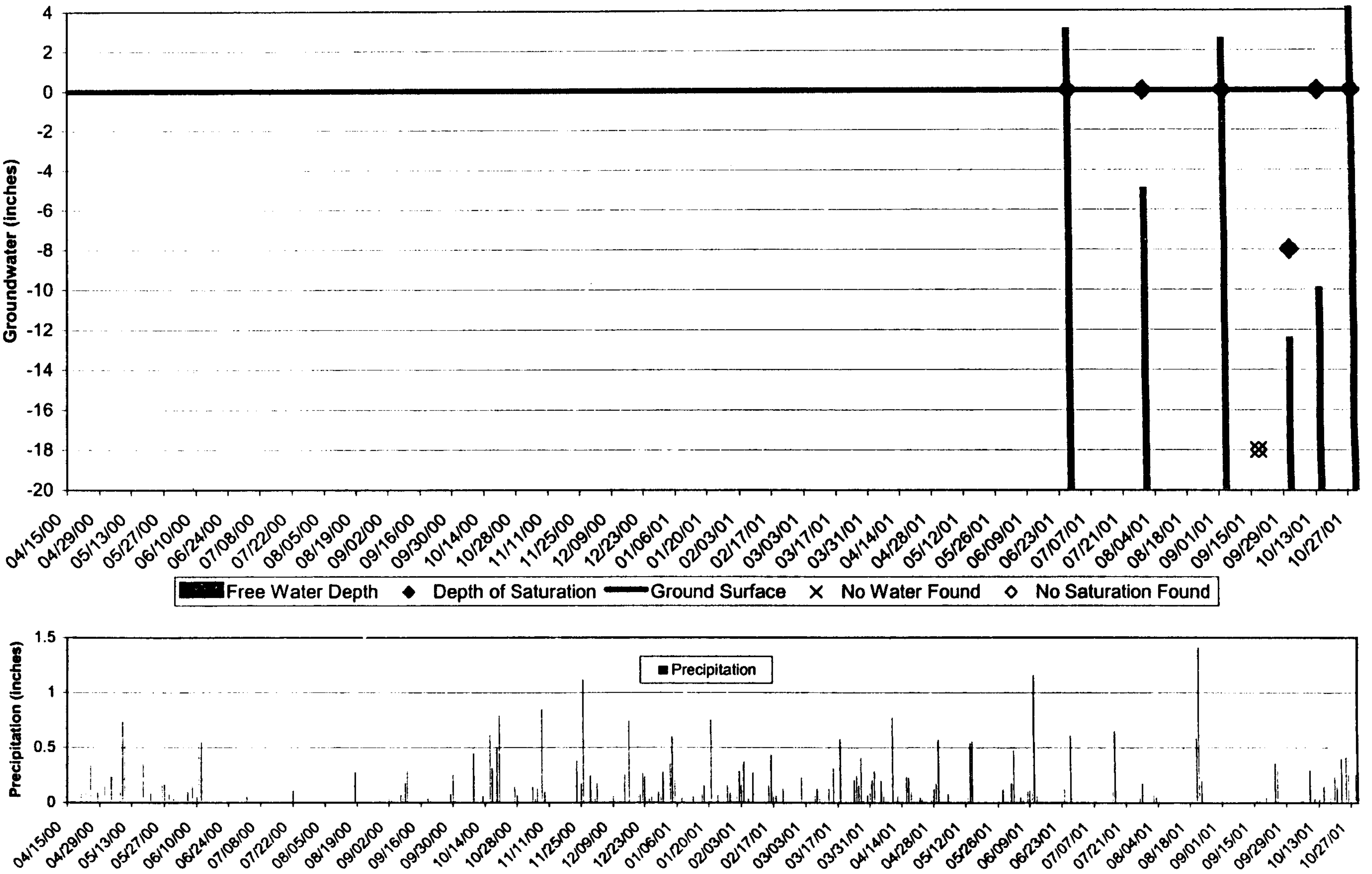

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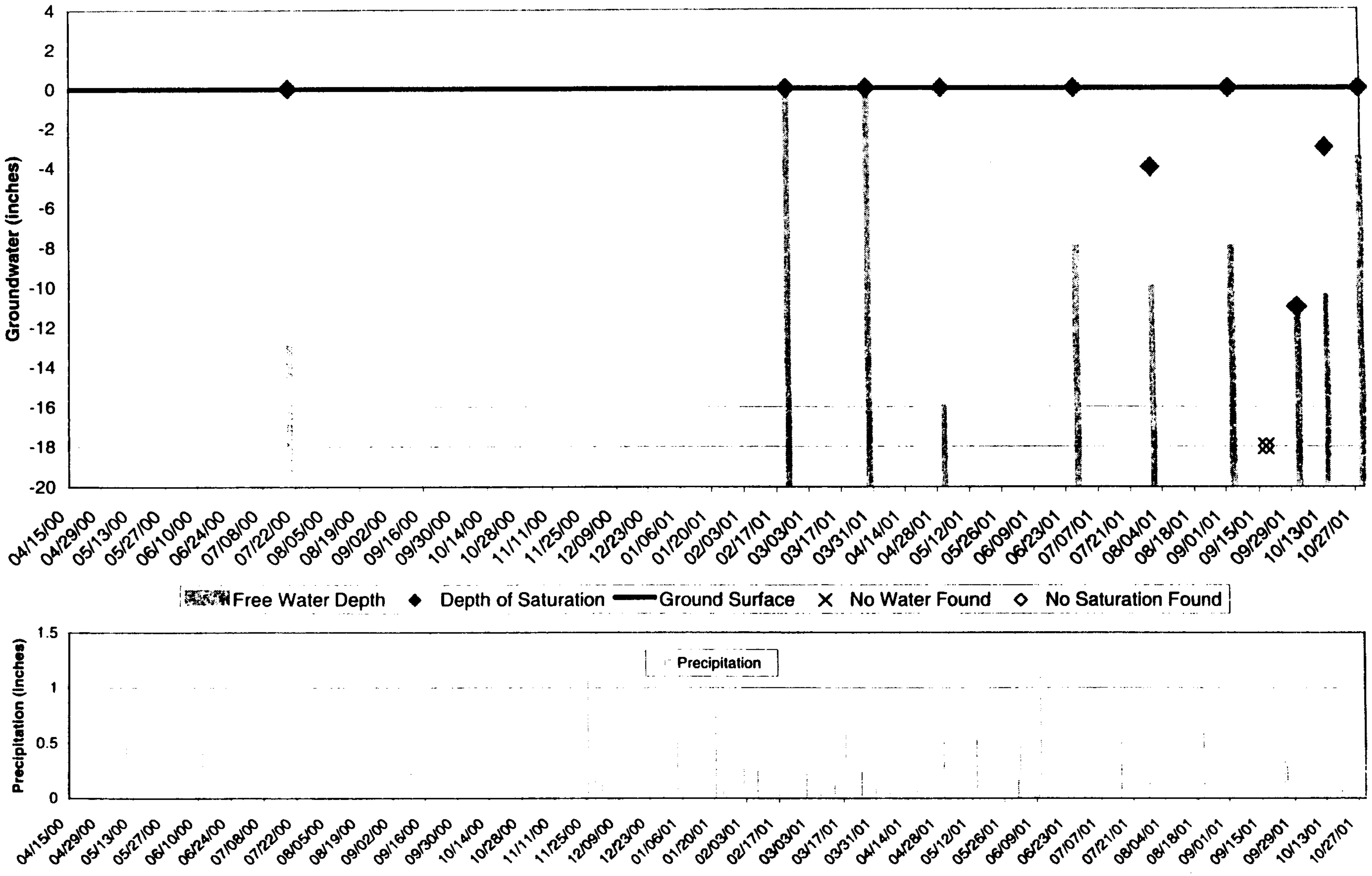

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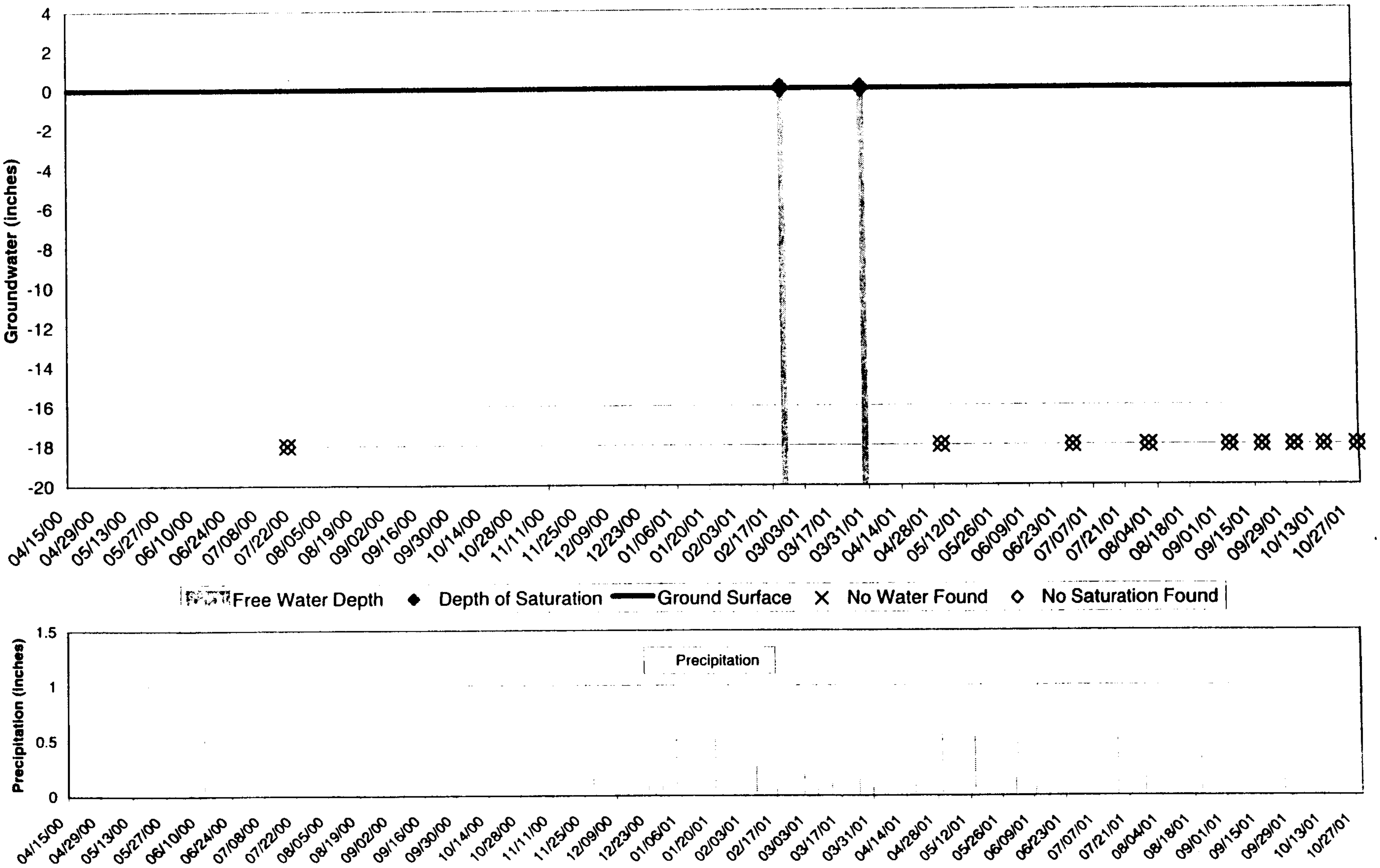
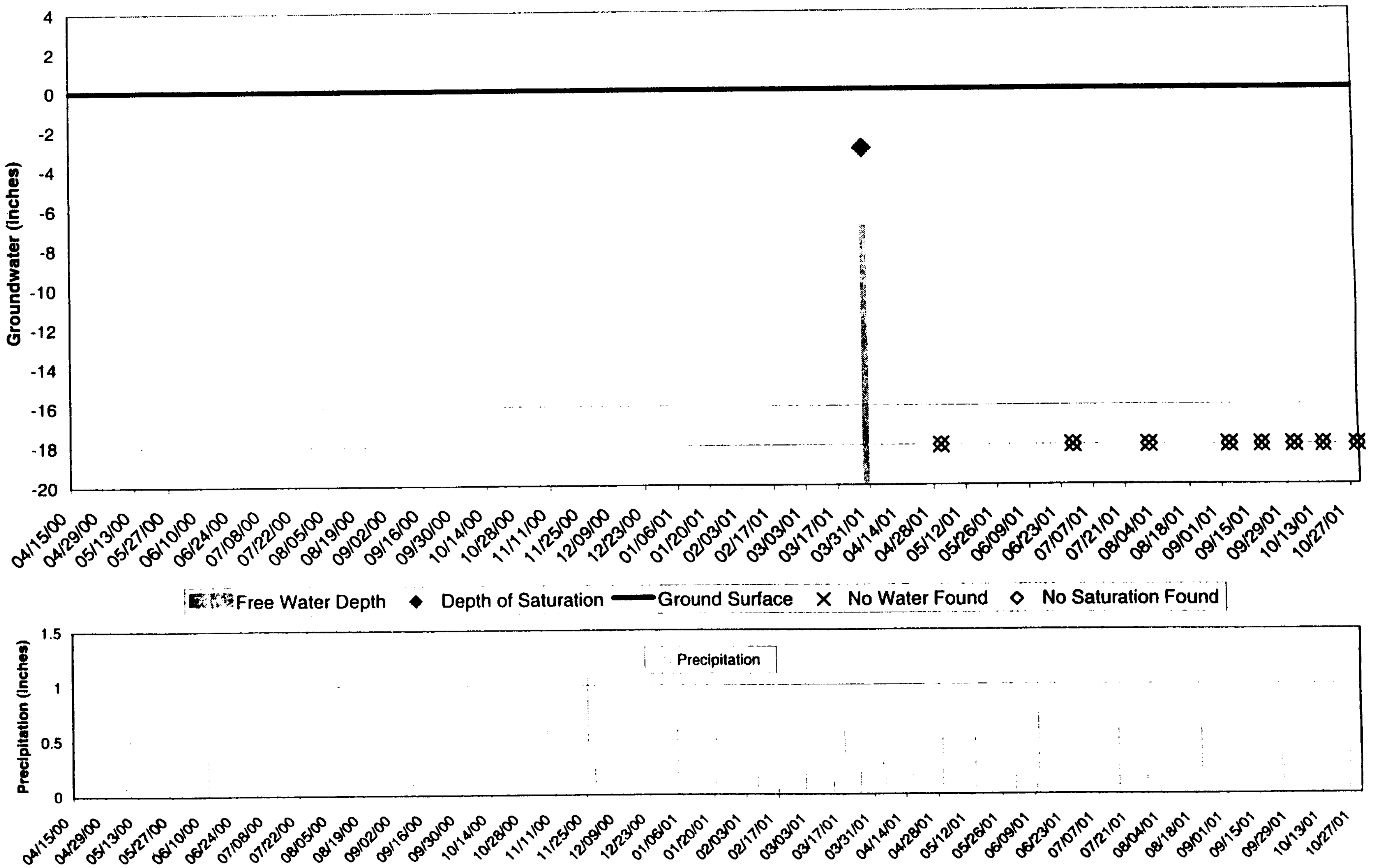
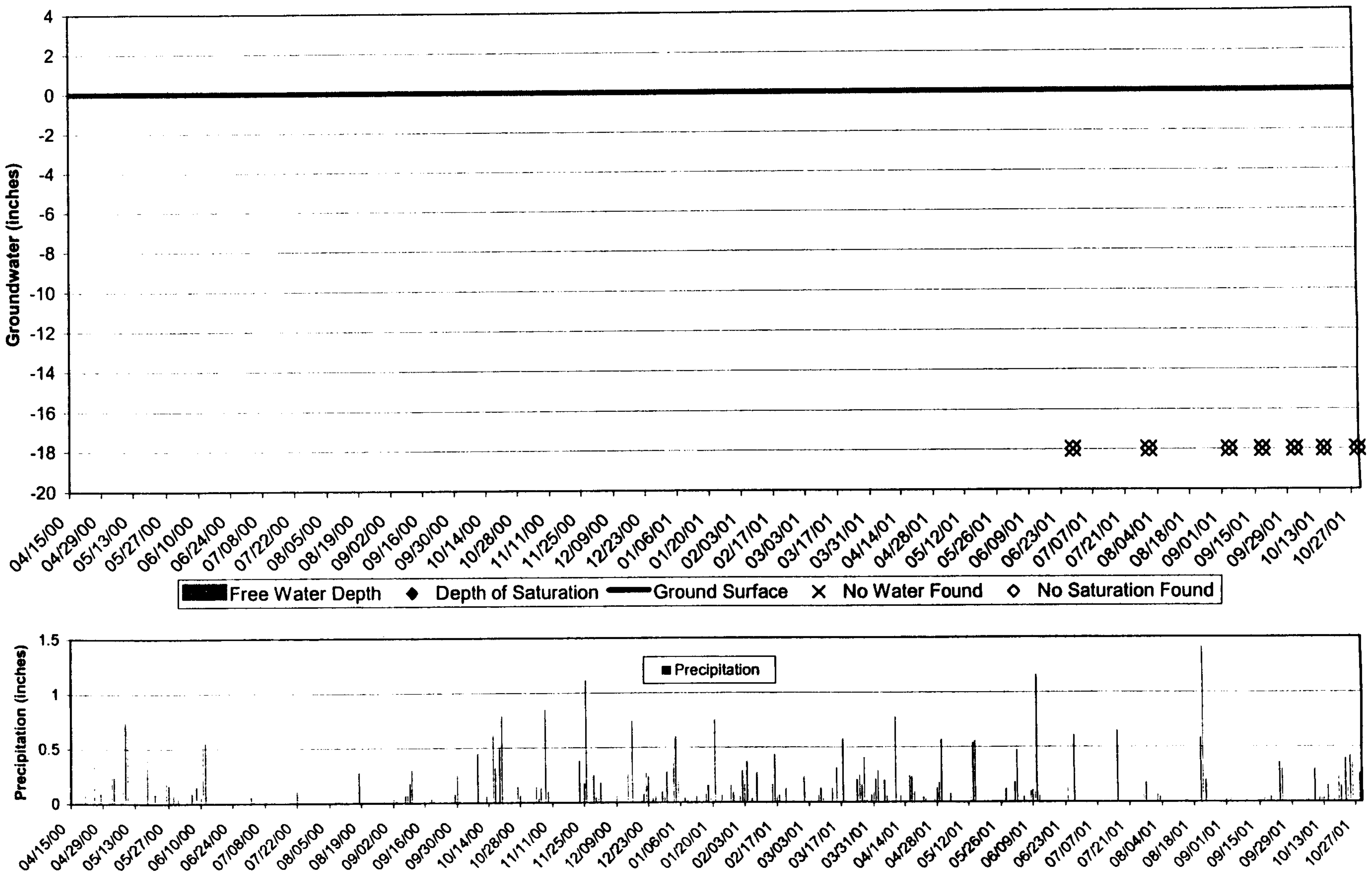


Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well 30.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well 32.



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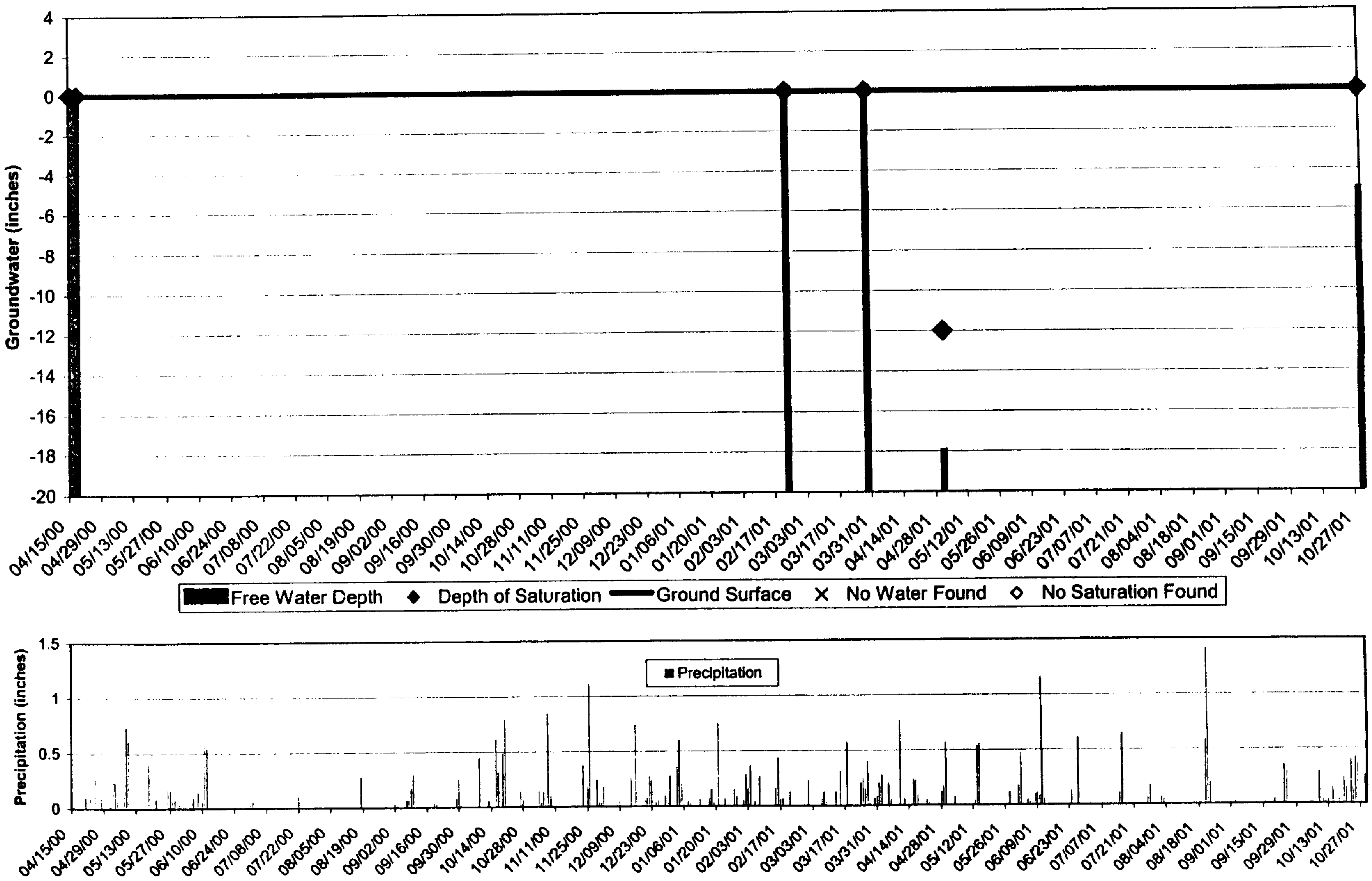

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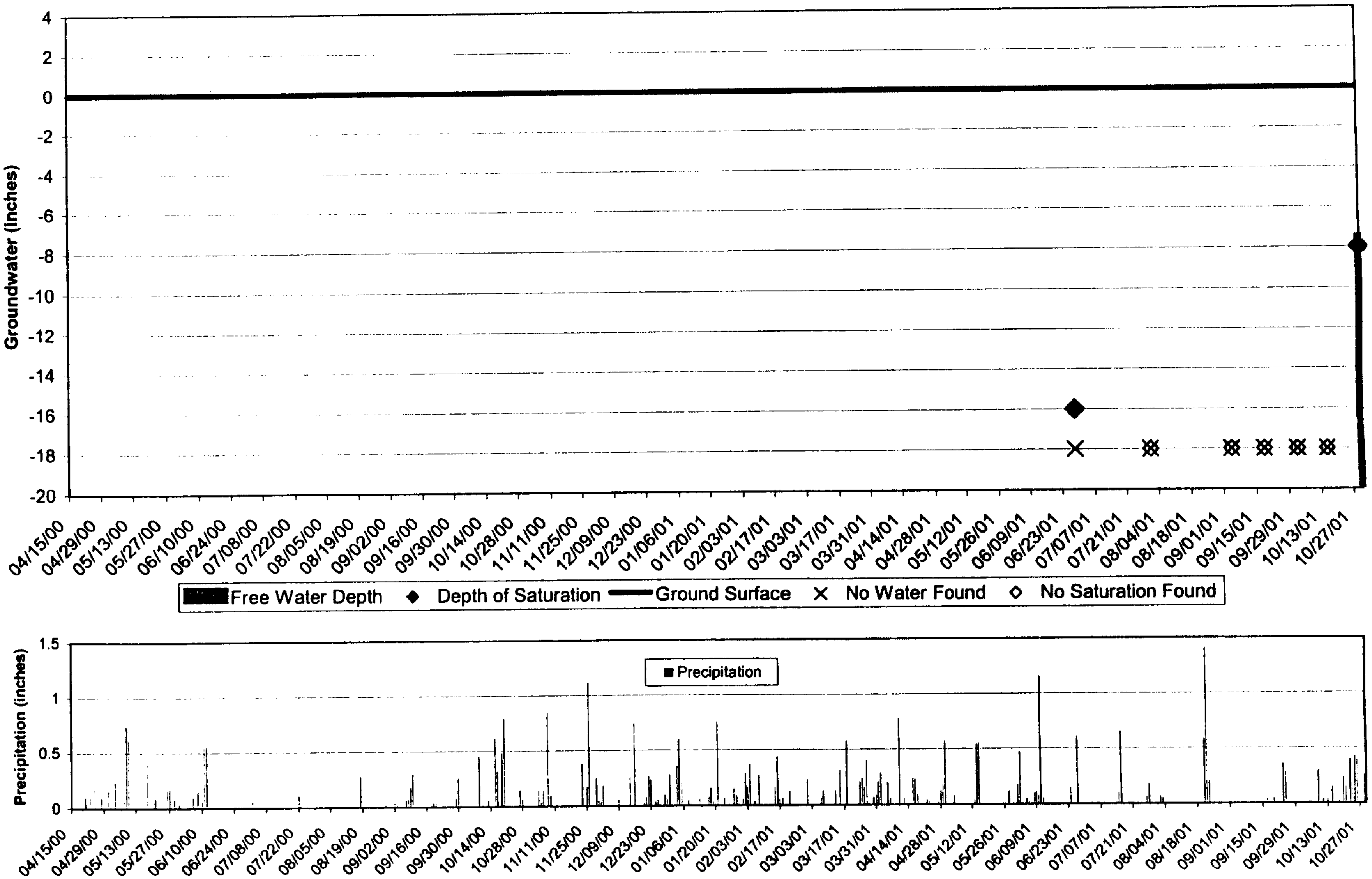

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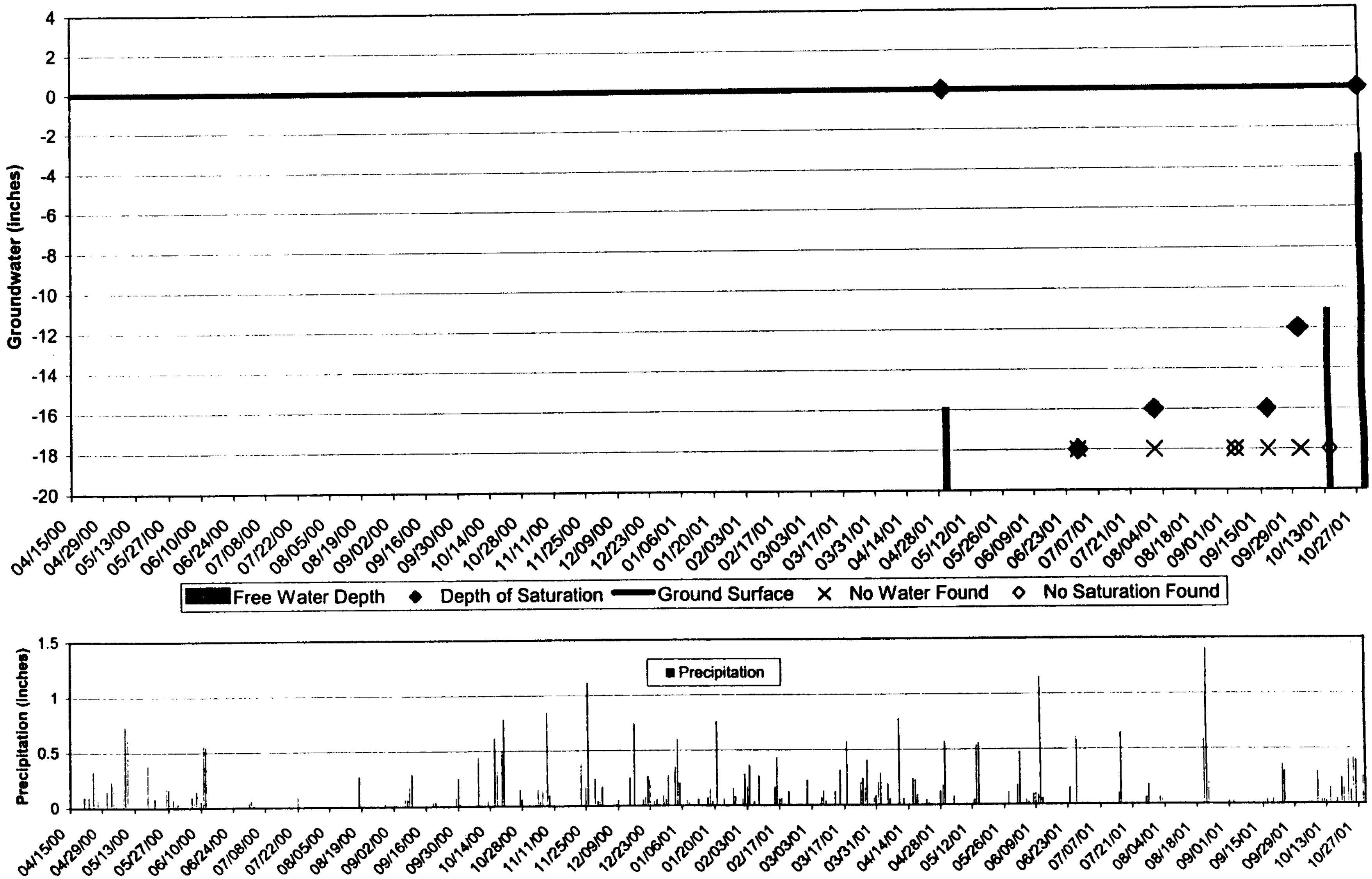

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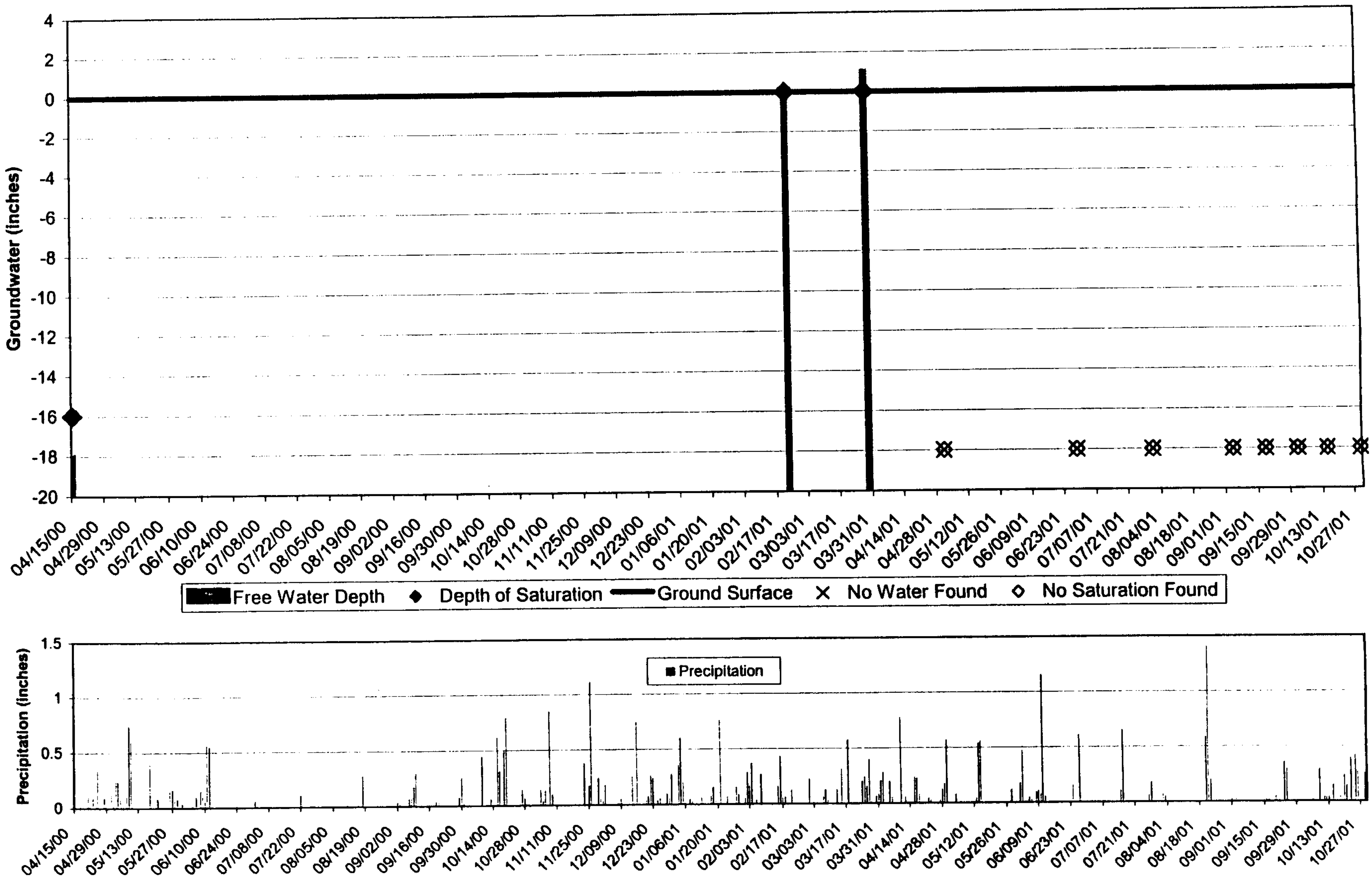
Appendix L
Natural Resource Mitigation Plan
Seattle-Tacoma International Airport Master Plan Update

November 2001
556-2912-001 (03)



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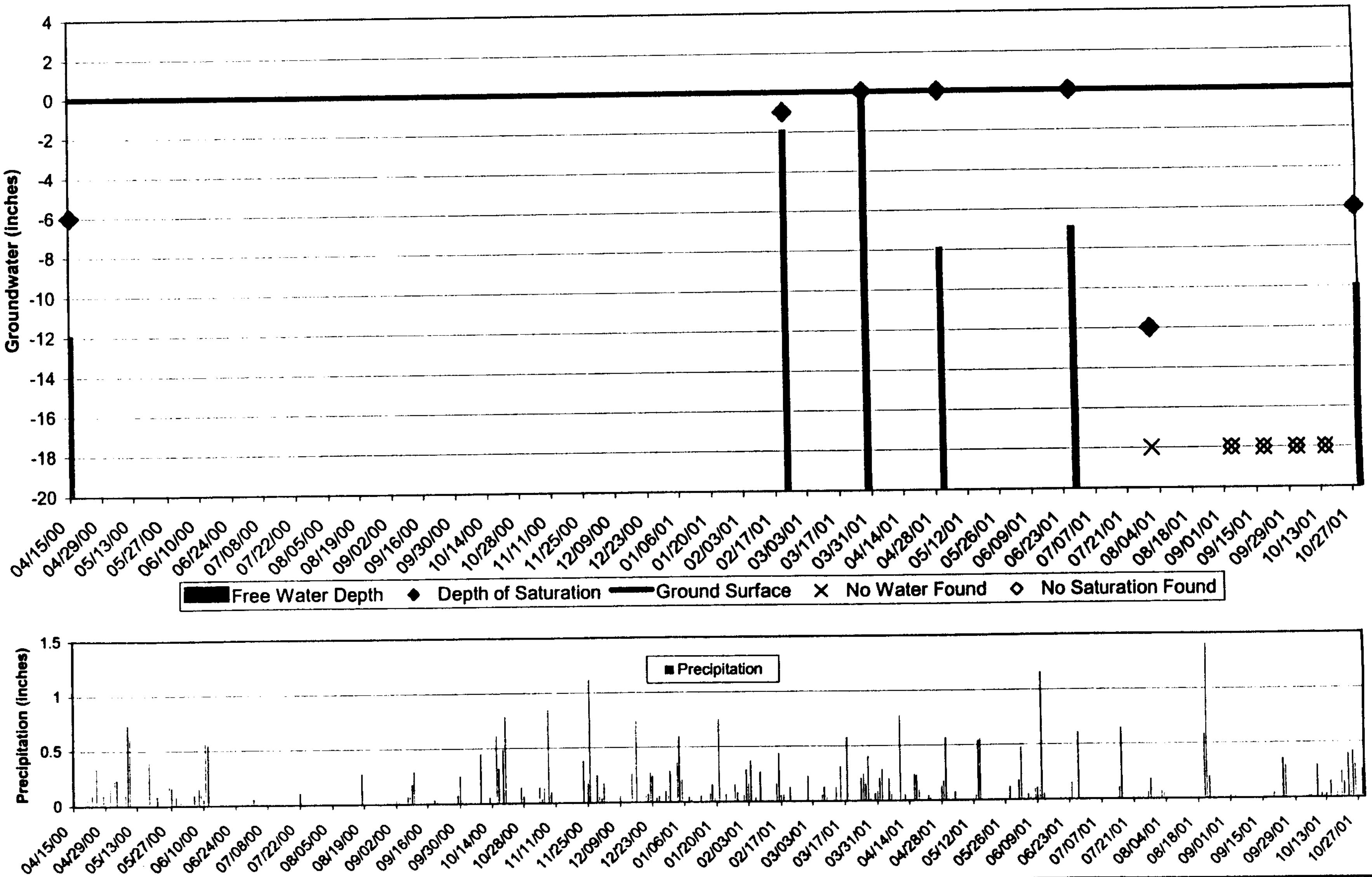

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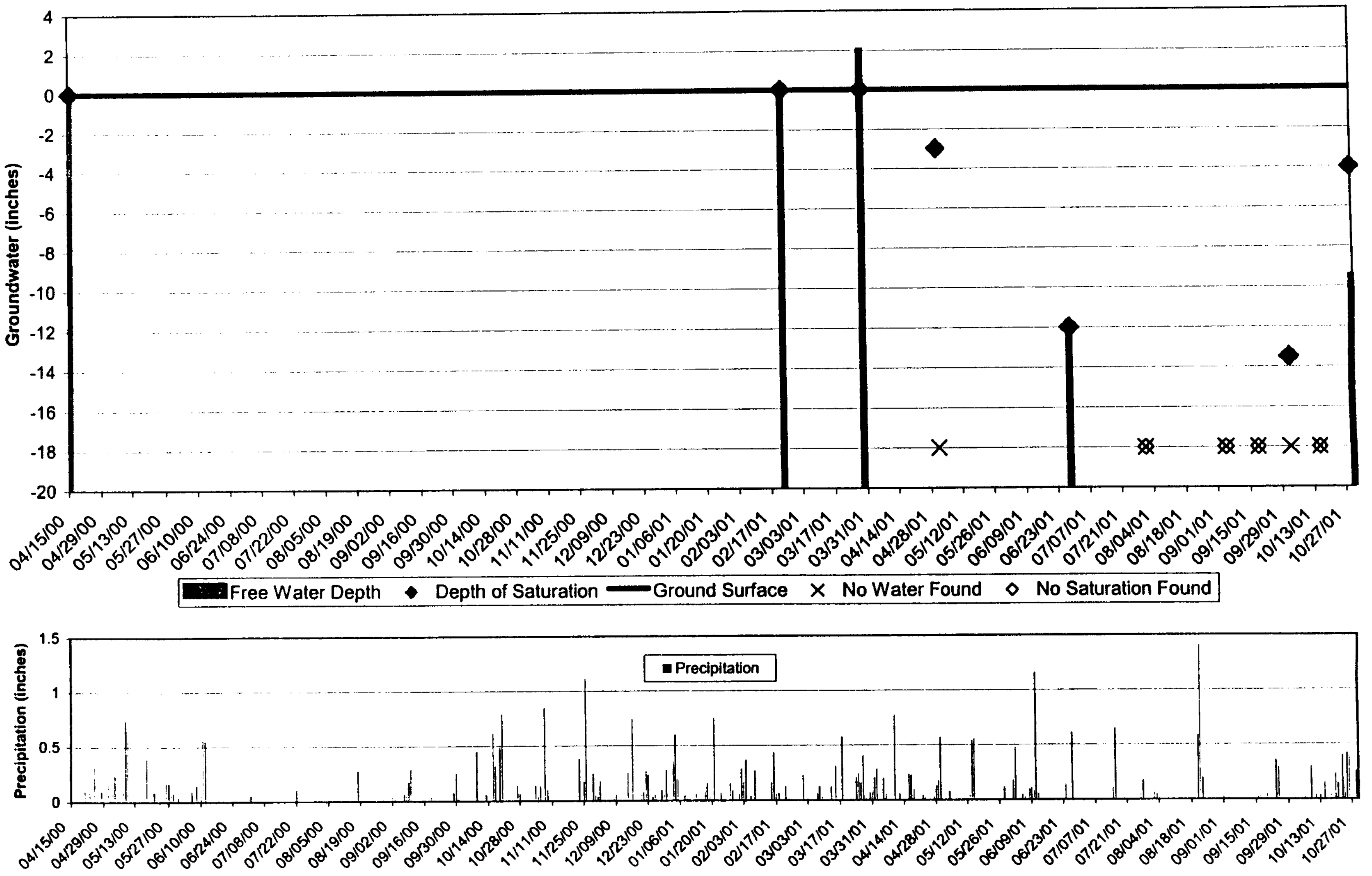

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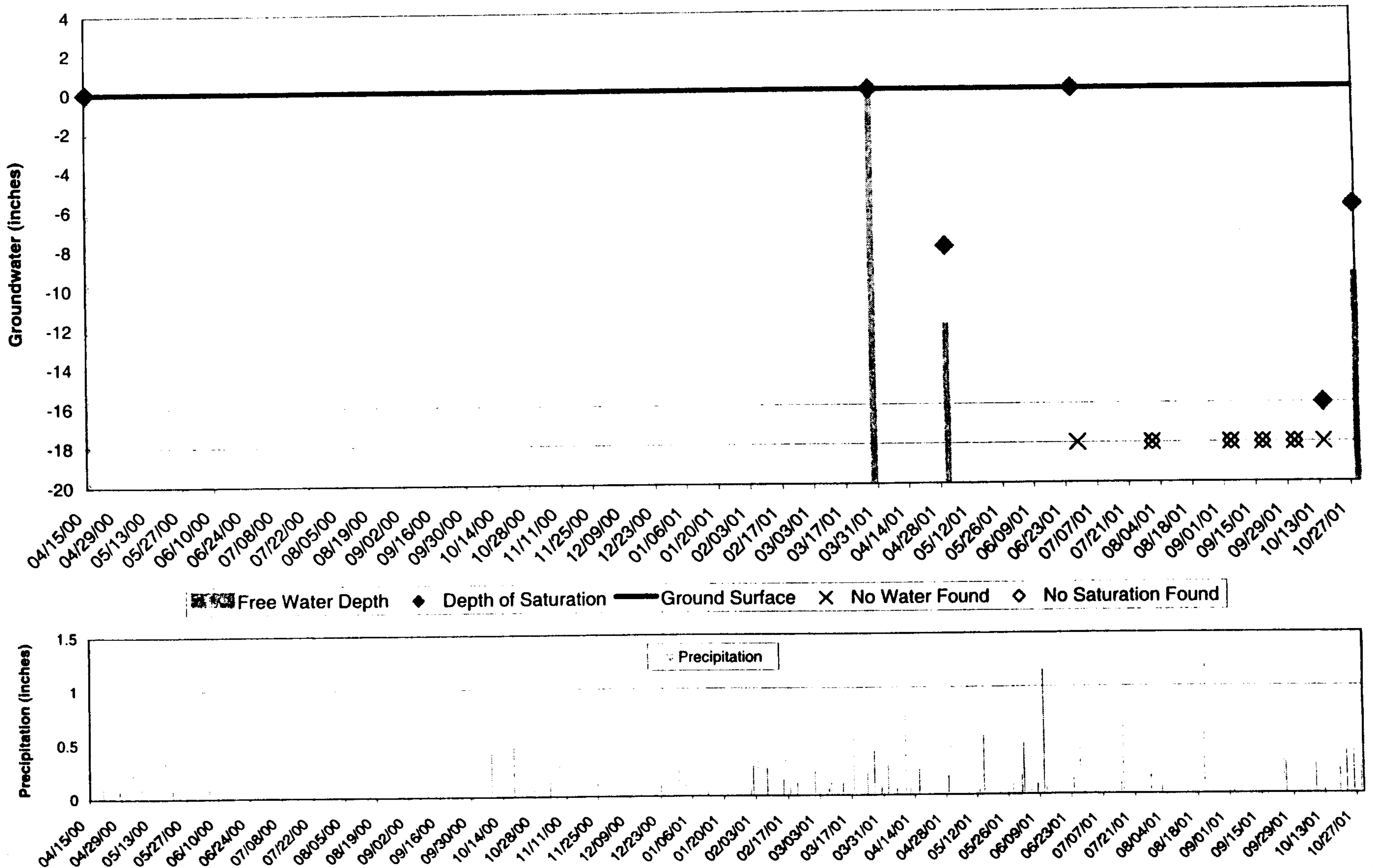

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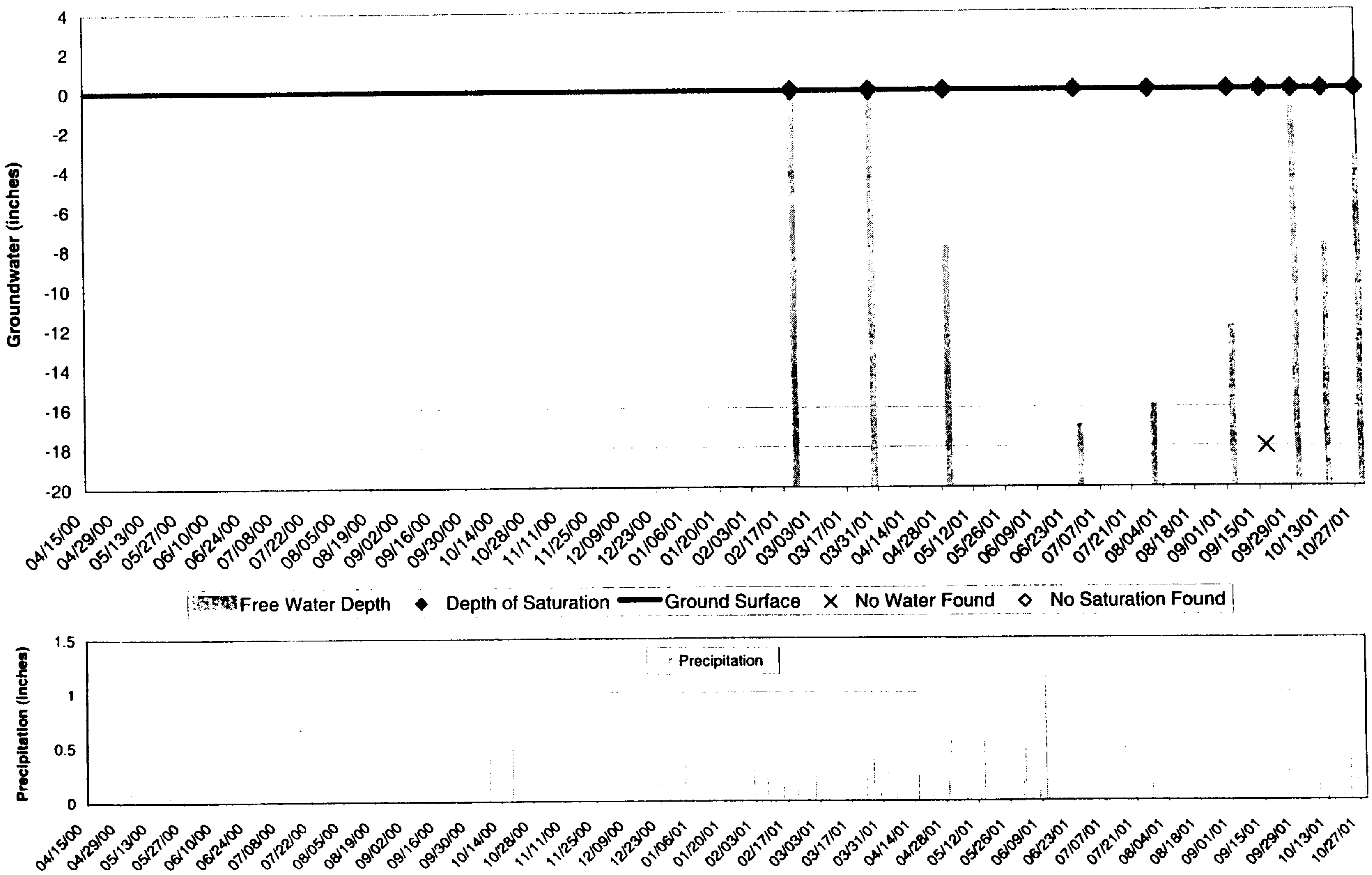

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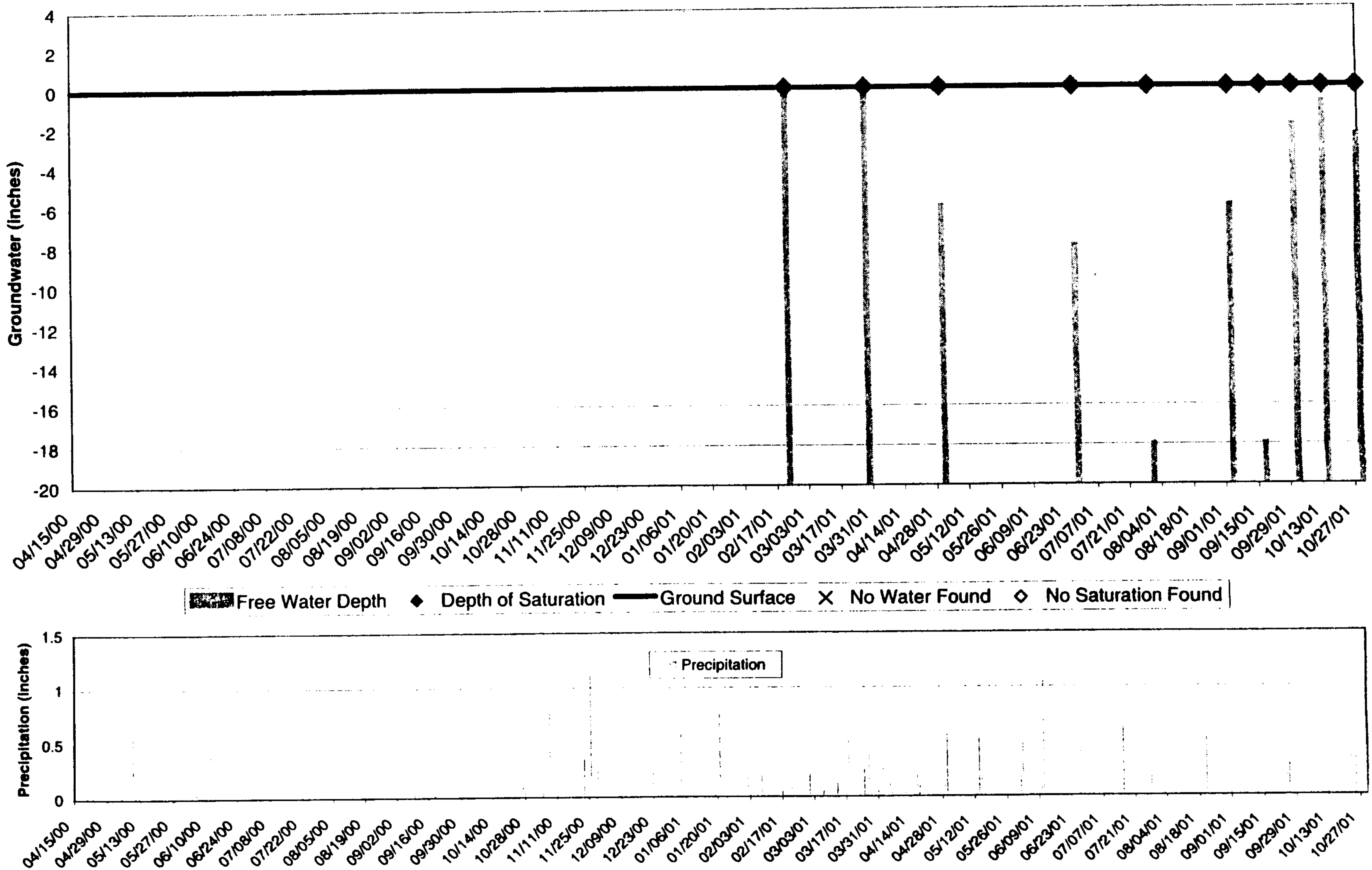

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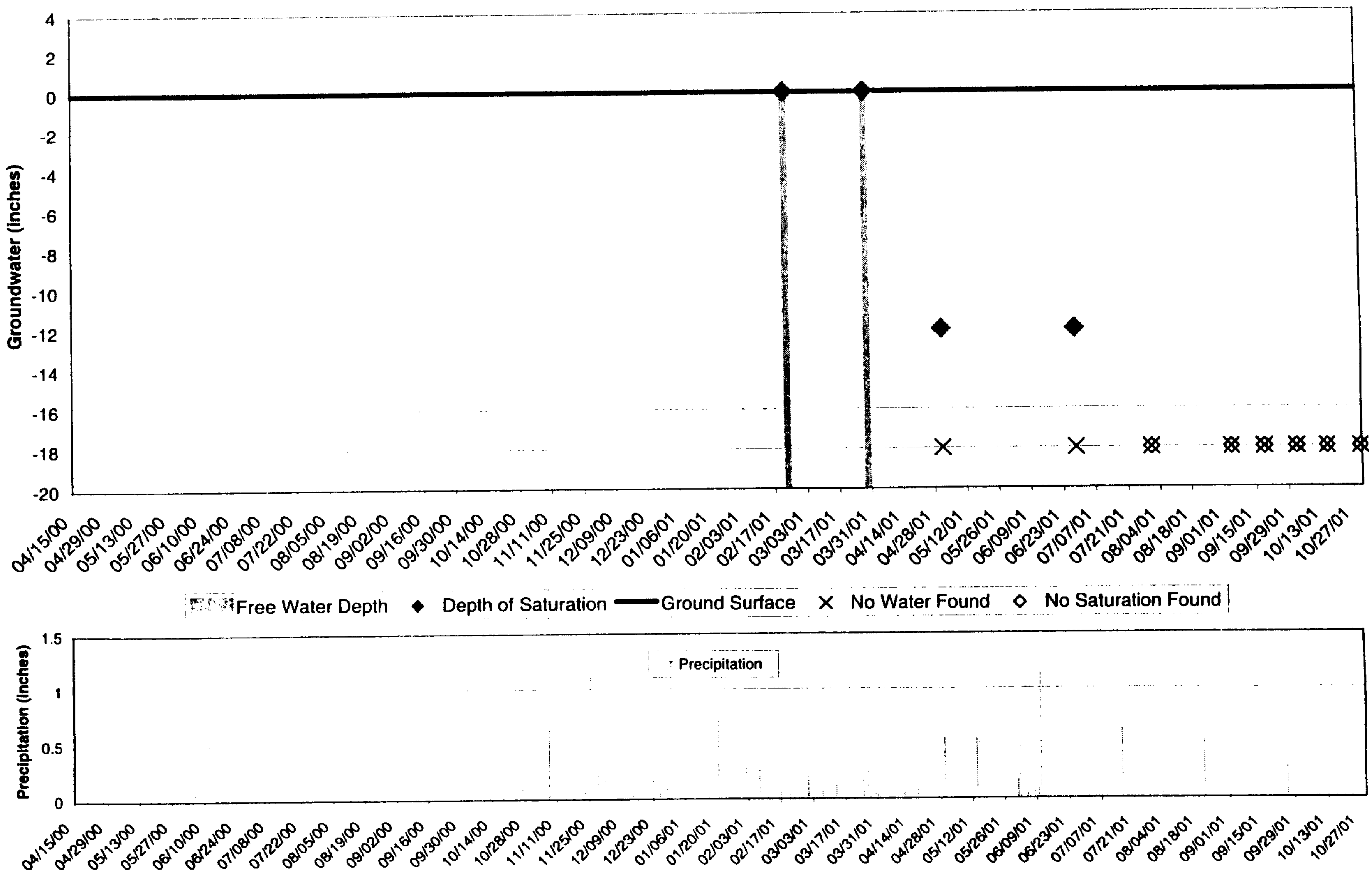

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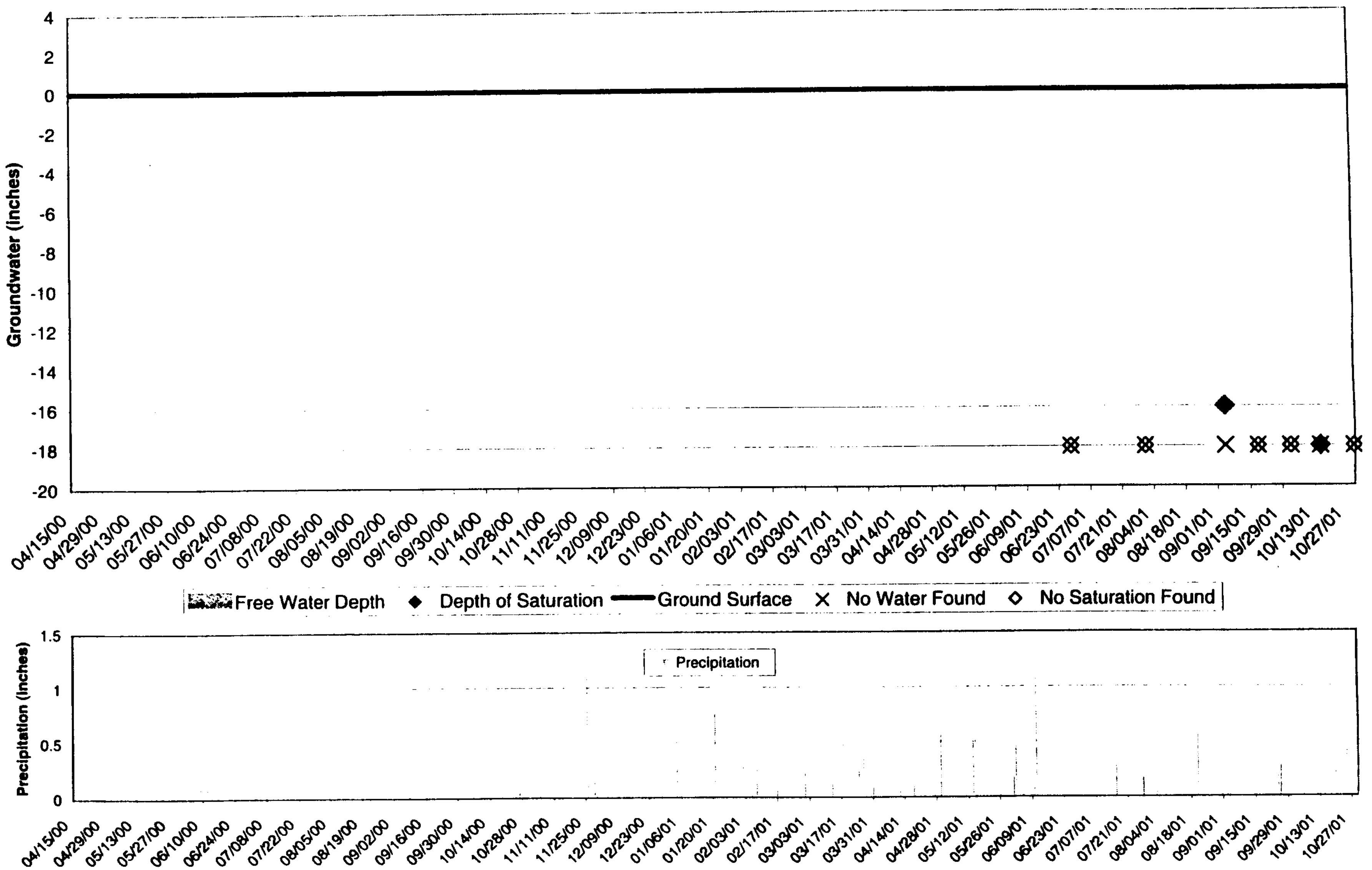
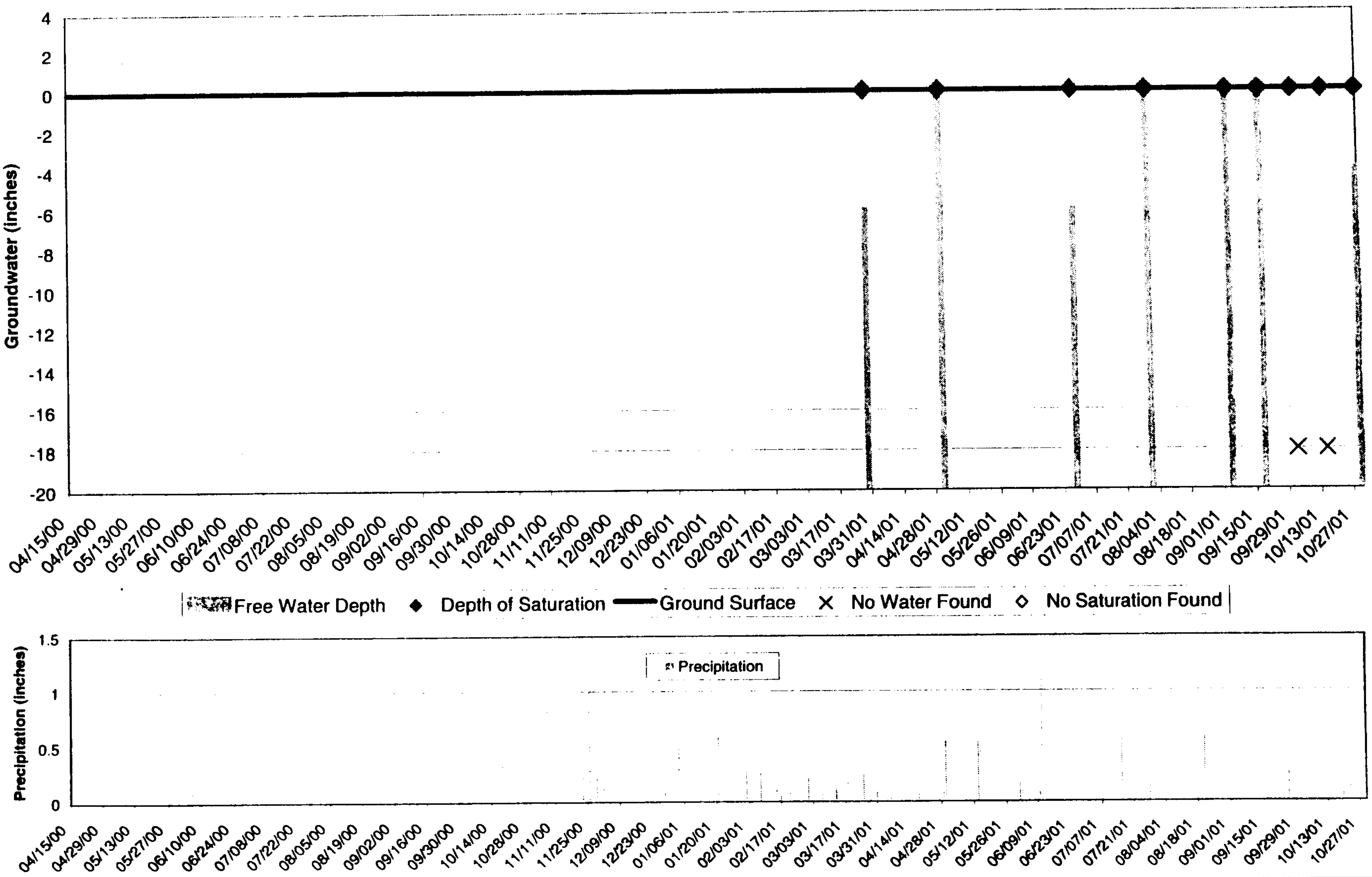
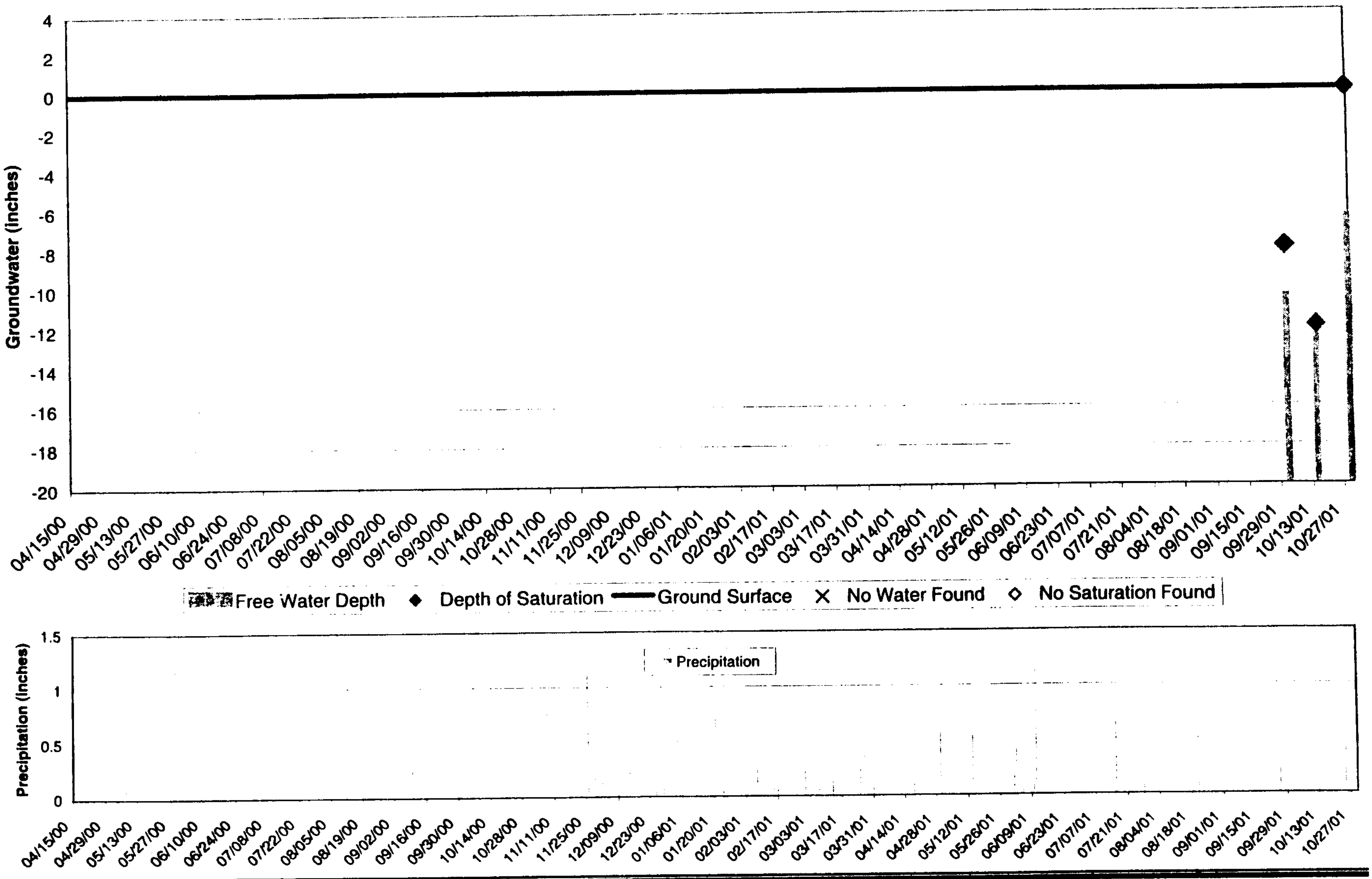


Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well 51.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Golf Course, Well 52.



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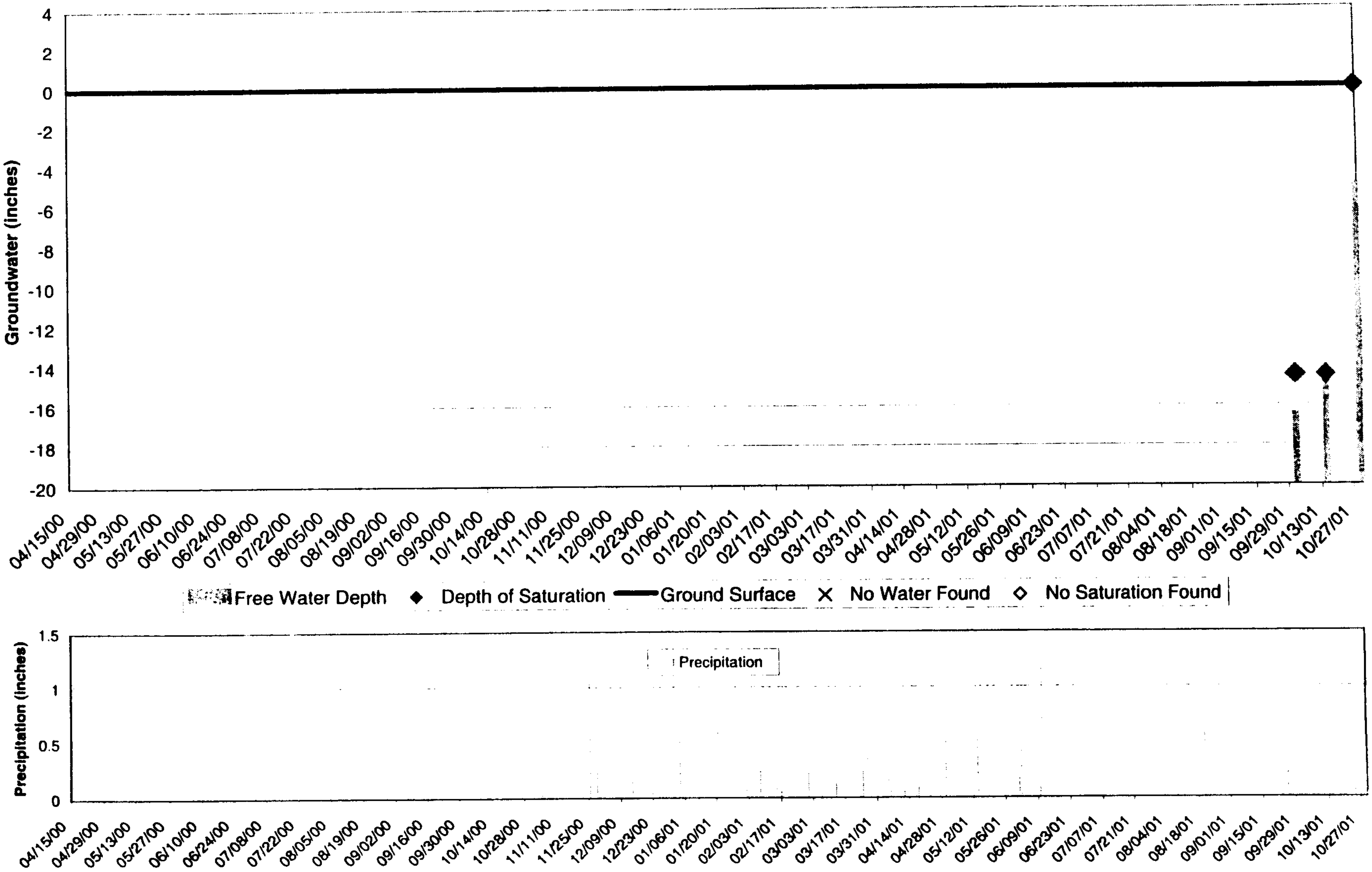

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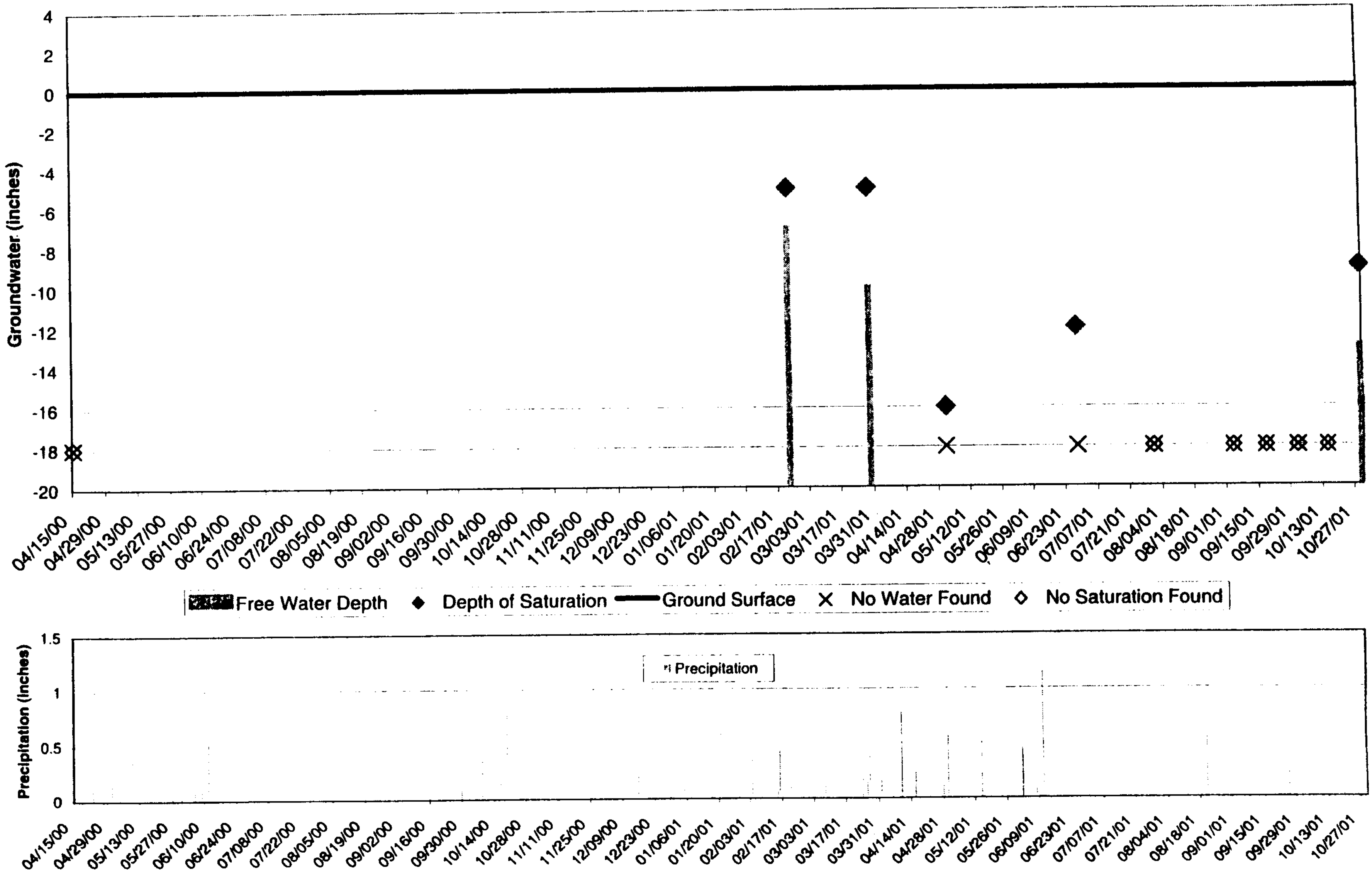

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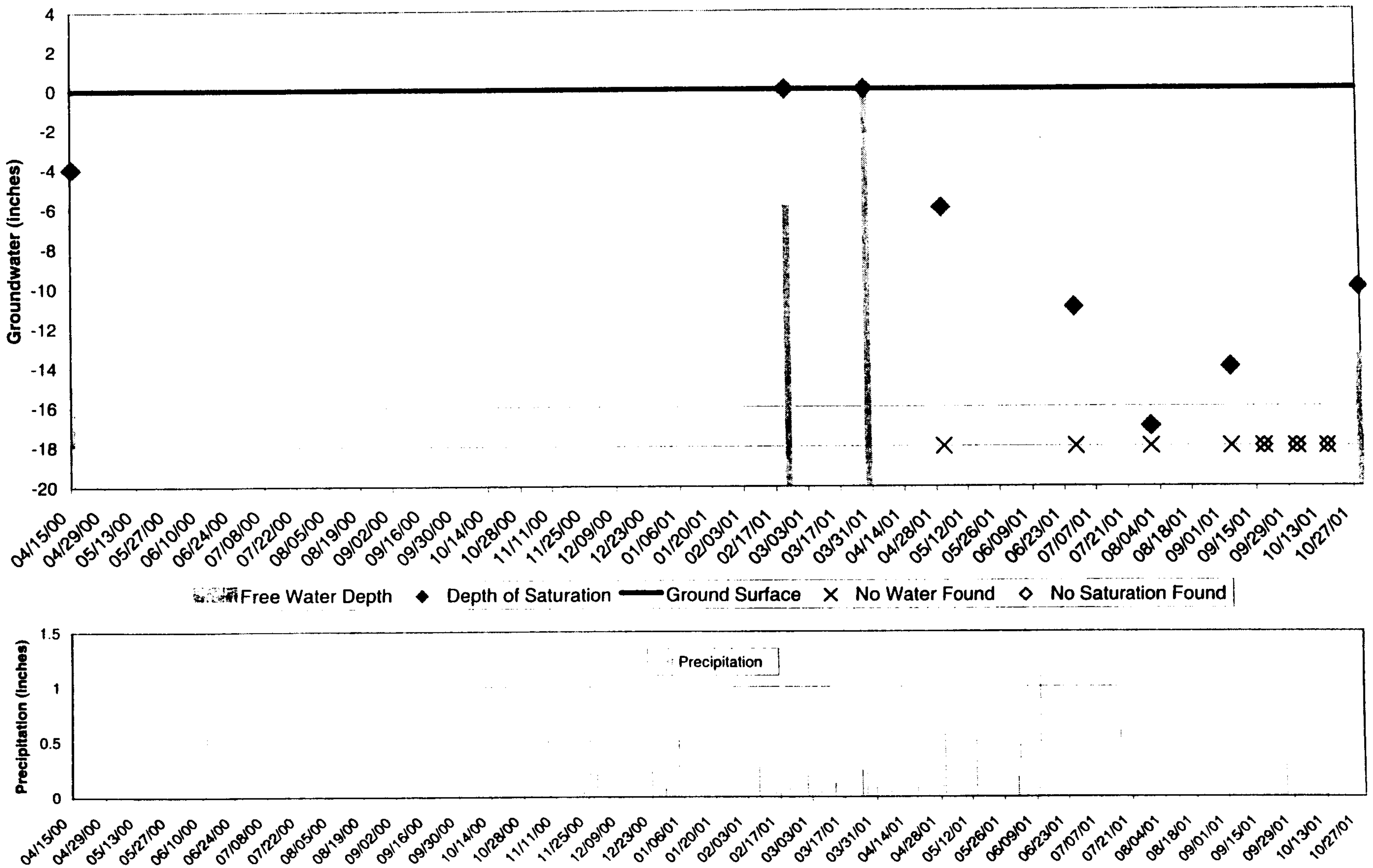

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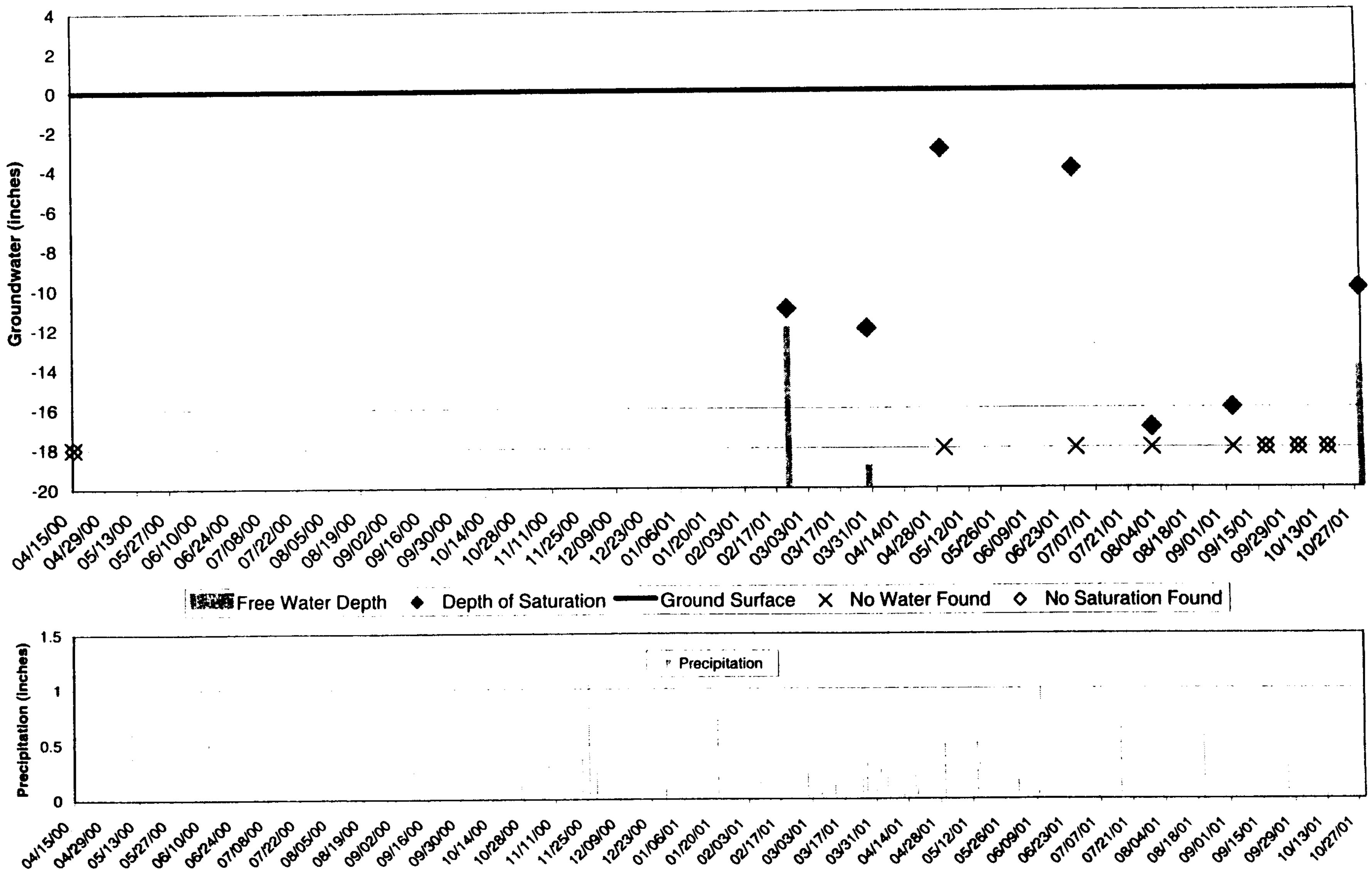

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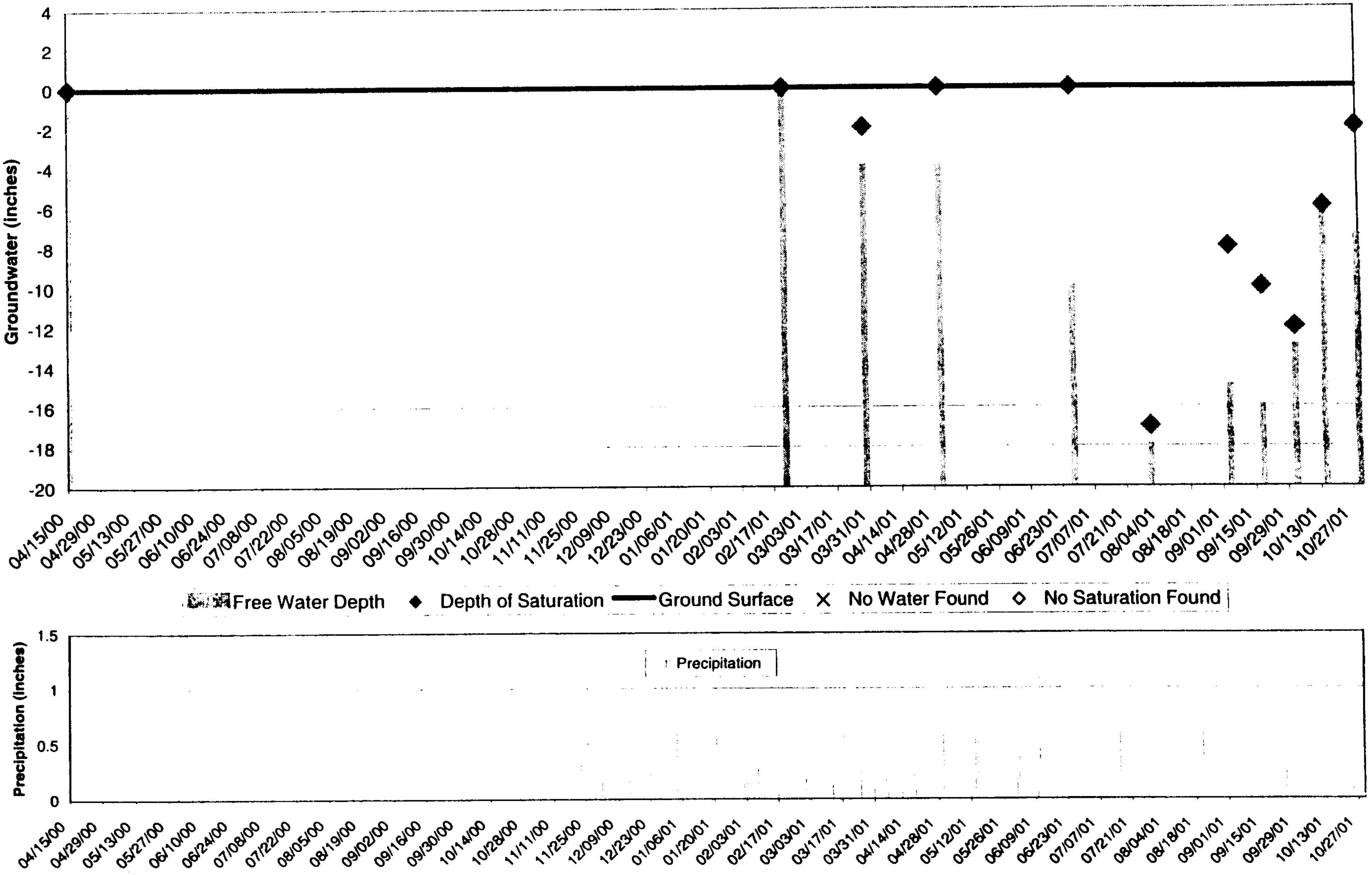

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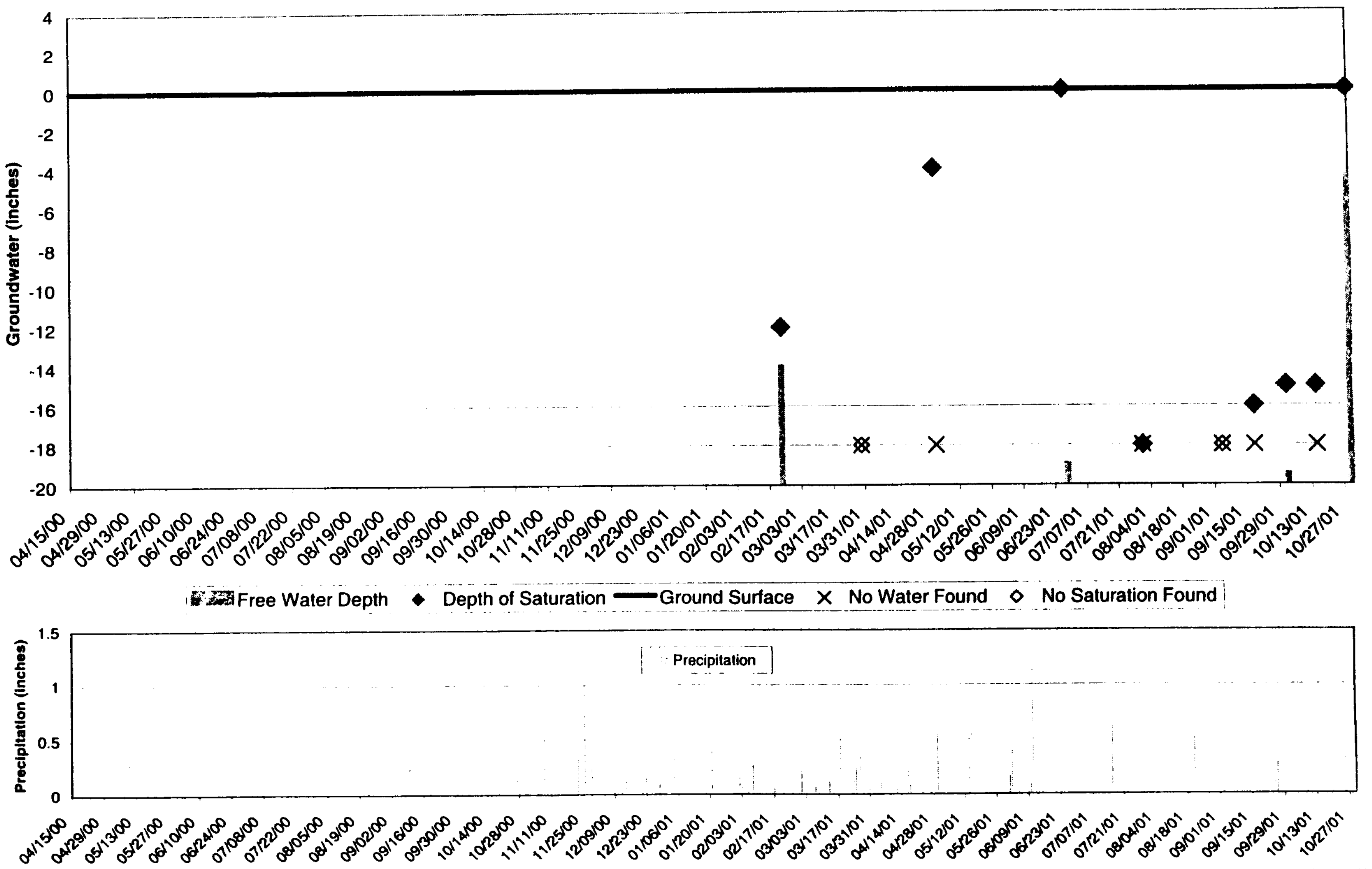
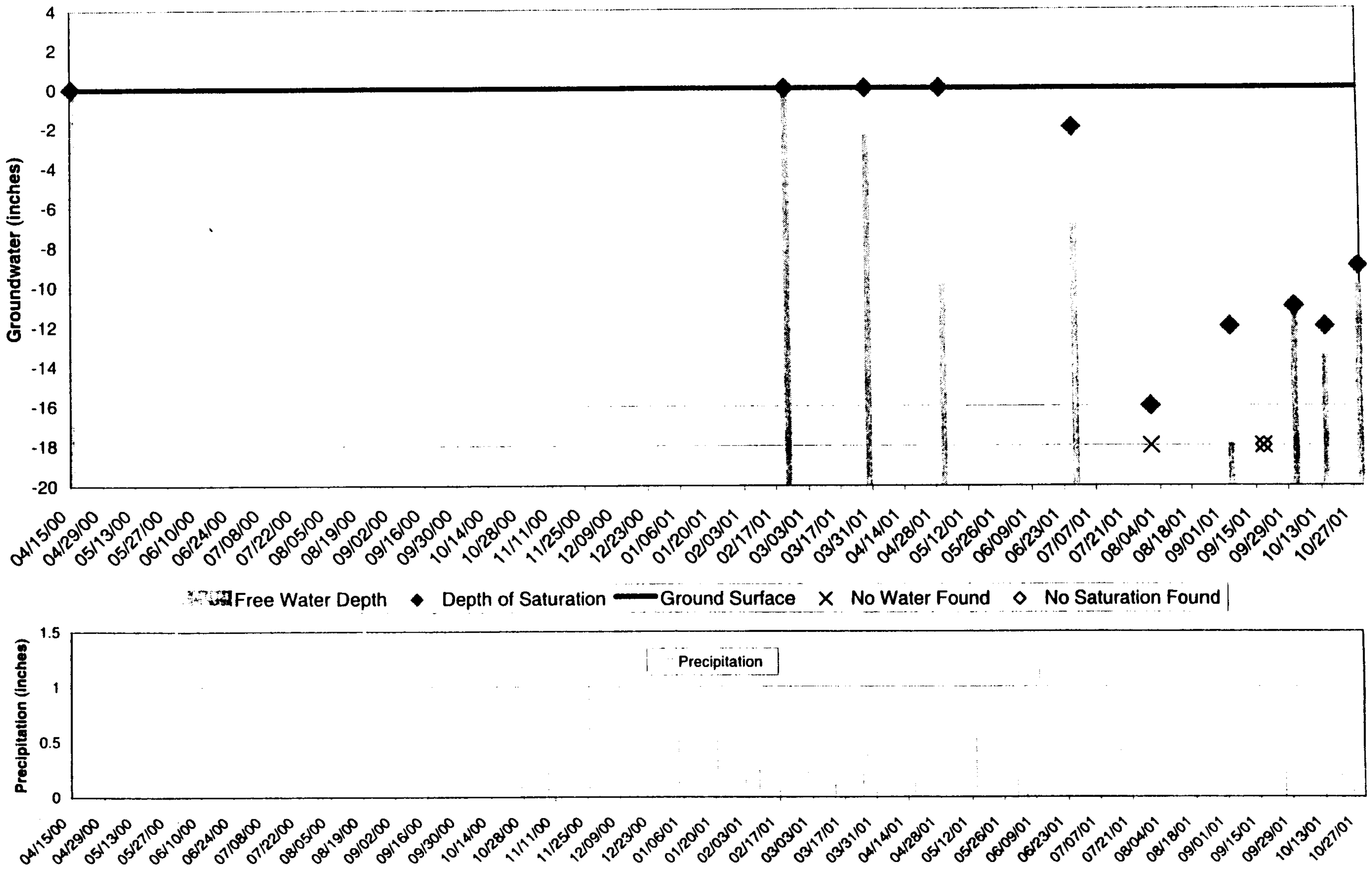
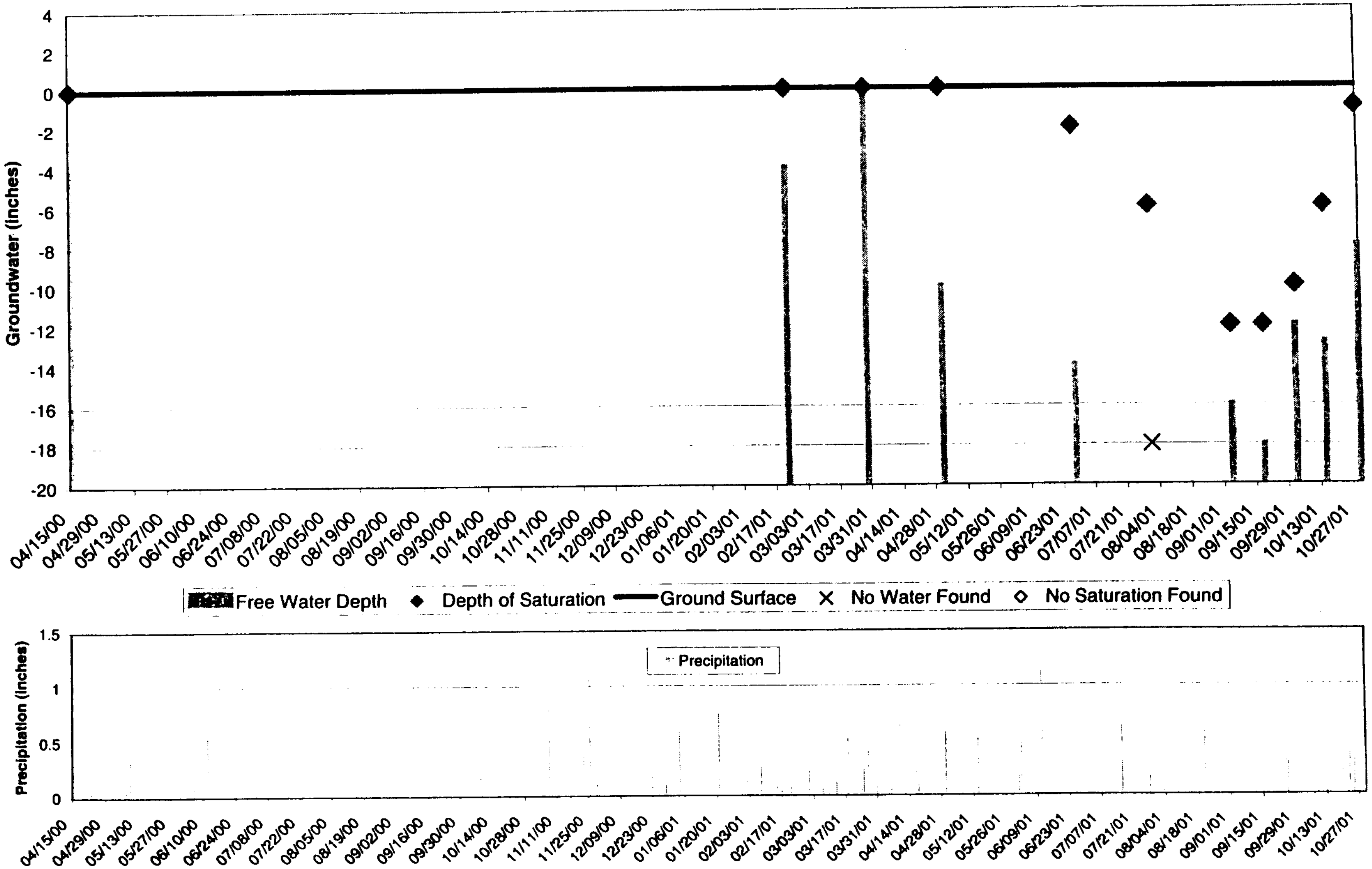


Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A-13, Well A-13.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A-14a, Well A-14a.



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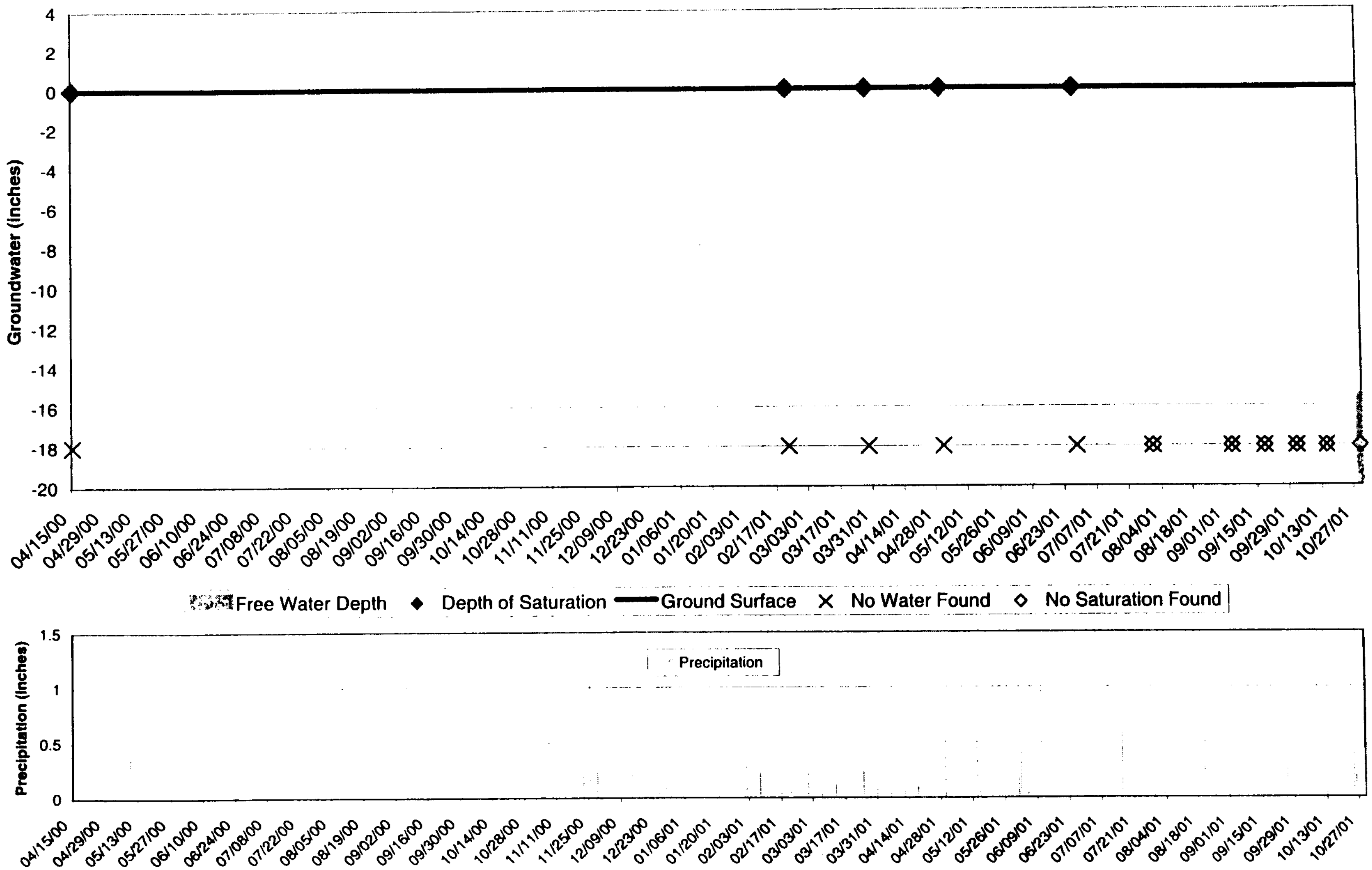

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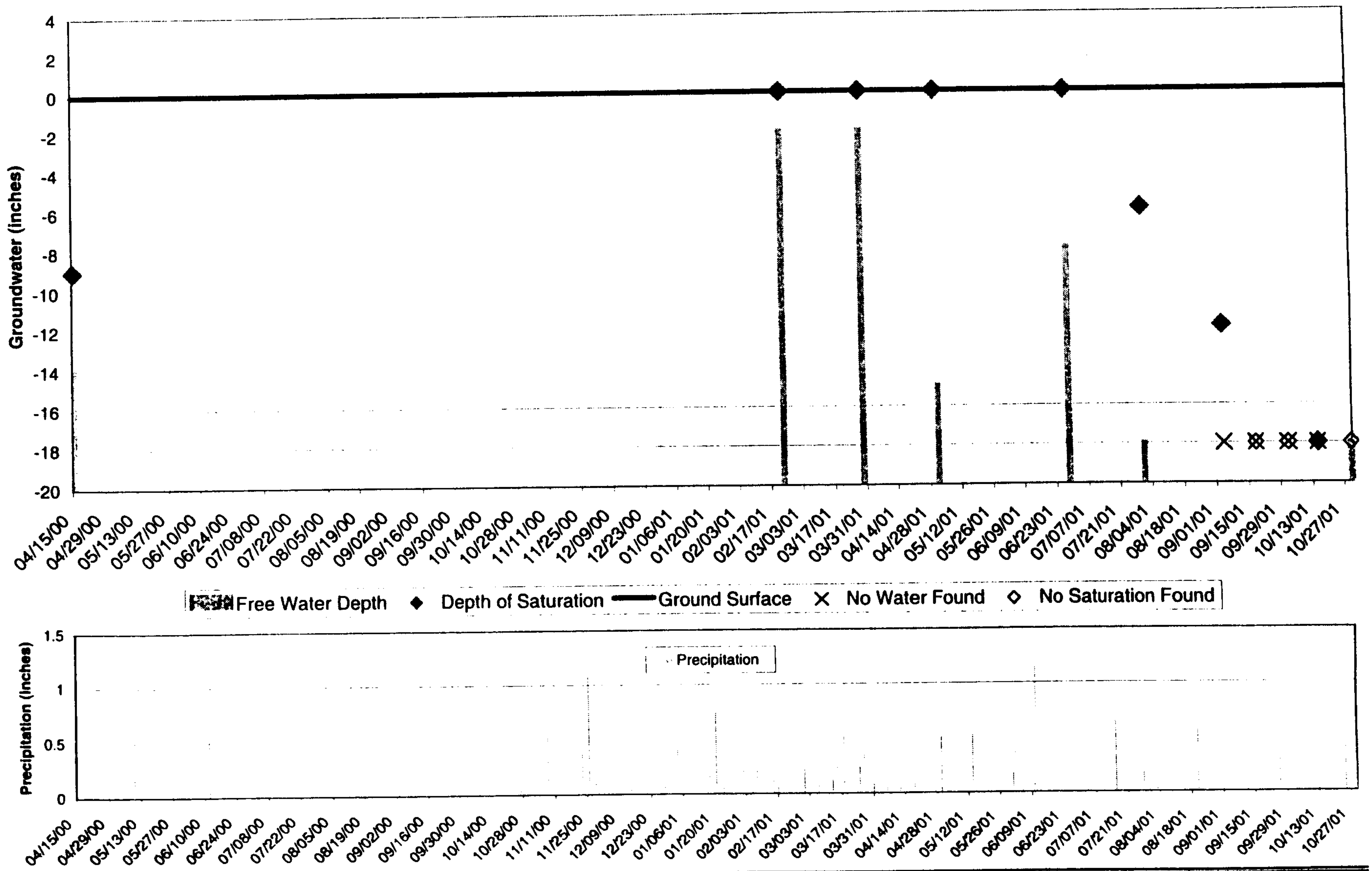
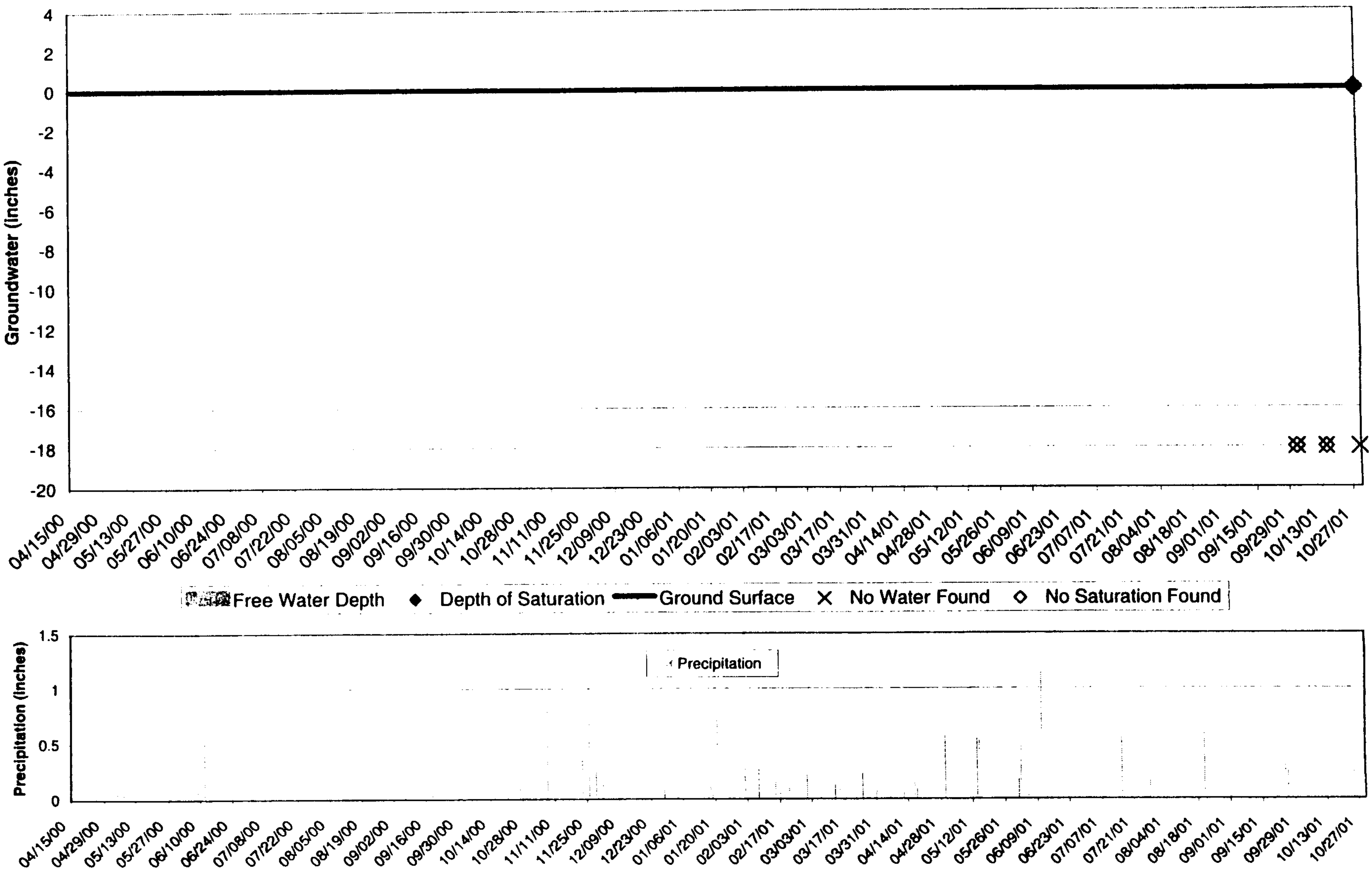


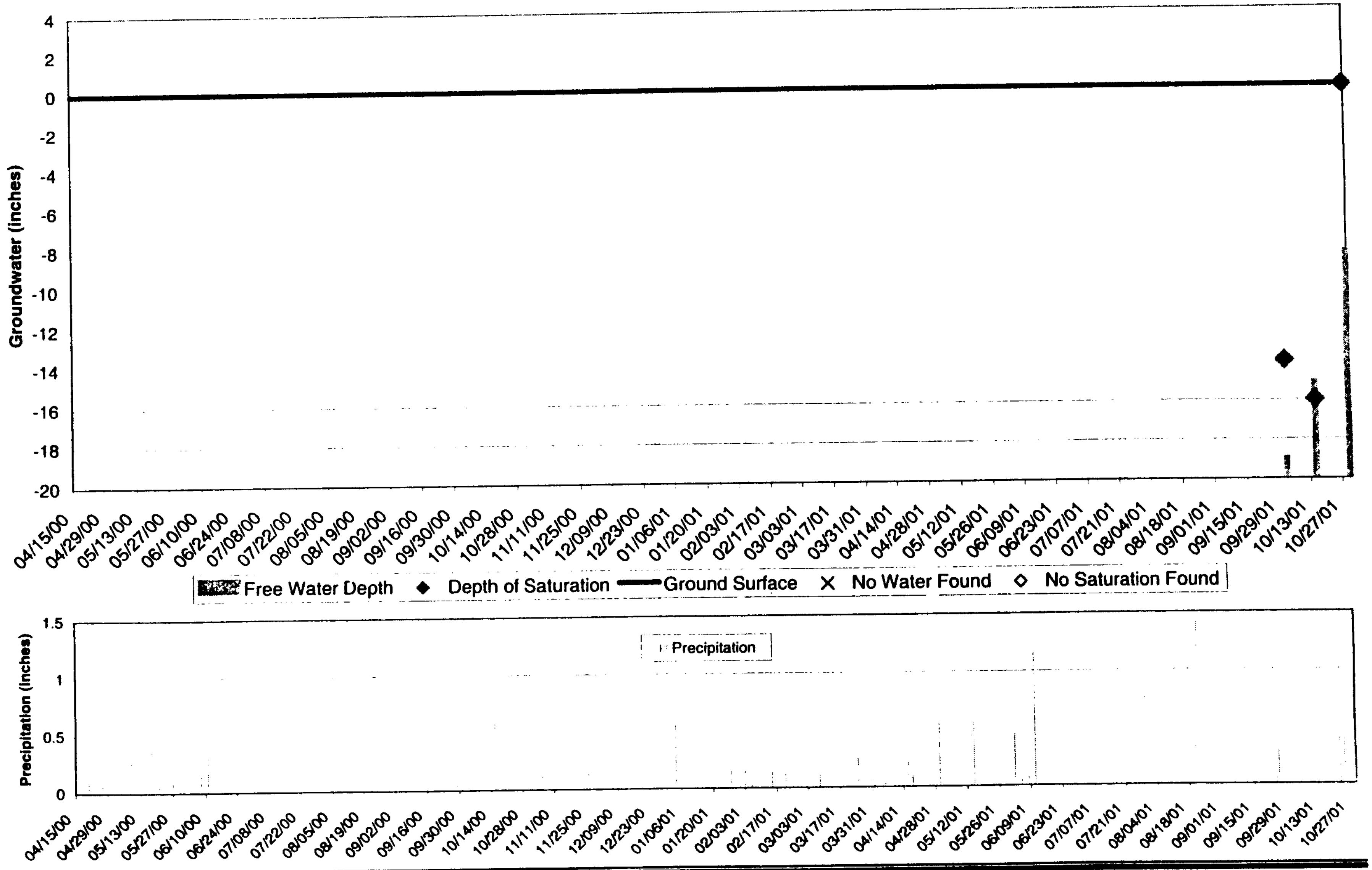
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A-16, Well A-16.



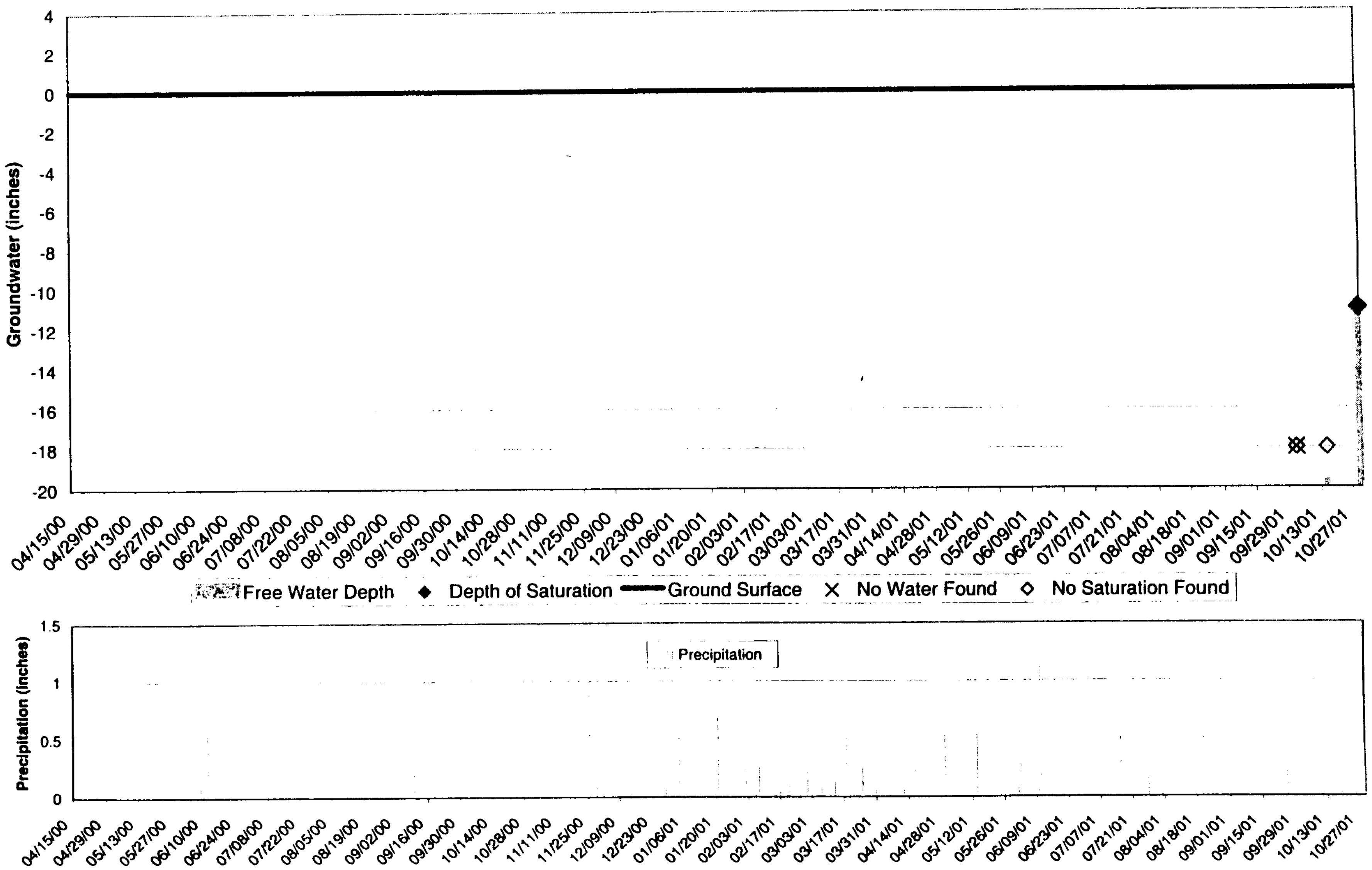
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A17, Well A17-A.

Appendix L
Natural Resource Mitigation Plan
Seattle-Tacoma International Airport Master Plan Update

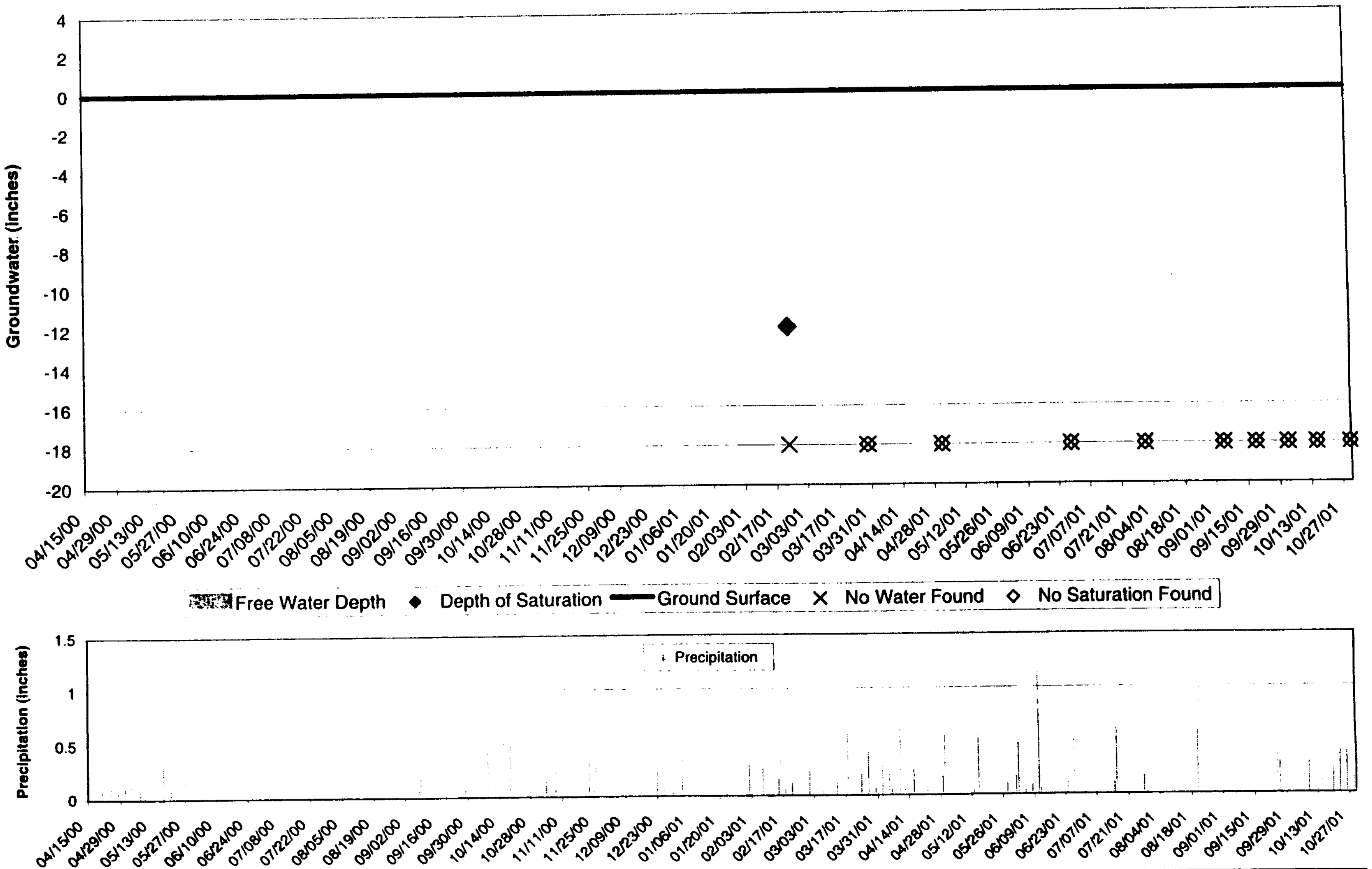
November 2001
556-2912-001 (03)



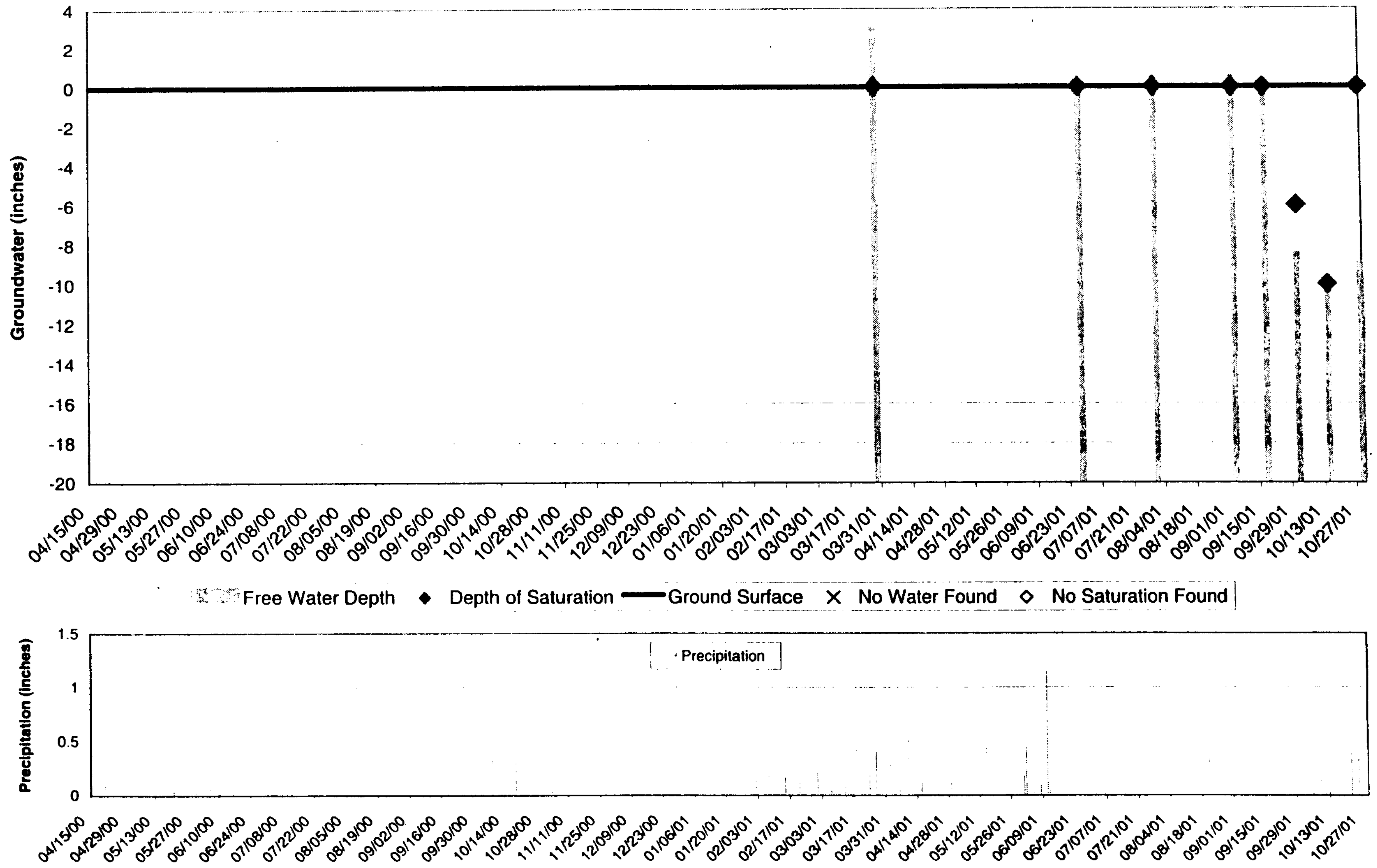
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A17, Well A17-C.



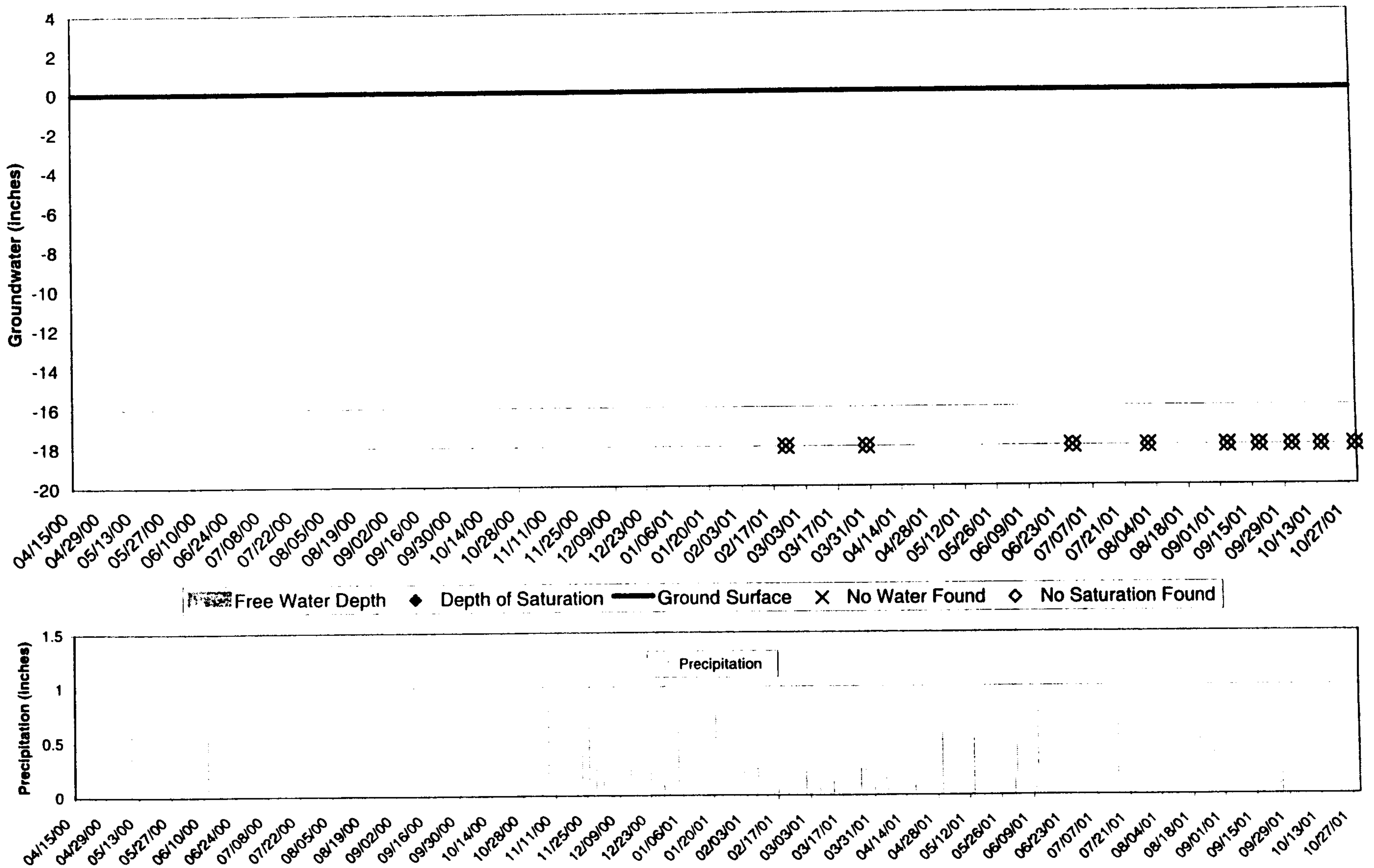
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland A17, Well A17-D.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B1.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B4.



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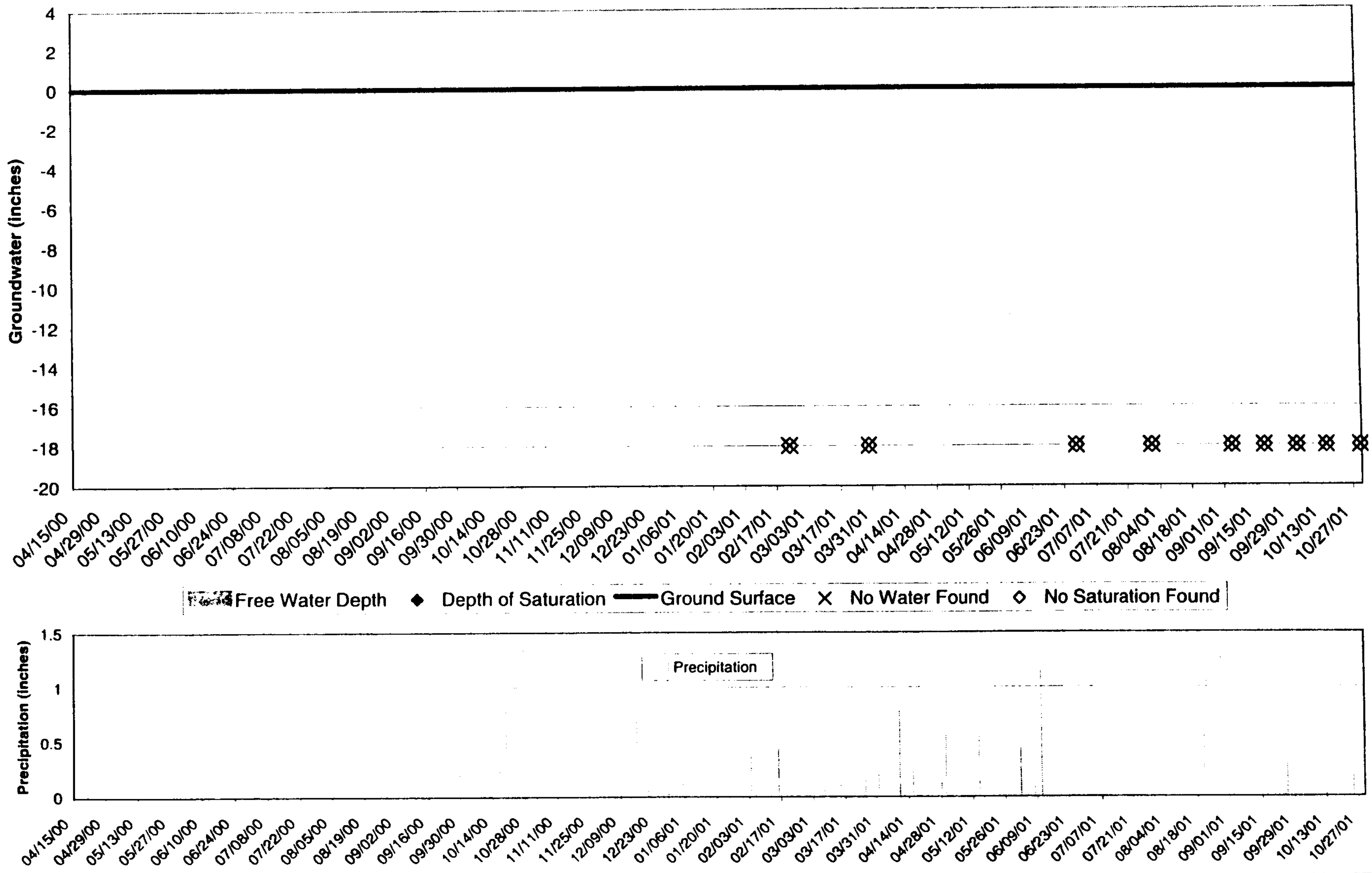

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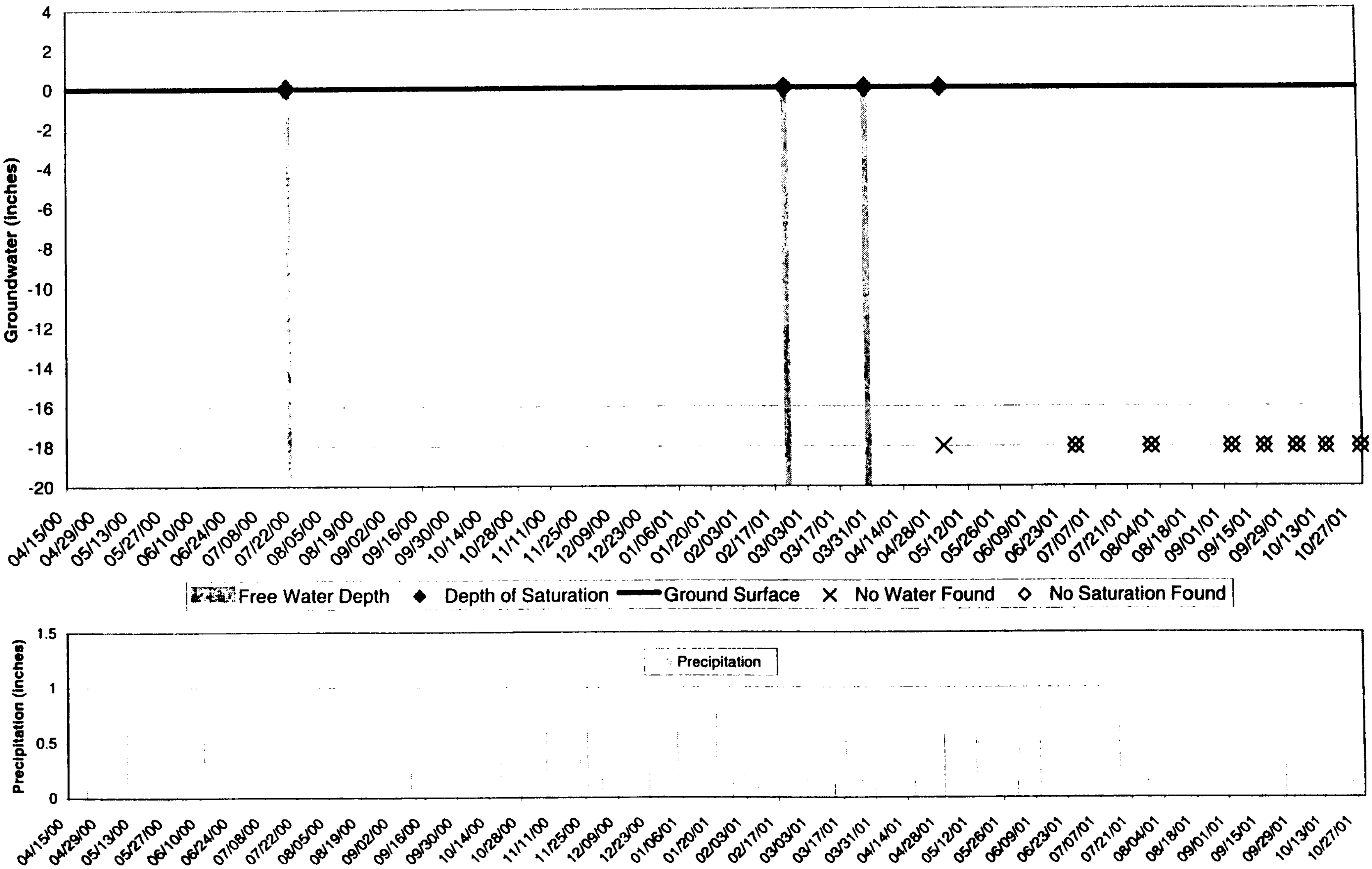
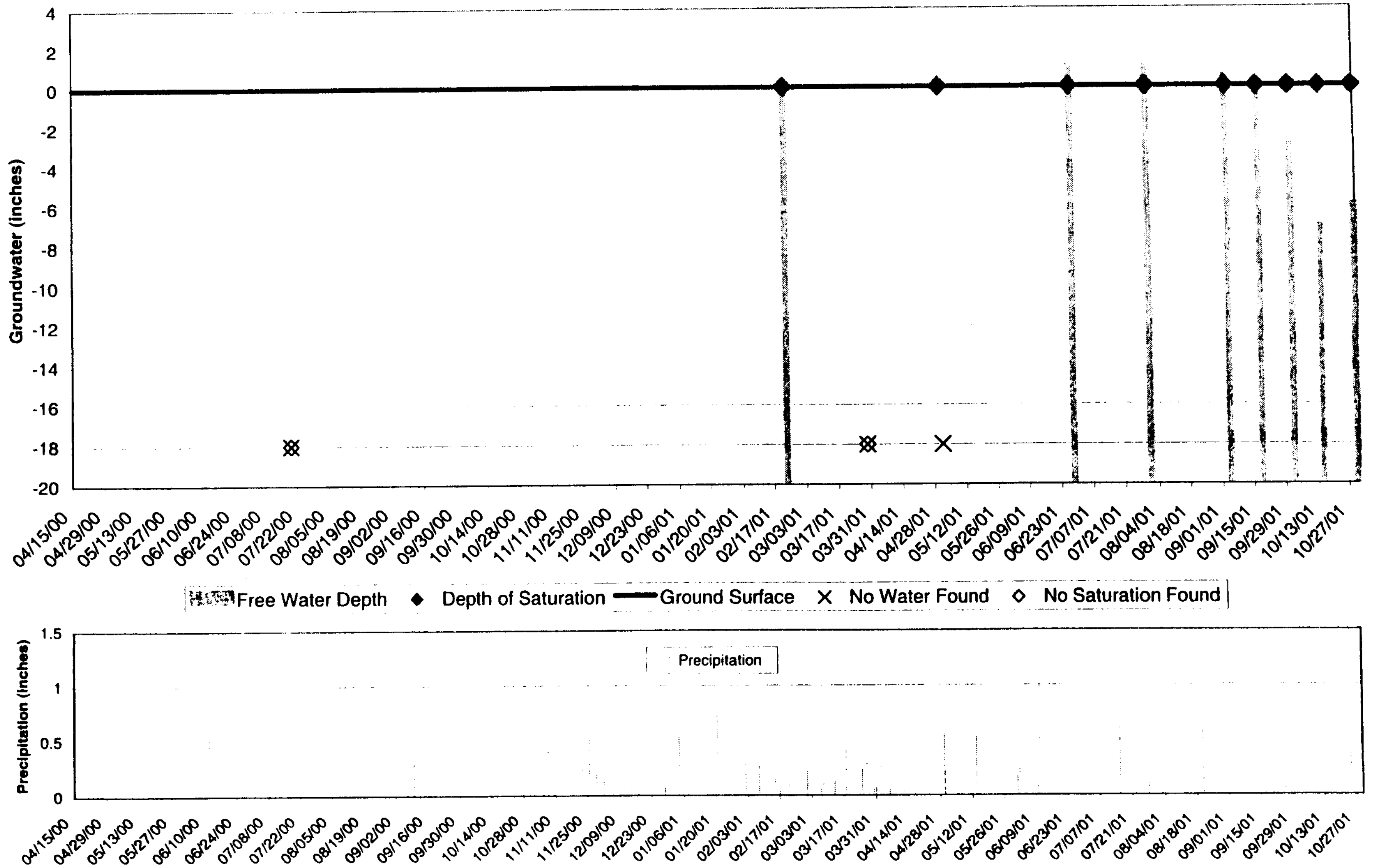
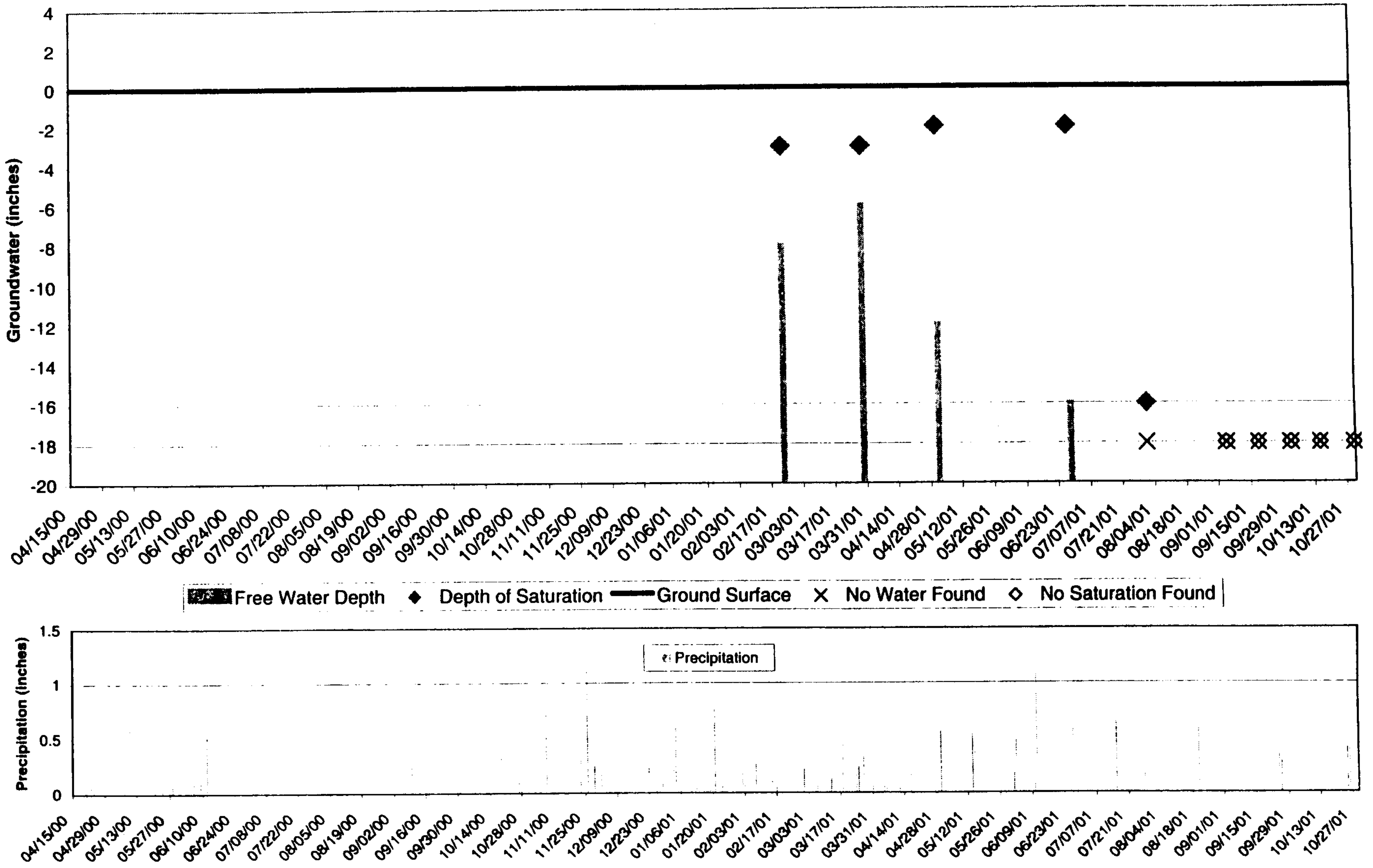


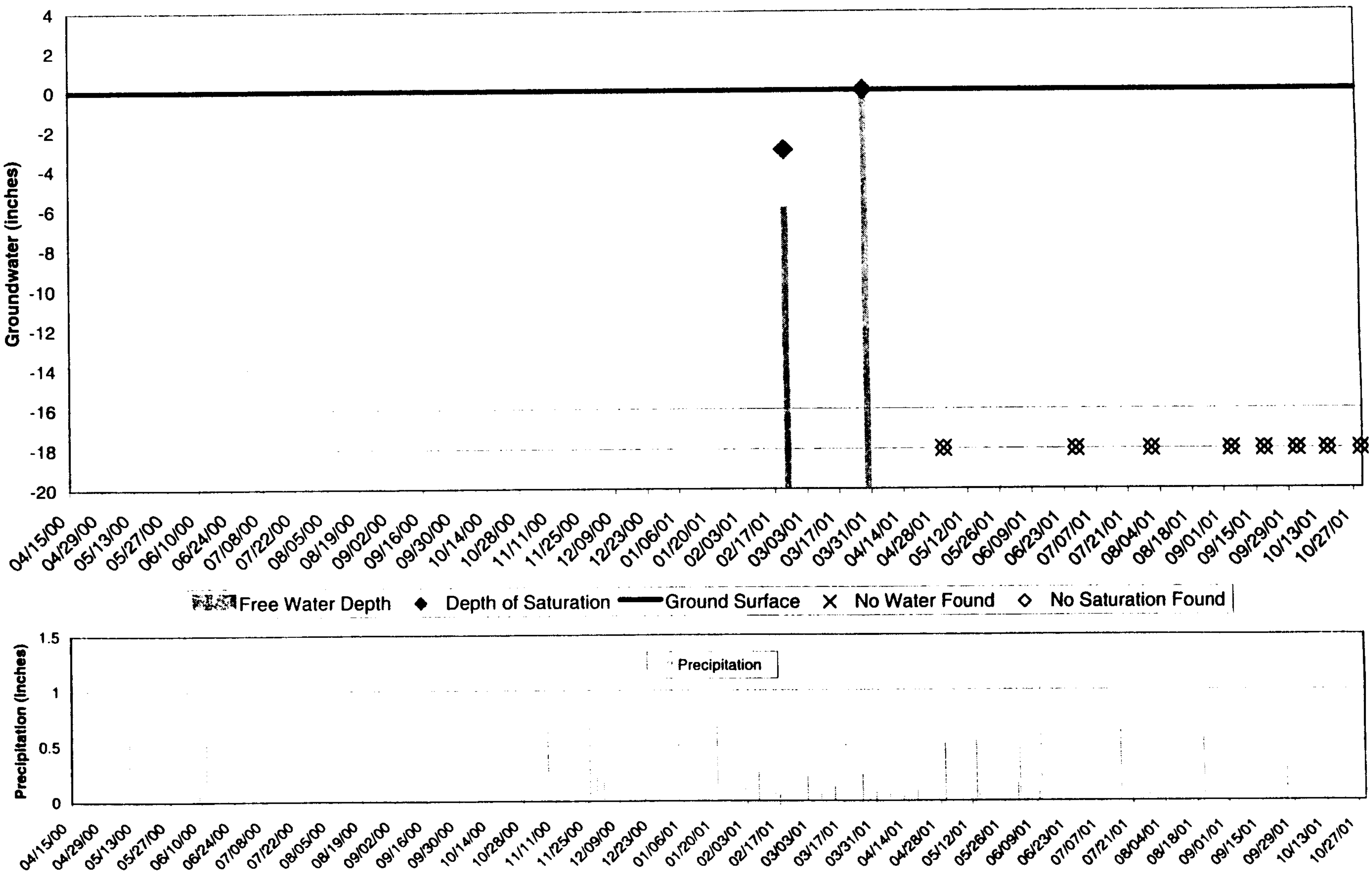
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B9.



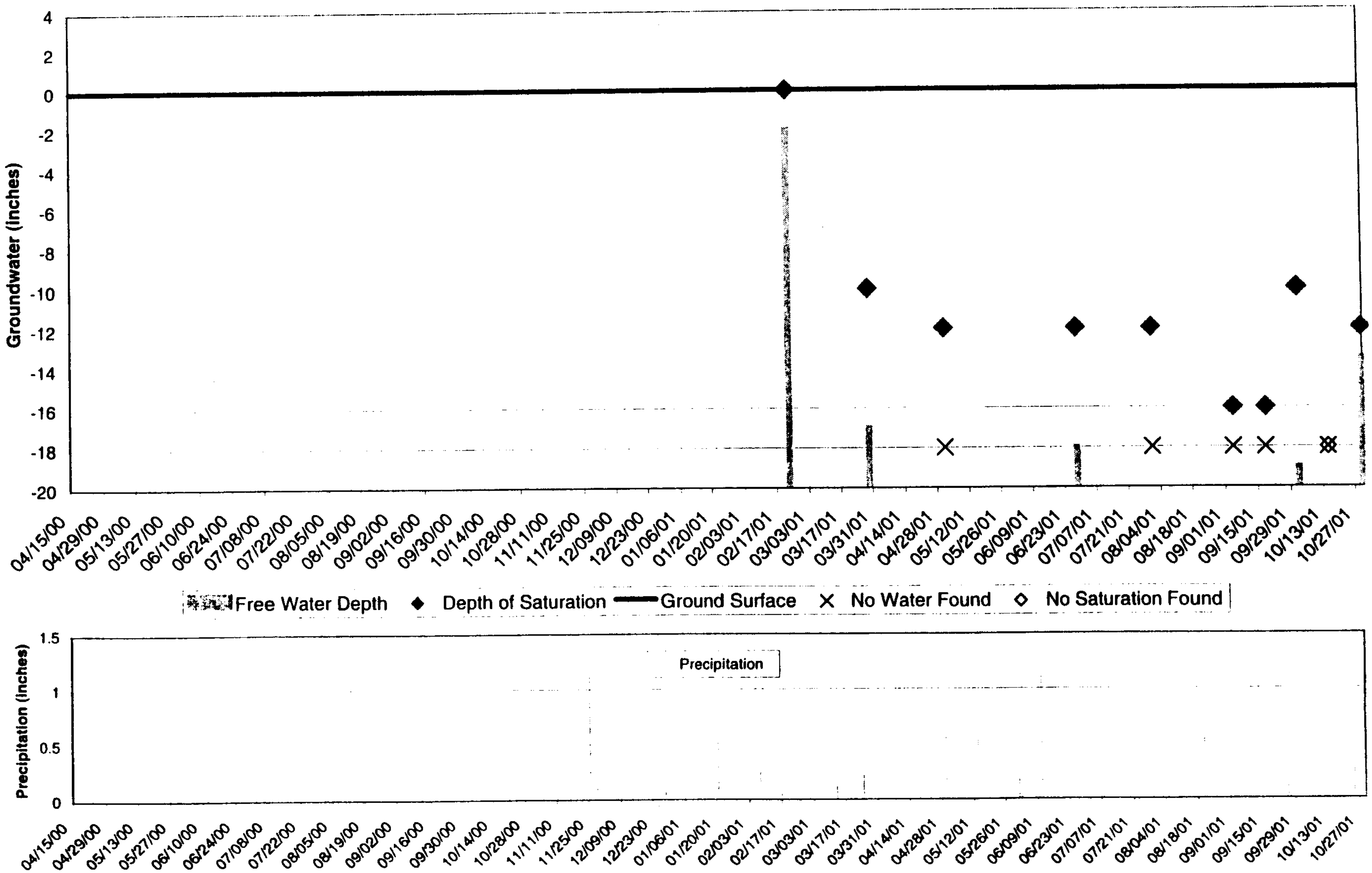
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B10.



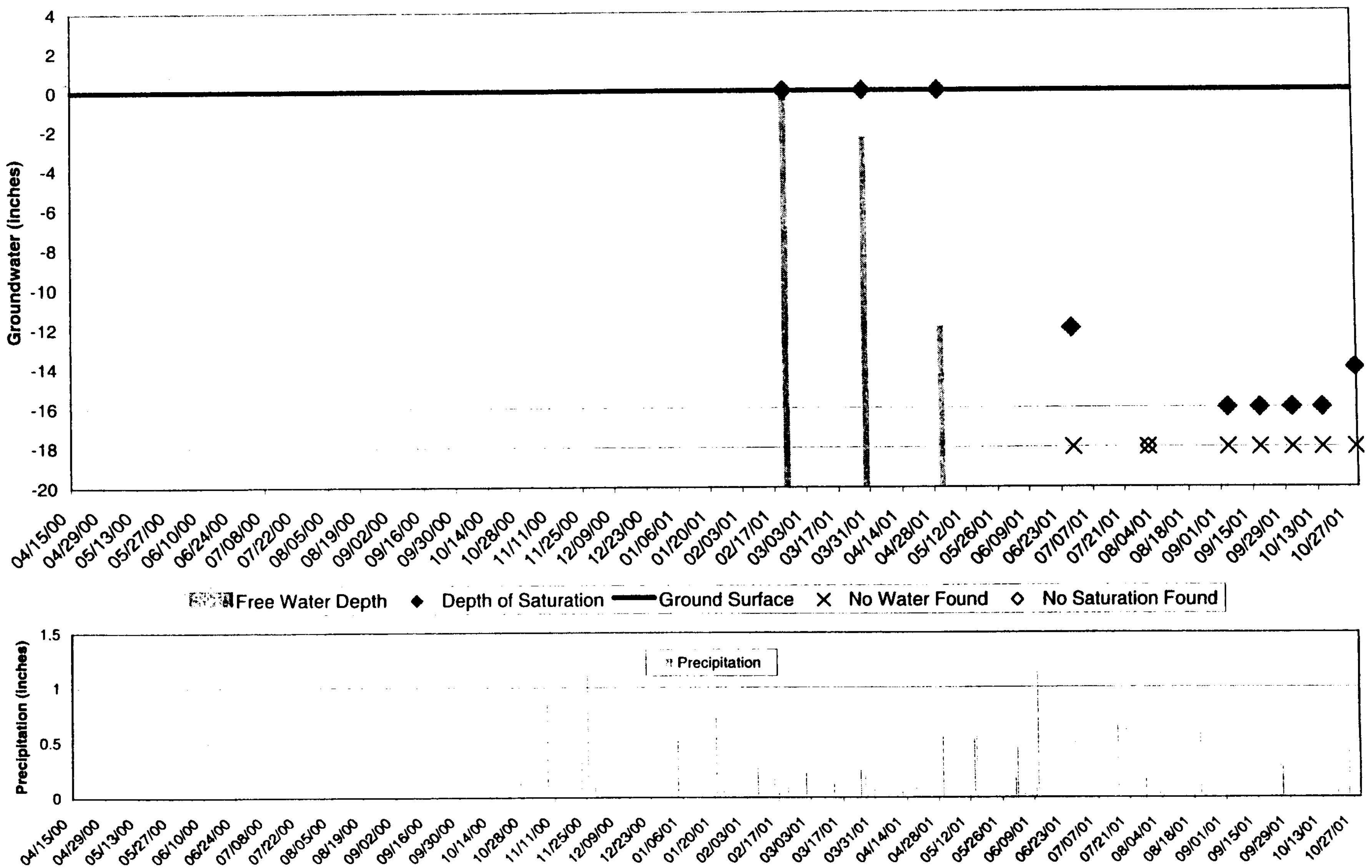
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B12.



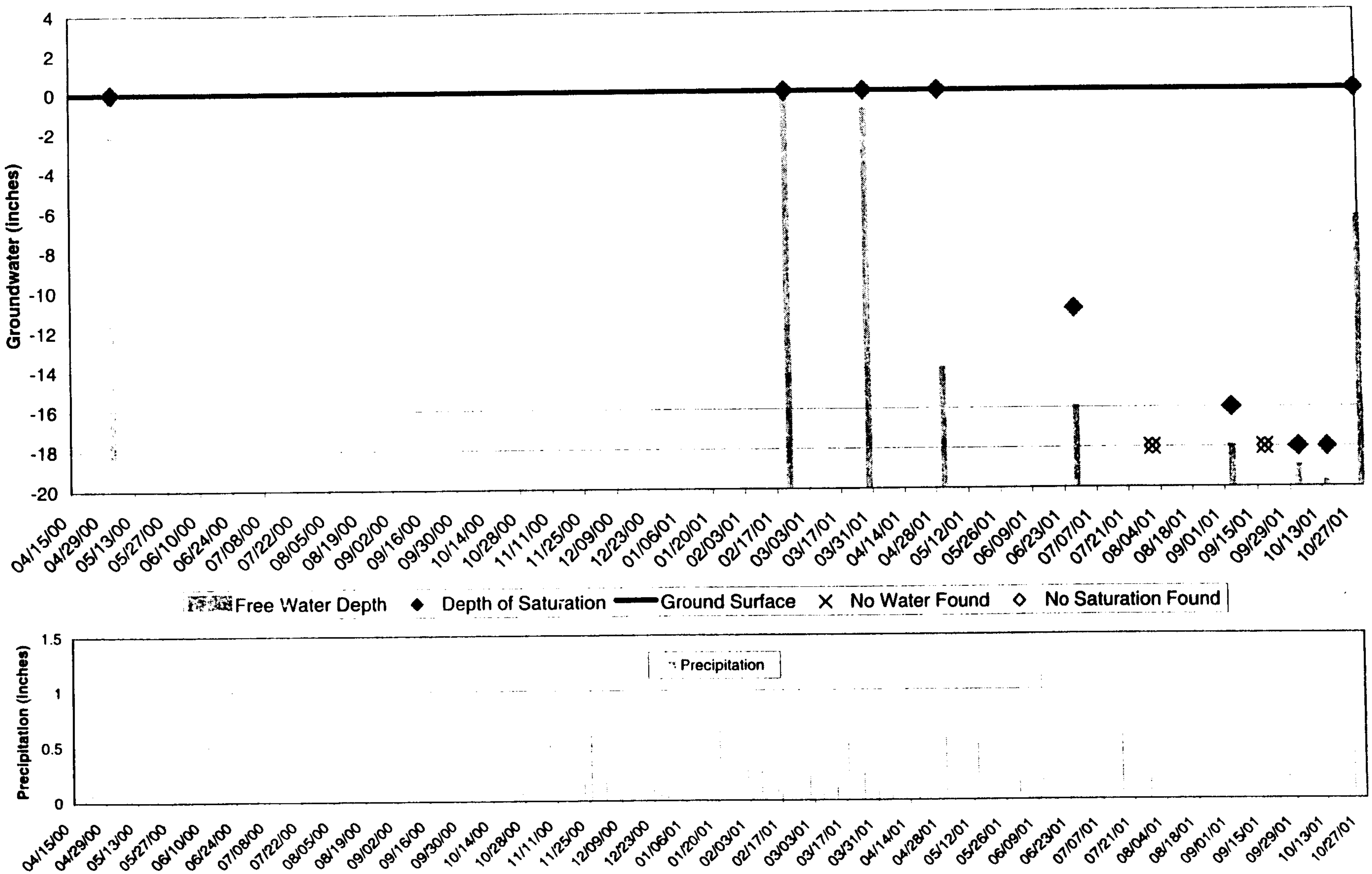
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Borrow Areas, Well B15.



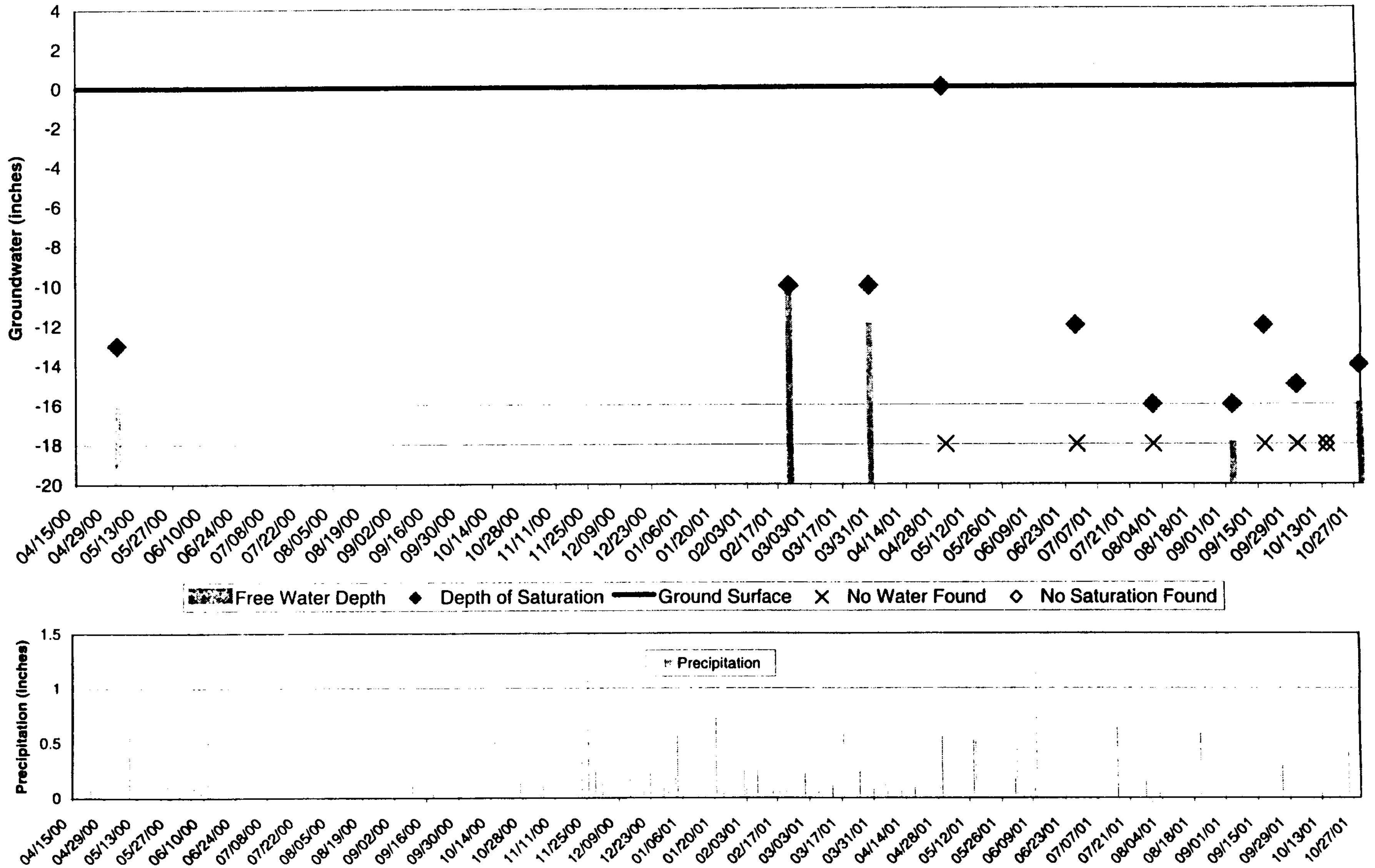
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R1, Well R1.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R2, Well R2.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R4, Well R4.



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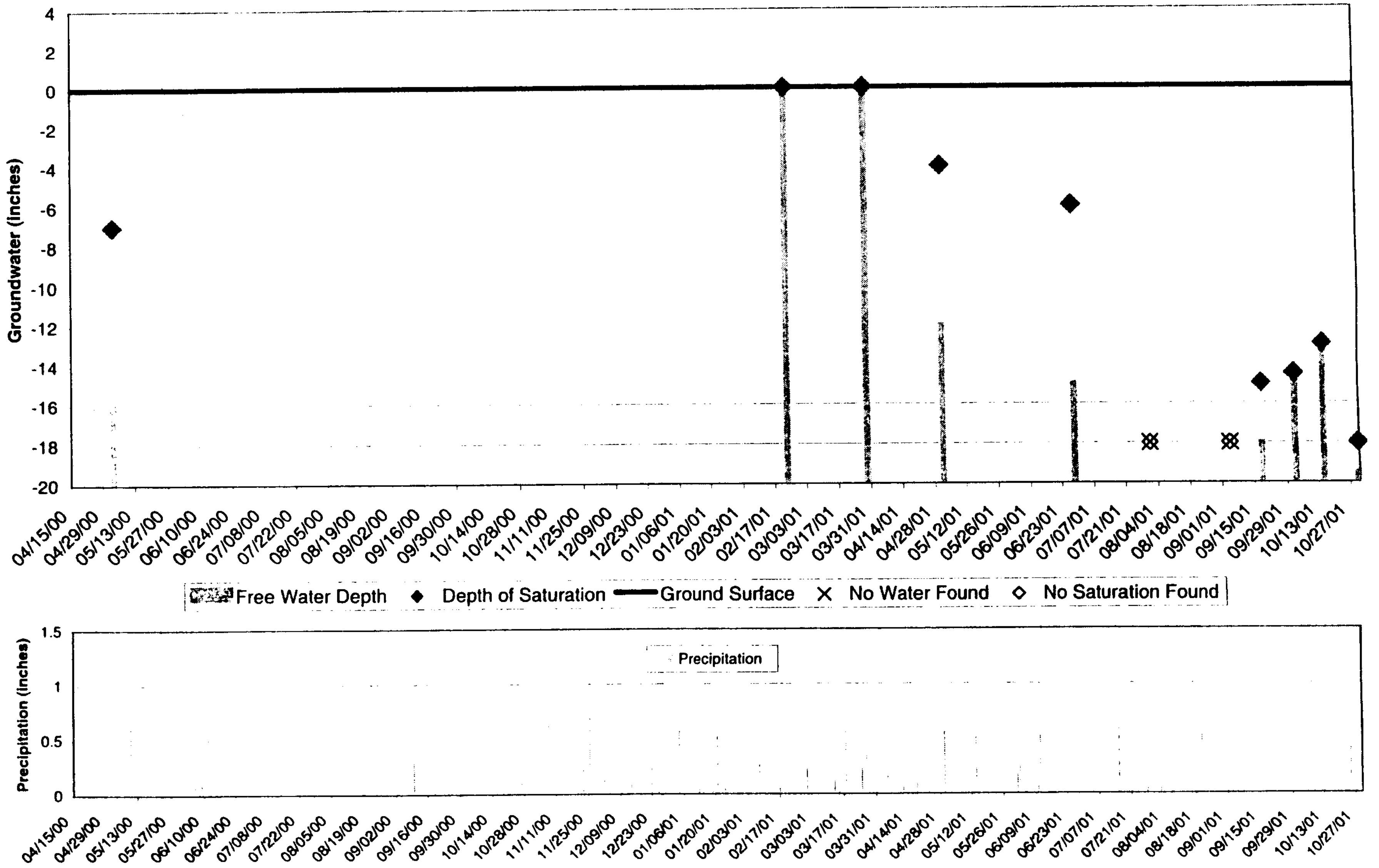
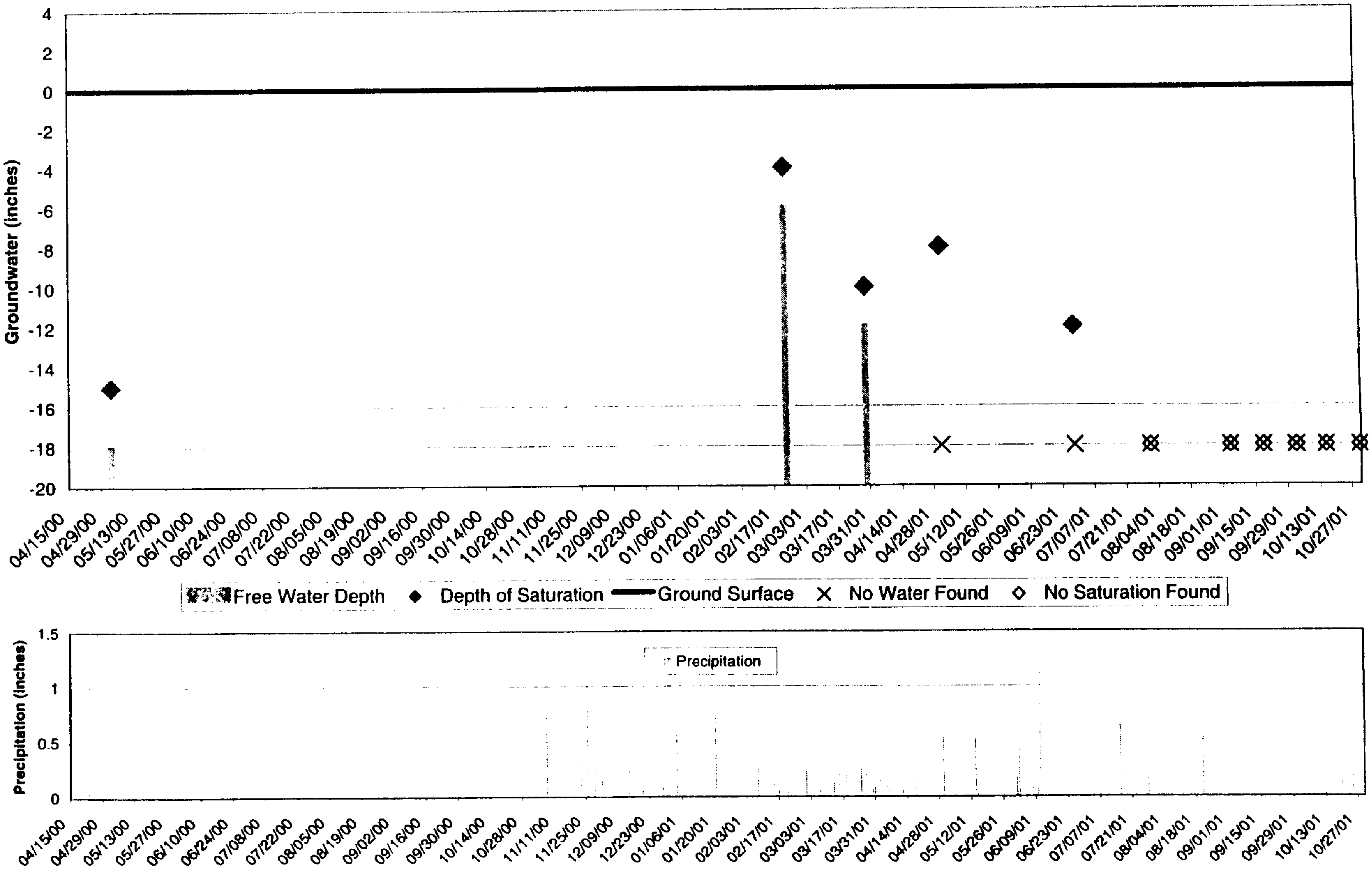
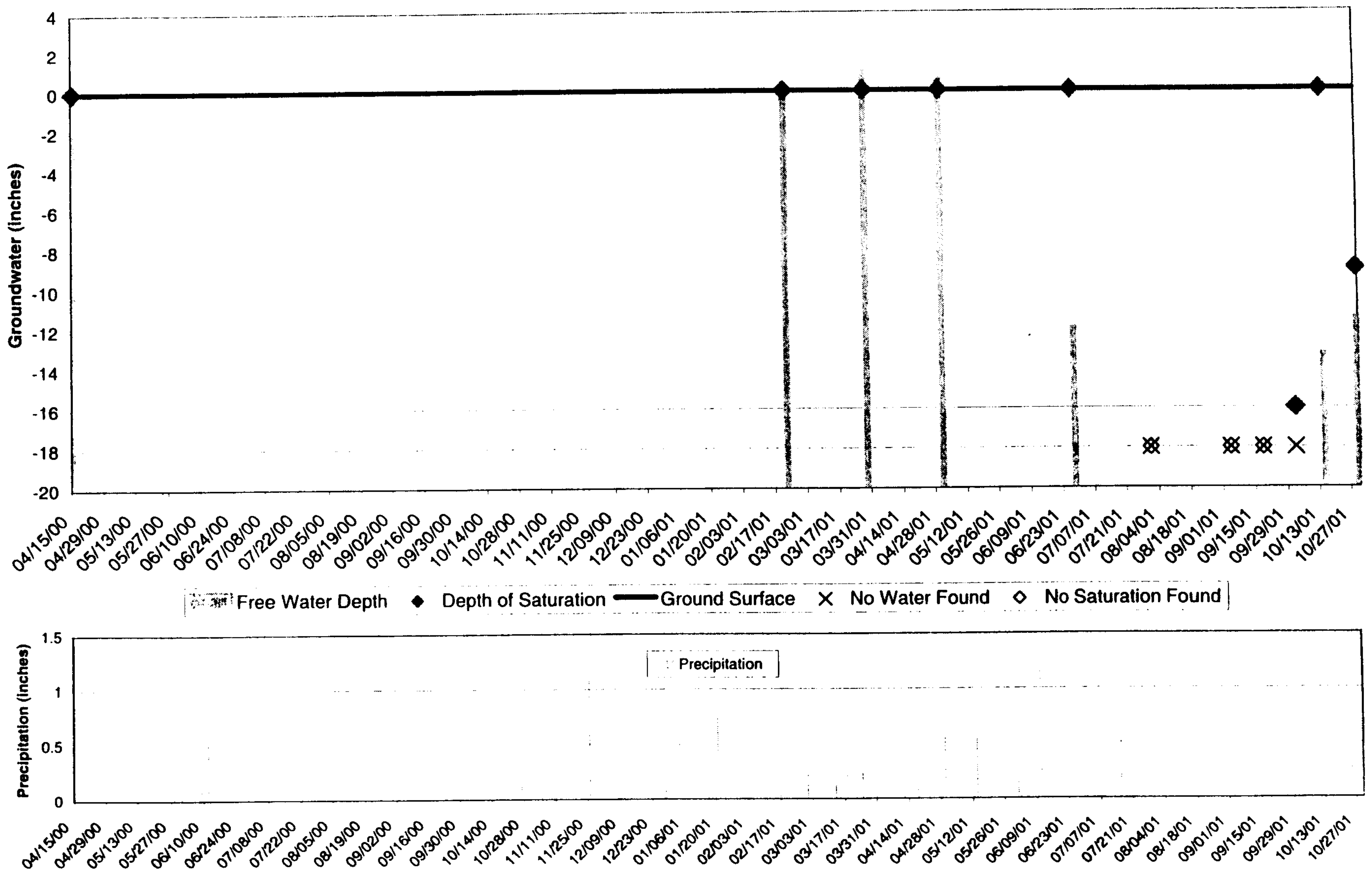


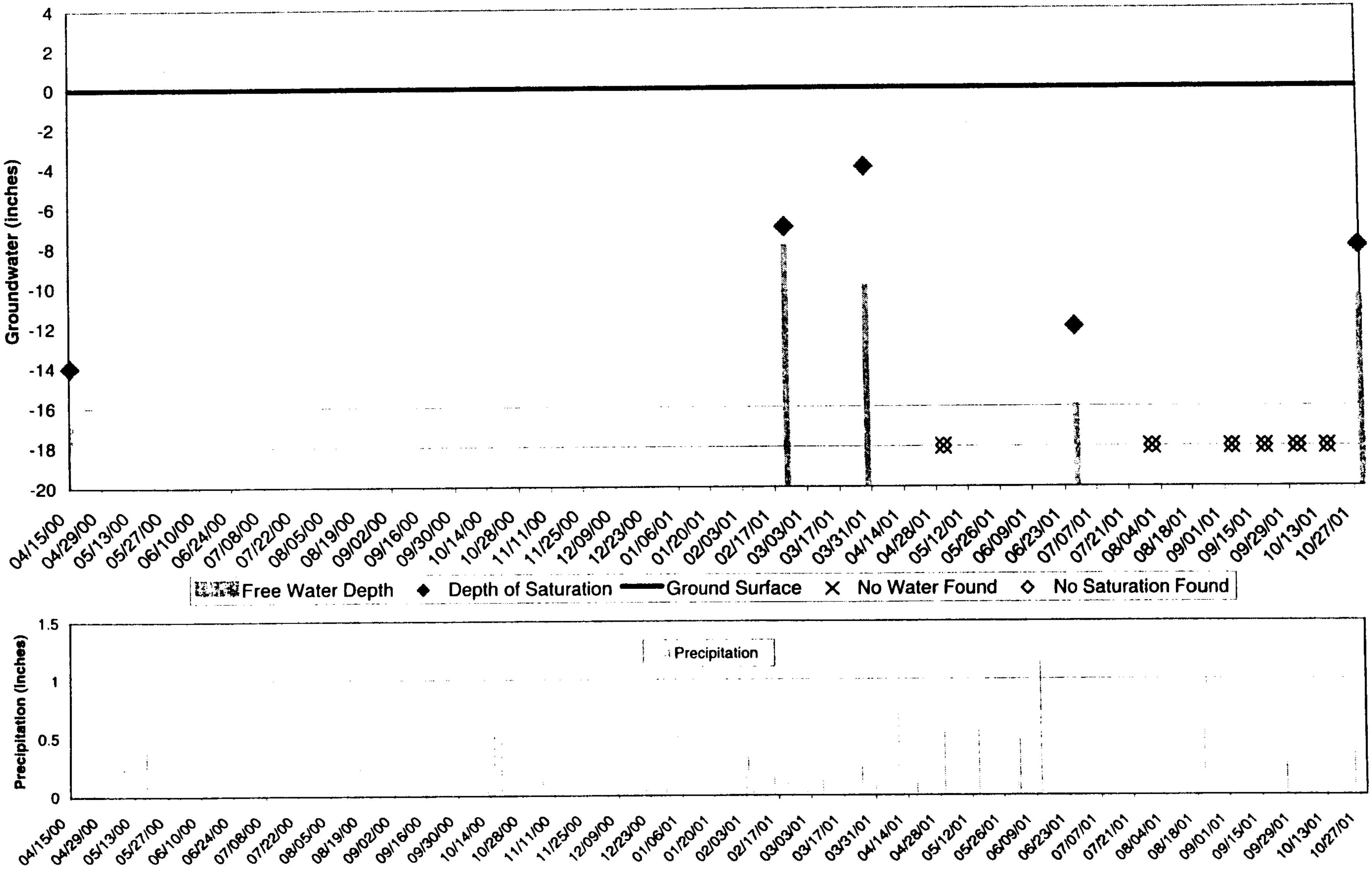
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R6, Well R6.



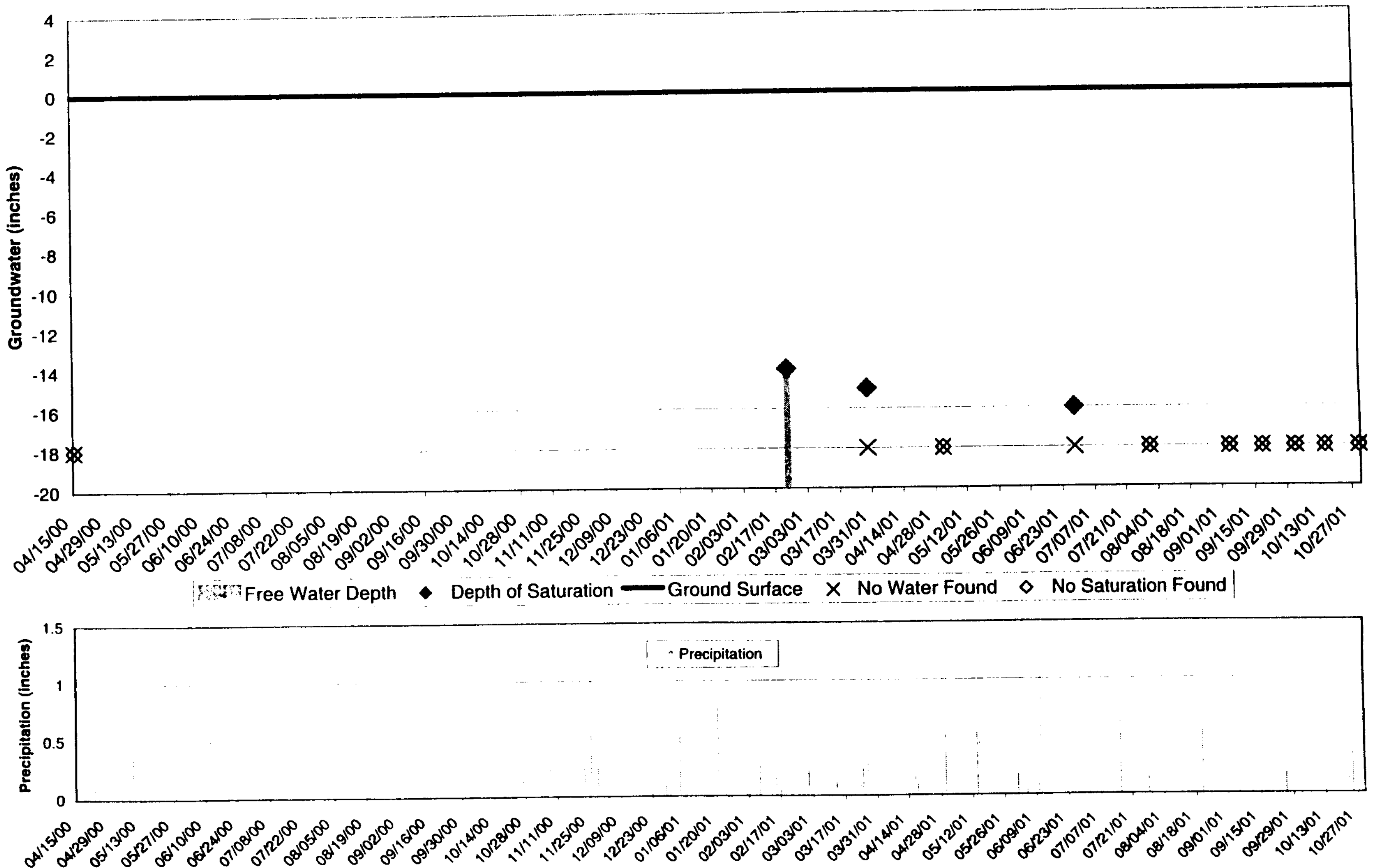
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R7a, Well R7a.



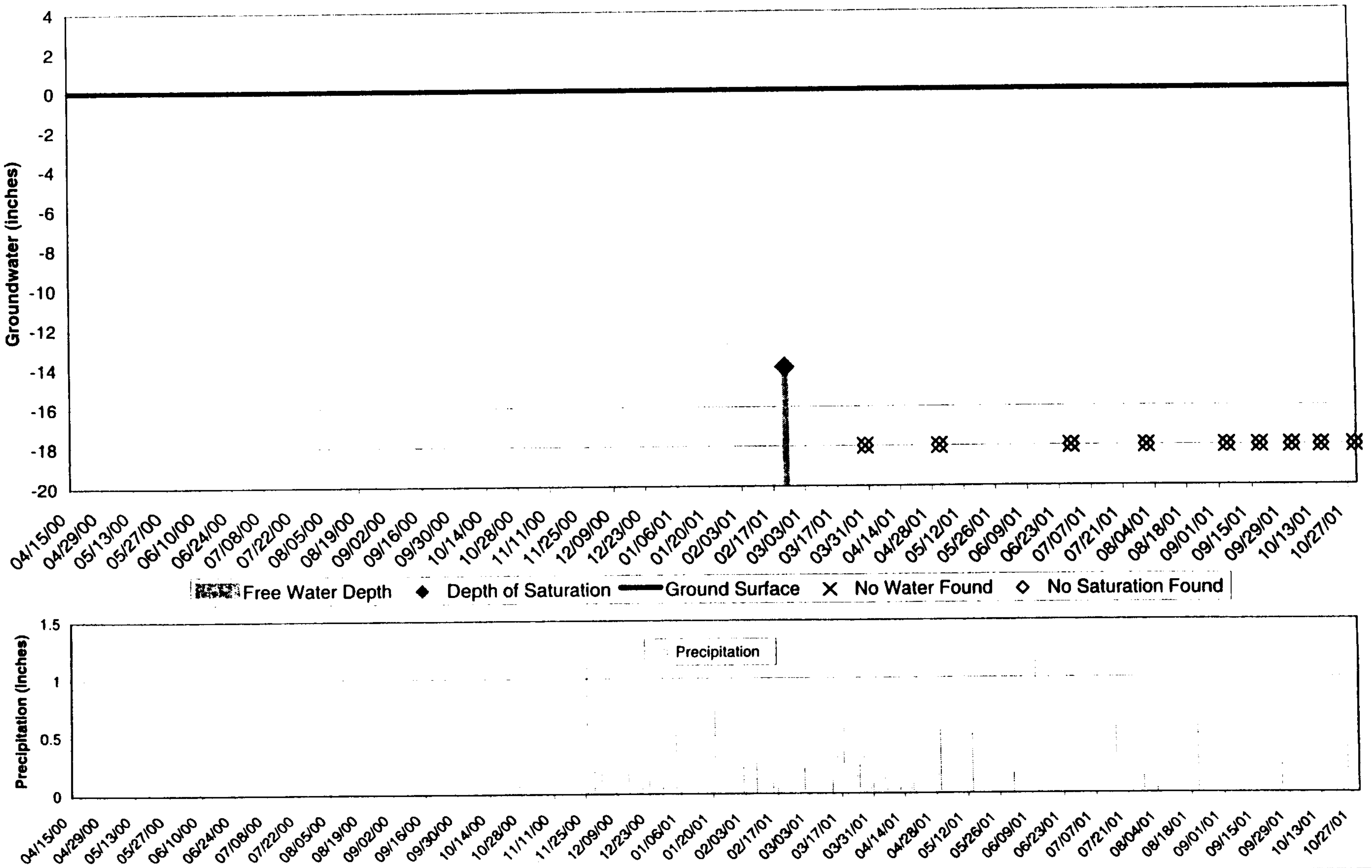
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R9, Well R9-1.



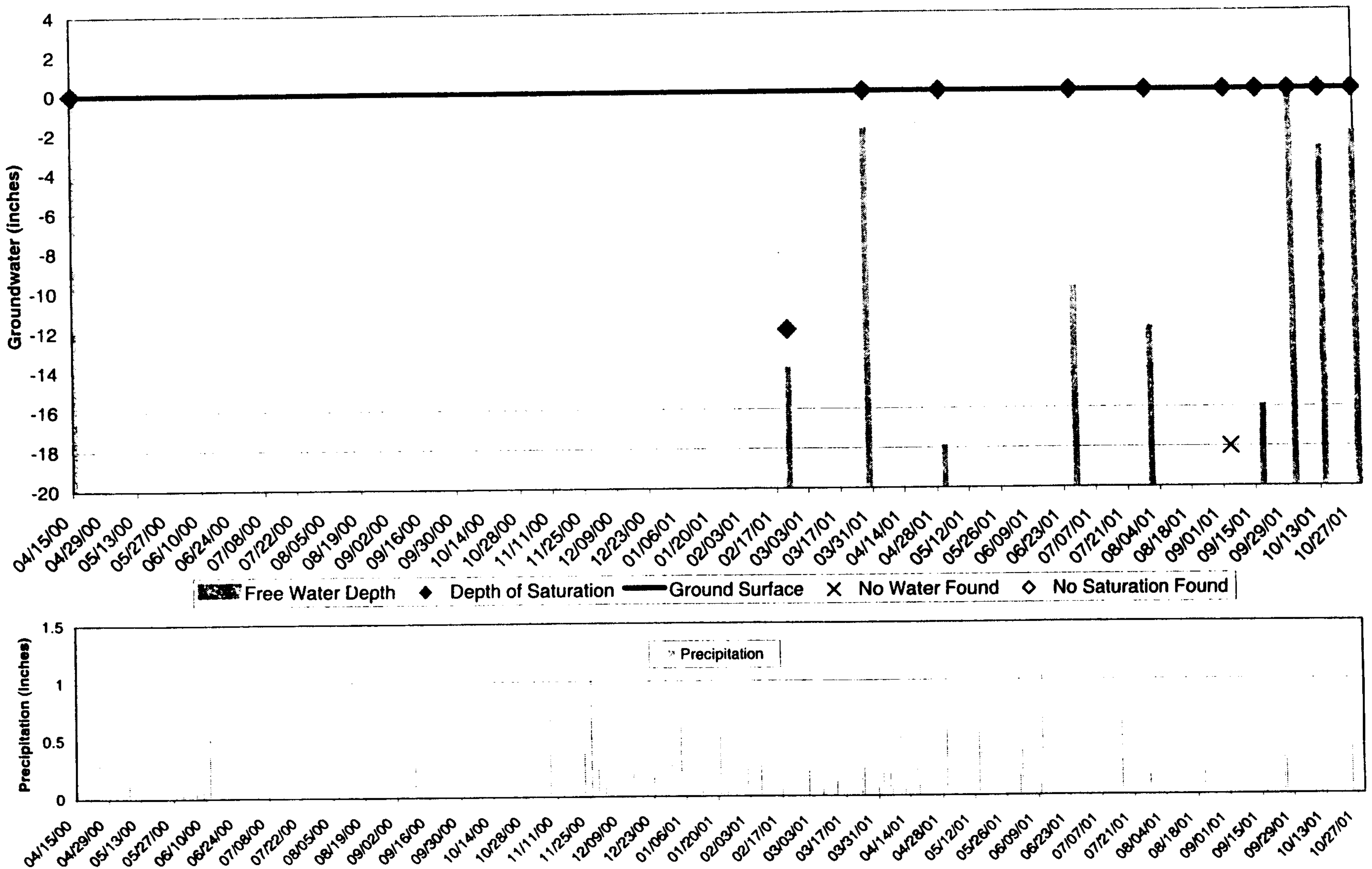
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R9, Well R9-2.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R10, Well R10.



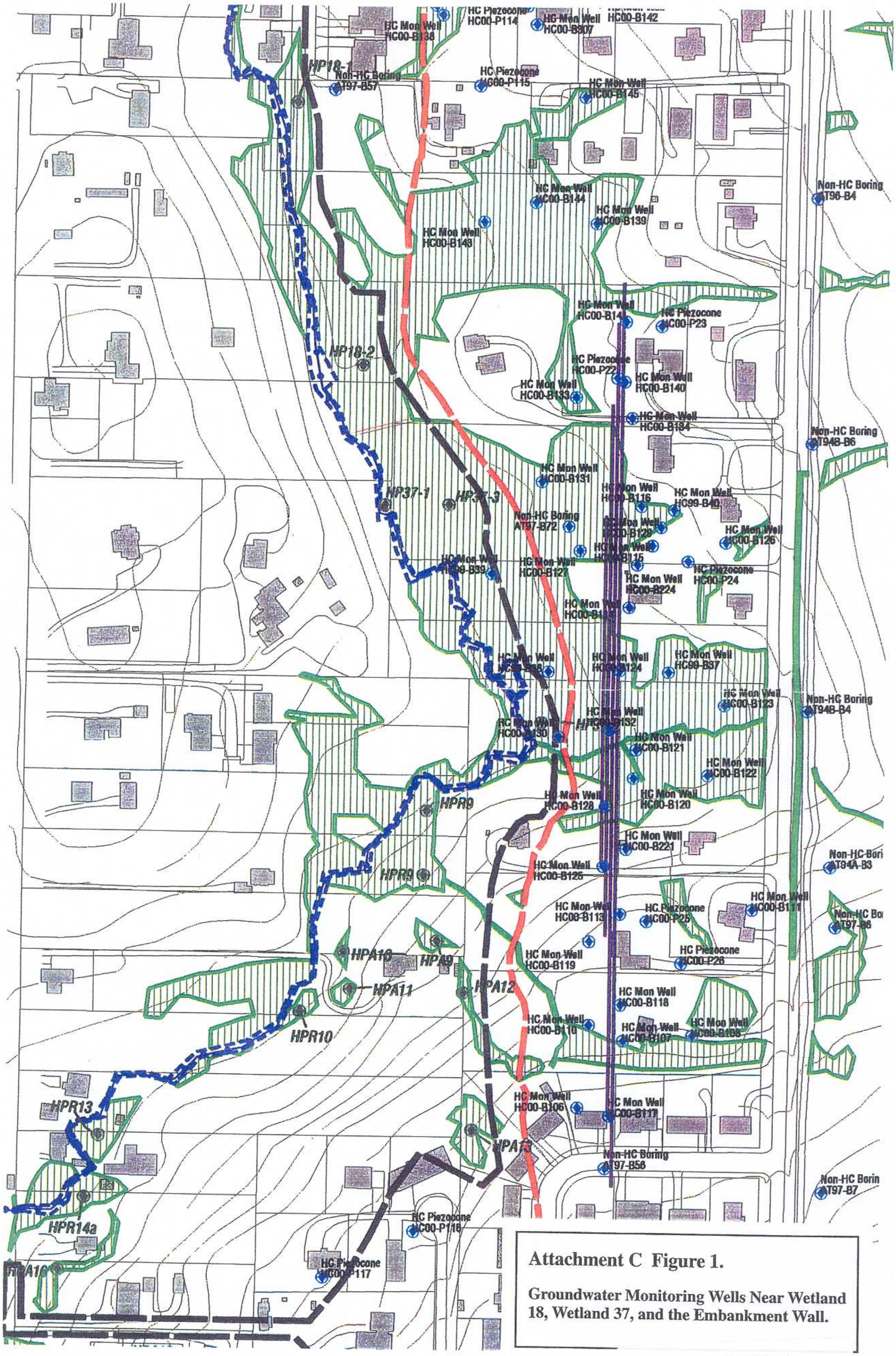
Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R13, Well R13.



Preconstruction Hydrologic Measurement of Groundwater, Saturated Soil, and Daily Precipitation Conditions at Wetland R14, Well R14.

ATTACHMENT C

GROUNDWATER DATA COLLECTED FOR GEOTECHNICAL STUDIES



Attachment C Figure 1.

Groundwater Monitoring Wells Near Wetland 18, Wetland 37, and the Embankment Wall.

ATTACHMENT C
Groundwater Monitoring Data Collected
Near Wetland 18, Wetland37, and the Embankment Wall

	AT94A-B3		AT96-B4		AT97-B69		HC99-B37		HC99-B38		HC99-B39		HC99-B40	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Measuring Point	0.00	*273.4*	0.00	*279.7*	0.00	*337.2*	0.00	237.65	0.00	230.88	0.00	230.80	0.00	250.63
Ground Level*	1.4	*272*	*-0.3*	*280*	3.2	*334*	3.1	234.6	3.3	227.6	-0.3	231.1	2.0	248.6
Top of Screen*	23.4	*250.0*	36.7	*243.0*	*27.7*	*310*	9.1	228.6	12.3	218.6	4.7	226.1	14.0	236.6
Bottom of Screen*	33.4	*240.0*	46.7	*233.0*	*29.7*	*308*	19.1	218.6	22.3	208.6	14.7	216.1	24.0	226.6
Date: 3/8/1999					--	--	3.52	234.13	4.40	226.48	0.69	230.11	4.88	245.75
3/10/1999					6.18	331.0								
4/5/1999					6.59	330.6	3.58	234.07	4.41	226.47	0.74	230.06	5.26	245.37
5/4/1999					7.43	329.8	3.82	233.83	4.60	226.28	0.86	229.94	5.75	244.88
5/15/1999					--	--								
6/14/1999					8.08	329.1	5.12	232.53	5.90	224.98	1.68	229.12	6.89	243.74
7/13/1999					8.41	328.8	4.72	232.93	5.93	224.95	2.05	228.75	7.18	243.45
8/13/1999					8.83	328.4	5.70	231.95	6.08	224.80	2.18	228.62	7.13	243.50
9/14/1999					9.16	328.0	6.47	231.18	6.48	224.40	2.51	228.29	7.67	242.96
10/13/1999					9.12	328.1	4.50	233.15	5.98	224.90	2.09	228.71	7.32	243.31
11/11/1999					8.13	329.1	3.22	234.43	4.25	226.63	2.90	227.90	5.80	244.83
12/9/1999					6.80	330.4	3.27	234.38	4.38	226.50	0.27	230.53	5.00	245.63
1/13/2000					6.48	330.7	3.20	234.45	4.35	226.53	0.54	230.26	4.86	245.77
2/14/2000					6.54	330.7	3.12	234.53	4.33	226.55	0.59	230.21	4.49	246.14
3/9/2000	Flowing	>272	Flowing	>280	6.82	330.4	3.17	234.48	4.43	226.45	0.61	230.19	5.57	245.06
4/11/2000	Flowing	>272	Flowing	>280	7.45	329.8	3.35	234.30	4.60	226.28	0.88	229.92	5.08	245.55
5/10/2000	Flowing	>272	Flowing	>280	7.78	329.4	3.19	234.46	4.32	226.56	0.88	229.92	5.14	245.49
6/19/2000	-7.15	280.6	Flowing	>280	8.40	328.8	3.76	233.89	4.91	225.97	1.15	229.65	6.01	244.62
7/10/2000	-6.00	279.4	-1.73	281.4	8.84	328.4	3.96	233.69	5.72	225.16	1.61	229.19	6.50	244.13
10/10/2000	-1.38	274.8	-0.81	280.5	9.90	327.3	3.84	233.81	5.99	224.89	2.17	228.63	8.39	242.24
1/22/2001	-8.30	281.7	-2.35	282.1	7.82	329.4	3.30	234.35	4.42	226.46	0.79	230.01	5.25	245.38
5/4/2001	-8.54	281.9	1.04	278.7	8.93	328.3	3.31	234.34	4.58	226.30	1.05	229.75	5.44	245.19

ATTACHMENT C
Groundwater Monitoring Data Collected
Near Wetland 18, Wetland37, and the Embankment Wall

	HC00-B106		HC00-B111		HC00-B118		HC00-B120		HC00-B121		HC00-B123		HC00-B125	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Measuring Point	0.00	315.81	0.00	286.06	0.00	298.61	0.00	236.93	0.00	231.78	0.00	237.64	0.00	257.8
Ground Level*	1.7	314.1	0.8	285.3	1.0	297.7	2.9	234.0	2.1	229.7	2.9	234.7	-0.4	258.2
Top of Screen*	11.7	304.1	9.8	276.3	7.0	291.7	17.6	219.3	6.8	225.0	14.0	223.7	3.6	254.2
Bottom of Screen*	21.7	294.1	19.8	266.3	12.0	286.7	22.6	214.3	16.8	215.0	24.0	213.7	8.6	249.2
Date: 3/8/1999														
3/10/1999														
4/5/1999														
5/4/1999														
5/15/1999														
6/14/1999														
7/13/1999														
8/13/1999														
9/14/1999														
10/13/1999														
11/11/1999														
12/9/1999														
1/13/2000														
2/14/2000	5.49	310.32	6.80	279.26	6.63	291.98								
3/9/2000	5.50	310.31	6.94	279.12	6.71	291.90								
4/11/2000	6.21	309.60	8.34	277.72	7.84	290.77	5.1	231.83	0.80	230.98	2.06	235.58	3.74	254.06
5/10/2000	6.38	309.43	8.59	277.47	7.64	290.97	4.92	232.01	0.62	231.16	1.90	235.74	3.89	253.91
6/19/2000	7.04	308.77	9.17	276.89	8.52	290.09	5.52	231.41	1.09	230.69	2.25	235.39	4.79	253.01
7/10/2000	7.47	308.34	9.95	276.11	9.12	289.49	6.1	230.83	1.53	230.25	2.61	235.03	6.39	251.41
10/10/2000	8.52	307.29	10.83	275.23	9.85	288.76	6.23	230.70	1.53	230.25	2.59	235.05	6.83	250.97
1/22/2001	7.02	308.79	6.57	279.49	6.37	292.24	4.87	232.06	0.52	231.26	1.90	235.74	5.66	252.14
5/4/2001	7.69	308.12	7.77	278.29	7.75	290.86	4.97	231.96	0.56	231.22	2.00	235.64	5.07	252.73

ATTACHMENT C
Groundwater Monitoring Data Collected Near Wetland 18, Wetland37, and the Embankment Wall

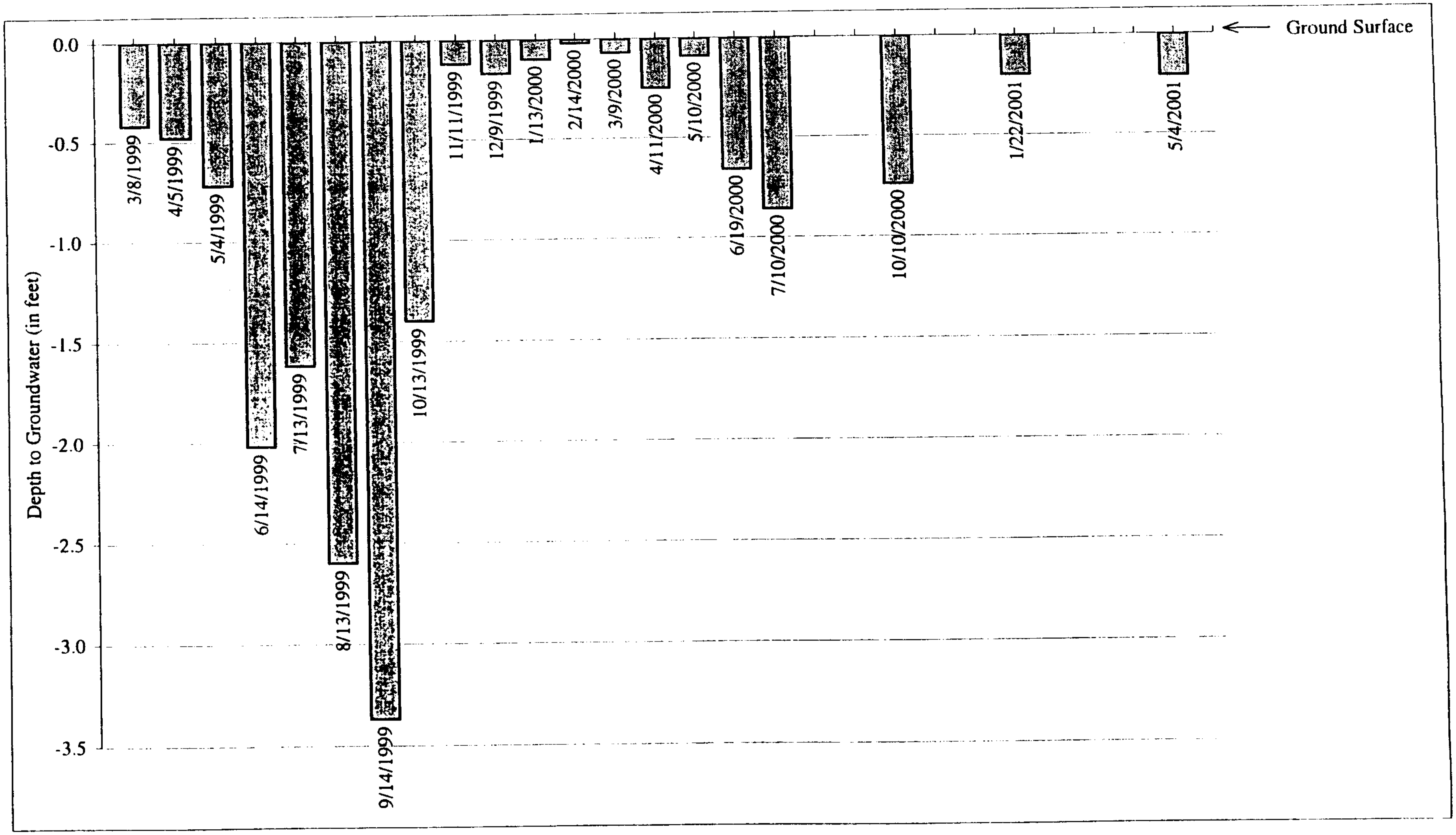
	HC00-B126		HC00-B129		HC00-B130		HC00-B132		HC00-B133		HC00-B137		HC00-B141	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Measuring Point	0.00	251.56	0.00	245.83	0.00	225.46	0.00	229.96	0.00	243.47	0.00	267.21	0.00	258.64
Ground Level*	1.4	250.2	2.6	243.2	2.3	223.1	2.6	227.4	2.4	241.1	2.8	264.5	0.9	257.8
Top of Screen*	8.4	243.2	9.6	236.2	7.3	218.1	13.6	216.4	7.4	236.1	9.8	257.5	12.9	245.8
Bottom of Screen*	13.4	238.2	14.6	231.2	11.4	214.1	18.6	211.4	12.4	231.1	17.8	249.5	22.9	235.8
Date: 3/8/1999														
3/10/1999														
4/5/1999														
5/4/1999														
5/15/1999														
6/14/1999														
7/13/1999														
8/13/1999														
9/14/1999														
10/13/1999														
11/11/1999														
12/9/1999														
1/13/2000														
2/14/2000	2.02	249.54	3.07	242.76					2.51	240.96			7.94	250.70
3/9/2000	1.82	249.74	3.15	242.68					2.44	241.03			8.91	249.73
4/11/2000	1.97	249.59	3.59	242.24	1.73	223.73	2.65	227.31	2.53	240.94			10.21	248.43
5/10/2000	2.07	249.49	3.6	242.23	1.67	223.79	2.55	227.41	2.61	240.86			10.75	247.89
6/19/2000	2.54	249.02	4.56	241.27	1.92	223.54	2.91	227.05	3.97	239.50	2.54	264.67	11.50	247.14
7/10/2000	2.68	248.88	5.01	240.82	2.14	223.32	3.24	226.72	5.01	238.46	4.12	263.09	11.88	246.76
10/10/2000	5.15	246.41	6.6	239.23	1.88	223.58	3.29	226.67	5.94	237.53			12.99	245.65
1/22/2001	2.40	249.16	4.75	241.08	1.47	223.99	2.58	227.38	2.71	240.76			9.43	249.21
5/4/2001	2.19	249.37	3.94	241.89	1.56	223.90	2.63	227.33	2.76	240.71			10.32	248.32

ATTACHMENT C
Groundwater Monitoring Data Collected
Near Wetland 18, Wetland37, and the Embankment Wall

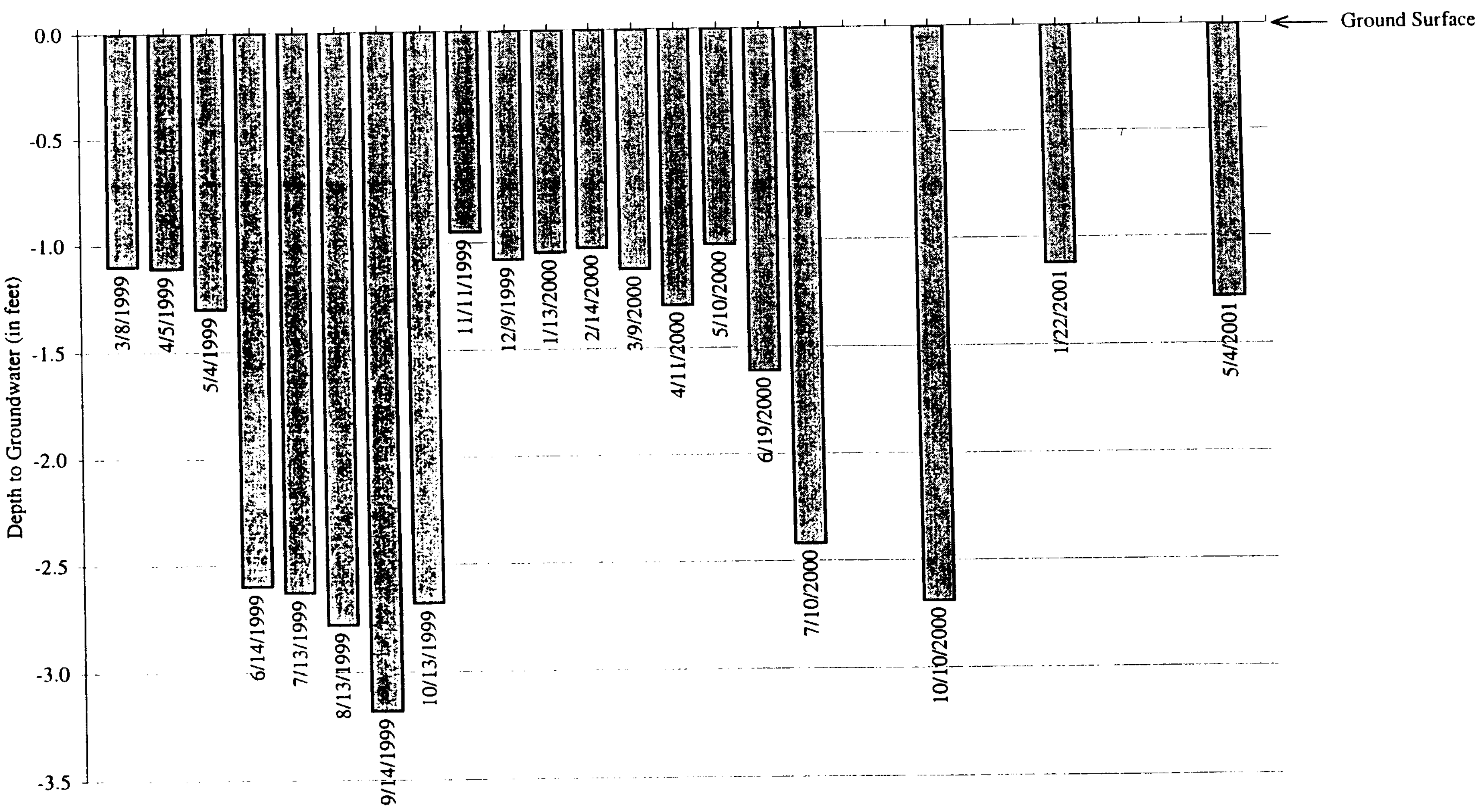
	HC00-B142		HC00-B143		HC00-B144		HC00-B145		HC00-B146	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Measuring Point	0.00	272.72	0.00	242.27	0.00	248.99	0.00	265.11	0.00	263.55
Ground Level*	2.7	270.1	3.2	239.1	2.4	246.6	2.3	262.8	2.9	260.7
Top of Screen*	17.2	255.6	7.2	235.1	8.9	240.1	12.3	252.8	11.9	251.7
Bottom of Screen*	22.2	250.6	12.2	230.1	13.9	235.1	17.3	247.8	16.9	246.7
Date: 3/8/1999										
3/10/1999										
4/5/1999										
5/4/1999										
5/15/1999										
6/14/1999										
7/13/1999										
8/13/1999										
9/14/1999										
10/13/1999										
11/11/1999										
12/9/1999										
1/13/2000										
2/14/2000							2.94	262.17		
3/9/2000	3.27	269.45			2.98	246.01	3.14	261.97	3.81	259.74
4/11/2000	3.53	269.19			3.17	245.82	3.51	261.60	4.02	259.53
5/10/2000	3.58	269.14			3.00	245.99	3.18	261.93	3.79	259.76
6/19/2000	4.57	268.15	4.23	238.04	4.11	244.88	3.95	261.16	4.56	258.99
7/10/2000	5.17	267.55	5.96	236.31	5.76	243.23	4.59	260.52	5.92	257.63
10/10/2000	6.19	266.53			7.07	241.92	5.84	259.27	6.26	257.29
1/22/2001	3.85	268.87	3.61	238.66	3.11	245.88	3.38	261.73	3.63	259.92
5/4/2001	3.94	268.78	3.64	238.63	3.35	245.64	3.59	261.52	3.94	259.61

Source: Hart Crowser

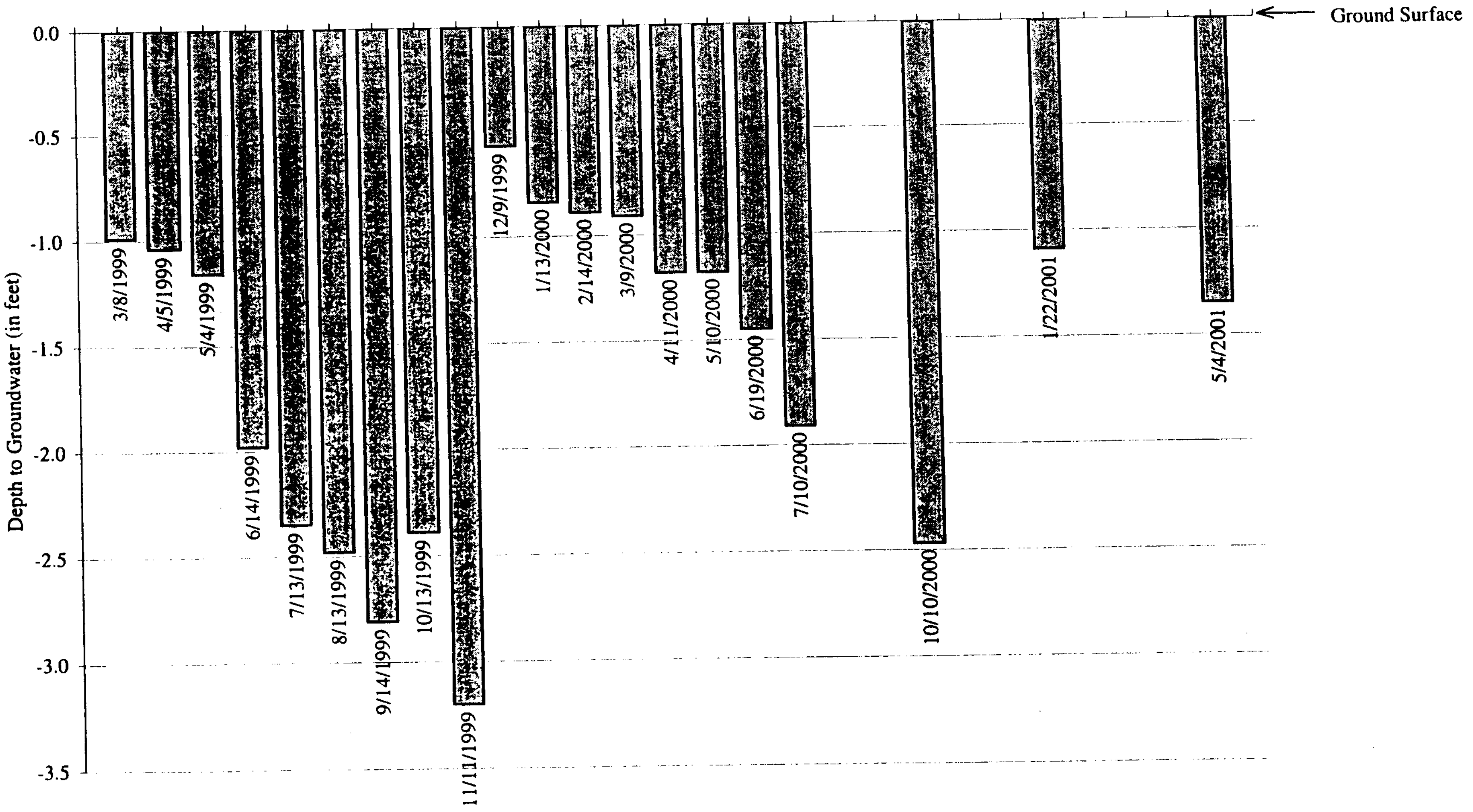
Italics = Estimated
Depth* All depths are below measuring point (NOT below the ground surface)
-- Indicates data not available.



Groundwater Conditions in Wetlands Near the Retaining Wall, Well HC99-B37



Groundwater Conditions in Wetlands Near the Retaining Wall, Well HC99-B38



Groundwater Conditions in Wetlands Near the Retaining Wall, Well HC99-B39

APPENDIX M

MILLER CREEK CHANNEL CONDITIONS

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TECHNICAL MEMORANDUM

Date:	August 16, 2001
Subject:	Sediment and Channel Morphology Data near Instream Mitigation Sites on Miller Creek
Project Number:	556-2912-001-01-03
Project Name:	Port of Seattle Master Pan Update – Environmental Permitting

---

Introduction

A component of the mitigation for natural resource impacts associated with the Port of Seattle master Plan update includes instream enhancement of fish and aquatic habitat in Miller Creek (Sheet C2). The *Natural Resource Mitigation Plan* provides a detailed description and design of the four instream enhancement projects.

Review of the Seattle-Tacoma International Airport's Master Plan Update - *Natural Resource Mitigation Plan* by the U.S. Army Corps of Engineers prompted a request for information on the conditions in Miller Creek. Specifically, the Corps requested:

> *"Provide data regarding the existing channel morphology of Miller Creek. Provide the information from locations which will be used in the post-construction monitoring of the changes made to Miller Creek. This information will be used to determine if there are adverse effects to the stream as a result of the proposed project and mitigation."*

The purpose of this technical memorandum is to document pre-construction channel morphology and substrate conditions in the vicinity of the Miller Creek instream mitigation sites. The memorandum also provides data regarding channel and sediment conditions at several locations between Port of Seattle property and Puget Sound.

Methods

Channel Morphology near Instream Mitigation Sites

Four sampling stations were established in representative channel sections downstream of each instream mitigation project site (see Sheet C2). At these sites (designated MS-1 through MS-4), substrate conditions were measured through pebble counts and channel morphology measurements were made.

Pebble counts were completed following procedures described in Wolman (1954) and Bain and Stevenson (1999). The pebble counts consist of randomly collecting and measuring 100 surface particles along a representative stream transect.

Channel morphology measurements at each site were made following standard assessment techniques (Bain and Stevenson 1999). The key measurements included determining bankfull width, bankfull depths, bankfull elevation, floodplain width, water surface elevations, and the thalweg elevations (i.e., the elevation of the deepest part the of the channel). Other measures of channel morphology were calculated as specified in table presented in Attachment A.

Other Sampling

Representative cross sections along the creek channel were also identified in several areas located downstream of the Port of Seattle property. The sites selected for sampling and their general conditions are summarized in Table M-1. The locations sampled represent a variety of stream conditions, and therefore, not all features are present at each location. There are generally two cross-sections at Sites 1 through 7 (Figure 2); one section represents a riffle zone and a second cross-section represents pool habitat.

Pebble count and McNeil core sampling was conducted at Sites 1 through 7 to characterize surface and subsurface substrate, respectively. McNeil core samples were collected by forcing a cylinder in the substrate and removing the substrate within the cylinder for size composition analysis (McNeil and Ahnell 1960). Particle size distributions were determined by calculation and plotting the cumulative frequency curves of particle size diameters (e.g., D_{50} = particle diameter greater than 50 percent of the collected particles). In such plots, the median (D_{50}) is generally considered a more robust measure than the mean for describing sediment size because a few large particles in a sample will bias the mean more so than the median. Sediment particle sizes often follow a log-normal size distribution with a high proportion of particles in the low-to-middle size classes. Therefore, a logarithmic X-axis scale is required to plot cumulative frequency of sediment particles expressed in millimeters. However, the preferable approach is to express particle sizes as phi where *phi = ln (mm) / -ln(2)* with the assumption that the particle sizes are log-normally distributed. Under this assumption, the distribution of particle sizes can be described by the mean phi and the standard deviation. In the following plots, particle sizes are expressed in either millimeters or phi. Tables present the data in both millimeters and phi for reference.

Results

Results of the sampling described above are provided in Attachment A and Attachment B. Attachment A contains the results of the cross sections, longitudinal profile, and Wolman pebble count downstream of each instream enhancement site. The pebble count for MS-4 is coincidental to the Site 5 pebble count (Attachment B). Attachment B contains the results of the Wolman pebble count and McNeil core samples from six representative reaches throughout Miller Creek from the buy-out area to the mouth above the estuarine influence. Site 1 (Stations 39-30) are not sampled because they lie within the intertidal zone and are not representative of the stream itself. A partially blocked culvert inundated Site 4 (Stations 140-139) and created a low-gradient depositional area. The very fine-grained substrate at Site 4 was not representative of substrate conditions throughout the basin.

This data will be used as representative baseline data. Monitoring of post construction conditions at mitigation sites and elsewhere will repeat the sampling described in this report. A comparison of pre- and post-construction conditions will be used to measure changes over time to the Miller Creek channel (these changes could be the result of Master Plan Improvement or other activities occurring in the watershed).

Table M-1. Comparison of Miller Creek sampling site conditions.

Reach	Site /Station No.	General Description	Potential for Bedload Transport	Proximity to Hydraulic Structures	Representative of Basin Drainage Area	Adjacent to Mitigation Sites
	1 /39-30	Tidal	X		X (L/S)	
A	2 /49-42	Depositional	X	X	X (L/S)	
	3 /99-90	High Gradient	X		X (L/S)	
	4 /140-139	Ponded/ Depositional	X			
B	5 /181-180	Medium Gradient	X	X	X (M/S)	
	6 /250-240	Medium Gradient	X		X (U/S)	
C	7 /282-281	Medium Gradient	X	X	X (U/S)	
	MS-1 to MS-4					X

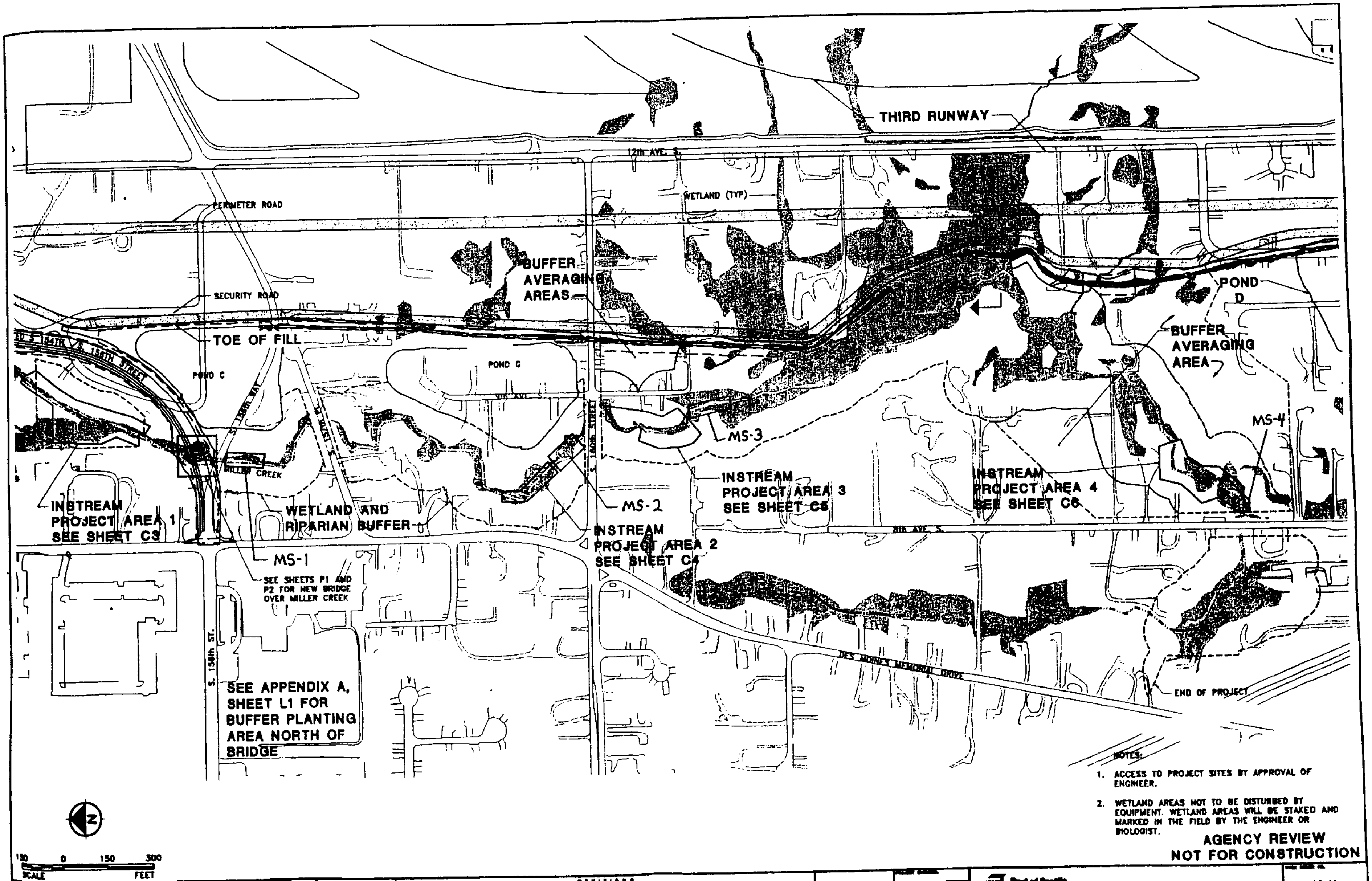
Notes: L/S – lower section from mouth to 1st Avenue South
M/S – middle sections from 1st Avenue South to South 156th Street
U/S – upper section from South 156th Street to MCDF

References

Bain, M.B. and N.S. Stevenson. 1999. Aquatic habitat assessment-Common methods. American Fisheries Society. Bethesda, Maryland.

McNeil, W.J. and W.H. Ahnell. 1960. Measurements of gravel composition of salmon streambeds. Circular 120. Fisheries Research Institute, University of Washington, Seattle, Washington.

Wolman, M.G. 1954. A method of sampling coarse river-bed material. *Transactions of the American Geophysical Union*, 35:951-956.



NOTES:

1. ACCESS TO PROJECT SITES BY APPROVAL OF ENGINEER.
2. WETLAND AREAS NOT TO BE DISTURBED BY EQUIPMENT. WETLAND AREAS WILL BE STAKED AND MARKED IN THE FIELD BY THE ENGINEER OR BIOLOGIST.

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1"=150'
DECEMBER 1999
-
P. FENDT

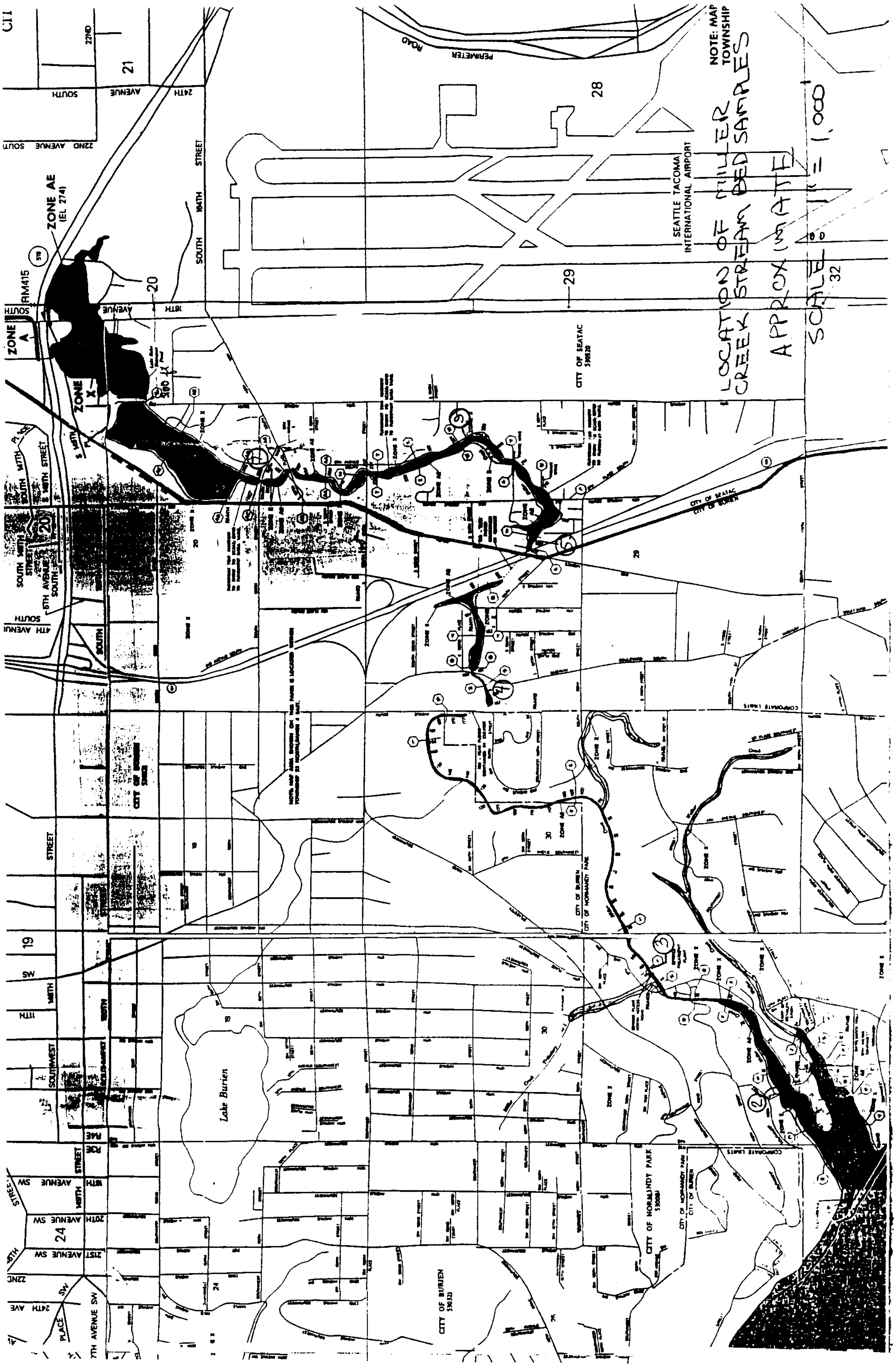
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT

PROJECT PLAN

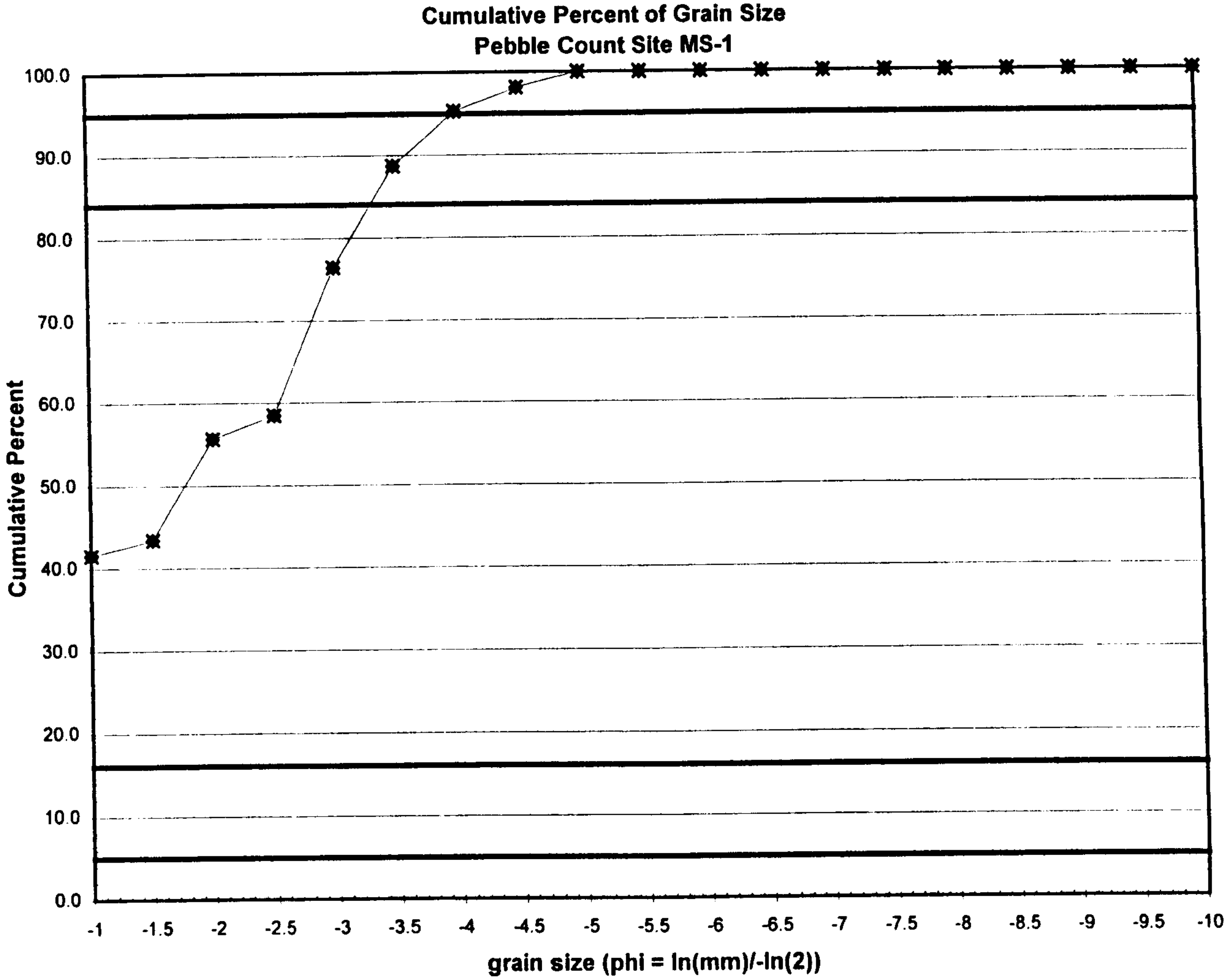
C3406
291281C16
STIA-9806-C2

APPENDIX B


LOCATION OF MILLER CREEK STREAM BED SAMPLES
APPROXIMATE SCALE 1" = 1,000'
NOTE: MAP
TOWNSHIP
SEATTLE TACOMA INTERNATIONAL AIRPORT
PERIMETER ROAD
ZONE AE
(EL 274)
ZONE A
ZONE X
RM415
SOUTH 164TH STREET
24TH AVENUE SOUTH
22ND AVENUE SOUTH
16TH AVENUE
SOUTH 160TH STREET
4TH AVENUE SOUTH
6TH AVENUE SOUTH
CITY OF SEATAC
530320
CITY OF BURIEN
530321
CITY OF NORMANDY PARK
530081
CORPORATE LIMITS
Lake Burien
AMBAUM
SOUTHWEST
20TH AVENUE SW
21ST AVENUE SW
18TH AVENUE SW
24TH AVE
PLACE SW
27TH AVENUE SW
20
21
28
29
32
19
24
30
2
3
4
5
6

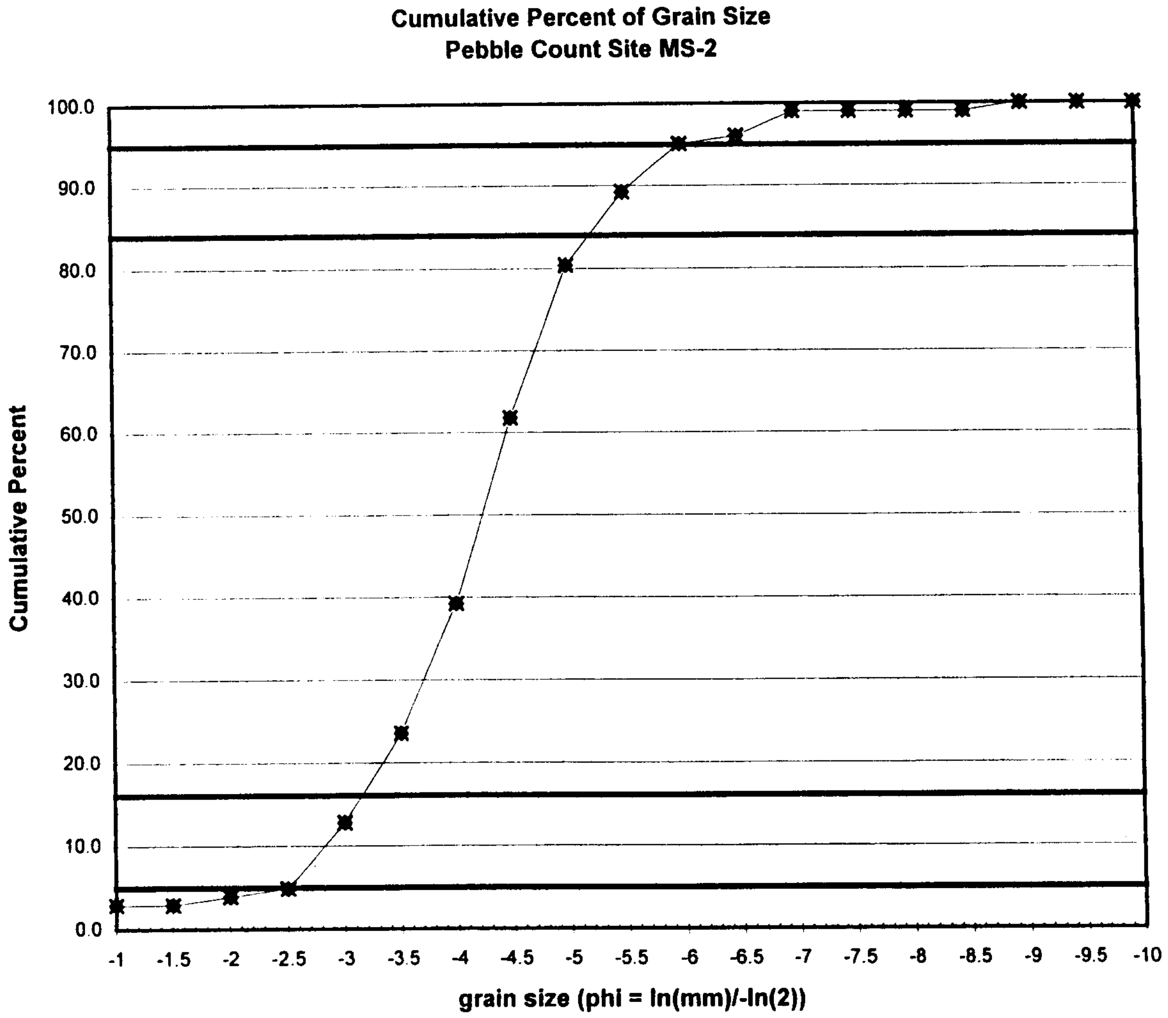
ATTACHMENT A

Diameter (mm)	
D95	15.78
D90	12.13
D84	9.92
D50 (median)	3.41
D16	1
D10	1
D5	1
Mean Diameter	3.23
Standard Deviation	3.16



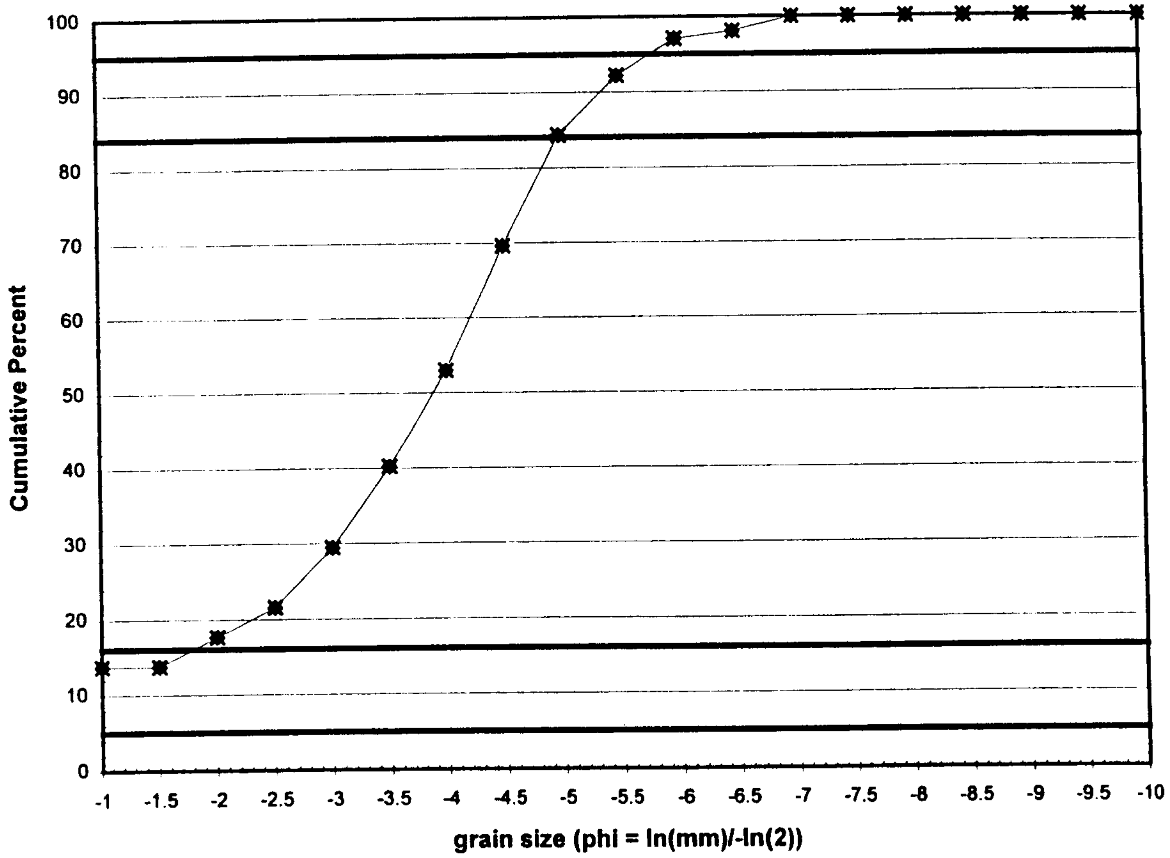
Cumulative Percent of Grain Size
Pebble Count Site MS-1

Diameter (mm)	
D95	63.56
D90	47.5
D84	36.76
D50 (median)	18.9
D16	8.88
D10	7.11
D5	5.7
Mean Diameter	18.38
Standard Deviation	2.04



Diameter (mm)	
D95	55.33
D90	41.07
D84	31.78
D50 (median)	14.72
D16	3.46
D10	1
D5	1
Mean Diameter	11.71
Standard Deviation	3.03

Cumulative Percent of Grain Size
Pebble Count Site MS-3



Miller Creek Watershed
Channel Pattern, Dimension, and Profile

Site # MS-1 Site Name/River Location Miller Cr.
Drainage miller cr. Lat___ ___ . ___' Long___ ___ . ___'
Team Pos/Parr Date ______

Landscape Context

Watershed Area (sq. mi.)	
Valley Type	

Cross-Section

No. cross-section cells	4
BF Width (ft)	11.30
BF Mean Depth (ft)	0.85
BF Mean Cross-Sectional Area (sq ft)	9.61
BF Width:BF Mean Depth Ratio	13.29
Floodprone Area Width (2X thalweg) (ft)	13.50
Entrenchment Ratio (Floodprone Area Width/BF Width)	1.19
BF Wetted Perimeter (P=2(BF Depth)+BF Width)	13.00
BF Hydraulic Radius (R_{BF}=Bf Cross-Sectional Area/P)	0.74

Longitudinal Profile

Mean Water Surface Slope	1.20
Mean Bankfull Slope	3.05

Pattern

Valley Slope (percent)	2.07	
Sinuosity (channel length/valley length)	1.00	
Belt Width (ft)	13.50	
Meander Width Ratio (Belt Width/Bankfull Width)	1.19	
Meander Wavelength (WL=10.9(BF Width))	123.17	
	min	max
Meander Radius of Curvature (R_C=2.5(BF Width) to 2.9(BF Width))	28.25	32.77

Rosgen Stream Type

C4

Cross-Section			Longitudinal Profile									
Station	Elevation	BF Depth	Station	BF Elevation	BF Slopes	WS Elevation	WS Slopes	Thalweg Elevation	Thalweg Slopes	Thalweg Depth	Position of Measurement
1RL	10.00	0.00	0.0	10.00		10.35		11.05			riffle
2	10.80	0.80	12.3	10.40	1.08	10.85	1.36				pool
3	11.00	1.00	15.4	11.28	9.46	10.90	0.54	11.80	1.62		
4	11.05	1.05	24.0	11.68	1.55	11.48	2.25	11.83	0.12		
5	10.55	0.55	30.0	11.70	0.11	11.60	0.67	12.28	2.50		
6RR	10.00	0.00									

Miller Creek Watershed
Channel Pattern, Dimension, and Profile

Site # MS-2 Site Name/River Location Miller Cr.
Drainage Miller Cr. Lat___ ___ . ___' Long___ ___ . ___'
Team Cas/Amr Date ______

Landscape Context

Watershed Area (sq. mi.)	
Valley Type	

Cross-Section

No. cross-section cells	5
BF Width (ft)	12.00
BF Mean Depth (ft)	0.21
BF Mean Cross-Sectional Area (sq ft)	2.54
BF Width:BF Mean Depth Ratio	56.60
Floodprone Area Width (2X thalweg) (ft)	15.00
Entrenchment Ratio (Floodprone Area Width/BF Width)	1.25
BF Wetted Perimeter (P=2(BF Depth)+BF Width)	12.42
BF Hydraulic Radius (R_{BF}=Bf Cross-Sectional Area/P)	0.20

Longitudinal Profile

Mean Water Surface Slope	1.39
Mean Bankfull Slope	1.54

Pattern

Valley Slope	2.07	
Sinuosity (channel length/valley length)	1.44	
Belt Width (ft)	40.00	
Meander Width Ratio (Belt Width/Bankfull Width)	3.33	
Meander Wavelength (WL=10.9(BF Width))	130.80	
	min	max
Meander Radius of Curvature (R_C=2.5(BF Width) to 2.9(BF Width))	30.00	34.80

Rosgen Stream Type

C4

Cross-Section			Longitudinal Profile								
Station	Elevation	BF Depth	Station	BF Elevation	BF Slopes	WS Elevation	WS Slopes	Thalweg Elevation	Thalweg Slopes	Thalweg Depth	Position of Measurement
1RL	5.85	0.00	-19.0	5.12		5.35		5.50			riffle
2	5.90	0.05	-14.5	5.35	1.70	5.70	2.59				pool
3	6.11	0.26	-7.0	5.43	0.36	5.70	0.00	6.20	1.94		riffle
4	6.05	0.20	0.0	5.85	2.00	5.90	0.95	6.20	0.00		
5	6.20	0.35	7.0	6.35	2.38	6.35	2.14				pool
6	6.05	0.20	11.0	6.50	1.25	6.50	1.25	6.75	1.67		riffle
7RR	5.85	0.00									

Miller Creek Watershed
Channel Pattern, Dimension, and Profile

Site # MS-3 Site Name/River Location Miller Cr.
Drainage Miller Cr. Lat ___ ___ . ___' Long ___ ___ . ___'
Team Pos/Baxr Date ___________

Landscape Context

Watershed Area (sq. mi.)	
Valley Type	

Cross-Section

No. cross-section cells	5
BF Width (ft)	11.25
BF Mean Depth (ft)	0.43
BF Mean Cross-Sectional Area (sq ft)	4.88
BF Width:BF Mean Depth Ratio	25.92
Floodprone Area Width (2X thalweg) (ft)	13.00
Entrenchment Ratio (Floodprone Area Width/BF Width)	1.16
BF Wetted Perimeter (P=2(BF Depth)+BF Width)	12.12
BF Hydraulic Radius (R_{BF}=Bf Cross-Sectional Area/P)	0.40

Longitudinal Profile

Mean Water Surface Slope	2.49
Mean Bankfull Slope	1.80

Pattern

Valley Slope	2.07	
Sinuosity (channel length/valley length)	1.13	
Belt Width (ft)	22.20	
Meander Width Ratio (Belt Width/Bankfull Width)	1.97	
Meander Wavelength (WL=10.9(BF Width))	122.63	
	min	max
Meander Radius of Curvature (R_C=2.5(BF Width) to 2.9(BF Width))	28.13	32.63

Rosgen Stream Type

C4

Cross-Section			Longitudinal Profile									
Station	Elevation	BF Depth	Station	BF Elevation	BF Slopes	WS Elevation	WS Slopes	Thalweg Elevation	Thalweg Slopes	Thalweg Depth	Position of Measurement
1RL	7.65	0.00	0.0	7.65		7.85		8.32			riffle
2	7.85	0.20	7.0	7.95	1.43	8.05	0.95	8.40	0.38		riffle
3	7.85	0.20	11.0	8.10	1.25	8.30	2.08	8.55	1.25		riffle-tail
4	8.15	0.50	13.0	8.30	3.33	8.73	7.17				pool
5	8.32	0.67	19.3	8.45	0.79	8.73	0.00				pool-tail
6	8.25	0.60	22.1	8.75	3.57	8.95	2.62	9.05	1.50		riffle
7RR	7.65	0.00	26	8.80	0.43	9.20	2.14				glide

Miller Creek Watershed
Channel Pattern, Dimension, and Profile

Site # MS-4 Site Name/River Location M:llr Cr.
Drainage Miller Cr. Lat___ ___ . ___' Long___ ___ . ___
Team Pos / Pa-r Date ______

Landscape Context

Watershed Area (sq. mi.)	
Valley Type	

Cross-Section

No. cross-section cells	5
BF Width (ft)	9.30
BF Mean Depth (ft)	0.32
BF Mean Cross-Sectional Area (sq ft)	2.98
BF Width:BF Mean Depth Ratio	29.06
Floodprone Area Width (2X thalweg) (ft)	10.50
Entrenchment Ratio (Floodprone Area Width/BF Width)	1.13
BF Wetted Perimeter (P=2(BF Depth)+BF Width)	9.94
BF Hydraulic Radius (R_{BF}=Bf Cross-Sectional Area/P)	0.30

Longitudinal Profile

Mean Water Surface Slope	1.56
Mean Bankfull Slope	1.63

Pattern

Valley Slope	2.07	
Sinuosity (channel length/valley length)	1.99	
Belt Width (ft)	31.00	
Meander Width Ratio (Belt Width/Bankfull Width)	3.33	
Meander Wavelength (WL=10.9(BF Width))	101.37	
	min	max
Meander Radius of Curvature (R_C=2.5(BF Width) to 2.9(BF Width))	23.25	26.97

Rosgen Stream Type

C4

Cross-Section			Longitudinal Profile								
Station	Elevation	BF Depth	Station	BF Elevation	BF Slopes	WS Elevation	WS Slopes	Thalweg Elevation	Thalweg Slopes	Thalweg Depth	Position of Measurement
1RL	5.85	0.00	-35.0	3.65		3.90		4.12			riffle
2	6.10	0.25	-23.0	4.90	3.47	5.05	3.19	5.42	3.61		riffle
3	6.10	0.25	-17.0	5.10	1.11	5.32	1.50				pool
4	6.25	0.40	-5.0	5.57	1.31	5.92	1.67	6.05	1.17		riffle
5	6.30	0.45	6.5	6.15	1.68	6.42	1.45				pool
6	6.10	0.25	15.0	6.30	0.59	6.42	0.00	7.20	1.92		glide
7RR	5.85	0.00									

Summer low flow assessment: cross section data

3rd Runway Project

Creek:	Miller		
Cross-section # :	MS-1		
Date Surveyed	9/24/2001		
Field Crew	HW, RF	Stadia:	RF
Date Entered	9/25/2001	Notes:	HW
Entered By	RF		
Vert Dist from level to datum:		12.28	feet

Definitions:

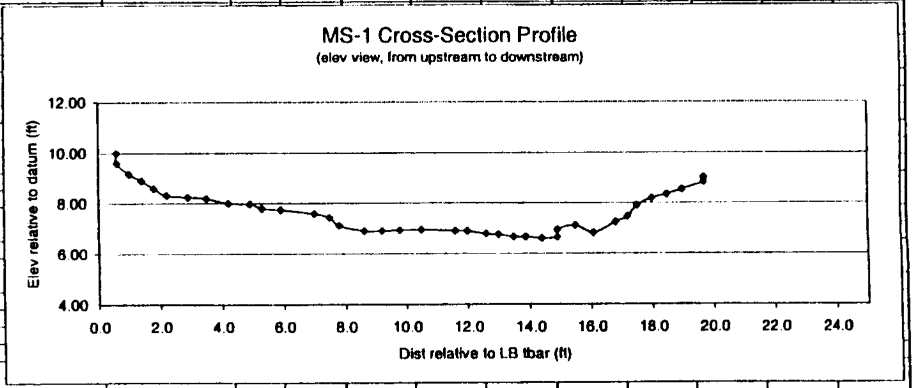
RB - right bank, looking d/s
LB - left bank, looking d/s
OHWM - ordinary high water mark
EOW - edge of water
SS - substrate
BFW - bank full width
WW - wetted width

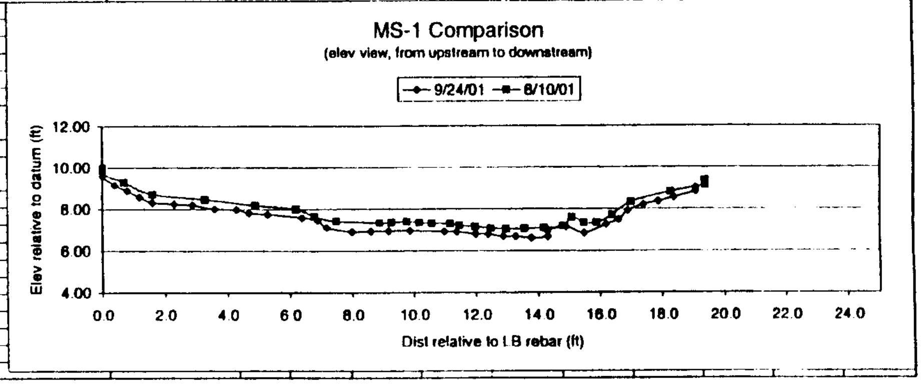
BFW est (ft) =	9.5	(to nearest 0.5 ft)
WW (ft) =	3.3	
Ave H20 depth (ft) =	0.56	
Max H20 depth (ft) =	0.83	

Conventions

measurements begin on left bank
datum defined at 10 feet below top of LB rebar

RAW DATA			**Final Values**			
8/10 datum		19.73				
9/24 datum		12.28				
level elev diff		-7.45				
Description	**dist (ft)**	**height (ft)**	**dist (ft)**	**wrt 8/10 (ft)**	**elev (ft)**	**H20 depth (ft)**
top LB t-bar	3.0	-0.40	0.00	-0.60	12.68	
base LB t-bar	3.0	2.79	0.00	-0.60	9.49	
top LB rebar	3.6	2.28	0.60	0.00	10.00	
base LB rebar	3.6	2.69	0.60	0.00	9.59	
	4.0	3.13	1.00	0.40	9.15	
	4.4	3.40	1.40	0.80	8.88	
	4.8	3.71	1.80	1.20	8.57	
	5.2	3.97	2.20	1.60	8.31	
	5.9	4.04	2.90	2.30	8.24	
	6.5	4.10	3.50	2.90	8.18	
	7.2	4.29	4.20	3.60	7.99	
	7.9	4.32	4.90	4.30	7.96	
	8.3	4.49	5.30	4.70	7.79	
	8.9	4.55	5.90	5.30	7.73	
	10.0	4.70	7.00	6.40	7.58	
OHWM	10.5	4.85	7.50	6.90	7.43	0.00
	10.8	5.18	7.80	7.20	7.10	0.33
	11.6	5.39	8.60	8.00	6.89	0.54
	12.2	5.37	9.20	8.60	6.91	0.52
	12.8	5.36	9.80	9.20	6.92	0.51
	13.5	5.34	10.50	9.90	6.94	0.49
EOW-LB	14.6	5.39	11.60	11.00	6.89	0.54
ss	15.0	5.40	12.00	11.40	6.88	0.55
ss	15.6	5.50	12.60	12.00	6.78	0.65
ss	16.0	5.52	13.00	12.40	6.76	0.67
ss	16.5	5.62	13.50	12.90	6.66	0.77
ss	16.9	5.62	13.90	13.30	6.66	0.77
thalweg	17.4	5.68	14.40	13.80	6.60	0.83
ss - LB side of boulder/E(	17.9	5.63	14.90	14.30	6.65	0.78
EOW/WSE - RB at bould	17.9	5.34	14.90	14.30	6.94	0.49
top of boulder	18.5	5.16	15.50	14.90	7.12	
RB side of boulder	19.1	5.46	16.10	15.50	6.82	
OHWM	19.8	5.04	16.80	16.20	7.24	
	20.2	4.82	17.20	16.60	7.46	
	20.5	4.39	17.50	16.90	7.89	
	21.0	4.10	18.00	17.40	8.18	
	21.5	3.95	18.50	17.90	8.33	
	22.0	3.75	19.00	18.40	8.53	
base RB rebar	22.7	3.46	19.70	19.10	8.82	
top RB rebar	22.7	3.28	19.70	19.10	9.00	
base RB t-bar	23.2	3.23	20.20	19.60	9.05	
top RB t-bar	23.2	0.04	20.20	19.60	12.24	


MS-1 Cross-Section Profile
(elev view, from upstream to downstream)


MS-1 Comparison
(elev view, from upstream to downstream)

Summer low flow assessment: cross section data
3rd Runway Project

Creek:	Miller		
Cross-section # :	MS-2		
Date Surveyed:	9/24/2001		
Field Crew:	HW, RF	Stadia	HW
Date Entered:	9/25/2001	Notes	RF
Entered By:	RF		

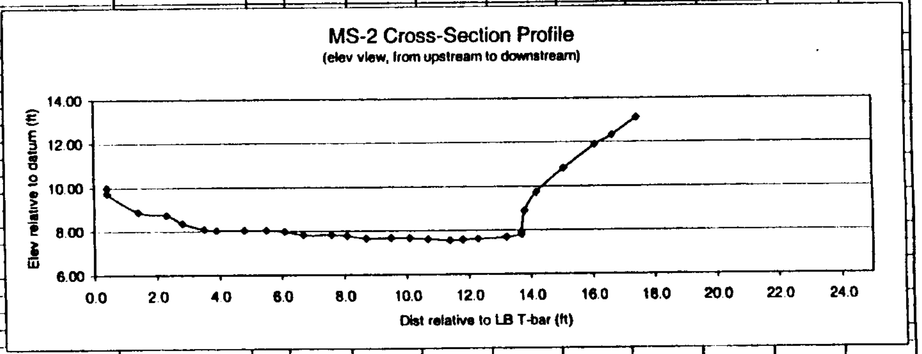
Vert Dist from level to datum: 15.38 feet

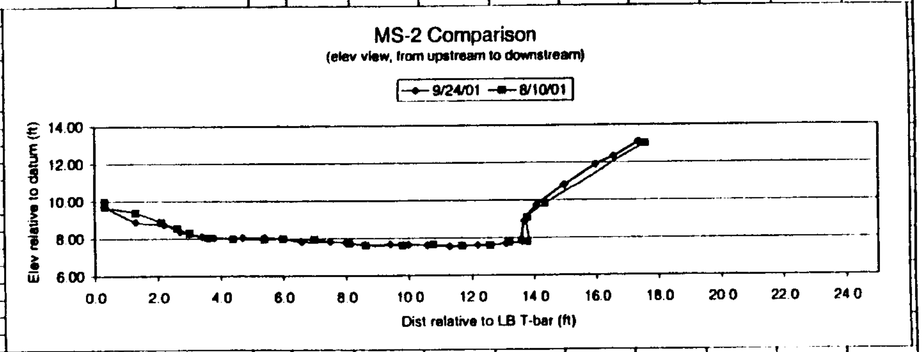
Definitions:
RB - right bank, looking d/s
LB - left bank, looking d/s
OHWM - ordinary high water mark
EOW - edge of water
SS - substrate
BFW - bank full width
WW - wetted width

BFW est (ft) =	11.5	(to nearest 0.5 ft)
WW (ft) =	7.6	
Ave H20 depth (ft) =	0.27	
Max H20 depth (ft) =	0.43	

Conventions:
measurements begin on left bank
datum defined at 10 feet below top of LB datum rebar

RAW DATA			Final Values			
8/10 datum		16.52				
9/24 datum		15.38				
level elev diff		-1.14				
Description	**dist (ft)**	**height (ft)**	**dist (ft)**	**wrt 8/10 (ft)**	**elev (ft)**	**H20 depth (ft)**
top LB Tbar	2.1	1.92	0.00	-0.10	13.46	
base LB Tbar	2.1	5.60	0.00	-0.10	9.78	
top LB datum rebar	2.5	5.38	0.40	0.30	10.00	
base LB datum rebar	2.5	5.65	0.40	0.30	9.73	
	3.5	6.5	1.40	1.30	8.88	
OHWM	4.4	6.64	2.30	2.20	8.74	
	4.9	7.02	2.80	2.70	8.36	
	5.6	7.30	3.50	3.40	8.08	
	6.0	7.36	3.90	3.80	8.02	
	6.9	7.35	4.80	4.70	8.03	
	7.6	7.36	5.50	5.40	8.02	
EOW	8.2	7.41	6.10	6.00	7.97	0.00
ss	8.8	7.57	6.70	6.60	7.81	0.16
ss	9.7	7.57	7.60	7.50	7.81	0.16
ss	10.2	7.63	8.10	8.00	7.75	0.22
ss	10.8	7.75	8.70	8.60	7.63	0.34
ss	11.6	7.72	9.50	9.40	7.66	0.31
ss	12.2	7.73	10.10	10.00	7.65	0.32
ss	12.8	7.78	10.70	10.60	7.60	0.37
thalweg	13.5	7.84	11.40	11.30	7.54	0.43
ss	13.9	7.81	11.80	11.70	7.57	0.40
ss	14.4	7.78	12.30	12.20	7.60	0.37
ss	15.3	7.71	13.20	13.10	7.67	0.30
EOW	15.8	7.58	13.70	13.60	7.80	0.17
EOW/WSE	15.8	7.45	13.70	13.60	7.93	
OHWM	15.9	6.50	13.80	13.70	8.88	
	16.3	5.65	14.20	14.10	9.73	
	17.2	4.57	15.10	15.00	10.81	
	18.2	3.50	16.10	16.00	11.88	
	18.8	3.07	16.70	16.60	12.31	
base RB Tbar	19.6	2.28	17.50	17.40	13.10	
top RB Tbar	19.6	-1.54	17.50	17.40	16.92	


MS-2 Cross-Section Profile
(elev view, from upstream to downstream)


MS-2 Comparison
(elev view, from upstream to downstream)

Summer low flow assessment: cross section data

3rd Runway Project

Creek:	Miller		
Cross-section # :	MS-3		
Date Surveyed:	9/24/2001		
Field Crew:	HW, RF	Stadia	RF
Date Entered:	9/25/2001	Notes	HW
Entered By:	RF		

Definitions:

RB - right bank, looking d/s
LB - left bank, looking d/s
OHWM - ordinary high water mark
EOW - edge of water
SS - substrate
BFW - bank full width
WW - wetted width

BFW est (ft) =	13.5	(to nearest 0.5 ft)
WW (ft) =	9.3	
Ave H20 depth (ft) =	0.14	
Max H20 depth (ft) =	0.31	

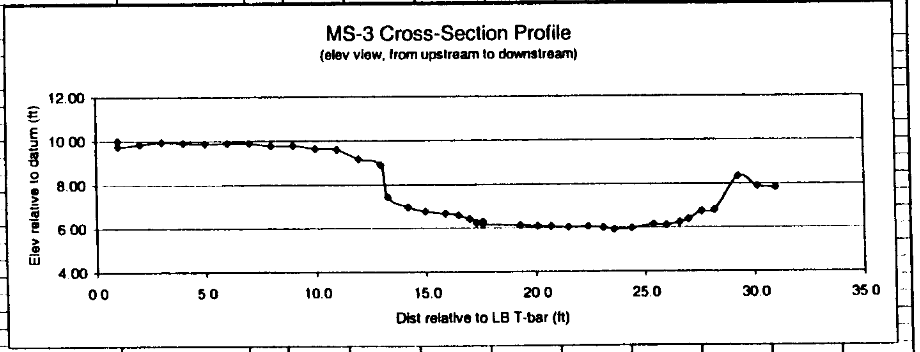
Conventions:

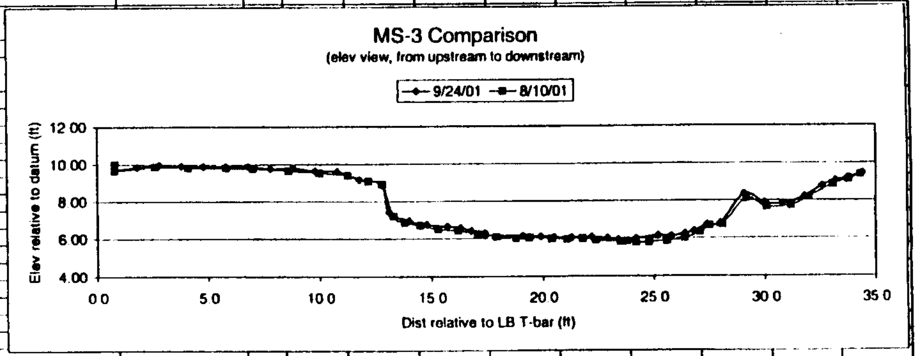
measurements begin on left bank
datum defined at 10 feet below top of LB datum rebar

Vert Dist from level to datum: 10.98 feet

RAW DATA	
8/10 datum	14.70
9/24 datum	10.98
level elev diff	-3.72

	RAW DATA		Final Values			
Description	**dist (ft)**	**height (ft)**	**dist (ft)**	**wrt 8/10 (ft)**	**elev (ft)**	**H20 depth (ft)**
top LB Tbar	2.0	-2.39	0.00	-0.20	13.37	
base LB Tbar	2.0	1.27	0.00	-0.20	9.71	
top LB datum rebar	3.0	0.98	1.00	0.80	10.00	
base LB datum rebar	3.0	1.25	1.00	0.80	9.73	
	4.0	1.15	2.00	1.80	9.83	
	5.0	1.04	3.00	2.80	9.94	
	6.0	1.08	4.00	3.80	9.90	
	7.0	1.11	5.00	4.80	9.87	
	8.0	1.10	6.00	5.80	9.88	
	9.0	1.10	7.00	6.80	9.88	
	10.0	1.22	8.00	7.80	9.76	
	11.0	1.20	9.00	8.80	9.78	
top of vertical bank	12.0	1.35	10.00	9.80	9.63	
bottom of bank	13.0	1.39	11.00	10.80	9.59	
	14.0	1.82	12.00	11.80	9.16	
	15.0	2.09	13.00	12.80	8.89	
	15.3	3.56	13.30	13.10	7.42	
OHWM	16.2	4.03	14.20	14.00	6.95	
	17.0	4.23	15.00	14.80	6.75	
	17.9	4.33	15.90	15.70	6.65	
	18.5	4.41	16.50	16.30	6.57	
	19.0	4.58	17.00	16.80	6.40	
	19.6	4.70	17.60	17.40	6.28	
EOW	19.3	4.76	17.30	17.10	6.22	0.00
ss	19.6	4.82	17.60	17.40	6.16	0.06
ss	21.3	4.86	19.30	19.10	6.12	0.10
ss	22.1	4.90	20.10	19.90	6.08	0.14
ss	22.7	4.92	20.70	20.50	6.06	0.16
ss	23.5	4.95	21.50	21.30	6.03	0.19
ss	24.4	4.93	22.40	22.20	6.05	0.17
ss	25.1	4.98	23.10	22.90	6.00	0.22
thalweg	25.6	5.07	23.60	23.40	5.91	0.31
ss	26.4	5.01	24.40	24.20	5.97	0.25
ss	27.4	4.85	25.40	25.20	6.13	0.09
ss	28.0	4.88	26.00	25.80	6.10	0.12
EOW	28.6	4.75	26.60	26.40	6.23	-0.01
	29.0	4.61	27.00	26.80	6.37	
OHWM	29.6	4.26	27.60	27.40	6.72	
base of boulder LB	30.2	4.19	28.20	28.00	6.79	
top of boulder	31.3	2.65	29.30	29.10	8.33	
base of boulder RB	32.2	3.10	30.20	30.00	7.88	
	33.0	3.16	31.00	30.80	7.82	
	34.0	2.79	32.00	31.80	8.19	
	34.8	2.21	32.80	32.60	8.77	
	35.4	1.94	33.40	33.20	9.04	
	36.0	1.76	34.00	33.80	9.22	
base RB tbar	36.6	1.54	34.60	34.40	9.44	
top RB tbar	36.6	-2.22	34.60	34.40	13.20	





Summer low flow assessment: cross section data
3rd Runway Project

Creek:	**Miller**		
Cross-section # :	MS-4		
Date Surveyed:	9/24/2001		
Field Crew:	HW, RF	Stadia:	HW
Date Entered:	9/25/2001	Notes:	RF
Entered By:	RF		

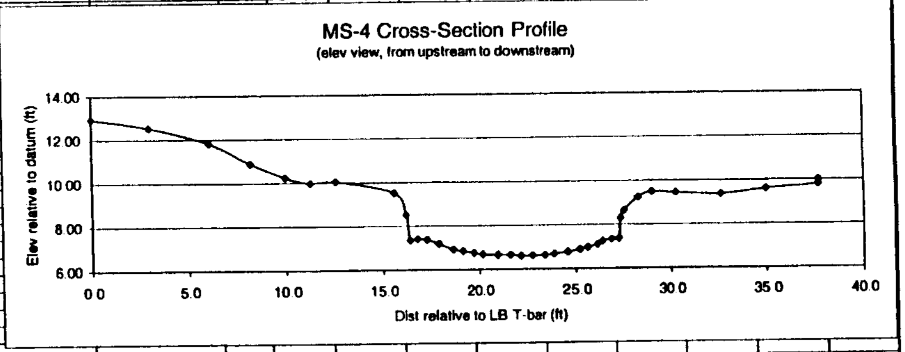
Definitions:
RB - right bank, looking d/s
LB - left bank, looking d/s
OHWM - ordinary high water mark
EOW - edge of water
SS - substrate
BFW - bank full width
WW - wetted width

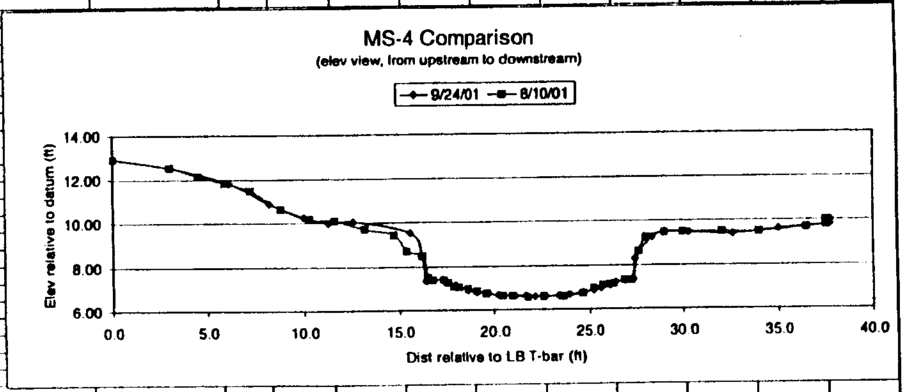
BFW est (ft) =	11.5	(to nearest 0.5 ft)
WW (ft) =	9.6	
Ave H20 depth (ft) =	0.48	
Max H20 depth (ft) =	0.78	

Conventions:
measurements begin on left bank
datum defined at 10 feet below top of RB datum rebar (LB too soft)

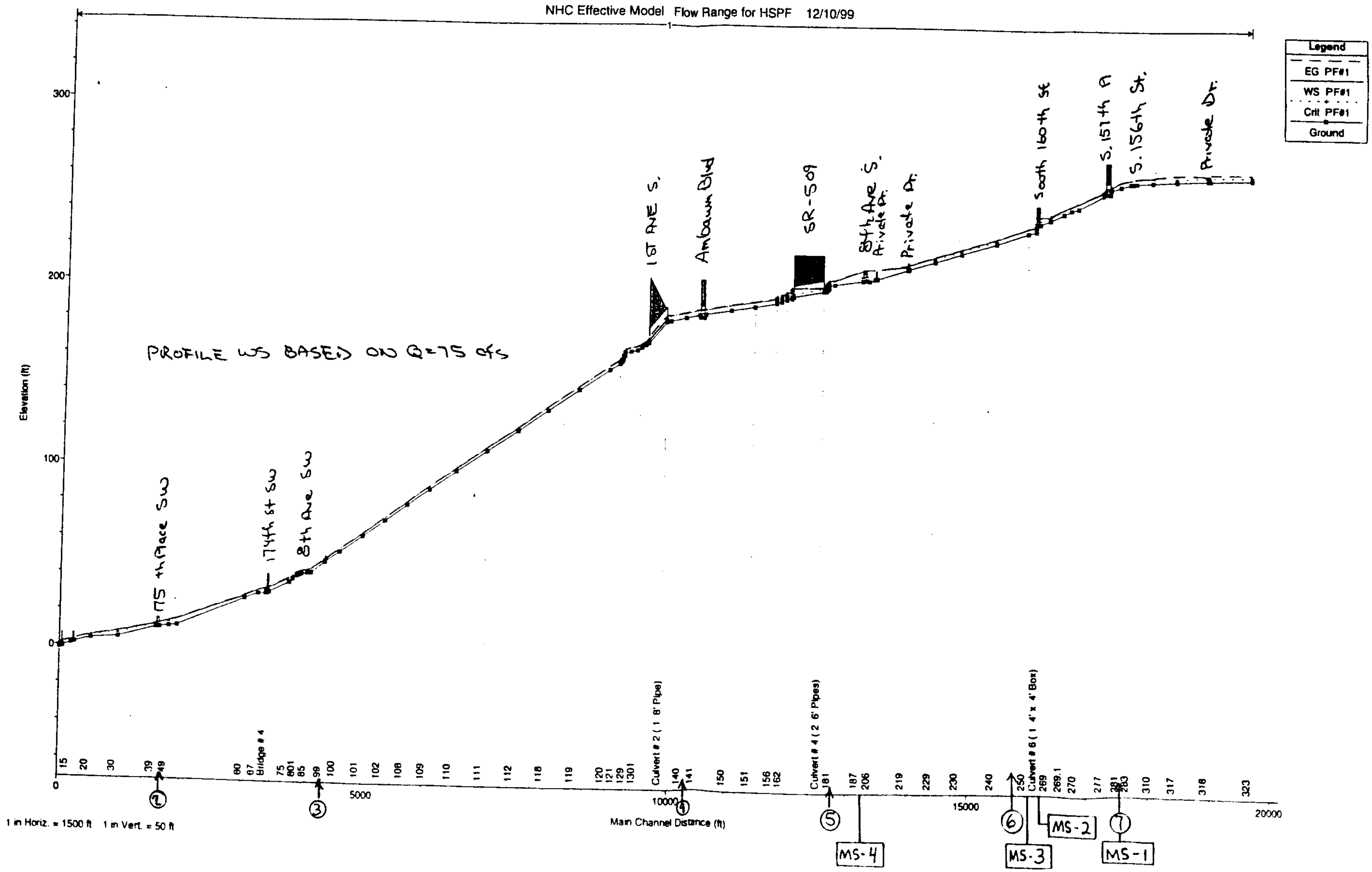
Vert Dist from level to datum: 14.01 feet

RAW DATA			**Final Values**			
8/10 datum		14.74				
9/24 datum		14.01				
level elev diff		-0.73				
Description	**dist (ft)**	**height (ft)**	**dist (ft)**	**wrt 8/10 (ft)**	**elev (ft)**	**H20 depth (ft)**
top LB Tbar	3.0	-2.41	0.00	0.00	16.42	
base LB Tbar	3.0	1.07	0.00	0.00	12.94	
(datum rebar located on RB)	6.0	1.47	3.00	3.00	12.54	
	9.1	2.19	6.10	6.10	11.82	
	11.2	3.13	8.20	8.20	10.88	
	13.0	3.77	10.00	10.00	10.24	
	14.3	4.05	11.30	11.30	9.96	
	15.6	3.97	12.60	12.60	10.04	
fern roots in soft, wet soil	18.6	4.50	15.60	15.60	9.51	
OHWM	19.2	5.51	16.20	16.20	8.50	
	19.4	6.67	16.40	16.40	7.34	
	19.8	6.61	16.80	16.80	7.40	
EOW/WSE	20.3	6.65	17.30	17.30	7.36	0.00
ss	20.9	6.85	17.90	17.90	7.16	0.20
ss	21.6	7.10	18.60	18.60	6.91	0.45
ss	22.1	7.18	19.10	19.10	6.83	0.53
ss	22.7	7.26	19.70	19.70	6.75	0.61
ss	23.2	7.32	20.20	20.20	6.69	0.67
ss	24.0	7.36	21.00	21.00	6.65	0.71
ss	24.6	7.36	21.60	21.60	6.65	0.71
thalweg	25.1	7.41	22.10	22.10	6.60	0.76
ss	25.7	7.39	22.70	22.70	6.62	0.74
ss	26.4	7.38	23.40	23.40	6.63	0.73
ss	26.9	7.32	23.90	23.90	6.69	0.67
ss	27.6	7.24	24.60	24.60	6.77	0.59
ss	28.2	7.14	25.20	25.20	6.87	0.49
ss	28.6	7.04	25.60	25.60	6.97	0.39
ss	29.1	6.91	26.10	26.10	7.10	0.26
ss	29.4	6.77	26.40	26.40	7.24	0.12
EOW/WSE	29.9	6.69	26.90	26.90	7.32	0.04
base of rip rap	30.3	6.64	27.30	27.30	7.37	
on rip rap	30.4	5.72	27.40	27.40	8.29	
OHWM	30.6	5.37	27.60	27.60	8.64	
	31.3	4.77	28.30	28.30	9.24	
top of rip rap	32.0	4.52	29.00	29.00	9.49	
	33.3	4.56	30.30	30.30	9.45	
	35.6	4.64	32.60	32.60	9.37	
	38.0	4.42	35.00	35.00	9.59	
base RB datum rebar	40.7	4.22	37.70	37.70	9.79	
top RB datum rebar	40.7	4.01	37.70	37.70	10.00	
base RB Tbar	41.2	4.21	38.20	38.20	9.80	
top RB Tbar	41.2	0.49	38.20	38.20	13.52	


MS-4 Cross-Section Profile
(elev view, from upstream to downstream)


MS-4 Comparison
(elev view, from upstream to downstream)

ATTACHMENT B


NHC Effective Model Flow Range for HSPF 12/10/99

PROFILE WS BASED ON Q=75 cfs

Miller Creek Pebble Count

phi	mm <=	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
-1	2	17	1	100	21.5	15.5	18.5
-1.5	3	1			0.5	1	0.5
-2	4		1		2.5	3	3
-2.5	6	4	2		7	5	4.5
-3	8	5	3		11	9	7.5
-3.5	11	6	2		9.5	7	11
-4	16	13	4		18.5	18	18.5
-4.5	23	16	7		12.5	15.5	11
-5	32	21	11		7	9.5	9.5
-5.5	45	8	16		3	13	5.5
-6	64	5	25		2.5	3.5	5
-6.5	91	4	13		1.5		1
-7	128		11		3		1
-7.5	181		1				3.5
-8	256		1				
-8.5	362						
-9	512						
-9.5	724		1				
-10	1024		1				
Total		100	100	100	100	100	100
Diameter in mm							
D95		59.71	123.64	1.97	59.71	43.41	76.11
D90		43.41	106.15	1.93	32	38.05	46.85
D84		33.36	88.03	1.89	23.75	32.45	32
D50(median)		17.51	47.18	1.68	10.48	13.55	12.47
D16		1.96	18.51	1.49	1.83	2.38	1.91
D10		1.73	12.38	1.46	1.66	1.77	1.71
D5		1.57	6.36	1.44	1.54	1.58	1.56
Mean Diameter = sum of D16 - 84		17.61	51.24	1.69	12.02	16.13	15.46
Standard Deviation = D84 - D16 / 2		15.7	34.76	0.2	10.96	15.04	15.05
Kurtosis *		0.704	-0.109	204.333	0.701	1.399	0.327
Skewness*		-0.087	-0.323	-0.667	0.243	-0.466	0.189
Sorting Coefficient		1.57	1.50	1.07	1.75	1.68	1.94
Geometric Mean Diameter		10.82	47.84	1.71	10.45	10.16	12.06
Fredle Index		6.87	31.89	1.60	5.98	6.07	6.22
.85 mm		21.00	11.00	0.00	7.00	9.50	9.50
*Inman 1952 (modified)							

Miller Creek McNeil Analysis

		McNeil Averages					
phi	mm <=	Site 2	Site 3	Site 4.1	Site 5	Site 6	Site 7
2.00	0.25	13.97	4.58	100.00	15.93	26.44	17.18
0.23	0.85	0.94	0.16		2.99	0.96	4.83
0.00	1	4.56	3.69		10.58	6.69	10.33
-1.00	2	4.76	6.33		10.17	8.03	7.45
-2.00	4	9.82	8.81		19.16	9.18	13.81
-3.00	8	21.77	14.70		27.77	23.56	17.95
-4.25	19	22.02	12.03		9.67	15.22	9.97
-4.98	31.5	17.38	35.28		3.11	9.91	15.91
-5.98	63	4.78	14.42		0.62	0.00	2.57
Total		100.00	100.00	100.00	100.00	100.00	100.00
Diameter in mm		Site 2	Site 3	Site 4.1	Site 5	Site 6	Site 7
D95		31.34	55.72	0.24	18.13	26.35	29.86
D90		28.44	49.52	0.24	15.14	18.9	26.72
D84		25.11	30.91	0.24	7.73	16.56	23.59
D75		18.13	28.44	0.23	6.92	13.45	15.14
D50(median)		7.31	18.9	0.21	3.41	3.81	3.66
D25		2.91	5.86	0.19	0.86	0.24	0.78
D16		0.77	2.97	0.19	0.61	0.22	0.24
D10		0.23	1.54	0.18	0.22	0.2	0.22
D5		0.2	0.73	0.18	0.2	0.19	0.2
Mean Diameter = sum of D16 - 84		18.08	29.03	0.35	6.51	11.43	14.47
Standard Deviation = D84 - D16 / 2		12.17	13.97	0.03	3.56	8.17	11.68
Kurtosis *		0.279	0.968	0.200	1.518	0.601	0.270
Skewness*		0.463	-0.140	0.200	0.213	0.561	0.707
Sorting Coefficient		2.50	2.20	1.10	2.84	7.49	4.41
Geometric Mean Diameter		4.40	9.58	0.21	2.17	1.91	2.38
Fredle Index		1.76	4.35	0.19	0.77	0.25	0.54
% Fines Below .85 mm		13.97	4.58	100.00	15.93	26.44	17.18
*Inman 1952 (modified)							

APPENDIX N

DES MOINES WAY NURSERY MITIGATION PROJECT

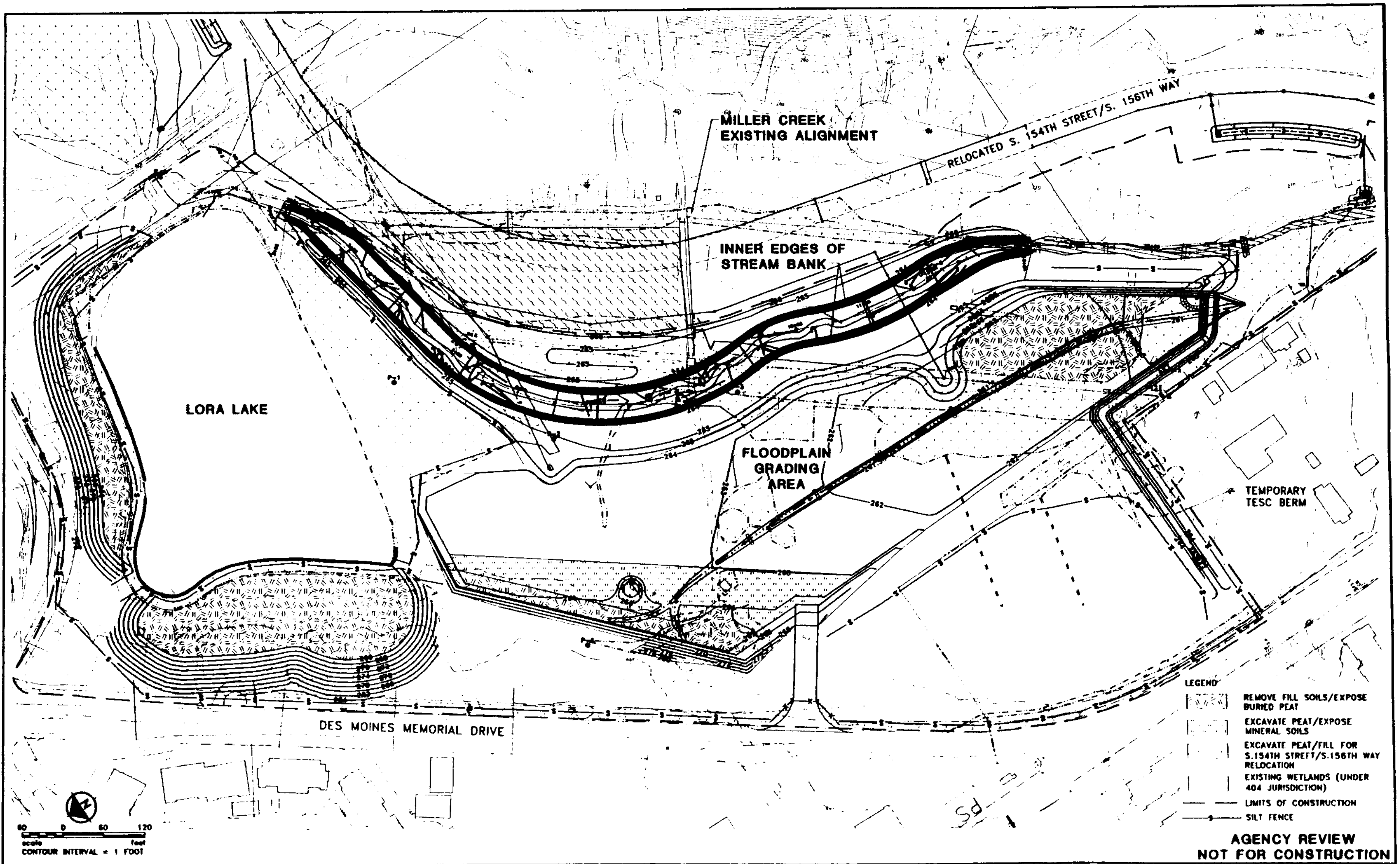
APPENDIX O

CHANGES IN PEAT SOIL CONDITIONS AT THE VACCAFARM MITIGATION AREA

APPENDIX O

CHANGES IN PEAT SOIL CONDITIONS AT THE VACCAFARM MITIGATION AREA

This appendix maps changes to peat and organic muck soil conditions in the Vacca Farm and Lora Lake area as a result of the excavation required to implement the mitigation. The mapping was prepared from the planned grading and excavation plan, historical maps of peat soils on the site, historical aerial photographs, hand borings, and other observations.



CONTOUR INTERVAL = 1 FOOT

LEGEND

▨	REMOVE FILL SOILS/EXPOSE BURIED PEAT
▨	EXCAVATE PEAT/EXPOSE MINERAL SOILS
▨	EXCAVATE PEAT/FILL FOR S.154TH STREET/S.156TH WAY RELOCATION
☐	EXISTING WETLANDS (UNDER 404 JURISDICTION)
— —	LIMITS OF CONSTRUCTION
—●—	SILT FENCE

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1"=60'
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION

CHANGES IN PEAT AND MUCK SOIL AT VACCA FARM

100051
291217C1
STIA 9805 C1

156.DWG 291217BA.DWG 91201DE.DWG

APPENDIX O

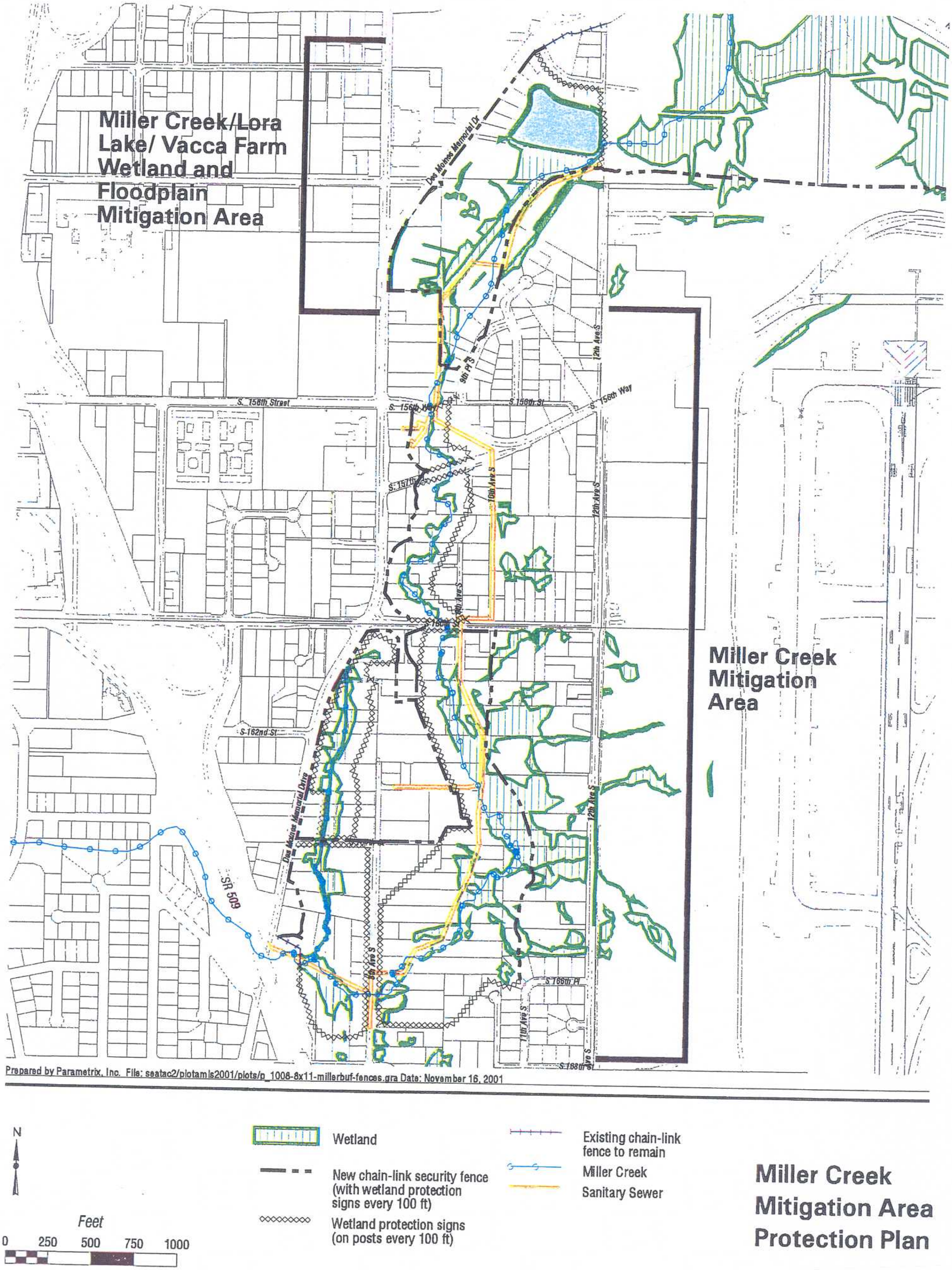
APPENDIX P

FENCING PLAN FOR PROTECTING MITIGATION AREAS

APPENDIX P

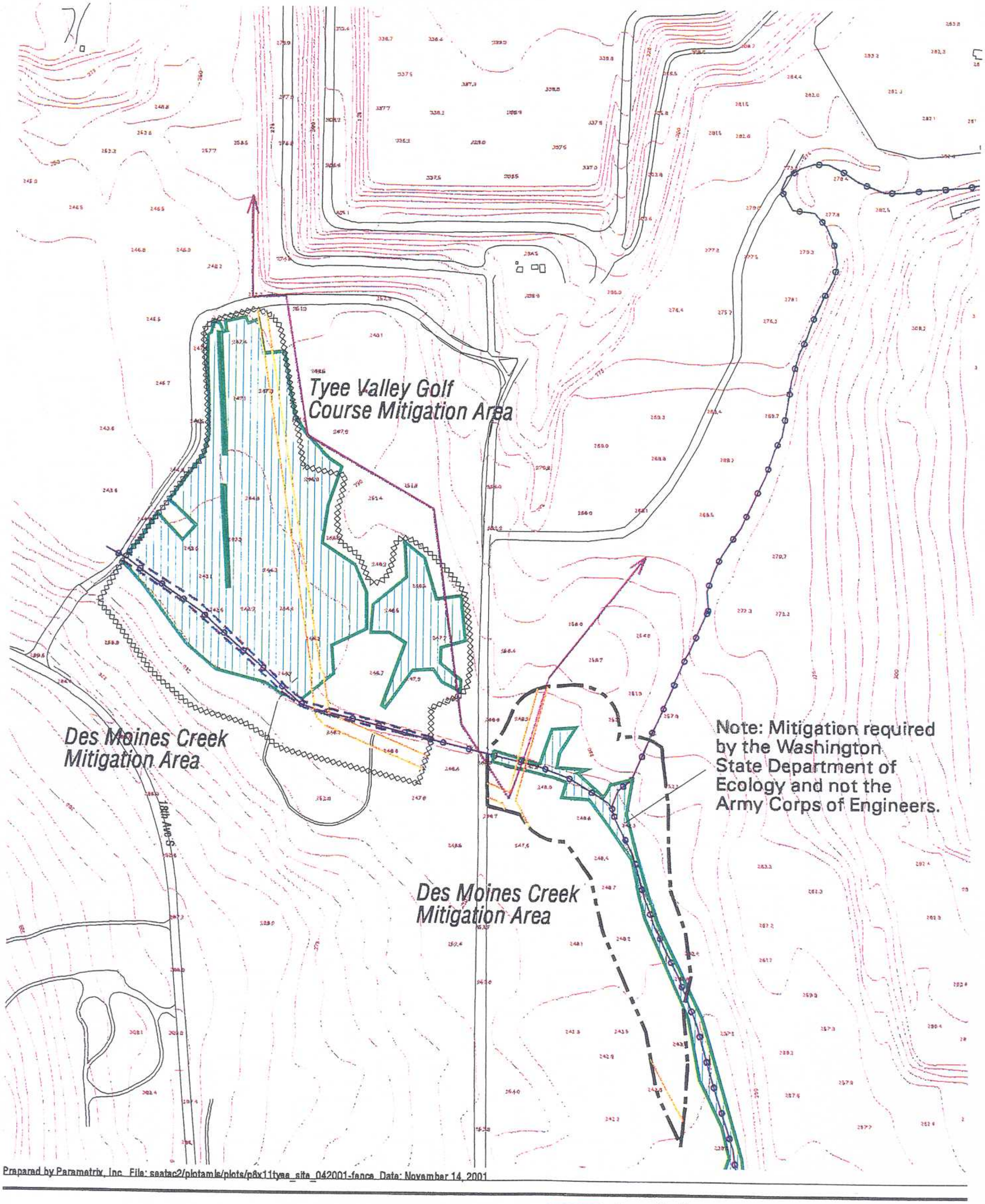
FENCING PLAN FOR PROTECTING MITIGATION AREAS

This appendix contains maps of each mitigation area and where fencing and signage will be placed to mark the mitigation boundaries and protect them from potential impacts (primarily human intrusion, pet intrusion, and dumping of wastes). Fence types specified are based on evaluation of protection needs and consideration of the security needs of Seattle-Tacoma International Airport.



Prepared by Parametrix, Inc. File: seatac2/plotamls2001/plots/p_1008-8x11-millerbuf-fences.gra Date: November 16, 2001

Miller Creek Mitigation Area Protection Plan



Note: Mitigation required by the Washington State Department of Ecology and not the Army Corps of Engineers.

Prepared by Parametrix, Inc. File: seatac2/plotamls/plots/p8x11tyee_site_042001-fence Date: November 14, 2001

N

Feet
0 100 200 300 400

- ××××× Wetland protection signs (on posts every 100 ft)
- ▬ ▪ ▪ New Chain-link security fence may be removed upon golf course closure (with wetland protection signs every 100 ft)
- Sewer Line Easement
- IWS Line
- Des Moines Creek
- Surveyed OHWM Des Moines Creek
- ▥ Riparian Wetland

Des Moines Creek Mitigation Area Protection Plan
Seattle - Tacoma International Airport

Prepared by Parametrix, Inc. File: seatac2/plotamls2001/plots/p_1113-nursery-rescov-fence.gra Date: November 14, 2001

▨ Wetland

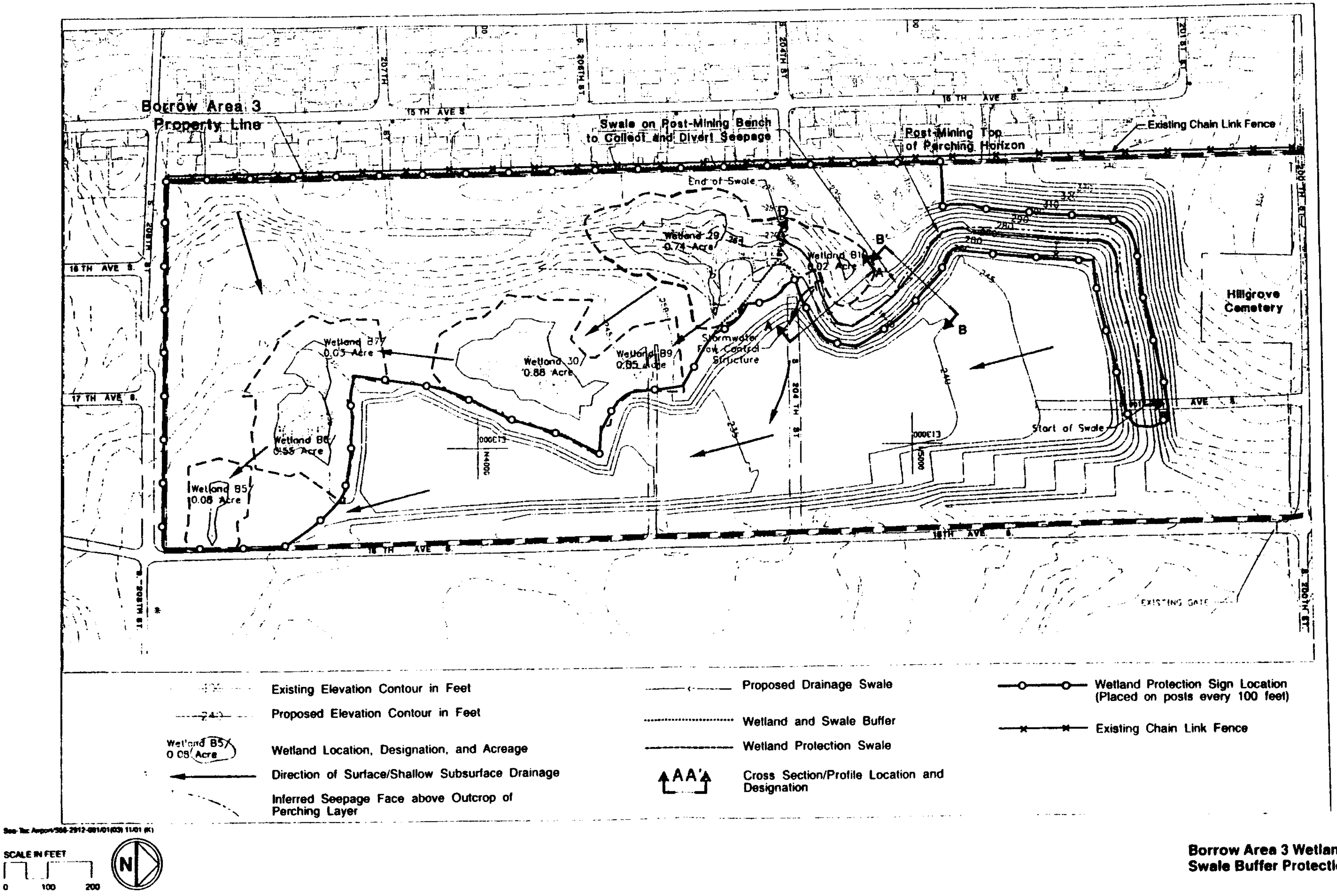
▬ ▬ New chain-link security fence (with wetland protection signs every 100 ft)

┼┼┼ Existing fence (with wetland protection signs every 100 ft)

-○- Miller Creek

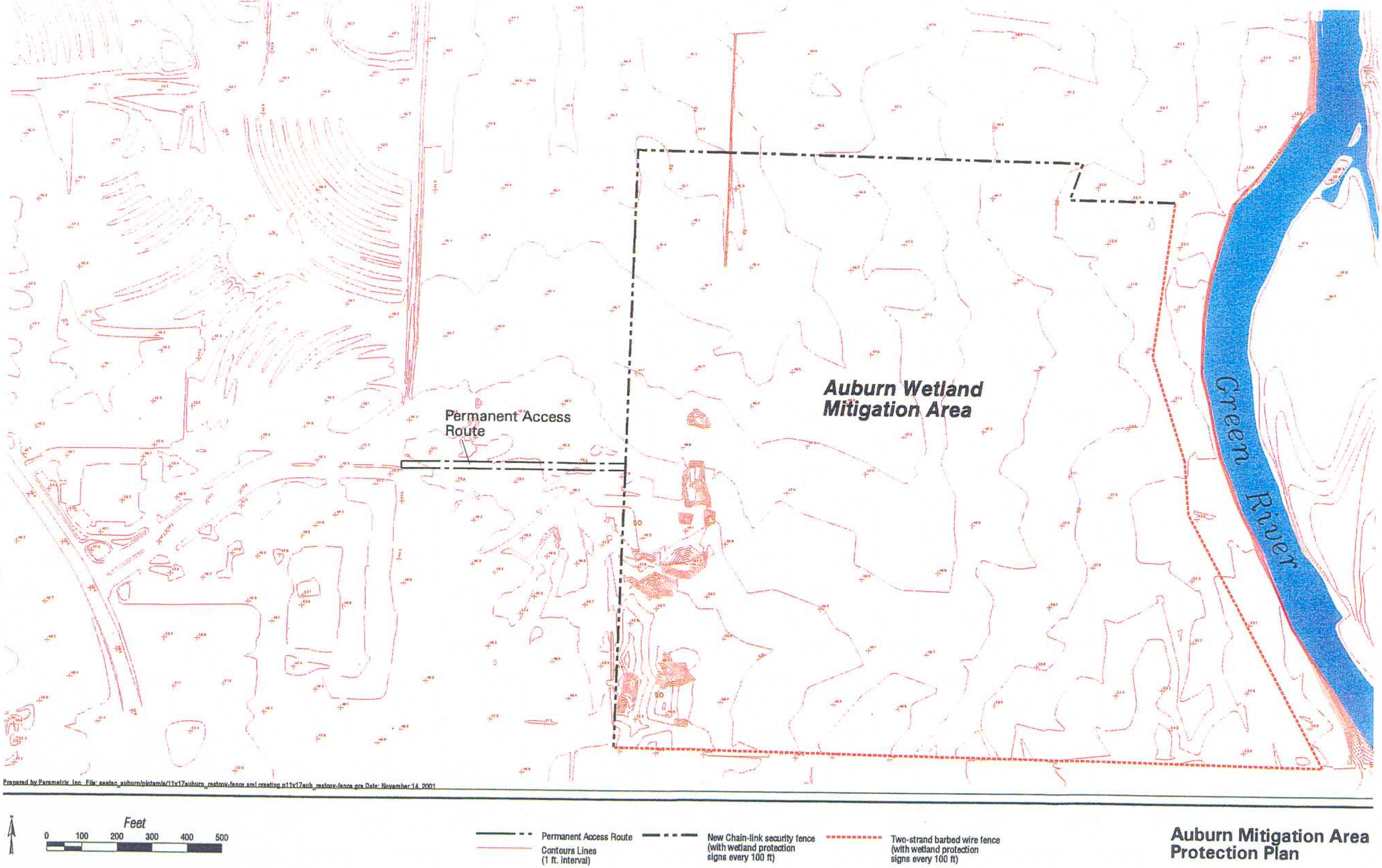
── Parcel Boundary

Des Moines Way Nursery Mitigation Area Protection Plan



Sea-Tac Airport/556-2912-001/01(03) 11/01 (K)

Borrow Area 3 Wetland and Swale Buffer Protection Plan



Prepared by Parametrix, Inc. File: seatac_auburn/plotamls/11x17auburn_restcov-fence.aml creating p11x17aub_restcov-fence.gra Date: November 14, 2001

Auburn Mitigation Area Protection Plan

APPENDIX Q

AVOIDANCE OF WETLAND IMPACTS TEMPORARY STORMWATER POND A

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Avoidance of Wetland Impacts Temporary Stormwater Pond A Sea-Tac Third Runway

Prepared for
HNTB and the Port of Seattle

June 18, 2001
4978-06

Prepared by
Hart Crowser, Inc.

MICHAEL A.P. KENRICK
6/18/01
EXPIRES 9/17/01

MICHAEL J. BAILEY
22484
EXPIRES 12/[illegible]/01

Michael A.P. Kenrick, P.E.
Senior Associate Hydrogeologist

Michael J. Bailey, P.E.
Project Manager

1910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
Tel 206.324.9530

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AVOIDANCE OF WETLAND IMPACTS TEMPORARY STORMWATER POND A SEA-TAC THIRD RUNWAY

SUMMARY

The design and construction of Temporary Stormwater Pond A at the Sea-Tac Third Runway project has been analyzed to avoid potential effects on groundwater flow and wetland hydrology. This report examines the hydrogeologic and geotechnical issues related to design, construction, and operation of Pond A. Potential impacts to the hydrology of riparian wetlands between Pond A and Miller Creek can be mitigated through appropriate engineering design.

Pond A will be excavated about 6 to 10 feet in wetland soils, and would have an operating water level roughly 0 to 10 feet below the current water table in the wetlands. A sheet pile wall has been included in the design that isolates the pond from the surrounding water table and wetland hydrology. This wall will prevent Pond A from acting as a hydraulic sink and potentially altering the hydrology of adjacent wetlands.

To prevent the proposed sheet pile wall from disrupting the natural groundwater flow to the wetlands, a gravel-filled trench is planned to convey groundwater flow around the sheet pile wall and allow it to re-infiltrate on the downgradient side of Pond A. This will help to maintain groundwater levels on the western side of the sheet pile wall and thus avoid temporary impacts to the wetlands.

INTRODUCTION

This report addresses engineering and hydrogeologic issues related to the design and construction of temporary Stormwater Pond A at the Sea-Tac Third Runway project. Figure 1 shows a site plan including location of existing subsurface explorations and elevation contours for the shallow groundwater.

Construction of Pond A is planned to occur at the toe of the Third Runway embankment, near the West MSE Wall. The location is within riparian wetlands adjacent to Miller Creek. This report explains the engineering design for the pond and how this design is to avoid impacts to the hydrology of the adjacent wetland.

The purpose of Pond A is temporary collection of stormwater during part of the embankment construction, and is anticipated to be in service for one to two years. During wet weather, a low water level would be maintained near the bottom of Pond A by pumping to provide storage of runoff from storm events. During the summer months, the pond would fill with groundwater seepage, to avoid cost of pumping.

If the pond were constructed without the sheet pile wall, calculations suggest that the rate of seepage into the pond would be low (less than 5 gpm). Since this could be enough to lower the water table locally and potentially alter the hydrology of the wetland, the Port has developed plans to avoid impacting the wetland hydrology as described herein. The proposed pond design and mitigation includes the following elements:

- Stockpiling native wetland soil for use in restoring temporary wetland impacts.
- Installation of a continuous ring of sheet piles to form a cutoff wall around the pond to limit seepage into the pond. The sheet pile wall would be driven into the top of very dense silty sand soils below the surficial soils, effectively cutting off seepage of groundwater into the pond.
- Installation of a gravel-filled trench (similar to a "French drain") around the outside of the sheet pile wall to maintain existing groundwater flow and avoid potential lowering of water levels on the immediate downgradient side of the pond.
- Monitoring wetland vegetation adjacent to the pond during construction and pond operation to verify no loss of wetland functions and/or to enable supplemental mitigation, if needed.
- Removal of the temporary sheet pile wall and French drain after construction in the area is complete, backfilling with native soil, and revegetation to restore pre-construction conditions (see Section 5.2.4 of the Natural Resources Mitigation Plan; Parametrix 2000). Backfill would consist of soil types similar to those excavated; compaction would be avoided to enhance revegetation and to restore pre-construction seepage conditions.

The following sections of this report provide a summary of subsurface conditions, followed by a detailed description of the proposed design and mitigation. Figure 1 shows a site plan and existing shallow groundwater contours. Figure 2 shows a general geologic cross section through the pond. Figure 3 shows a detailed layout of temporary Pond A including a sheet pile wall and French drain around the perimeter. Figure 4 shows a cross section through the sheet pile wall and French drain.

Appendix A presents logs of soil borings at Pond A; Appendix B discusses hydrogeologic modeling used to verify effectiveness of the proposed French drain in maintaining shallow groundwater movement to the downslope wetland; and Appendix C describes geotechnical analysis of the sheet pile.

SUMMARY OF SUBSURFACE CONDITIONS

Subsurface conditions in the vicinity of Pond A generally consist of 5 to 15 feet of soft or loose soils overlying very dense glacial till. The soft surficial soils consist of interbedded silty to very silty sand, peat and slightly sandy silt. Below these soils, the borings encountered silty, slightly gravelly to gravelly sand (glacial till). Logs of borings in the area of Pond A are presented in Appendix A. Figure 2 presents a generalized cross section through the long axis of the proposed Pond A.

The proposed bottom of pond elevation is 220 feet (existing ground surface elevations between about 226 to 230 feet). Groundwater levels vary seasonally between about 224 to 230 feet (Table 1).

Groundwater in the area of Pond A is within a few feet of the ground surface throughout the year. The groundwater level varies seasonally up to about 2-1/2 feet, as indicated by measurements in observation wells HC99-B38 and HC99-B39 from March of 1999 through January 2001 (Table 1).

PROTECTION OF WETLANDS

Given the potential for Pond A to alter wetland hydrology, alternative methods for protecting the wetland were considered. These included modifications to the operating regime for Pond A with operation restricted during the summer to prevent any potential for wetland impacts at this time. A design that hydraulically isolates Pond A was also developed and the effect of this isolation on the hydrology of the neighboring wetlands was analyzed using a simplified groundwater flow model (Appendix B).

The sheet pile wall will completely encircle Pond A, forming a hydraulic barrier from groundwater in the surficial soils surrounding the pond (Figure 3). Seepage below the sheet piles is anticipated to be negligible, due to the low hydraulic conductivity of the very dense silty sand (glacial till) and limited differential head between the bottom of the pond and groundwater level outside the pond. Details of the sheet pile wall design are presented in Appendix C.

Although the sheet pile wall will provide hydraulic isolation of Pond A from the surrounding wetland, a potential effect of the wall could be a disruption of the natural pattern of shallow groundwater movement in the subsoils downslope of the wall. To prevent disruption of groundwater flow, the design also includes a gravel-filled trench, constructed as a French drain encircling the sheet pile wall. This French drain will convey groundwater flow around the "obstruction" created by the pond.

A numerical groundwater flow model was used to assess the potential for changes in groundwater levels and flows as a result of the sheet pile wall, and to test alternatives measures for mitigating these effects (Appendix B). Worst case simulations suggested that without the French drain system, groundwater levels could potentially be reduced by 1 to 2 feet on the downgradient side of the sheet pile wall in the zone between Pond A and Miller Creek. The French drain is designed to avoid this potential impact.

Groundwater flow would be maintained around the sheet pile wall by conventional French drain consisting of a gravel-filled trench with a perforated drain pipe located within the gravel. The gravel-filled trench provides for relatively uniform seepage into the French drain and from the French drain into the adjacent undisturbed soil. The pipe enables effective transmission of water around the sheet piled area with relatively little loss of head. A geotextile filter fabric around the gravel will prevent migration of fine soil particles and potential clogging that might otherwise diminish effectiveness over the one to two year operating life of the system. Dimensions and details of the system are shown on Figure 4.

The trench will collect shallow groundwater on the upstream (eastern) side of Pond A, and convey it to the soils on the downstream (western) side of the pond. Flow can occur around both the southern and northern ends of the pond. Groundwater that seeps into the upgradient side of the drain will be available to re-infiltrate back into the shallow soils on the western side of Pond A, thus maintaining groundwater levels in the wetland.

The rate of flow into and out of the trench will be limited by the hydraulic conductivity of the native soils. Accordingly the drain would not lower water tables in upgradient soils.

USE OF THIS REPORT

This report was prepared for the Port of Seattle for the site and facility described herein. We completed this work in accordance with conventionally accepted geotechnical engineering practices for the nature and conditions of work conducted in the same or similar localities at the time the work was performed.

Hart Crowser would be pleased to address any questions on this report.

REFERENCES

Parametrix 2000. "Final Natural Resource Mitigation Plan, Master Plan Update Improvements, Seattle-Tacoma International Airport."

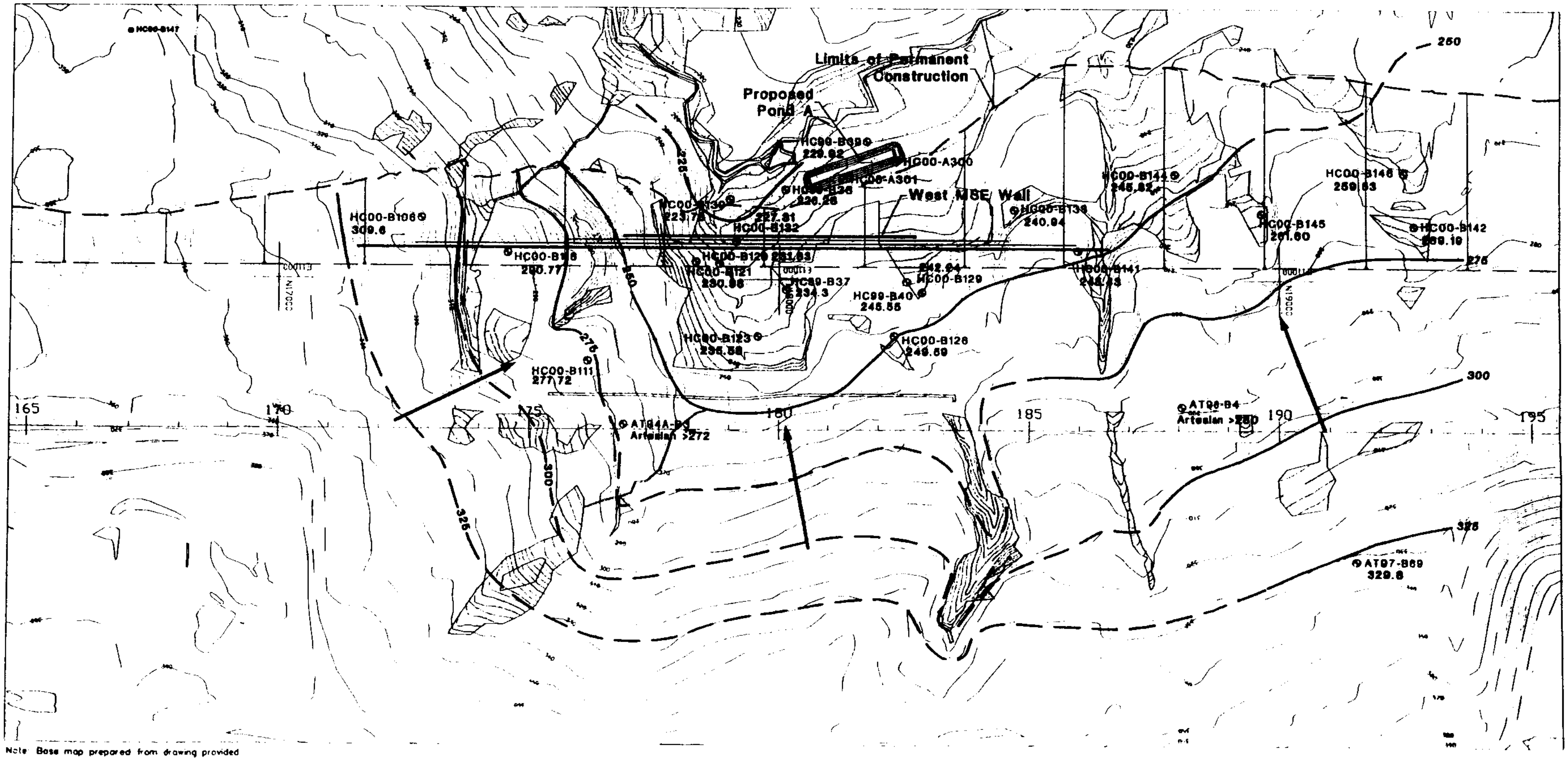
F:\Docs\Jobs\497806\PondAReportRev2.doc

Table 1 - Observed Groundwater Levels in Monitoring Wells near Pond A

Monitoring Well:	HC99-B38		HC99-B39	
	Depth* in Feet	Elevation in Feet	Depth* in Feet	Elevation in Feet
Measuring Point	0.00	230.88	0.00	230.80
Ground Level*	3.3	227.6	-0.3	231.1
Top of Screen*	12.3	218.6	4.7	226.1
Bottom of Screen*	22.3	208.6	14.7	216.1
Date: 3/8/1999	4.40	226.48	0.69	230.11
3/10/1999				
4/5/1999	4.41	226.47	0.74	230.06
5/4/1999	4.60	226.28	0.86	229.94
5/15/1999				
6/14/1999	5.90	224.98	1.68	229.12
7/13/1999	5.93	224.95	2.05	228.75
8/13/1999	6.08	224.80	2.18	228.62
9/14/1999	6.48	224.40	2.51	228.29
10/13/1999	5.98	224.90	2.09	228.71
11/11/1999	4.25	226.63	2.90	227.90
12/9/1999	4.38	226.50	0.27	230.53
1/13/2000	4.35	226.53	0.54	230.26
2/14/2000	4.33	226.55	0.59	230.21
3/9/2000	4.43	226.45	0.61	230.19
4/11/2000	4.60	226.28	0.88	229.92
5/10/2000	4.32	226.56	0.88	229.92
6/19/2000	4.91	225.97	1.15	229.65
7/10/2000	5.72	225.16	1.61	229.19
10/10/2000	5.99	224.89	2.17	228.63
1/22/2001	4.42	226.46	0.79	230.01
5/4/2001	4.58	226.30	1.05	229.75

Depth* All depths are below measuring point (NOT below the ground surface)
Blank indicates data not available.

Site and Exploration Plan
Groundwater Elevation Contour Map
Pond A



Note: Base map prepared from drawing provided by HNTB entitled "Topo_Full.dwg," dated October 4, 1999. Wetland delineation prepared from drawing provided by Parametrix entitled "W_020800.dwg," dated February 8, 2000.

⊕HC00-B118	Monitoring Well Location and Number
⊙HC00-A300	Hand Auger Boring Location and Number
290.77	Groundwater Elevation in Feet (April 11, 2000)
Artesian >272	Confirmed Groundwater Estimated Piezometric Level in Feet
( )	Wetland Location
— —250—	Groundwater Elevation Contour in Feet (Dashed where Inferred)
←	Inferred Groundwater Flow Direction
185	Proposed Runway Centerline Stationing

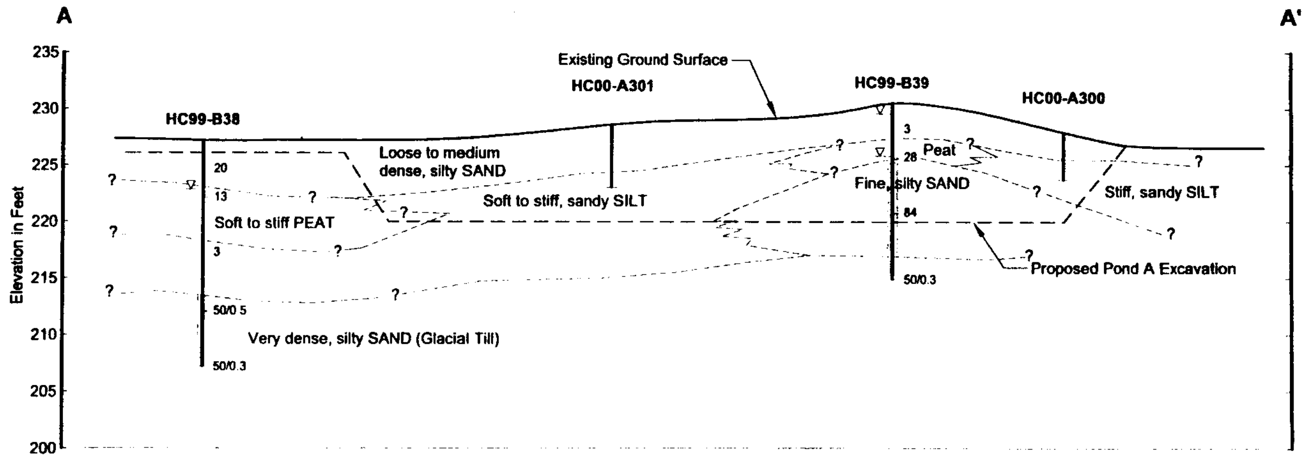
N

0 200 400
Scale in Feet

HARTCROWSER
J-4978-06 08/01
Figure 1

JC 8/18/00 1=200 [illegible]
49780684

Cross Section A-A'



Note. Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

HC00-A301 Exploration Number

Exploration Location

▽ Groundwater Level

50/0.3 Standard Penetration Resistance in Blows per Foot (or fraction)

Monitoring Well Screen Section

Inferred Geologic Contact

Horizontal Scale in Feet

0 30 60

0 10 20

Vertical Scale in Feet

Vertical Exaggeration x 3

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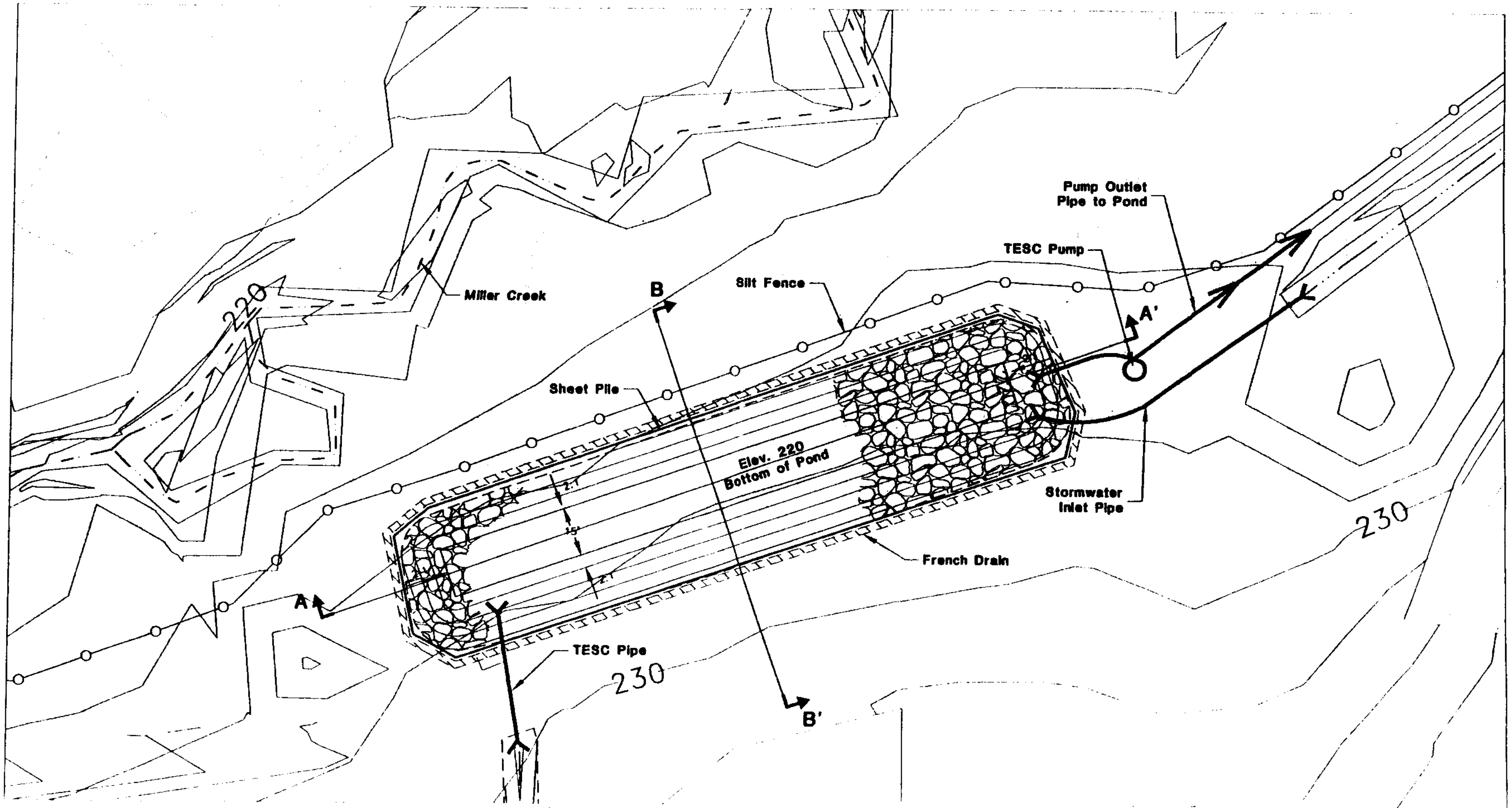
J-4978-06 6/01

Figure 2

Pond A Detail

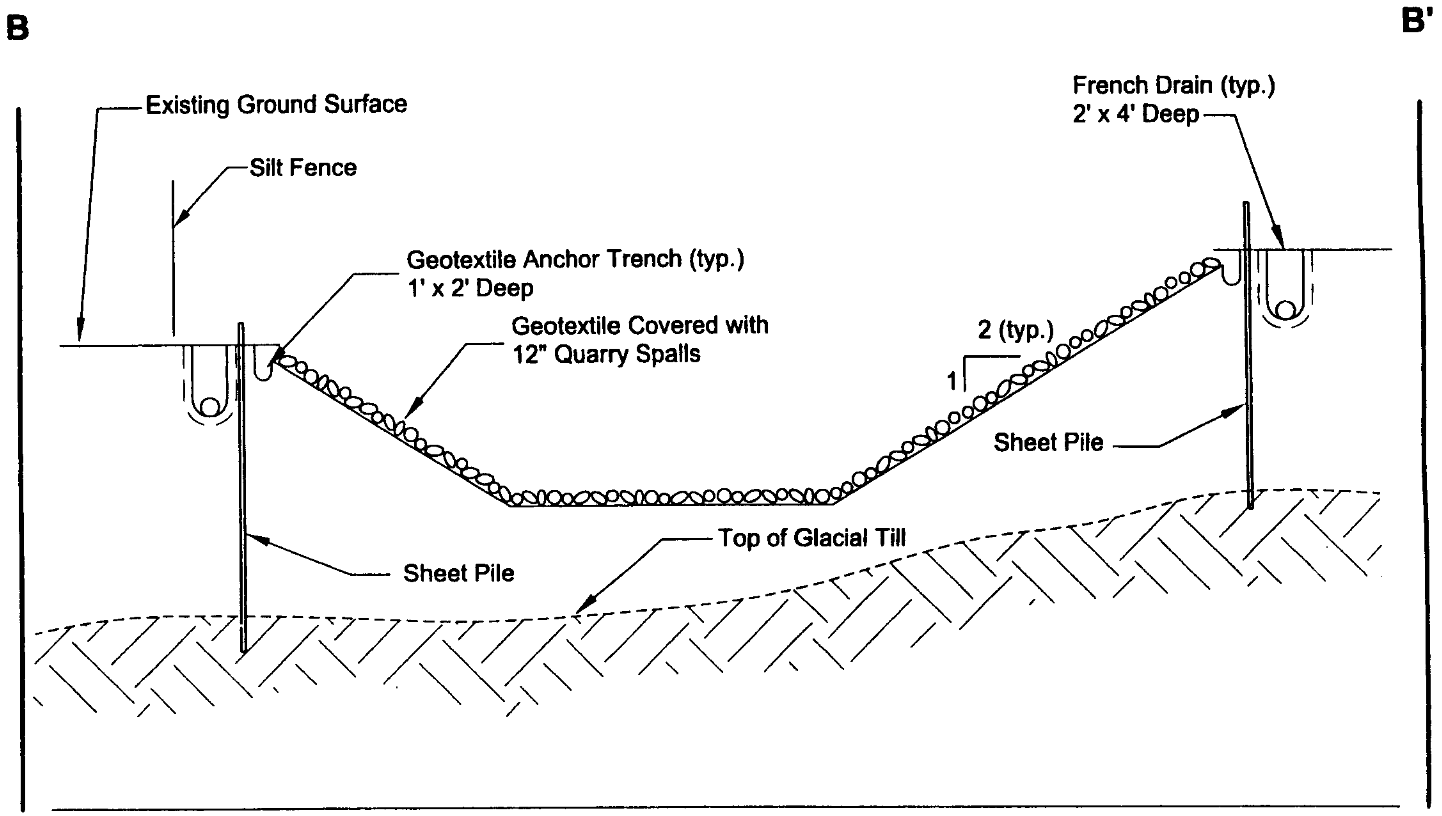


Note: Base map prepared from drawing provided by HNTB entitled "X_topo.dwg," dated April 4, 2001. Wetland delineation prepared from drawing provided by Parametrix entitled "W_022201.dwg," dated February 22, 2001

HARTCROWSER
J-4978-06 6/01
Figure 3

DTN 6/18/01 1=1 charlie-B.pc2 49780679

Cross Section B-B'



Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

Not to Scale

HARTCROWSER
J-4978-06 6/01
Figure 4

APPENDIX A
SUBSURFACE EXPLORATIONS

Key to Exploration Logs

Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance.
Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL Density	Standard Penetration Resistance (N) in Blows/Foot	SILT or CLAY Consistency	Standard Penetration Resistance (N) in Blows/Foot	Approximate Shear Strength in TSF
Very loose	0 – 4	Very soft	0 – 2	<0.125
Loose	4 – 10	Soft	2 – 4	0.125 – 0.25
Medium dense	10 – 30	Medium stiff	4 – 8	0.25 – 0.5
Dense	30 – 50	Stiff	8 – 15	0.5 – 1.0
Very dense	>50	Very stiff	15 – 30	1.0 – 2.0
		Hard	>30	>2.0

Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

Minor Constituents

	Estimated Percentage
Not identified in description	0 – 5
Slightly (clayey, silty, etc.)	5 – 12
Clayey, silty, sandy, gravelly	12 – 30
Very (clayey, silty, etc.)	30 – 50

Legends

Sampling Test Symbols

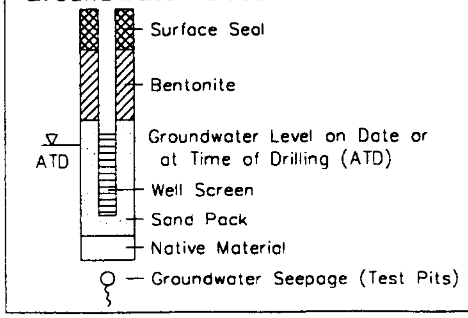
BORING SAMPLES

☒	Split Spoon
⧅	Shelby Tube
▥	Cuttings
◫	Core Run
*	No Sample Recovery
P	Tube Pushed, Not Driven

TEST PIT SAMPLES

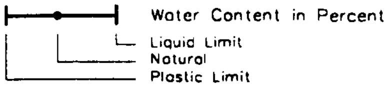
☒	Grab (Jar)
⧄	Bag
⧅	Shelby Tube

Groundwater Observations



Test Symbols

GS	Grain Size Classification
CN	Consolidation
UU	Unconsolidated Undrained Triaxial
CU	Consolidated Undrained Triaxial
CD	Consolidated Drained Triaxial
QU	Unconfined Compression
DS	Direct Shear
K	Permeability
PP	Pocket Penetrometer Approximate Compressive Strength in TSF
TV	Torvane Approximate Shear Strength in TSF
CBR	California Bearing Ratio
MD	Moisture Density Relationship
AL	Atterberg Limits



PID	Photoionization Detector Reading
CA	Chemical Analysis
DT	*In Situ* Density Test

1=1 A-1 STANDARD

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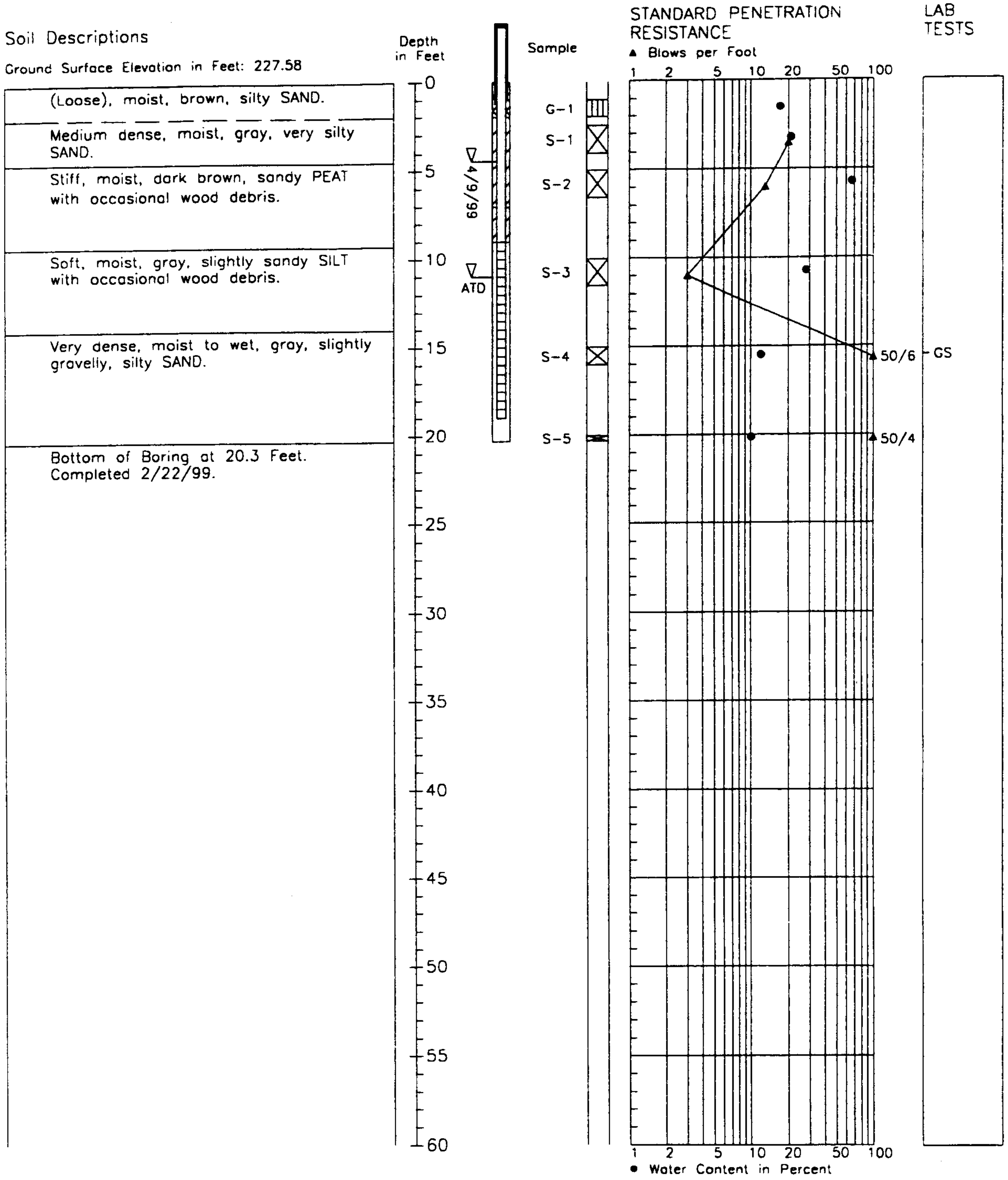
J-4978-06 **6/01**

Figure A-1

Boring Log HC99-B38

N 18,011.99, E 10,819.39



Soil Descriptions

Ground Surface Elevation in Feet: 227.58

(Loose), moist, brown, silty SAND.

Medium dense, moist, gray, very silty SAND.

Stiff, moist, dark brown, sandy PEAT with occasional wood debris.

Soft, moist, gray, slightly sandy SILT with occasional wood debris.

Very dense, moist to wet, gray, slightly gravelly, silty SAND.

Bottom of Boring at 20.3 Feet. Completed 2/22/99.

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

DTN 6/18/01 1=1 charlie.pc2
4978\LOGS\99 BORINGS

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J-4978-06 **6/01**

Figure A-2

Boring Log HC99-B39

N 18,174.14, E 10,722.31

Soil Descriptions

Ground Surface Elevation in Feet: 231.10

6 inches of TOPSOIL over very loose, moist, brown and gray, slightly gravelly, silty SAND.

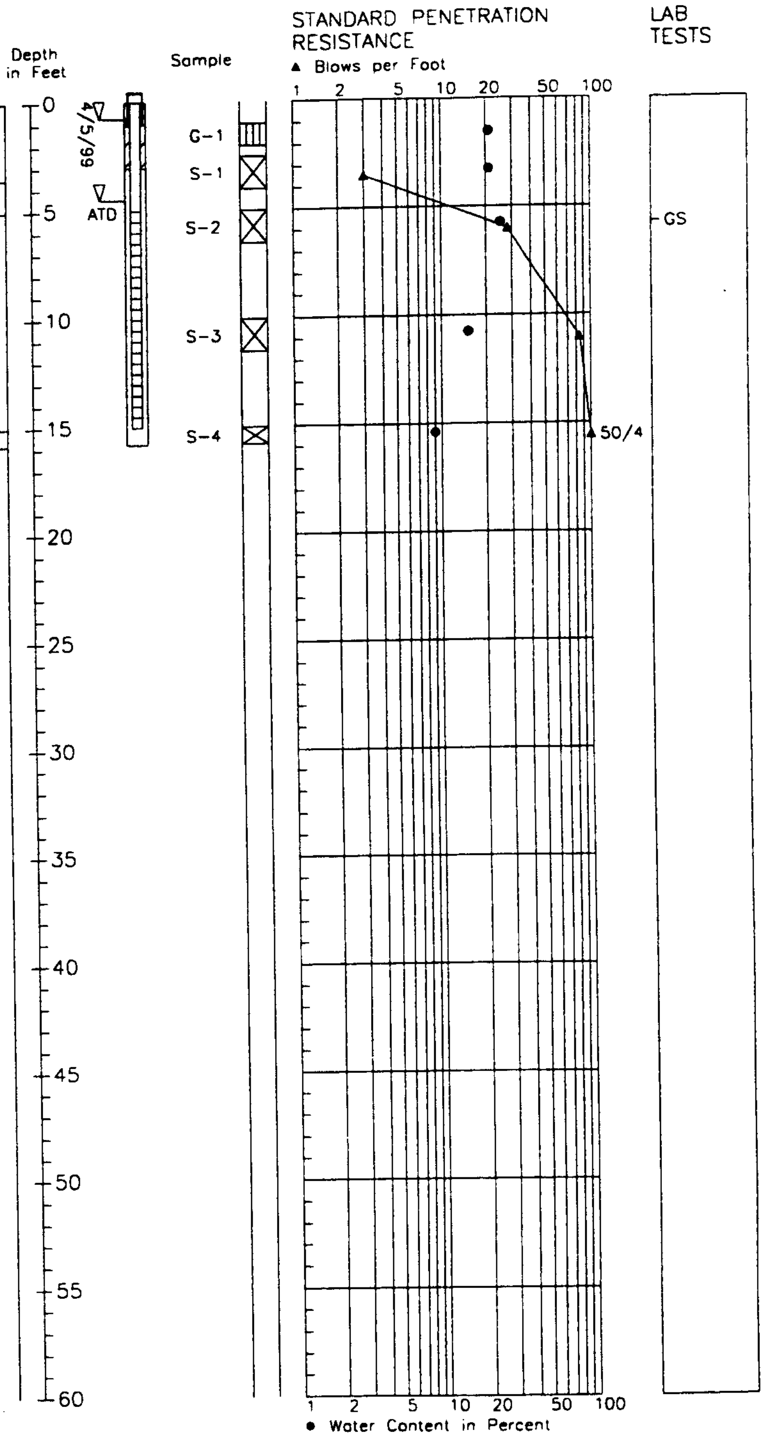
Soft, moist, brown PEAT.

Medium dense to very dense, moist, gray, silty, fine SAND.

8-inch layer of silty CLAY.

Very dense, moist, gray, silty, gravelly SAND.

Bottom of Boring at 15.8 Feet.
Completed 2/16/99.



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.

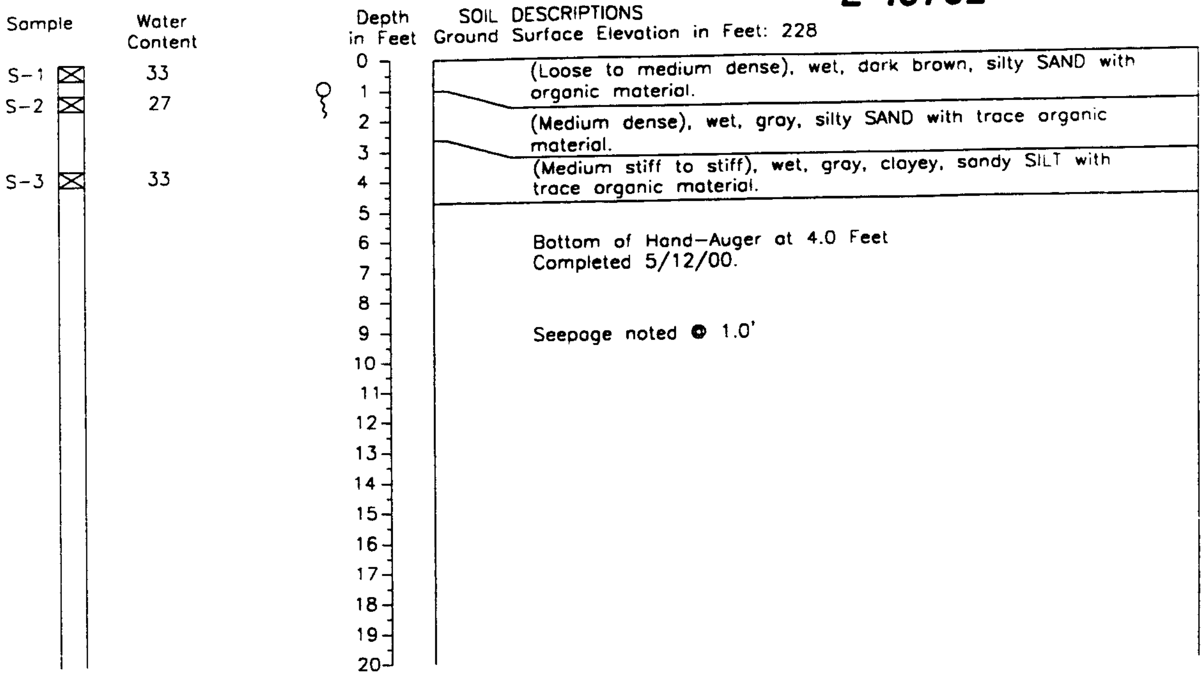
DTN 6/18/01 1=1 charlie.pc2
4978\LOGS\99 BORINGS

HARTCROWSER

J-4978-06 6/01
Figure A-3

Hand-Auger Log HC00-A300

N 18235
E 10762



Sample	Water Content
S-1 ☒	33
S-2 ☒	27
S-3 ☒	33

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 228

(Loose to medium dense), wet, dark brown, silty SAND with organic material.

(Medium dense), wet, gray, silty SAND with trace organic material.

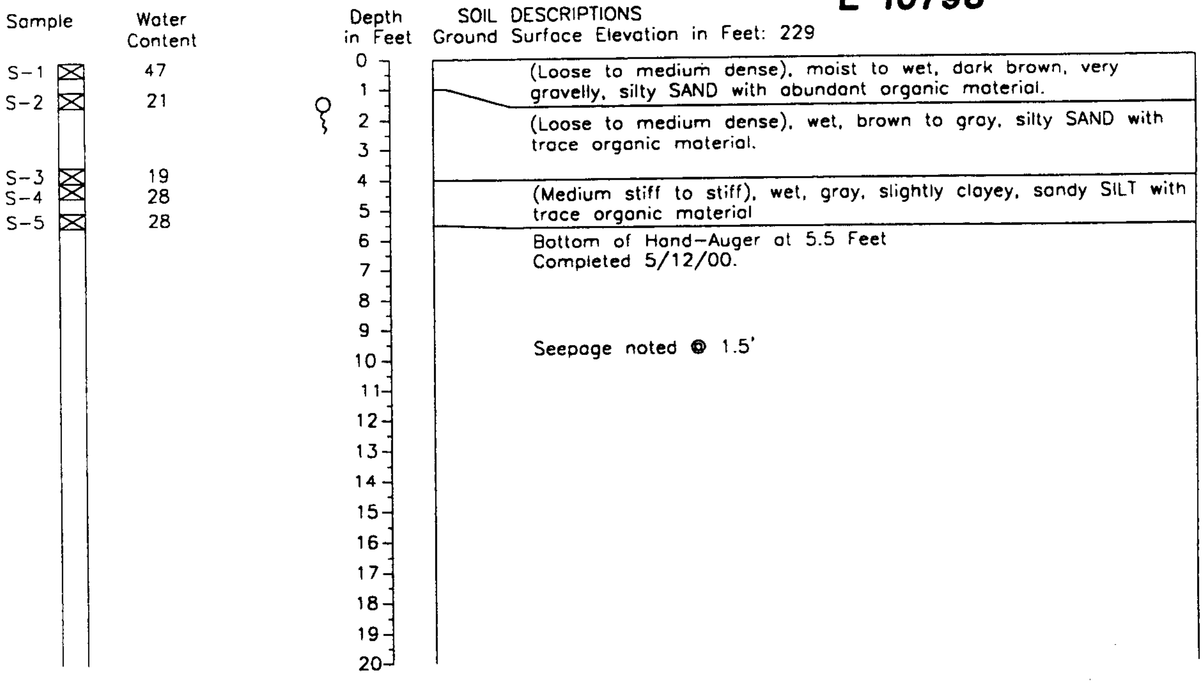
(Medium stiff to stiff), wet, gray, clayey, sandy SILT with trace organic material.

Bottom of Hand-Auger at 4.0 Feet
Completed 5/12/00.

Seepage noted @ 1.0'

Hand-Auger Log HC00-A301

N 18127
E 10798



Sample	Water Content
S-1 ☒	47
S-2 ☒	21
S-3 ☒	19
S-4 ☒	28
S-5 ☒	28

SOIL DESCRIPTIONS
Ground Surface Elevation in Feet: 229

(Loose to medium dense), moist to wet, dark brown, very gravelly, silty SAND with abundant organic material.

(Loose to medium dense), wet, brown to gray, silty SAND with trace organic material.

(Medium stiff to stiff), wet, gray, slightly clayey, sandy SILT with trace organic material

Bottom of Hand-Auger at 5.5 Feet
Completed 5/12/00.

Seepage noted @ 1.5'

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at the time of excavation. Conditions may vary with time.

DTN 6/30/00 1=1 CHARLIE-8.PC2
497806 HANDAUGERS.dwg

HARTCROWSER
J-4978-06 6/01
Figure A-4

APPENDIX B
GROUNDWATER SEEPAGE ANALYSIS

APPENDIX B
GROUNDWATER SEEPAGE ANALYSIS

This appendix describes the groundwater seepage analysis that was performed to examine the potential hydrologic effect of Pond A on groundwater. The analysis was also used to design sheet pile wall and a gravel-filled trench (French drain) that mitigates the potential hydrologic effect of the pond.

Approach

The approach taken to assess the effect of the sheet pile wall and the French drain on the groundwater flow regime was to prepare a simplified groundwater flow model, using a MODFLOW computer model based on observations of groundwater levels in nearby monitoring wells. The model showed the generalized effect of the sheet pile wall as a blockage to the pre-construction groundwater flow pattern in the area.

The model simulates changes in groundwater flowpaths, as well as the mounding effect on the upstream side of the sheet piles, and the corresponding reduction in groundwater levels on the downstream side of the sheet piles. Simulation of the French drain with the same model shows how it will collect water that mounds on the upstream side, and conduct it around to the downstream side of the sheet piles. On the downstream side, seepage re-infiltrates into the shallow soils so as to maintain groundwater levels in the wetland. The re-infiltration of groundwater is considered important to sustain the hydrologic regime of the riparian wetland adjacent to Miller Creek.

Model Setup

A numerical groundwater flow model was used to assess the likelihood for changes in groundwater levels and flows due to the proposed sheet pile wall around Pond A, and to test alternatives measures for mitigating these effects. The model was created using the USGS MODFLOW code (McDonald and Harbaugh 1988) with the Visual MODFLOW pre- and post-processor (Waterloo Hydrogeologic 2000). MODFLOW is a block-centered finite difference code capable of simulating steady-state and transient groundwater flow in a range of aquifer types and configurations.

The model was set up to provide a simplified representation of the shallow groundwater flow system in the vicinity of Pond A. The model represents a numerical approximation to the general pattern of groundwater flow, for the purpose of demonstrating cause and effect of the proposed sheet piling and French drain relative to an assumed base condition. This approach is valid for the mitigation design since, using a consistent set of groundwater and soil parameters in the model, it focuses on the changes to groundwater flow caused by the proposed construction and shows how these impacts are avoided by the proposed mitigation.

The model domain is shown on Figure B-1 and encompasses an area extending from north of South 166th Street, to Detention Pond G in the south, with Detention Pond A located approximately in the center. The lateral extent covered by the model is the area west of the existing airfield, bounded on the west side by Miller Creek.

The model was configured with its top surface defined by the existing topography, and its base defined as the top of the glacial till (very dense silty sand) underlying the site, as determined from geotechnical borings conducted in the area. Shallow groundwater flow occurs in the surficial soils based on observation of seepage in test pits and inferred from water level measurements in monitoring wells nearby. Groundwater flow conditions in the area are well documented because of various exploratory borings and monitoring wells observations for the Third Runway. Data sources are listed at the end of this appendix.

The MODFLOW model was constructed with two layers to represent the construction of a gravel-filled trench surrounding the sheet piles. The upper layer of the model consisted of a 3-foot-thick layer that mimics the surface topography. The lower layer represents the remainder of the shallow surficial soils (above the glacial till) that varies in thickness from about 3 to 10 feet across the area of the model. The horizontal area of the aquifer to be modeled was discretized into a rectangular grid with a cell size of 10 feet by 13 feet covering the area of interest (Figure B-1).

Aquifer Material

The aquifer parameters listed below were assigned to both layers with the exception of the ring of cells representing the drainage layer in the upper layer. The silty sands and other deposits above the glacial till were represented as general aquifer material with the following uniform properties:

- Hydraulic conductivity: 8.2×10^{-5} fps

No attempt was made to represent the likely spatial variation in aquifer properties within the surficial soils around Pond A.

Drainage Layer Material

The French drain used to maintain groundwater levels around the outside of the sheet piles was represented in the model with a more permeable material typical of a non-silty free-draining gravel:

- Hydraulic conductivity: 6.6×10^{-3} fps

Boundary Conditions

Constant-head boundaries were established along the eastern edge of the model to represent existing groundwater flow derived from the east. The elevation of the applied head was adjusted along the boundary to simulate the approximate variation in groundwater levels observed at the site. The west side of the modeled domain was represented by a series of river nodes to simulate the course of Miller Creek.

The northern and southern sides of the model were simulated as no-flow boundaries representative of groundwater streamlines in the aquifer, with groundwater flow in the body of the model occurring parallel to these sides. The lateral boundaries of the model were established a sufficient distance from Pond A (with the exception of Miller Creek) such that small changes in the boundaries would not strongly affect the groundwater flow pattern in the area of Pond A. The dense glacial till soils underlying the modeled area are assumed to be relatively low in permeability such that flow through the till is small in comparison to flow in the shallow soils, and can be ignored.

Recharge was applied uniformly over the entire area of the model to help simulate the general shape of the observed water table at the site.

Calibration

The model was calibrated in a general sense to two sets of water levels representative of the range observed in site monitoring wells (Table 1): an average winter high-water level and an average late-summer low-water level were used to define conditions for two separate model scenarios. Different water levels were achieved by varying the areal groundwater recharge value applied in the model from 16 to 10 in/yr.

Monitoring Points

Two virtual observation wells were assigned within the model to track simulated water levels at specific locations: one upgradient and one downgradient of Pond A.

Assumptions

Listed below are the assumptions associated with the construction and use of this groundwater model:

- Groundwater flow in the shallow aquifer is unconfined and modeled as steady-state;
- The underlying till/dense silty sands have lower permeability such that groundwater flow through these layers can be neglected;
- Aquifer materials are homogeneous and isotropic;
- Recharge to the groundwater is uniform over the model domain;
- Miller Creek is treated as a fixed-head river boundary defined by streambed elevation interpolated from topographic map coverage;
- Groundwater discharges to Miller Creek as baseflow;
- The area west of Miller Creek is ignored (inactive) in the model;
- Wetland function is not modeled explicitly but represented by groundwater levels at or close to ground surface; and
- Evapotranspiration from shallow groundwater table and/or wet surface soils is not modeled.

Results

The following results were obtained from steady-state solutions of the groundwater model described above for two different water level regimes.

Simulated Winter Water Levels

Three steady-state solutions were analyzed for determining the effect of the sheet pile wall on the shallow groundwater flow system in winter conditions. The resulting groundwater head distributions and streamflow lines are shown in the following figures:

- Figure B-2 - Existing Winter Conditions
- Figure B-3 - Pond A with Sheet Piles
- Figure B-4 - Pond A with Sheet Piles and Diversion Drain

Comparison of predicted water levels for the above scenarios show a rise in groundwater levels upgradient of Pond A and decreased groundwater levels downgradient of Pond A when only the sheet piles surround Pond A. Upon adding a groundwater diversion drain around the perimeter of Pond A, the groundwater levels return to pre-construction elevations, thus demonstrating no effect to the method.

Simulated Later Summer Water Levels

Two steady-state solutions were analyzed for determining the effect of the sheet pile wall on the shallow groundwater flow system in late summer conditions. The resulting groundwater head distributions and streamflow lines are shown in the following figures:

- Figure B-5 - Existing Conditions
- Figure B-6 - Pond A with Sheet Piles and Diversion Drain

Comparison of predicted water levels for the above scenarios show the groundwater levels at pre-construction elevations, thus demonstrating no effect to the Wetland.

Data Sources for Appendix B

FAA 1995. DRAFT Environmental Impact Statement for Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport. US Department of Transportation, Federal Aviation Administration, April 1995.

Hart Crowser 1999, Subsurface Conditions Data Report, 404 Permit Support, Third Runway Embankment, Sea-Tac International Airport, SeaTac, Washington, July 1999.

Hart Crowser 2000. DRAFT Subsurface Conditions Data Report, West MSE Wall, Third Runway Embankment, Sea-Tac International Airport, SeaTac, Washington, June 2000.

Hart Crowser 2000. DRAFT Subsurface Conditions Data Report, Additional Field Explorations and Advanced Testing, Third Runway Embankment, Sea-Tac International Airport, August 2000.

Hart Crowser 2001. Appendix C, DRAFT Geotechnical Engineering Analyses and Recommendations, Third Runway Embankment, Seattle-Tacoma International Airport, SeaTac, WA

Pacific Groundwater Group 2000. "Sea-Tac Runway Fill Hydrologic Studies Report", June 19, 2000.

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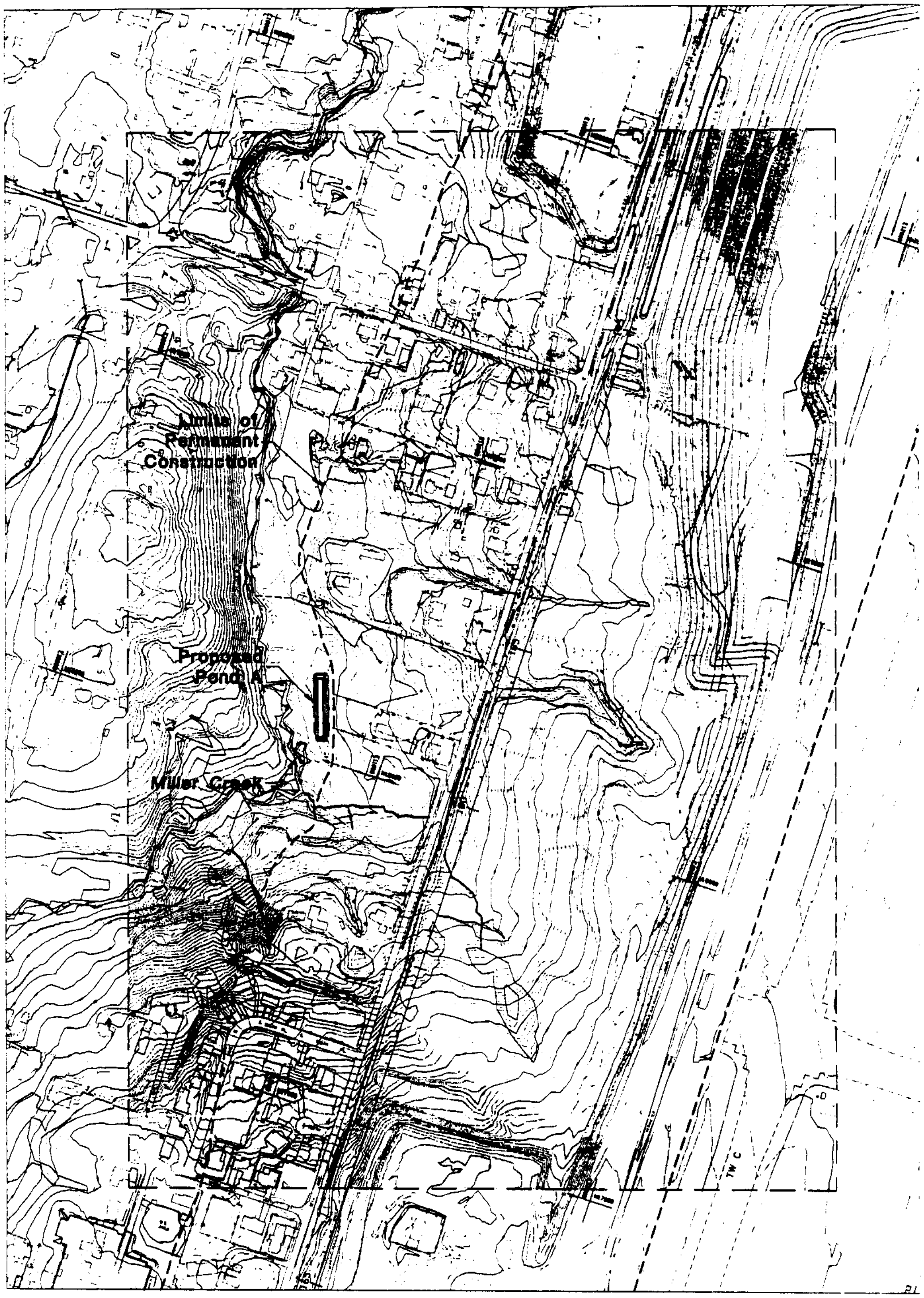
Groundwater Modeling Area

Pond A



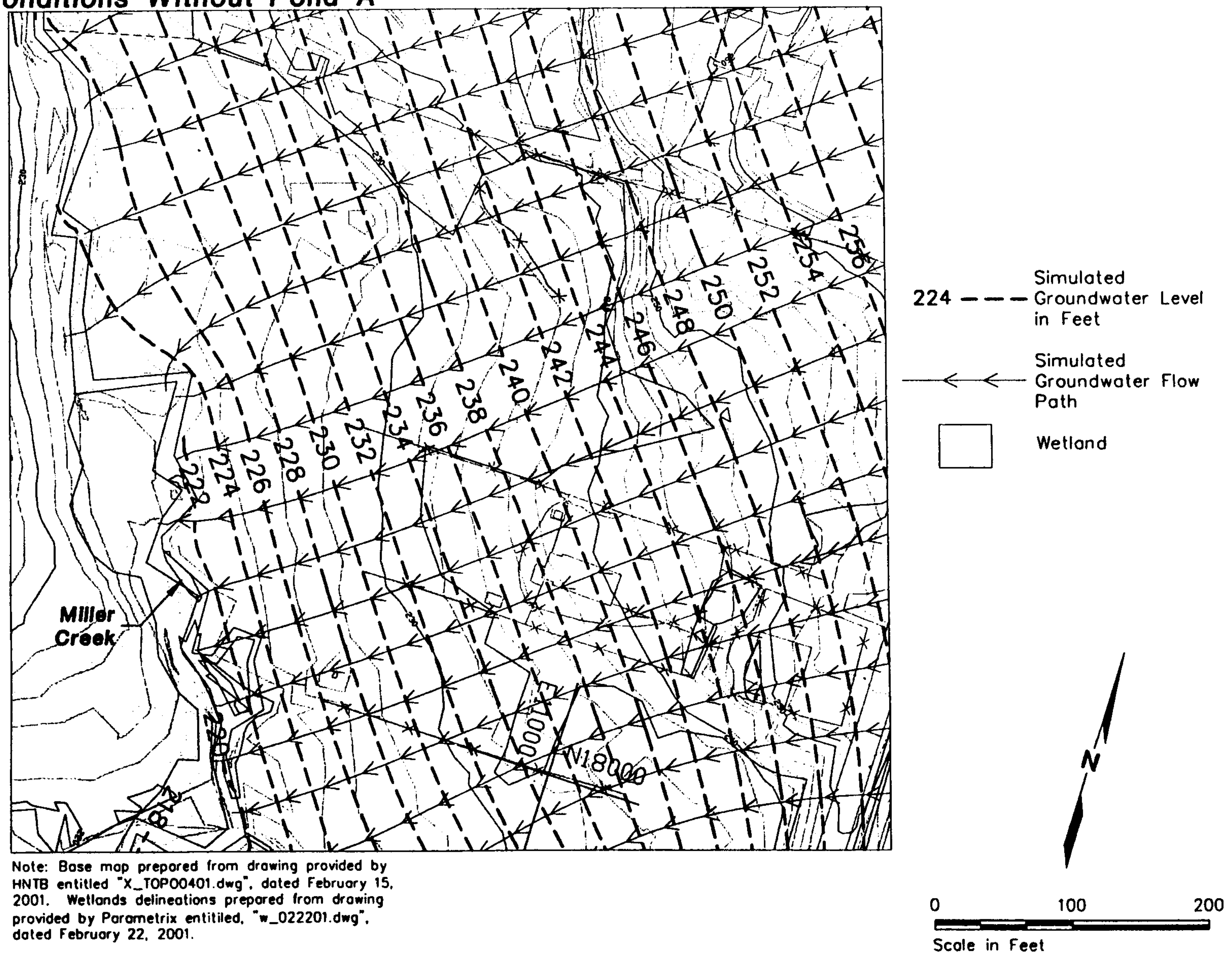
Note: Base map prepared from drawing provided by HNTB entitled "X_TOP00401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER
J-4978-06 6/01
Figure B-1

RC 6/18/01 1=100 (xref)see drawing file/charlie-8.pc2 49780682

Simulated Average Water Table

Existing Conditions Without Pond A



Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER

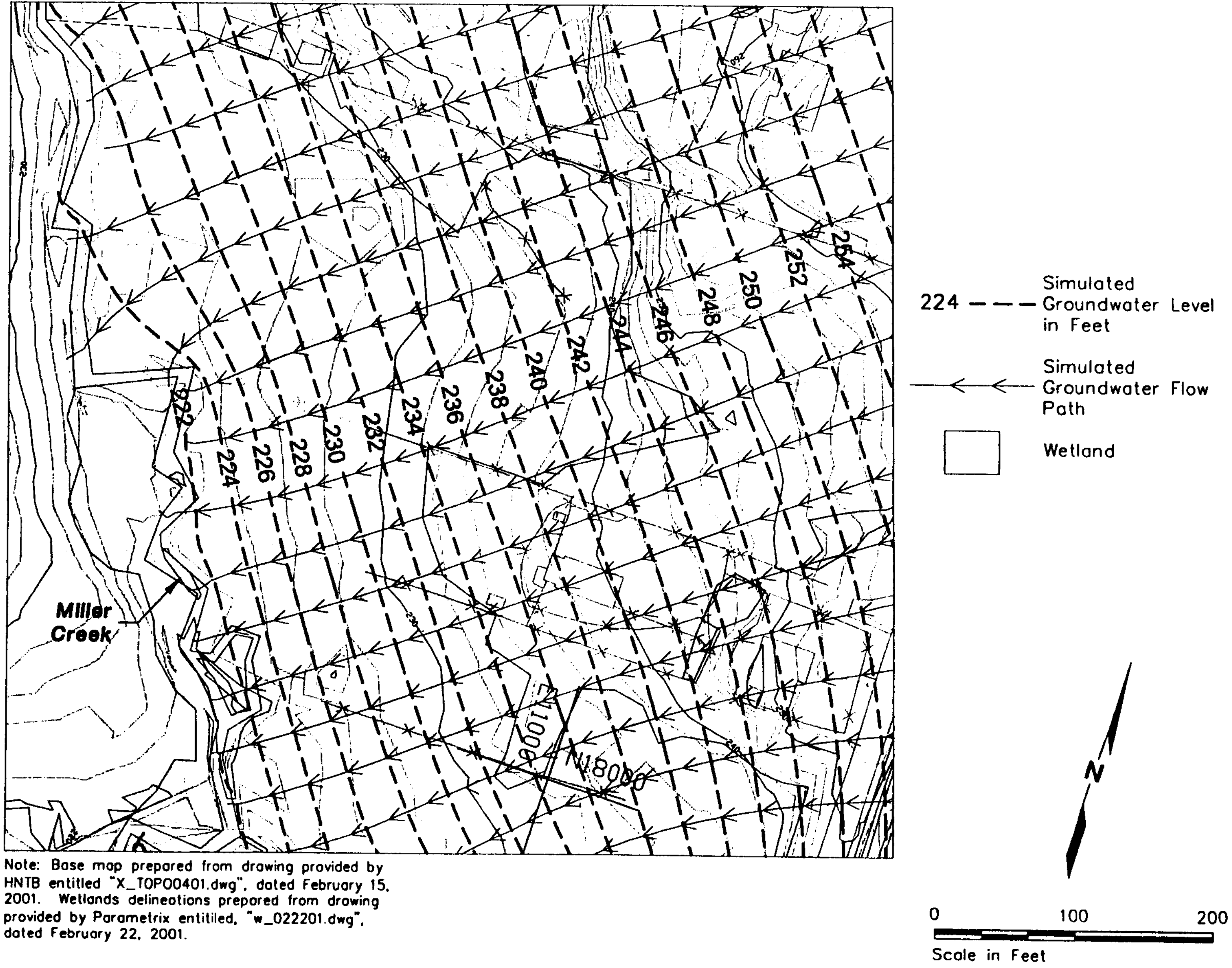
J-4978-06 6/01

Figure B-2

RC 6/1c/01 1=100 (xref)see drawing file/charlie-8.pc2 49780685

Simulated Late Summer Water Table

Existing Conditions Without Pond A



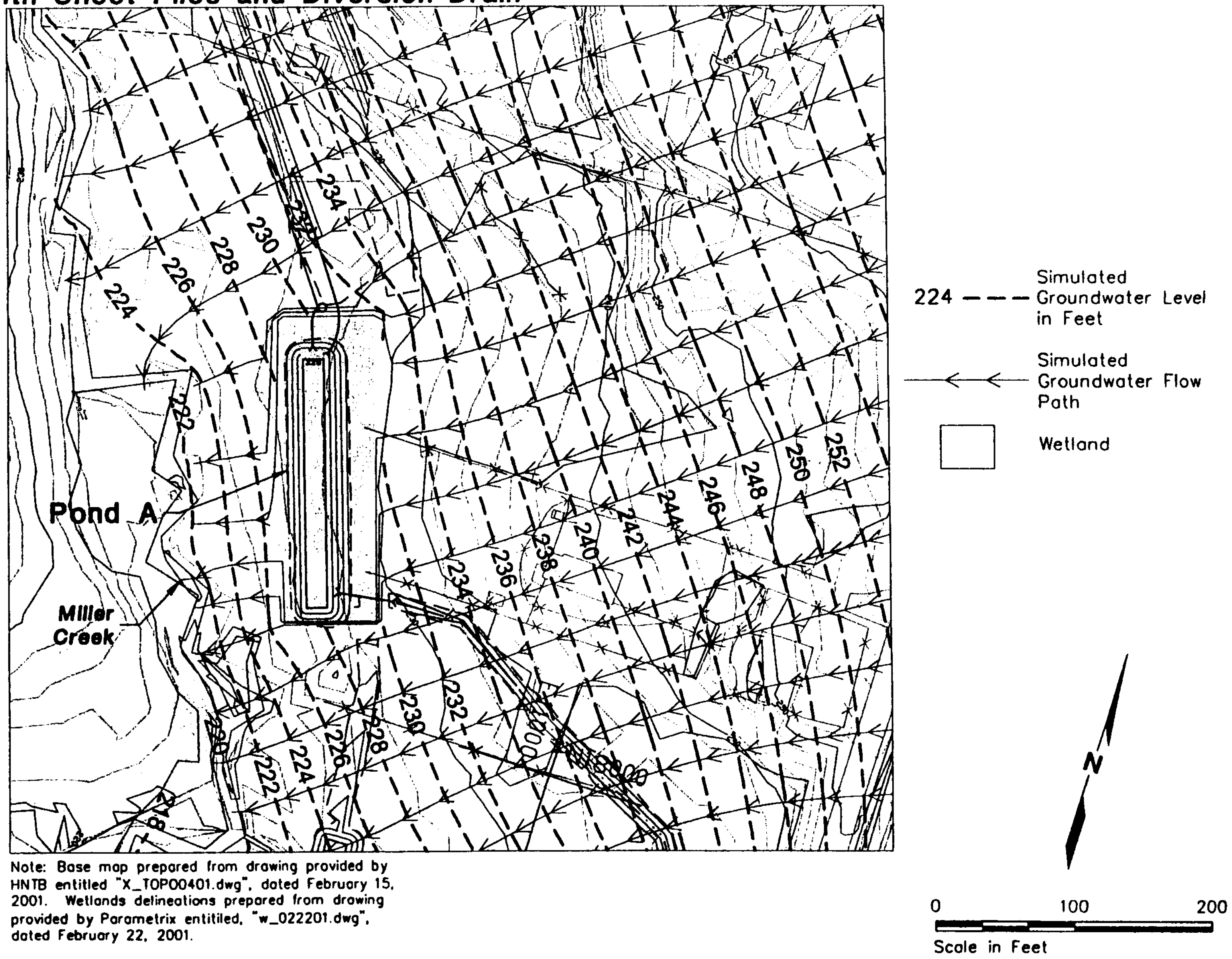
Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER
J-4978-06 6/01
Figure B-5

RC 6/18/01 1=100 (xref)see drawing file/charlie-8.pc2 49780683

Simulated Average Water Table

Pond A With Sheet Piles and Diversion Drain



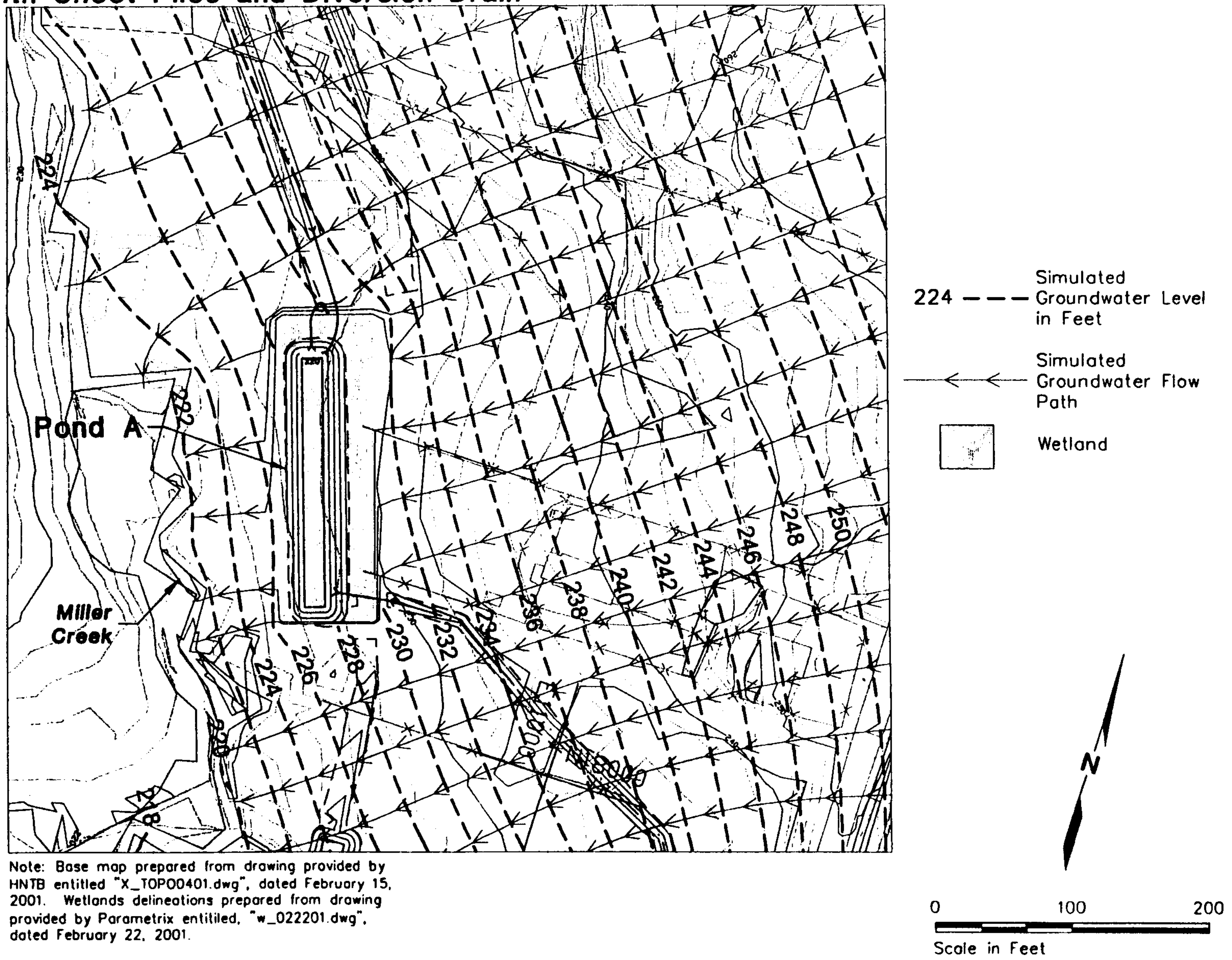
Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER
J-4978-06 6/01
Figure B-4

RC 6/18/01 1=100 (xref)see drawing file/charlie-8.pc7 49780686

Simulated Late Summer Water Table

Pond A With Sheet Piles and Diversion Drain



Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER

J-4978-06 6/01

Figure B-6

APPENDIX C
SHEET PILE DESIGN AND CONSTRUCTION

APPENDIX C
SHEET PILE DESIGN AND CONSTRUCTION

The proposed sheet piles around Pond A were designed to fulfill three functions:

a. Cut-off shallow groundwater so that seepage into the pond does not remove shallow groundwater from the adjacent wetland;

b. Protect adjacent wetlands from potential excavation-induced impacts such as slope failure and sloughing of loose/soft soil during excavation of the pond); and

c. Provide long-term static stability for pond constructed within a soil profile of loose and soft soils above glacial till.

Design

Sheet pile design to address the functional requirements noted above was based on soil and groundwater conditions encountered in local borings (see Appendix A). For design, we assumed water level in the pond varied from completely full to completely empty, or about 226 to 220 feet in elevation. We assumed groundwater coincides with ground surface on the upslope side of the sheet pile walls due to the anticipated effects of the perimeter drainage trench.

Table C-1 provides the soil parameters used in our slope stability and force/moment calculation. These analyses are discussed further below.

Earth Pressure Diagrams

Soil strength parameters were used to develop earth pressure diagrams for the embedded portion of the sheet pile. The diagrams enable a structural engineer to calculate the required sheet pile section modulus.

We assumed the sheet pile "cell" around the pond should be designed as a cantilever wall without anchorage. Active earth pressures acting on the piles located east of Pond A typically should include a surcharge pressure equal to the weight of an additional 2 feet of soil, to account for increased loads where the access road is located adjacent to the sheet pile wall. Passive earth pressures were factored to account for the loss of support due to the pond excavation.

Our analysis of sliding and overturning discussed below indicates the passive resistance sufficient to achieve target factors of safety depends on embedment, therefore design may need to be reviewed and/or modified in the event minimum embedment is not obtained due to variations in elevation of the glacial till. However, since the till is relatively impermeable and much stronger than the surficial soils, reduced penetration of piles due to shallow glacial till is not anticipated to result in any reduction in slope factors of safety.

Our analysis of the stability of the sheet pile wall and pond slopes consisted of two separate analyses: limit equilibrium analysis using the program Slope/W to analyze global slope stability (i.e., potential for failure below sheet piles) and b) force/moment equilibrium calculations to check factors of safety against sliding and rotation.

Slope Stability Analysis

We used Slope/W with Spencer's method for limit equilibrium analysis to calculate factors of safety for circular and wedge-type failure surfaces passing below the sheet pile wall. We analyzed the following conditions:

- Steady state (pond full) including the effect of soil buoyancy;
- Steady state (pond empty) without the effect of buoyancy; and
- Rapid drawdown (pond empty) including the effect of pore pressures.

Minimum target factors of safety were 1.5 for steady state conditions and 1.1 for rapid drawdown, consistent with normal geotechnical engineering practice for this area.

Factors of safety met target criteria provided sheet pile can be embedded at least 8 feet (to the top of the very dense glacial till) on the north side of the pond, with the case of rapid drawdown of the pond level being most critical. Embedment was critical for stability.

Force and Moment Equilibrium

Analyses were completed to verify that adequate factors of safety were achieved for both force and moment equilibrium, for resistance to sliding (or translation) and rotation. Target factors of safety were achieved for both steady state (pond full, buoyant conditions) and rapid drawdown conditions. By inspection we concluded that the steady state (pond empty) condition was less critical than the other two cases.

Erosion and Sloughing

Hart Crowser used the weighted creep method of analysis to assess potential for piping below the bottom of the sheet piles through fine to medium sand and silt soils. Results indicate mitigation is needed. Also, considering the soft and loose to medium dense soils that will be exposed in the 2H:1V pond side slopes, we expect that the slopes of the pond may undergo sloughing related to water level fluctuations during normal pond operations.

Recommended mitigation consists of driving the sheet piles to refusal in the underlying glacial till and lining the pond with a geotextile separation fabric and minimum 1 foot thickness of quarry spalls.

Construction

Hart Crowser makes the following recommendations for construction:

- Install the perimeter French drain entirely around the proposed pond prior to any sheet pile installation. This will assure adequate access for construction on the west side of the pond without any wetland encroachment and avoid any interruption of groundwater seepage as the sheet piles are installed.
- Install sheet piles on the west, north, and south sides of the pond (i.e., the sides closest to Miller Creek) prior to excavation. This will enable the piles to protect the creek in the event there is any excavation sloughing during pond construction.
- Drive piles to refusal in the top of the glacial till soils. The Port's contract documents should state that "jetting" shall not be used to aid driving.
- Prior to construction, the Contractor should provide the Port with a submittal that describes pile driving equipment and sequence of construction. During construction, the Port should verify that minimum embedment criteria are met.

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Table C-1 - Soil Parameters Used in Design

Soil Type	Moist Unit Weight in pcf	Drained Strength		Undrained Strength	
		c' in psf	ϕ' in deg.	c in psf	ϕ in deg.
Loose to Medium Dense Sand	125	0	32	-	-
Medium Dense to Dense Sand	130	0	35	-	-
Dense to Very Dense Silty Sand (Glacial Till)	135	250	40	-	-
Soft Peat or Organic Silt	90	0	15	300	0
Soft to Stiff Silt/Clay	115	0	30	1000	0

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Port of Seattle
Aviation Division

APPENDICES A-F

DESIGN DRAWINGS
NATURAL RESOURCE MITIGATION PLAN
SEATTLE-TACOMA INTERNATIONAL AIRPORT

APPENDIX A - MILLER CREEK RELOCATION AND FLOODPLAIN ENHANCEMENT
APPENDIX B - MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
APPENDIX C - TYEE VALLEY GOLF COURSE AND DES MOINES CREEK BUFFER PLANTING PLAN
APPENDIX D - REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS
APPENDIX E - AUBURN WETLAND MITIGATION
APPENDIX F - DES MOINES WAY NURSERY WETLAND RESTORATION

Parametrix, Inc.

NOVEMBER 2001
AGENCY REVIEW
NOT FOR CONSTRUCTION

Port of Seattle
Aviation Division

APPENDIX A

MILLER CREEK RELOCATION
SEATTLE-TACOMA INTERNATIONAL AIRPORT

SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE
STIA-9805-T1	TITLE SHEET	STIA-9805-L1	IRRIGATION DETAILS AND LEGEND		
STIA-9805-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS	STIA-9805-L2	IRRIGATION PLAN N		
STIA-9805-C1.1	MILLER CREEK RELOCATION AND FLOODPLAIN ENHANCEMENT	STIA-9805-L3	IRRIGATION PLAN S		
STIA-9805-C1.2	CROSS SECTION MILLER CREEK RELOCATION AND	STIA-9805-L4	PLANTING PLAN		
	S. 154TH/S. 156TH ST. AT STREET STA 108+50	STIA-9805-L5	PLANTING SCHEDULE AND DETAILS		
STIA-9805-C2	SITE PLAN	STIA-9805-L6	SHADECLOTH SECTION AND DETAIL		
STIA-9805-C3	SITE PLAN-NOTES				
STIA-9805-C3.1	BIOFILTRATION SWALE AND OUTFALL LOCATION				
	S. 154TH/S. 156TH STREET (WEST END)				
STIA-9805-C3.2	TYPICAL CROSS SECTION OF LORA LAKE BUFFER ENHANCEMENT				
STIA-9806-C3.3	BIOFILTRATION SWALE OUTFALLS				
STIA-9805-C4	CHANNEL PROFILE				
STIA-9805-C5	CHANNEL SECTIONS AND DETAILS				
STIA-9805-C6	FLOODPLAIN SECTIONS				
STIA-9805-C6.1	VACCA FARM FLOOD PLAIN SOIL PROFILE				
STIA-9805-C7	MISCELLANEOUS SECTIONS AND DETAILS				
STIA-9805-C7.1	MICROTOPOGRAPHIC FEATURE DETAIL				
STIA-9805-C8	HABITAT LOG-LAYOUT PLAN AND DETAILS				
STIA-9805-TE1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN				
STIA-9805-TE2	TEMPORARY EROSION AND SEDIMENT CONTROL SECTIONS AND DETAILS				

DATE: 11/13/01 FILENAME: 2912171T1 IMAGES: XREF'S

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MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

DATE

DATE

DATE

APPROVED BY

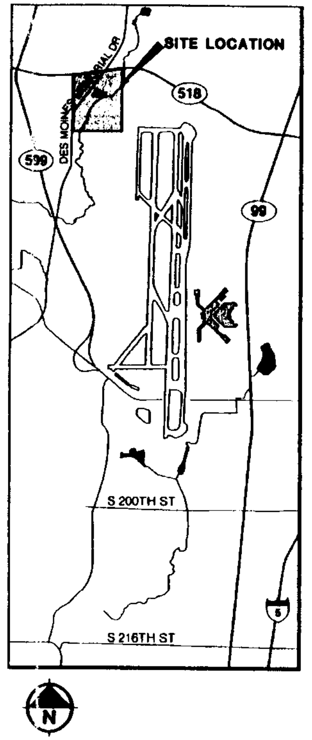
DATE

WORK ORDER NO. 100051

PROJECT NO. STIA-9805-T1

APPENDIX A

VICINITY MAP

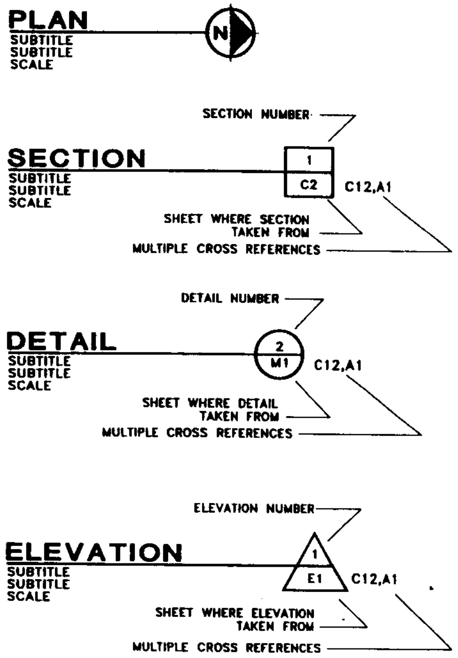


LEGEND

	CULVERT
	SPOT ELEVATION
1	KEY NOTE NUMBER REFERENCE
	SURFACE WATER DITCH
	EXISTING CONTOUR
—265—	PROPOSED CONTOUR
— — — —	EXISTING GRADE (SECTION)
	SPAWNING GRAVEL (SECTION)
▨	CRUSHED SURFACING BASE COURSE (SECTION)
▨	QUARRY SPALLS
▨	CONCRETE
▨	EMBANKMENT
▨	NATIVE SUBGRADE
▨	GRAVEL
	PAVEMENT (PLAN)
	SLOPE INDICATOR
N 8100 E 5800	CONTROL POINT
—S—S—	SILT FENCE
	SILT CURTAIN
	GEOTEXTILE
— EM —	EROSION CONTROL MATTING
	STRAW BALE BARRIER
P-1 ⊗	EXISTING MONITORING WELL
—x—	CHAIN LINK FENCE
	PRIVATE PROPERTY BOUNDARY
	POINT OF INTERSECTION
	BERM
	CHANNEL CENTERLINE AND STATION
	EXISTING SANITARY SEWER LINE
—SS—	PROPOSED SANITARY SEWER LINE
	LIMIT OF CONSTRUCTION (PROJECT)
⌖	SURVEY CONTROL POINT
	LIMIT OF RESTRICTED AREA
	EXISTING STORM DRAIN

GENERAL LEGEND

DRAWING TITLE:



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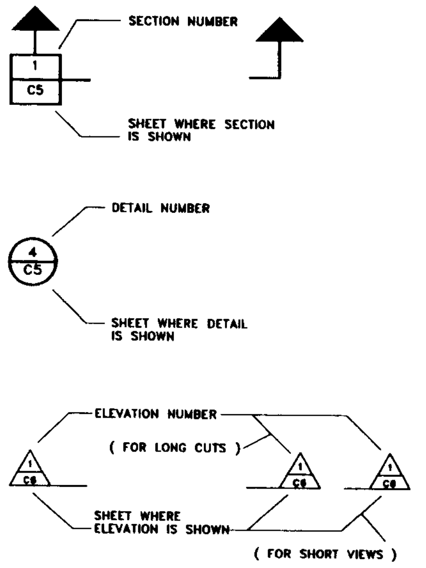

GENERAL ABBREVIATIONS

&	AND	N	NORTH/NORTHING
ACP	ASPHALT CONCRETE PAVEMENT	NO.	NUMBER
APPROX.	APPROXIMATE	N.T.S.	NOT TO SCALE
℄	CENTERLINE	O.C.	ON CENTER
CMP	CORRUGATED METAL PIPE	PP	POWER POLE
DIA	DIAMETER	R	RADIUS
E	EAST/EASTING	RCP	REINFORCED CONCRETE PIPE
EL OR ELEV	ELEVATION	S	SOUTH
EXIST	EXISTING	SD	STORM DRAIN
FT	FOOT (FEET)	S.F.	SQUARE FOOT/FEET
GAL	GALLON	SS	SANITARY SEWER
HORIZ/H	HORIZONTAL	STA	STATION
HT.	HEIGHT	TYP	TYPICAL
I.E.	INVERT ELEVATION	W/	WITH
LF	LINEAR FEET/FOOT	WD	WOODY DEBRIS
MAX	MAXIMUM	VERT/V	VERTICAL
MIN	MINIMUM		
MISC	MISCELLANEOUS		

SURVEY CONTROL POINTS

9704-2 = REBAR WITH YELLOW CAP MARKED PMX CONTROL NEAR THE SOUTHEAST CORNER OF LORA LAKE. 11.0' SOUTHERLY OF A DOUBLE TRUNK (12" & 10") ALDER TREE WHICH IS @ THE TOP OF THE BANK & 21.0' NORTHWESTERLY FROM A SANITARY SEWER MANHOLE.

9704-3 = REBAR WITH YELLOW CAP MARKED PMX CONTROL NEAR THE SOUTHWEST CORNER OF LORA LAKE. 6.0' SOUTHERLY OF THE TOP OF BANK & 33.2' WEST SOUTHWEST OF A DOUBLE TRUNK (12" & 12") ALDER TREE.

9704-4 = REBAR WITH YELLOW CAP MARKED PMX CONTROL IN THE NORTHWESTERLY MARGIN OF THE DIRT ROAD THAT RUNS BETWEEN THE PUMPKIN PATCHES, @ THE EASTERLY END OF A BLACKBERRY PATCH, 82' +/- EASTERLY OF THE MOST NORTHWESTERLY CORNER OF A WOODEN STORAGE SHED.

NOTE: SEE C2 FOR SURVEY CONTROL POINT COORDINATES AND ELEVATIONS.

GENERAL NOTES

1. CALL "DIG-SAFE" (1-800-425-5555) PRIOR TO COMMENCING ANY GRADING OR EXCAVATION WORK ON THE SITE.
2. INSTALLATION OF TEMPORARY EROSION AND SEDIMENT CONTROLS SHALL BE COMPLETED PRIOR TO SITE WORK.

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J. LEAVITT/K. LUDWA
PJT/SRH
AS SHOWN
NOVEMBER 2001
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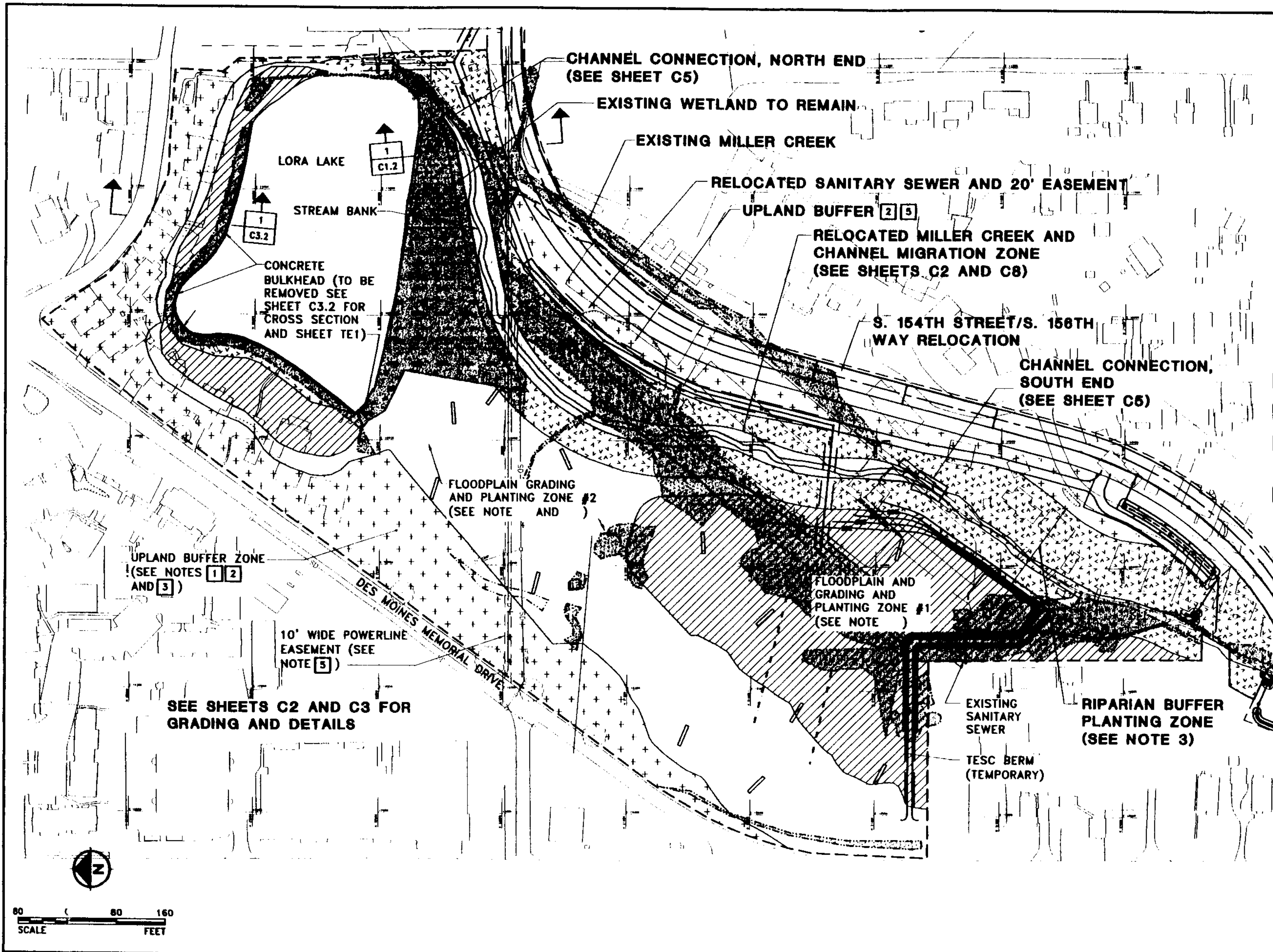
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

—
291217C1
STIA-9805-C1
APPENDIX A

DATE: 11/19/01 FILENAME: 291217C1



LEGEND

▓	WETLAND
░	MILLER CREEK RELOCATION AND PLANTING ZONE (SEE SHEET L1)
▨	FLOODPLAIN ZONE #1
☐	FLOODPLAIN ZONE #2
░	UPLAND BUFFER ZONE 5
▓	ENHANCED EXISTING WETLAND
░	EXISTING WETLAND (TO REMAIN)
▭	DOWNED LOG (TYP) (SEE SHEET C7)
☐	MILLER CREEK PLANTING
	EXISTING CONTOUR
– – –	LIMIT OF CONSTRUCTION
— — —	ROAD RIGHT-OF-WAY
———	RELOCATED SANITARY SEWER
	EXISTING SANITARY SEWER
	POWERLINE EASEMENT

NOTES:

1. SEE SHEETS L1 AND L2 FOR PLANT SCHEDULE AND PLANTING DETAILS.
2. IRRIGATION SYSTEM WILL BE INSTALLED IN ALL AREAS EXCEPT ZONE 1.
3. SEE SHEET C2 FOR EXTENT OF GRADING IN FLOODPLAIN.
4. SEE SHEET C6 FOR CREEK CROSS SECTIONS.
5. NO MITIGATION CREDIT ASSIGNED FOR PLANTING IN ROAD R.O.W., SEWER, OR POWERLINE EASEMENTS.

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PJT/SBM
1"=80'
NOVEMBER 2001
-
-

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: **MILLER CREEK RELOCATION AND FLOODPLAIN ENHANCEMENT**

100051
291217C1-1
STIA-9805-C1.1

291201WL.DWG
291217BA.DWG
154ALIGN.DWG
SEWER.DWG
SD-SS.DWG
APPENDIX A

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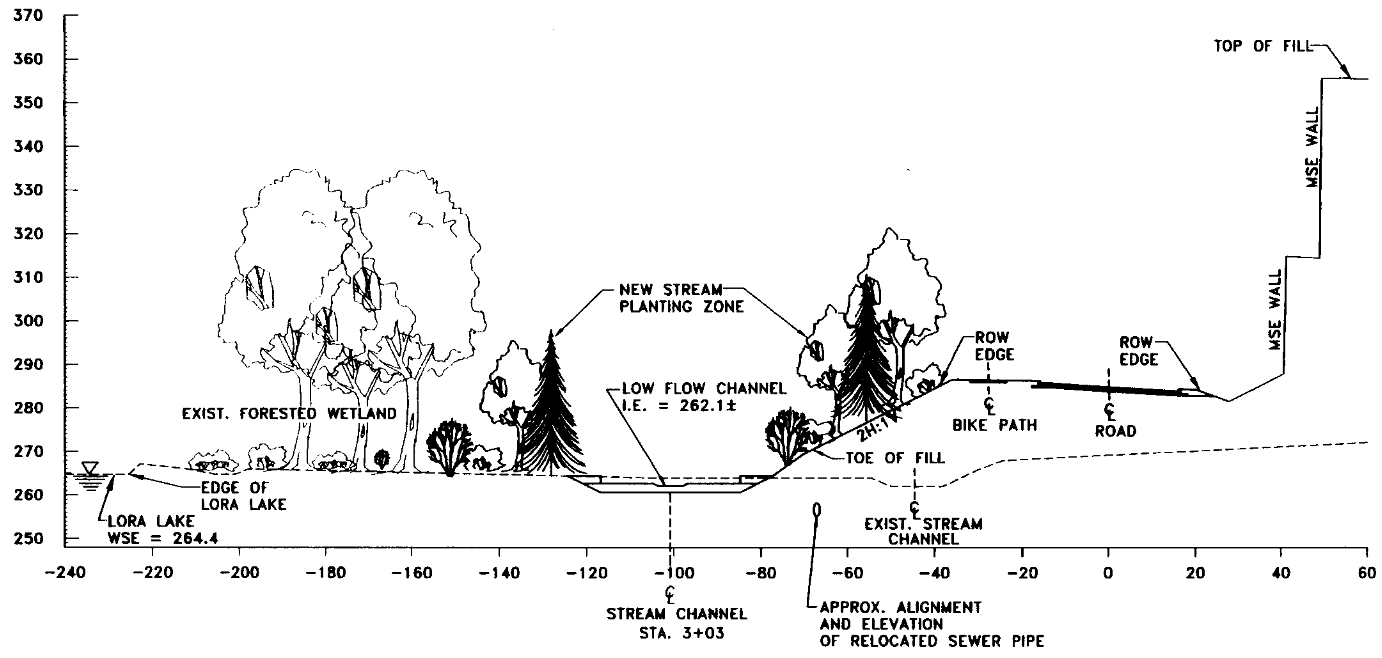

SECTION

MILLER CREEK CROSS SECTION
AT STA 108+50
SCALE: 1" = 15'

1
C1.1

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DATE: 11/13/01 FILENAME: 291201C3-1

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NOVEMBER 2001

0 1"
ONE INCH AT FULL SCALE
IF NOT SCALE ACCORDINGLY

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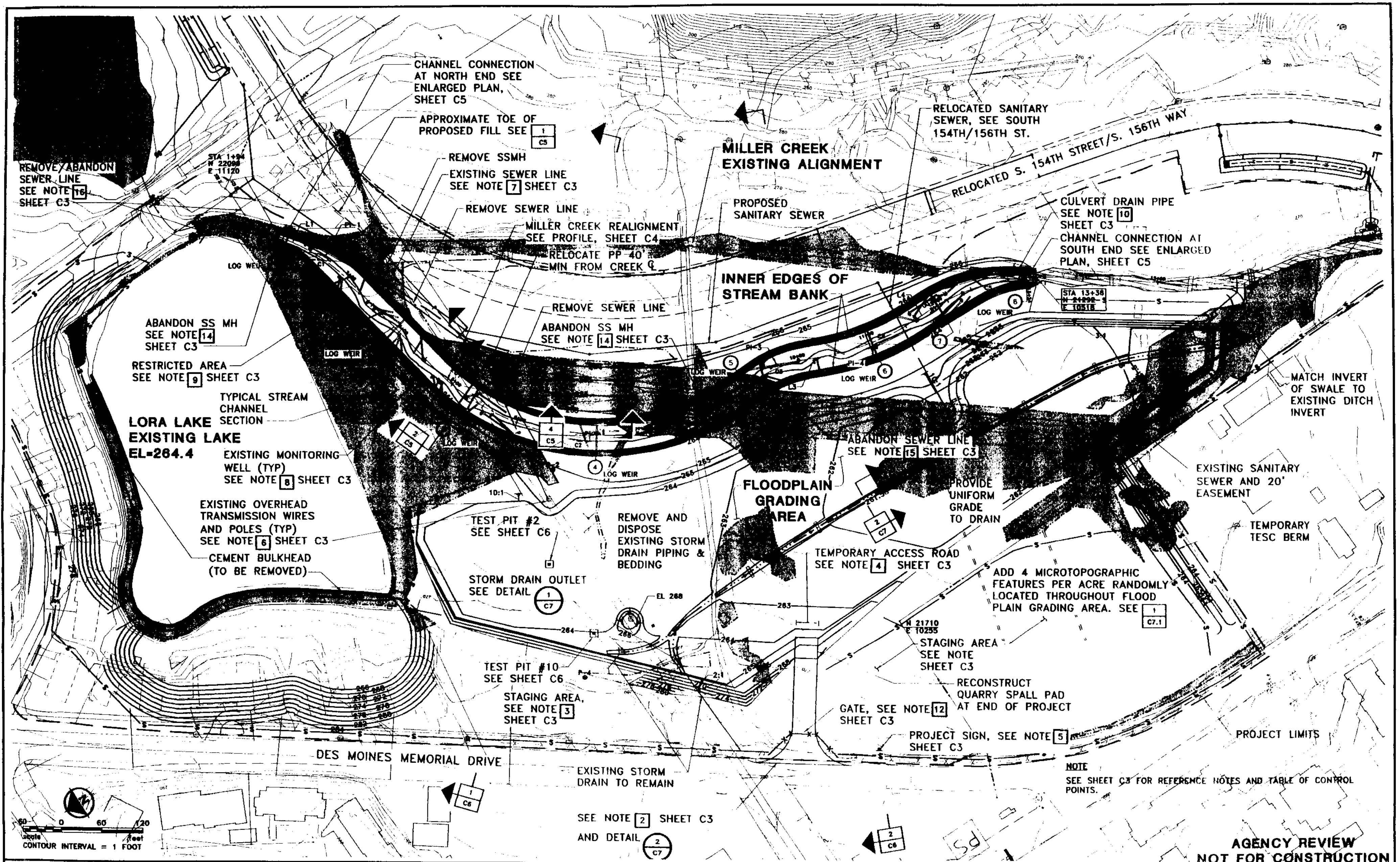
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
CROSS SECTION MILLER CREEK RELOCATION AND
S. 154TH/S. 156TH ST. AT STREET STA. 108+50

100051
291217C3-1
STIA-9805-C1.2
APPENDIX A

DATE: 10/09/01 FILENAME: 291217C2 IMAGES: XREF'S: 291217BA 156 291201WL SD_FIG1 DE SEWER SD-SS



NOTE

SEE SHEET C3 FOR REFERENCE NOTES AND TABLE OF CONTROL POINTS.

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1"=60'
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: **SITE PLAN**

100051
291217C2
STIA-9805-C2

156.DWG 291217BA.DWG 91201DE.DWG

APPENDIX A

NOTES

CURVE TABLE FOR CHANNEL		
PI NUMBER	NORTHING	EASTING
PI-1	22062	11084
PI-2	21962	10580
PI-3	21642	10612
PI-4	21524	10559
PI-5	21336	10559

CURVE NUMBER	STARTING STATION	ENDING STATION	LENGTH	RADIUS
C1	2+14.41	3+06.52	92.10	250
C2	4+74.67	9+29.94	455.27	311
C3	9+29.94	10+13.27	83.33	175
C4	10+31.06	11+66.16	135.16	320
C5	11+84.60	13+40.00	155.40	275

TANGENT TABLE FOR CHANNEL		
TANGENT NUMBER	DISTANCE	BEARING
L1	20.41	S 55°41'27" W
L2	168.16	S 78°12'53" W
L3	17.79	S 24°11'26" W
L4	18.43	S 00°00'00" E

SURVEY CONTROL POINTS			
9704-2	N 22129.25	E 11119.55	ELEV 265.81
9704-3	N 22187.74	E 10753.57	ELEV 266.63
9704-4	N 21857.42	E 10447.77	ELEV 266.25

VERTICAL DATUM: KING COUNTY
HORIZONTAL DATUM: SEA-TAC GRID

NOTES

1. IMPLEMENT TEMPORARY SEDIMENT AND EROSION CONTROL PLANS PRIOR TO BEGINNING ANY SITE WORK. SEE SHEET TE1.

2 PROVIDE PAVED SITE ENTRANCE. MATCH GRADE AT DES MOINES WAY SOUTH. MAINTAIN ASPHALT SURFACE THROUGHOUT ALL PHASES OF THE PROJECT. KEEP ASPHALT SURFACE CLEAN AND FREE OF SEDIMENT AT ALL TIMES USING A VACUUM STREET CLEANING MACHINE. PROVIDE SIGNING AND TRAFFIC CONTROLS PER PROJECT SPECIFICATIONS AND AS REQUIRED FOR PUBLIC SAFETY.

3 STAGING AREAS SHOWN ARE APPROXIMATE. ADDITIONAL STAGING AREAS MAY BE AS REQUESTED AND AS APPROVED BY THE ENGINEER.

4 PROVIDE TEMPORARY CONSTRUCTION ACCESS ROADS TO PERFORM THE WORK. LOCATION OF ACCESS ROADS SHALL BE AS APPROVED BY THE ENGINEER. REMOVE TEMPORARY ACCESS ROADS AT END OF PROJECT.

5 FURNISH AND INSTALL PROJECT SIGN PER SPECIFICATIONS.

6 PROTECT EXISTING POWER POLES. NO EXCAVATION ALLOWED WITHIN 10' OF EXISTING POWER POLES. POWER POLE NEAR CHANNEL STA 5+00 TO BE RELOCATED.

7 PROTECT EXISTING SEWER LINE AND MANHOLES DURING ALL PHASES OF CONSTRUCTION.

8 ABANDON EXISTING MONITORING WELLS PER SPECIFICATIONS.

9 NO CLEARING, VEHICLE OR SELF PROPELLED EQUIPMENT ACCESS, OR DISTURBANCE IN WETLAND ENHANCEMENT AREA.

10 ROUTE CULVERT FROM 154TH STREET BIOSWALE INTO RELOCATED CREEK AT CHANNEL CONNECTION AS DIRECTED BY ENGINEER.

11. PROVIDE TREE PROTECTION IN ALL AREAS NOT LOCATED WITHIN FLOOD PLAIN GRADING AREA OR PROPOSED MILLER CREEK CORRIDOR.

12 PROVIDE 30' DOUBLE SWING CHAIN LINK GATE.

13. IRRIGATION TO BE INSTALLED IN PROJECT AREA. SEE SHEETS L1 THROUGH L3.

14 MANHOLE STRUCTURE SHALL BE DEMOLISHED TO AT LEAST 4 FT BELOW GROUND SURFACE, PIPES PLUGGED, AND REMAINING STRUCTURE BACKFILLED.

15 ABANDONED PIPES SHALL BE PLUGGED AT BOTH ENDS.

16 SEWER LINE SHALL BE ABANDONED IN AREAS OUTSIDE WORK AREAS, INCLUDING WETLANDS. ABANDONED PIPES SHALL BE PLUGGED AT BOTH ENDS. REMAINING SEWER LINE WITHIN WORK AREA SHALL BE REMOVED.

17 BUILDINGS SHOWN WITH HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.

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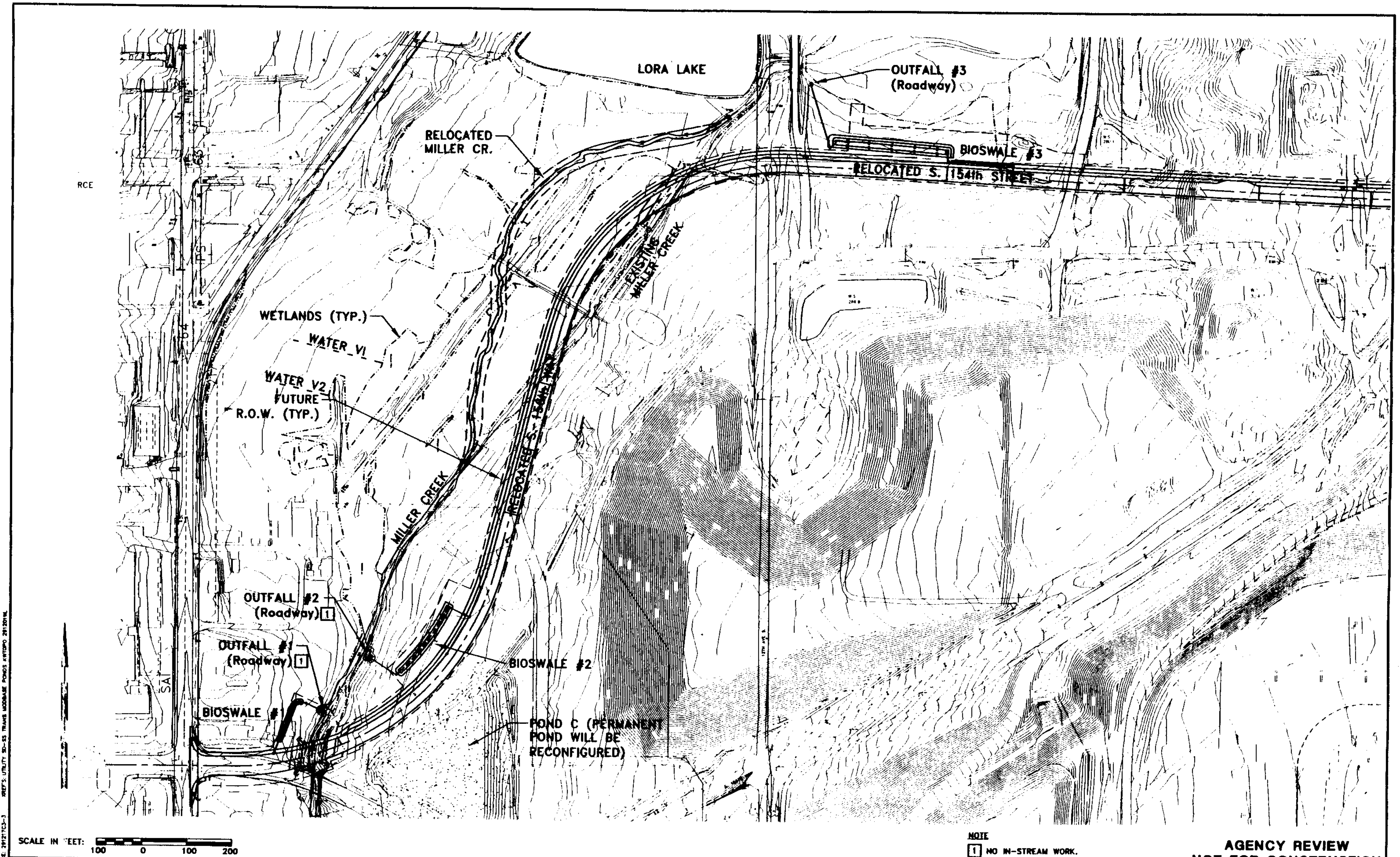
1"=60'
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: SITE PLAN - NOTES

100051
291217C3N
STIA-9805-C3
APPENDIX A

DATE: 11/15/01 FILENAME: 291217C3N XREFS: IMAGES:



NOTE

1 NO IN-STREAM WORK.

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J. ULMAN
PJT/SRH
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: BIOFILTRATION SWALE AND OUTFALL LOCATION
S. 154TH/S. 156TH STREET (WEST END)

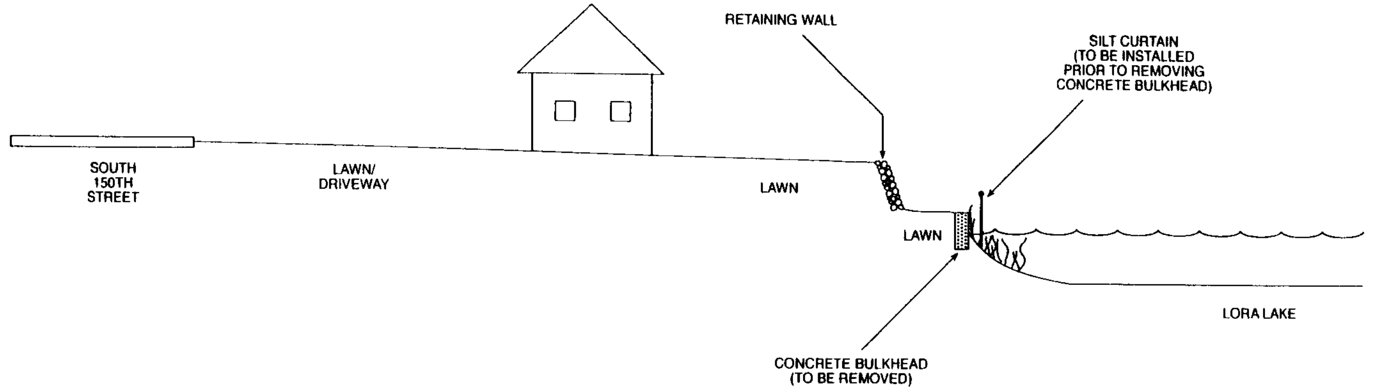
100051
291217C3-3
STIA-9805-C3.1

APPENDIX A

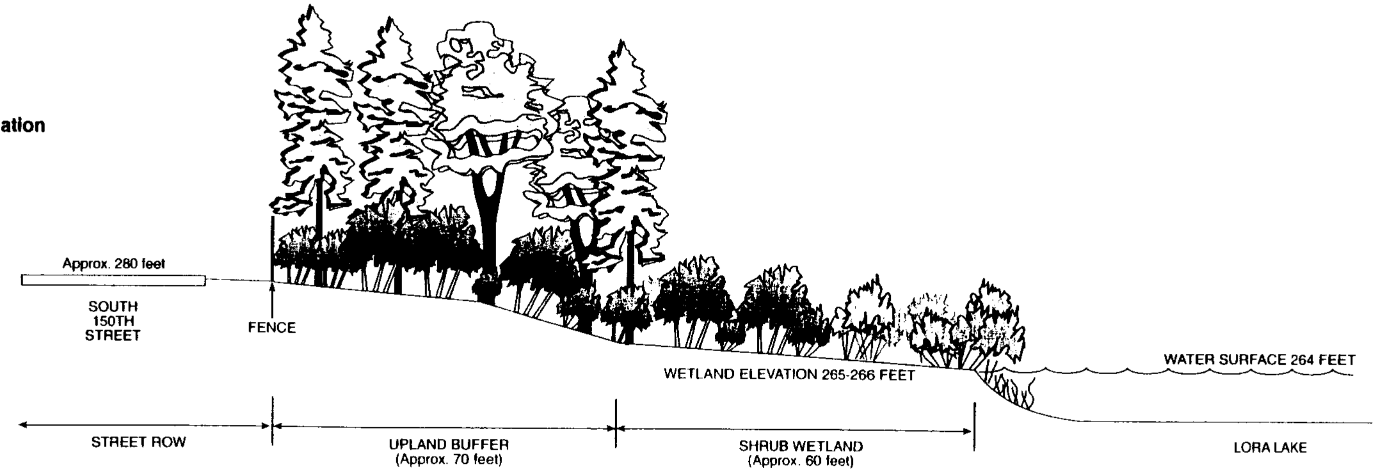
DATE: 11/13/01 FILENAME: 291217C3-3

156.DWG
291217BA.DWG
91201DE.DWG

Existing Conditions



Post-Mitigation



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J ULMAN
J BURTON
1" = 30'
NOVEMBER 2001
P FENDT

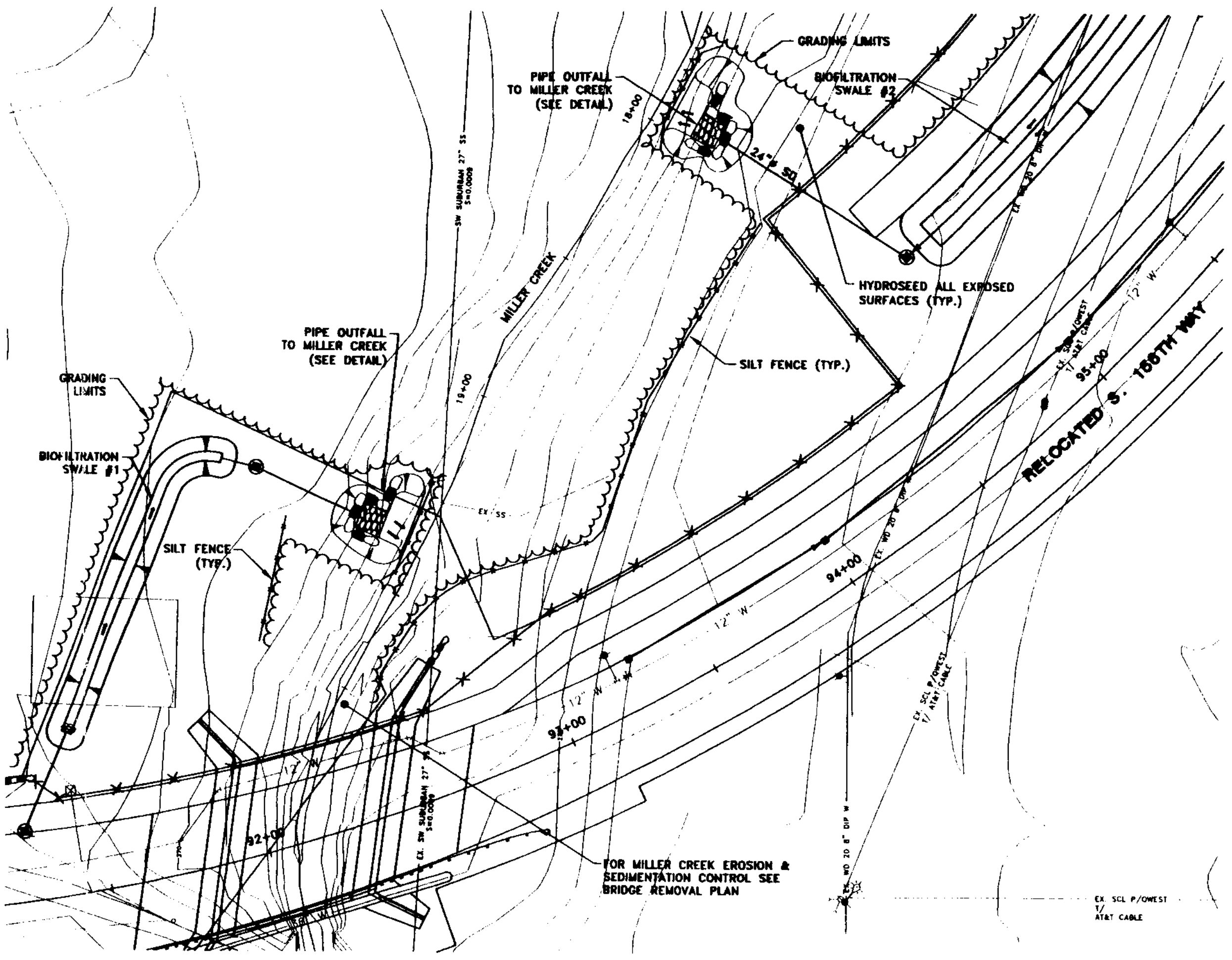
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION

TYPICAL CROSS SECTION OF LORA LAKE WETLAND RESTORATION AND BUFFER

100051
291217C3.2
STIA 9805 C3.2

APPENDIX A



N

BIOFILTRATION SWALE OUTFALLS

SCALE IN FEET: 20 0 20 40

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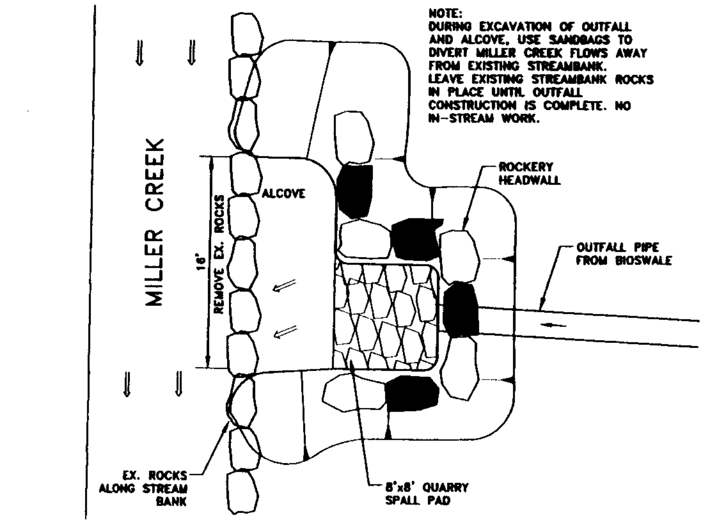
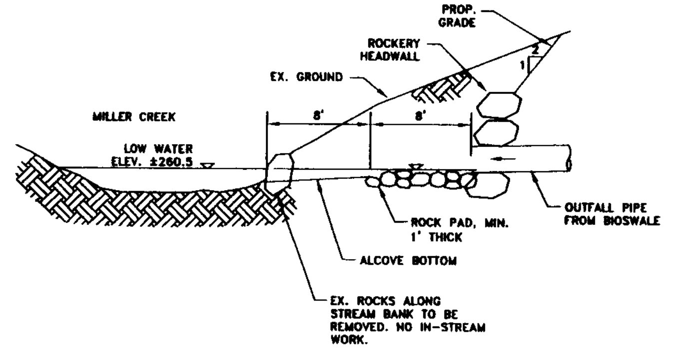


NOTE:
DURING EXCAVATION OF OUTFALL AND ALCOVE, USE SANDBAGS TO DIVERT MILLER CREEK FLOWS AWAY FROM EXISTING STREAMBANK. LEAVE EXISTING STREAMBANK ROCKS IN PLACE UNTIL OUTFALL CONSTRUCTION IS COMPLETE. NO IN-STREAM WORK.

PLAN



ELEVATION

PIPE OUTFALL DETAIL

N.T.S.

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Seattle, WA 98121
(206)448-4200
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PROJECT ENGR./ARCH: BSK
DESIGNED: KBS
DRAWN BY: KBS/JS
SCALE: 1"=20'
DATE: NOVEMBER 2001
CHECKED BY: BSK
APPROVED BY:

NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

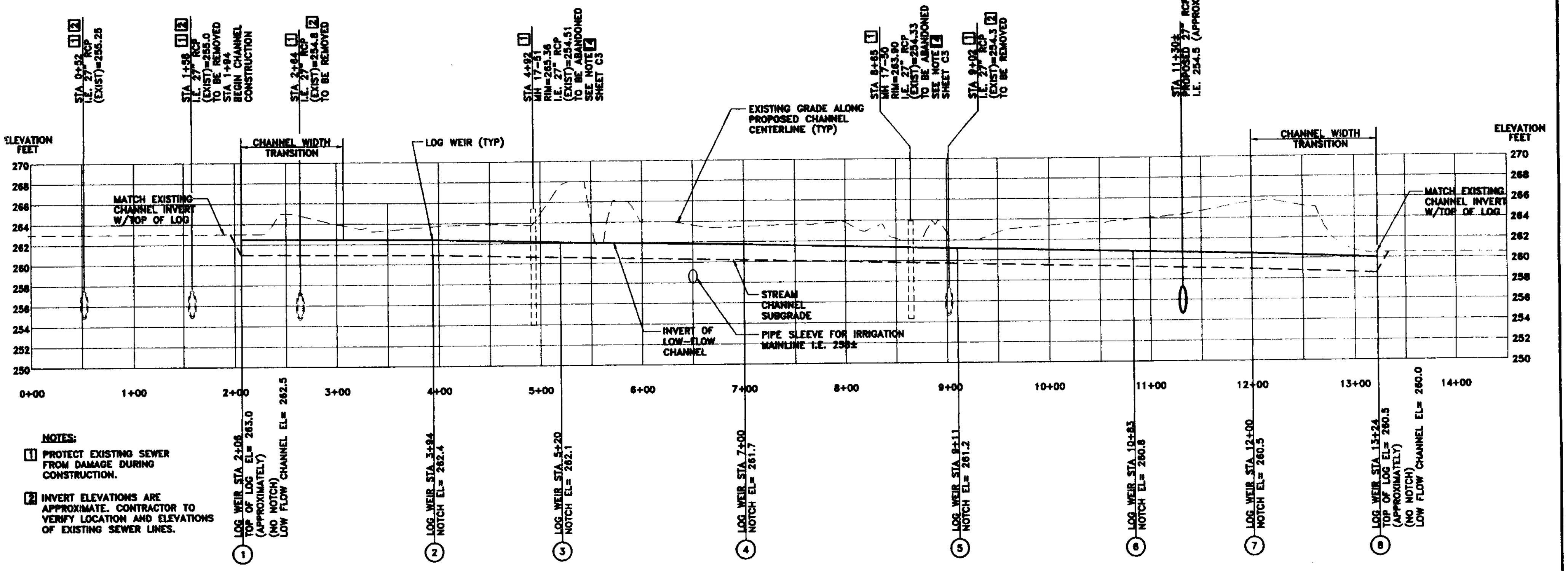
PROJECT ENGINEER:
DESIGNER:
DRAWN BY:
SCALE:
DATE:
CHECKED BY:
APPROVED BY:

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: **BIOFILTRATION SWALE OUTFALLS**

WORK ORDER NO. C3486
CONSULTANT'S NO. 98-382
PORT OF SEATTLE NO. STIA-9806-C3.3

APPENDIX A

DATE: 11/15/01 FILENAME: BIOSWALE-OUTFALLS



NOTES:

1 PROTECT EXISTING SEWER FROM DAMAGE DURING CONSTRUCTION.

2 INVERT ELEVATIONS ARE APPROXIMATE. CONTRACTOR TO VERIFY LOCATION AND ELEVATIONS OF EXISTING SEWER LINES.

PROFILE

PROPOSED MILLER CREEK CHANNEL
SCALE: H 1"=50' V 1"=5'

DATE: 11/13/01 FILENAME: 291217C3RV

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P. FENDT

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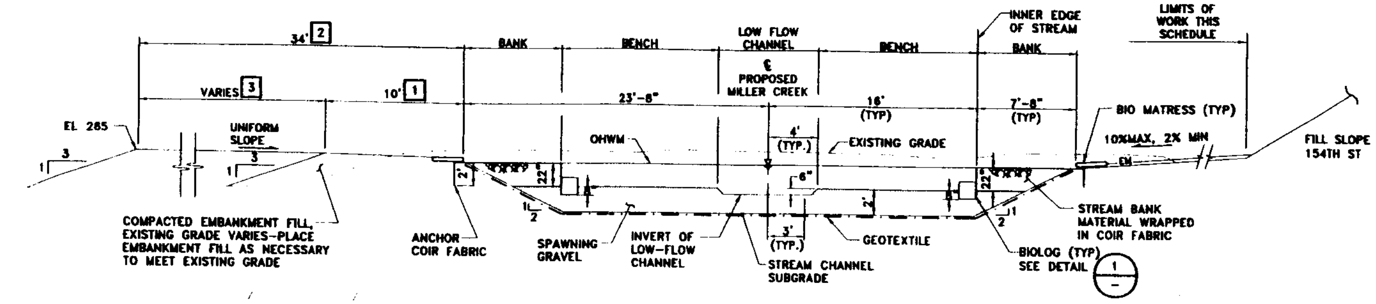
NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION

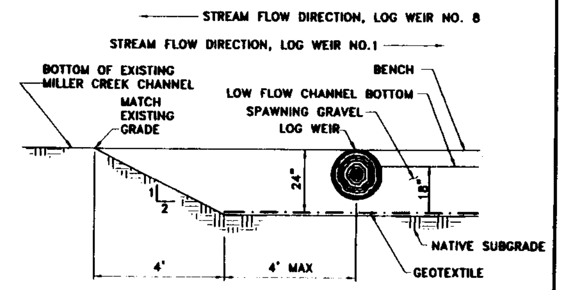
CHANNEL PROFILE

100051
291217C3RV
STIA-9805-C4
APPENDIX A

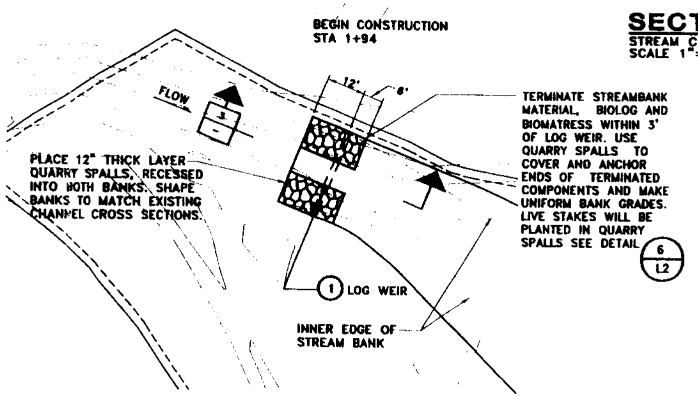


SECTION
STREAM CHANNEL
SCALE 1"=5'
1
C2

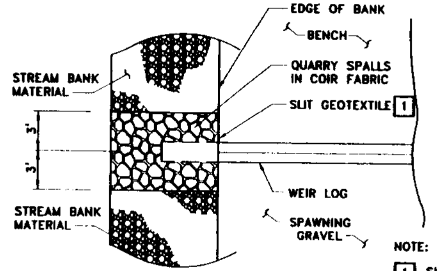
NOTES:
1 STA. 2+00 TO 6+00
2 STA. 7+00 TO 13+00
3 TRANSITION FROM 1 TO 2, STA. 6+00 TO 7+00
4. SEE SHEET L6 FOR SHADE CLOTH SECTION AND DETAIL.



SECTION
CHANNEL END SECTION
AT LOG WEIRS NO.1 & NO.8
SCALE: 1"=2'
3
—

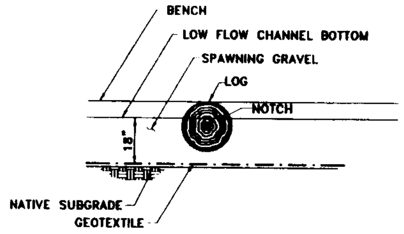


PLAN
CHANNEL CONNECTION
NORTH END
SCALE: 1"=20'

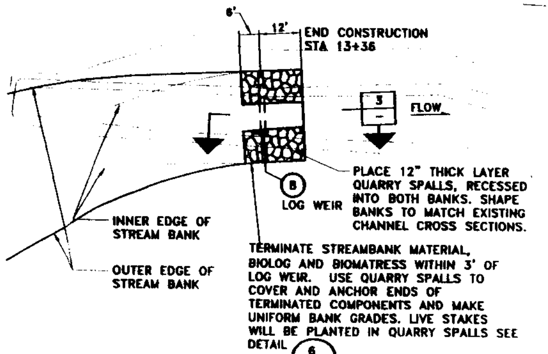


PLAN
TYPICAL LOG WEIR
SCALE: 1"=5'

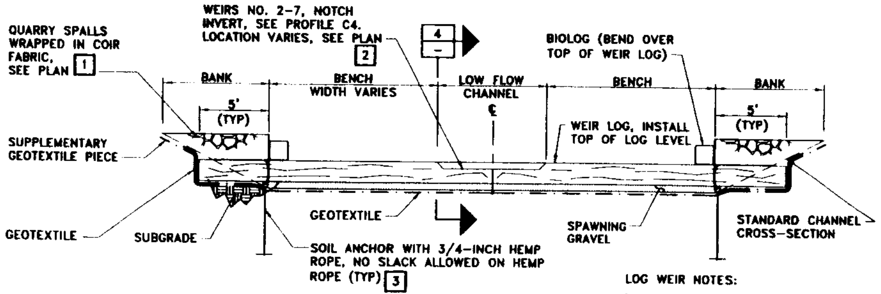
NOTE:
1 SLIT GEOTEXTILE AS NEEDED TO INSTALL LOG. PLACE SUPPLEMENTARY GEOTEXTILE AS NEEDED TO PROVIDE 12" MIN OVERLAP. PLACE LOG, AND BACKFILL.



SECTION
CHANNEL SECTION
AT LOG WEIRS NO. 2-7
SCALE: 1"=2'
4
—

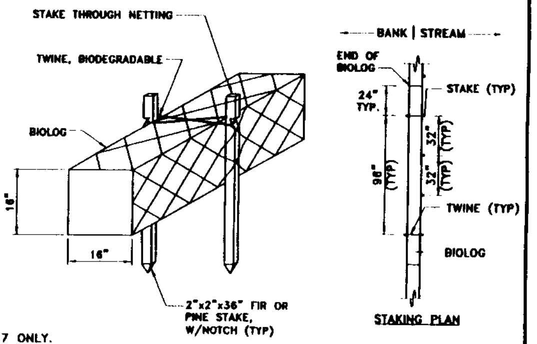


PLAN
CHANNEL CONNECTION
SOUTH END
SCALE: 1"=20'



SECTION
TYPICAL LOG WEIR
SCALE 1"=5'
2
C2,
C8

LOG WEIR NOTES:
1 COIR FABRIC USED AT LOG WEIRS No. 2-7 ONLY.
2 WEIR NOTCH DEPTH CAN VARY FROM 4" TO 8" AS NEEDED TO PROVIDE LEVEL SURFACE ACROSS NOTCH WIDTH.
3 SOIL ANCHORS ARE 65 INCHES LONG WITH AN 8-INCH DIAMETER ANCHORING HELIX. THEY ARE SIZED BASED ON ANCHORING STRENGTH OF PEAT SOILS.



DETAIL
BIOLOG STAKING
NTS
1
—

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0 1"
ONE INCH AT FULL SCALE IF NOT SCALE ACCORDINGLY

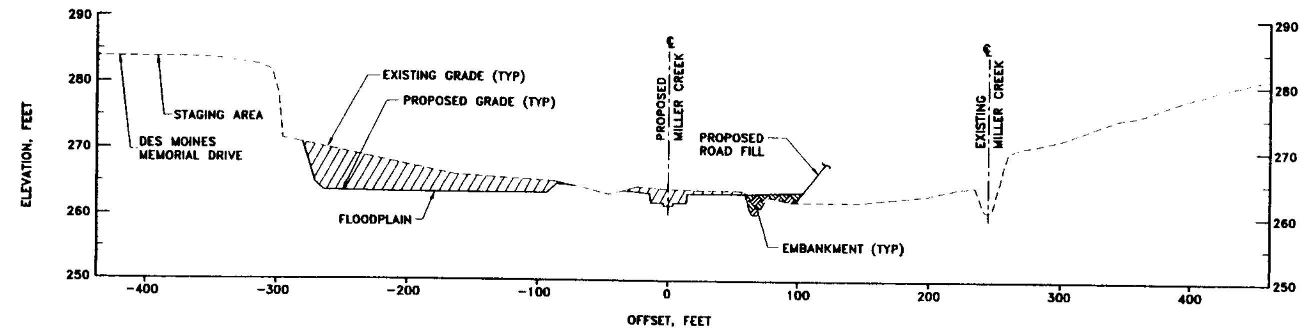
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
CHANNEL SECTIONS AND DETAILS

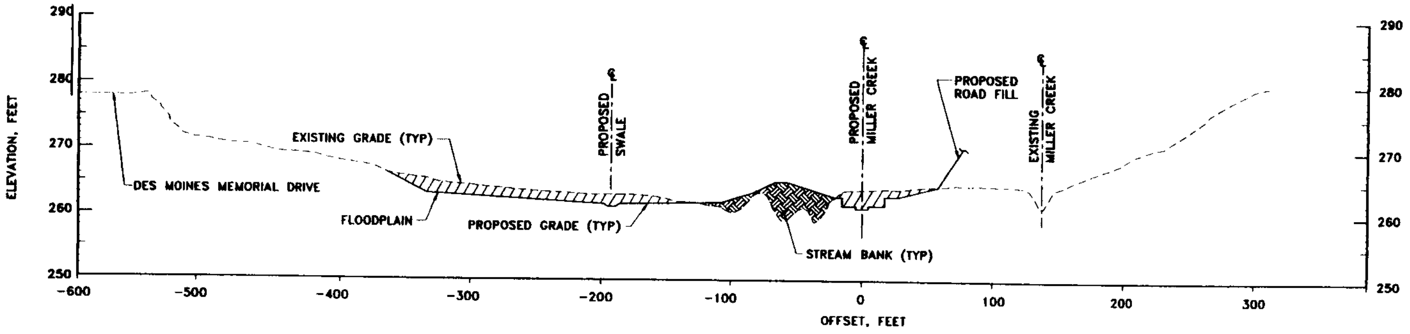
100051
291217C4
STIA-9805-C5
APPENDIX A

156.DWG
291217BA.DWG
91201DE.DWG

DATE 11/15/01 FILENAME 291217C4 IMAGES XREF'S 91201BA SEWER



SECTION 1 / C2
PROPOSED CROSS SECTION
AT STA 6+50
SCALE: H 1" = 50' V 1" = 10'



SECTION 2 / C2
PROPOSED CROSS SECTION
AT STA 10+13
SCALE: H 1" = 50' V 1" = 10'

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0 1"
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IF NOT SCALE ACCORDINGLY

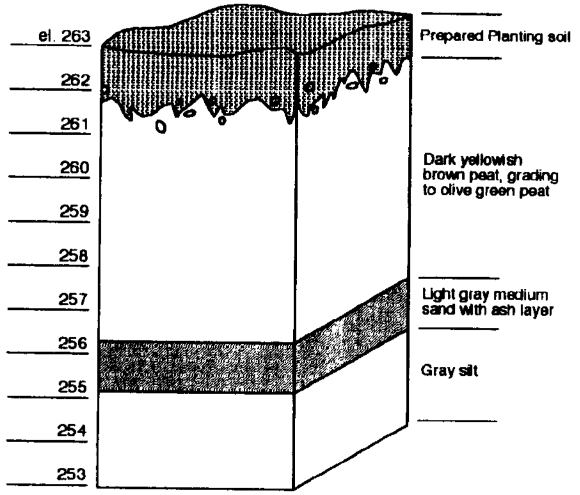
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: FLOODPLAIN SECTIONS

100051
291217C5
STIA-9805-C8
APPENDIX A

DATE 11/13/01 FILENAME 291217C5 IMAGES XREF'S

Planting soil over peat subgrade
(Example based on proposed conditions near Test Pit #2*)

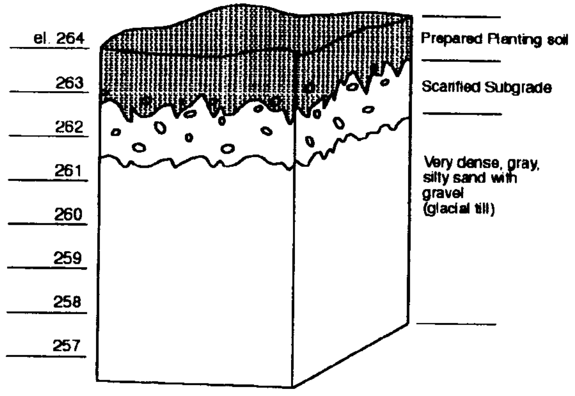


Where final grade is in peat deposits the subgrade will be over-excavated and 1 foot of planting soil will be placed over the peat.

- Excavate 12" below finish grade
- Place 12" prepared planting soil from stockpile
- Install plant materials

*See Sheet C2 in Appendix A for test pit locations

Planting soil over mineral soil subgrade
(Example based on proposed conditions near Test Pit #10*)



Where final grade is in sand, gravel or glacial till deposits, the subgrade will be over-excavated and 1 foot of planting soil will be placed over the subgrade

- Excavate 12" below finish grade
- Scarify subgrade surface
- Place 12" prepared planting soil from stockpil
- Install plant materials

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NOVEMBER 2001

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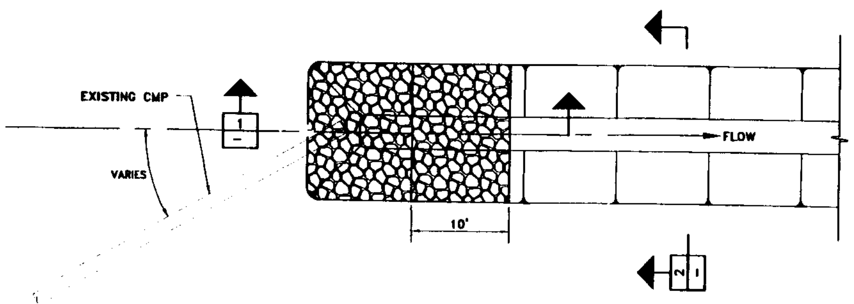
MILLER CREEK RELOCATION
VACCA FARM FLOOD PLAIN
SOIL PROFILE

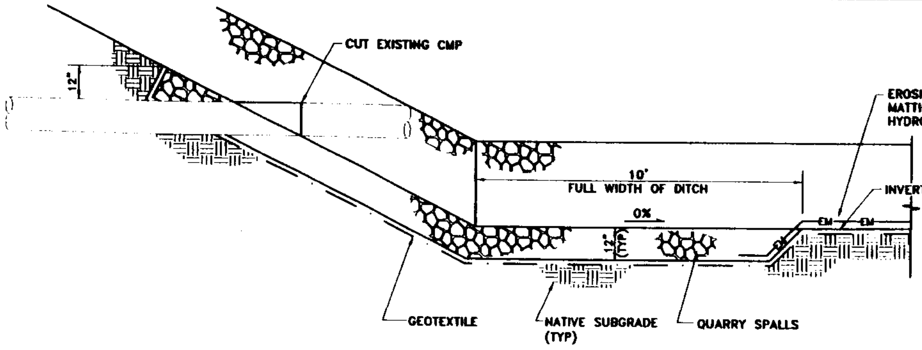
100051
291217C6-1
STIA-9805-C6.1
APPENDIX A

DATE: 11/13/01 FILENAME: 291217C6-1

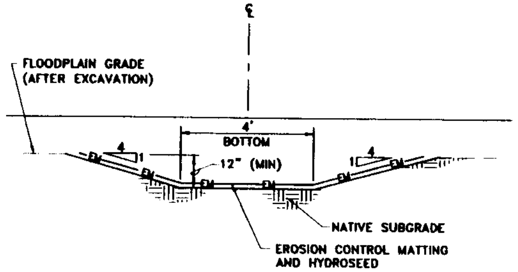
156.DWG
291217BA.DWG
91201DE.DWG



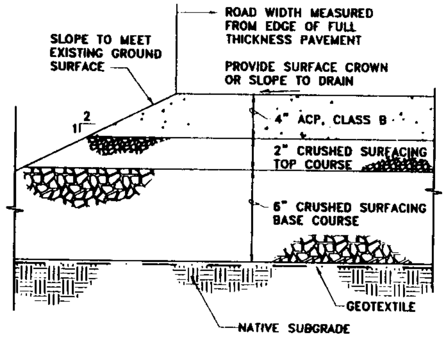
DETAIL
STORM DRAIN OUTLET
N.T.S.
1
C2



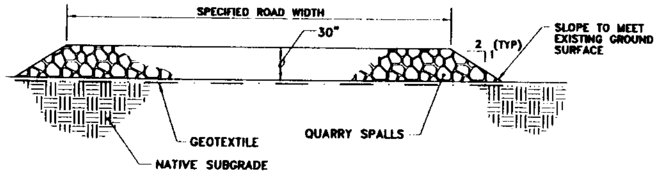
SECTION
STORM DRAIN OUTLET
SCALE: 1"= 2'
1
–



SECTION
SWALE
SCALE: 1"= 2'
2
C2, C7



DETAIL
TEMPORARY ASPHALT ROAD
N.T.S.
2
TE1, C2



SECTION
QUARRY SPALL PAD
SCALE: 1"=5'
3
TE1

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NOVEMBER 2001

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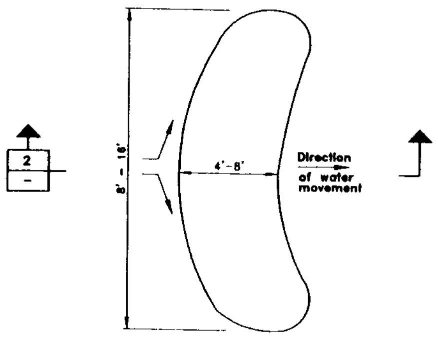
REVISIONS

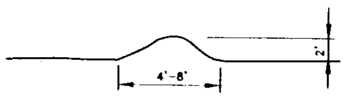
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: MISCELLANEOUS SECTIONS AND DETAILS

100051
291217C8
STIA-9805-C7
APPENDIX A

DATE: 11/13/01 FILENAME: 291217C8 IMAGES XREF'S



PLAN
N.T.S.
1
C2



SECTION
N.T.S.
2
–

NOTE:
1. MICROTOPOGRAPHIC FEATURES SHALL BE ORIENTED AS TO NOT IMPOUND WATER.

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NOVEMBER 2001

0 1"
ONE INCH AT FULL SCALE
IF NOT SCALE ACCORDINGLY

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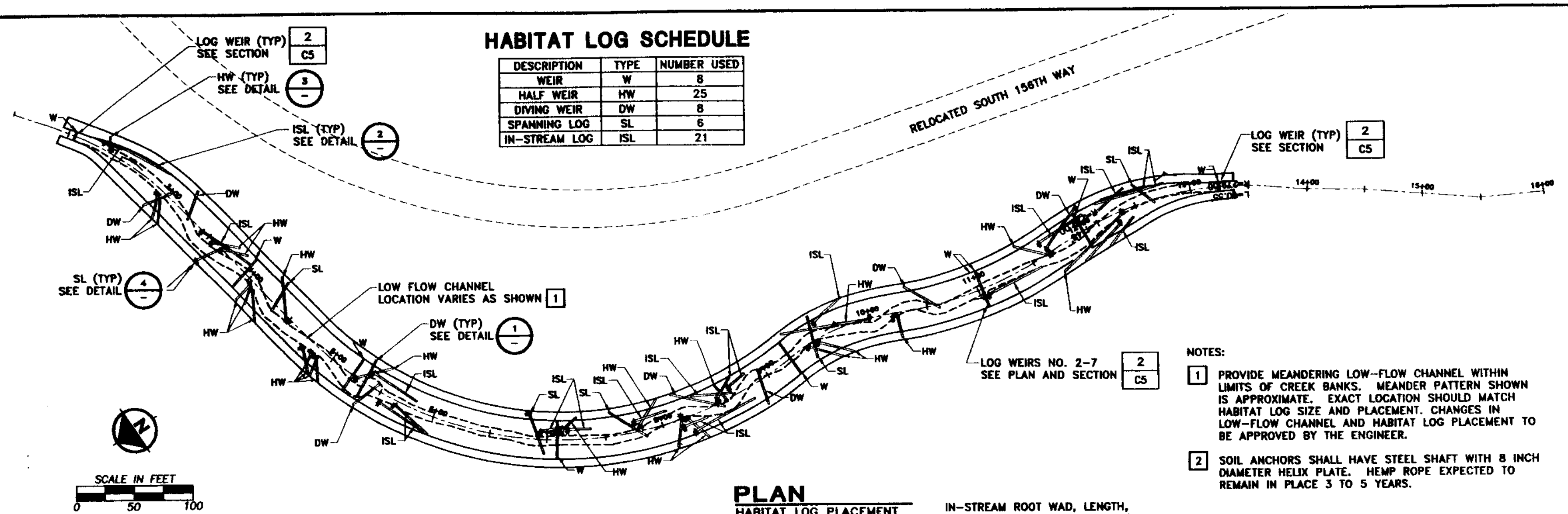
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
MICROTOPOGRAPHIC FEATURE
DETAIL

100051
291217C7-1
STIA-9805-C7.1
APPENDIX A

DATE: 11/13/01 FILENAME: 291217C7-1 IMAGES XREF'S



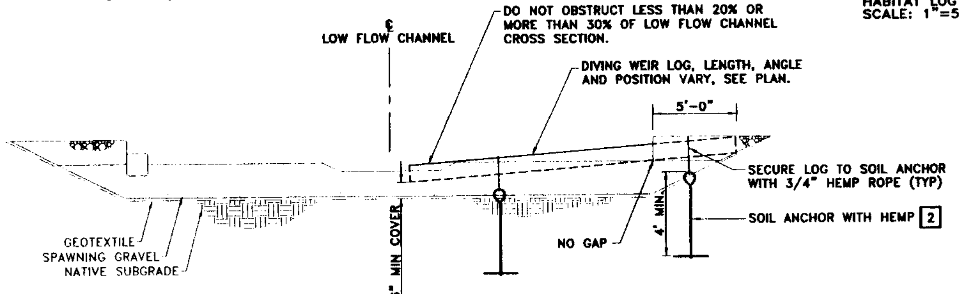
HABITAT LOG SCHEDULE

DESCRIPTION	TYPE	NUMBER USED
WEIR	W	8
HALF WEIR	HW	25
DIVING WEIR	DW	8
SPANNING LOG	SL	6
IN-STREAM LOG	ISL	21

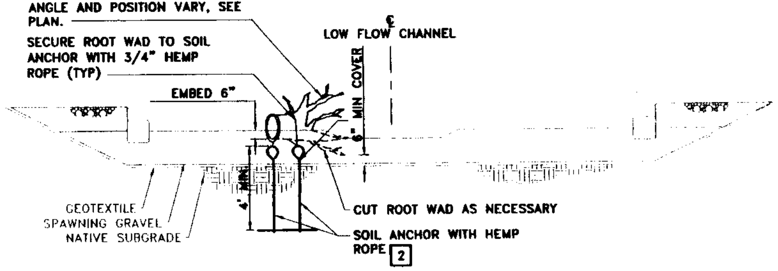
PLAN
HABITAT LOG PLACEMENT
SCALE: 1"=50'

NOTES:

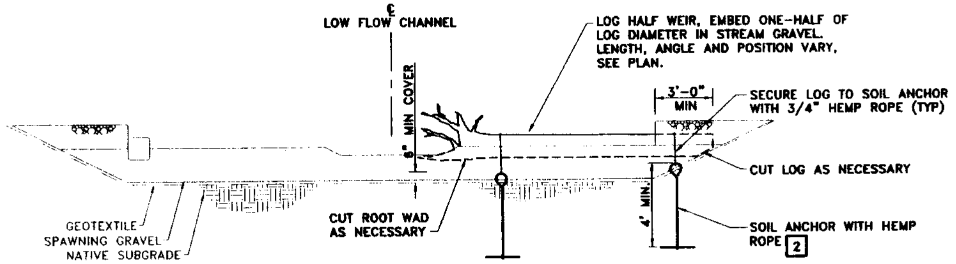
1. PROVIDE MEANDERING LOW-FLOW CHANNEL WITHIN LIMITS OF CREEK BANKS. MEANDER PATTERN SHOWN IS APPROXIMATE. EXACT LOCATION SHOULD MATCH HABITAT LOG SIZE AND PLACEMENT. CHANGES IN LOW-FLOW CHANNEL AND HABITAT LOG PLACEMENT TO BE APPROVED BY THE ENGINEER.
2. SOIL ANCHORS SHALL HAVE STEEL SHAFT WITH 8 INCH DIAMETER HELIX PLATE. HEMP ROPE EXPECTED TO REMAIN IN PLACE 3 TO 5 YEARS.



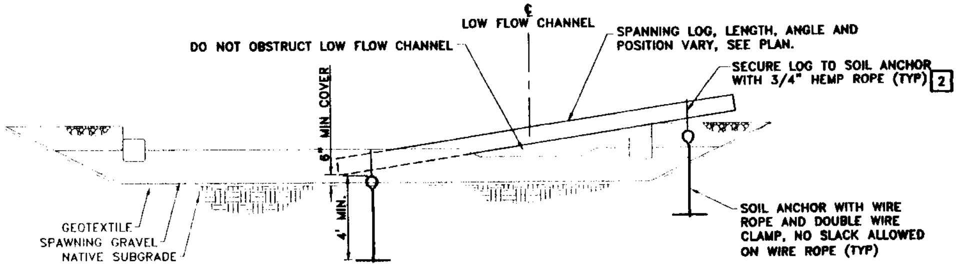
DETAIL 1
DW - DIVING WEIR
N.T.S.



DETAIL 2
ISL - IN-STREAM LOG
N.T.S.



DETAIL 3
HW - HALF WEIR
N.T.S.



DETAIL 4
SL - SPANNING LOG
N.T.S.

DATE: 11/13/01 FILENAME: 291217C7 IMAGES: XREF'S: XREF4 1544UGN

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SEA-TAC INTERNATIONAL AIRPORT
PROJECT: SOUTH 154TH STREET/156TH WAY/
MILLER CREEK RELOCATION
SHEET TITLE: HABITAT LOG -
LAYOUT PLAN AND DETAILS

100051
291217C7
STIA-9805-C8

APPENDIX A

NOTES:

1. INSTALL SILT FENCE PRIOR TO CONSTRUCTION ACTIVITIES. IN ADDITION TO SILT FENCE SHOWN, PROVIDE ADDITIONAL SILT FENCE AS DIRECTED BY ENGINEER. MAINTAIN SILT FENCE FOR DURATION OF PROJECT. PROTECT MILLER CREEK FROM SEDIMENT AND SEDIMENT LADEN SURFACE WATER RUNOFF, AND EROSION FROM CONSTRUCTION ACTIVITIES.

2. INSTALL SILT BARRIERS AT ALL LOCATIONS WHERE WATER DRAINS FROM PROJECT. INSTALL ADDITIONAL SILT BARRIERS ALONG SWALE IMMEDIATELY AFTER PORTIONS OF THE FLOOD PLAIN AREA ARE EXCAVATED. SEE SHEETS C2 FOR LOCATION OF FLOOD PLAIN SWALE.

3. CONSTRUCT TEMPORARY SEDIMENT SETTLING AREA TO GRADES SHOWN WITH BERMS, OUTLET AND SPILLWAY PRIOR TO EXCAVATION OR DEWATERING ACTIVITIES.

4. INSTALL AND MAINTAIN STABILIZED CONTRUCTION ENTRANCE AND WHEEL WASH. ROUTE ALL HAUL VEHICLES ACROSS WHEEL WASH PRIOR TO LEAVING SITE. STABILIZED CONSTRUCTION ENTRANCE AND WHEEL WASH SHALL BE REMOVED AND AREA RESTORED AT END OF PROJECT.

5. PROVIDE SILT FENCE AROUND ALL STOCKPILE AREAS.

6. KEEP ASPHALT SURFACE CLEAN AND FREE OF SEDIMENT AT ALL TIMES W/VACUUM SWEEPER. NO STONE, MUD OR SEDIMENT SHALL BE TRACKED OUT ONTO DES MOINES WAY SOUTH. PAVED ENTRANCE SHALL BE REMOVED OR AS DIRECTED BY ENGINEER AND AREA RESTORED AT END OF PROJECT.

7. ALL DEWATERING WATER AND STORM WATER RUNOFF FROM DISTURBED AREAS SHALL BE ROUTED THROUGH SEDIMENT SETTLING AREA. WATER WILL BE PUMPED FROM SEDIMENT SETTLING AREA TO POND C FOR TREATMENT BEFORE DISCHARGE. POND C IS LOCATED SOUTH OF PROJECT AREA BETWEEN EXISTING S. 156TH WAY AND S. 157TH ST.

8. PROVIDE SILT FENCE ALONG WETLAND ENHANCEMENT AREA. SEE NOTE 9 SHEET C3 FOR ACCESS RESTRICTIONS TO THIS AREA.

9. PROVIDE PLAN TO INTERCEPT AND DIVERT ALL STORM DRAIN (SD) WATER FROM ENTERING THE WORK AREA. PLAN TO BE APPROVED BY ENGINEER.

10. CONTRACTOR SHALL SUBMIT PLAN FOR SEQUENCING CONSTRUCTION ACTIVITIES TO CONTROL SEDIMENT AND EROSION, OPERATING SEDIMENT SETTLING AREA, DIVERTING MILLER CREEK FLOWS, AND RE-INTRODUCING WATER TO THE NEW PORTION OF MILLER CREEK. SEE SPECIFICATIONS, SECTION 8-37.

11. CONTRACTOR SHALL PLACE NON-WOVEN GEOTEXTILE BETWEEN EXISTING CATCH BASIN OPENING AND GRATE TO PROTECT FROM SEDIMENT.

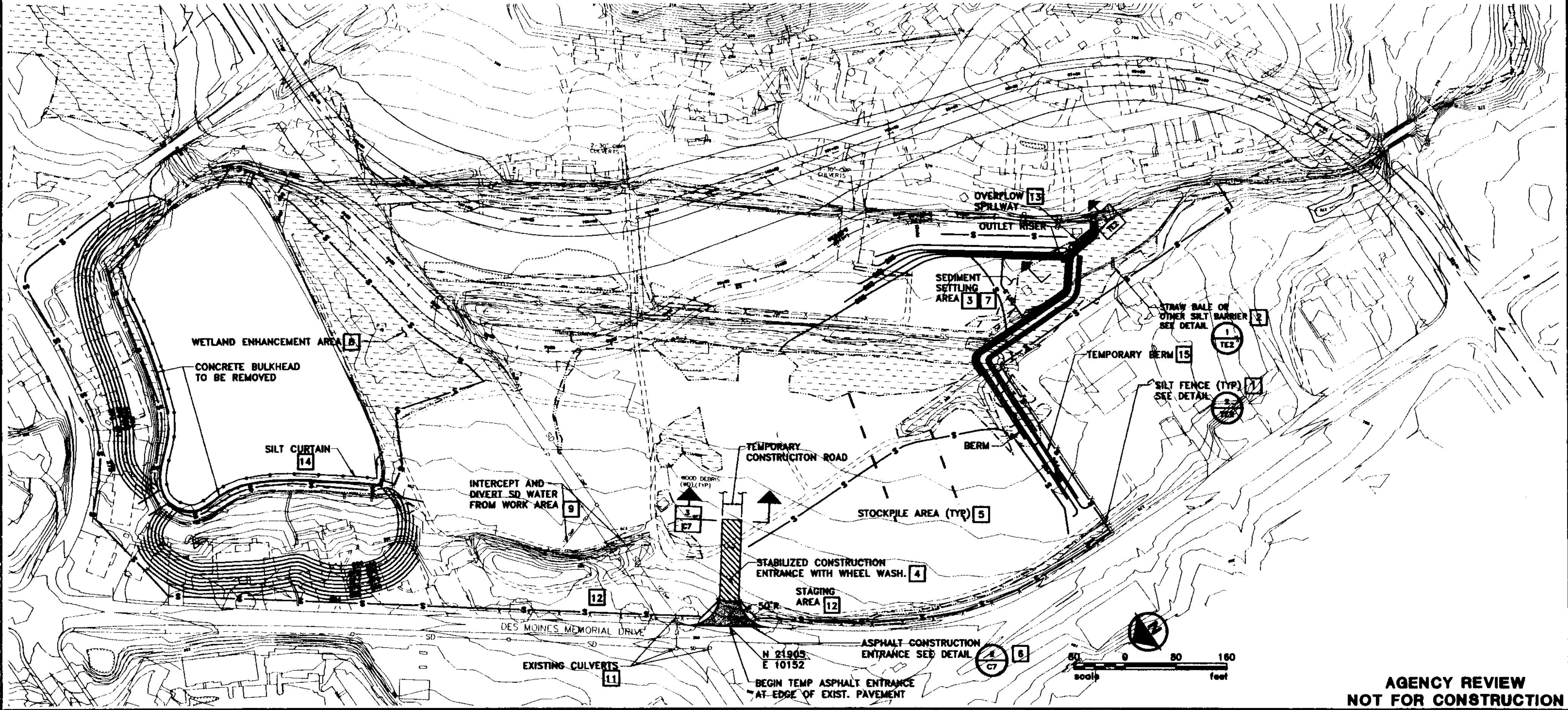
12. CONTRACTOR'S EMPLOYEE PARKING AREA SHALL BE ADJACENT TO ENTRANCE, AND AREA SHALL BE CONSTRUCTED AT A MINIMUM OF 6" CRUSHED ROCK OVER A GEOTEXTILE FABRIC. CONTRACTOR SHALL RESTORE AREA AT END OF PROJECT.

13. OVERFLOW SPILLWAY, OUTLET RISER, AND PORTION OF BERM SHALL BE REMOVED AND RESTORED AT END OF MILLER CREEK PROJECT.

14. PROVIDE SILT CURTAIN PRIOR TO REMOVAL OF BULKHEAD. MAINTAIN SILT CURTAIN UNTIL ALL GRADING AND PLANTING IS COMPLETED AROUND LORA LAKE AND BANK IS STABILIZED.

15. TEMPORARY BERM TO BLOCK EXISTING DRAINAGE DITCH AND PREVENT SEDIMENT MIGRATION. RESTORE TO PRECONSTRUCTION GRADE AFTER FLOODPLAIN AREA IS STABILIZED.

16. BUILDINGS SHOWN WITH - HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.



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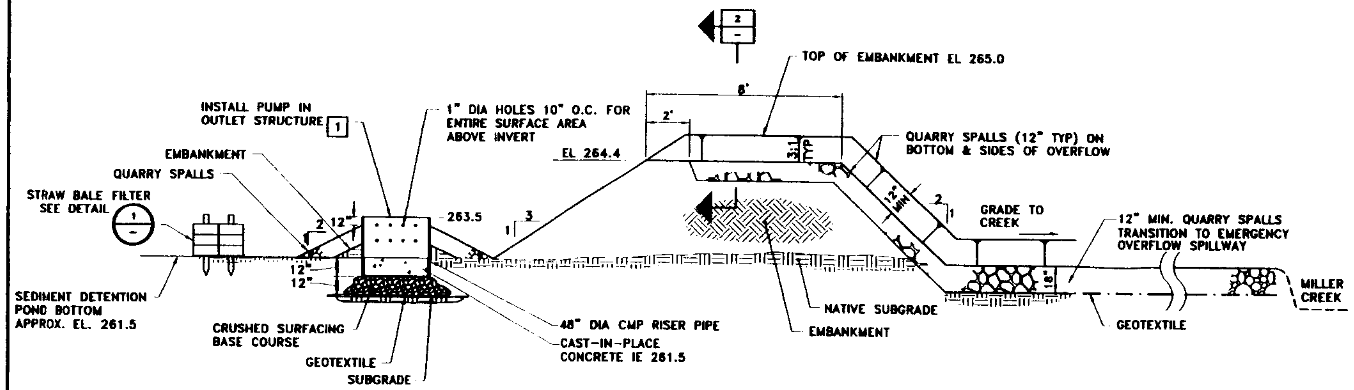
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION

TEMPORARY EROSION AND
SEDIMENT CONTROL PLAN

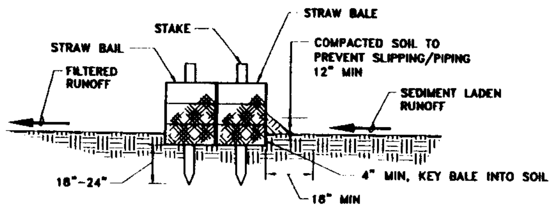
100051
291217TE1
STIA-9805-TE1

APPENDIX A



NOTE:
1 INSTALL PUMP WITH 100 GPM MIN. CAPACITY. OPERTATE PUMP TO KEEP WATER LEVEL BELOW EL. 263.5 AT ALL TIMES DURING CONSTRUCTION. PUMP WATER TO SEDIMENTATION POND C.

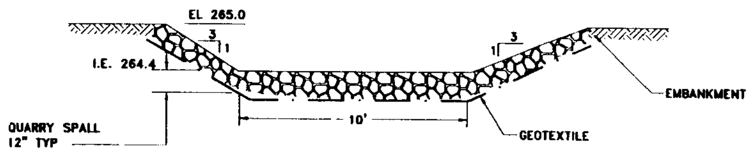
SECTION
EMERGENCY OVERFLOW SPILLWAY
N.T.S.
1 / TE1



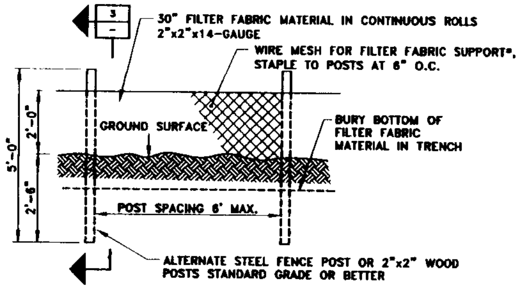
DETAIL
STRAW BALE FILTER INSTALLATION
N.T.S.
1 / TE1

NOTES:

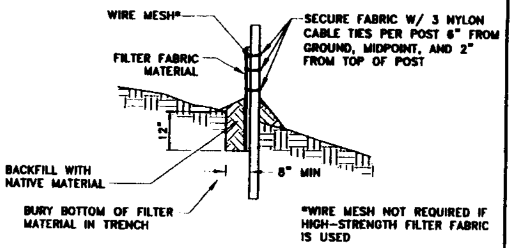
1. PROVIDE TWO ROWS OF STRAW BALES TO BLOCK SWALE (DITCH). STAGGER BUTT JOINTS BETWEEN ROWS.
2. STAKES SHALL BE REBAR STEEL PICKETS OR 2"x2" WOOD STAKES, 2 PER BALE. ANGLE FIRST STAKE TOWARDS PREVIOUSLY LAID BALE. PLACE SECOND STAKE VERTICAL ON ADJOINING BALES. TIE STAKES TOGETHER WITH WIRE.
3. INSTALL BALES FULL WIDTH OF SWALE, OR AS DIRECTED BY ENGINEER.



SECTION
EMERGENCY OVERFLOW SPILLWAY
N.T.S.
2 / –



DETAIL
SILT FENCE
N.T.S.
2 / TE1



*WIRE MESH NOT REQUIRED IF HIGH-STRENGTH FILTER FABRIC IS USED

SECTION
SILT FENCE
N.T.S.
3 / –

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Port of Seattle
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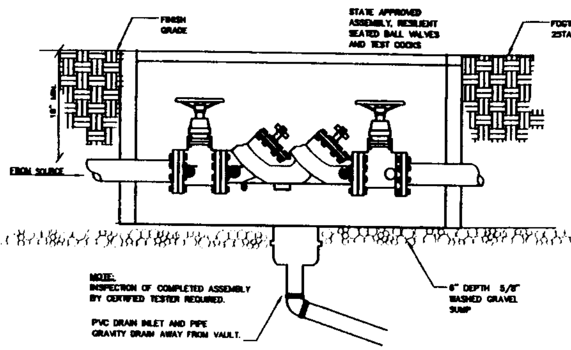
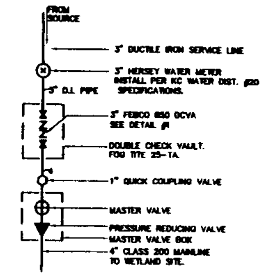
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: TEMPORARY EROSION AND SEDIMENT CONTROL SECTIONS AND DETAILS

100051
291217TE2
STIA-9805-TE2
APPENDIX A

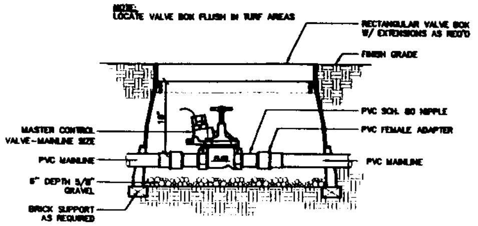
DATE: 11/13/01 FILENAME: 291217TE2 IMAGES: XREF'S



DETAIL
DOUBLE CHECK VALVE ASSEMBLY
SCALE: N.T.S.
1 / L2

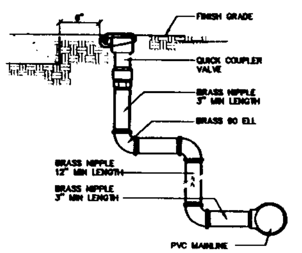


DETAIL
P.O.C. SCHEMATIC
SCALE: N.T.S.
2 / L2

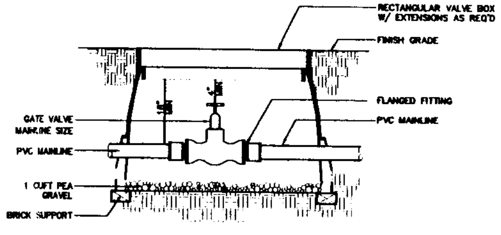


MASTER CONTROL IS TO BE WIRED TO AUTOMATIC CONTROLLER AS DESIGNATED. CONTROLLER TERMINALS PROVIDED BY THE MANUFACTURER. USE UF WIRE FROM VALVE TO CONTROLLER SAME SIZE AS CONTROL WIRE CALLED OUT IN THE MATERIALS LEGEND.

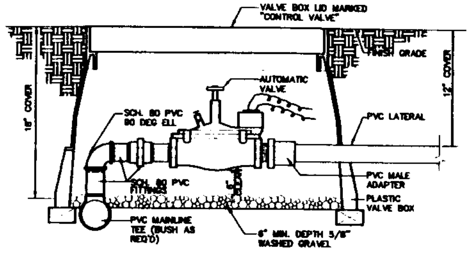
DETAIL
MASTER VALVE
SCALE: N.T.S.
3 / L2



DETAIL
QUICK COUPLER VALVE
SCALE: N.T.S.
4 / L2 L3

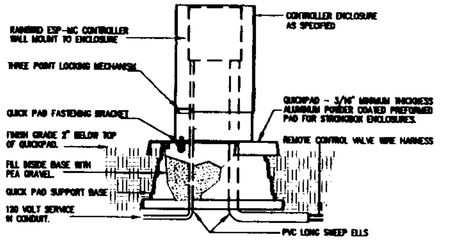


DETAIL
MAINLINE GATE VALVE
SCALE: N.T.S.
5 / L2 L3

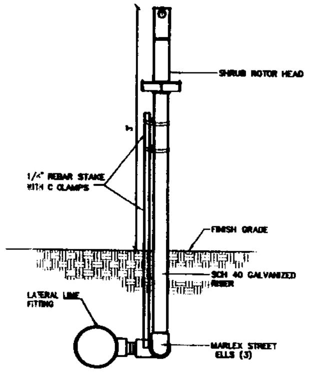


*USE VALVE BOX EXTENSIONS AS REQUIRED.
INLET NIPPLE SIZE TO MATCH OUTLET LATERAL LINE SIZE

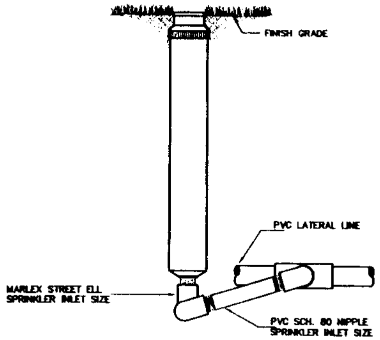
DETAIL
REMOTE CONTROL VALVE
SCALE: N.T.S.
6 / L2 L3



DETAIL
CONTROLLER & ENCLOSURE
SCALE: N.T.S.
7 / L2



DETAIL
SHRUB RISER
SCALE: N.T.S.
8 / L2 L3



DETAIL
SHRUB ROTOR
SCALE: N.T.S.
9 / L2 L3

GENERAL NOTES

1. PRIOR TO THE COMMENCEMENT OF WORK, CONTRACTOR MUST VERIFY A MINIMUM OF 100 LBS.(PSI) STATIC WATER PRESSURE AT POINT OF CONNECTION. NOTIFY ENGINEER OF ANY DISCREPANCY.
2. IRRIGATION CONTRACTOR SHALL LOCATE AND PROTECT ALL UTILITIES ENCOUNTERED THROUGH THE SCOPE OF HIS WORK.
3. ALL DRAWINGS ARE DIAGRAMMATIC. FIELD VARIANCES MAY OCCUR. NOTIFY ENGINEER OF ANY DISCREPANCY.
4. MAINLINE AND VALVES ARE SHOWN IN HARDSCAPE FOR PURPOSES OF CLARITY. LOCATE IN ADJACENT LANDSCAPE AREA.
5. CONTRACTOR IS RESPONSIBLE TO PROVIDE ALL NECESSARY SLEEVING UNDER ALL HARDSCAPES INCLUDING TEMPORARY ROADWAYS, WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT. SLEEVING SHOULD EXTEND 6" BEYOND HARDSCAPE EDGE.
6. CONTRACTOR IS TO INSTALL 3" DUCTILE IRON SERVICE LINE AND 3" HERSEY WATER METER PER KING COUNTY WATER DISTRICT 20 SPECIFICATIONS.
7. PIPING SHOWN IN PARALLEL MAY BE INSTALLED IN A COMMON TRENCH. ALLOW A MINIMUM OF THREE (3") INCHES BETWEEN PARALLEL PIPE LINES. LOCATE TRENCHES TO AVOID CONFLICT WITH INSTALLATION OF TREES & SHRUBS.
8. ALL UNSIZED TERMINAL LATERAL LINES SHALL BE 1" PIPE.
9. COORDINATE PLANTING AND SPRINKLER HEAD LOCATIONS TO AVOID CONFLICT AND POTENTIAL PLANT DAMAGE. INSTALL ROTORS AS PER DETAILS.
10. CONTRACTOR IS RESPONSIBLE TO FINE TUNE ALL NOZZLES ON SITE TO INSURE COVERAGE AND MINIMIZE OVERSPRAY.
11. VERIFY CONTROLLER LOCATIONS WITH ENGINEER.
12. CONTRACTOR IS RESPONSIBLE FOR WINTERIZATION OF SYSTEM. SYSTEM MUST BE WINTERIZED BY BLOWING OUT WITH COMPRESSED AIR.
13. MAINLINE LAYOUT IS DIAGRAMMATIC, IT HAS BEEN SHOWN OUTSIDE WETLAND PERIMETER FOR PURPOSES OF CLARITY. LOCATE INSIDE WETLAND LIMIT OF WORK.

IRRIGATION LEGEND

SYMBOL	DESCRIPTION	GPM
◔ ◑ ◓	ROTOR, HUNTER I-10-SERIES SHRUB ROTOR--LA NOZZLE #2.5	2.8
◔ ◑	ROTOR, HUNTER I-10 SERIES SHRUB ROTOR--NOZZLE #4	4.2
◓ ◕ ◉	ROTOR, HUNTER I-10 SERIES SHRUB ROTOR--NOZZLE #8	8
◕	WEATHERMATIC 11000CR SERIES ELECTRIC REMOTE CONTROL VALVE PLASTIC -- SIZE AS INDICATED ON DRAWING.	
⊖	VALVE DETAIL---ZONE NUMBER GPM VALVE SIZE	
M ⧗	POINT OF CONNECTION 3" HERSEY WATER METER--3" D.I. SERVICE LINE 3" FEBCO 850Y DOUBLE CHECK VALVE ASSEMBLY 3" ZURN WILKENS 500HR PRV--FACTORY SET AT 85 PSI 3" WEATHERMATIC 8200 CR MASTER VALVE BUCKNER 1" QUICK COUPLER VALVE	
⊕	MAINLINE GATE VALVE--SIZE TO MATCH MAINLINE.	
○	BUCKNER 1" QUICK COUPLER VALVE	
C	RAINBIRD ESP-MC SERIES SOLID STATE CONTROLLER-- 40 STATIONS INPUT REQUIRED: 117 VOLT AC, 60 HZ. OUTPUT: 26.5 VAC, 2.5 A. UL LISTED AND APPROVED	
	MAINLINE-- CLASS 200 PVC- SIZE AS NOTED ON DRAWING	
———	LATERAL LINE---CLASS 200, SIZE AS NOTED ON DRAWING	
- - - -	SLEEVING--CLASS 200 PVC--MIN. 2X DIAMETER OF INTERIOR PIPE MINIMUM 18" COVER OVER ALL SLEEVING UNDER ROADWAYS AND DRIVEWAYS.	

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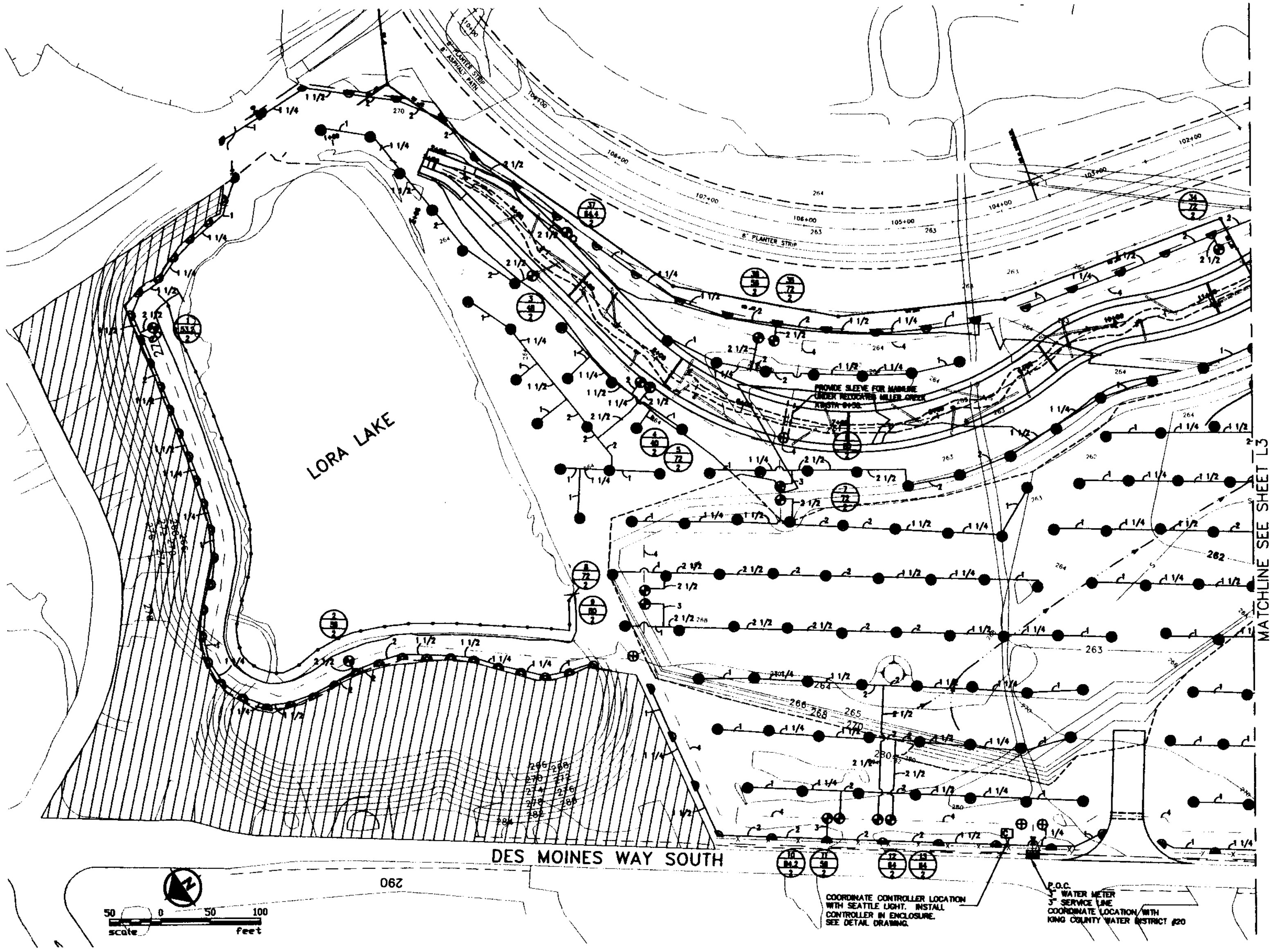
SHEET TITLE: IRRIGATION DETAILS & LEGEND

291217L1
STIA-9805-L1
APPENDIX A

DATE: 11/15/01 FILENAME: 291217L1 XREFS IMAGES



COORDINATE CONTROLLER LOCATION WITH SEATTLE LIGHT. INSTALL CONTROLLER IN ENCLOSURE. SEE DETAIL DRAWING.

P.O.C.
3" WATER METER
3" SERVICE LINE
COORDINATE LOCATION WITH KING COUNTY WATER DISTRICT #20

IRRIGATION LEGEND

SYMBOL	DESCRIPTION	GPM
◔ ◑ ◓	ROTOR, HUNTER I-10-SERIES SHRUB ROTOR---LA NOZZLE #2.5	
◔ ◑	ROTOR, HUNTER I-10 SERIES SHRUB ROTOR---NOZZLE #4	
◓ ◕ ●	ROTOR, HUNTER I-10 SERIES SHRUB ROTOR---NOZZLE #8	
⊕	WEATHERMATIC 11000CR SERIES ELECTRIC REMOTE CONTROL VALVE PLASTIC --- SIZE AS INDICATED ON DRAWING.	
⊜	VALVE DETAIL----ZONE NUMBER GPM VALVE SIZE	
M ⧗	POINT OF CONNECTION 3" HERSEY WATER METER---3" D.I. SERVICE LINE 3" FEBCO 850Y DOUBLE CHECK VALVE ASSEMBLY 3" ZURN WILKENS 500HR PRV---FACTORY SET AT 85 PSI 3" WEATHERMATIC 8200 CR MASTER VALVE BUCKNER 1" QUICK COUPLER VALVE	
⊕	MAINLINE GATE VALVE---SIZE TO MATCH MAINLINE.	
○	BUCKNER 1" QUICK COUPLER VALVE	
C	RAINBIRD ESP-MC SERIES SOLID STATE CONTROLLER--- 40 STATIONS INPUT REQUIRED: 117 VOLT AC, 60 HZ. OUTPUT: 26.5 VAC, 2.5 A. UL LISTED AND APPROVED	
───	MAINLINE--- CLASS 200 PVC- SIZE AS NOTED ON DRAWING	
───	LATERAL LINE----CLASS 200, SIZE AS NOTED ON DRAWING	
- - -	SLEEVING---CLASS 200 PVC---MIN. 2X DIAMETER OF INTERIOR PIPE MINIMUM 18" COVER OVER ALL SLEEVING UNDER ROADWAYS AND DRIVEWAYS.	
▨	TEMPORARY IRRIGATION SYSTEM TO BE DESIGNED	

GENERAL NOTES

1. PRIOR TO THE COMMENCEMENT OF WORK, CONTRACTOR MUST VERIFY A MINIMUM OF 100 LBS.(PSI) STATIC WATER PRESSURE AT POINT OF CONNECTION. NOTIFY ENGINEER OF ANY DISCREPANCY.
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6. CONTRACTOR IS TO INSTALL 3" DUCTILE IRON SERVICE LINE AND 3" HERSEY WATER METER PER KING COUNTY WATER DISTRICT 20 SPECIFICATIONS.
7. PIPING SHOWN IN PARALLEL MAY BE INSTALLED IN A COMMON TRENCH. ALLOW A MINIMUM OF THREE (3") INCHES BETWEEN PARALLEL PIPE LINES. LOCATE TRENCHES TO AVOID CONFLICT WITH INSTALLATION OF TREES & SHRUBS.
8. ALL UNSIZED TERMINAL LATERAL LINES SHALL BE 1" PIPE.
9. COORDINATE PLANTING AND SPRINKLER HEAD LOCATIONS TO AVOID CONFLICT AND POTENTIAL PLANT DAMAGE. INSTALL ROTORS AS PER DETAILS.
10. CONTRACTOR IS RESPONSIBLE TO FINE TUNE ALL NOZZLES ON SITE TO INSURE COVERAGE AND MINIMIZE OVERSPRAY.
11. VERIFY CONTROLLER LOCATIONS WITH ENGINEER.
12. CONTRACTOR IS RESPONSIBLE FOR WINTERIZATION OF SYSTEM. SYSTEM MUST BE WINTERIZED BY BLOWING OUT WITH COMPRESSED AIR.

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PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: IRRIGATION PLAN N

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STIA-9805-L2

APPENDIX A

DATE: 11/15/01 FILENAME: 291217L2 IMAGES: XREF'S:

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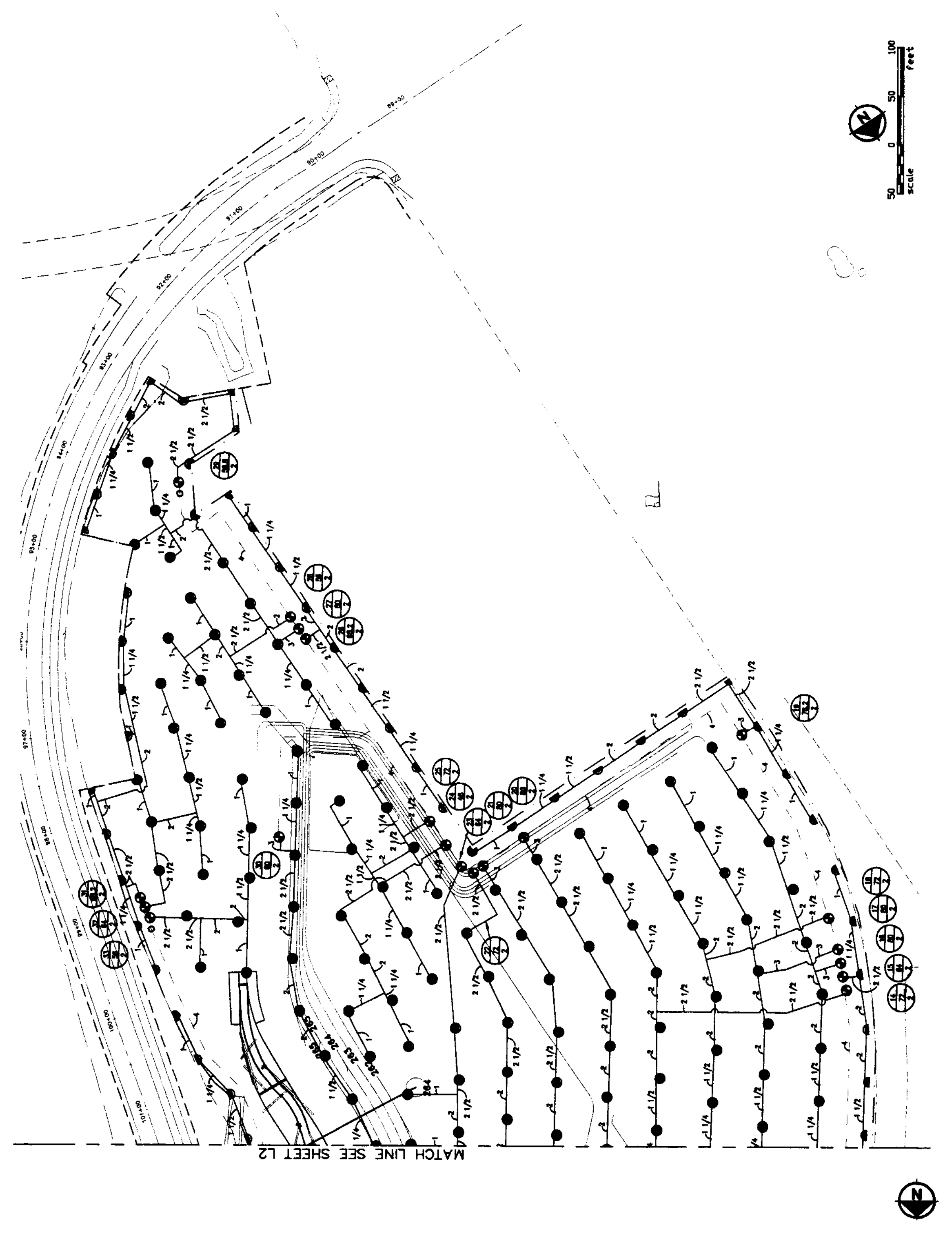

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SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK RELOCATION
SHEET TITLE: IRRIGATION PLAN S

281217L3

STIA-9805-L3

APPENDIX A

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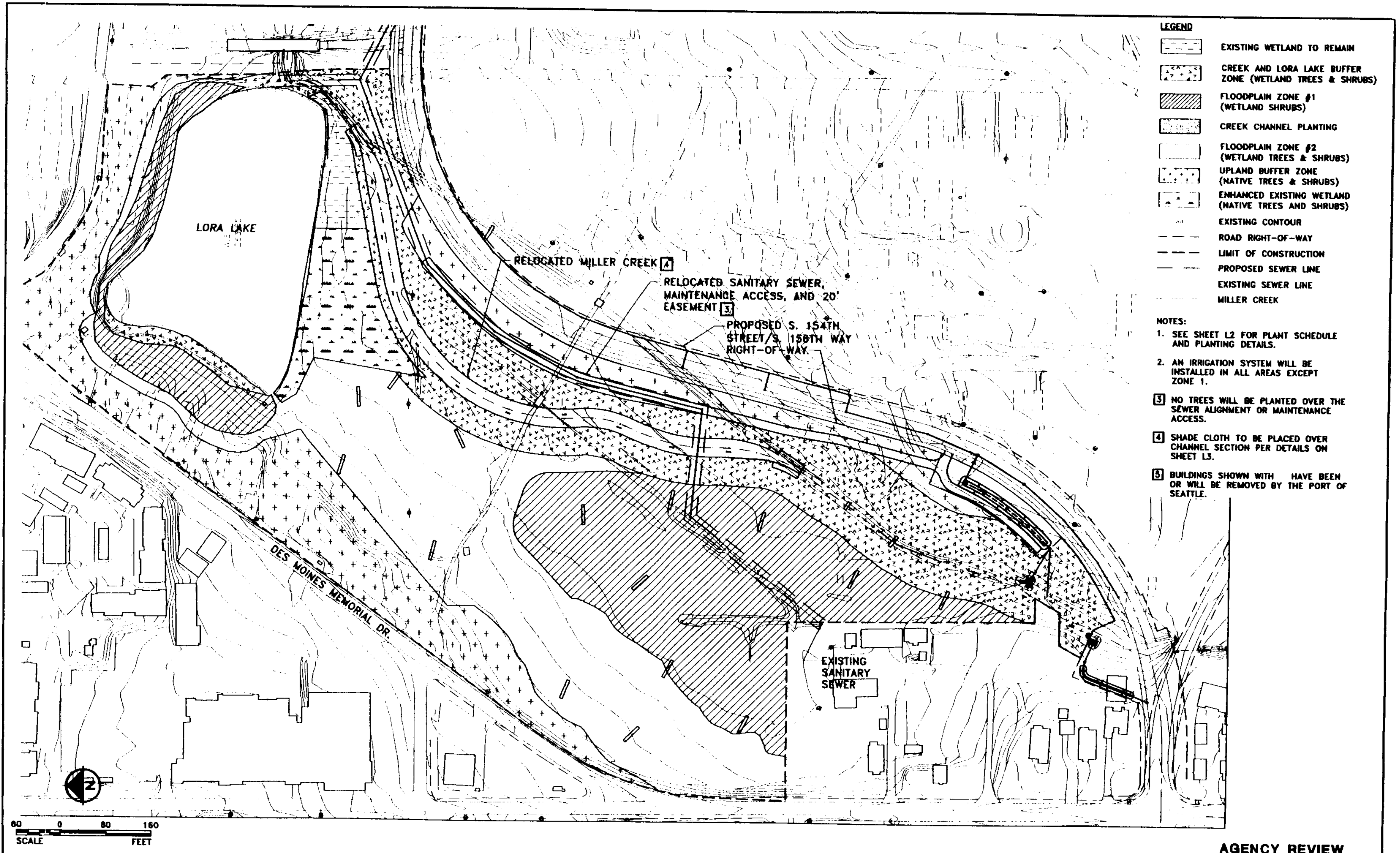

LEGEND

▭	EXISTING WETLAND TO REMAIN
▨	CREEK AND LORA LAKE BUFFER ZONE (WETLAND TREES & SHRUBS)
▨	FLOODPLAIN ZONE #1 (WETLAND SHRUBS)
▨	CREEK CHANNEL PLANTING
▭	FLOODPLAIN ZONE #2 (WETLAND TREES & SHRUBS)
▨	UPLAND BUFFER ZONE (NATIVE TREES & SHRUBS)
▨	ENHANCED EXISTING WETLAND (NATIVE TREES AND SHRUBS)
	EXISTING CONTOUR
— —	ROAD RIGHT-OF-WAY
— —	LIMIT OF CONSTRUCTION
— —	PROPOSED SEWER LINE
	EXISTING SEWER LINE
	MILLER CREEK

NOTES:

1. SEE SHEET L2 FOR PLANT SCHEDULE AND PLANTING DETAILS.
2. AN IRRIGATION SYSTEM WILL BE INSTALLED IN ALL AREAS EXCEPT ZONE 1.

3 NO TREES WILL BE PLANTED OVER THE SEWER ALIGNMENT OR MAINTENANCE ACCESS.

4 SHADE CLOTH TO BE PLACED OVER CHANNEL SECTION PER DETAILS ON SHEET L3.

5 BUILDINGS SHOWN WITH HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.

AGENCY REVIEW
NOT FOR CONSTRUCTION

DATE: 11/13/01 FILENAME: 291217L4 XREF'S: 156 SEWER BID 2912018A 291217LA IMAGES:

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M. LOUTHER
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1"=80'
NOVEMBER 2001
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REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
PLANTING PLAN

100051
291217L4
STIA-9805-L4

156.DWG

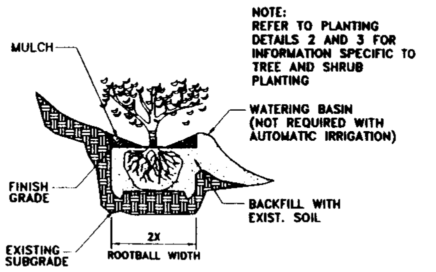
291217BA.DWG

APPENDIX A

VA:CA FARM & MIILER CREEK RELOCATION PLANT SCHEDULE

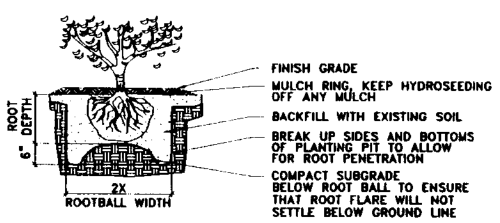
Symbol	Botanical Name / Common Name	Size	Density (Plants Per Acre)	Condition / Remarks
	MIILER CREEK RELOCATION ZONE			
▒	**Trees**		280	
	Acer macrophyllum / big leaf maple	4'-6' ht.		- Container or B&B. Rooting to sides and bottom of can or burlap.
	Alnus rubra/red alder	2 gal.		
	Fraxinus latifolia/Oregon ash	4'-6' ht.		
	Populus trichocarpa/black cottonwood	4'-6' ht.		
	Shrubs - Single Species Groups of 3 to 7		2,100	
	Acer circinatum/vine maple	2 gal.		- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Physocarpus capitatus/pacific ninebark	1 gal.		
	Rosa pisocarpa/clustered rose	1 gal.		
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		
	FLOODPLAIN ZONE #1			
▨	**Shrubs - Single Species Groups of 7 to 12**		2,100	
	Salix hookeriana/Hookers willow	1gal/Live stake		- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Salix lucida spp lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		
	Spiraea douglasii/hardhack spiraea	1 gal.		
	FLOODPLAIN ZONE #2			
☐	**Trees**		80	
	Picea sitchensis/Sitka spruce *	3'-4' ht		- Container or B&B. Rooting to sides and bottom of can or burlap.
	Thuja plicata/western redcedar *	3'-4' ht.		
	Shrubs - Single Species Groups of 3 to 7		2,100	
	Physocarpus capitatus/Pacific ninebark	1 gal.		- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		
	Spiraea douglasii/hardhack spiraea	1 gal.		
	UPLAND BUFFER ZONE			
▒	**Trees**		280	
	Abies grandis / grand fir	4'-6' ht.		- Container or B&B. Rooting to sides and bottom of can or burlap.
	Acer macrophyllum / big leaf maple	4'-6' ht.		
	Alnus rubra/red alder	2 gal.		
	Picea sitchensis/Sitka spruce *	3'-4' ht		
	Populus trichocarpa/black cottonwood	4'-6' ht.		
	Pseudotsuga menziesii/douglas fir	3'-4' ht.		
	Thuja plicata/western redcedar *	3'-4' ht.		
	Tsuga heterophylla/western hemlock *	3'-4' ht.		
	Shrubs - Single Species Groups of 3 to 7		2,100	
	Acer circinatum/vine maple	2 gal.		- Container. Rooting to sides and bottom of can. - Space 4.5' O.C. typical.
	Philadelphus lewisii/mock orange	1 gal.		
	Rosa nutkana/Nootka rose	1 gal.		
	ENHANCED EXISTING WETLAND		2,100	
▒	**Shrubs**			
	Acer circinatum/vine maple	2 gal.		- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Philadelphus lewisii/mock orange	1 gal.		
	Rosa nutkana/Nootka rose	1 gal.		
	Rosa pisocarpa/Clustered rose	1 gal.		
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		
	CREEK CHANNEL PLANTING			
■	**Shrubs**			
	Salix lucida spp. lasiandra/Pacific willow	Live stakes		- Live stakes 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 30" on center (O.C).
	Salix scouleriana/Scoulers willow	Live stakes		
	Salix sitchensis/Sitka willow	Live stakes		

* Western redcedar, Western hemlock and Sitka spruce shall be planted in a second planting phase, to follow year-3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture are present.

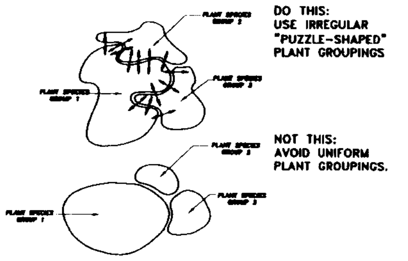


NOTE:
REFER TO PLANTING DETAILS 2 AND 3 FOR INFORMATION SPECIFIC TO TREE AND SHRUB PLANTING

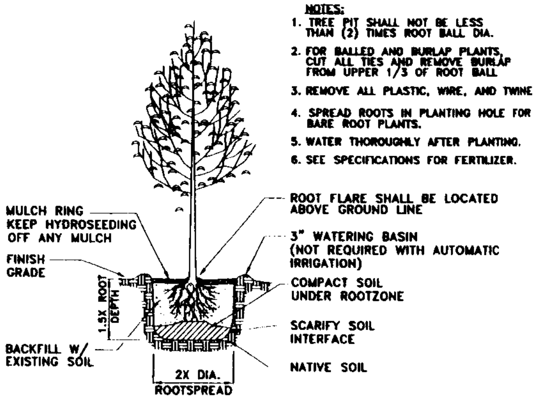
DETAIL ① TYP
PLANTING ON SLOPES
N.T.S.



DETAIL ③ TYP
SHRUB PLANTING
(TYPICAL)

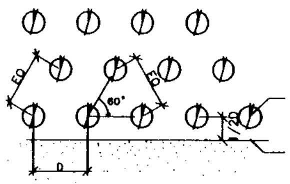


DETAIL ⑤ TYP
SHAPES OF PLANTING MASSES
N.T.S.



NOTES:
1. TREE PIT SHALL NOT BE LESS THAN (2) TIMES ROOT BALL DIA.
2. FOR BALLED AND BURLAP PLANTS, CUT ALL TIES AND REMOVE BURLAP FROM UPPER 1/3 OF ROOT BALL
3. REMOVE ALL PLASTIC, WIRE, AND TWINE
4. SPREAD ROOTS IN PLANTING HOLE FOR BARE ROOT PLANTS.
5. WATER THOROUGHLY AFTER PLANTING.
6. SEE SPECIFICATIONS FOR FERTILIZER.

DETAIL ② TYP
TREE PLANTING
(TYPICAL)



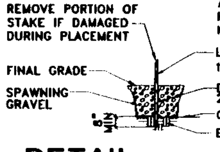
NOTE:
ALL SHRUB SPACING SHALL BE EQUIDISTANT UNLESS OTHERWISE SPECIFIED

DISTANCE (D) ON CENTER AS REQUIRED TO MEET PLANTS PER ACRE STANDARD.

START FIRST ROW OF PLANTING AT 1/2 THE PERPENDICULAR SPACING BETWEEN ROWS

EDGE OF PLANTING AREA

DETAIL ④ TYP
TRIANGULAR SHRUB SPACING
(TYPICAL)



NOTE:
AFTER PLANTING STAKE MUST HAVE MIN. NUMBER OF BUDS NOTED IN PLANTING LEGEND

DETAIL ⑥ TYP
LIVE STAKE PLANTING
N.T.S.

NOTES:

1. For installation of plant material through coir fabric wrap, excavate to reveal wrap cut "x" pattern through wrap, fold & secure under adjacent wrap, install planting as per typical detail.
2. Preserve and protect all trees and shrubs not designated for removal. Provide, erect, and maintain barricades necessary to prevent access to areas within drip lines of existing trees. Allow no vehicular or pedestrian traffic, or stacking and/or storage of construction materials within barricades.
3. For each planting zone Contractor shall lay out a 10,000 s.f. test plot, in which the positions of all plants shall be staked with flags that are color coded to represent specific species. Layout for each zone shall be inspected and approved prior to commencement of planting. Approved staking shall serve as the plant layout standard for the remainder of each zone.
4. Shrub masses shall consist of multiple single-species groups (see detail 5). Contractor shall ensure that these single-species groups have a variety of sizes and shapes, and that shrub masses have a variety of species. See planting schedule for numbers of plants in single-species groups.
5. Hydroseed all planting areas. Re-seed areas that are disturbed by subsequent work. Keep hydroseeding off any mulch circles except where needed to protect roots of conifers.

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NOVEMBER 2001

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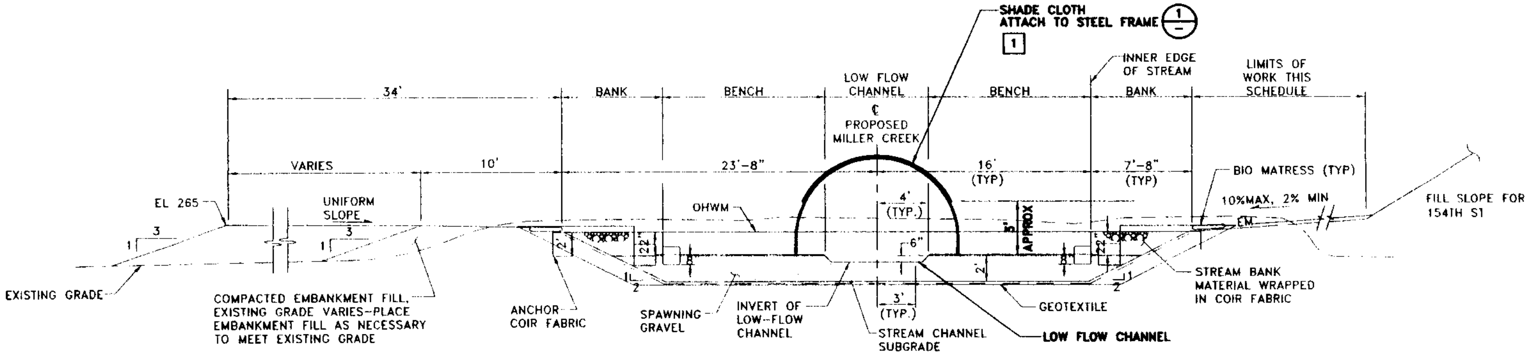
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
PLANTING SCHEDULE AND DETAILS

100051
291217L5
STIA-9805-L5
APPENDIX A

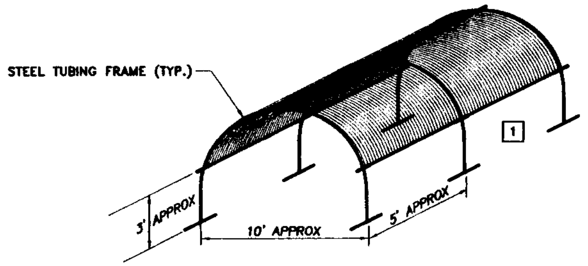
DATE: 11/19/01 FILENAME: 291217L5 IMAGES: XREF'S:



SECTION

SHADECLOTH
SCALE 1"=5'

1
C2



1 INSTALL SHADE CLOTH BETWEEN STATIONS 2+00 AND 13+00.

DETAIL

SHADECLOTH
NTS

1
–

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0 1"
ONE INCH AT FULL SCALE
IF NOT SCALE ACCORDINGLY

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Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK RELOCATION
SHADECLOTH SECTION AND DETAIL

100051
291217L6
STIA-9805-L6

APPENDIX A

DATE: 11/15/01 FILENAME: 291217L6 IMAGES: XREF'S:

Port of Seattle
Aviation Division

APPENDIX B

MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

AGENCY REVIEW
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SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE
STIA-9806-T1	TITLE SHEET	STIA-9806-L1	LANDSCAPE INDEX	STIA-9806-TA7	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS
STIA-9806-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS	STIA-9806-L1.1	LANDSCAPE PLAN	STIA-9806-TA8	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS
STIA-9806-C2	PROJECT PLAN	STIA-9806-L2	LANDSCAPE PLAN		
STIA-9806-C3	INSTREAM PROJECT AREA 1 PLAN	STIA-9806-L3	LANDSCAPE PLAN		
STIA-9806-C4	INSTREAM PROJECT AREA 2 PLAN	STIA-9806-L4	LANDSCAPE PLAN		
STIA-9806-C5	INSTREAM PROJECT AREA 3 PLAN	STIA-9806-L5	LANDSCAPE PLAN		
STIA-9806-C6	INSTREAM PROJECT AREA 4 PLAN	STIA-9806-L5.1	LANDSCAPE PLAN		
STIA-9806-C7	INSTREAM LWD PLACEMENT PLAN	STIA-9806-L5.2	IRRIGATION PLAN		
STIA-9806-C8	INSTREAM SECTIONS AND PROFILE	STIA-9806-L5.3	LANDSCAPE PLAN		
STIA-9806-C9	INSTREAM DETAILS	STIA-9806-L5.4	LANDSCAPE PLAN		
STIA-9806-C10	LWD DETAILS	STIA-9806-L5.5	IRRIGATION PLAN		
STIA-9806-C11	STREAM BUFFER AND EMBANKMENT CROSS-SECTION	STIA-9806-L6	PLANTING SCHEDULE AND DETAILS		
STIA-9806-C12	SITE GRADING	STIA-9806-P1	GRADING AT S. 156TH WAY BRIDGE		
STIA-9806-C13	SITE GRADING	STIA-9806-P2	BRIDGE REMOVAL AND TEMPORARY EROSION CONTROL PLAN		
STIA-9806-TE1	TESC PLAN - PROJECT AREA 1	STIA-9806-TA1	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		
STIA-9806-TE2	TESC PLAN - PROJECT AREA 2	STIA-9806-TA2	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		
STIA-9806-TE3	TESC PLAN - PROJECT AREA 3	STIA-9806-TA3	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		
STIA-9806-TE4	TESC PLAN - PROJECT AREA 4	STIA-9806-TA4	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		
STIA-9806-TE5	TESC DETAILS	STIA-9806-TA5	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		
STIA-9806-TE6	TESC DETAILS	STIA-9806-TA6	EXISTING CONDITIONS AND WETLAND ENHANCEMENT ACTIONS		

DATE: 11/15/01 FILENAME 2912817 IMAGES XREF'S

MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

DATE

DATE

DATE

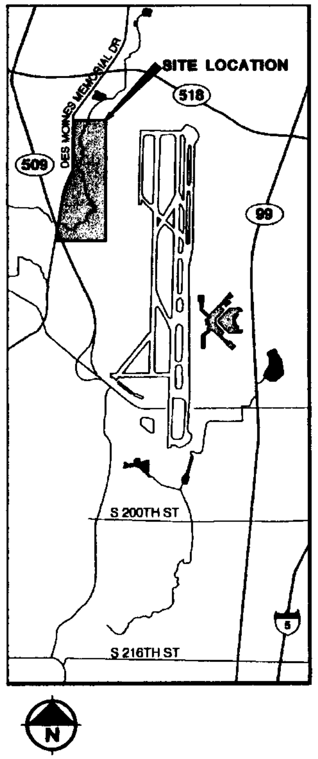
APPROVED BY

DATE

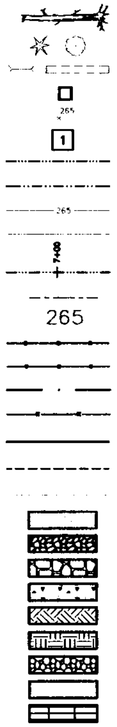
WORK ORDER NO.	PROJECT NO.
WORK ORDER #	STIA-9806-T1

APPENDIX B

VICINITY MAP



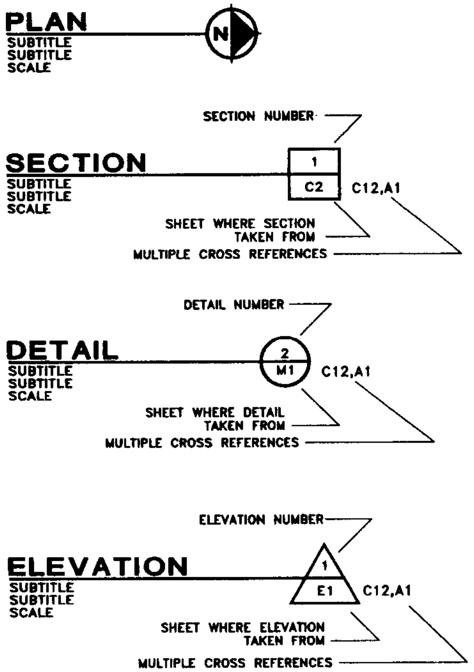
LEGEND



- LARGE WOODY DEBRIS (LWD)
- EXISTING TREES
- CULVERT
- SUMP
- SPOT ELEVATION
- KEY NOTE NUMBER REFERENCE
- WATER BODY
- WETLAND BOUNDARY
- EXISTING CONTOUR (MAJOR)
- EXISTING CONTOUR (MINOR)
- STREAM CENTERLINE AND STATIONING
- PARCEL BOUNDARY
- PARCEL NUMBER
- SILT FENCE
- SILT CURTAIN
- GEOTEXTILE (SECTION)
- CHAIN LINK FENCE
- PROJECT LIMIT
- LIMIT OF 100 FT RIPARIAN BUFFER
- RIPRAP
- SPAWNING GRAVEL (SECTION)
- RIPRAP
- QUARRY SPALLS
- CONCRETE
- EMBANKMENT/PREPARED SUBGRADE
- NATIVE SUBGRADE
- STREAM BANK MATERIAL
- WETLAND AREAS
- LIVE STAKING (EROSION CONTROL)

GENERAL LEGEND

DRAWING TITLE:



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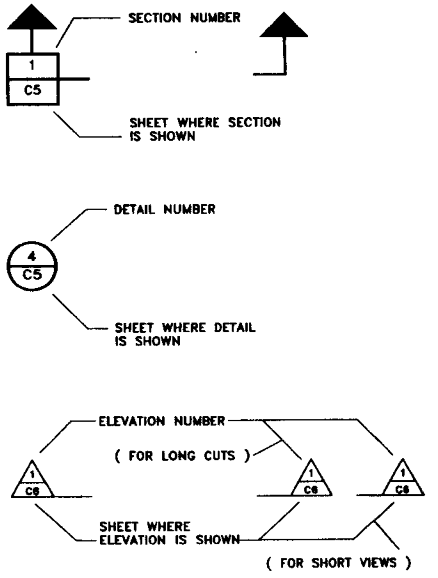

GENERAL ABBREVIATIONS

&	AND	NTS	NOT TO SCALE
APPROX	APPROXIMATE	NIC	NOT IN CONTRACT
CB	CATCH BASIN	OC	ON CENTER
C L OR ℄	CENTERLINE	POS	PORT OF SEATTLE
CONC	CONCRETE	RCP	REINFORCED CONCRETE PIPE
CONST	CONSTRUCTION	REQD	REQUIRED
CMP	CORRUGATED METAL PIPE	R/W	RIGHT OF WAY
DIA	DIAMETER	SCH	SCHEDULE
E	EAST/EASTING	SD	STORM DRAIN
EL OR ELEV	ELEVATION	SPEC	SPECIFICATION(S)
EX OR EXIST	EXISTING	SQ	SQUARE
FT	FOOT (FEET)	SF	SQUARE FOOT/FEET
GA	GAUGE	SS	SANITARY SEWER
GAL	GALLON	SY	SQUARE YARD/YARDS
GR	GRADE	STA	STATION
HT	HEIGHT	ST	STREET
HORIZ OR H	HORIZONTAL	STD	STANDARD
IE	INVERT ELEVATION	TEMP	TEMPORARY
LF	LINEAR FEET/FOOT	TYP	TYPICAL
MAX	MAXIMUM	VERT OR V	VERTICAL
MIN	MINIMUM	W/	WITH
MISC	MISCELLANEOUS	WS	WATER SURFACE
N	NORTH/NORTHING	YR	YEAR

GENERAL NOTES

1. WETLAND AND OTHER VEGETATION NOT TO BE DISTURBED WILL BE DELINEATED AND FENCED BY THE ENGINEER.
2. HAZARDOUS MATERIALS AND SOILS WILL BE DISPOSED OFF SITE IN A PRE-APPROVED LOCATION.

GENERAL TEMPORARY EROSION AND SEDIMENTATION CONTROL (TESC) NOTES

1. TESC BMPS SHALL BE INSTALLED BY CONTRACTOR AND APPROVED BY THE ENGINEER PRIOR TO ANY EARTHWORK.
2. ALL DISTURBED AREAS SHALL BE COVERED IMMEDIATELY WHEN UNWORKED. ALL DISTURBED AREAS COMPLETED OR TO REMAIN UNWORKED FOR MORE THAN 15 DAYS SHALL BE SEEDED WITHIN 7 DAYS.
3. BIODEGRADABLE COIR FABRIC MATTING SHALL BE PLACED OVER DISTURBED SLOPES (EXCEPT IN AREAS WHERE COIR FABRIC LIFTS ARE IN PLACE). GEOTEXTILE FABRIC SHALL BE PLACED AFTER SEEDING.
4. CONSTRUCTION ACTIVITY OCCURRING WITHIN THE ORDINARY HIGH WATER MARK SHALL BE CONDUCTED DURING SUMMER BASE FLOW CONDITIONS AND WITH NO PRECIPITATION FORECAST WITHIN 48 HOURS. ALL ACTIVITIES WITHIN ORDINARY HIGH WATER MARK SHALL BE STAGED SUCH THAT DISTURBED AREAS ARE STABILIZED WITHIN 24 HOURS. ALL EQUIPMENT WILL OPERATE OUTSIDE THE ORDINARY HIGH WATERMARK.

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AS SHOWN
NOVEMBER 2001
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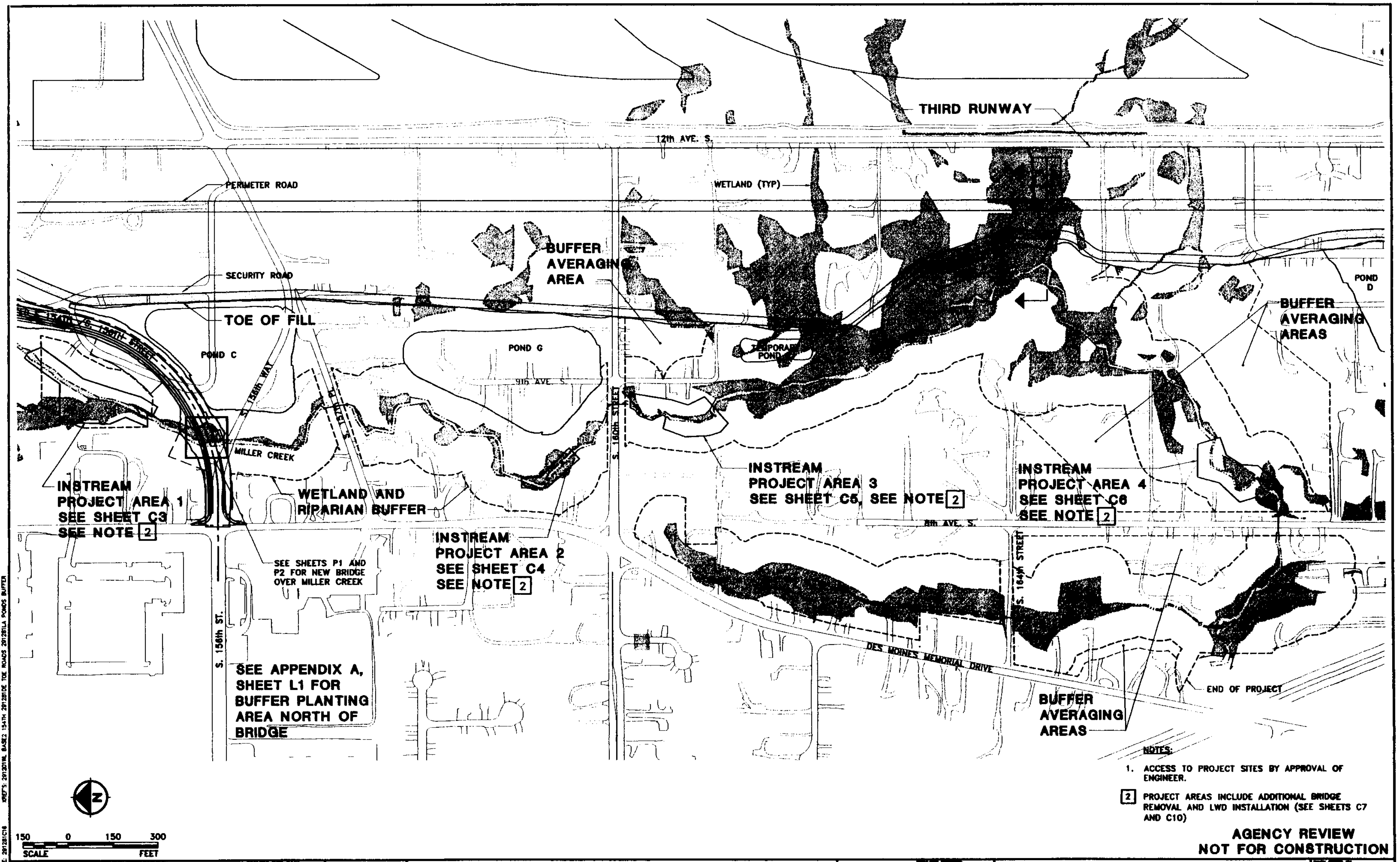
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

–
291281C1
STIA-9806-C1

APPENDIX B

DATE: 11/19/01 FILENAME: 291281C1 IMAGES: VicinityMapAppendixB XREF'S:



NOTES:

1. ACCESS TO PROJECT SITES BY APPROVAL OF ENGINEER.

2 PROJECT AREAS INCLUDE ADDITIONAL BRIDGE REMOVAL AND LWD INSTALLATION (SEE SHEETS C7 AND C10)

AGENCY REVIEW
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DATE: 11/13/01 FILENAME: 291281C16
XREF'S: 291201WL BASE2 154TH 291281DE TOE ROADS 291281LA PONDS BUFFER
IMAGES:

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PJT/SNN
1"=150'
NOVEMBER 2001
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P. FENDT

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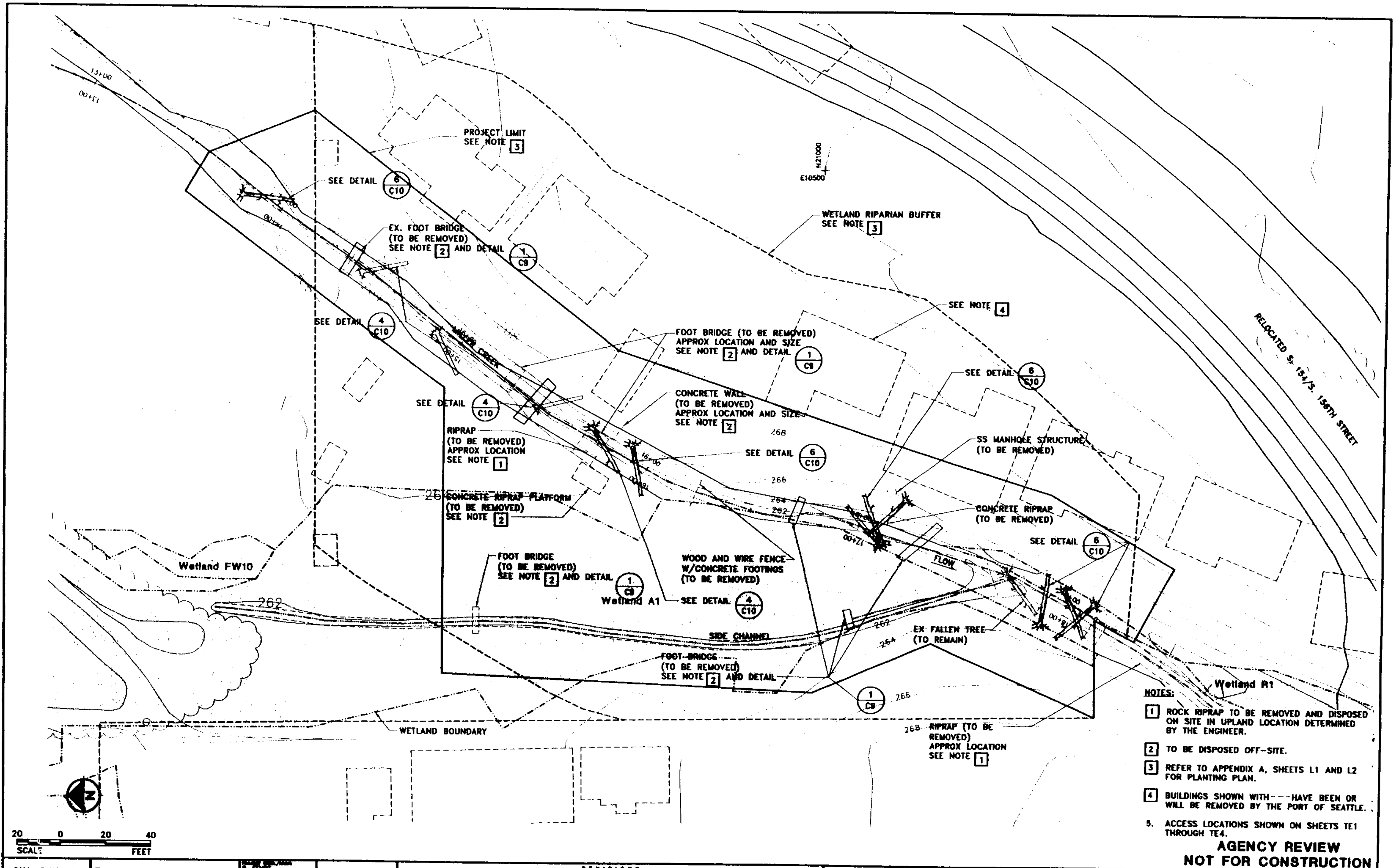
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
PROJECT PLAN

C3496
291281C16
STIA-9806-C2
APPENDIX B

291201BA2 291281DE 291281SV 291201WL



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF-SITE.
3. REFER TO APPENDIX A, SHEETS L1 AND L2 FOR PLANTING PLAN.
4. BUILDINGS SHOWN WITH- - -HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.
5. ACCESS LOCATIONS SHOWN ON SHEETS TE1 THROUGH TE4.

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PJT/SBH
1"=20'
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P. FENDT

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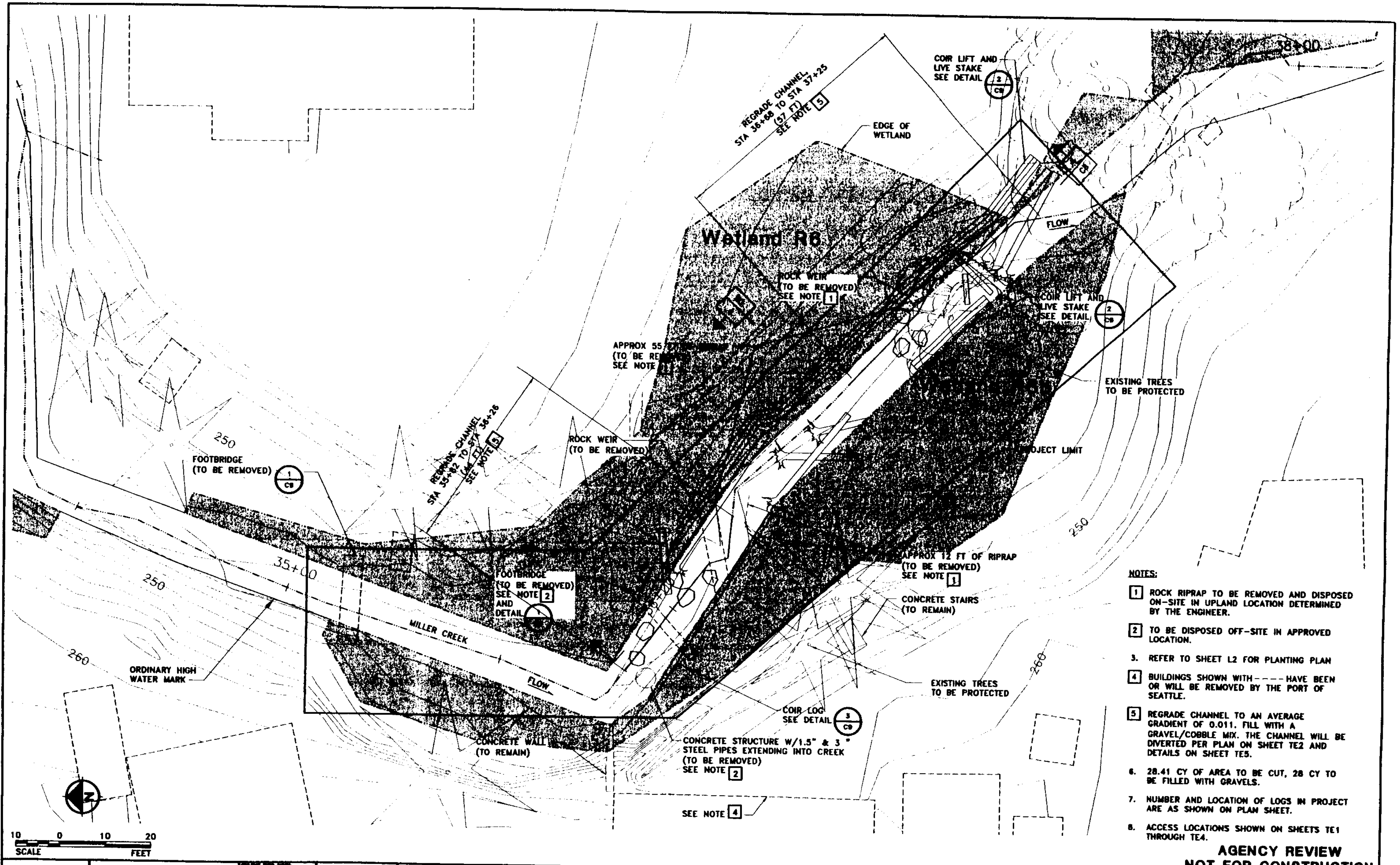
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
INSTREAM PROJECT AREA 1 PLAN

–
291281C2
STIA-XXXX-C3

DATE: 11/13/01 FILENAME: 291281C2

291201BA2 291281DE 291281SV 291201WL

APPENDIX B



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON-SITE IN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF-SITE IN APPROVED LOCATION.
3. REFER TO SHEET L2 FOR PLANTING PLAN
4. BUILDINGS SHOWN WITH - - - - HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.
5. REGRADE CHANNEL TO AN AVERAGE GRADIENT OF 0.011. FILL WITH A GRAVEL/COBBLE MIX. THE CHANNEL WILL BE DIVERTED PER PLAN ON SHEET TE2 AND DETAILS ON SHEET TE5.
6. 28.41 CY OF AREA TO BE CUT, 28 CY TO BE FILLED WITH GRAVELS.
7. NUMBER AND LOCATION OF LOGS IN PROJECT ARE AS SHOWN ON PLAN SHEET.
8. ACCESS LOCATIONS SHOWN ON SHEETS TE1 THROUGH TE4.

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REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

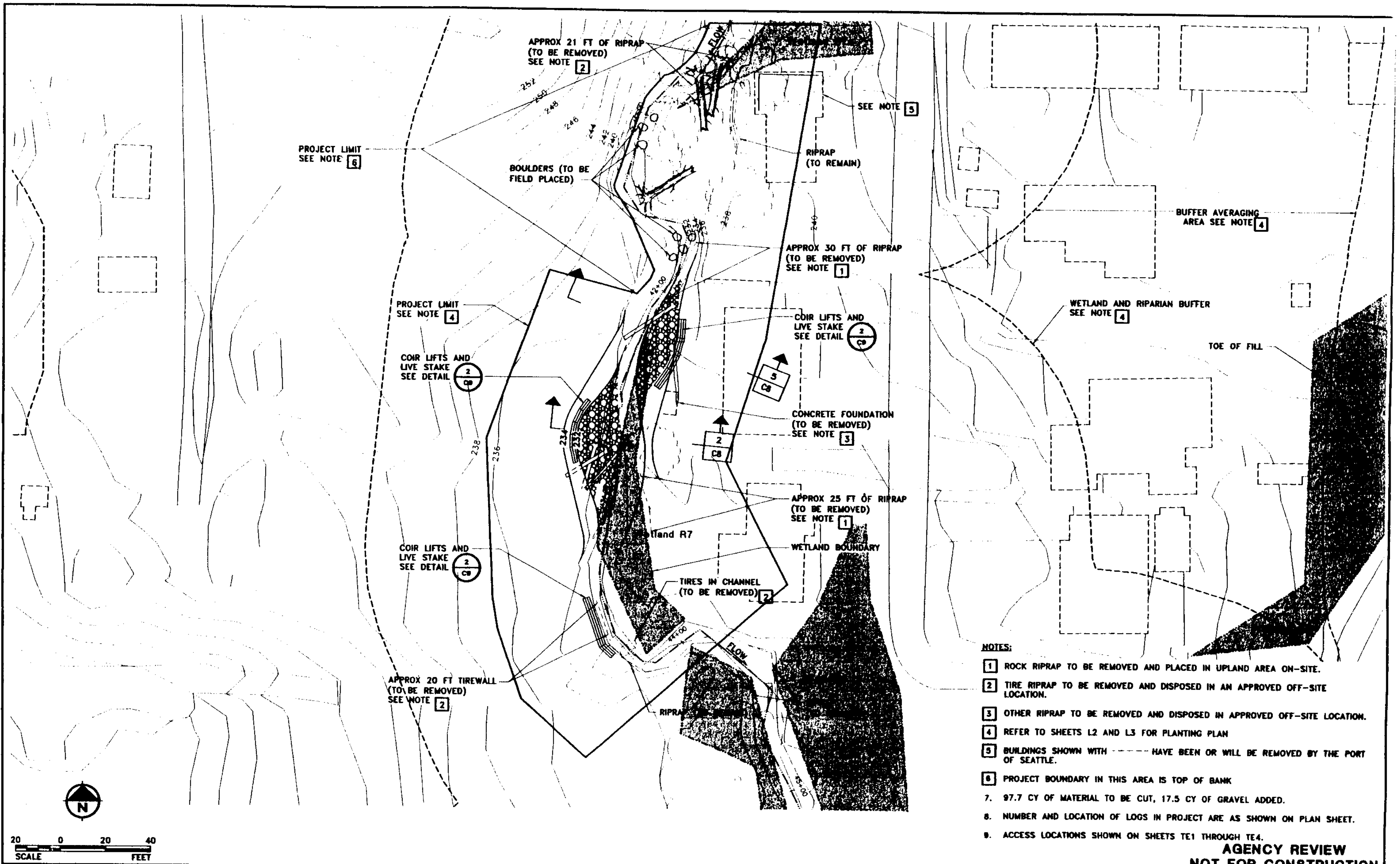
INSTREAM PROJECT AREA 2 PLAN

-
291281C3
STIA-XXXX-C4

APPENDIX B

291201BA2 291281DE 291281SV 291201WL

DATE: 11/13/01 FILENAME: 291281C3 XREF'S: BASE 291281SV 291201WL 291281DE ROADS TOE IMAGES:



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND PLACED IN UPLAND AREA ON-SITE.
2. TIRE RIPRAP TO BE REMOVED AND DISPOSED IN AN APPROVED OFF-SITE LOCATION.
3. OTHER RIPRAP TO BE REMOVED AND DISPOSED IN APPROVED OFF-SITE LOCATION.
4. REFER TO SHEETS L2 AND L3 FOR PLANTING PLAN
5. BUILDINGS SHOWN WITH - - - - - - HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.
6. PROJECT BOUNDARY IN THIS AREA IS TOP OF BANK
7. 97.7 CY OF MATERIAL TO BE CUT, 17.5 CY OF GRAVEL ADDED.
8. NUMBER AND LOCATION OF LOGS IN PROJECT ARE AS SHOWN ON PLAN SHEET.
9. ACCESS LOCATIONS SHOWN ON SHEETS TE1 THROUGH TE4.

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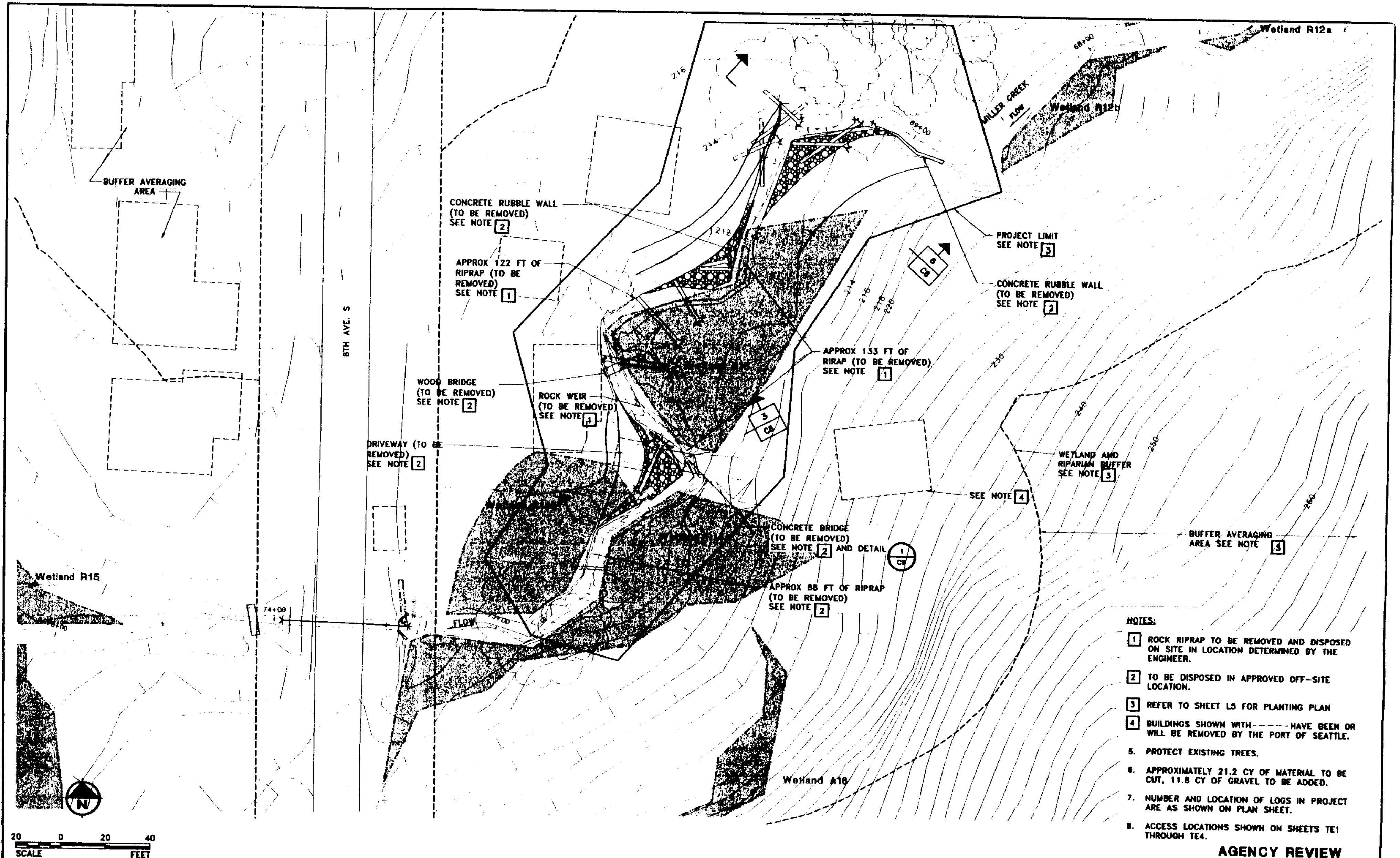
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE: **INSTREAM PROJECT AREA 3 PLAN**

–
291281C4
STIA-9806-C5
APPENDIX B

DATE: 11/13/01 FILENAME: 291281C4
IMAGES:
XREF'S: BASE 291201WL 291281DE 291281SV TOE ROADS BUFFER

291201BA2 291281DE 291281SV 291201WL



NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED IN APPROVED OFF-SITE LOCATION.
3. REFER TO SHEET L5 FOR PLANTING PLAN
4. BUILDINGS SHOWN WITH - - - - - HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE.
5. PROTECT EXISTING TREES.
6. APPROXIMATELY 21.2 CY OF MATERIAL TO BE CUT, 11.8 CY OF GRAVEL TO BE ADDED.
7. NUMBER AND LOCATION OF LOGS IN PROJECT ARE AS SHOWN ON PLAN SHEET.
8. ACCESS LOCATIONS SHOWN ON SHEETS TE1 THROUGH TE4.

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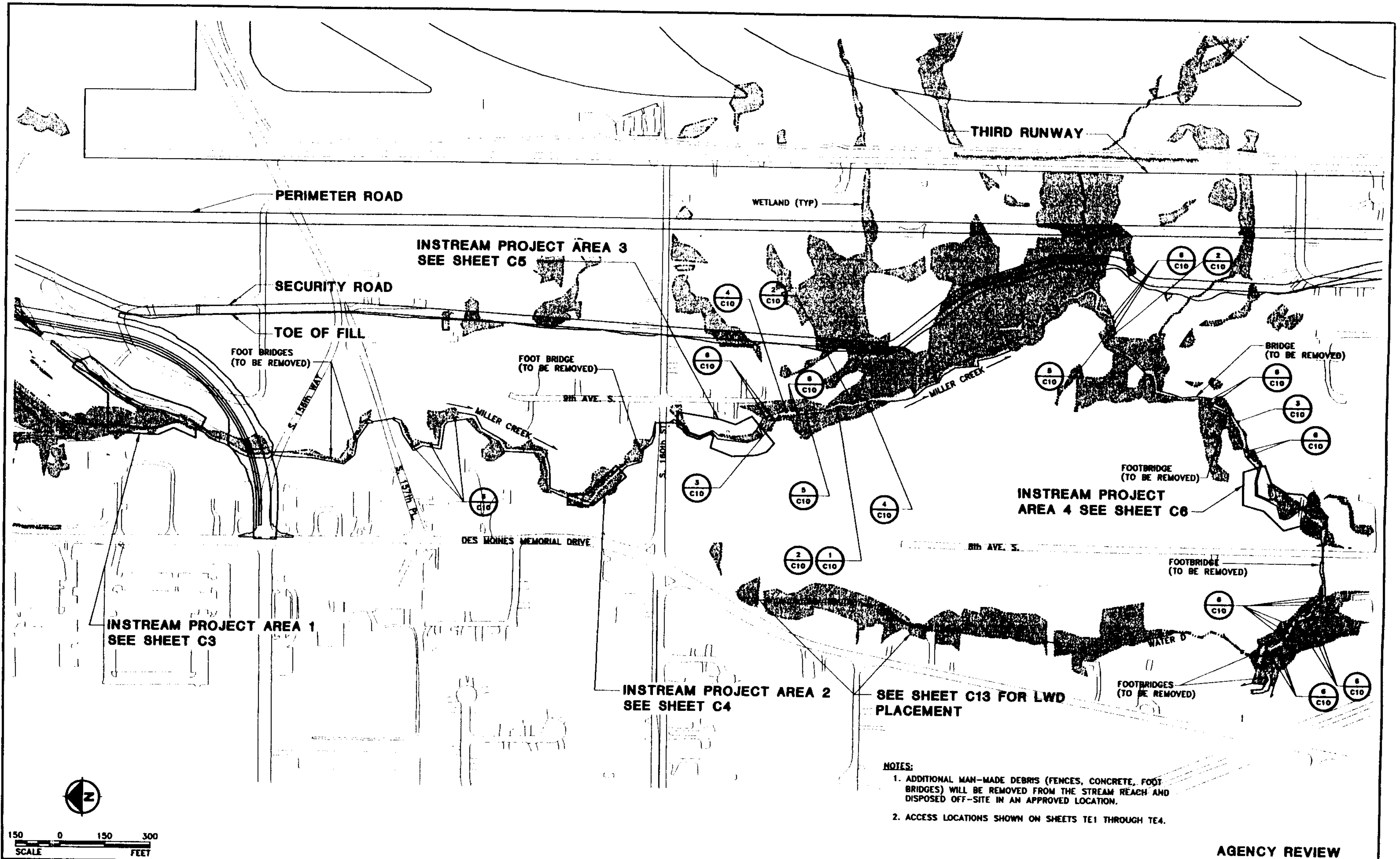
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
INSTREAM PROJECT AREA 4 PLAN

–
291281C5(A)
STIA-XXXX-C8
APPENDIX B

291201BA2
291281DE
291281SV
291201WL

DATE: 11/13/01 FILENAME: 291281C5(A)
XREF'S: BASE 291281SV 291201WL 291281DE ROADS TOE BUFFER
IMAGES:



NOTES:

1. ADDITIONAL MAN-MADE DEBRIS (FENCES, CONCRETE, FOOT BRIDGES) WILL BE REMOVED FROM THE STREAM REACH AND DISPOSED OFF-SITE IN AN APPROVED LOCATION.
2. ACCESS LOCATIONS SHOWN ON SHEETS TE1 THROUGH TE4.

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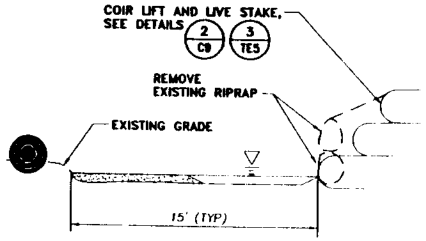
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM BUFFER ENHANCEMENT

INSTREAM LWD PLACEMENT PLAN

–
291281C15
STIA-XXXX-C7
APPENDIX B

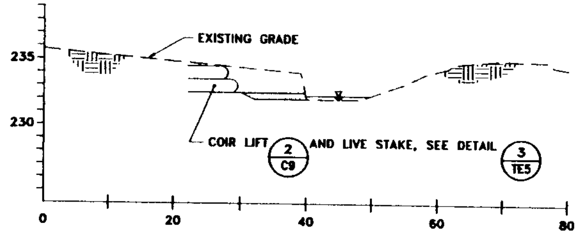
291201BA2 291281DE 291281SV 291201WL

DATE 11/13/01 FILENAME: 291281C15 XREF'S: 291281DE BA2 291281SV ROADS TOE 291201WL IMAGES:



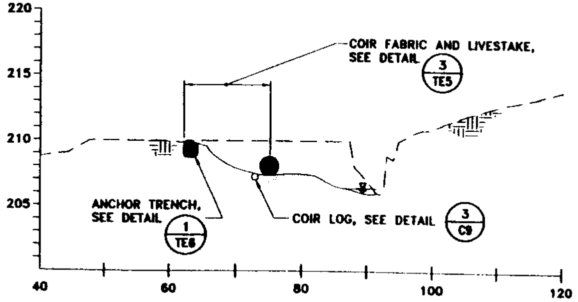
SECTION (TYP) 1 / C4

CHANNEL GRADING AND GRAVEL PLACEMENT
HORIZ SCALE: 1" =4'
VERT SCALE: 1"=4'



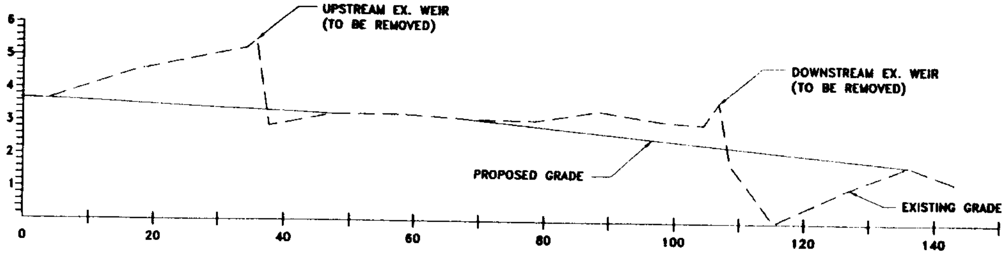
SECTION (TYP) 2 / C5

CHANNEL GRADING AND GRAVEL PLACEMENT
HORIZ SCALE: 1" =10'
VERT SCALE: 1"=5'



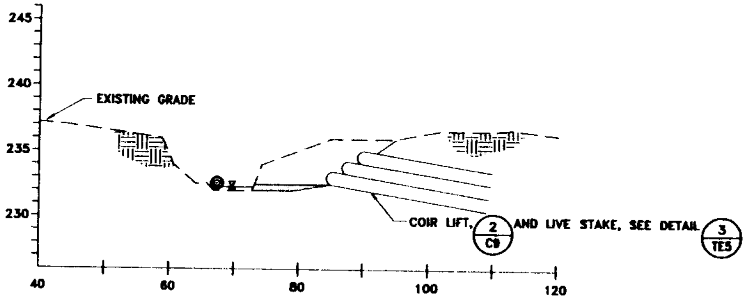
SECTION (TYP) 3 / C6

CHANNEL GRADING AND GRAVEL PLACEMENT
HORIZ SCALE: 1" =10'
VERT SCALE: 1"=5'



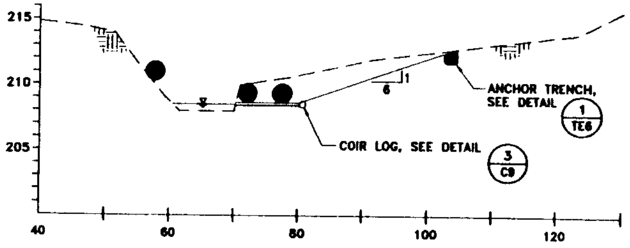
SECTION (TYP) 4 / C4

THALWEG PROFILE
HORIZ SCALE: 1" =10'
VERT SCALE: 1"=2'



SECTION (TYP) 5 / C5

CHANNEL GRADING AND GRAVEL PLACEMENT
HORIZ SCALE: 1" =10'
VERT SCALE: 1"=5'



SECTION (TYP) 6 / C6

CHANNEL GRADING AND GRAVEL PLACEMENT
HORIZ SCALE: 1" =10'
VERT SCALE: 1"=5'

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0 1"
ONE INCH AT FULL SCALE
IF NOT SCALE ACCORDINGLY

REVISIONS

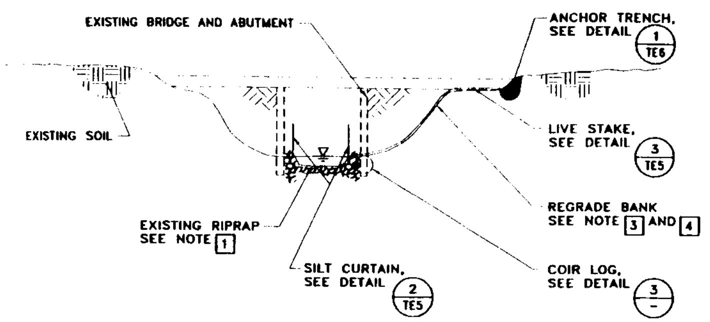
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

INSTREAM SECTIONS AND PROFILE

-
291281C6
STIA-9806-C6

APPENDIX B

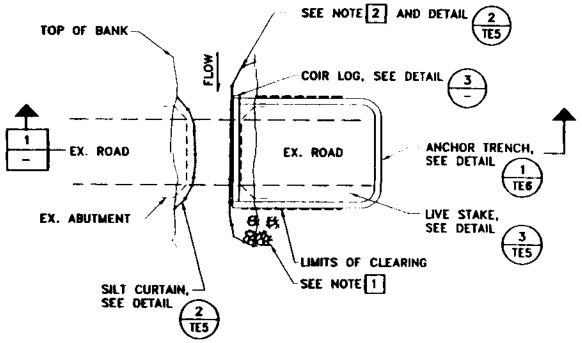
DATE: 11/13/01 FILENAME: 291281C6 XREF'S: IMAGES:



SECTION

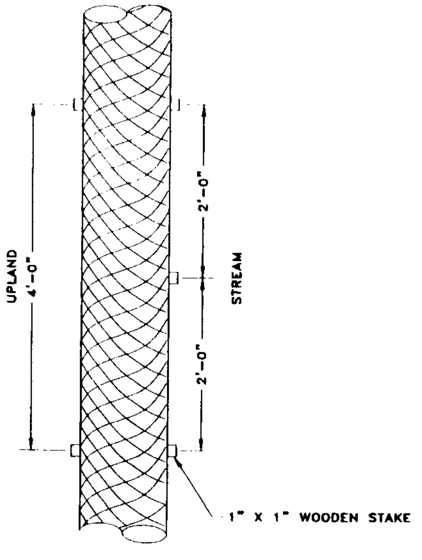
CONSTRUCTION SEQUENCE:

1. REMOVE BRIDGE DECK
2. INSTALL SILT CURTAIN, REMOVE ABUTMENT, AND STABILIZE BANK ON ONE SIDE AT A TIME (UNLESS DIRECTED BY THE ENGINEER)

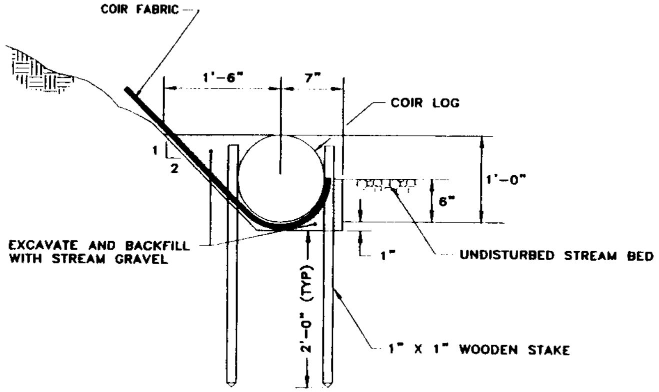


PLAN

DETAIL 1 C3, C4,C6
TYP BRIDGE W/ ABUTMENT REMOVAL DETAIL
SCALE: 1" = 10'

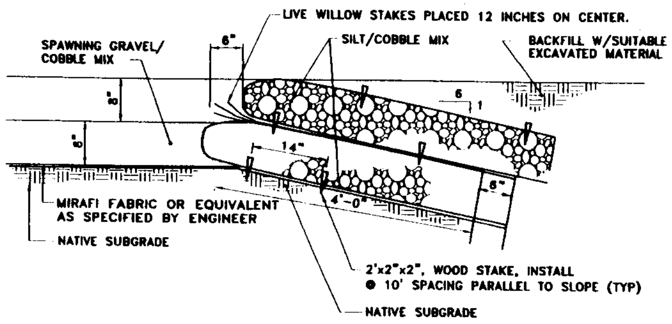


PLAN



SECTION

DETAIL 3 C4, C8
TYPICAL DETAIL
COIR LOG (TYP)
NO SCALE



DETAIL 2 C4, C5, C8
TYPICAL DETAIL
COIR FABRIC LIFTS
NO SCALE

GENERAL NOTES:

1. REMOVE EXISTING RIPRAP AS DETERMINED BY THE ENGINEER.
2. INSTALL SILT CURTAIN UPSTREAM AND DOWNSTREAM OF CONSTRUCTION.
3. REGRADE BANKS TO MATCH EXISTING UPSTREAM AND DOWNSTREAM CROSS SECTIONS.
4. STABILIZE BANKS WITH EROSION CONTROL MATTING, LIVE STAKES, AND SEEDING.

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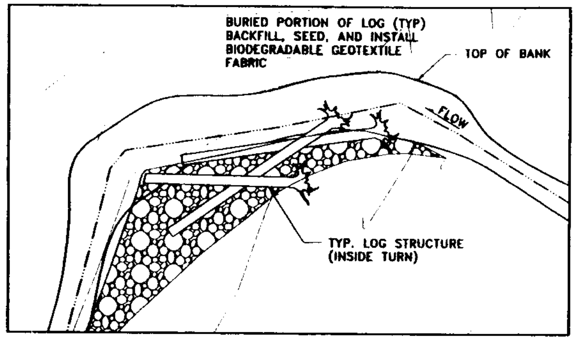
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE: INSTREAM DETAILS

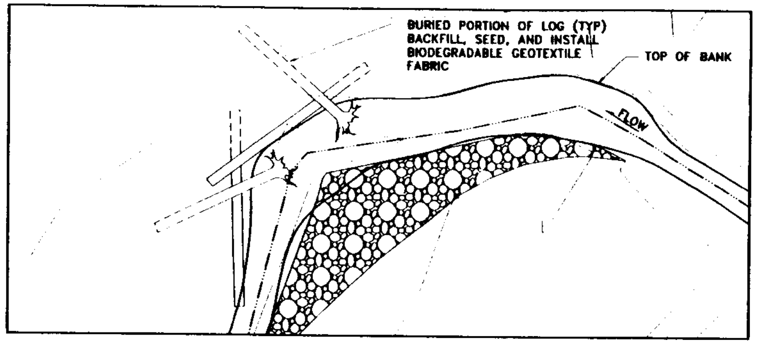
–
291281C7
STIA-9806-C9

APPENDIX B

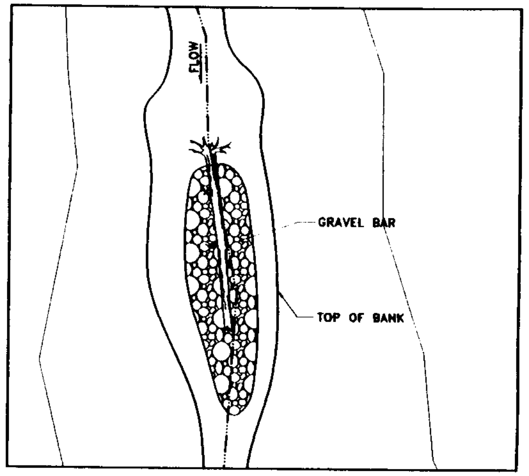
DATE 11/13/01 FILENAME: 291281C7 IMAGES XREF'S



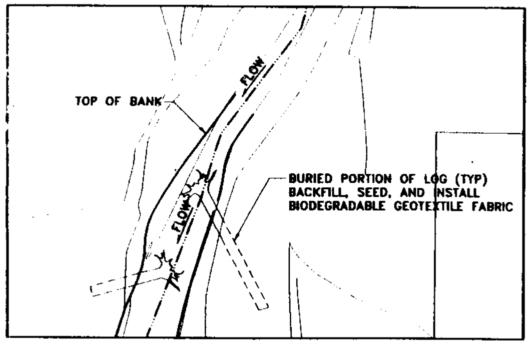
DETAIL ① C7
TYPICAL DETAIL
INSIDE TURN LOG STRUCTURE
SCALE 1"-10'



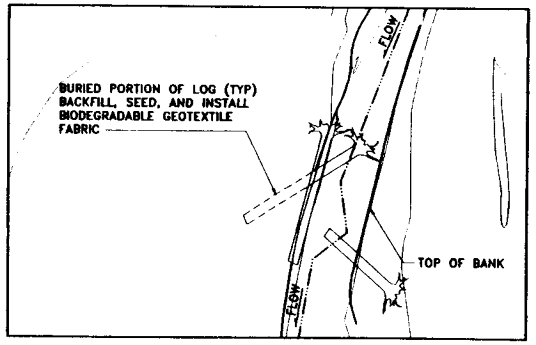
DETAIL ② C7
TYPICAL DETAIL
OUTSIDE TURN LOG STRUCTURE
SCALE 1"-10'



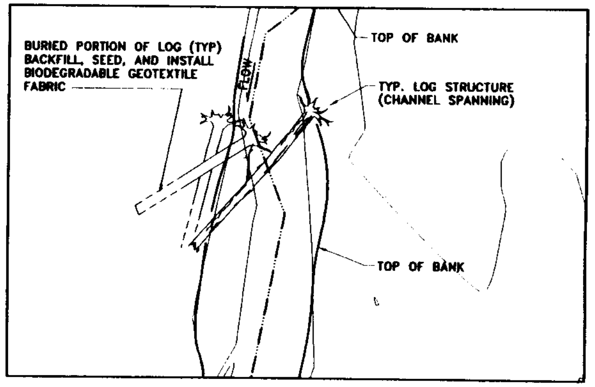
DETAIL ③ C7
TYPICAL DETAIL
BAR LOG STRUCTURE
SCALE 1"-10'



DETAIL ④ C3, C7
TYPICAL DETAIL
TURNING LOG STRUCTURE 1
SCALE 1"-10'



DETAIL ⑤ C7
TYPICAL DETAIL
TURNING LOG STRUCTURE 2
SCALE 1"-10'



DETAIL ⑥ C3, C7
TYPICAL DETAIL
CHANNEL SPANNING LOG STRUCTURE
SCALE 1"-10'

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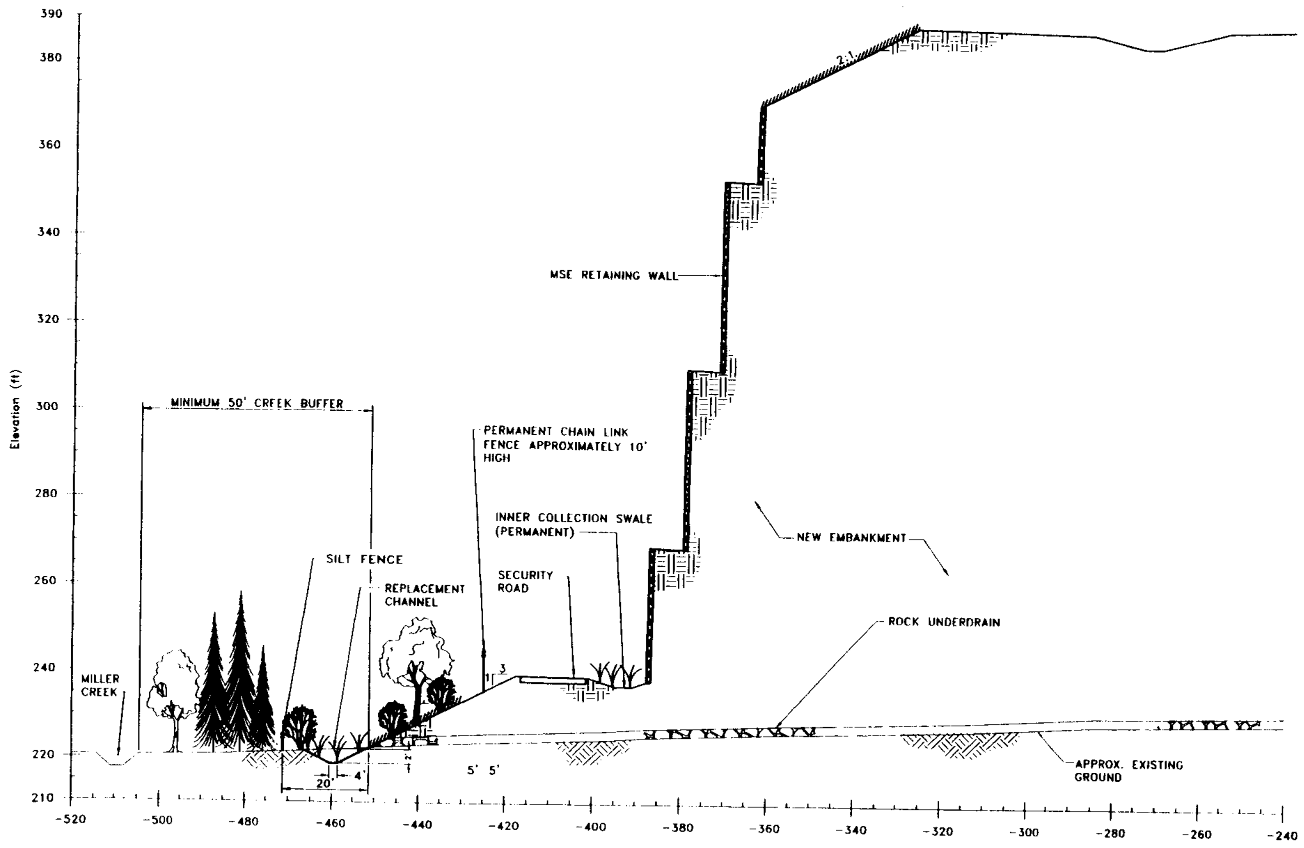
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
LWD DETAILS

–
291281C12
STIA-9806-C10
APPENDIX B

DATE: 11/13/01 FILENAME: 291281C12 XREF'S: BASE 291281SV 291281DE IMAGES:

291201BA2 291281DE 291281SV 291201WL



SECTION

STREAM BUFFER AND EMBANKMENT
NO SCALE

1
C2

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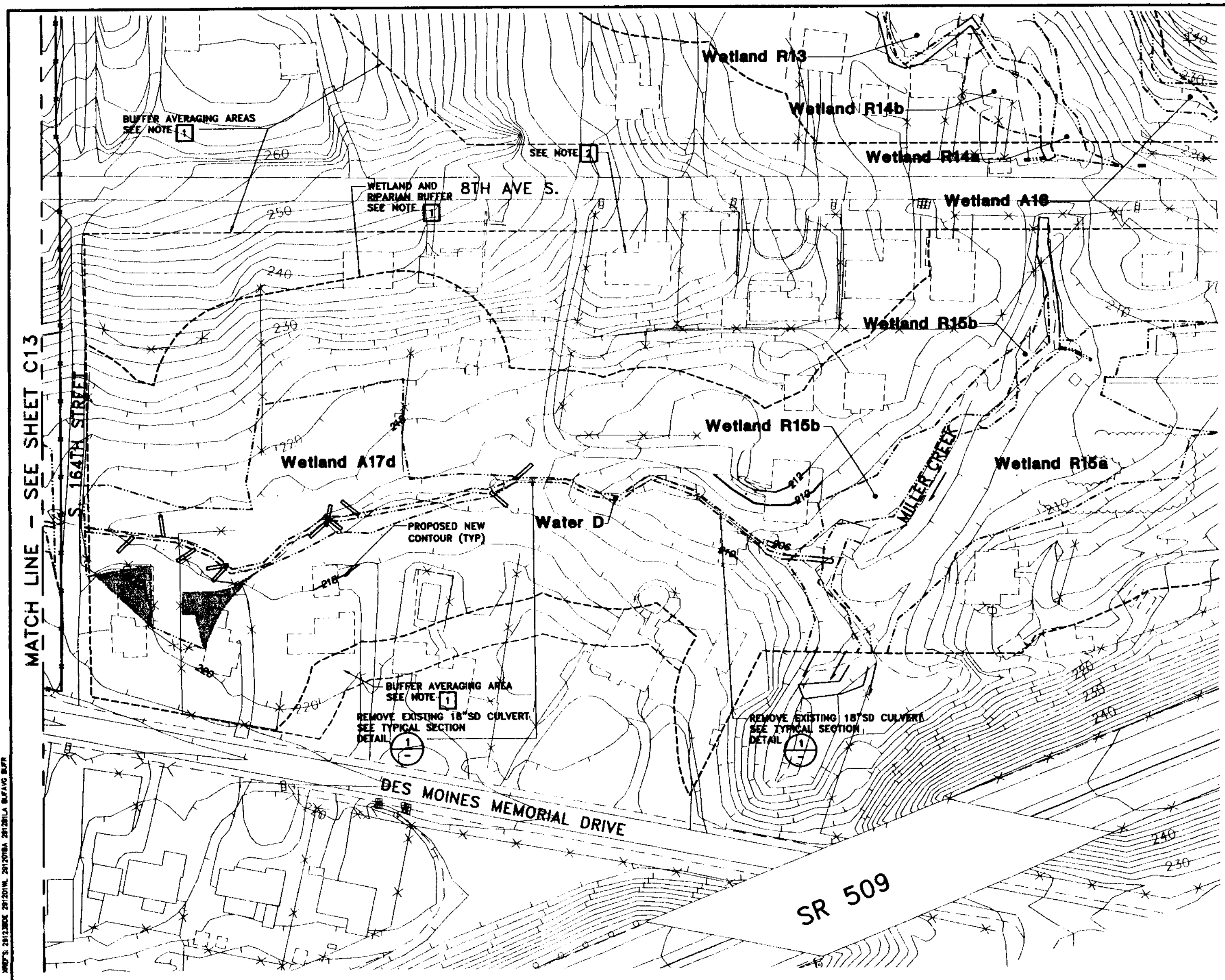
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

STREAM BUFFER AND
EMBANKMENT CROSS-SECTION

—
291281C17
STIA-9806-C11

APPENDIX 9

DATE: 11/13/01 FILENAME: 291281C17 MAGES: XREFS



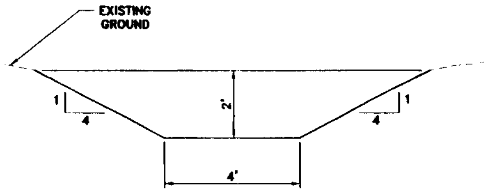
LEGEND

260	EXISTING CONTOUR
280	PROPOSED CONTOUR
>———<	EXISTING CULVERT
— - — - —	WETLAND BOUNDARY
⟋	WOODY DEBRIS (LOGS)
▨	WETLAND RESTORATION

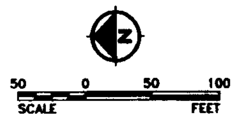
NOTES:

1 REFER TO SHEETS L5.1 AND L5.2 FOR PLANTING PLAN

2 BUILDINGS SHOWN WITH - - - HAVE BEEN OR WILL BE REMOVED BY THE PORT OF SEATTLE



DETAIL (1/–)
TYPICAL CROSS SECTION
FOR CHANNEL AFTER CULVERT
(MATCH EXISTING CULVERT SLOPE)
N.T.S.



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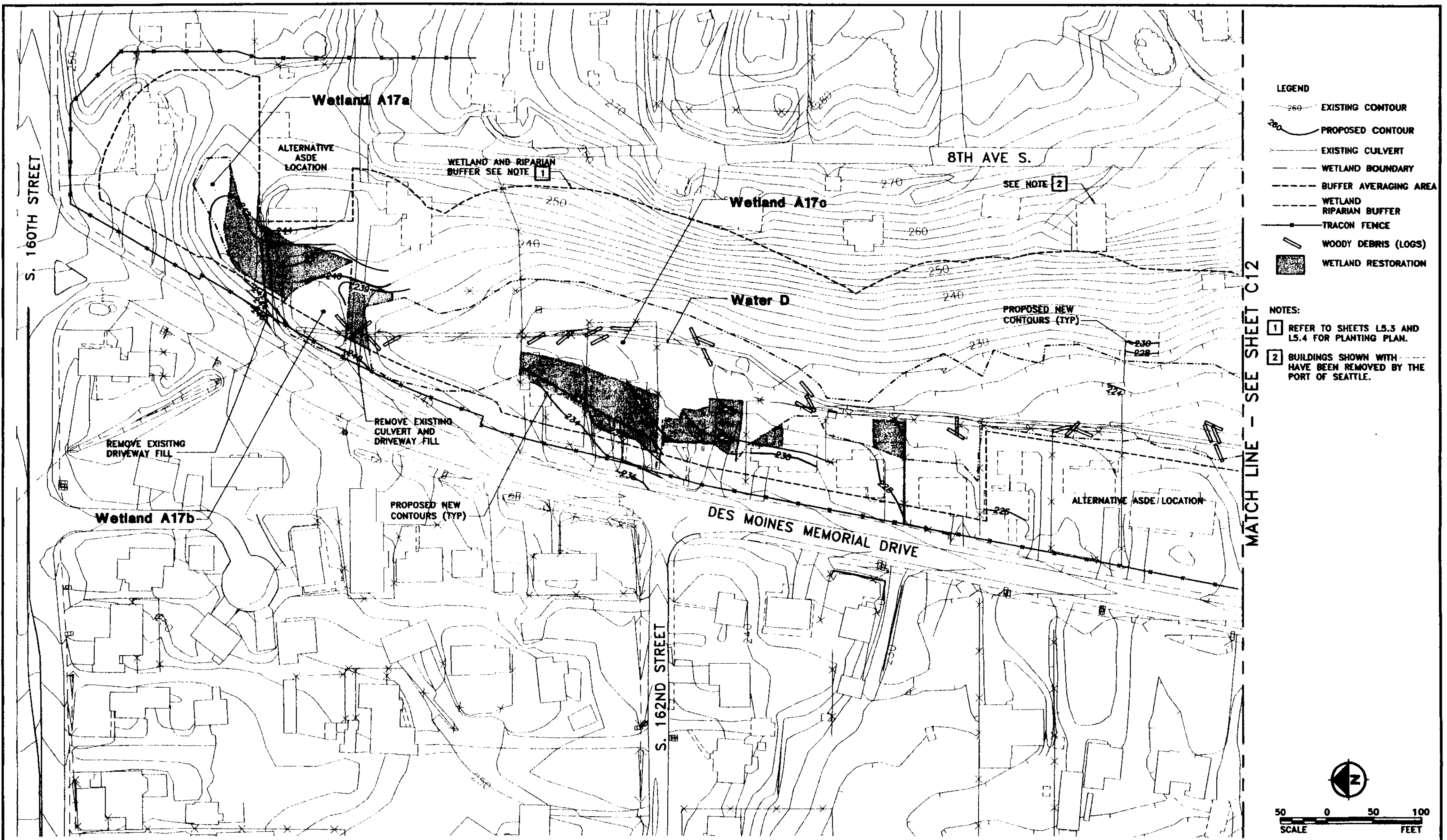
WETLAND A17 MITIGATION
SITE GRADING

291281C-18
STIA-9806-C12

APPENDIX B

DATE: 11/13/01 FILENAME: 291281C-18 IMAGES: XREF'S: 291238DE 291201WL 291201BA 291281LA BUFAVG BUFR



NOTES:

1. REFER TO SHEETS L5.3 AND L5.4 FOR PLANTING PLAN.
2. BUILDINGS SHOWN WITH - - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.

AGENCY REVIEW
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DATE: 11/13/01 FILENAME: 291281C-19 IMAGES: XREF'S:

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SITE GRADING

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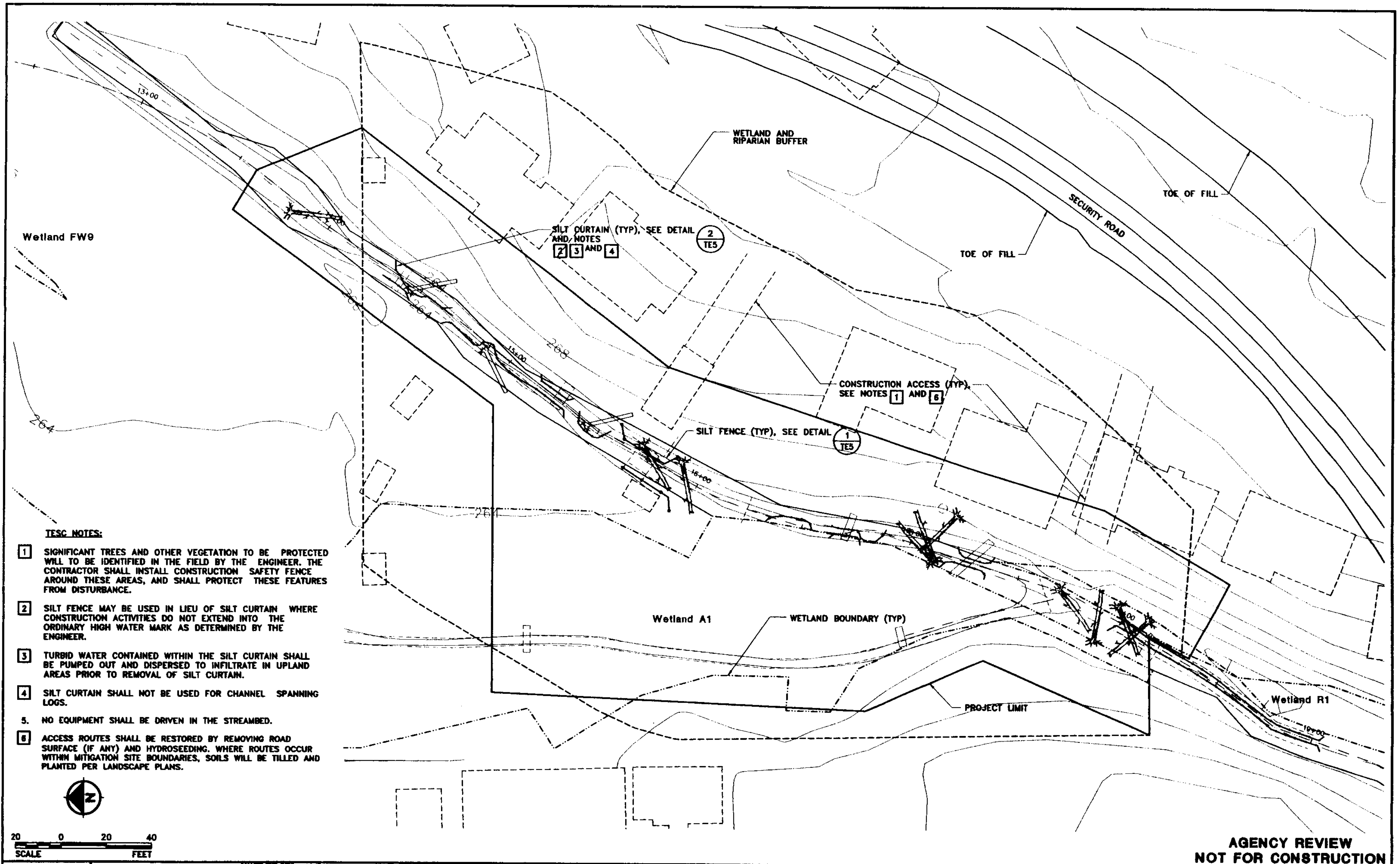
291281C-19
STIA-9806-C13

APPENDIX B



TESC NOTES:

1. SIGNIFICANT TREES AND OTHER VEGETATION TO BE PROTECTED WILL TO BE IDENTIFIED IN THE FIELD BY THE ENGINEER. THE CONTRACTOR SHALL INSTALL CONSTRUCTION SAFETY FENCE AROUND THESE AREAS, AND SHALL PROTECT THESE FEATURES FROM DISTURBANCE.
2. SILT FENCE MAY BE USED IN LIEU OF SILT CURTAIN WHERE CONSTRUCTION ACTIVITIES DO NOT EXTEND INTO THE ORDINARY HIGH WATER MARK AS DETERMINED BY THE ENGINEER.
3. TURBID WATER CONTAINED WITHIN THE SILT CURTAIN SHALL BE PUMPED OUT AND DISPERSED TO INFILTRATE IN UPLAND AREAS PRIOR TO REMOVAL OF SILT CURTAIN.
4. SILT CURTAIN SHALL NOT BE USED FOR CHANNEL SPANNING LOGS.
5. NO EQUIPMENT SHALL BE DRIVEN IN THE STREAMBED.
6. ACCESS ROUTES SHALL BE RESTORED BY REMOVING ROAD SURFACE (IF ANY) AND HYDROSEEDING. WHERE ROUTES OCCUR WITHIN MITIGATION SITE BOUNDARIES, SOILS WILL BE TILLED AND PLANTED PER LANDSCAPE PLANS.

20 0 20 40
SCALE FEET

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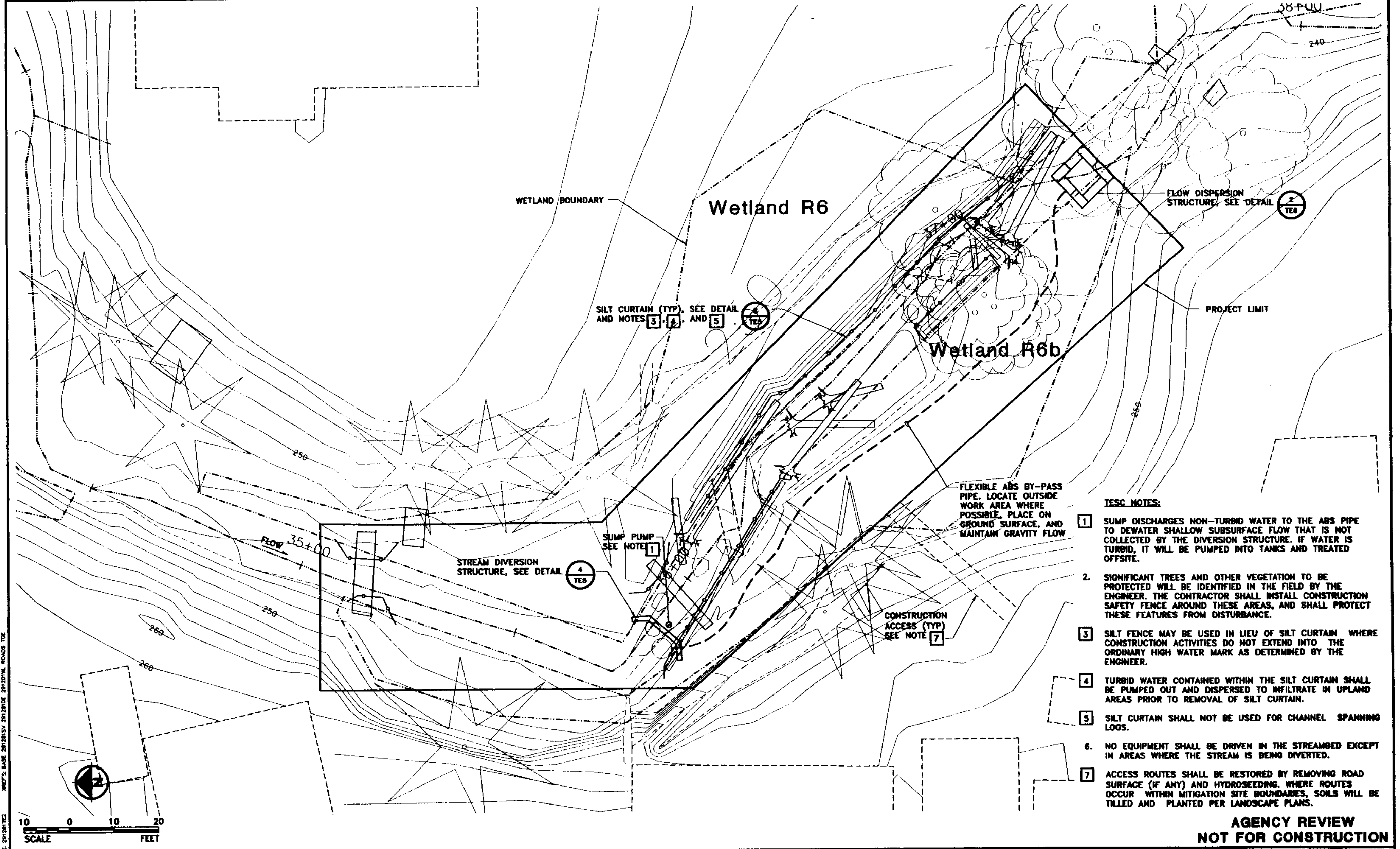
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
TESC PLAN - PROJECT AREA 1

–
291281TE1
STIA-9806-TE1
APPENDIX B

DATE: 11/13/01 FILENAME: 291281TE1
IMAGES:
XREF'S: BASE2 291281DE 291281SV 291201WL TOE ROADS BUFFER

291201BA2 291281DE 291281SV 291201WL



TESC NOTES:

1. SUMP DISCHARGES NON-TURBID WATER TO THE ABS PIPE TO DEWATER SHALLOW SUBSURFACE FLOW THAT IS NOT COLLECTED BY THE DIVERSION STRUCTURE. IF WATER IS TURBID, IT WILL BE PUMPED INTO TANKS AND TREATED OFFSITE.
2. SIGNIFICANT TREES AND OTHER VEGETATION TO BE PROTECTED WILL BE IDENTIFIED IN THE FIELD BY THE ENGINEER. THE CONTRACTOR SHALL INSTALL CONSTRUCTION SAFETY FENCE AROUND THESE AREAS, AND SHALL PROTECT THESE FEATURES FROM DISTURBANCE.
3. SILT FENCE MAY BE USED IN LIEU OF SILT CURTAIN WHERE CONSTRUCTION ACTIVITIES DO NOT EXTEND INTO THE ORDINARY HIGH WATER MARK AS DETERMINED BY THE ENGINEER.
4. TURBID WATER CONTAINED WITHIN THE SILT CURTAIN SHALL BE PUMPED OUT AND DISPERSED TO INFILTRATE IN UPLAND AREAS PRIOR TO REMOVAL OF SILT CURTAIN.
5. SILT CURTAIN SHALL NOT BE USED FOR CHANNEL SPANNING LOGS.
6. NO EQUIPMENT SHALL BE DRIVEN IN THE STREAMBED EXCEPT IN AREAS WHERE THE STREAM IS BEING DIVERTED.
7. ACCESS ROUTES SHALL BE RESTORED BY REMOVING ROAD SURFACE (IF ANY) AND HYDROSEEDING. WHERE ROUTES OCCUR WITHIN MITIGATION SITE BOUNDARIES, SOILS WILL BE TILLED AND PLANTED PER LANDSCAPE PLANS.

AGENCY REVIEW
NOT FOR CONSTRUCTION

DATE: 11/13/01 FILENAME: 291281TE2
IMAGES:
XREF'S: BASE 291281SV 291281DE 291201WL ROADS TOE

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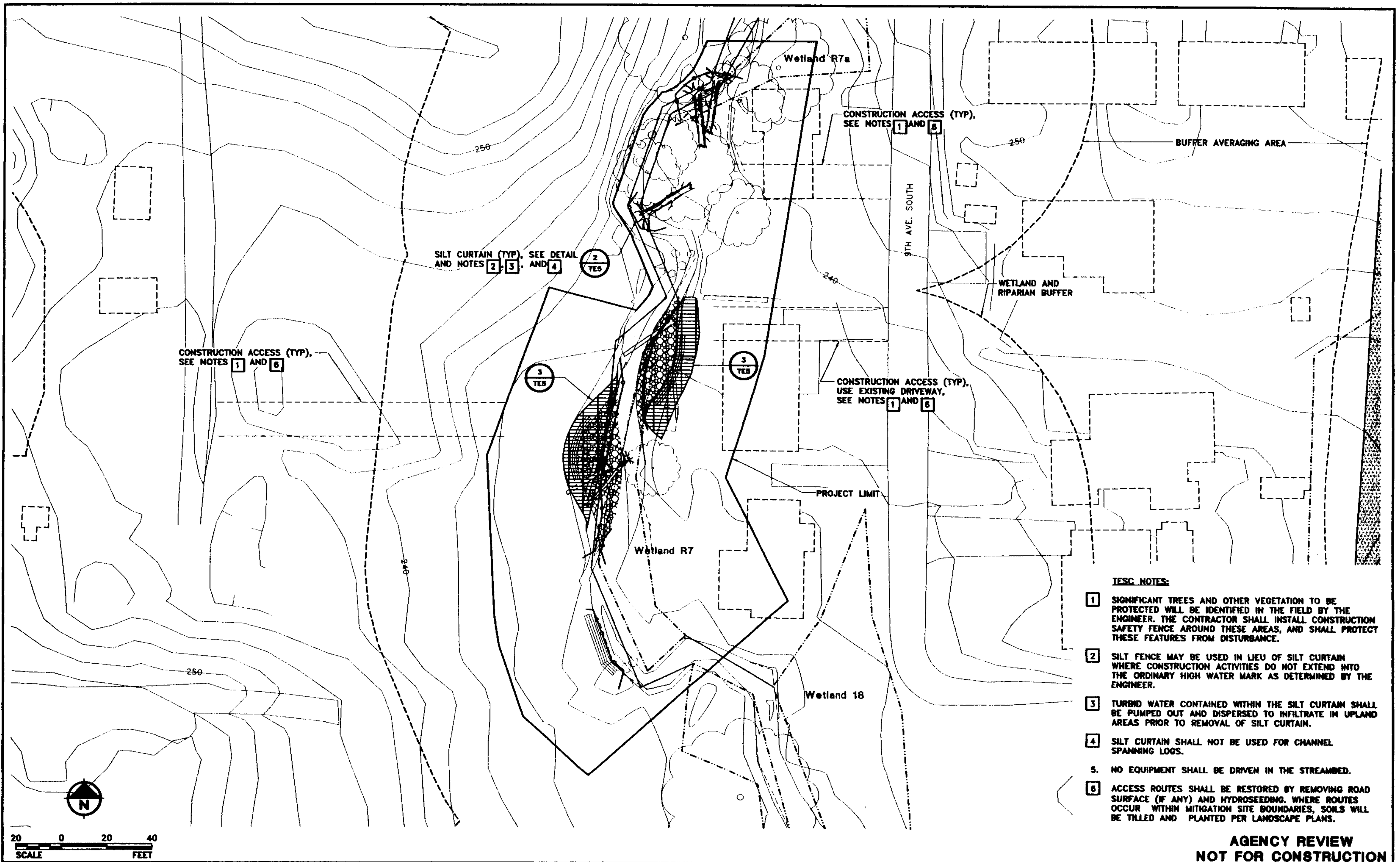
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

TESC PLAN - PROJECT AREA 2

-
291281TE2
STIA-9806-TE2
APPENDIX B

291201BA2 291281DE 291281SV 291201WL



TESC NOTES:

1. SIGNIFICANT TREES AND OTHER VEGETATION TO BE PROTECTED WILL BE IDENTIFIED IN THE FIELD BY THE ENGINEER. THE CONTRACTOR SHALL INSTALL CONSTRUCTION SAFETY FENCE AROUND THESE AREAS, AND SHALL PROTECT THESE FEATURES FROM DISTURBANCE.
2. SILT FENCE MAY BE USED IN LIEU OF SILT CURTAIN WHERE CONSTRUCTION ACTIVITIES DO NOT EXTEND INTO THE ORDINARY HIGH WATER MARK AS DETERMINED BY THE ENGINEER.
3. TURBID WATER CONTAINED WITHIN THE SILT CURTAIN SHALL BE PUMPED OUT AND DISPERSED TO INFILTRATE IN UPLAND AREAS PRIOR TO REMOVAL OF SILT CURTAIN.
4. SILT CURTAIN SHALL NOT BE USED FOR CHANNEL SPANNING LOGS.
5. NO EQUIPMENT SHALL BE DRIVEN IN THE STREAMBED.
6. ACCESS ROUTES SHALL BE RESTORED BY REMOVING ROAD SURFACE (IF ANY) AND HYDROSEEDING. WHERE ROUTES OCCUR WITHIN MITIGATION SITE BOUNDARIES, SOILS WILL BE TILLED AND PLANTED PER LANDSCAPE PLANS.

AGENCY REVIEW
NOT FOR CONSTRUCTION

DATE: 11/13/01 FILENAME: 291281TE3
IMAGES:
XREF'S: BASE 291201WL 291281DE 291281SV TOE ROADS BUFFER

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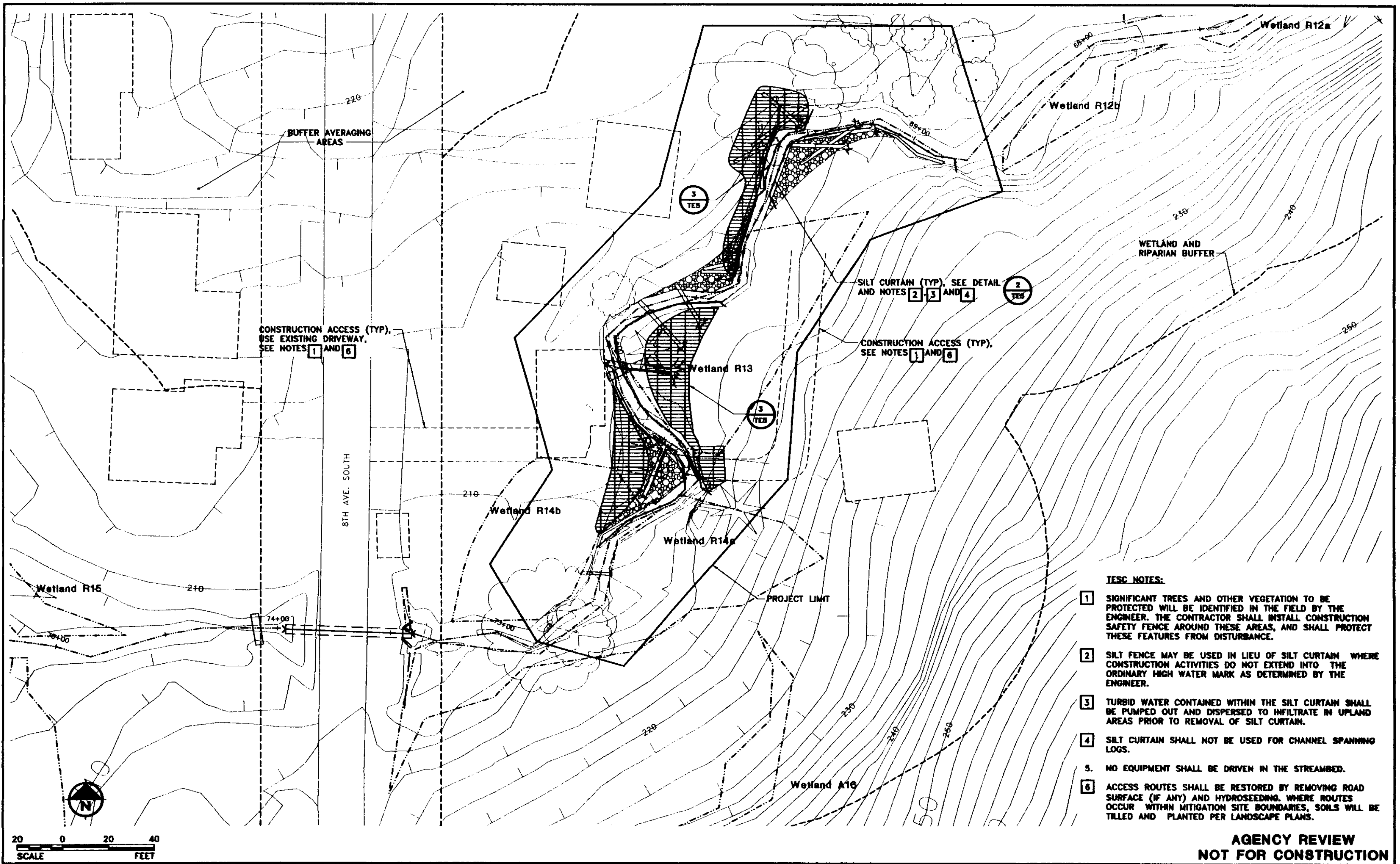
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
TESC PLAN - PROJECT AREA 3

–
291281TE3
STIA-9806-TE3

291201BA2 291281DE 291281SV 291201WL

APPENDIX B



BUFFER AVERAGING AREAS

CONSTRUCTION ACCESS (TYP), USE EXISTING DRIVEWAY, SEE NOTES 1 AND 6

SILT CURTAIN (TYP), SEE DETAIL AND NOTES 2, 3 AND 4

CONSTRUCTION ACCESS (TYP), SEE NOTES 1 AND 6

WETLAND AND RIPARIAN BUFFER

PROJECT LIMIT

TESC NOTES:

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5. NO EQUIPMENT SHALL BE DRIVEN IN THE STREAMBED.
6. ACCESS ROUTES SHALL BE RESTORED BY REMOVING ROAD SURFACE (IF ANY) AND HYDROSEEDING. WHERE ROUTES OCCUR WITHIN MITIGATION SITE BOUNDARIES, SOILS WILL BE TILLED AND PLANTED PER LANDSCAPE PLANS.

AGENCY REVIEW
NOT FOR CONSTRUCTION

DATE: 11/13/01 FILENAME: 291281TE4 IMAGES: XREF'S: BASE 291281SV 291201WL 291281DE ROADS TOE BUFFER

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REVISIONS

NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

Port of Seattle
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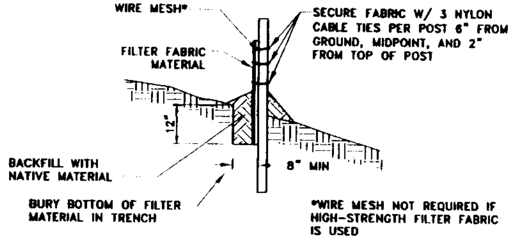
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

TESC PLAN - PROJECT AREA 4

-
291281TE4
STIA-9806-TE4

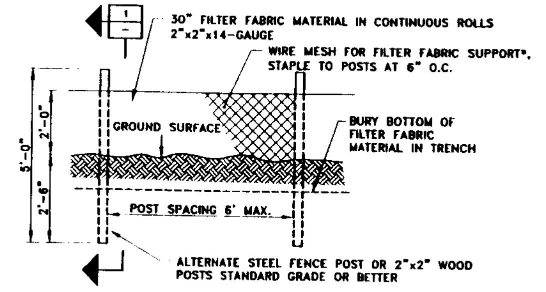
291201BA2 291281DE 291281SV 291201WL

APPENDIX B



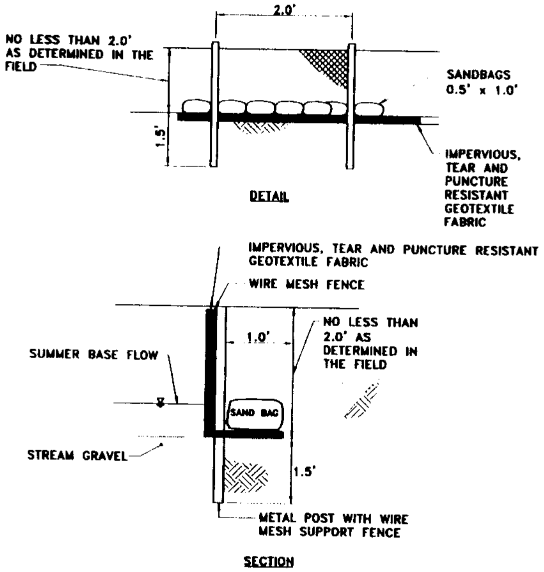
SECTION
SILT FENCE
NO SCALE

1
–



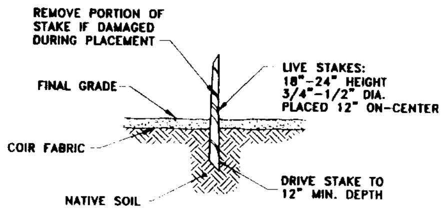
DETAIL
SILT FENCE
NO SCALE

1
TE1



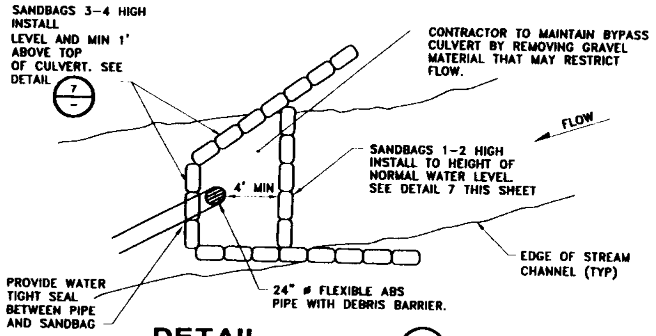
DETAIL
TYPICAL DETAIL
SILT CURTAIN INSTALLATION
NO SCALE

2
C9, TE1,TE2,TE3,TE4



DETAIL
TYPICAL DETAIL
LIVE STAKE
NO SCALE

3
C8, C9,TE3,TE4



DETAIL
STREAM DIVERSION STRUCTURE
NO SCALE

4
TE2

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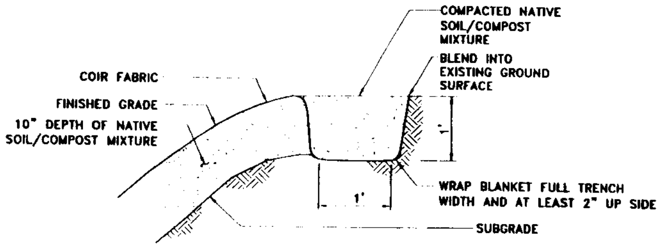
SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

TESC DETAILS

–
291281TE5
STIA-9806-TE5
APPENDIX B

DATE: 11/13/01 FILENAME: 291281TE5 IMAGES: XREFS:

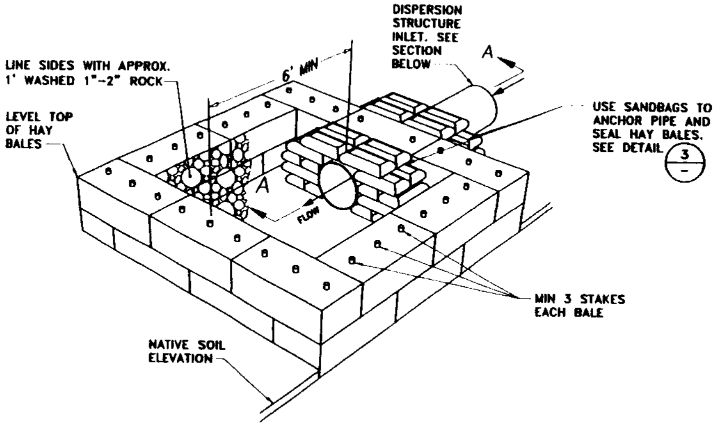
291201BA2 291281DE 291281SV 291201WL



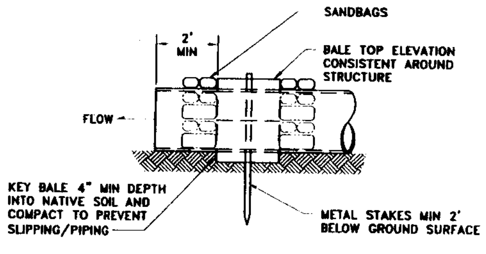
DETAIL

TYPICAL DETAIL
ANCHOR TRENCH
NO SCALE

①
C8, C9



PLAN

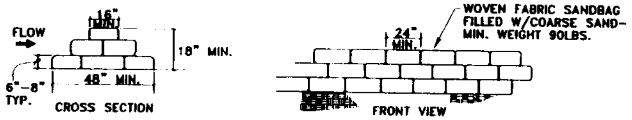


SECTION A

DETAIL

FLOW DISPERSION STRUCTURE
NO SCALE

②
TE2



NOTES:

1. WHEN SANDBAG IS FILLED WITH COARSE GRADE SAND MATERIAL, THE OPEN END SHOULD BE STAPLED OR TIED WITH NYLON OR POLY CORD. THE WEIGHT SHALL BE 90 - 125 LBS.
2. SANDBAGS SHOULD BE STACKED IN AT LEAST THREE VERTICAL ROWS ABUTTING EACH OTHER, AND IN STAGGERED ARRANGEMENT. (REFER TO FRONT VIEW).
3. THE BASE OF THE BERM SHOULD BE AT LEAST 3 SANDBAGS DEEP AND CAN BE REDUCED TO 2 AND 1 BAG IN THE SECOND AND THIRD ROWS RESPECTIVELY. (REFER TO CROSS SECTION).

DETAIL

SANDBAG BERM
NO SCALE

③
–

AGENCY REVIEW
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DATE: 11/13/01 FILENAME: 291281TE6 IMAGES XREFS

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TESC DETAILS

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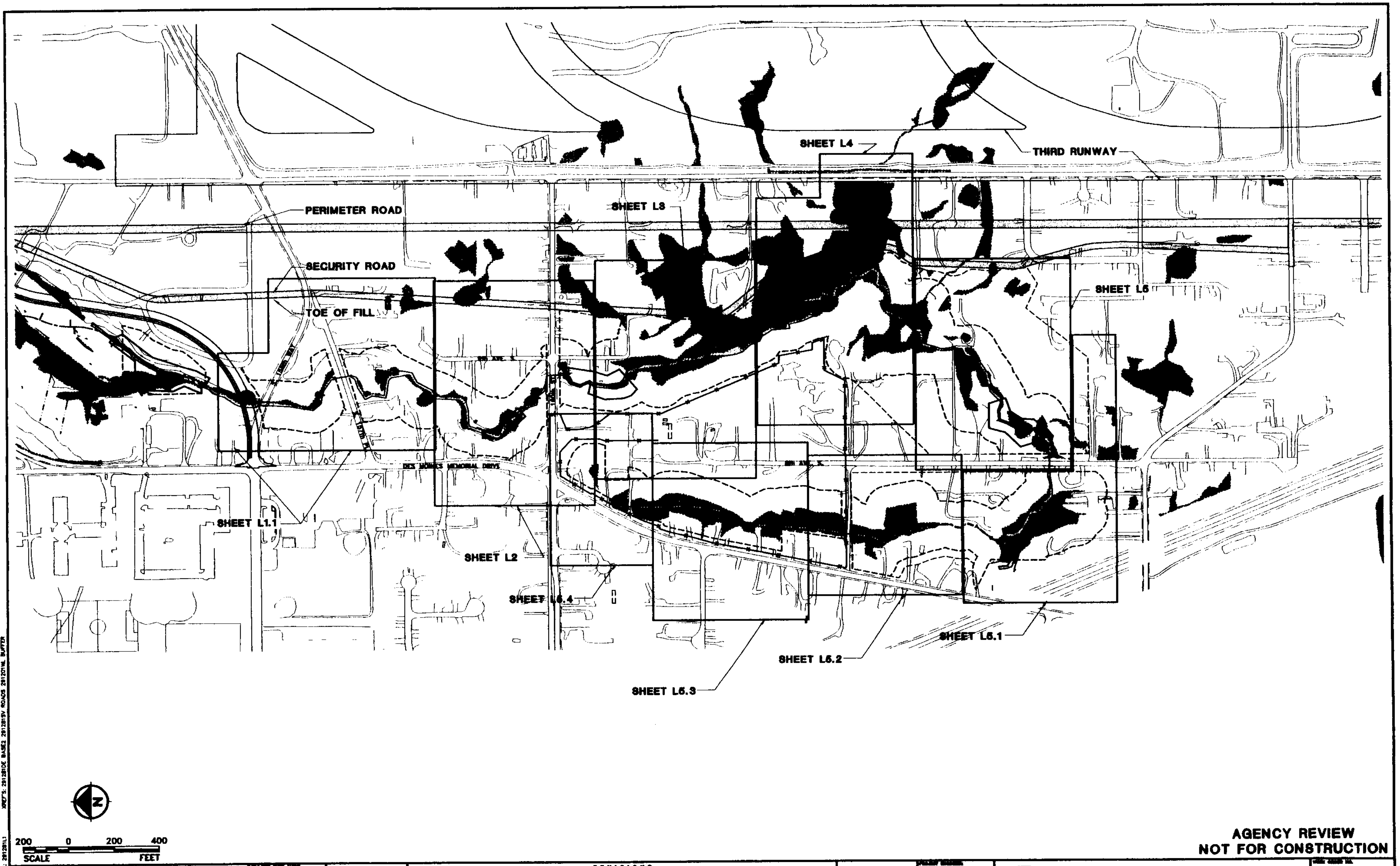
291281TE6
STIA-9806-TE6
APPENDIX B

291201BA2 291281DE 291281SV 291201WL



AGENCY REVIEW
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DATE: 11/13/01 FILENAME: 291281L1 XREF'S: 291281DE BASE2 291281SV ROADS 291201WL BUFFER IMAGES:

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SEA-TAC INTERNATIONAL AIRPORT

MILLER CREEK INSTREAM BUFFER ENHANCEMENT

LANDSCAPE INDEX

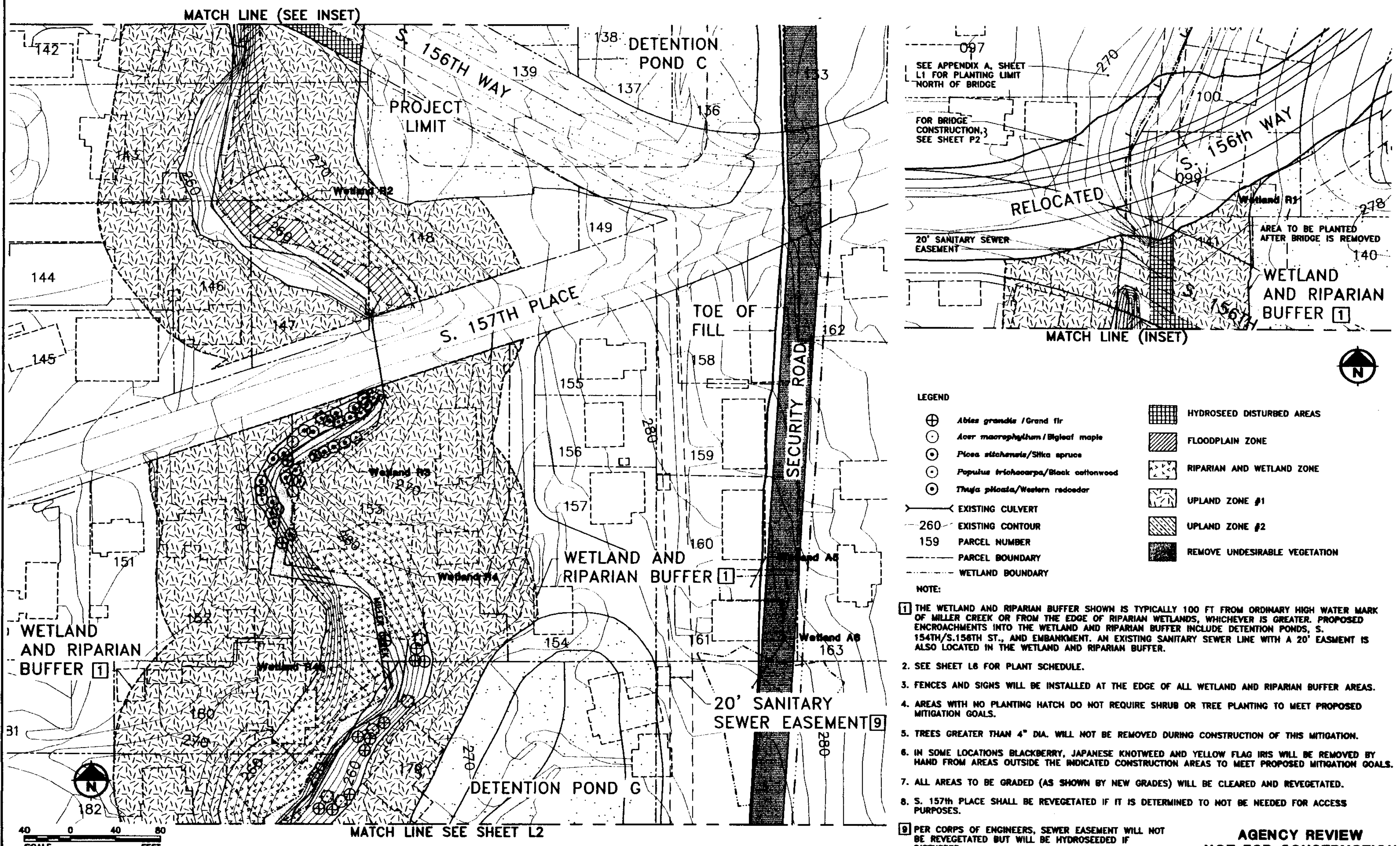
—

291281L1

STIA-9806-L1

APPENDIX 9

291201BA2 291281DE 291281SV 291201WL



LEGEND

- ⊕ *Abies grandis* /Grand fir
- ⊙ *Acer macrophyllum* / Bigleaf maple
- ⊙ *Picea sitchensis*/Sitka spruce
- ⊙ *Populus trichocarpa*/Black cottonwood
- ⊙ *Thuja plicata*/Western redcedar
- >——< EXISTING CULVERT
- 260 EXISTING CONTOUR
- 159 PARCEL NUMBER
- ——-—— PARCEL BOUNDARY
- —··—·· WETLAND BOUNDARY
- ▦ HYDROSEED DISTURBED AREAS
- ▨ FLOODPLAIN ZONE
- ▩ RIPARIAN AND WETLAND ZONE
- ▧ UPLAND ZONE #1
- ▨ UPLAND ZONE #2
- ■ REMOVE UNDESIRABLE VEGETATION

NOTE:

1 THE WETLAND AND RIPARIAN BUFFER SHOWN IS TYPICALLY 100 FT FROM ORDINARY HIGH WATER MARK OF MILLER CREEK OR FROM THE EDGE OF RIPARIAN WETLANDS, WHICHEVER IS GREATER. PROPOSED ENCROACHMENTS INTO THE WETLAND AND RIPARIAN BUFFER INCLUDE DETENTION PONDS, S. 154TH/S.156TH ST., AND EMBANKMENT. AN EXISTING SANITARY SEWER LINE WITH A 20' EASMENT IS ALSO LOCATED IN THE WETLAND AND RIPARIAN BUFFER.

2. SEE SHEET L6 FOR PLANT SCHEDULE.

3. FENCES AND SIGNS WILL BE INSTALLED AT THE EDGE OF ALL WETLAND AND RIPARIAN BUFFER AREAS.

4. AREAS WITH NO PLANTING HATCH DO NOT REQUIRE SHRUB OR TREE PLANTING TO MEET PROPOSED MITIGATION GOALS.

5. TREES GREATER THAN 4" DIA. WILL NOT BE REMOVED DURING CONSTRUCTION OF THIS MITIGATION.

6. IN SOME LOCATIONS BLACKBERRY, JAPANESE KNOTWEED AND YELLOW FLAG IRIS WILL BE REMOVED BY HAND FROM AREAS OUTSIDE THE INDICATED CONSTRUCTION AREAS TO MEET PROPOSED MITIGATION GOALS.

7. ALL AREAS TO BE GRADED (AS SHOWN BY NEW GRADES) WILL BE CLEARED AND REVEGETATED.

8. S. 157th PLACE SHALL BE REVEGETATED IF IT IS DETERMINED TO NOT BE NEEDED FOR ACCESS PURPOSES.

9 PER CORPS OF ENGINEERS, SEWER EASEMENT WILL NOT BE REVEGETATED BUT WILL BE HYDROSEEDED IF DISTURBED.

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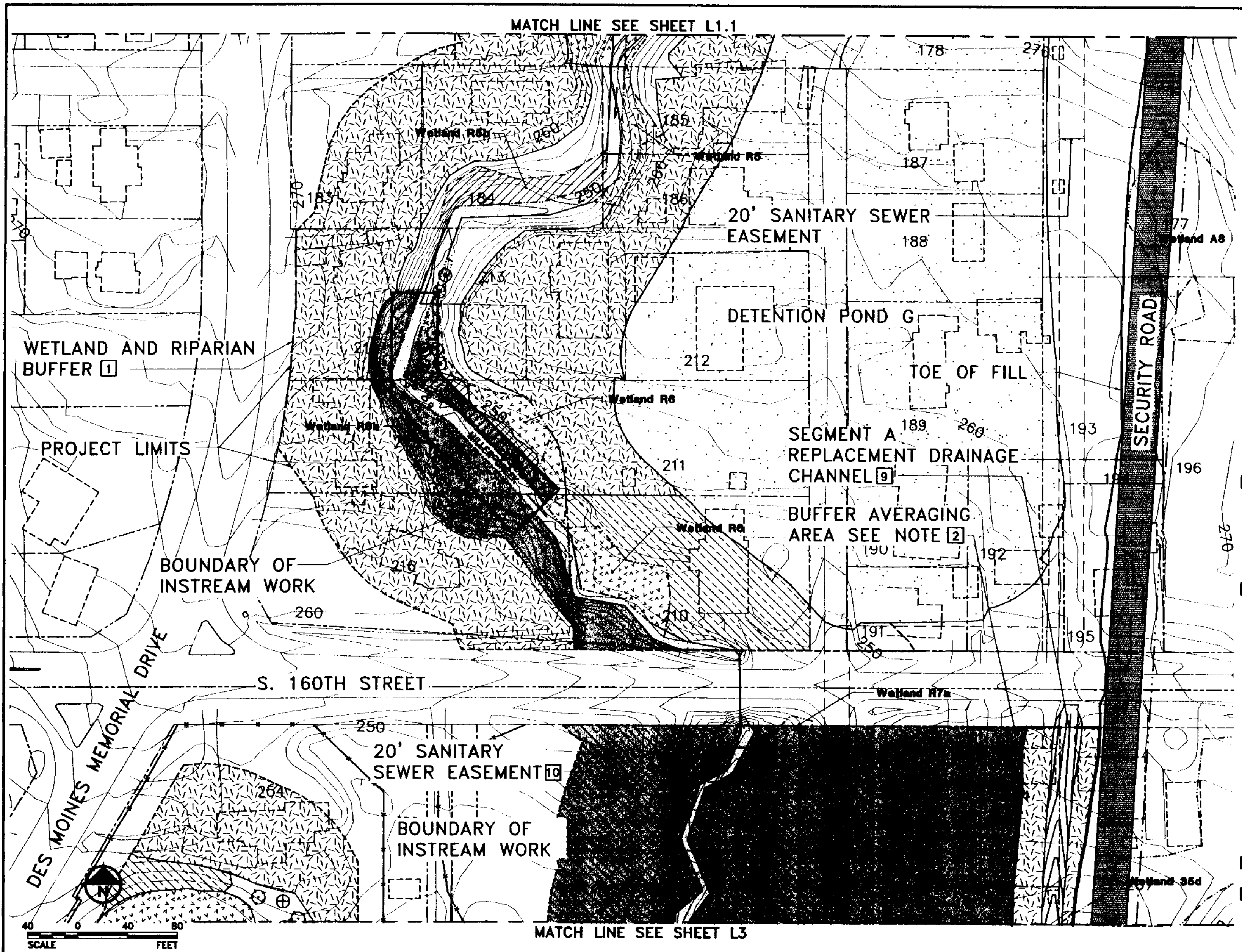
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
LANDSCAPE PLAN

—
291281L1_1
STIA-9806-L1.1
APPENDIX B



LEGEND

- ⊕ *Abies grandis*/Grand fir
- ⊙ *Acer macrophyllum*/Bigleaf maple
- ⚙ *Picea sitchensis*/Sitka spruce
- ○ *Populus trichocarpa*/Black cottonwood
- ◉ *Thuja plicata*/Western redcedar
- EXISTING CULVERT
- PARCEL BOUNDARY
- WETLAND BOUNDARY
- 260 EXISTING CONTOUR
- 159 PARCEL NUMBER
- ▦ HYDROSEED DISTURBED AREAS
- ▨ FLOODPLAIN ZONE
- ▧ RIPARIAN AND WETLAND ZONE
- ▧ UPLAND ZONE #1
- ▨ UPLAND ZONE #2
- ■ REMOVE UNDESIRABLE VEGETATION

NOTE:

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2. APPROXIMATELY 9 ACRES OF BUFFER AVERAGING AREA IS ADDED TO THE WETLAND AND RIPARIAN BUFFER TO COMPENSATE FOR ENCROACHMENTS AND THE EXISTING SANITARY SEWER EASEMENT. ALL BUFFER AREAS ARE PLACED IN RESTRICTIVE COVENANTS.
3. SEE SHEET L6 FOR PLANT SCHEDULE.
4. FENCES AND SIGNS WILL BE INSTALLED AT THE EDGE OF ALL WETLAND AND RIPARIAN BUFFER AREAS.
5. TREES GREATER THAN 4" DIA. WILL NOT BE REMOVED DURING CONSTRUCTION OF THIS MITIGATION.
6. IN SOME LOCATIONS BLACKBERRY, JAPANESE KNOTWEED AND YELLOW FLAG IRIS WILL BE REMOVED BY HAND FROM AREAS OUTSIDE THE INDICATED CONSTRUCTION AREAS TO MEET PROPOSED MITIGATION GOALS.
7. ALL AREAS TO BE GRADED (AS SHOWN BY NEW GRADES) WILL BE CLEARED AND REVEGETATED.
8. S. 160th STREET SHALL BE REVEGETATED IF IT IS DETERMINED TO NOT BE NEEDED FOR ACCESS PURPOSES.
9. THIS AREA WILL BE CLEAR OF VEGETATION DUE TO EMBANKMENT CONSTRUCTION.
10. PER CORPS OF ENGINEERS, SEWER EASEMENT WILL NOT BE REVEGETATED BUT WILL BE HYDROSEEDED IF DISTURBED.

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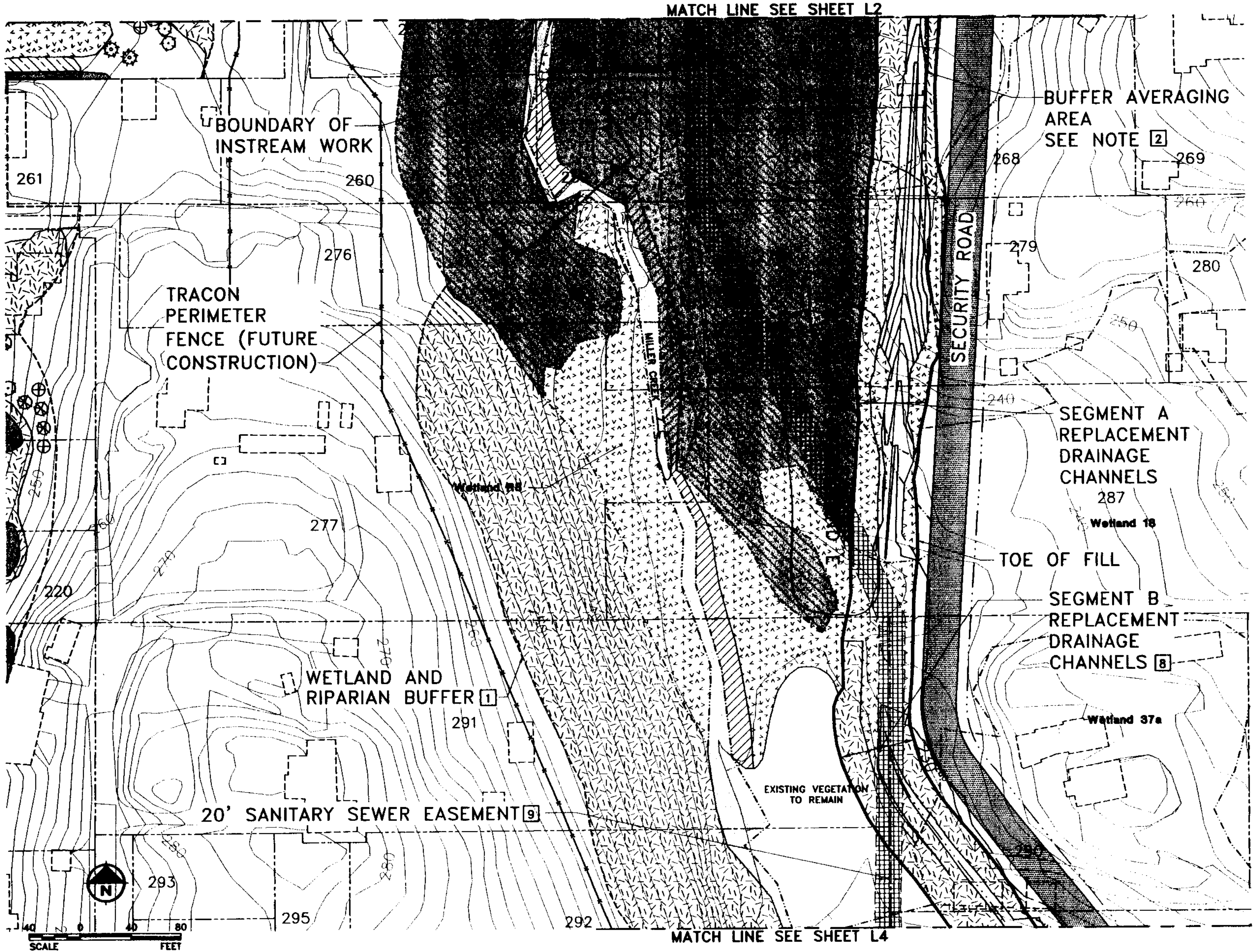
SHEET TITLE: LANDSCAPE PLAN

-
281281L2
STIA-9806-L2
APPENDIX B

DATE: 11/13/01 FILENAME: 281281L2

MATCH LINE SEE SHEET L2



MATCH LINE SEE SHEET L4

LEGEND

⊕	*Abies grandis* / Grand fir
⊙	*Acer macrophyllum* / Bigleaf maple
⚙	*Picea sitchensis*/Sitka spruce
⊙	*Populus trichocarpa*/Black cottonwood
⊙	*Thuja plicata*/Western redcedar
260	EXISTING CONTOUR
159	PARCEL NUMBER
▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
▤	RIPARIAN AND WETLAND ZONE
▤	UPLAND ZONE #1
▧	UPLAND ZONE #2
▩	REMOVE UNDESIRABLE VEGETATION
—··—··—	WETLAND BOUNDARY

NOTES:

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3. SEE SHEET L6 FOR PLANT SCHEDULE.
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9. PER CORPS OF ENGINEERS, SEWER EASEMENT WILL NOT BE REVEGETATED, BUT WILL BE HYDROSEEDED IF DISTURBED.

AGENCY REVIEW
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MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT

LANDSCAPE PLAN

291281L3

STIA-9806-L3

APPENDIX B

NOTES:

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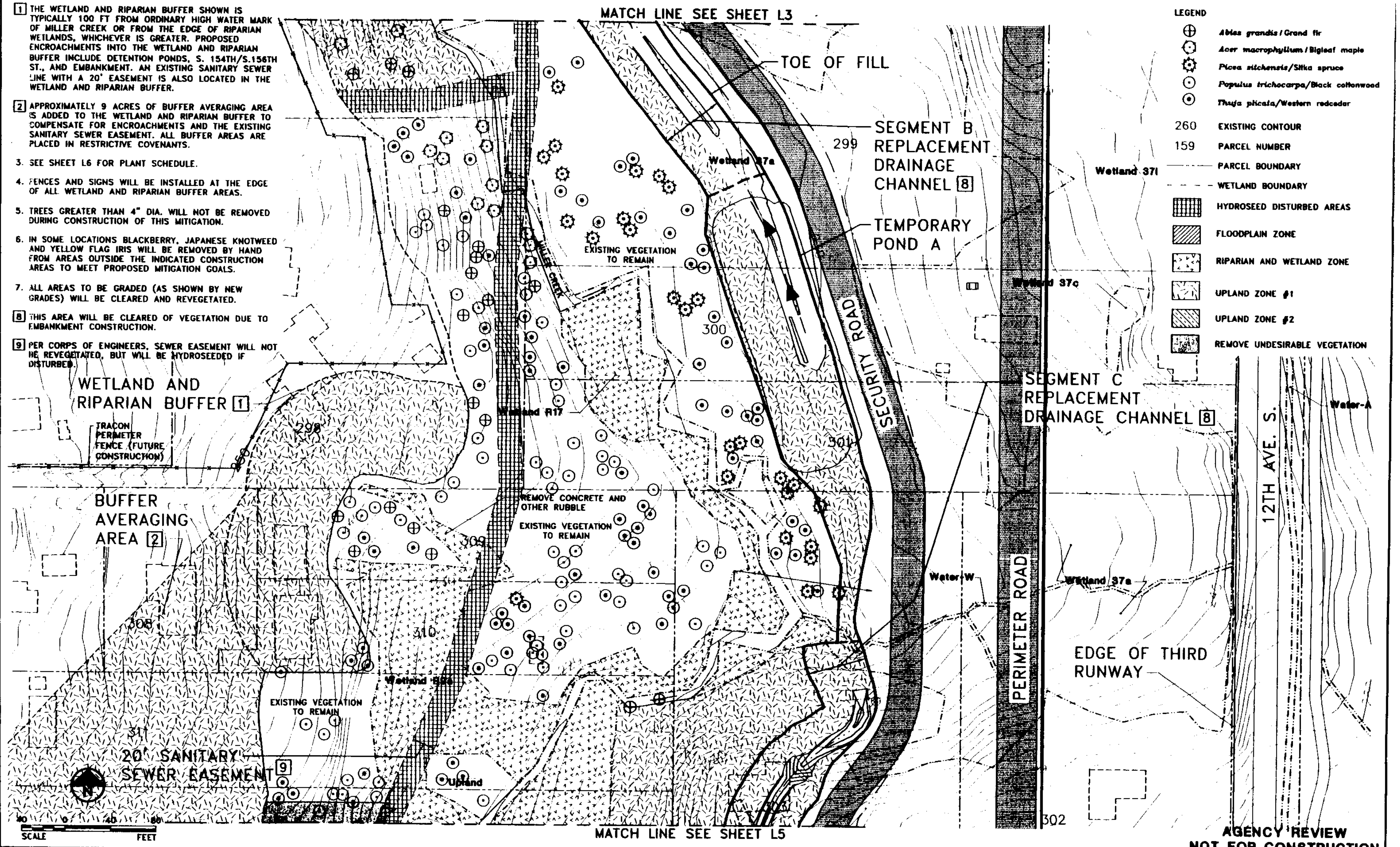

LEGEND

⊕	*Abies grandis / Grand fir*
⊙	*Acer macrophyllum / Bigleaf maple*
✲	*Picea sitchensis/Sitka spruce*
⊙	*Populus trichocarpa/Black cottonwood*
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260	EXISTING CONTOUR
159	PARCEL NUMBER
— - - —	PARCEL BOUNDARY
- - - -	WETLAND BOUNDARY
▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
▒	RIPARIAN AND WETLAND ZONE
▒	UPLAND ZONE #1
▧	UPLAND ZONE #2
▓	REMOVE UNDESIRABLE VEGETATION

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SHEET TITLE: LANDSCAPE PLAN

-
291281L4
STIA-9806-L4
APPENDIX B

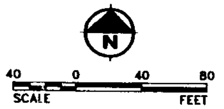
DATE: 11/13/01 FILENAME: 291281l4

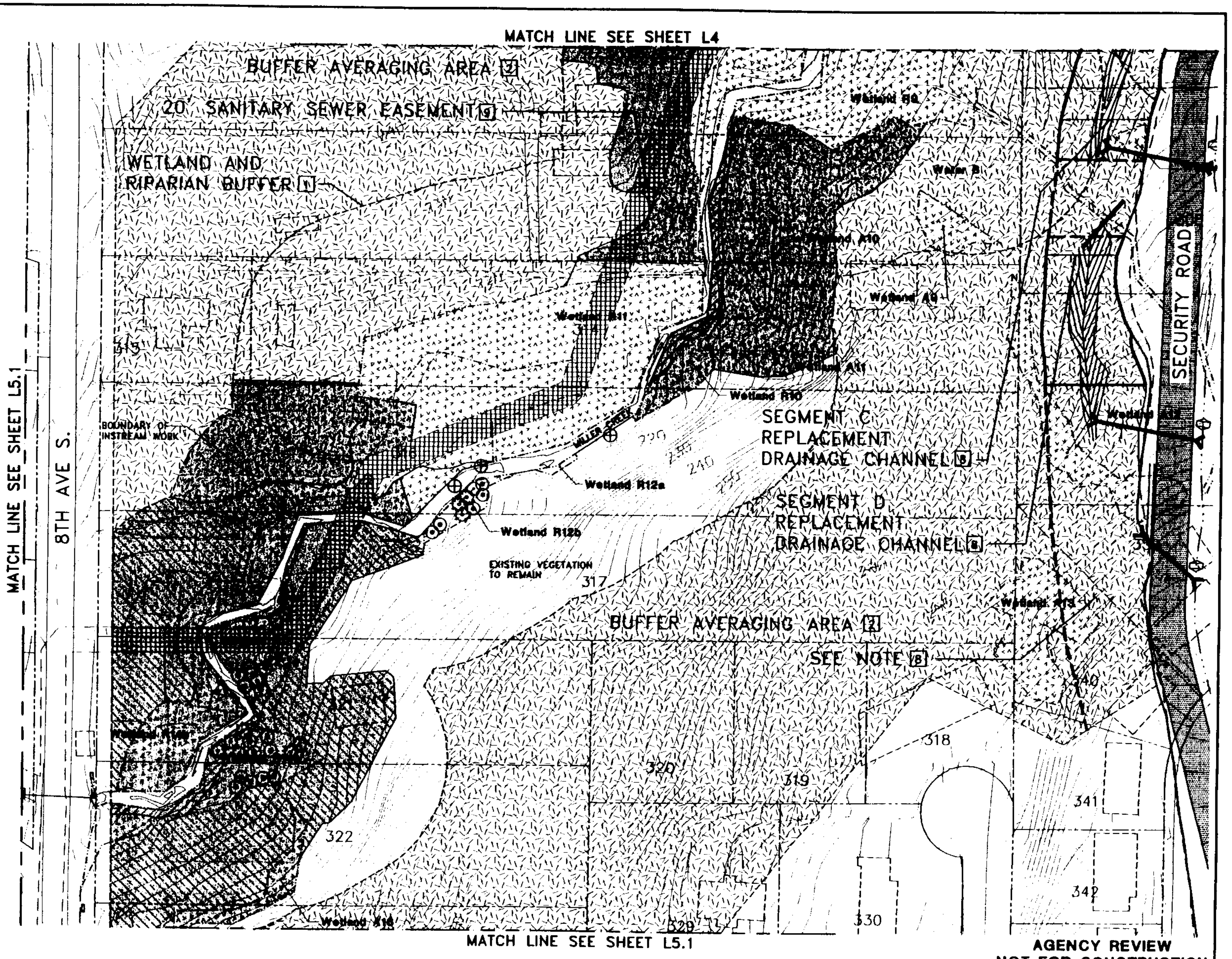
HOTES:

1. THE WETLAND AND RIPARIAN BUFFER SHOWN IS TYPICALLY 100 FT FROM ORDINARY HIGH WATER MARK OF MILLER CREEK OR FROM THE EDGE OF RIPARIAN WETLANDS, WHICHEVER IS GREATER. PROPOSED ENCROACHMENTS INTO THE WETLAND AND RIPARIAN BUFFER INCLUDE DETENTION PONDS, S. 154TH/S.156TH ST., AND EMBANKMENT. AN EXISTING SANITARY SEWER LINE WITH A 20' EASEMENT IS ALSO LOCATED IN THE WETLAND AND RIPARIAN BUFFER.
2. APPROXIMATELY 9 ACRES OF BUFFER AVERAGING AREA IS ADDED TO THE WETLAND AND RIPARIAN BUFFER TO COMPENSATE FOR ENCROACHMENTS AND THE EXISTING SANITARY SEWER EASEMENT. ALL BUFFER AREAS ARE PLACED IN RESTRICTIVE COVENANTS.
3. SEE SHEET L6 FOR PLANT SCHEDULE.
4. FENCES AND SIGNS WILL BE INSTALLED AT THE EDGE OF ALL WETLAND AND RIPARIAN BUFFER AREAS.
5. TREES GREATER THAN 4" DIA. WILL NOT BE REMOVED DURING CONSTRUCTION OF THIS MITIGATION.
6. IN SOME LOCATIONS BLACKBERRY, JAPANESE KNOTWEED AND YELLOW FLAG IRIS WILL BE REMOVED BY HAND FROM AREAS OUTSIDE THE INDICATED CONSTRUCTION AREAS TO MEET PROPOSED MITIGATION GOALS.
7. ALL AREAS TO BE GRADED (AS SHOWN BY NEW GRADES) WILL BE CLEARED AND REVEGETATED.
8. THIS AREA WILL BE CLEARED OF VEGETATION AS A RESULT OF EMBANKMENT CONSTRUCTION.
9. PER CORPS OF ENGINEERS, SEWER EASEMENT WILL NOT BE REVEGETATED, BUT WILL BE HYDROSEEDED IF DISTURBED.

LEGEND

⊕	*Abies grandis* / Grand fir
⊙	*Acer macrophyllum* / Bigleaf maple
✲	*Picea sitchensis* / Sitka spruce
⊙	*Populus trichocarpa* / Black cottonwood
◉	*Thuja plicata* / Western redcedar
>——<	EXISTING CULVERT
260	EXISTING CONTOUR
159	PARCEL NUMBER
——	PARCEL BOUNDARY
- - -	WETLAND BOUNDARY
▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
▒	RIPARIAN AND WETLAND ZONE
▒	UPLAND ZONE #1
▨	UPLAND ZONE #2
▒	REMOVE UNDESIRABLE VEGETATION





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Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
SHEET TITLE: LANDSCAPE PLAN

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291281L5
STIA-9806-L5

APPENDIX B

DATE: 11/13/01 FILENAME: 291281L5

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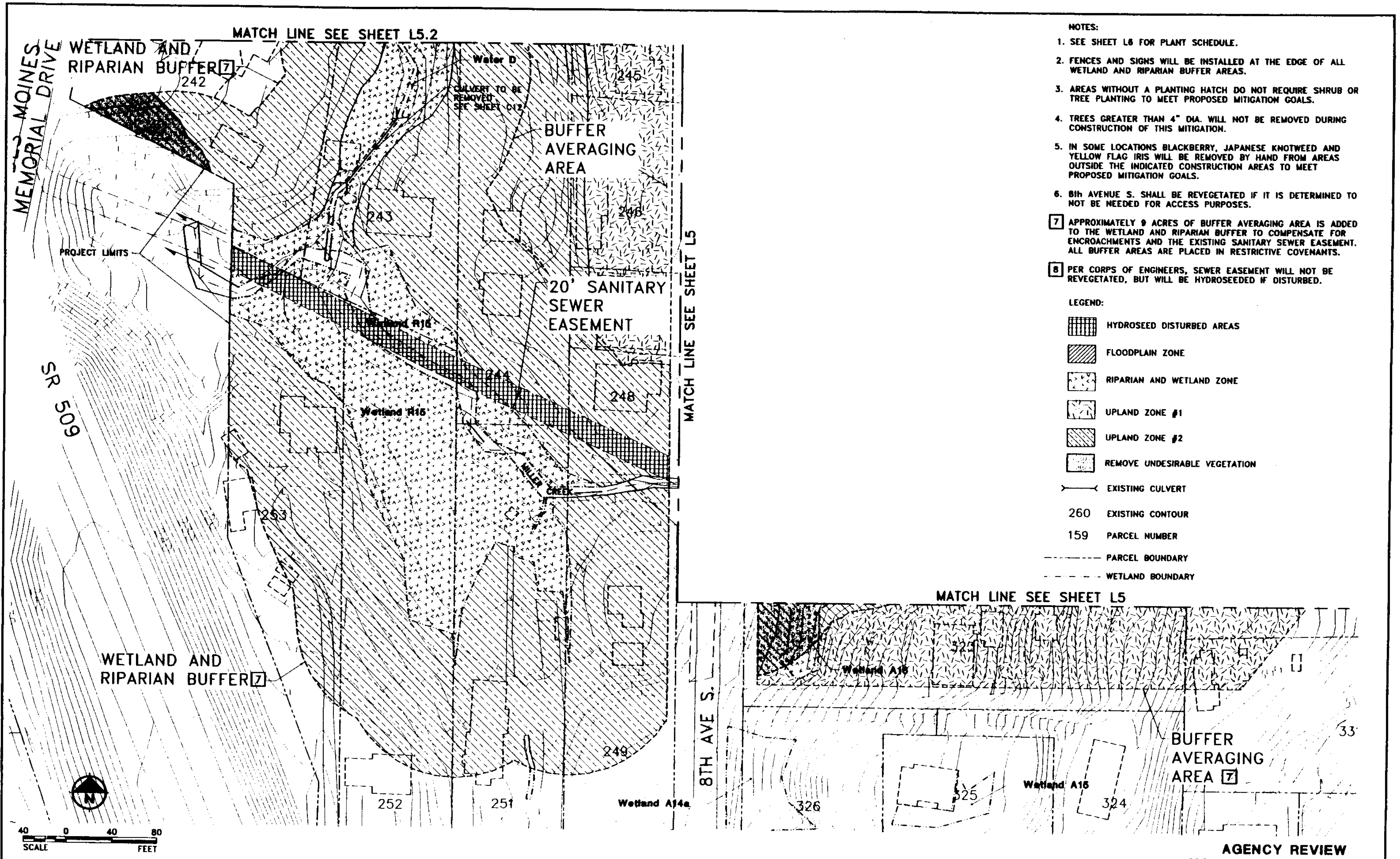

NOTES:

1. SEE SHEET L6 FOR PLANT SCHEDULE.
2. FENCES AND SIGNS WILL BE INSTALLED AT THE EDGE OF ALL WETLAND AND RIPARIAN BUFFER AREAS.
3. AREAS WITHOUT A PLANTING HATCH DO NOT REQUIRE SHRUB OR TREE PLANTING TO MEET PROPOSED MITIGATION GOALS.
4. TREES GREATER THAN 4" DIA. WILL NOT BE REMOVED DURING CONSTRUCTION OF THIS MITIGATION.
5. IN SOME LOCATIONS BLACKBERRY, JAPANESE KNOTWEED AND YELLOW FLAG IRIS WILL BE REMOVED BY HAND FROM AREAS OUTSIDE THE INDICATED CONSTRUCTION AREAS TO MEET PROPOSED MITIGATION GOALS.
6. 8th AVENUE S. SHALL BE REVEGETATED IF IT IS DETERMINED TO NOT BE NEEDED FOR ACCESS PURPOSES.

7 APPROXIMATELY 9 ACRES OF BUFFER AVERAGING AREA IS ADDED TO THE WETLAND AND RIPARIAN BUFFER TO COMPENSATE FOR ENCROACHMENTS AND THE EXISTING SANITARY SEWER EASEMENT. ALL BUFFER AREAS ARE PLACED IN RESTRICTIVE COVENANTS.

8 PER CORPS OF ENGINEERS, SEWER EASEMENT WILL NOT BE REVEGETATED, BUT WILL BE HYDROSEEDED IF DISTURBED.

LEGEND:

▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
⁘	RIPARIAN AND WETLAND ZONE
▧	UPLAND ZONE #1
▨	UPLAND ZONE #2
░	REMOVE UNDESIRABLE VEGETATION
>——<	EXISTING CULVERT
260	EXISTING CONTOUR
159	PARCEL NUMBER
————	PARCEL BOUNDARY
— — —	WETLAND BOUNDARY

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SHEET TITLE: LANDSCAPE PLAN

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STIA-9806-L5.1
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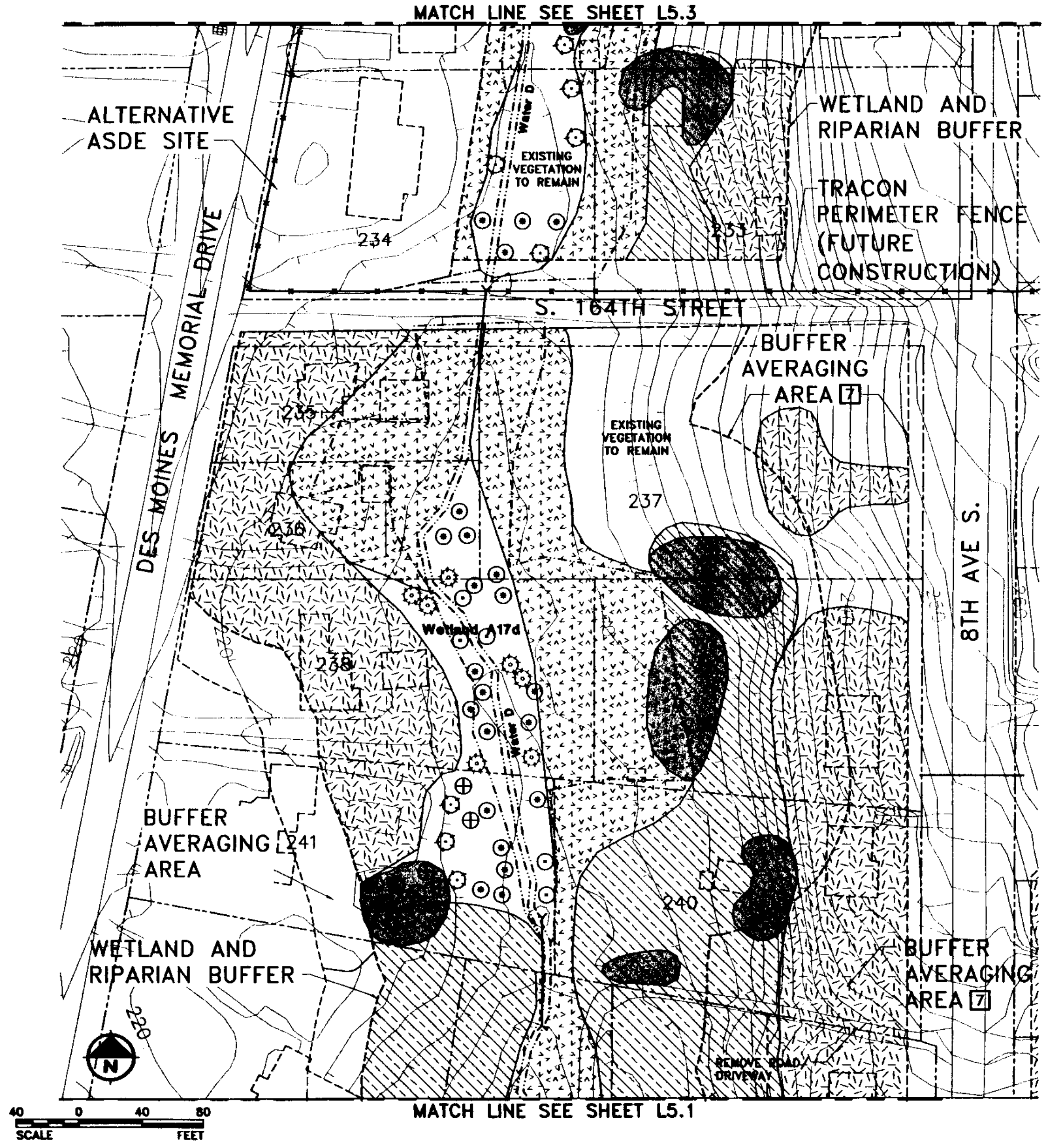

NOTES:

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LEGEND

⊕	*Abies grandis* /Grand fir
⊙	*Acer macrophyllum* /Bigleaf maple
✹	*Picea sitchensis*/Sitka spruce
○	*Populus trichocarpa*/Black cottonwood
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⊗	*Pseudotsuga menziesii*/Douglas Fir
▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
▩	RIPARIAN AND WETLAND ZONE
▧	UPLAND ZONE #1
▨	UPLAND ZONE #2
■	REMOVE UNDESIRABLE VEGETATION
>——<	EXISTING CULVERT
—260—	EXISTING CONTOUR
159	PARCEL NUMBER
——-——	PARCEL BOUNDARY
—··—··	WETLAND BOUNDARY

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LANDSCAPE PLAN

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STIA-9806-L5.2

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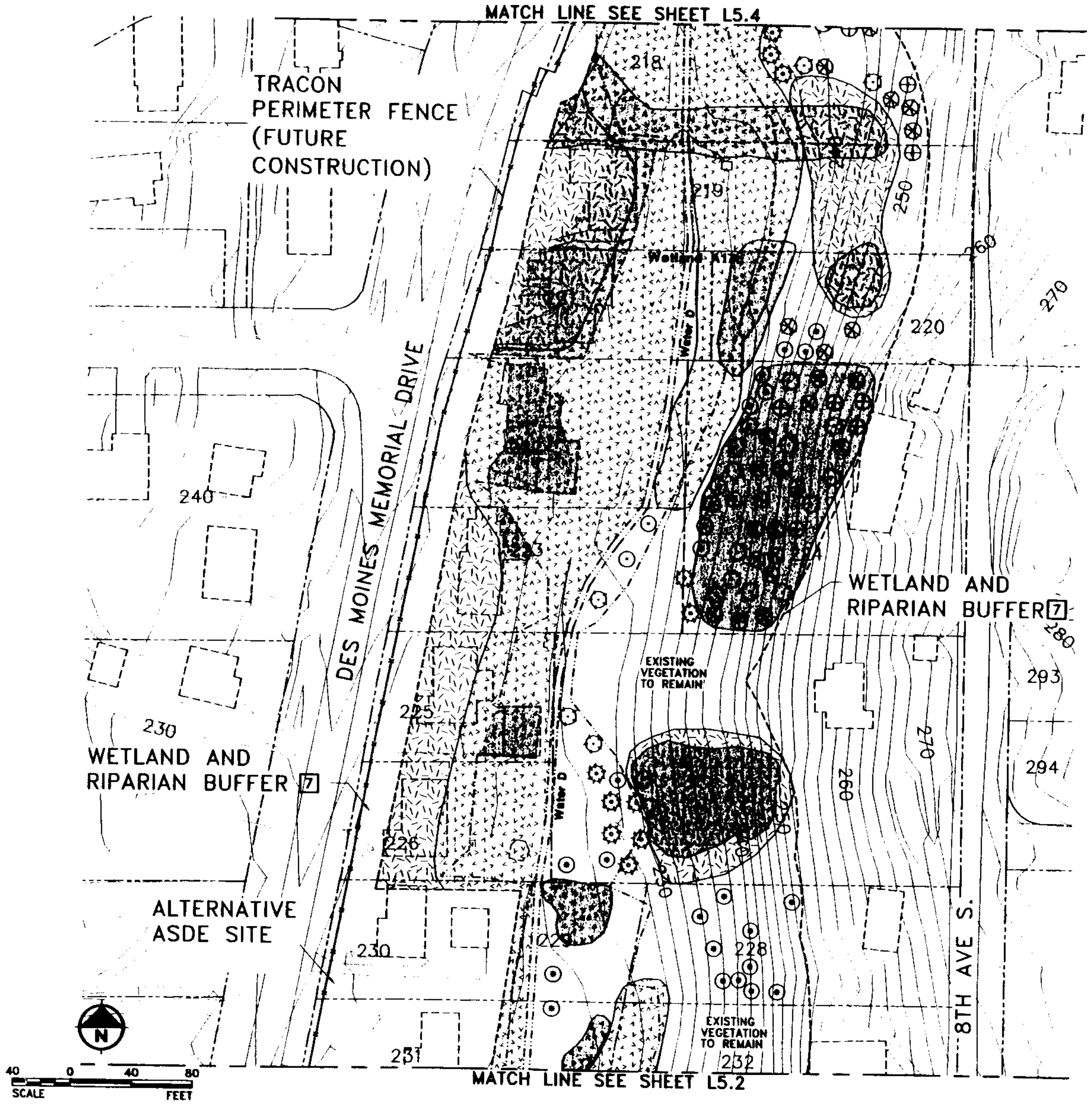
DATE: 11/13/01 FILENAME: 291281L5_2



NOTES:

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6. S. 164TH STREET SHALL BE REVEGETATED IF IT IS DETERMINED TO NOT BE NEEDED FOR ACCESS PURPOSES.

7 APPROXIMATELY 9 ACRES OF BUFFER AVERAGING AREA IS ADDED TO THE WETLAND AND RIPARIAN BUFFER TO COMPENSATE FOR ENCROACHMENTS AND THE EXISTING SANITARY SEWER EASEMENT. ALL BUFFER AREAS ARE PLACED IN RESTRICTIVE COVENANTS.

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⚙	*Acer macrophyllum* / Bigleaf maple
✲	*Picea sitchensis* / Sitka spruce
⊙	*Populus trichocarpa* / Black cottonwood
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⊗	*Pseudotsuga menziesii* / Douglas Fir
▦	HYDROSEED DISTURBED AREAS
▨	FLOODPLAIN ZONE
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▧	UPLAND ZONE #1
▨	UPLAND ZONE #2
▓	REMOVE UNDESIRABLE VEGETATION
260	EXISTING CONTOUR
159	PARCEL NUMBER
—·—·—	PARCEL BOUNDARY
– – –	WETLAND BOUNDARY

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LANDSCAPE PLAN

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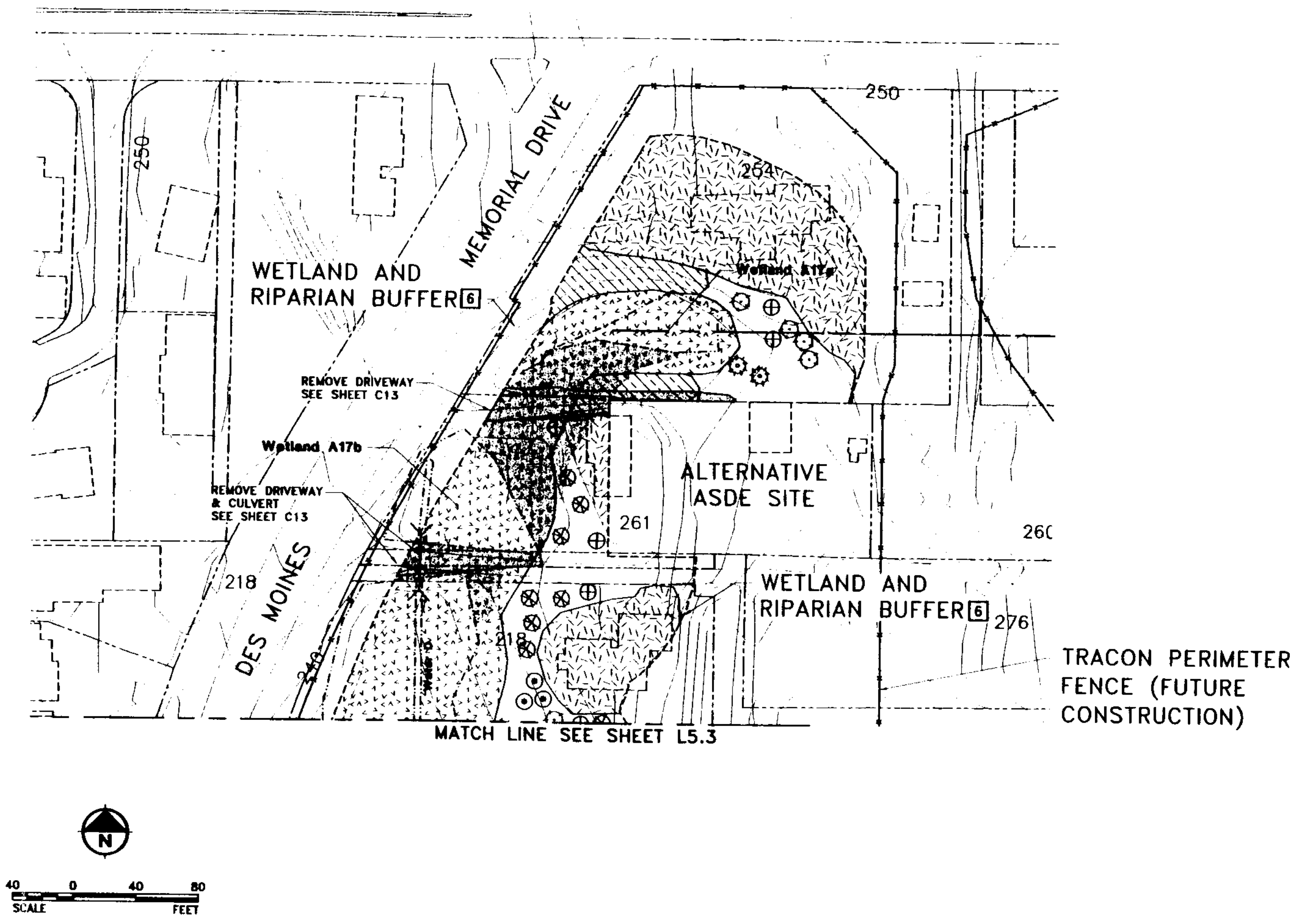
APPENDIX B

DATE 11/13/01 FILENAME 291281L5_3



NOTES:

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LEGEND

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⊙	*Acer macrophyllum* /Bigleaf maple
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⊙	*Populus trichocarpa*/Black cottonwood
◉	*Thuja plicata*/Western redcedar
⊗	*Pseudotsuga menziesii*/Douglas Fir
▦	HYDROSEED DISTURBED AREAS
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MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
LANDSCAPE PLAN

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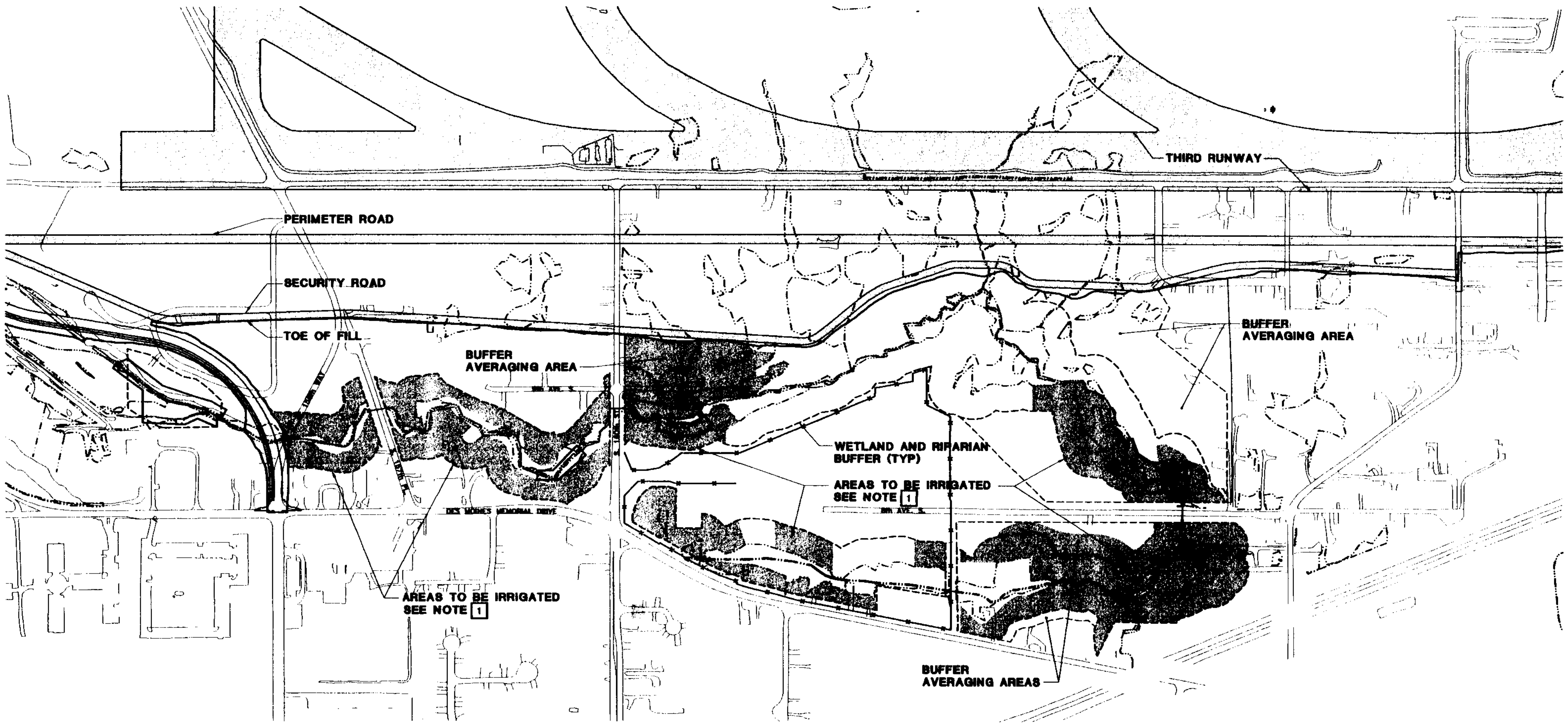
STIA-9806-L5.4
APPENDIX B

DATE: 11/13/01 FILENAME: 291281L5_4 IMAGES: XREF'S: TOE 291201P PONDS BASE 291201M, 291281DE ROADS 291281LA BUFFER



NOTE:

1. ENHANCEMENT PLANTINGS ARE PROPOSED WITHIN THE SHADED AREA. TEMPORARY IRRIGATION WILL BE PROVIDED DURING THE ESTABLISHMENT PERIOD OF THE NEW PLANTINGS TO PROMOTE PLANT SURVIVAL. IRRIGATION SYSTEMS MAY BE ABOVE OR BELOW GROUND, AND WILL BE DESIGNED BY THE CONTRACTOR TO MEET PERFORMANCE STANDARDS.
2. ANY IRRIGATION SYSTEMS WILL BE SHOWN IN THE AS-BUILT REPORT.

200 0 200 400
SCALE FEET

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IRRIGATION PLAN

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291201BA2 291281DE 291281SV 291201WL

APPENDIX B

DATE: 11/13/01 FILENAME: 291281L5 IMAGES: XREF'S: 291281DE BASE2 291281SV ROADS TOE 291201WL 291281LA BUF-AVE BUFFER

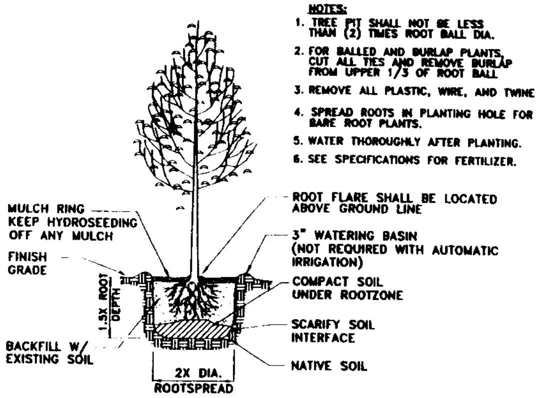
MILLER CREEK BUFFER ENHANCEMENT PLANT SCHEDULE

Symbol	Botanical Name /Common Name	Size	Quantity	Condition / Remarks
⊕	*Abies grandis* / Grand fir	18"- 72"ht.	27	Container or B&B. Rooting to sides and bottom of can or burlap.
⊙	*Acer macrophyllum* / Bigleaf maple	18"- 72"ht.	18	" "
⊙	*Picea sitchensis*/Sitka spruce *	18"- 72"ht.	56	" "
⊙	*Populus trichocarpa*/Black cottonwood	18"- 72"ht.	77	" "
◉	*Thuja plicata*/Western redcedar *	18"- 72"ht.	142	" "
⊗	*Pseudotsuga menziesii*/Douglas Fir	18"- 72"ht.		
▨	**FLOODPLAIN ZONE** - Single Species Groups of 3 to 7		Density(Plants Per Acre)	
	TREES		280	- Container or B&B. Rooting to sides and bottom of can or burlap.
	Alnus rubra/Red alder	36"- 72" ht.		
	Populus trichocarpa/Black cottonwood	36"- 72" ht.		
	SHRUBS		2,100	- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Salix hookeriana/Hooker's willow	1gal/Live stakes		
	Salix lucida spp lasiandra/Pacific willow	1gal/Live stakes		
	Salix scouleriana/Scoulers willow	1gal/Live stakes		
	Salix sitchensis/Sitka willow	1gal/Live stakes		
	Spiraea douglasii/Hardhack spiraea	1 gal.		
▨	**RIPARIAN AND WETLAND ZONE** - Single Species Groups of 7 to 12			
	TREES		280	- Container or B&B. Rooting to sides and bottom of can or burlap.
	Alnus rubra/Red alder	36"- 72" ht.		
	Fraxinus latifolia/Oregon Ash	36"- 72" ht.		
	Picea sitchensis/Sitka spruce *	36"- 72" ht.		
	Populus trichocarpa/Black cottonwood	36"- 72" ht.		
	Thuja plicata/Western redcedar *	36"- 72" ht.		
	SHRUBS		2,100	- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Physocarpus capitatus/Pacific ninebark	1 gal.		
	Rosa pisocarpa/Clustered rose	1 gal.		
	Salix hookeriana/Hookers willow	1gal/Live stakes		
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stakes		
	Salix scouleriana/Scoulers willow	1gal/Live stakes		
	Salix sitchensis/Sitka willow	1gal/Live stakes		
	Spiraea douglasii/Hardhack spiraea	1 gal.		
▨	**UPLAND ZONE #1** - Single Species Groups of 7 to 12			
	TREES		280	- Container or B&B. Rooting to sides and bottom of can or burlap.
	Acer macrophyllum/Bigleaf maple	36"- 72" ht.		
	Alnus rubra/Red alder	36"- 72" ht.		
	Pseudotsuga menziesii/Douglas fir	36"- 72" ht.		
	Tsuga heterophylla/Western hemlock *	36"- 72" ht.		
	SHRUBS		2,100	- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Acer circinatum/Vine maple	1 gal.		
	Rosa pisocarpa/Clustered rose	1 gal.		
	Salix scouleriana/Scoulers willow	1gal/Live stakes		
	Spiraea douglasii/Hardhack spiraea	1 gal.		
▨	**UPLAND ZONE #2** - Single Species Groups of 3 to 7			
	TREES		280	- Container or B&B. Rooting to sides and bottom of can or burlap.
	Acer macrophyllum/Bigleaf maple	36"- 72" ht.		
	Picea sitchensis/Sitka spruce *	36"- 72" ht.		
	Pseudotsuga menziesii/Douglas fir	36"- 72" ht.		
	Thuja plicata/Western redcedar *	36"- 72" ht.		
	Tsuga heterophylla/Western hemlock *	36"- 72" ht.		
	SHRUBS		2,100	- Container. Rooting to sides and bottom of can. Live stakes shall be 36"-48" ht., 1/2"-1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3-4 buds shall be below grade. - Space 4.5' O.C. typical.
	Acer circinatum/Vine maple	1 gal.		
	Salix scouleriana/Scoulers willow	1gal/Live stakes		
	Spiraea douglasii/Hardhack spiraea	1gal		

* Western redcedar, Western hemlock and Sitka spruce shall be planted in a second planting phase, to follow year-3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

Notes:

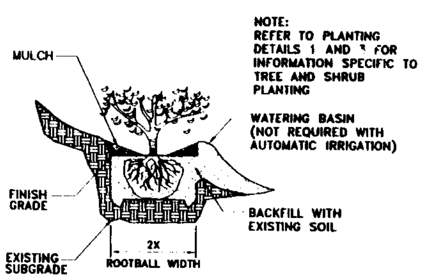
1. Preserve and protect all trees and shrubs not designated for removal. Provide, erect, and maintain barricades necessary to prevent access to area within driplines of existing trees. Allow no vehicular or pedestrian traffic, or storage of construction materials within barricades.
2. For each planting zone Contractor shall lay out a 10,000 s.f. test plot, in which the positions of all plants shall be staked with flags that are color coded to represent specific species. Layout for each zone shall be inspected and approved prior to commencement of planting. Approved staking shall serve as the plant layout standard for the remainder of each zone.
3. Shrub masses shall consist of multiple single-species groups (see detail 6). Contractor shall ensure that these single-species groups have a variety of sizes and shapes, and that shrub masses have a variety of species. See planting schedule for numbers of plants in single-species groups.
4. Hydroseed all planting areas. Re-seed areas that are disturbed by subsequent work. Keep hydroseeding off any mulch circles except where needed to protect roots of conifers.



NOTES:

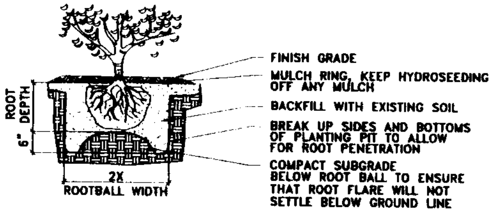
1. TREE PIT SHALL NOT BE LESS THAN (2) TIMES ROOT BALL DIA.
2. FOR BALLED AND BURLAP PLANTS, CUT ALL TIES AND REMOVE BURLAP FROM UPPER 1/3 OF ROOT BALL
3. REMOVE ALL PLASTIC, WIRE, AND TWINE
4. SPREAD ROOTS IN PLANTING HOLE FOR BARE ROOT PLANTS.
5. WATER THOROUGHLY AFTER PLANTING.
6. SEE SPECIFICATIONS FOR FERTILIZER.

DETAIL 1 TYP
TREE PLANTING
(TYPICAL)

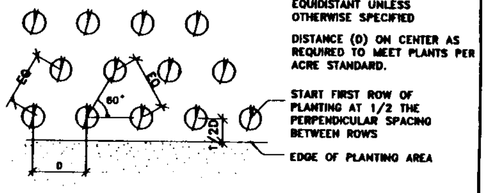


NOTE:
REFER TO PLANTING DETAILS 1 AND 3 FOR INFORMATION SPECIFIC TO TREE AND SHRUB PLANTING

DETAIL 2 TYP
PLANTING ON SLOPES
N.T.S.



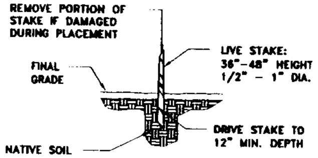
DETAIL 3 TYP
SHRUB PLANTING
(TYPICAL)



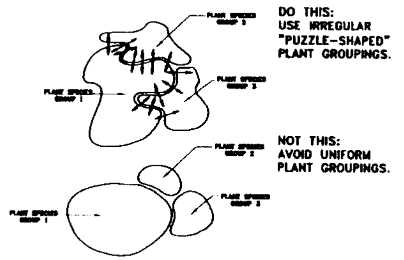
NOTE:
ALL GROUNDCOVER/SHRUB SPACING SHALL BE EQUIDISTANT UNLESS OTHERWISE SPECIFIED

DISTANCE (D) ON CENTER AS REQUIRED TO MEET PLANTS PER ACRE STANDARD.

DETAIL 4 TYP
TRIANGULAR SHRUB SPACING
(TYPICAL)



DETAIL 5 TYP
LIVE STAKE
(TYPICAL)



DETAIL 6 TYP
SHAPES OF PLANTING MASSES
NTS

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SHEET TITLE: PLANTING SCHEDULE AND DETAILS

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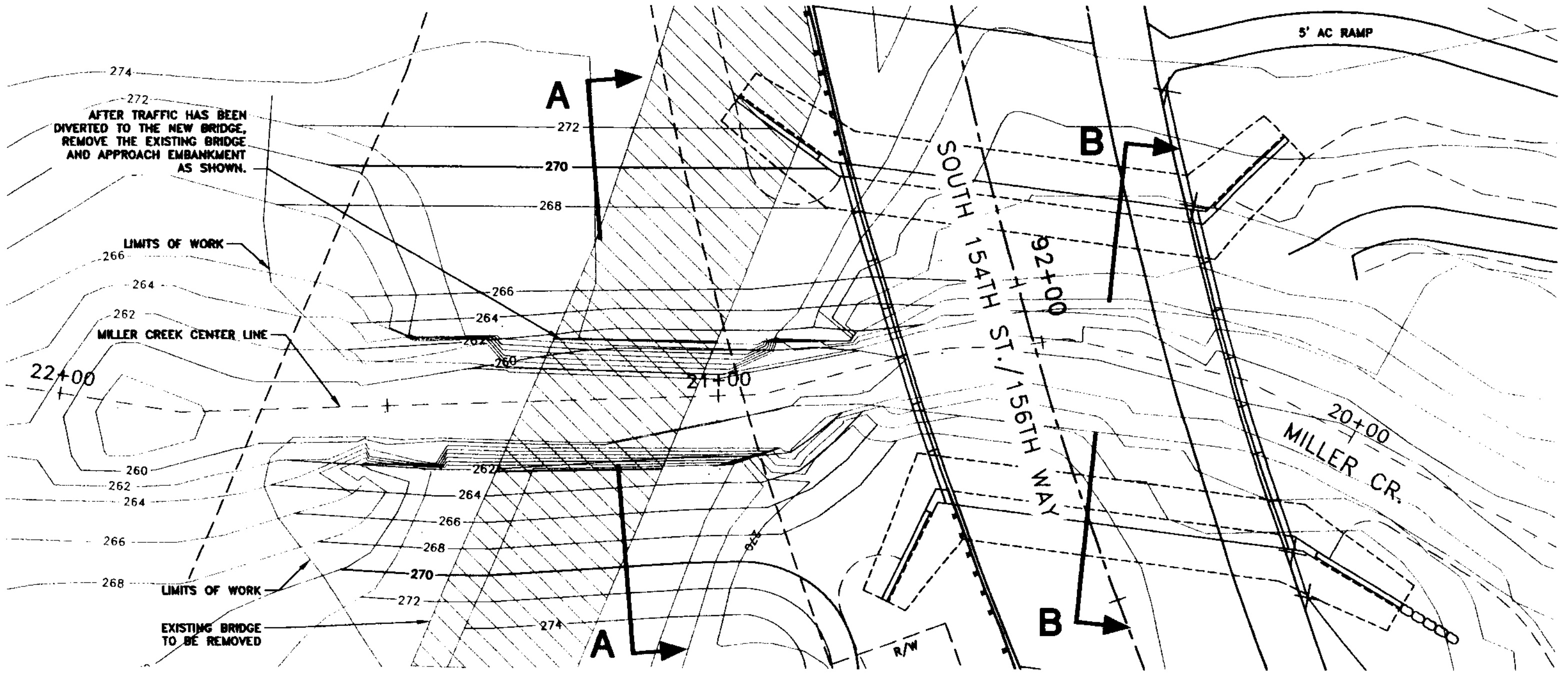
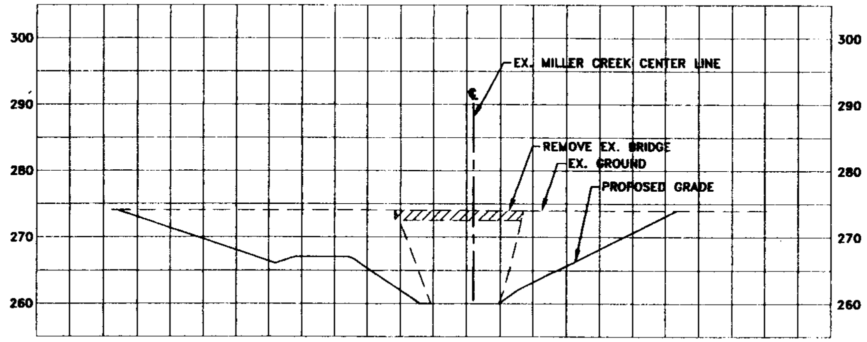
STIA-9806-L6
APPENDIX B

DATE: 11/15/01 FILENAME: 291281L6 IMAGES XREF'S



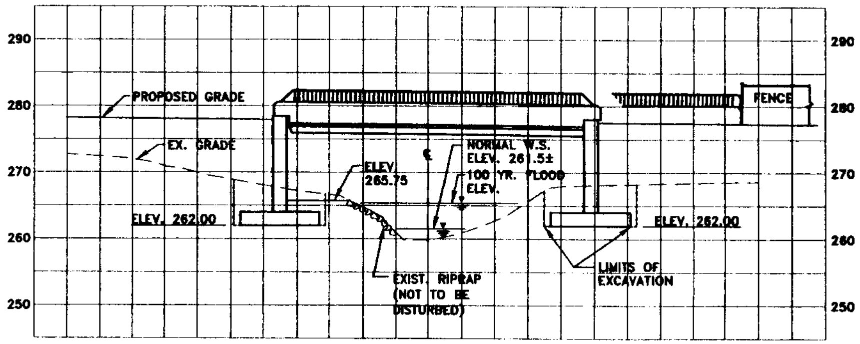
MILLER CREEK RECLAMATION

SCALE IN FEET: 10 0 10 20



MILLER CREEK CROSS SECTION – A

SCALE IN FEET: 10 0 10 20



MILLER CREEK CROSS SECTION – B

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(206)448-4200
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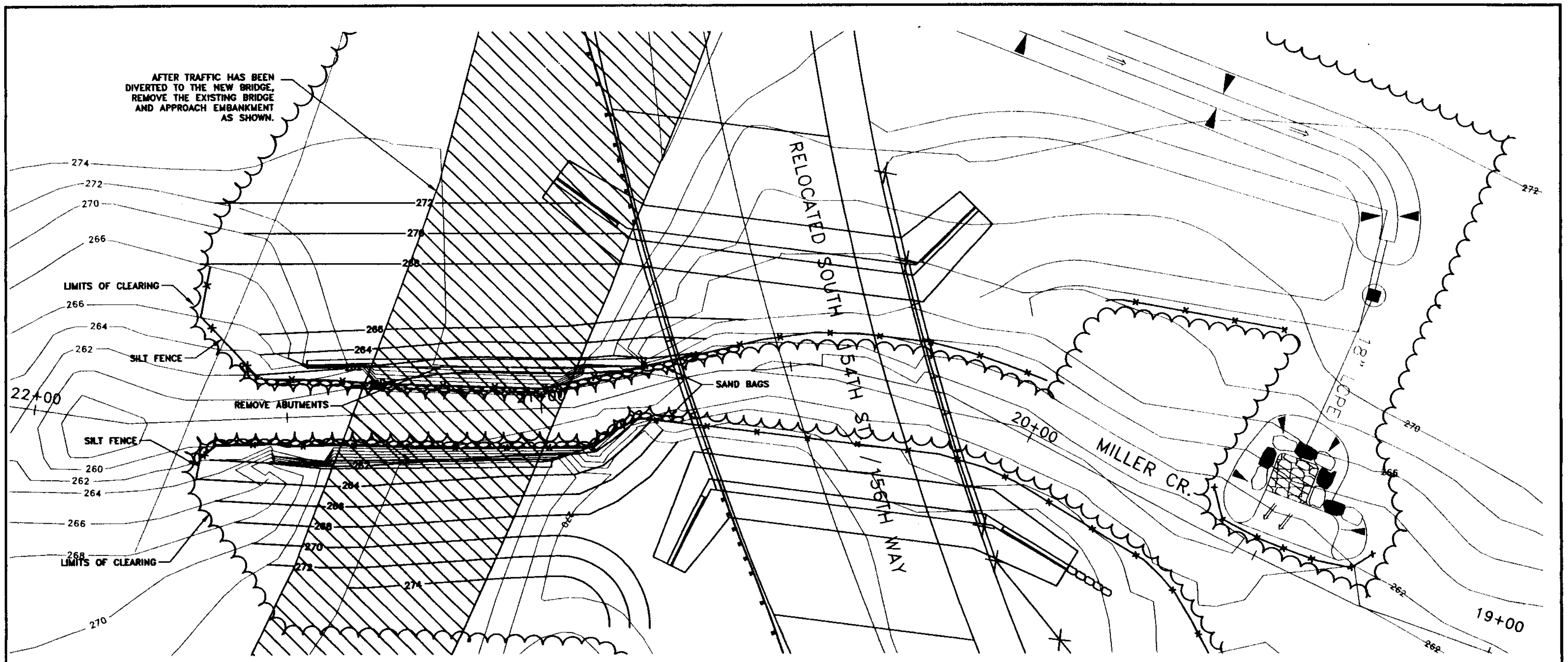
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENT
SHEET TITLE: **GRADING AT S. 156TH WAY BRIDGE**

C3496
291281P1
STIA-9806-P1
APPENDIX B

DATE: 11/13/01 FILENAME: 291281P1 IMAGES: XREF'S: J_PH1PH2 HPA-BASE XREF1



BRIDGE REMOVAL & TEMPORARY EROSION CONTROL PLAN

BRIDGE DEMOLITION SEQUENCE:

1. INSTALL TESC SYSTEMS.
2. REMOVE BRIDGE DECK.
3. DIVERT STREAM FLOWS TO WEST SIDE OF CHANNEL WITH SAND BAGS.
4. REMOVE EAST ABUTMENT AND REGRADE PER PLAN. STABILIZE STREAM BANK WITH EROSION CONTROL BLANKET.
5. DIVERT STREAM FLOWS TO EAST SIDE OF CHANNEL WITH SAND BAGS.
6. REMOVE WEST ABUTMENT AND REGRADE PER PLAN. STABILIZE STREAM BANK WITH EROSION CONTROL BLANKET.
7. HYDROSEED NEW SLOPES AND ADJACENT DISTURBED AREAS. USE WETLAND MANAGEMENT SEED MIX FOR ELEVATIONS BELOW 266 AND UPLAND SEED MIX FOR ELEVATIONS ABOVE 266.

NOTES:

1. ALL WORK PERFORMED ADJACENT TO MILLER CREEK SHALL BE DONE IN ACCORDANCE WITH THE "HYDRAULIC PROJECT APPROVAL" FOR THIS PROJECT.
2. WETLANDS EXIST ADJACENT TO MILLER CREEK. DISTURBANCE TO THESE WETLANDS IS ONLY ALLOWED WITHIN THE CLEARING LIMITS SHOWN. FOR ADDITIONAL INFORMATION REFER TO SHEET TE2 OF THE TESC PLANS.
3. SAND BAGS, SILT FENCE, AND CLEAR PLASTIC COVERING TO BE INSTALLED WHERE NECESSARY TO MINIMIZE SEDIMENT SUSPENSION DURING BRIDGE REMOVAL.

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DATE: 11/13/01 FILENAME: 291281P2 IMAGES: XREF'S: J_PH1PH2 HPA-BASE XREF1 SD-SS

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2003 Western Avenue
555 Market Place One
Seattle, WA 98121
(206)448-4200
A Division of TranSystems Corporation

PROJECT ENGR./ARCH.	ESK
DESIGNED BY:	SSS
DRAWN BY:	AR
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APPROVED BY:	

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APPROVED BY:	

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: SOUTH 154TH STREET/156TH WAY/ MILLER CREEK RELOCATION
SHEET TITLE: BRIDGE REMOVAL AND TEMP. EROSION CONTROL PLAN

WORK ORDER NO.	C3496
CONSULTANT'S NO.	291281P2
PORT OF SEATTLE NO.	STIA-9806-P2

BRIDGE-REMOVE.DWG \engr\j_ph1ph2.dwg \hpo plans\hpa-base.dwg

APPENDIX B

Appendix B. Descriptions of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek.

Sheet Number	Parcel Number	Existing Conditions	Proposed Mitigation Actions
See Appendix A, Sheet L1	97 through 100	The parcels contain residential structures with lawn and ornamental plantings. Overstory is red alder near stream and native coniferous trees in upland.	Remove residential structures and plant lawn area with native upland trees and shrubs.
See Appendix A, Sheet L1	101	This entire parcel is located on the east bank. Lawn is found above the banks of the creek and associated with the private residence. Overstory consists of Douglas fir in upland with red alder near stream.	Remove residential structures and plant lawn area with upland trees and shrubs on east bank, west of the proposed 154th Street relocation.
L1.1	141	The parcel is currently the location of South 156th Way. This parcel also has areas of lawn and ornamental plantings. Overstory has native coniferous trees with an understory of ornamental shrubs and blackberry.	Remove road and plant native upland trees and shrubs. Plant upland trees and shrubs in lawn areas. Remove areas of blackberry and plant with native trees and shrubs.
L1.1	142	The east bank contains a steep slope with black cottonwood in the overstory and English ivy and Himalayan blackberry below. The west bank also consists of a steep slope with western hemlock and weeping willow in the overstory and cherry laurel and English ivy dominant below. A residence is located in the outer half of the buffer.	No action to be taken on the east bank because of the steep slope. Remove existing structures, English ivy, and cherry laurel on west bank and plant with upland trees and shrubs.
L1.1	143	The eastern bank contains a red alder riparian wetland fringe with a lawn in the remaining portion of the buffer. A residence is located in outer third of the buffer on the west bank. A terraced yard leads down to the creek. Vegetation near the residence and along the slope includes red alder, black cottonwood, and western redcedar with English ivy dominant on the constructed terraces	Plant east bank wetland fringe and lawn with trees and shrubs. Remove residential structures on west bank and plant with trees and shrubs. Remove creosote timbers, install erosion control fabric or other BMP, and plant with native trees and shrubs. Remove English ivy and plant wetland fringe with native trees and shrubs.
L1.1	144	Residential structures are located in the outer portion of the buffer.	Remove structures and plant with upland trees and shrubs.
L1.1	146	A red alder and shrub wetland are located on the east bank. Trees on the west bank include red alder and western hemlock with English holly, cherry laurel, Himalayan blackberry, and reed canarygrass in the understory.	Remove garden debris on east bank and underplant with native wetland shrubs. Remove the blackberry and cherry laurel and interplant with native coniferous trees on west bank and on upland areas near residence.
L1.1	147	Dominant canopy species on east and west bank include red alder and western hemlock. English holly, cherry laurel, Himalayan blackberry, reed canarygrass, and lawn are dominant in the understory.	Remove residence on west bank and clear of English holly, cherry laurel, and blackberry. Plant cleared areas with upland native trees and shrubs on both the east and west banks.
L1.1	148	Lawn is located above the creek on the east bank. Red alder riparian wetland is located along the east bank of the creek with ornamental trees, English holly, and cherry laurel also near the creek. Himalayan blackberry and English ivy dominate understory along the creek edge. The west bank is a steep slope with cherry laurel, English ivy, and Himalayan blackberry.	Plant lawn area with native upland vegetation on east bank. Remove English holly, cherry laurel, English ivy, and blackberry along the creek edge and plant with native vegetation.
L1.1	152	Most of the buffer on this parcel is located on the west bank. Representative vegetation on the upland portion of the west bank includes lawn and ornamental trees associated with the residence. Red alder and shrubs grow near the creek. Himalayan blackberry is dominant along the steep slope on the west bank south of South 157th Street.	Remove residence on west bank and plant lawn area. Interplant creek bank with upland shrubs and trees. Remove Himalayan blackberry south of South 157th Street and interplant with western redcedar and native shrubs.
L1.1	153	Lawn is located beyond the edge of the east bank, adjacent to residential structures. Himalayan blackberry is the dominant plant along the east bank, adjacent to the creek. Some salmonberry is found in a riparian wetland on the east bank. Western redcedar and Douglas fir trees are located in the lawn area. The west bank is vegetated with western redcedar and Douglas fir in the canopy; Himalayan blackberry dominates in the shrub layer.	Remove residences and paved driveway on east bank and plant large areas of upland lawn and wetland lawn with upland and wetland trees and shrubs. No action immediately next to the channel on the west bank because it is already heavily vegetated. Interplant streambank slope with coniferous tree species. Remove areas of blackberry and plant with native trees and shrubs.
L1.1	154	Representative vegetation on this upland parcel includes lawn and ornamental trees associated with a residence. Areas of the parcel contain non-native species including Himalayan blackberry and English holly. Native plants include Douglas fir, western redcedar, and red alder.	Remove residence and paved driveway and plant areas with upland trees and shrubs. Remove blackberry and English holly and plant with native trees and shrubs.
L1.1/L2	179	Ornamental trees, shrubs, and lawn are found on the bench above the creek with western redcedar and Douglas fir dominant on the east bank. Himalayan blackberry dominates the entire steep slope along the streambank.	Remove residence above the eastern creek bank and plant large areas of lawn with native upland vegetation. Remove Himalayan blackberry along streambank and plant native trees and shrubs.
L1.1	180	The representative vegetation on the west bank includes ornamental trees, shrubs, and lawn that are associated with the existing residence. Western redcedar is also present.	Remove residence from west bank and plant large areas of lawn with native wetland and upland vegetation.
L1/L2	182	Representative vegetation on the west bank includes western redcedar, black cottonwood, ornamental trees, shrubs, and lawn associated with the existing residence. English ivy is also present.	Remove residence and plant native vegetation on west bank. Remove English ivy and plant native vegetation.
L2	183	Ornamental shrubs and lawn are associated with the residence. Vegetation in the canopy layer near the creek includes black cottonwood.	Remove residence and associated structures and plant lawn with native upland coniferous tree species and native shrubs.
L2	184	Private residence and lawn area is located on the west bank. Black cottonwood, red alder, western redcedar, and western hemlock compose the tree layer along the east and west banks. The shrub layer includes Himalayan blackberry, red-twig dogwood, salmonberry, and willow.	Remove residence and plant area with native trees and shrubs. Plant west bank above the creek with upland trees and shrubs. Remove patches of Himalayan blackberry from the west bank of the creek edge and plant native riparian shrubs.
L2	185 and 186	Representative vegetation includes ornamental trees, shrubs, and lawn associated with the two residences on the east bank.	Remove existing residence and plant area with native trees and shrubs on east and west bank.
L2	210	The east bank contains ornamental trees, shrubs, lawn, and an existing residence. Red alder, western redcedar, Douglas fir, salmonberry, and western hazelnut are also present near the creek.	Remove existing residence and outbuildings on east bank and plant native trees and shrubs.
L2	211 and 212	Lawn, ornamental trees, western redcedar, and red alder are associated with existing residences.	Remove residences and plant lawn area with native trees and shrubs.
L2	213	A lawn area associated with the residence is on the east bank. Overstory vegetation is western redcedar with salmonberry, willow, cherry laurel, and bamboo understory.	Remove residence, cherry laurel, and bamboo from east bank and plant lawn and other areas with native vegetation.

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DRAWN BY: J. BURTON
SCALE: AS SHOWN
DATE: NOVEMBER 2001
CHECKED BY: -
APPROVED BY: P. FENDT

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Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE: **EXISTING VEGETATION & WETLAND ENHANCEMENT ACTIONS**

WORK ORDER NO:
CONSULTANT'S NO:
PORT OF SEATTLE NO: STIA-XXXX TA1

APPENDIX B

Appendix B. **Descriptions of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).**

Sheet Number	Parcel Number	Existing Conditions	Proposed Mitigation Actions
L2	214	The residence has a landscape including western redcedar, ornamental trees, shrubs, and lawn. A steep slope adjacent to the creek is vegetated with grasses	Remove residence and plant lawn and other areas with native upland vegetation.
L2	215	The east bank contains a forested wetland dominated by red alder. The representative vegetation on the west bank includes western redcedar, ornamental trees, shrubs, and lawn associated with the existing residence	Plant both upland and wetland vegetation on the east bank. Remove the existing residence on the west bank and plant lawn with a combination of native wetland and upland trees and shrubs.
L2	216	The west bank has a red alder forest with an understory of Himalayan blackberry, cherry laurel. English holly, salmonberry, and western hazelnut	Plant shrubs and native coniferous trees on east bank. Remove residence on west bank, above the creek bank, and plant with upland trees and shrubs. Remove areas of blackberry, cherry laurel, and English ivy and plant with native vegetation
L5.1	242 through 244	The residences are associated with ornamental trees, shrubs, and lawn are in the outer portion of the buffer on the north and west side of the creek. Red alder, black cottonwood, and Himalayan blackberry are dominant on a slope and adjacent to the creek.	Remove residences and areas of blackberry and plant with native trees and shrubs. Plant native vegetation in lawn areas.
L5.1	247	The existing residence has a landscape including ornamental trees, shrubs, and lawn.	Remove residence. Plant open areas with native trees and shrubs.
L5.1	248	A large lawn area is associated with existing residence. Black cottonwood and red alder dominate the tree layer. Shrubs include Himalayan blackberry, red-twig dogwood, English holly, and cherry laurel.	Remove residence and English holly. Plant native trees and shrubs in the lawn area on west bank.
L5.1	249	A residence with areas of compacted soil is located adjacent to the creek. Black cottonwood and red alder dominate the tree layer along the east bank of the creek. The shrub layer near the creek edge includes Himalayan blackberry, red-twig dogwood, English holly, and cherry laurel.	Remove residence and gravel parking area. Scarify soils and amend as necessary. Plant native riparian and upland trees and shrubs. Remove blackberry, English holly, and cherry laurel and plant native vegetation
L5.1	251 and 252	Residences with associated ornamental trees, shrubs, and lawn are in the outer portion of the buffer. Black cottonwood, red alder, Himalayan blackberry, and a lawn area are near the creek.	Remove residences and plant native trees and shrubs. Plant native vegetation in lawn areas and areas where blackberry plants are removed.
L5.1	253	Residence and associated lawn; red alder and western redcedar grow near the creek.	Remove structure; plant lawn and open areas with native vegetation. Underplant with native trees and shrubs near the creek.
L2	255	Himalayan blackberry and Japanese knotweed dominate the entire parcel.	Clear area within the buffer and remove top 6 to 12 inches of soil, amend with topsoil if necessary, and plant with upland shrubs and trees.
L2/L3	256	Himalayan blackberry and Japanese knotweed dominate the entire parcel.	Clear area within the buffer and plant with wetland and upland trees and shrubs.
L2/L3	257 and 258	The parcels are vegetated with lawn, ornamental trees, and shrub, associated with the existing residences on the east bank.	Remove existing structures and plant a combination of native upland trees and shrubs near the residences and wetland shrubs near the creek edge.
L3	259	The dominant vegetation includes ornamental shrubs and lawn associated with an existing residence on the east bank. A stand of quaking aspen is located on the creek's bank.	Remove existing structure and plant a combination of native wetland and upland trees and shrubs.
L3	260	Representative vegetation on the west bank includes ornamental fruit trees and lawn.	Remove trees and excavate fill material to connect stream with floodplain, replant buffer with native upland trees and shrubs. Plant benches along the creek with emergent species if appropriate.
L2 L3	262-264, 267 265, 266	Typical vegetation includes ornamental trees, shrubs, and lawn. Overstory vegetation includes native coniferous and deciduous trees.	Remove residences and plant open areas with native trees and shrubs.
L3	268	The dominant vegetation includes ornamental trees, shrubs, and lawn that are associated with the existing residence. Overstory vegetation also includes patches of native coniferous and deciduous trees.	Remove existing structure and plant a combination of native wetland and upland trees and shrubs in cleared and lawn areas.
L3	276	The east bank is a red alder-dominated wetland with Himalayan blackberry in the shrub layer. The west bank is dominated by ornamental lawn.	Remove patches of Himalayan blackberry on the east bank and interplant with native trees and shrubs. Plant lawn area with native upland trees and shrubs.
L3	277	The west bank is a black cottonwood and red alder upland dominated by a Himalayan blackberry shrub layer.	Remove patches of Himalayan blackberry and interplant with native wetland trees and shrubs.
L3	278	The east bank is a red alder-dominated wetland that also contains black cottonwood and western hemlock. The understory is dominated by Himalayan blackberry with salmonberry and western hazelnut. The west bank is dominated by black cottonwood and red alder with Himalayan blackberry in the shrub layer.	Remove patches of Himalayan blackberry and interplant native wetland trees and shrubs on east and west banks. To avoid damage to existing vegetation and wetland soil, planting will be limited to accessible areas of the existing wetland.
L3	287	The east bank is a black cottonwood and red alder wetland dominated by a Himalayan blackberry shrub layer. The west bank is a red alder-dominated wetland with black cottonwood and western hemlock also present. The understory is dominated by Himalayan blackberry with traces of salmonberry and western hazelnut.	Remove patches of Himalayan blackberry and interplant with trees and shrubs on both the east and west banks. No planting will occur on the steep slopes in areas where salmonberry is dominant.
L3	290	The parcel has areas of Himalayan Blackberry, ornamental shrubs, and grasses with an overstory of red alder and big-leaf maple.	Remove blackberry and plant open areas with native trees and shrubs.
L3	291	The east bank is a red alder-dominated wetland with some big-leaf maple present. The shrub layer is Himalayan blackberry and Japanese knotweed with some Indian plum, western hazelnut, and salmonberry present. The west bank is a black cottonwood, red alder, and western redcedar forest. Himalayan blackberry, salmonberry, and western hazelnut are dominant in the shrub layer.	Remove patches of Himalayan blackberry and interplant native wetland trees and shrubs on both the east and west banks. Remove Japanese knotweed and plant native vegetation.

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DRAWN BY: J. BURTON
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APPROVED BY: P. FENDT

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PROJECT MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE **EXISTING VEGETATION & WETLAND ENHANCEMENT ACTIONS**

STIA XXXX IA2

APPENDIX B

Appendix B. Descriptions of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).

Sheet Number	Parcel Number	Existing Conditions	Proposed Mitigation Actions
L3/L4	292	The east bank is a red alder-dominated wetland with small amounts of big-leaf maple and Douglas fir. The shrub layer is Himalayan blackberry and Japanese knotweed with some Indian plum, western hazelnut, and salmonberry present. Reed canarygrass dominates the herbaceous layer. The west bank is a black cottonwood, red alder, and western redcedar forest. The shrub layer is dominated by Himalayan blackberry and Japanese knotweed with salmonberry and western hazelnut.	Remove portions of Himalayan blackberry on east bank and interplant with upland shrubs. Remove Japanese knotweed on the west bank and plant with native tree and shrubs.
L4	298	The east bank is a red alder-dominated wetland with big-leaf maple and Douglas fir also present. Himalayan blackberry and Japanese knotweed dominate the shrub layer. Western redcedar dominates the west bank with big-leaf maple and red alder. Himalayan blackberry and Japanese knotweed are the dominant shrubs with willow, Indian plum, and cherry laurel also present. Several large snags are also present.	No action is recommended on the east bank due to the high quality of the existing native vegetation. Remove patches of Himalayan blackberry and interplant with native wetland and upland trees and shrubs near the creek edge on the west bank. Remove abandoned vehicles from upland buffer area.
L4	299	The east bank is a red alder-dominated wetland with some big-leaf maple occurring adjacent to the upland. The understory includes Himalayan blackberry, with skunk cabbage and creeping buttercup dominant in the herbaceous layer.	Remove Himalayan blackberry and plant native riparian and upland vegetation.
L4	300	A red alder wetland is located immediately next to the creek with pasture grasses located to the east. Big-leaf maple grows in the upland areas. Dominant west bank trees include western redcedar, red alder, and big-leaf maple. Himalayan blackberry is dominant in the shrub stratum with red-twig dogwood, willow species, and red elderberry.	Remove areas of Himalayan blackberry found in the wetland on the east bank and interplant with native wetland vegetation. Plant pasture with wetland trees and shrubs. Remove patches of Himalayan blackberry from the west bank and interplant with upland trees and shrubs.
L4	301	Red alder is the dominant tree species on the east bank, with Himalayan blackberry and Japanese knotweed present along the stream and in a pasture. Western redcedar, big-leaf maple, and red alder are present on the west bank. Dominant shrub species include Himalayan blackberry and Japanese knotweed. A small island containing Japanese knotweed and Himalayan blackberry is present in the center of Miller Creek along the boundary of parcels 301 and 303.	Remove English holly, Himalayan blackberry, and Japanese knotweed, then interplant with native coniferous trees to provide shading.
L4/L5	303	A red alder-dominated wetland is on the east bank of the creek with large patches of skunk cabbage. The west bank contains a large stand of western redcedar. On the west bank, Himalayan blackberry, Japanese knotweed, reed canarygrass, and ornamental lawn dominate immediately adjacent to the creek, with salmonberry and western hazelnut also occurring. Cow parsnip is also present. A small island containing Japanese knotweed and Himalayan blackberry is present in the stream along the boundary of parcels 301 and 303.	Remove English holly, cherry laurel, and Japanese knotweed and plant native trees and shrubs. Plant areas of ornamental lawn with native wetland shrubs. Remove patches of Himalayan blackberry and interplant native coniferous trees in existing red alder wetland. Remove cow parsnip and replant with native shrub species.
L5	305 and 306	Red alder dominates the tree layer with Douglas fir also present. There are also ornamental trees and shrubs. Shrub layer includes Himalayan blackberry, English holly, salmonberry, western hazelnut, and ornamental shrub species.	Remove areas of Himalayan blackberry and interplant with native trees and shrubs. Remove English holly and plant native trees and shrubs. Plant areas of open lawn with native upland trees and shrubs.
L4	308 through 310	A large stand of black cottonwood dominates the tree layer on west bank with red alder and western hemlock also present. Several large stands of ornamental trees and shrubs are located on the bank. Shrub layer includes Himalayan blackberry, salmonberry, western hazelnut and ornamental rhododendron. Cow parsnip grows on west bank. There are existing residences on parcels 309 and 310.	Remove patches of the English holly and cherry laurel at the north and east portion of parcel 310 and replant with native trees and shrubs. Remove residences and areas of blackberry and plant open areas with native vegetation.
L4	311	Red alder is the dominant tree species with Douglas fir and western hemlock also present. Ornamental trees grow on both banks, along with some English holly and cherry laurel. Red-twig dogwood dominates both banks (within 25 to 30 ft of the bank) with Himalayan blackberry and reed canarygrass also present.	Remove patches of Himalayan blackberry on both the east and west banks and interplant native coniferous trees. Underplant ornamental trees with native coniferous and deciduous tree and shrub species.
L4/L5	312	A forested wetland is located on the east bank. Red alder is the dominant tree species on the east and west banks with Douglas fir present on the west bank. Himalayan blackberry, Japanese knotweed, and reed canarygrass dominate both banks. Red-twig dogwood becomes dominant toward the northern property line.	Remove patches of Himalayan blackberry and Japanese knotweed within wetland and interplant native shrubs and plant native upland and wetland vegetation on both the east and west banks. Remove residence and associated structures from the outer portion of the buffer on the west bank and replant with upland trees and shrubs.
L5	313	A tree layer is dominated by red alder and big-leaf maple on the east bank, with Himalayan blackberry and Japanese knotweed dominant in the shrub stratum. Reed canarygrass, Himalayan blackberry, and ornamental lawn dominate the west bank, especially in areas without overstory vegetation. Ornamental nursery stock trees, grown in rows, are present within the buffer on the west bank.	Remove patches of Japanese knotweed and patches of Himalayan blackberry from the east and west bank and interplant with native trees and shrubs. Remove some non-native nursery stock from the site.
L5	314 and 315	The tree layer includes western hemlock, western redcedar, and big-leaf maple. Himalayan blackberry and Japanese knotweed are the dominant shrubs with salmonberry also present. Reed canarygrass and ornamental lawn are dominant in the herbaceous layer. Ornamental nursery stock trees grown in agricultural rows are located on the west bank.	Remove Japanese knotweed, areas of ornamental lawn, and Himalayan blackberry and plant native wetland and upland vegetation. Excavate fill material along the west bank to expand the floodplain. Plant new floodplain area with native trees and shrubs. Remove and/or redistribute ornamental nursery stock.
L5	316	The tree layer includes big-leaf maple, western hemlock, and western redcedar. Big-leaf maple is dominant on the east bank. The shrub layer includes Himalayan blackberry on the east bank and Japanese knotweed and Himalayan blackberry on the west bank. Vegetation disturbance and soil compaction have resulted from adjacent commercial nursery.	Interplant native coniferous tree species on east bank. Remove patches of Japanese knotweed, Himalayan blackberry, and bamboo from the west bank and plant with native vegetation. Scarify and amend soil in compacted areas, remove all structures, and plant native trees and shrubs.
L5	317	Dominant trees on the east bank include red alder and black cottonwood with traces of western redcedar. Himalayan blackberry dominates the shrub layer with salmonberry and Indian plum also present. Red alder with traces of western redcedar are found in the canopy layer with Himalayan blackberry and lawn below.	Remove riprap and large patches of blackberry located along the east bank of the creek. Plant native coniferous tree species and upland shrubs. Remove driveway and patches of Himalayan blackberry and plant native vegetation on the west bank within the lawn area.

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SEA-TAC INTERNATIONAL AIRPORT
MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

EXISTING VEGETATION & WETLAND ENHANCEMENT ACTIONS

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APPENDIX B

Appendix B. Descriptions of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).

Sheet Number	Parcel Number	Existing Conditions	Proposed Mitigation Actions
L5	318 through 320	Red alder and big-leaf maple form a dense canopy. Ornamental shrubs, Himalayan blackberry, and grasses dominate the shrub and herbaceous layer.	Remove blackberry and plant areas with native trees and shrubs. Underplant areas of existing red alder and big-leaf maple with native coniferous trees and upland shrubs.
L5	321	Dominant vegetation associated with the existing residence includes ornamental shrubs, lawn, English holly, and cherry laurel.	Plant lawn with native trees and shrubs; remove areas of English holly and cherry laurel and plant with native trees and shrubs.
L5	322	Red alder dominates the tree layer on the west and east banks with Himalayan blackberry, cherry laurel, and English ivy dominant on the east bank. A small wetland area is located on a bench on the east bank.	Remove Himalayan blackberry, cherry laurel, and English ivy and interplant native wetland and upland species.
L5/L5.1	323	Red alder dominates the tree layer. Areas of grass and Himalayan blackberry are also present.	Remove blackberry and plant native trees and shrubs. Plant areas of grass with native trees and shrubs.
L5	329	Red alder is the dominant tree. There are areas of Himalayan blackberry, English ivy, and ornamental shrubs. There are also areas with trash within the shrub layer.	Remove blackberry and English ivy and plant with native trees and shrubs. Underplant areas of red alder with native coniferous trees and shrubs. Remove trash from the parcel.
L5	339 through 341	Dominant trees include red alder and black cottonwood with traces of western redcedar. Himalayan blackberry, salmonberry, Indian plum, and ornamental shrubs also present in the shrub layer.	Remove Himalayan blackberry and plant with native trees and shrubs.

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DRAWN BY: J. BURTON
SCALE: AS SHOWN
DATE: NOVEMBER 2001
CHECKED BY: -
APPROVED BY: P. FENDT

REVISIONS

NO	DATE	BY	DESCRIPTION	APPD	NO	DATE	BY	DESCRIPTION	APPD

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DESIGNER:
DRAWN BY:
SCALE:
DATE:
CHECKED BY:
APPROVED BY:

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT

PROJECT: MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS

SHEET TITLE: **EXISTING VEGETATION & WETLAND ENHANCEMENT ACTIONS**

WORK ORDER NO.:
CONSULTANT'S NO.:
PORT OF SEATTLE NO.: STIA XXXX TA4

APPENDIX B

Appendix B. Description of existing vegetation and proposed wetland and buffer enhancement actions along Miler Creek (continued).

Sheet Number	Parcel Number	Location	Existing Conditions	Proposed Mitigation Actions
1.5.3 and 1.5.4	218	Wetland / Stream	The area west of Water D is a young alder forest with relatively dense Himalayan blackberry and field morning glory in the understory. A driveway with a culvert has been placed in the wetland, at the north end of the wetland on this parcel.	Clear Himalayan blackberry from the wetland. Remove the driveway and culvert from the wetland. Regrade the area to match historic contours. Use BMPs and bioengineering techniques to stabilize the area after work is complete. Plant western redcedar and hemlock in red alder forest understory.
		Upland (House removed)	Upland areas are grassed or vegetated with red alder, western redcedar, big-leaf maple, or cherry laurel. A driveway crosses the upland.	Remove Himalayan blackberry and cherry laurel on southern property boundary. Remove driveway and associated fill, and regrade to match contours. Revegetate upland with tree and shrub species.
1.5.3	219	Wetland / Stream	West of Water D, wetland vegetation consists of lady fern, soft rush, small-fruited bulrush, common velvetgrass, watercress, and creeping buttercup. East of Water D, wetland vegetation consists of field horsetail, field morning glory, and Himalayan blackberry.	Control blackberry and plant wetland trees and shrubs in emergent wetland area.
		Upland (House remains)	A house, shed, lawn, ornamental shrubs, and areas of blackberry are present on the west side of the parcel. East of the stream, Himalayan blackberry and hydroseeded areas are present on the north side.	Remove driveway, house, shed and associated fill. Regrade to match historic conditions. Remove Himalayan blackberry and plant with trees. Near the wetland edge plant red alder and black cottonwood.
1.5.3	220	Wetland / Stream	The wetlands consist of field horsetail, common velvetgrass, and creeping buttercup.	Infill plant with specified plant species.
		Upland (No house present)	The parcel is forested with some Himalayan blackberry in the understory.	Remove blackberry located on the north side of the parcel and near the wetland edge. Plant sun-tolerant native coniferous tree species.
1.5.3	221	Wetland / Stream	Vegetation in the wetland consists of field horsetail, common velvetgrass, and creeping buttercup. Watercress is growing in Water D and three fruit trees are located in the wetland. Water D is lined with creosote railroad ties. Some reed canarygrass and Himalayan blackberry are located on the east property edge.	Remove creosote railroad ties, grade the area back to connect the stream with the floodplain, remove the blackberry, and replant the area with native wetland trees and shrubs.
		Upland (House remains)	This parcel is grassed with ornamental plantings around the house. The house is located at the wetland edge.	Remove the residential structures and assocated fill. Regrade to match historic conditions. Remove Himalayan blackberry on the north side and near the wetland edge. Plant open areas with sun-tolerant coniferous tree species.
1.5.3	222	Wetland / Stream	On the west side of the channel, the wetland borders the north, south, and east sides of the house. The wetland is dominated by creeping buttercup, field horsetail, and small-fruited bulrush. The east side of the channel is dominated by reed canarygrass with field horsetail and creeping buttercup. Himalayan blackberry borders the southern portion of the wetland.	Remove Himalayan blackberry and reed canarygrass on the east side. Plant willows.
		Upland (House remains)	A house is adjacent to the wetland. The upland area is lawn with a mature Douglas fir and small ornamental trees. Small ornamental shrubs are planted around the house. A compacted gravel driveway is located on the south side of the parcel.	Remove house, driveway, and associated fill. Regrade to smooth countours. Avoid damage to Douglas fir. Remove ornamental vegetation. Replant the area with native tree and shrub species.
1.5.3	223	Wetland / Stream	Near the house, the wetland is dominated by lady fern, creeping buttercup, and field horsetail in the emergent layer and salmonberry and Himalayan blackberry in the shrub stratum. A 3.5 ft high fence is located parallel to the channel, behind the house.	Remove fence. Remove blackberry. Plant wetland with willows.
		Upland (House remains)	The upland consists of a house, driveway, lawn, and ornamental shrubs. At the west edge of the wetland is a mature white oak tree and horse chestnut tree. In the SE corner, there is western redcedar, swordfern, creeping blackberry, ivy, and western hazelnut. Small areas of Himalayan blackberry, field morning glory, and English ivy are present in the understory of the forest.	Remove buildings, driveway, and associated fill. Regrade to smooth contours. Remove Himalayan blackberry, field morning glory, and ivy in the understory. Replant with native shade-tolerant shrub species (e.g., swordfern). Protect white oak and chestnut.
1.5.3	224	Wetland / Stream	See description for Parcel 222.	See description for Parcel 222.
		Upland (House remains)	The west portion of the property consists of a closed canopy forest of western redcedar, black cottonwood, big-leaf maple, and Douglas fir. The understory is composed of Indian plum, swordfern, with a dense coverage of Himalayan blackberry, some ivy, and English holly. A house remains on upland.	Remove structures and associated fill. Regrade to smooth contours. Control Himalayan blackberry and ivy near wetland edge. Plant shade-tolerant coniferous trees in the understory; otherwise little planting is required on this parcel.
1.5.3	225	Wetland / Stream (Garage and shed remain)	Half of the wetland is managed lawn and the other half is Himalayan blackberry and red alder trees. A garage and shed are located in the wetland.	Remove buildings and Himalayan blackberry. Plant native trees and shrubs.
		Upland (House remains)	The upland consists of a house, driveway, and lawn with ornamental shrubs next to the house. A raised concrete wall is located on the south side of the parcel, next to Parcel 226.	Remove buildings, concrete wall, and driveways. Regrade to smooth contours. Remove some ornamentals and English laurel and plant with mixed deciduous and coniferous native forest vegetation.

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SHEET TITLE: **EXISTING VEGETATION & WETLAND ENHANCEMENT ACTIONS**

STIA-XXXX-TA5

Appendix B. Description of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).

Sheet Number	Parcel Number	Location	Existing Conditions	Proposed Mitigation Actions
L5.3	226	Wetland / Stream (Shed remains)	The wetland area is primarily vegetated with lawn. Himalayan blackberry, field horsetail, field morning glory occur in patches and along east edge of the property. A shed is located in the wetland.	Remove buildings, driveway, and Himalayan blackberry; plant with willows.
		Upland (House remains outside buffer)	The upland consists of house, driveway, and lawn with ornamental shrubs.	Remove buildings, driveway, ornamental plants, and associated fill. Regrade to smooth contours. Plant with native trees and shrubs.
L5.3	227	Wetland / Stream	The wetland vegetation consists of alder trees and Himalayan blackberry.	Remove blackberry and plant additional coniferous trees to shade out blackberry.
		Upland (No structures)	Vegetation on the site consists predominantly of coniferous forest vegetation with a small area of lawn near the house and a patch of Himalayan blackberry west of the house. English ivy is present in the south central portion of the parcel.	Remove the Himalayan blackberry and plant the area with specified trees and shrubs. Remove English ivy in the south central portion of the parcel.
L5.3	228	Wetland / Stream	Small area of wetland in SE corner of parcel.	Plant with specified native trees and shrubs.
		Upland	The site is generally forested; however, some areas near the house are dominated by Himalayan blackberry.	Remove Himalayan blackberry and interplant with native coniferous tree species.
L5.3	229	Wetland / Stream	Wetland vegetation consists of creeping buttercup, reed canarygrass, and bentgrass. Black locust saplings/suckers are also present. A fence is located between the wetland and channel.	Remove fence. Remove reed canarygrass and locust. Plant willow trees and shrubs.
		Upland (No structures)	The small area of upland is located on the parcel and consists of grass and bare ground.	Plant this small area with a shade-tolerant tree or a few shade-tolerant shrubs.
L5.3	230	Wetland / Stream	A narrow fringe of palustrine emergent wetland is located near the east edge of the parcel (refer to the description of the wetland on Parcel 229).	Remove fence and locust saplings/suckers and plant this area with willow trees and shrubs.
		Upland (House remains)	Lawn and ornamental shrubs are planted around the house. Several trees are located along the channel and elsewhere. A house, garage, and concrete driveway are also present.	Remove buildings, driveway, and associated fill. Regrade to smooth contours. Plant with native trees and shrubs.
L5.2 and L5.3	231	Wetland / Stream	The wetland vegetation includes watercress, common velvetgrass, and field horsetail. There are red alder saplings and some ornamentals on the west side. The east side of the wetland is lined with larger red alder, western redcedar, and a cherry tree.	Remove reed canarygrass and blackberry. Plant with willow trees and shrubs.
		Upland (House removed)	The parcel has been graded and hydroseeded and is dominated by clover. A tulip tree is also on the site.	Plant entire upland area with native trees and shrubs.
L5.2 and L5.3	232	Wetland / Stream	The wetland includes a western redcedar overstory and an understory of alder saplings. The ground cover is primarily native emergent plants.	No action is necessary on this parcel.
		Upland (No structure in buffer)	The parcel is largely vegetated with an alder forest. The understory consists predominantly of native species including western hazelnut, Indian plum, and swordfern. Some blackberry cover is present on the south central property boundary. House is located outside buffer enhancement area.	Remove Himalayan blackberry in the southern portion of the site and plant the area with native trees.
L5.2	233	Wetland / Stream	The wetland contains forest and emergent areas. Red alder and large black cottonwood trees are present in the wetland. In open areas, emergent wetland vegetation consists of field horsetail, Himalayan blackberry, and yellow flag iris.	Remove Himalayan blackberry and yellow flag iris. Plant with willows and other trees and shrubs.
		Upland (House remains)	Vegetation is a mixture of lawn, ornamental shrubs, and native species (such as western hazelnut, bitter cherry, a couple of young Douglas fir). A garbage pile is located behind the house. There are two driveways on the property.	Remove garbage, buildings, driveways, concrete stairs, and associated fill. Grade to smooth contours. Remove vegetation between the house and the wetland and plant with specified native trees. Replant disturbed areas with specified trees and shrubs.
L5.2	234	Wetland / Stream	See description for Parcel 233.	See description for Parcel 233.
		Upland (House remains)	This area is mostly all lawn with no other vegetation present. Uplands contain house and driveway.	Remove buildings, driveway, and associated fill. Grade to smooth contours. Plant the open area with native sun-tolerant trees and shrubs.
L5.2	235	Wetland / Stream	Wetland vegetation consists of soft rush, small-fruited bulrush, creeping buttercup, sawbeak sedge, and field horsetail. Some Himalayan blackberry is present along and east of Water D. There is good tree cover (red alder, black cottonwood) on the east side of Water D.	Remove driveways and foundations. Plant open areas with willow trees and shrubs.

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EXISTING VEGETATION &
WETLAND ENHANCEMENT ACTIONS

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APPENDIX B

Appendix B. Description of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).

Sheet Number	Parcel Number	Location	Existing Conditions	Proposed Mitigation Actions
		Upland (House removed)	This area is primarily lawn with several large western redcedars are present on the north side of the parcel. A large horse chestnut is also present on the parcel. A driveway and foundation remain.	Remove driveways, foundations, and associated fill. Protect and preserve cedars. Grade to smooth contours. Plant the open area with specified native sun-tolerant trees and shrubs.
L5.2	236	Wetland / Stream	The wetland vegetation consists of common velvetgrass, field horsetail, and lady fern. Some Himalayan blackberry and field morning glory is present near Water D.	Remove Himalayan blackberry and field morning glory. Plant open and disturbed areas with willow trees and shrubs.
		Upland (Structures remain)	This area is predominantly lawn with scattered trees including Colorado blue spruce, mature western redcedar, and fruit trees (cherry and apple). A house, garage, and driveway remain on the east.	Remove structures, driveway, and associated fill. Grade to smooth contours. Plant lawn area with sun-tolerant coniferous tree species.
L5.2	237	Wetland / Stream	The wetland vegetation consists of wet meadow areas on the south side and red alder/black cottonwood forest, on the north side (near the road). In the open areas, some blackberry is present.	Remove Himalayan blackberry. Plant open areas with willow and underplant western redcedar trees.
		Upland	The majority of the upland area consists of relatively undisturbed Douglas fir and western redcedar forest. Understory consists of salal, Indian plum, western hazelnut, and swordfern. A small area of English ivy is located in the eastern portion of the parcel. Open, hydroseeded area remains on former home site, in the central portion of the parcel. Red alder saplings are growing in the cleared and hydroseeded areas.	Remove Himalayan blackberry and English ivy. Plant the open disturbed and open areas with native sun-tolerant trees.
L5.2	238	Wetland / Stream	Himalayan blackberry, field morning glory, climbing nightshade, and field horsetail are dominant in the wetland located near the east side of the parcel.	Remove Himalayan blackberry field morning glory, climbing nightshade. Plant disturbed areas with red alder, Sitka spruce, and black cottonwood.
		Upland (Structures remain)	A house, garage, and shed remain on the parcel. Lawn and ornamental shrubs are present near the house. Large pines and hemlock trees are also present on the site.	Remove building, driveway, and associated fill. Grade to smooth contours. Protect pines and hemlocks. Plant disturbed and open areas with native sun-tolerant coniferous trees. Remove ornamental shrubs and replant the area with vine maple.
L5.2	239	Wetland / Stream	This wetland contains some mature red alder and black cottonwood trees. Various grasses, soft rush, and field horsetail occur in the understory.	Remove Himalayan blackberry. Plant disturbed areas with western redcedar. Interplant western redcedar in forested areas.
		Upland (Structures removed)	Vegetation on the site includes grasses on the old house pad with Pacific madrone, red alder, cherry laurel, and western redcedar located around the perimeter of the house. Himalayan blackberry occurs in open areas, between the house and the wetland.	Remove Himalayan blackberry and field morning glory. Plant open and disturbed areas with specified native trees and shrubs.
L5.2	240	Wetland / Stream	The wetland vegetation includes an overstory of red alder and understory of Himalayan blackberry, field morning glory, and bentgrass. An approximately 30-ft segment of Water D has been placed in an 18-inch culvert, at the southern portion of the site.	Remove Himalayan blackberry and field morning glory. Daylight Water D by removing the 30-ft-long culvert. Stabilize the banks by using bioengineering techniques and replanting with willow stakes. Plant disturbed areas with western redcedar and willow.
		Upland (Shed remains)	Upland portion of the parcel is grassland. Ornamental trees and shrubs occur along the perimeter. Himalayan blackberry occurs in patches.	Remove driveway and Himalayan blackberry. Plant the open areas with native tree and shrub species.
L5.2	241	Wetland / Stream	This area has a young red alder overstory with a thick Himalayan blackberry and stinging nettle understory. Field morning glory is also present.	Remove blackberry and replant disturbed areas with native trees and shrubs.
		Upland	This area is largely grassland. Several large Douglas fir, cherry laurel, and pine trees occur near the north property line. Hazelnut and fir trees are present around the perimeter of the lot. An area of mounded soil and concrete blocks is present, behind the former house pad.	Remove blackberry and field morning glory. Remove concrete blocks and block fragments. Remove cherry laurel and plant disturbed and open areas with native trees and shrubs.
L5.1 and L5.2	242	Wetland / Stream	A narrow fringe of wetland is located on this parcel and associated with Miller Creek. The wetland contains creeping buttercup, field horsetail, and jewelweed. Common tansy and western hazelnut are located immediately adjacent to the wetland edge. Areas of blackberry, climbing nightshade, and yellow flag iris are located near and in the wetland.	Control blackberry, yellow flag iris, and climbing nightshade. Plant native shrub species near the wetland.
		Upland (Structures removed)	Vegetation on this site is largely grass. Several trees are present near the perimeter, and cherry laurel and other ornamental species are also present.	Plant open areas with native trees and shrubs.
L5.1 and L5.2	243	Wetland / Stream	The wetland is a narrow fringe located immediately adjacent to the channel. Vegetation in the channel includes Pacific willow, creeping buttercup, and field horsetail. A few large black cottonwood trees are located adjacent to the channel. An approximately 75-ft segment of Water D, between the driveway and outbuildings, has been placed in a cement culvert.	Remove Water D from the culvert. Restore the banks of Water D by using BMP's, bioengineering techniques, and planting willow stakes.

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PROJECT MILLER CREEK INSTREAM AND BUFFER ENHANCEMENTS
SHEET TITLE EXISTING VEGETATION &
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APPENDIX B

Appendix B. Description of existing vegetation and proposed wetland and buffer enhancement actions along Miller Creek (continued).

Sheet Number	Parcel Number	Location	Existing Conditions	Proposed Mitigation Actions
I.5.1 and I.5.2	243	Upland (Structures remain)	A gravel driveway occurs within 10 ft of the stream. Patches of native and non-native trees are present in a grassy meadow. Pacific willows are located next to the stream. Small patches of blackberry are becoming established in the meadow. A house and several outbuildings are still present.	Remove structures and the gravel driveway after access is no longer needed. Remove patches of blackberry and plant the disturbed areas and the open meadow with native trees and shrubs.
I.5.1 and I.5.2	244	Upland (Structures present)	Grasses dominate this area with areas of Himalayan blackberry and field morning glory becoming established. Cattail and other wetland plants are becoming established on recently graded and compacted areas where residential structures were recently removed. Several fruit trees are also present. There is an existing gravel driveway and several mounds of gravel.	Remove driveway, house, gravel, and associated fill. Remove blackberry and field morning glory, and plant with native trees and shrubs.
I.5.4	254	Wetland / Stream	Creeping buttercup is dominant in the wetland, with some Himalayan blackberry on the south and north sides. A Douglas fir on the east and a western redcedar on the west border the area.	Remove Himalayan blackberry. Plant trees (western redcedar) in the wetland.
		Upland (Structures removed)	The area is vegetated with grasses and scattered trees (western hemlock, black cottonwood, and several fruit trees).	Remove buildings, driveway, and associated fill. Grade to smooth contours. Plant disturbed areas with trees and shrubs.
I.5.4	261	Wetland / Stream	The wetland vegetation consists of creeping buttercup, field horsetail, and skunk cabbage, but a few red alder are also present. Blackberry is also present, especially along the perimeter of the wetland. A driveway has been constructed in the wetland, at the north edge of the wetland.	Remove Himalayan blackberry from wetland. Remove the driveway on the north side, between Parcel 254R and Parcel 261 and on the south side of the wetland between Parcels 261 and 218. Plant the open and disturbed areas with willow trees and shrubs.
		Upland (Structures removed)	Most of the area is grass. Coniferous trees are present on the south side, with big-leaf maple, western redcedar, and Douglas fir on the north side. Red alder saplings are becoming established on the parcel.	Protect existing conifers and big-leaf maple. Plant sun-tolerant trees and shrubs in open meadow areas.

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TYEE VALLEY GOLF COURSE AND DES MOINES CREEK BUFFER PLANTING PLAN SEATTLE-TACOMA INTERNATIONAL AIRPORT

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STIA-XXXX-T1	TITLE SHEET				
STIA-XXXX-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS				
STIA-XXXX-C2	PLANTING PLAN				
STIA-XXXX-C3	EXTENT OF FLOODING IN/AROUND WETLAND ENHANCEMENT AREAS				
STIA-XXXX-C4	CROSS SECTION OF MITIGATION AREA				
STIA-XXXX-L1	PLANTING SCHEDULE AND DETAILS				

MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

DATE

DATE

DATE

APPROVED BY

DATE

WORK ORDER NO.	PROJECT NO.
STIA-XXXX	STIA-XXXX-T1

APPENDIX C

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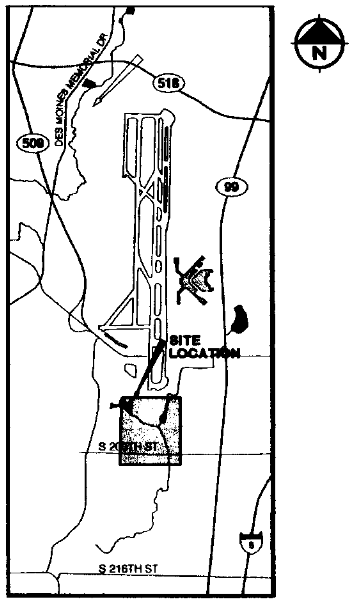
DATE: 10/31/01

VICINITY MAP



LEGEND

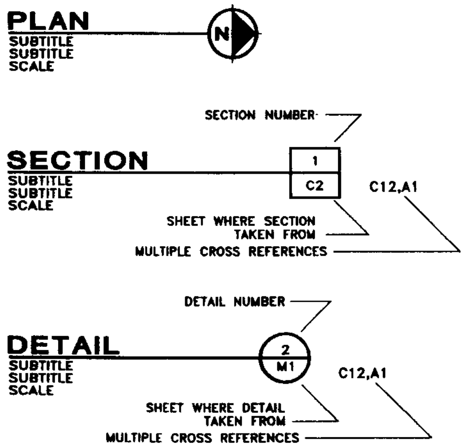
— 265 —	EXISTING CONTOUR
- - - - - -	EXISTING GRADE (SECTION)
——x——	CHAIN LINK FENCE
—·—··—··—	WETLAND BOUNDARY
————	EXISTING FLOODPLAIN BOUNDARY
————	PROPOSED FLOODPLAIN BUFFER
- - - - - - - -	LIMIT OF 100 FT RIPARIAN BUFFER
—··—··—	WATERBODY
—·—··—	BOUNDARY OF IWS

GENERAL ABBREVIATIONS

DIA	DIAMETER
E	EAST/EASTING
EQ	EQUIVALENT
GAL.	GALLON
N	NORTH/NORTHING
NTS	NOT TO SCALE
O.C.	ON CENTER
S.F.	SQUARE FOOT/FEET
SS	SANITARY SEWER
TYP.	TYPICAL

GENERAL LEGEND

DRAWING TITLE:



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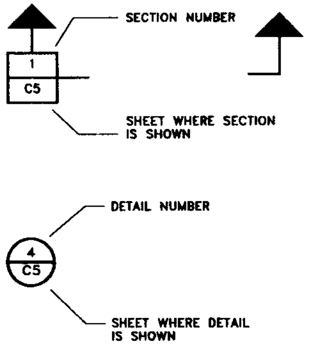

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1. CALL "DIG-SAFE" (1-800-425-5555) PRIOR TO COMMENCING ANY GRADING OR EXCAVATION WORK ON THE SITE.
2. INSTALLATION OF TEMPORARY EROSION AND SEDIMENT CONTROLS SHALL BE COMPLETED PRIOR TO SITE WORK.

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PROJECT: TYEE VALLEY GOLF COURSE WETLAND MITIGATION
SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

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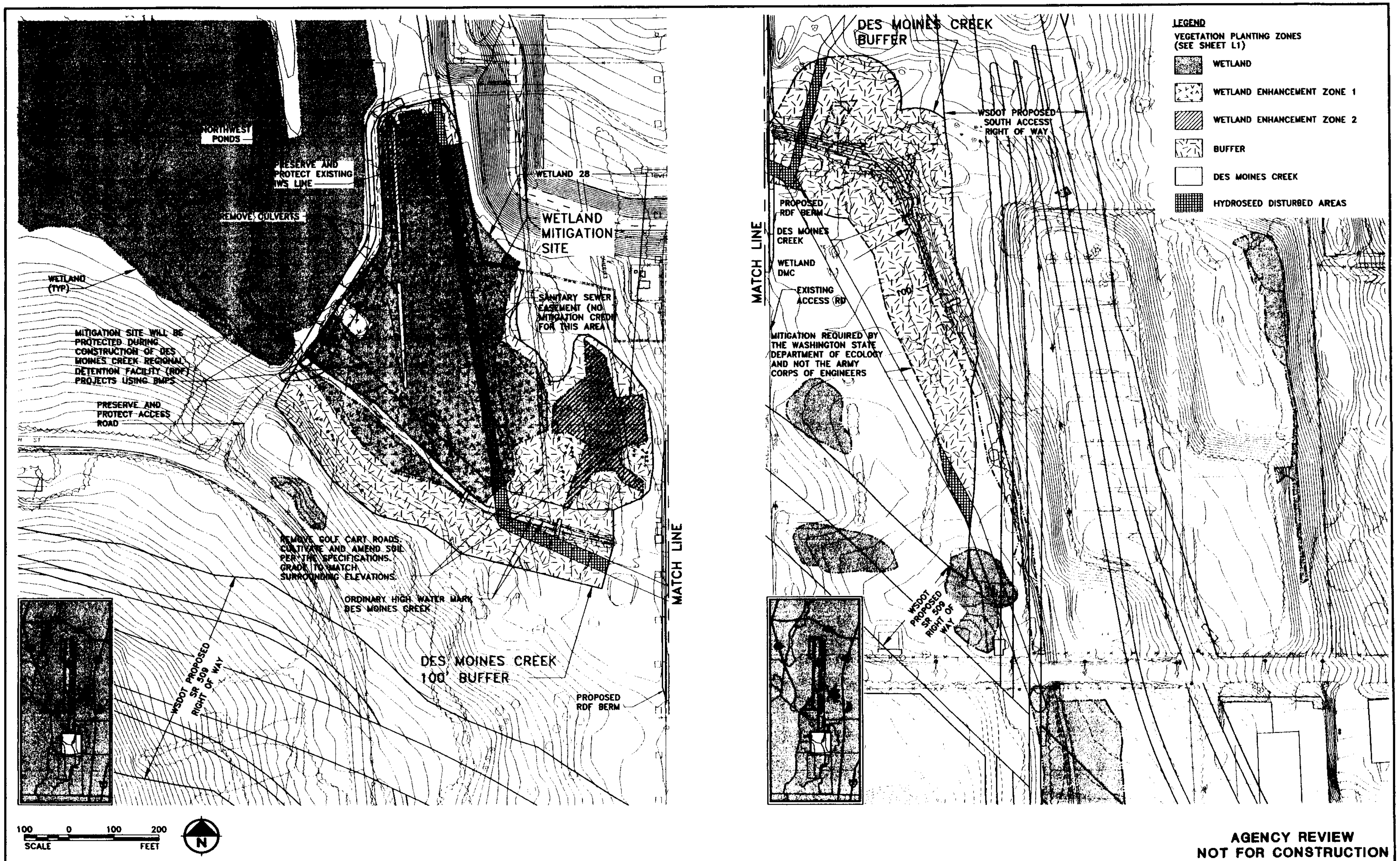
S714-XXXY-C1

APPENDIX C



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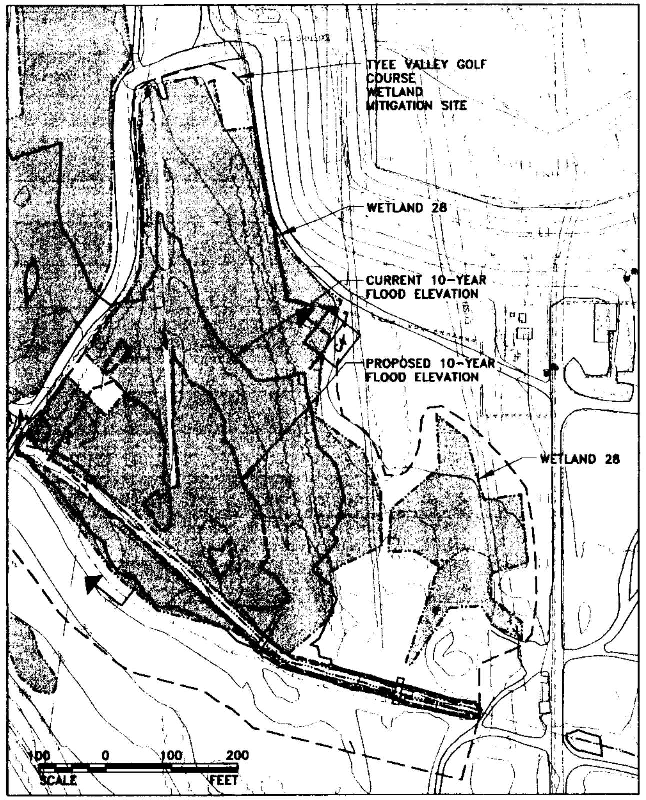
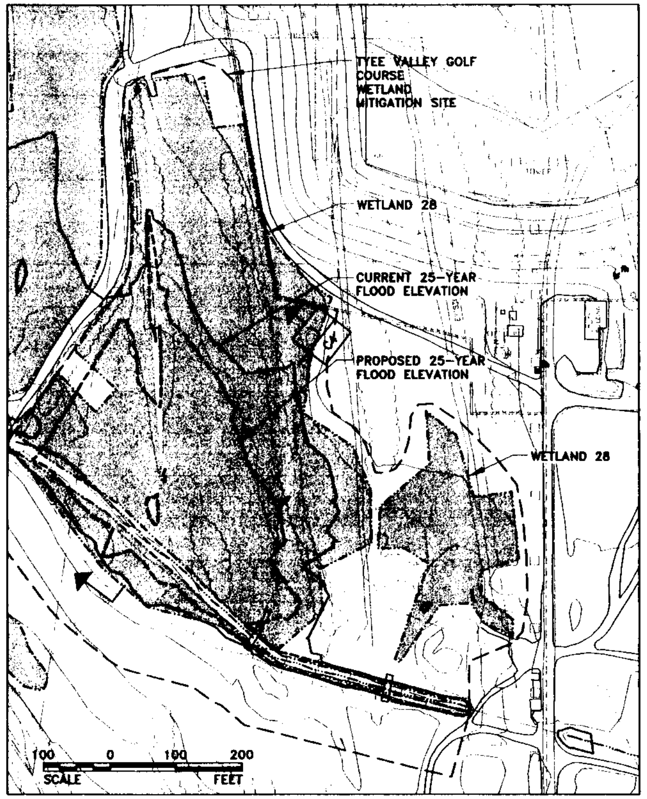
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: TYEE VALLEY GOLF COURSE
WETLAND MITIGATION
SHEET TITLE: PLANTING PLAN

291282C2
S714-XXXY-C2
APPENDIX C

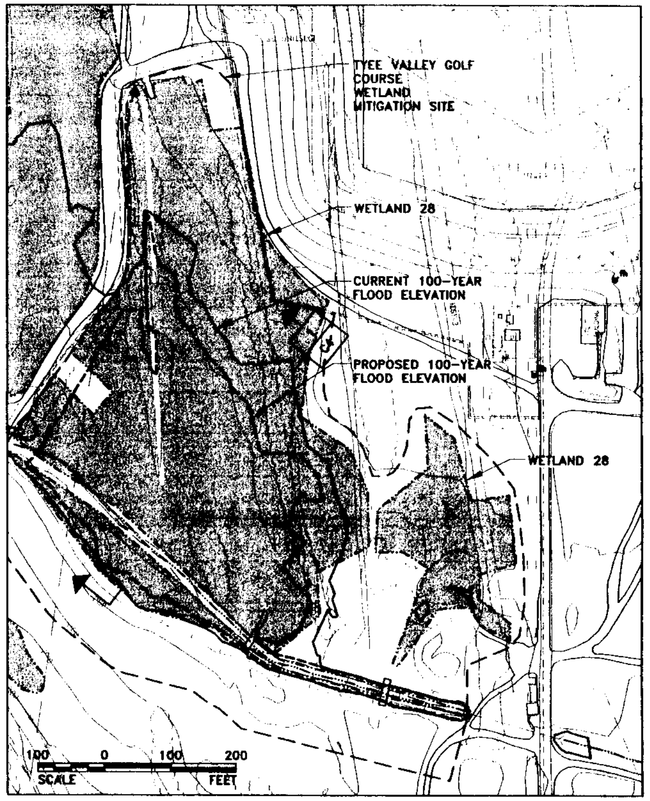
DATE: 11/15/01



PLAN
EXTENT OF CURRENT
AND PROPOSED
10-YEAR FLOOD LIMITS



PLAN
EXTENT OF CURRENT
AND PROPOSED
25-YEAR FLOOD LIMITS



PLAN
EXTENT OF CURRENT
AND PROPOSED
100-YEAR FLOOD LIMITS

LEGEND:

——— CURRENT WATER ELEVATION
- - - - - - PROPOSED WATER ELEVATION AFTER DES MOINES CREEK RECONSTRUCTION (BY OTHERS)
■ PROPOSED TYEE VALLEY GOLF COURSE WETLAND ENHANCEMENT
— — — — TYEE VALLEY GOLF COURSE WETLAND ENHANCEMENT AREA

SOURCE: DES MOINES CREEK BASIN PLANNING COMMITTEE

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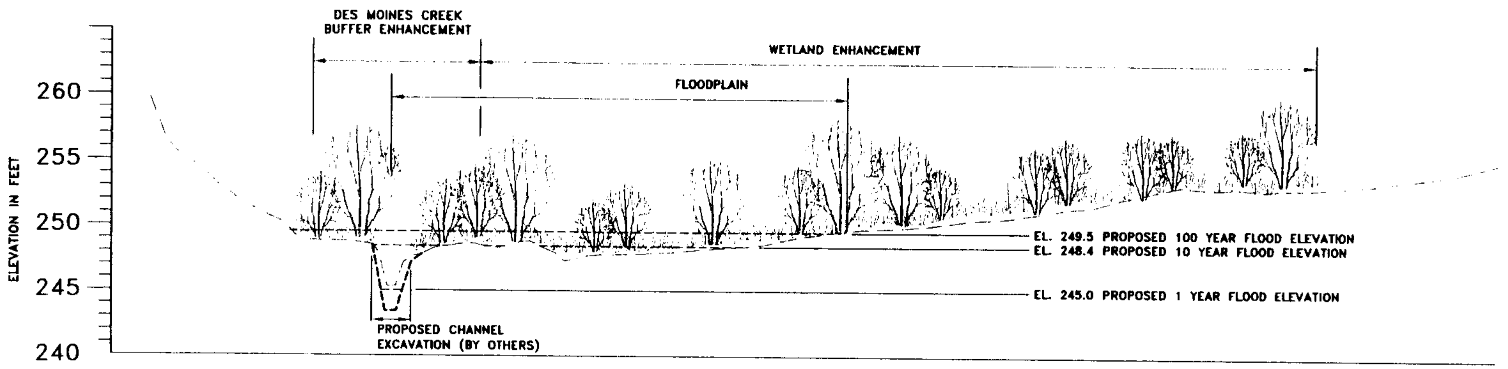
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: TYEE VALLEY GOLF COURSE
WETLAND MITIGATION
SHEET TITLE: **EXTENT OF FLOODING IN/AROUND WETLAND ENHANCEMENT AREAS**

291282C3
S714-XXXY-C3
APPENDIX C

DATE: 10/31/01 FILENAME: 291282C3



SECTION

1
C3

RDF HYDRAULICS AND TYEE GOLF
COURSE WETLAND MITIGATION SITE
HORIZ SCALE: 1" = 40'
VERT. SCALE: 1" = 5'

SOURCE: DES MOINES CREEK BASIN PLANNING COMMITTEE

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0 1"
ONE INCH AT FULL SCALE
IF NOT SCALE ACCORDINGLY

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SEA-TAC INTERNATIONAL AIRPORT
PROJECT: TYEE VALLEY GOLF COURSE
WETLAND MITIGATION
SHEET TITLE: **CROSS SECTION OF MITIGATION AREA**

291282C4
S714-XXXY-C4

APPENDIX C

DATE 10/31/01 FILENAME 291282C4

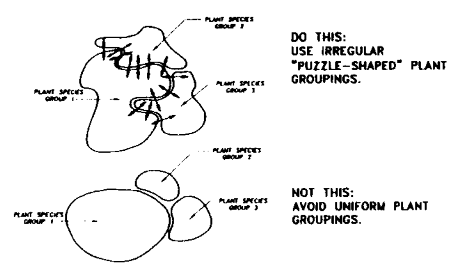
NOTES:

1. PRESERVE AND PROTECT ALL TREES AND SHRUBS NOT DESIGNATED FOR REMOVAL. PROVIDE, ERECT, AND MAINTAIN BARRICADES NECESSARY TO PREVENT ACCESS TO AREA WITHIN DRIP LINES OF EXISTING TREES. ALLOW NO VEHICULAR AND PEDESTRIAN TRAFFIC, OR STACKING AND/OR STORAGE OF CONSTRUCTION MATERIALS WITHIN BARRICADES.
2. CONTRACTOR SHALL LAY OUT A 10,000 S.F. TEST PLOT, IN WHICH THE POSITIONS OF ALL PLANTS SHALL BE STAKED WITH FLAGS THAT ARE COLOR CODED TO REPRESENT SPECIFIC SPECIES. LAYOUT SHALL BE INSPECTED AND APPROVED BY ENGINEER PRIOR TO COMMENCEMENT OF PLANTING. APPROVED STAKING SHALL SERVE AS THE PLANT LAYOUT STANDARD FOR THE REMAINDER OF THE PLANTING AREA.
3. SHRUB MASSES SHALL CONSIST OF MULTIPLE SINGLE-SPECIES GROUPS (SEE DETAIL 1). CONTRACTOR SHALL ENSURE THAT THESE SINGLE-SPECIES GROUPS HAVE A VARIETY OF SIZES AND SHAPES, AND THAT SHRUB MASSES HAVE A VARIETY OF SPECIES. SEE PLANTING SCHEDULE FOR NUMBERS OF PLANTS IN SINGLE-SPECIES GROUPS.
4. CONTRACTOR SHALL COMPLY WITH ARCHAEOLOGICAL MONITORING REQUIREMENTS, AND RESTRICTIONS RESULTING FROM CONTACT WITH ARCHAEOLOGICALLY SIGNIFICANT OBJECTS (SEE SPECIFICATIONS).
5. CONTRACTOR SHALL HYDROSEED ALL AREAS DISTURBED BY WORK, USING HERBACEOUS WETLAND SEED MIX (SEE SPECIFICATIONS). RE-SEED ALL AREAS THAT ARE DISTURBED BY SUBSEQUENT WORK. KEEP HYDROSEEDING OFF ANY MULCH CIRCLES.
6. AN AUTOMATIC IRRIGATION SYSTEM WILL BE PROVIDED FOR ALL PLANTING AREAS.

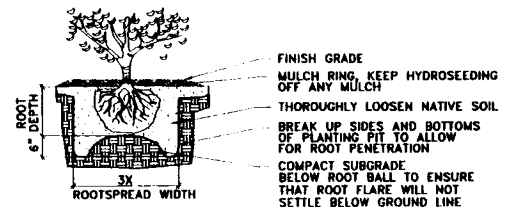
PLANT SCHEDULE

Symbol	Botanical Name	Size	Density (Plants Per Acre)	Condition / Remarks
▨	**Wetland Enhancement Zone 1**			
	SHRUBS		3,375	
	Salix hookeriana/Hookers willow *Salix sitchensis*/Sitka willow *Spiraea douglasii*/Hardhack spiraea *Salix lucida ssp. lasiandra*/Pacific willow	1 gal./Stakes 1 gal./Stakes 1 gal. 1 gal./Stakes		- IN CONTAINERS / ROOTING TO SIDES AND BOTTOM OF CONTAINER. LIVE STAKES SHALL BE 36"-48" HT., 1/2" -1" DIA., WITH A MIN. OF 10 VIABLE BUDS ON EACH STAKE. 3-4 BUDS SHALL BE BELOW GRADE. - LOCATE PLANTS IN SINGLE-SPECIES GROUPS OF 7 TO 12.
▨	**Wetland Enhancement Zone 2**			
	SHRUBS		3,375	
	Salix scouleriana/Scoulers willow *Physocarpus capitatus*/Pacific ninebark *Rosa pisocarpa*/Clustered wildrose	1 gal. 1 gal. 1 gal.		- IN CONTAINERS / ROOTING TO SIDES AND BOTTOM OF CONTAINER. - LOCATE PLANTS IN SINGLE-SPECIES GROUPS OF 7 TO 12.
▨	**Buffer Planting**			
	TREES		280	- IN CONTAINERS / ROOTING TO SIDES AND BOTTOM OF CONTAINER. LIVE STAKES SHALL BE 36"-48" HT., 1/2" -1" DIA., WITH A MIN. OF 10 VIABLE BUDS ON EACH STAKE. 3-4 BUDS SHALL BE BELOW GRADE. - LOCATE PLANTS IN SINGLE-SPECIES GROUPS OF 7 TO 12.
	Thuja plicata/Western redcedar * *Alnus rubra*/Red alder *Populus trichocarpa*/Black cottonwood	1 gal. 1 gal. 1 gal./Stakes		
	SHRUBS		2,100	
	Acer circinatum/Vine maple *Rosa nutkana*/Nootka rose	1 gal. 1 gal.		

* Western redcedar will be planted in a second planting phase, to follow year-3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.



DETAIL ① TYP
SHAPES OF PLANTING MASSES
NTS

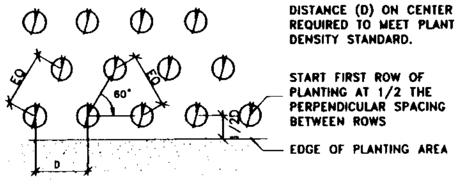


DETAIL ② TYP
TREE AND SHRUB PLANTING
(TYPICAL)

NOTE:

ALL SHRUB SPACING SHALL BE EQUIDISTANT UNLESS OTHERWISE SPECIFIED

DISTANCE (D) ON CENTER AS REQUIRED TO MEET PLANT DENSITY STANDARD.



DETAIL ③ TYP
TRIANGULAR SHRUB SPACING
(TYPICAL)

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Port of Seattle
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PROJECT: TYEE VALLEY GOLF COURSE WETLAND MITIGATION
SHEET TITLE: **PLANTING SCHEDULE AND DETAILS**

291282L1
S714-XXXY-L1
APPENDIX C

DATE: 11/09/01 FILENAME: 291282L1 IMAGES XREFS

Port of Seattle
Aviation Division

APPENDIX D

REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

AGENCY REVIEW
NOT FOR CONSTRUCTION

SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE
STIA-XXXX-T1	TITLE SHEET				
STIA-XXXX-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS				
STIA-XXXX-C2	PLAN				
STIA-XXXX-C3	PLAN				
STIA-XXXX-C3.1	LOCATION OF REPLACEMENT DRAINAGE CHANNELS				
STIA-XXXX-C4	PLAN				
STIA-XXXX-C5	PLAN				
STIA-XXXX-C6	PLAN				
STIA-XXXX-C7	PLAN				
STIA-XXXX-C8	STREAM BUFFER AND EMBANKMENT CROSS SECTION				
STIA-XXXX-C8.1	FLOW DISPERSION DETAILS				
STIA-XXXX-C9	TYPICAL SECTIONS				
STIA-XXXX-L1	PLANTING SCHEDULE AND DETAILS				

MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

DATE

DATE

DATE

APPROVED BY

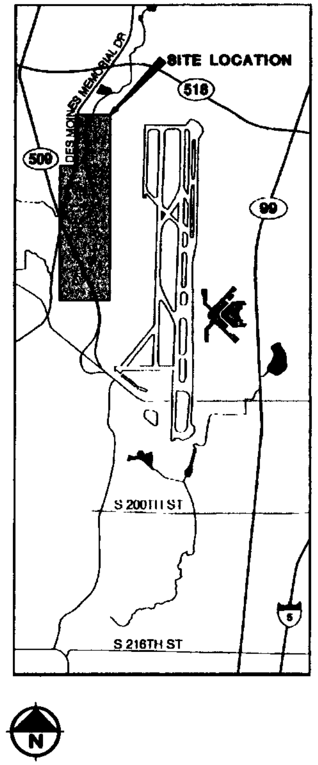
DATE

WORK ORDER NO.	PROJECT NO.
STIA-XXXX	STIA-XXXX-T1

APPENDIX D

IMAGES:
XREF'S:
FILENAME: 2912O3T1
DATE: 10/30/01

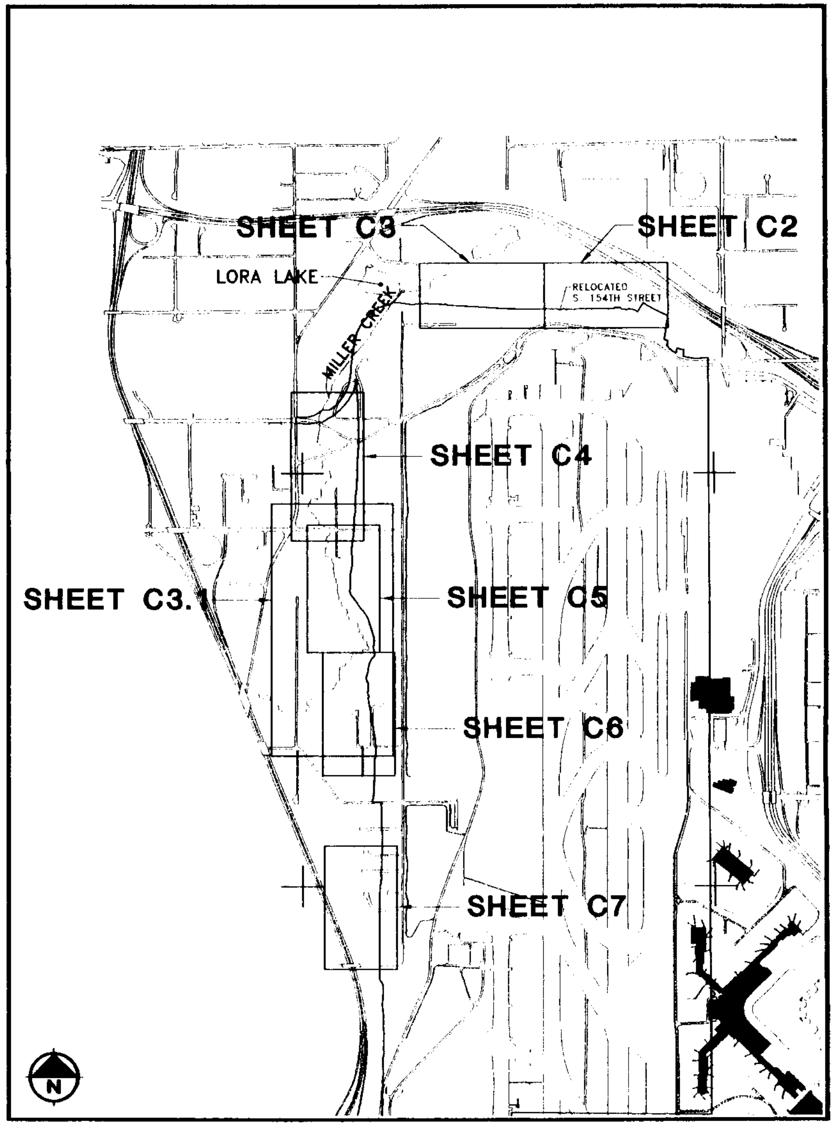
VICINITY MAP



LEGEND

⟩—⟨	CULVERT
—··—	WATER BODY
—·—·—	WETLAND BOUNDARY
—265—	EXISTING CONTOUR (MAJOR)
——	EXISTING CONTOUR (MINOR)
—+— 7+00	STREAM CENTERLINE AND STATIONING
—·—	PARCEL BOUNDARY
265	PARCEL NUMBER
▩	WETLAND
▨	RIPARIAN AND WETLAND PLANTING ZONE
▤	NATIVE SUBGRADE
▧	UPLAND BUFFER PLANTING ZONE
▭	STORMWATER POND
— — — —	TEMPORARY CONSTRUCTION BOUNDARY
———	PERMANENT IMPACT BOUNDARY
— — — —	WETLAND AND RIPARIAN BUFFER

KEY MAP



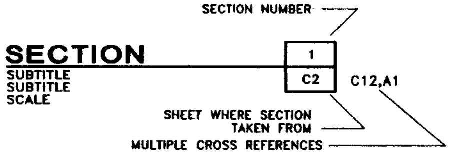
CONSTRUCTION AND RESTORATION NOTES:

1. THE ENGINEER SHALL IDENTIFY AREAS NOT TO BE DISTURBED. THESE AREAS SHALL BE PROTECTED WITH ORANGE BARRIER FENCE, SEDIMENT FENCE, OR OTHER BMPS DESIGNED TO PREVENT SEDIMENT RUNOFF OR VEGETATION DISTURBANCE.
2. POTENTIAL TEMPORARY WETLAND IMPACTS FROM CONSTRUCTION ARE SHOWN ON SHEETS C2 THROUGH C7. THE POTENTIAL TEMPORARY IMPACTS ARE NOT TO EXCEED IS 2.05 ACRES.
3. A QUALIFIED BIOLOGIST WILL IDENTIFY ALL DISTURBED WETLANDS TO BE RESTORED.
4. IN EXCAVATED AREAS, PRE-CONSTRUCTION GRADES WILL BE RESTORED BY FIRST PLACING SUB-SOILS IN THE EXCAVATION AREA. SECOND, A MINIMUM OF 12 INCHES OF TOP SOIL WILL BE PLACED TO ESTABLISH PRE-CONSTRUCTION GRADES.
5. IMPORTED TOPSOIL, IF USED, SHALL CONTAIN A MINIMUM OF 8% AND MAXIMUM OF 15% ORGANIC MATERIAL AND BE FREE OF WEED SEED.
6. AFTER CONSTRUCTION IS COMPLETE, AND PRIOR TO RESTORATION ACTIVITIES, ALL CONSTRUCTION DEBRIS AND TRASH WILL BE REMOVED FROM WETLAND AREAS AND PRE CONSTRUCTION GRADES WILL BE ACHIEVED.
7. ANY WETLAND SOIL THAT HAS BEEN COMPACTED DURING WORK ACTIVITIES SHALL BE CULTIVATED TO A DEPTH OF 12 INCHES AND HYDROSEEDED WITH A DESIGNATED WETLAND SEED MIX.
8. THE AREAS REQUIRING RESTORATION WILL BE REPLANTED WITH NATIVE TREE AND SHRUB SPECIES.

GENERAL ABBREVIATIONS

&	AND
DIA	DIAMETER
EQ	EQUIVALENT
EXIST	EXISTING
GA	GAUGE
GAL	GALLON
HT	HEIGHT
LS	LIVE STAKE
MIN	MINIMUM
NTS	NOT TO SCALE
SF	SQUARE FOOT/FEET
OC	ON CENTER

GENERAL



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PROJECT: REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS

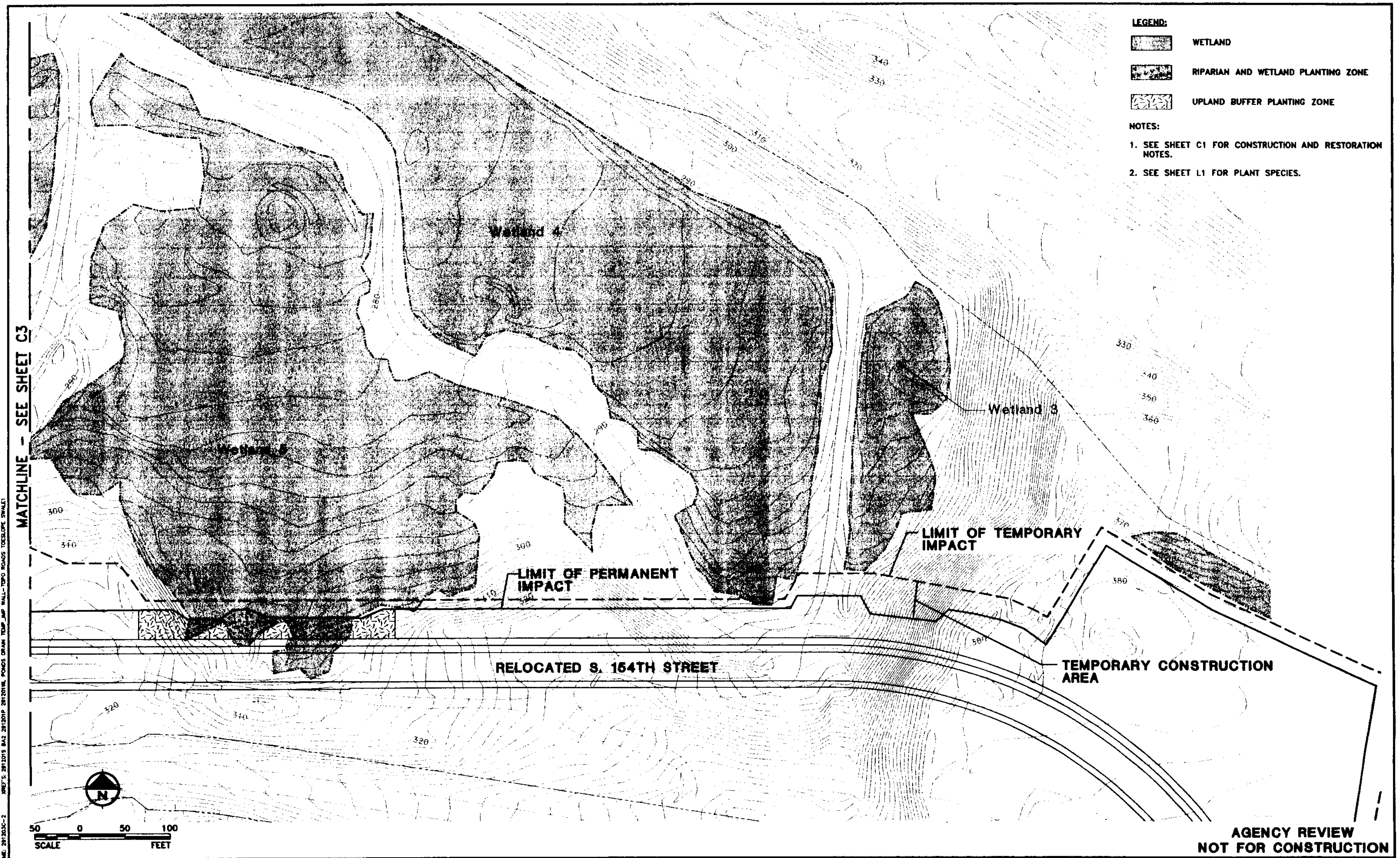
SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

--
291203C1
STIA-XXXX-C1

APPENDIX D

KEYMAP.DWG

DATE: 11/15/01 FILENAME: 291203C1



NOTES:

1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.

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29120WL

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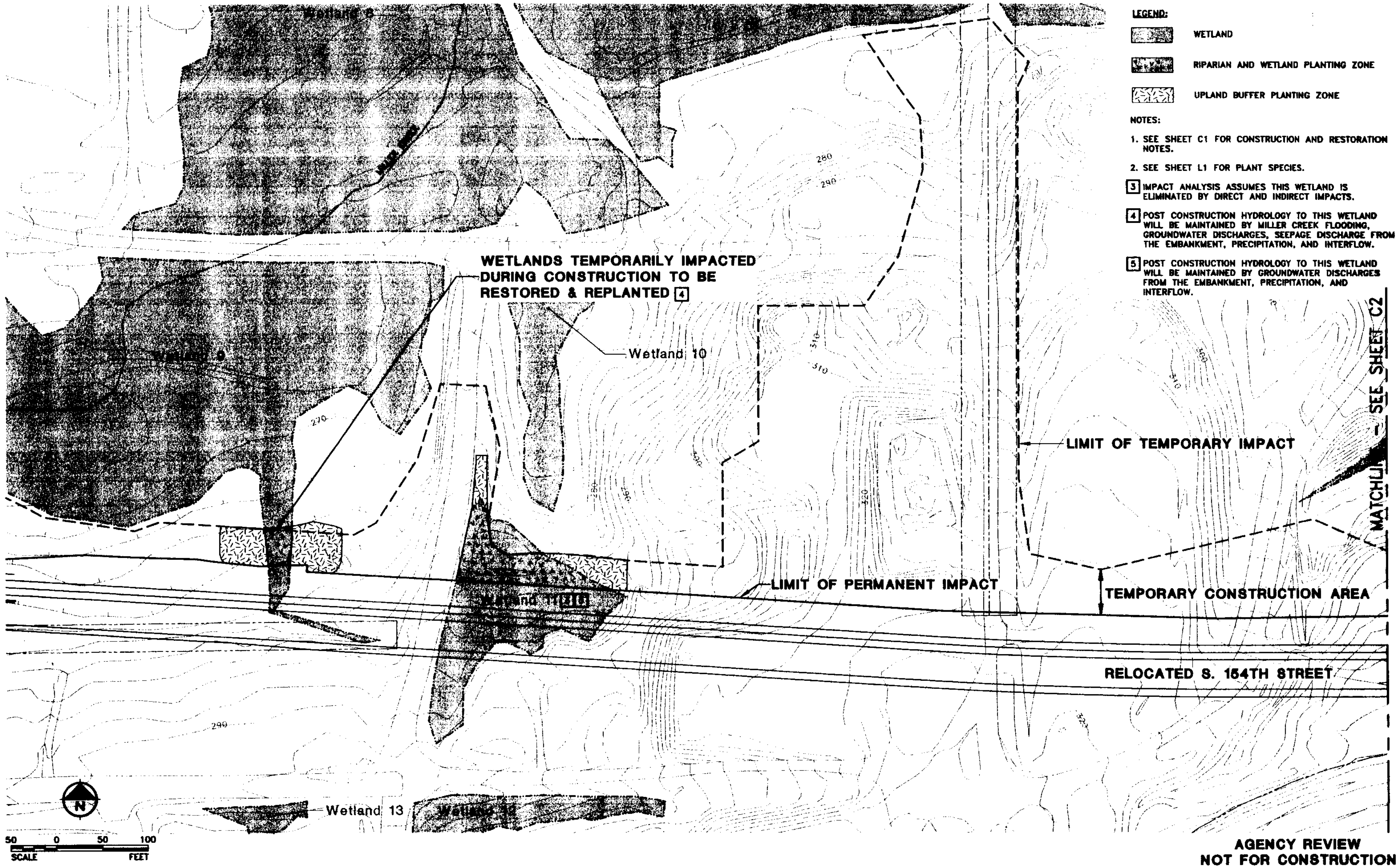
REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS
PLAN

–
291203C-2
STIA-XXXX-C2

APPENDIX D

DATE: 11/07/01 FILENAME: 291203C-2 XREF'S: 291201S BA2 291201P 29120WL PONDS DRAIN TEMP_IMP WALL-TOPO ROADS TOESLOPE SWALE1 IMAGES:



LEGEND:

▨	WETLAND
▩	RIPARIAN AND WETLAND PLANTING ZONE
▧	UPLAND BUFFER PLANTING ZONE

NOTES:

1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.

3 IMPACT ANALYSIS ASSUMES THIS WETLAND IS ELIMINATED BY DIRECT AND INDIRECT IMPACTS.

4 POST CONSTRUCTION HYDROLOGY TO THIS WETLAND WILL BE MAINTAINED BY MILLER CREEK FLOODING, GROUNDWATER DISCHARGES, SEEPAGE DISCHARGE FROM THE EMBANKMENT, PRECIPITATION, AND INTERFLOW.

5 POST CONSTRUCTION HYDROLOGY TO THIS WETLAND WILL BE MAINTAINED BY GROUNDWATER DISCHARGES FROM THE EMBANKMENT, PRECIPITATION, AND INTERFLOW.

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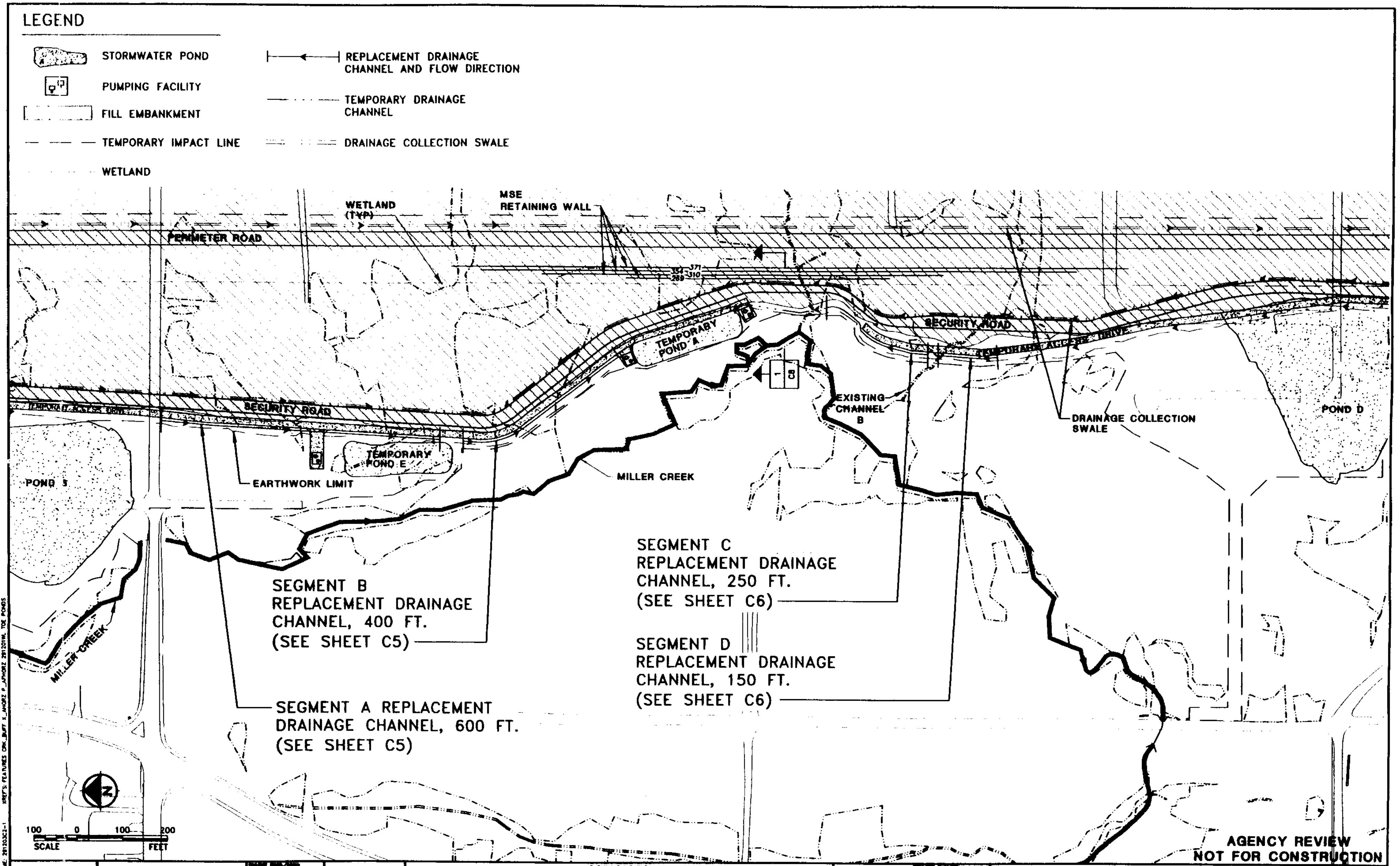
REPLACEMENT DRAINAGE CHANNELS AND
RESTORATION OF TEMPORARILY IMPACTED WETLANDS
PLAN

—
291203C2
STIA-XXXX-C3

291201BA2
29120WL

DATE: 10/30/01 FILENAME: 291203C2

APPENDIX D



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REPLACEMENT DRAINAGE CHANNELS AND
RESTORATION OF TEMPORARILY IMPACTED WETLANDS

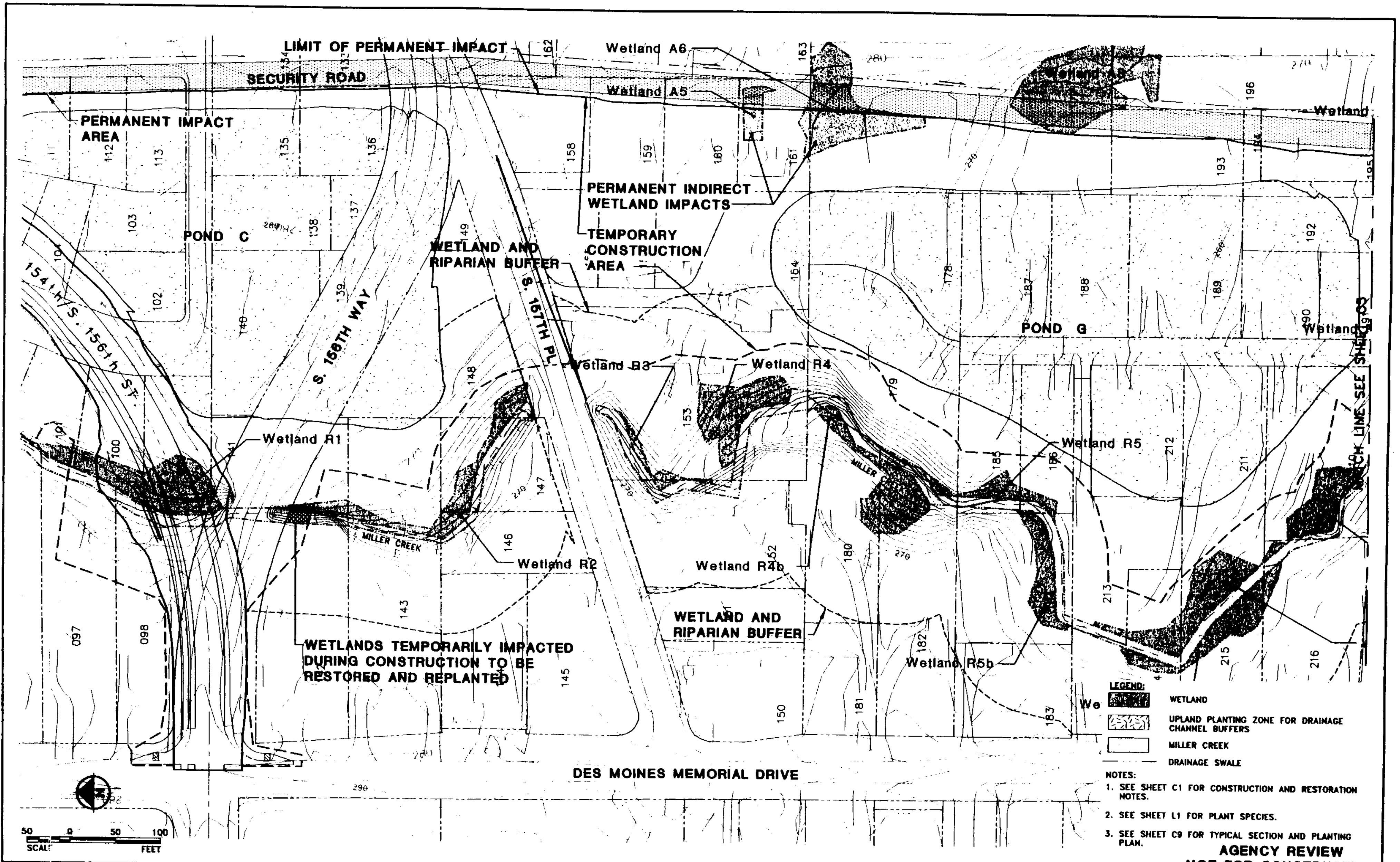
LOCATION OF REPLACEMENT DRAINAGE CHANNELS

—
291203C2-1
STIA-XXXX-C3.1

APPENDIX D

DATE: 11/15/01 FILENAME: 291203C2-1

KEYMAP.DWG



LEGEND:

▨	WETLAND
▨	UPLAND PLANTING ZONE FOR DRAINAGE CHANNEL BUFFERS
☐	MILLER CREEK
——	DRAINAGE SWALE

NOTES:

1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.
3. SEE SHEET C9 FOR TYPICAL SECTION AND PLANTING PLAN.

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PROJECT: REPLACEMENT DRAINANGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS

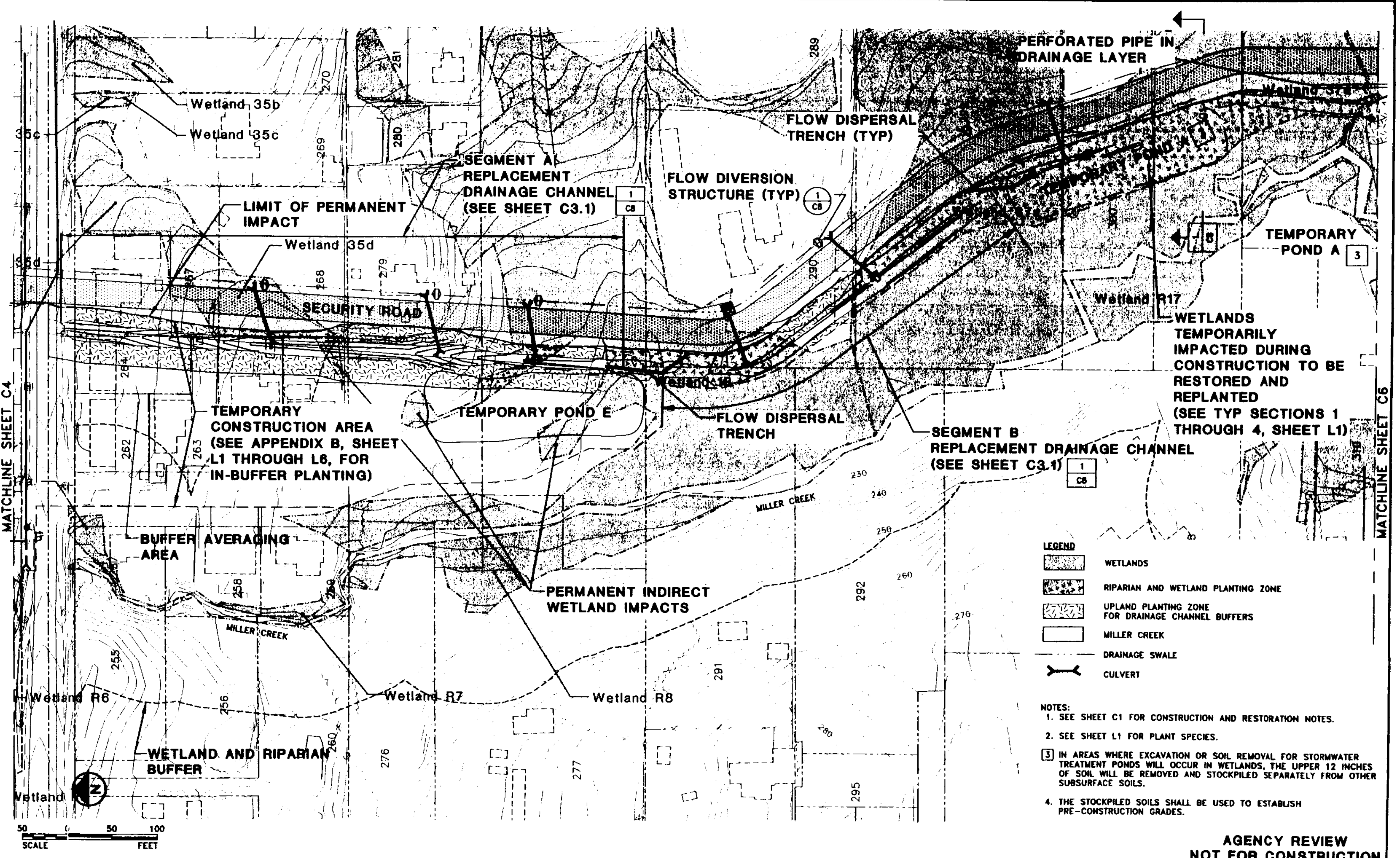
SHEET TITLE: PLAN

–
291203C3
STIA-XXXX-C4

APPENDIX D

291201BA2
291201WL

DATE: 11/14/01 FILENAME: 291203C3



LEGEND

▨	WETLANDS
▩	RIPARIAN AND WETLAND PLANTING ZONE
▧	UPLAND PLANTING ZONE FOR DRAINAGE CHANNEL BUFFERS
☐	MILLER CREEK
— · · · —	DRAINAGE SWALE
>—<	CULVERT

NOTES:
1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.
3. IN AREAS WHERE EXCAVATION OR SOIL REMOVAL FOR STORMWATER TREATMENT PONDS WILL OCCUR IN WETLANDS, THE UPPER 12 INCHES OF SOIL WILL BE REMOVED AND STOCKPILED SEPARATELY FROM OTHER SUBSURFACE SOILS.
4. THE STOCKPILED SOILS SHALL BE USED TO ESTABLISH PRE-CONSTRUCTION GRADES.

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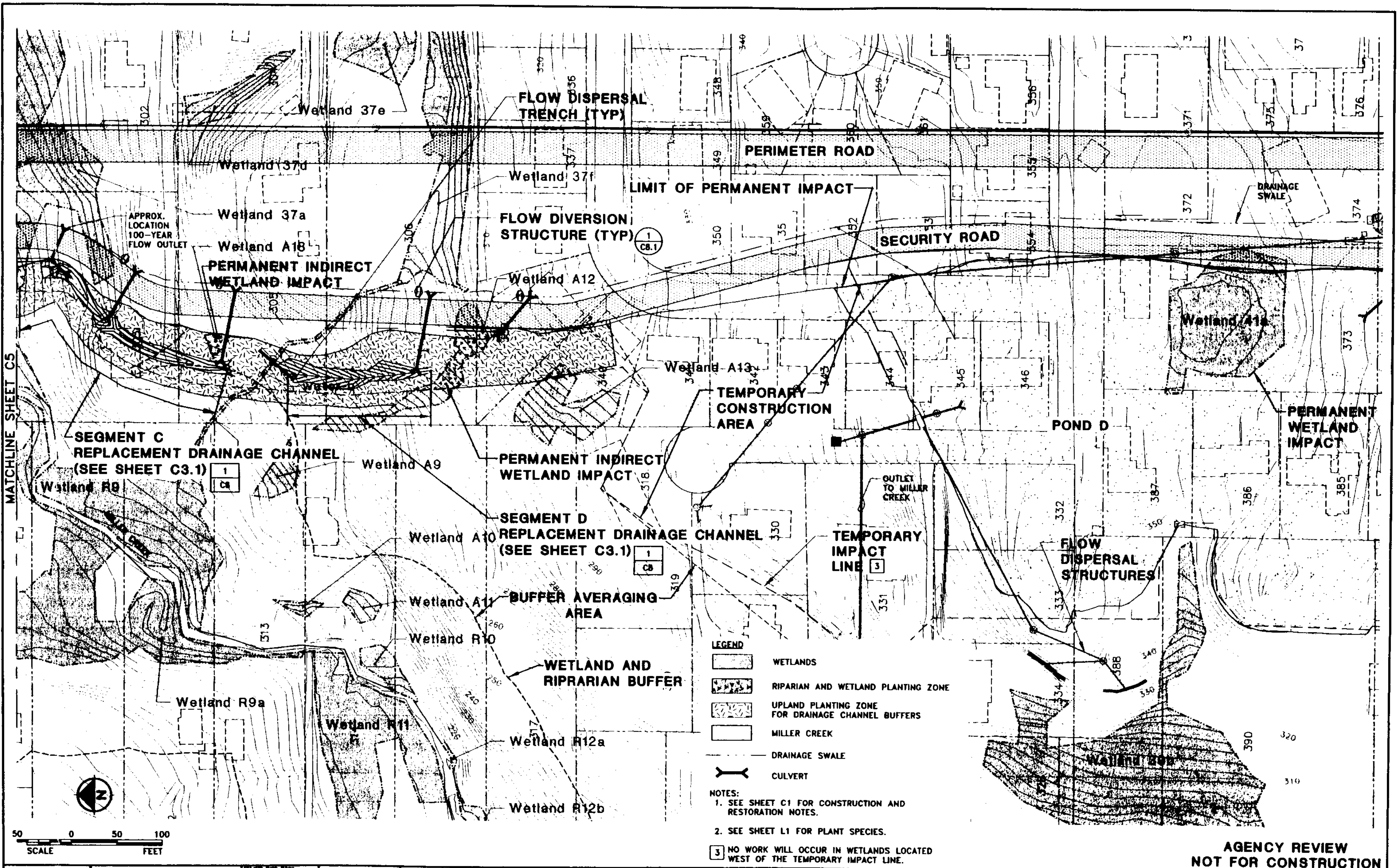
SHEET TITLE: PLAN

-
291203C4
STIA-XXXX-C5
APPENDIX D

291201BA2
291201WL

DATE 11/15/01 FILENAME 291203C4



LEGEND

▭	WETLANDS
▨	RIPARIAN AND WETLAND PLANTING ZONE
▨	UPLAND PLANTING ZONE FOR DRAINAGE CHANNEL BUFFERS
▭	MILLER CREEK
- · - · -	DRAINAGE SWALE
⟷	CULVERT

NOTES:
1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.

3 NO WORK WILL OCCUR IN WETLANDS LOCATED WEST OF THE TEMPORARY IMPACT LINE.

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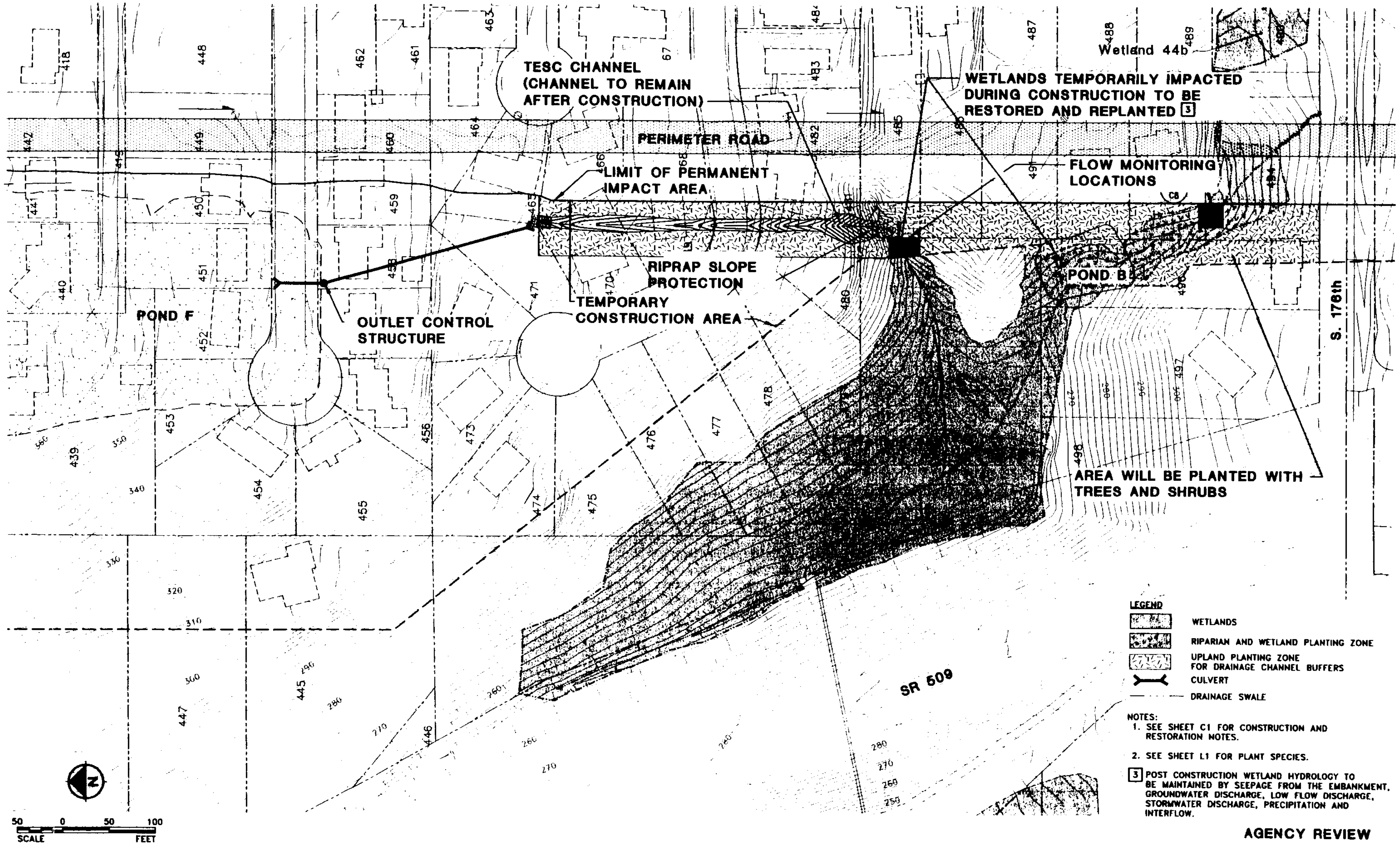
PROJECT: REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS
SHEET TITLE: PLAN

–
291203C5
STIA-XXXX-C6

291201BA2
291201WL



LEGEND

▨	WETLANDS
▩	RIPARIAN AND WETLAND PLANTING ZONE
▧	UPLAND PLANTING ZONE FOR DRAINAGE CHANNEL BUFFERS
⟩—⟨	CULVERT
— - - —	DRAINAGE SWALE

NOTES:

1. SEE SHEET C1 FOR CONSTRUCTION AND RESTORATION NOTES.
2. SEE SHEET L1 FOR PLANT SPECIES.

3 POST CONSTRUCTION WETLAND HYDROLOGY TO BE MAINTAINED BY SEEPAGE FROM THE EMBANKMENT, GROUNDWATER DISCHARGE, LOW FLOW DISCHARGE, STORMWATER DISCHARGE, PRECIPITATION AND INTERFLOW.

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1"=60'
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291201BA2

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291201WL

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SEA-TAC INTERNATIONAL AIRPORT

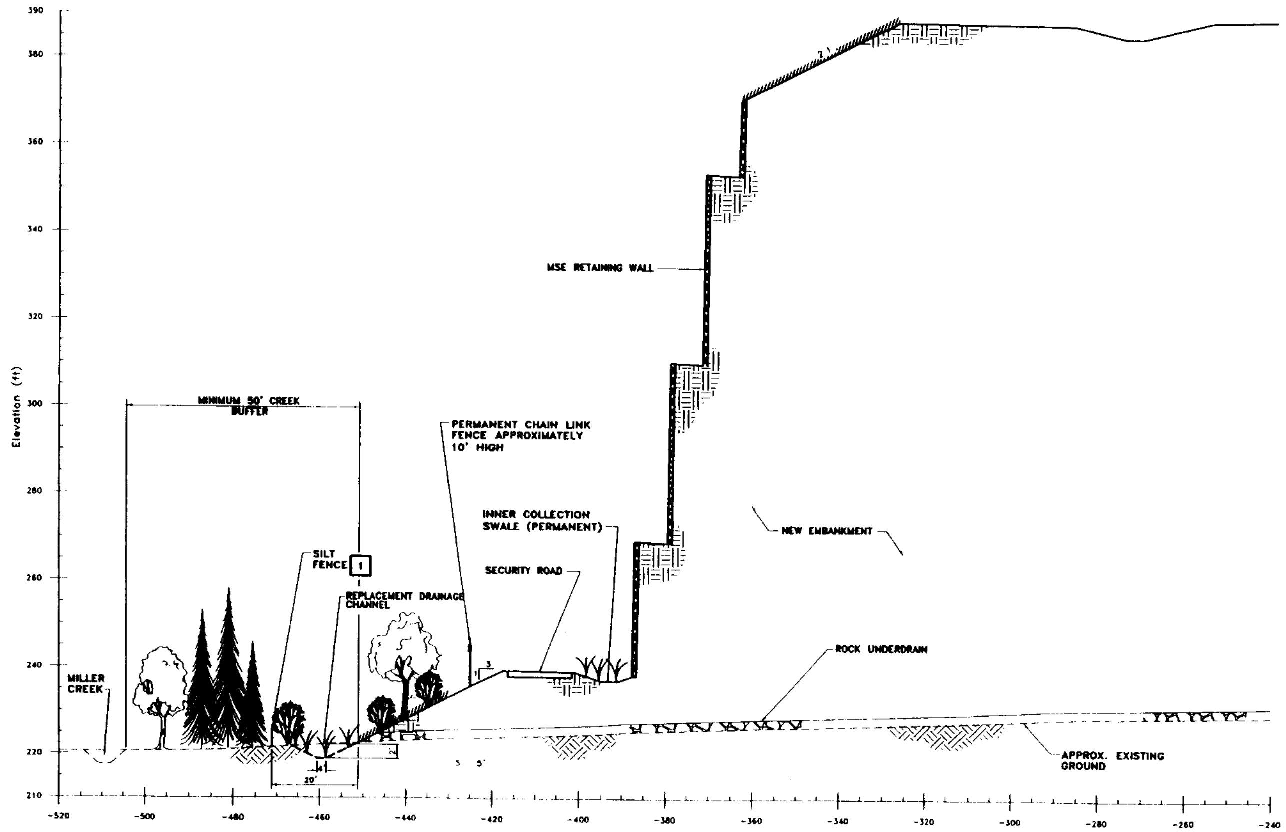
PROJECT: REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS

SHEET TITLE: PLAN

–
291203C8
STIA-XXXX-C7

APPENDIX D

DATE 11/14/01 FILENAME 291203C8 XREF'S 291201S BA2 291201P PONDS IMPACTS 291201WL ROADS DRAIN TOE FEATURES HNTB1 291281LA STS_ULT IMAGES



NOTES:
1 TO BE REMOVED FOLLOWING RESTORATION

SECTION

STREAM BUFFER AND EMBANKMENT
HORIZ SCALE: 1"=15'
VERT SCALE: 1"=15'

1
C3.1, C4, C5, C6

AGENCY REVIEW
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DATE 10/30/01 FILENAME 291203C7 XREFS IMAGES

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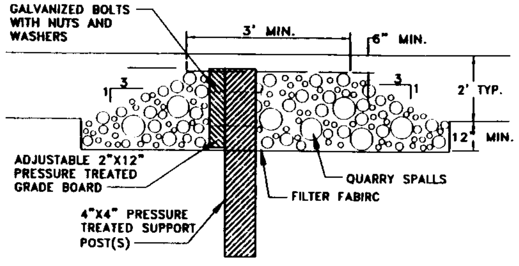
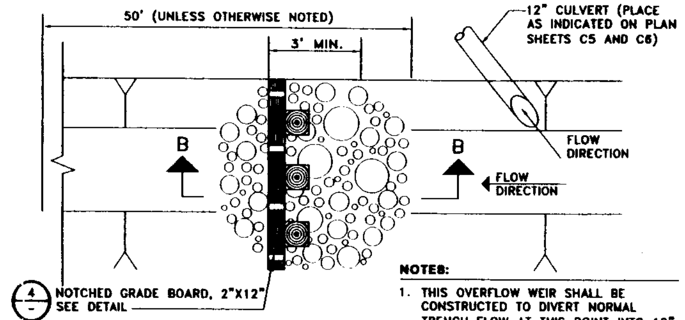
SEA-TAC INTERNATIONAL AIRPORT
REPLACEMENT DRAINAGE CHANNELS AND
RESTORATION OF TEMPORARILY IMPACTED WETLANDS
STREAM BUFFER AND EMBANKMENT
CROSS SECTION

–
291203C7
STIA-XXXX-C8

APPENDIX D



SECTION B-B
NTS

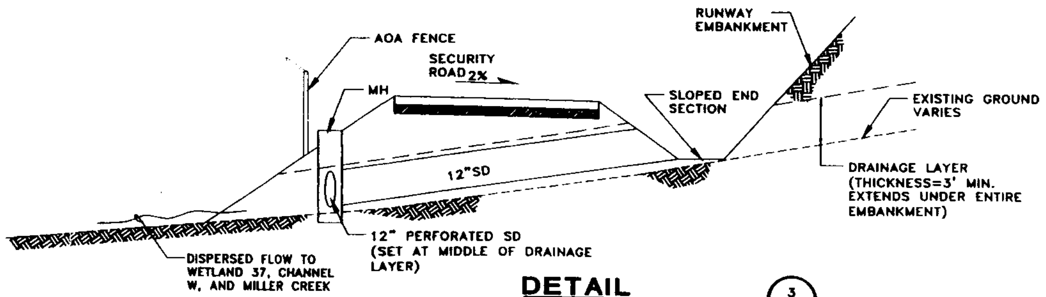


PLAN
NTS

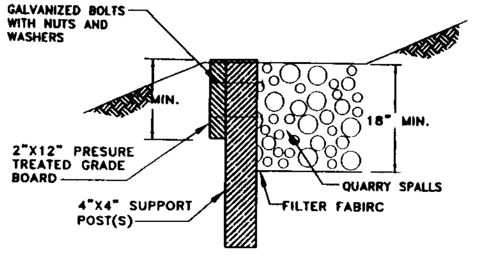
NOTES:

1. THIS OVERFLOW WEIR SHALL BE CONSTRUCTED TO DIVERT NORMAL TRENCH FLOW AT THIS POINT INTO 12" CULVERT.
2. GRADE BOARD MUST BE LEVEL.
3. SUPPORT POST SPACING AS REQUIRED BY SOIL CONDITIONS TO ENSURE GRADE BOARD REMAINS LEVEL.

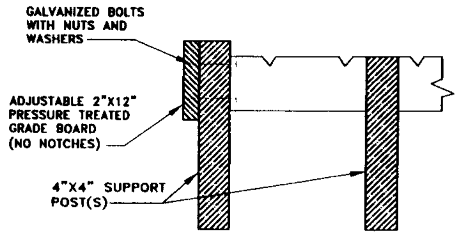
DETAIL ① C5 C6
FLOW DIVERSION STRUCTURE
WITH ADJUSTABLE OVERFLOW WEIR
N.T.S.



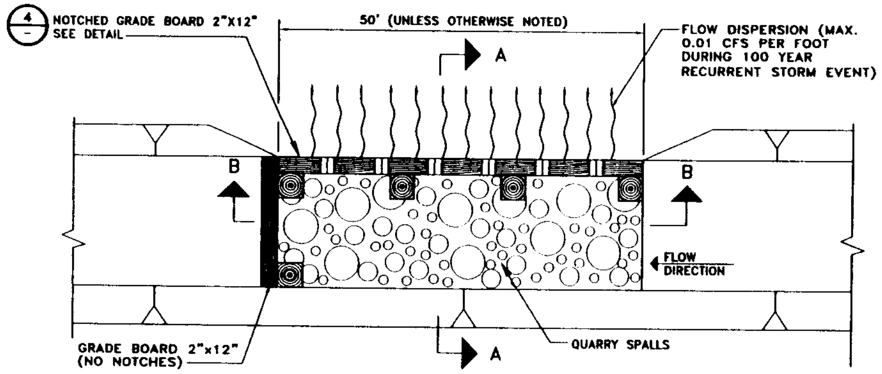
DETAIL ③ C5
PERFORATED PIPE IN DRAINAGE
LAYER (NEAR STATION N178000)
N.T.S.



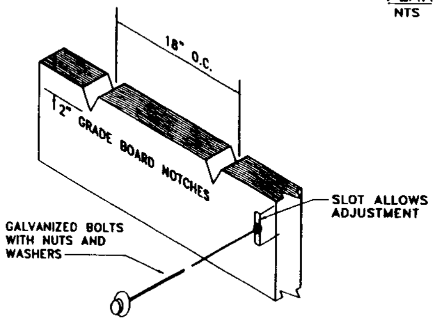
SECTION A-A
NTS



SECTION B-B
NTS



PLAN
NTS



DETAIL ④ -
2"x12" NOTCHED GRADE BOARD
ADJUSTABLE OVERFLOW WEIR
N.T.S.

NOTES:

1. THIS OVERFLOW WEIR SHALL BE CONSTRUCTED TO DIVERT NORMAL TRENCH FLOW AT THIS POINT AND DISPERSE IT INTO ADJACENT WETLAND AREAS.
2. THIS TRENCH SHALL BE CONSTRUCTED TO PREVENT POINT DISCHARGE AND/OR EROSION.
3. TRENCH AND GRADE BOARD MUST BE LEVEL. ALIGN TO FOLLOW CONTOURS OF SITE.
4. SUPPORT POST SPACING AS REQUIRED BY SOIL CONDITIONS TO ENSURE GRADE BOARD REMAINS LEVEL.

DETAIL ② C5 C6
FLOW DISPERSION TRENCH WITH
ADJUSTABLE OVERFLOW WEIR
N.T.S.

AGENCY REVIEW
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DATE: 11/15/01 FILENAME: 291203C8-1 IMAGES XREFS

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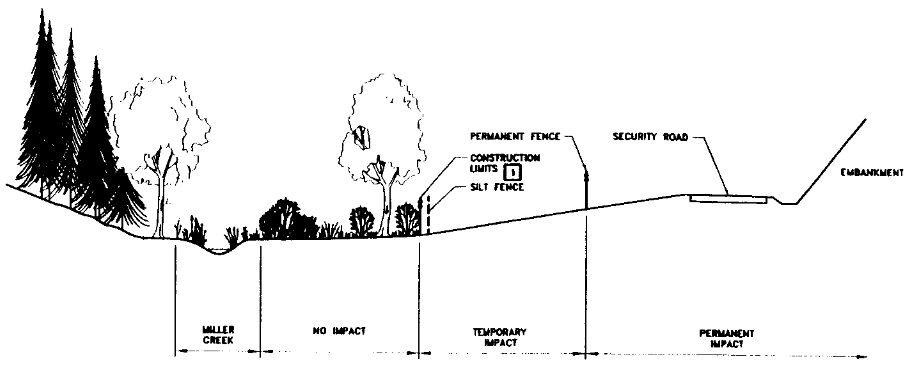
REPLACEMENT DRAINAGE CHANNELS AND
RESTORATION OF TEMPORARILY IMPACTED WETLANDS

FLOW DIVERSION AND DISPERSION STRUCTURE DETAILS

-
291203C8-1
STIA-XXXX-C8.1

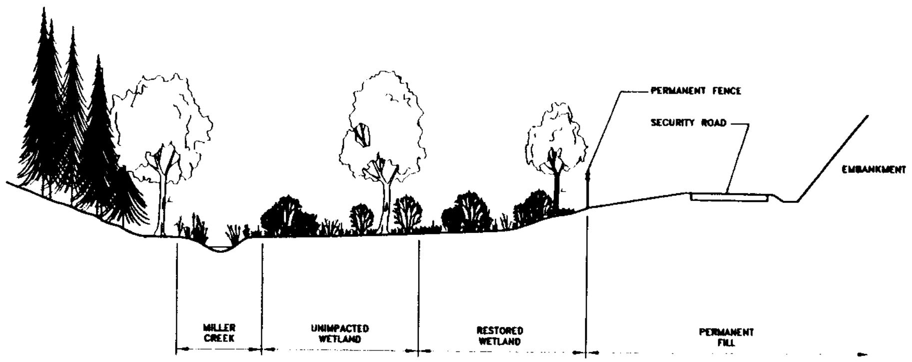
APPENDIX D

TEMPORARILY IMPACTED WETLAND
BEFORE RESTORATION



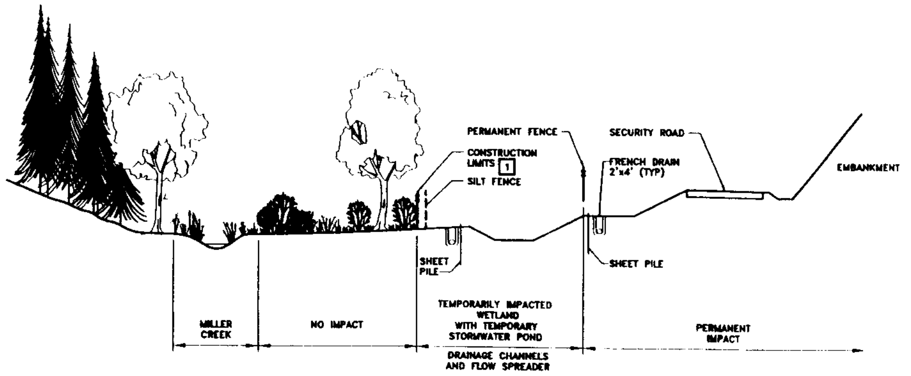
SECTION 1 TYP
TYPICAL SECTION
TEMPORARY WETLAND IMPACTS
NTS

TEMPORARILY IMPACTED WETLAND
AFTER RESTORATION



SECTION 2 TYP
TYPICAL SECTION
RESTORATION OF IMPACTED AREA
NTS

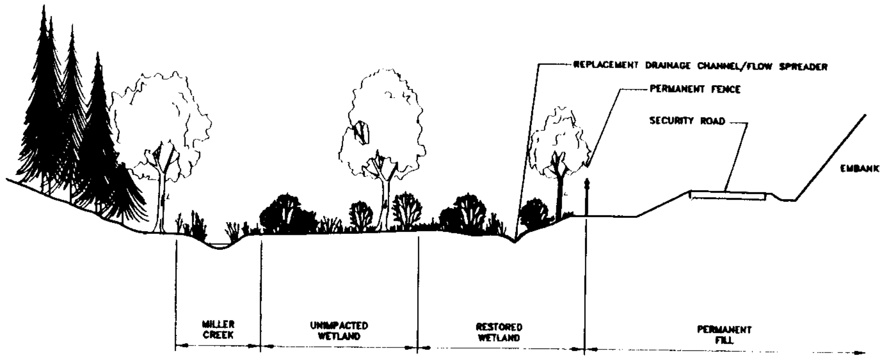
TEMPORARILY IMPACTED WETLAND (AT TEMPORARY POND A)
BEFORE RESTORATION



SECTION 3 TYP
TYPICAL SECTION
TEMP. STORMWATER POND IMPACT
NTS

NOTE:
1 CONSTRUCTION LIMITS WILL BE MARKED WITH CONSTRUCTION FENCING AND CONCRETE BARRIERS

TEMPORARILY IMPACTED WETLAND (AT TEMPORARY POND A)
AFTER RESTORATION



SECTION 4 TYP
TYPICAL SECTION
RESTORATION OF IMPACTED AREA
NTS

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PROJECT: REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS

SHEET TITLE: TYPICAL SECTIONS

-
291203L1
STIA-XXXX-C9

APPENDIX D

DATE 10/30/01 FILENAME 291203L1 IMAGES XREFS

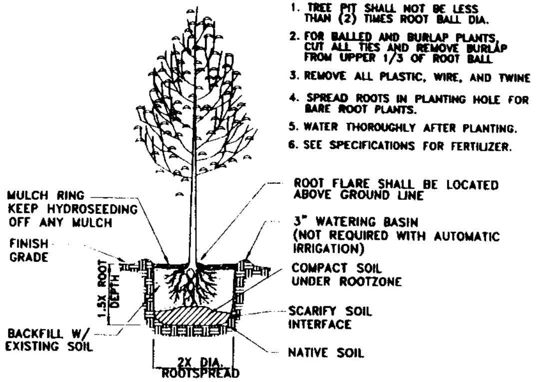
TEMPORARY WETLAND IMPACT PLANT SCHEDULE

Symbol	Botanical Name	Size	Density (Plants Per Acre)	Condition / Remarks
▨	**RIPARIAN AND WETLAND ZONE** **Single Species Groups of 7 to 12**			
	TREES		280	
	Alnus rubra/Red alder	36"–72" ht.		– Container or B&B. Rooting to sides and bottom of can or burlap.
	Fraxinus latifolia/Oregon Ash	36"–72" ht.		
	Picea sitchensis/Sitka spruce *	18"–72" ht.		
	Thuja plicata/Western redcedar *	18"–72" ht.		
	SHRUBS		2,100	
	Salix hookeriana/Hooker's willow	1 gal / Live stake		– Container. Rooting to sides and bottom of can. Live stakes shall be 36"–48" ht., 1/2"–1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3–4 buds shall be below grade. – Space 4.5' O.C. typical.
	Salix lucida spp. *lasiandra*/Pacific willow	1 gal / Live stake		
	Salix scouleriana/Scouler's willow	1 gal / Live stake		
	Salix sitchensis/Sitka willow	1 gal / Live stake		
	Spiraea douglasii/Hardhack spiraea	1 gal.		
▨	**UPLAND PLANTING ZONE** **Single Species Groups of 7 to 12**			
	TREES		280	
	Alnus rubra/Red alder	36"–72" ht.		– Container or B&B. Rooting to sides and bottom of can or burlap.
	Acer macrophyllum/Bigleaf maple	36"–72" ht.		
	Pseudotsuga menziesii/Douglas fir	36"–72" ht.		
	Tsuga heterophylla/Western hemlock *	36"–72" ht.		
	SHRUBS		2,100	
	Acer circinatum/Vine maple	1 gal.		– Container. Rooting to sides and bottom of can. Live stakes shall be 36"–48" ht., 1/2"–1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3–4 buds shall be below grade. – Space 4.5' O.C. typical.
	Rosa pisocarpa/Clustered rose	1 gal.		
	Salix scouleriana/Scouler's willow	1 gal / Live stake		
	Spiraea douglasii/Hardhack spiraea	1 gal / Live stake		

* Western redcedar, Western hemlock and Sitka spruce shall be planted in a second planting phase, to follow year–3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

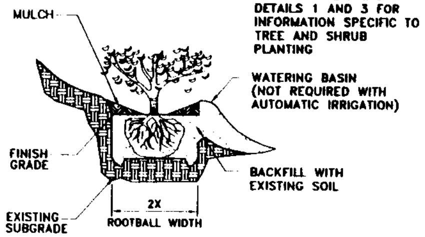
NOTES:

1. PRESERVE AND PROTECT ALL TREES AND SHRUBS NOT DESIGNATED FOR REMOVAL. PROVIDE, ERECT, AND MAINTAIN BARRICADES NECESSARY TO PREVENT ACCESS TO AREA WITHIN DRIPLINES OF EXISTING TREES.
2. FOR EACH PLANTING ZONE CONTRACTOR SHALL LAY OUT A 10,000 S.F. TEST PLOT, IN WHICH THE POSITIONS OF ALL PLANTS SHALL BE STAKED WITH FLAGS THAT ARE COLOR CODED TO REPRESENT SPECIFIC SPECIES. LAYOUT FOR EACH ZONE SHALL BE INSPECTED AND APPROVED PRIOR TO COMMENCEMENT OF PLANTING. APPROVED STAKING SHALL SERVE AS THE PLANT LAYOUT STANDARD FOR THE REMAINDER OF EACH ZONE.
3. SHRUB MASSES SHALL CONSIST OF MULTIPLE SINGLE-SPECIES GROUPS (SEE DETAIL 6). CONTRACTOR SHALL ENSURE THAT THESE SINGLE-SPECIES GROUPS HAVE A VARIETY OF SIZES AND SHAPES, AND THAT SHRUB MASSES HAVE A VARIETY OF SPECIES. SEE PLANTING SCHEDULE FOR NUMBERS OF PLANTS IN SINGLE-SPECIES GROUPS.
4. CONTRACTOR SHALL HYDROSEED ALL PLANTING AREAS. RE-SEED ALL AREAS THAT ARE DISTURBED BY SUBSEQUENT WORK. KEEP HYDROSEEDING OFF ANY MULCH CIRCLES EXCEPT WHERE NEEDED TO PROTECT ROOTS OF CONIFERS.
5. LIVE STAKE WILLOW SPECIES MAY BE SUBSTITUTED FOR 1 GALLON CONTAINER IF SITE CONDITIONS ARE WARANTED. LIVE STAKES SHOULD BE 36"–48" IN HT., 1/2"–1" IN DIA., WITH A MINIMUM OF 10 VIABLE, UNDAMAGED BUDS ON EACH STAKE. 3–4 BUDS SHALL BE BELOW GRADE.



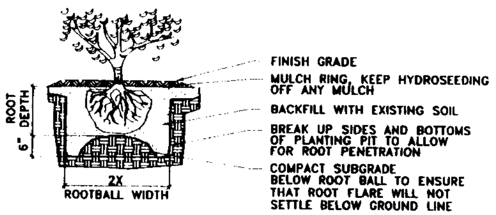
NOTES:
1. TREE PIT SHALL NOT BE LESS THAN (2) TIMES ROOT BALL DIA.
2. FOR BALLED AND BURLAP PLANTS, CUT ALL TIES AND REMOVE BURLAP FROM UPPER 1/3 OF ROOT BALL
3. REMOVE ALL PLASTIC, WIRE, AND TWINE
4. SPREAD ROOTS IN PLANTING HOLE FOR BARE ROOT PLANTS.
5. WATER THOROUGHLY AFTER PLANTING.
6. SEE SPECIFICATIONS FOR FERTILIZER.

DETAIL 1 TYP
TREE PLANTING
(TYPICAL)

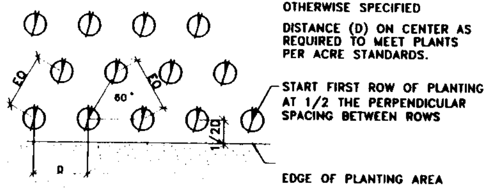


NOTE:
REFER TO PLANTING DETAILS 1 AND 3 FOR INFORMATION SPECIFIC TO TREE AND SHRUB PLANTING

DETAIL 2 TYP
PLANTING ON SLOPES
N.T.S.



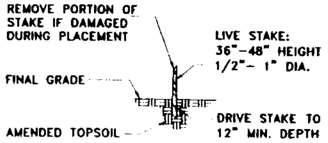
DETAIL 3 TYP
SHRUB PLANTING
(TYPICAL)



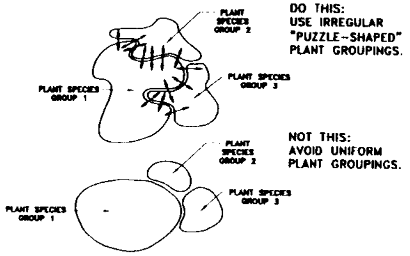
NOTE:
ALL SHRUB SPACING SHALL BE EQUIDISTANT UNLESS OTHERWISE SPECIFIED

DISTANCE (D) ON CENTER AS REQUIRED TO MEET PLANTS PER ACRE STANDARDS.

DETAIL 4 TYP
TRIANGULAR SHRUB SPACING
(TYPICAL)



DETAIL 5 TYP
LIVE STAKE PLANTING
NTS



DETAIL 6 TYP
SHAPES OF PLANTING MASSES
NTS

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PROJECT: REPLACEMENT DRAINAGE CHANNELS AND RESTORATION OF TEMPORARILY IMPACTED WETLANDS
SHEET TITLE: PLANTING SCHEDULE AND DETAILS

–
291203L2
STIA-XXXX-L1

APPENDIX D

DATE 11/15/01 FILENAME 291203L2

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Aviation Division

APPENDIX E

AUBURN WETLAND MITIGATION FOR SEATTLE-TACOMA INTERNATIONAL AIRPORT

AGENCY REVIEW
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SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE
STIA-9804-T1	TITLE SHEET	STIA-9804-L7	PLANTING PLAN NW		
STIA-9804-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS	STIA-9804-L8	PLANTING PLAN SW		
STIA-9804-C2	PROJECT AREA AND SHEET KEY	STIA-9804-L9	PLANTING SCHEDULE		
STIA-9804-C3	PHASE 1 GRADING PLAN NE	STIA-9804-L10	PLANTING SCHEDULE AND DETAILS		
STIA-9804-C4	PHASE 1 GRADING PLAN SE				
STIA-9804-C5	PHASE 2 GRADING PLAN NW				
STIA-9804-C6	PHASE 2 GRADING PLAN SW				
STIA-9804-C7	SECTIONS AND DETAILS				
STIA-9804-C7.1	SECTIONS AND DETAILS				
STIA-9804-C8	GRADING SECTIONS AND DETAILS				
STIA-9804-C8.1	BUFFER AND TEMPORARY MAINTENANCE ROAD PROFILE				
STIA-9804-C8.2	SECTIONS AND DETAILS				
STIA-9804-C9	SOIL AND HABITAT FEATURES PLAN				
STIA-9804-TE1	TESC PLAN				
STIA-9804-L1	IRRIGATION DETAILS AND LEGEND				
STIA-9804-L2	PHASE 1 IRRIGATION PLAN NE				
STIA-9804-L3	PHASE 1 IRRIGATION PLAN SE				
STIA-9804-L4	MISCELLANEOUS CONSTRUCTION DETAILS				
STIA-9804-L5	PLANTING PLAN NE				
STIA-9804-L6	PLANTING PLAN SE				

DATE: 11/08/01 FILENAME 2912141T1 IMAGES XREF'S

MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

_______________ DATE

_______________ DATE

_______________ DATE

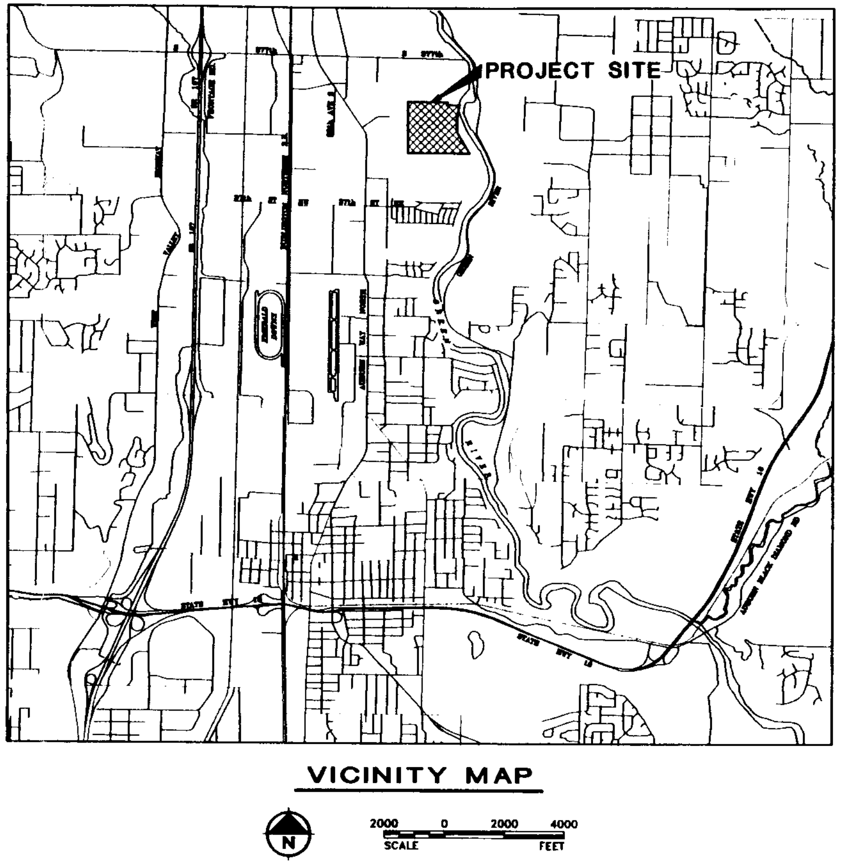
APPROVED BY

____

_______ DATE

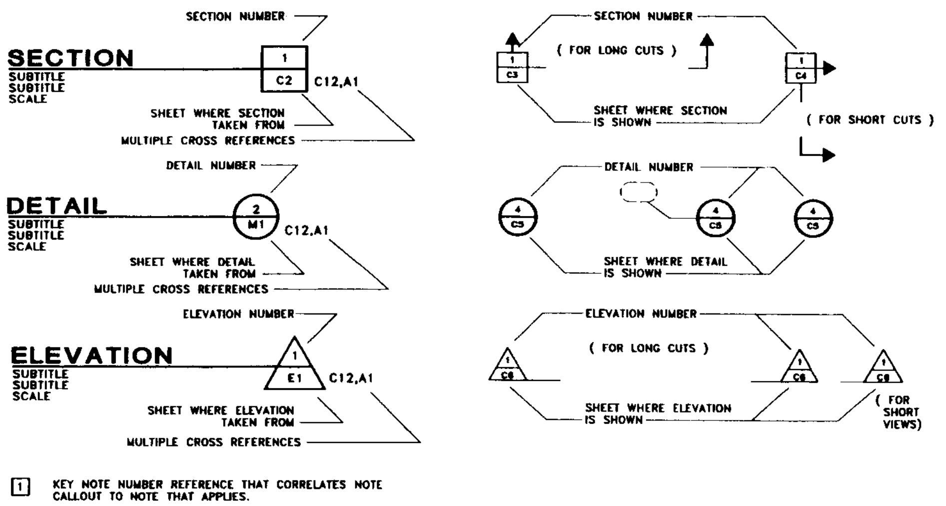
WORK ORDER NO.	PROJECT NO.
100052	STIA-9804-T1

APPENDIX E



VICINITY MAP

GENERAL LEGEND



☐1 KEY NOTE NUMBER REFERENCE THAT CORRELATES NOTE CALLOUT TO NOTE THAT APPLIES.

GENERAL ABBREVIATIONS

ALUM	ALUMINUM	O.C.	ON CENTER
CL	CLASS	P.O.C.	POINT OF CONCENTRATION
f'c	COMPRESSIVE STRENGTH	PE	POLYETHYLENE
℄	CENTERLINE	PVC	POLYVINYL CHLORIDE
CMP	CORRUGATED METAL PIPE	⅊	PROPERTY LINE
CONC	CONCRETE	PL	PLATE
CONT	CONTINUOUS	psi	POUNDS PER SQUARE INCH
CUFT	CUBIC FOOT	REQ'D	REQUIRED
DCVA	DIRECT CURRENT VOLTAGE	S	SOUTH
DEG	DEGREE	SCH	SCHEDULE
DIA OR ⌀	DIAMETER	SS	STAINLESS STEEL
E	EAST	ST	STREET
EA	EACH	TYP	TYPICAL
EL OR ELEV	ELEVATION	VERT OR V	VERTICAL
ELL	ELBOW	W	WEST
EW	EACH WAY	WL	WATER LEVEL
EXIST.	EXISTING	fy	YIELD STRENGTH
FT	FOOT (FEET)	X	BY
FY	FORCE YIELD	@	AT
GA	GAUGE	℄	CENTERLINE
GPM	GALLONS PER MINUTE	"	INCHES
GRS	GALVANIZED RIGID STEEL	'	FEET
HDPE	HIGH DENSITY POLYETHYLENE	&	AND
HORIZ OR H	HORIZONTAL	=	EQUALS
I.E.	INVERT ELEVATION	%	PERCENT
ksi	KIPS PER SQUARE INCH	°	DEGREES
LF	LINEAR FEET/FOOT	±	PLUS OR MINUS
MAX	MAXIMUM		
MIN	MINIMUM		
N	NORTH		
N.T.S.	NOT TO SCALE		
N.I.C.	NOT IN CONTRACT		
NE	NORTHEAST		
NW	NORTHWEST		

NOTES

1. THE APPROXIMATELY 67-ACRE PROJECT SITE IS LOCATED IN SECTION 31, TOWNSHIP 22 NORTH, RANGE 5 EAST, WILLAMETTE MERIDIAN, KING COUNTY, WASHINGTON.

2. TOPOGRAPHIC BASEMAP FOR PLAN SHEETS WAS OBTAINED FROM THE CITY OF AUBURN, 1995. SUPPLEMENTAL 1' CONTOURS WITHIN THE PROJECT LIMITS ARE BASED ON FIELD SURVEY BY PARAMETRIX IN 1995 WITH ADDITIONAL SURVEY IN 1996, 1997 AND 1998.

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IF NOT SCALE ACCORDINGLY

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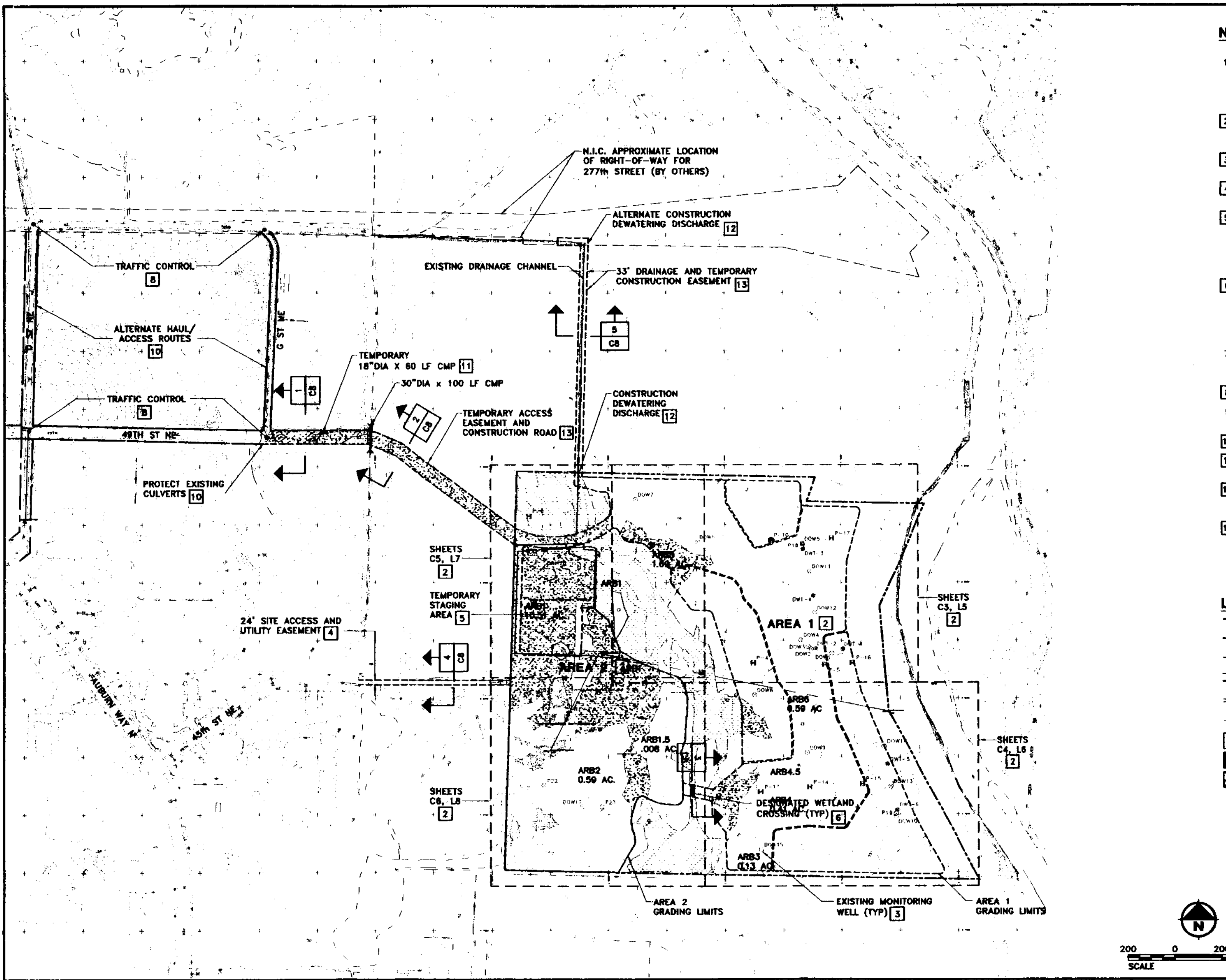
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

100052
291214C1-2
STIA-9804-C1

APPENDIX E

DATE 11/14/01 FILENAME 291214C1-2 IMAGES XREFS



NOTES:

1. PROVIDE TEMPORARY EROSION AND SEDIMENT CONTROLS PER SHEET TE1 PRIOR TO ANY EARTHWORK. NO CONSTRUCTION ACTIVITIES SHALL OCCUR OUTSIDE OF APPROVED RIGHT-OF-WAY, CONSTRUCTION EASEMENTS, CONTRACTOR'S STAGING AREA, WETLAND CROSSINGS, GRADING LIMITS, OR APPROVED DISCHARGE POINT.

2 CONSTRUCTION PHASING: AREA 1 EARTHWORK SHALL BE COMPLETED PRIOR TO BEGINNING AREA 2 EARTHWORK. AREA 1 GRADING WILL LIKELY OCCUR 1 YEAR BEFORE AREA 2 GRADING.

3 PROTECT EXISTING WELLS PER SPECIFICATIONS. ABANDON WELLS UPON COMPLETION OF PHASED CONSTRUCTION AS SPECIFIED.

4 PROVIDE TEMPORARY ELECTRIC SERVICE AND IRRIGATION LINE PER SPECIFICATIONS. EASEMENT TO BE STAKED BY ENGINEER.

5 STAGING AREA SHALL BE GRADED LEVEL AS NEEDED FOR CONTRACTOR STAGING AND STOCKPILING. HAUL ROADS AND STOCKPILES WITHIN STAGING AREA SHALL BE DESIGNED AND MAINTAINED BY THE CONTRACTOR. ADDITIONAL STAGING FOR STOCKPILING SHALL BE MADE AVAILABLE WITHIN LIMITED PORTIONS OF PHASE 2 GRADING LIMITS UPON SUBMITTAL REQUEST AND APPROVAL PROCESS.

6 NO CONSTRUCTION ACTIVITIES OR DISTURBANCE SHALL OCCUR IN EXISTING WETLAND AREAS EXCEPT FOR DESIGNATED WETLAND CROSSING AREAS, WITHIN GRADING LIMITS AND ACCESS ROUTES. WETLAND CROSSING AREAS SHALL BE FIELD LOCATED BY THE ENGINEER. MOWING WILL OCCUR IN EXISTING WETLAND PRIOR TO INSTALLATION OF ABOVE GROUND IRRIGATION AND PLANT MATERIAL.

7. ALL DISTURBED AREAS SHALL BE HYDROMULCH SEEDED PER SPECIFICATIONS UNLESS OTHERWISE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

8 PROVIDE TRAFFIC CONTROL AT INTERSECTIONS PER SPECIFICATIONS.

9. ALTERNATE CONSTRUCTION ACCESS/HAUL ROUTES SHALL BE PER AGREEMENT WITH CITY. SEE SPECIFICATIONS.

10 PROTECT EXISTING CULVERTS, FENCE AND LANDSCAPE PLANTINGS.

11 TEMPORARY CMP TO BE FIELD STAKED BY ENGINEER. REMOVE AT END OF PROJECT.

12 CONSTRUCTION DEWATERING WATER SHALL BE DISCHARGED TO EXISTING SURFACE WATER DITCH. ALTERNATIVE DISCHARGE POINT AT 277TH ST STORM DRAIN TO BE USED ONLY WITH APPROVAL FROM CITY OF AUBURN.

13 TEMPORARY WETLAND IMPACTS IN ACCESS ROADS WILL BE RESTORED AND HYDROSEEDED WITH EMERGENT WETLAND COMMUNITY. SEE SHEET L8.

LEGEND

———	PROPERTY BOUNDARY
— — —	100' BUFFER LINE
- - - -	GRADING LIMITS
═ ═	HAUL ACCESS ROUTES
======	GRAVEL PATH
- · -	EXISTING WETLAND BOUNDARY
☐	EXISTING WETLANDS IN PROJECT AREA 6
■	WETLAND CROSSING AREA WITH CULVERTS
▨	EXISTING WETLANDS TO BE MODIFIED 13, 14
DOW12	EXISTING DEWATERING OBSERVATION WELL
DWT-4	EXISTING DEWATERING TEST WELL
H P-10	EXISTING MONITORING WELL
TP-5	TEST PIT LOCATION

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REVISIONS

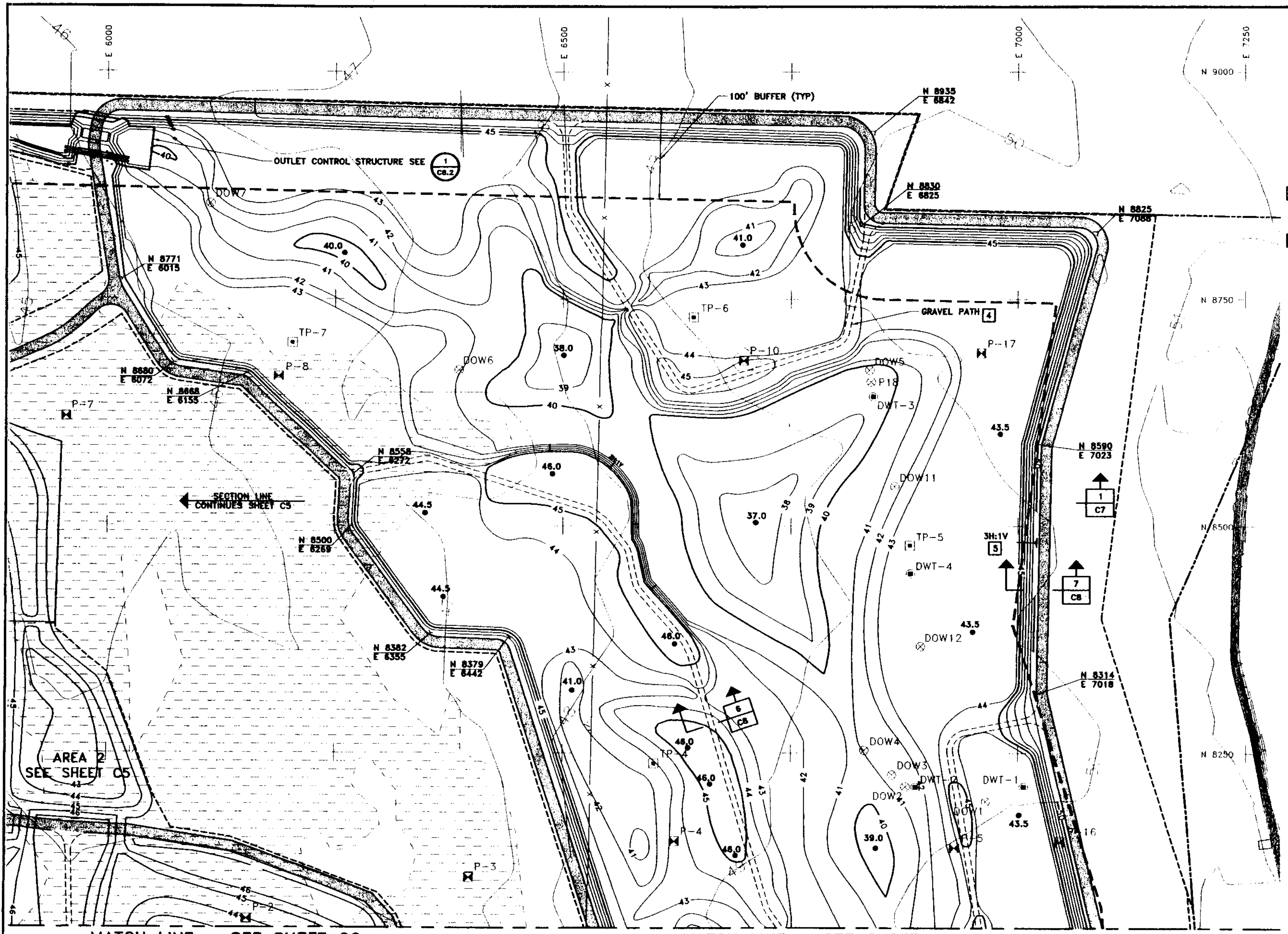
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: PROJECT AREA AND SHEET KEY

100052
291214C2
STIA-9804-C2

DATE 11/12/01 FILENAME 291214C2 IMAGES: XREF'S: 291214BA 291214AL 291214DE

291214BA
291214DE

APPENDIX E



NOTES:

1. PROPOSED CONTOURS AS SHOWN INDICATE FINISH GRADE. FINISH GRADE INCLUDES 12" WETLAND SOIL. SEE DETAIL (1/C7)
2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.

4. GRAVEL PATH IS TEMPORARY AND IS TO REMAIN THROUGH PLANTING AND MONITORING PERIOD AND THEN BE DECOMMISSIONED PER SPECIFICATIONS.

5. GRADE SHOWN AT 3H:1V BUT WILL VARY BETWEEN 3H:1V AND 5H:1V TO PROVIDE VARIATION IN UPLAND/WETLAND BOUNDARY.

6. MICROTOPOGRAPHIC FEATURES WILL BE ADDED IN GRADED AREAS. SEE PLAN (4/C8.2)
7. GRADED AREAS SHALL BE HYDROSEEDED WITH ONE OF THE FOLLOWING THREE SEED MIXES:
   - WET ZONE SEED MIX FROM THE 38 FT TO 41 FT ELEVATION.
   - TRANSITION SEED MIX FROM THE 41 FT TO 45 FT ELEVATION.
   - UPLAND SEE MIX ABOVE 45 FT ELEVATION.

   SEE SHEET L10 FOR HYDROSEED MIXTURE.

LEGEND:

☐	EXISTING WETLAND
▨	WETLAND CROSSING AREA WITH CULVERTS
- - - - -	GRADING LIMITS
— — —	100' BUFFER
———	PROPERTY BOUNDARY
	EXISTING WETLAND BOUNDARY
=======	GRAVEL PATH
	SLOPE INDICATOR
▨	MAINTENANCE ROAD
N 8824 E 7104	CONTROL POINT FOR GRADING
⊗ DOW12	EXISTING DEWATERING OBSERVATION WELL
■ DWT-4	EXISTING DEWATERING TEST WELL
⧓ P-10	EXISTING MONITORING WELL
⊡ TP-5	TEST PIT LOCATION

N

50 0 50 100
SCALE FEET

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DATE: 11/14/01 FILENAME: 291214C3 XREF'S: 291214BA 291214DE 291214ML IMAGES:

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REVISIONS

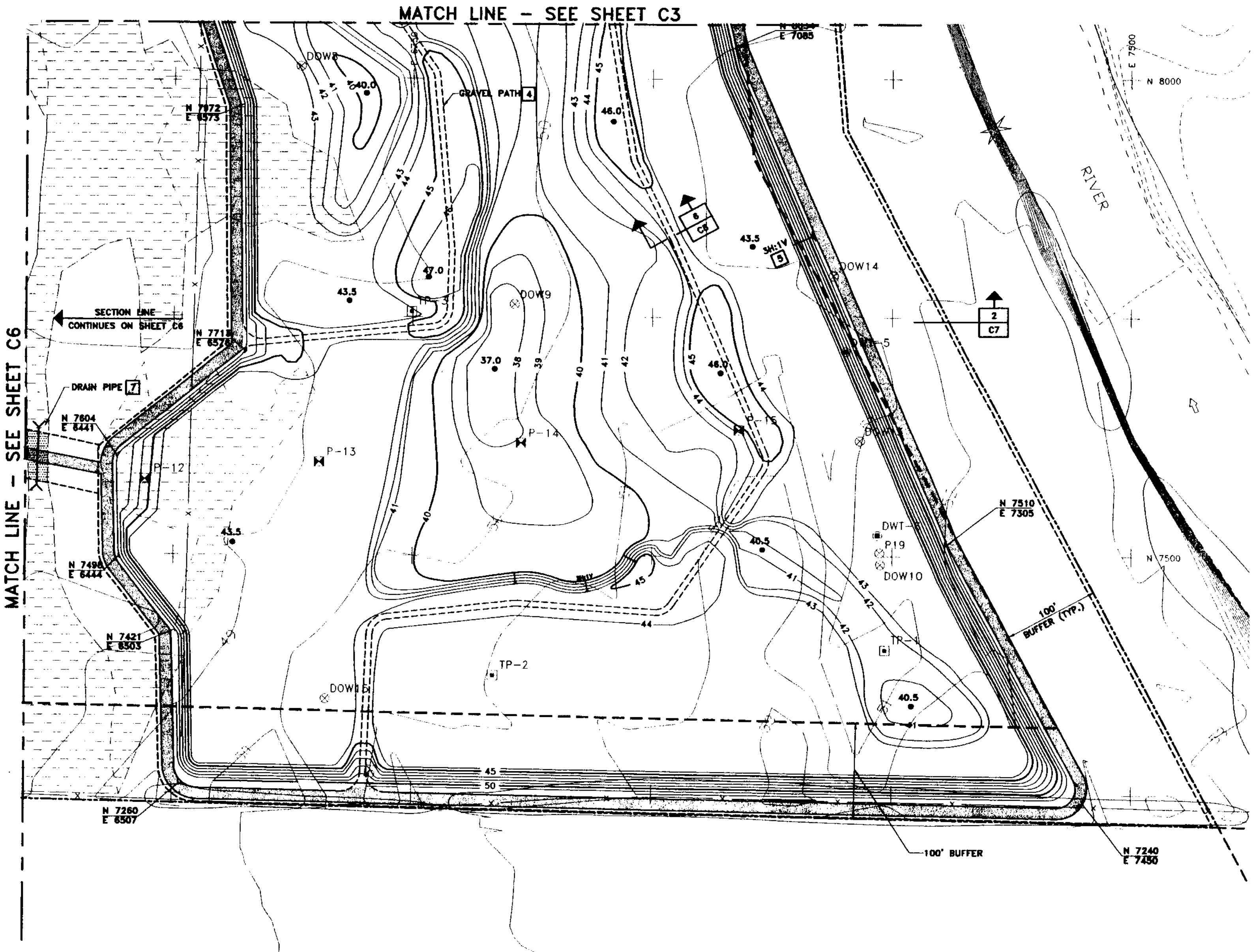
NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PHASE I GRADING PLAN NE**

291214C3
STIA-9804-C3

291214BA
291214DE

APPENDIX C



NOTES:

1. PROPOSED CONTOURS AS SHOWN INDICATE FINISH GRADE. FINISH GRADE INCLUDES 12" WETLAND SOIL. SEE DETAIL 1/C7
2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.

[4] GRAVEL PATH IS TEMPORARY AND IS TO REMAIN THROUGH PLANTING AND MONITORING PERIOD AND THEN DECOMMISSIONED PER SPECIFICATIONS.

[5] GRADE SHOWN AT 3H:1V BUT WILL VARY BETWEEN 3H:1V AND 5H:1V TO PROVIDE VARIATION IN UPLAND/WETLAND BOUNDARY.

6. MICROTOPOGRAPHIC FEATURES WILL BE ADDED IN GRADED AREAS. SEE PLAN 4/C8.2

[7] 60 FOOT DRAIN PIPES ARE REQUIRED DURING CONSTRUCTION. THESE WILL BE CUT TO ABOUT 20 FT FOR THE MAINTENANCE ROAD.

8. GRADED AREAS SHALL BE HYDROSEEDED WITH ONE OF THE FOLLOWING THREE SEED MIXES;
-WET ZONE SEED MIX FROM THE 38 FT TO 41 FT ELEVATION.
-TRANSITION SEED MIX FROM THE 41 FT TO 45 FT ELEVATION.
-UPLAND SEED MIX ABOVE THE 45 FT ELEVATION.
SEE SHEET L10 FOR SEED MIXTURE.

LEGEND:

— — — —	MATCH LINE
☐	EXISTING WETLAND
▨	WETLAND CROSSING AREA WITH CULVERTS
- - - - -	GRADING LIMITS
— — —	100' BUFFER
—·—·—	PROPERTY BOUNDARY
· · · ·	EXISTING WETLAND BOUNDARY
══	GRAVEL PATH
	SLOPE INDICATOR
	MAINTENANCE ROAD
N 8824 E 7104	CONTROL POINT FOR GRADING
DOW12	EXISTING DEWATERING OBSERVATION WELL
DWT-4	EXISTING DEWATERING TEST WELL
P-10	EXISTING MONITORING WELL
TP-5	TEST PIT LOCATION

50 0 50 100
SCALE FEET

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REVISIONS

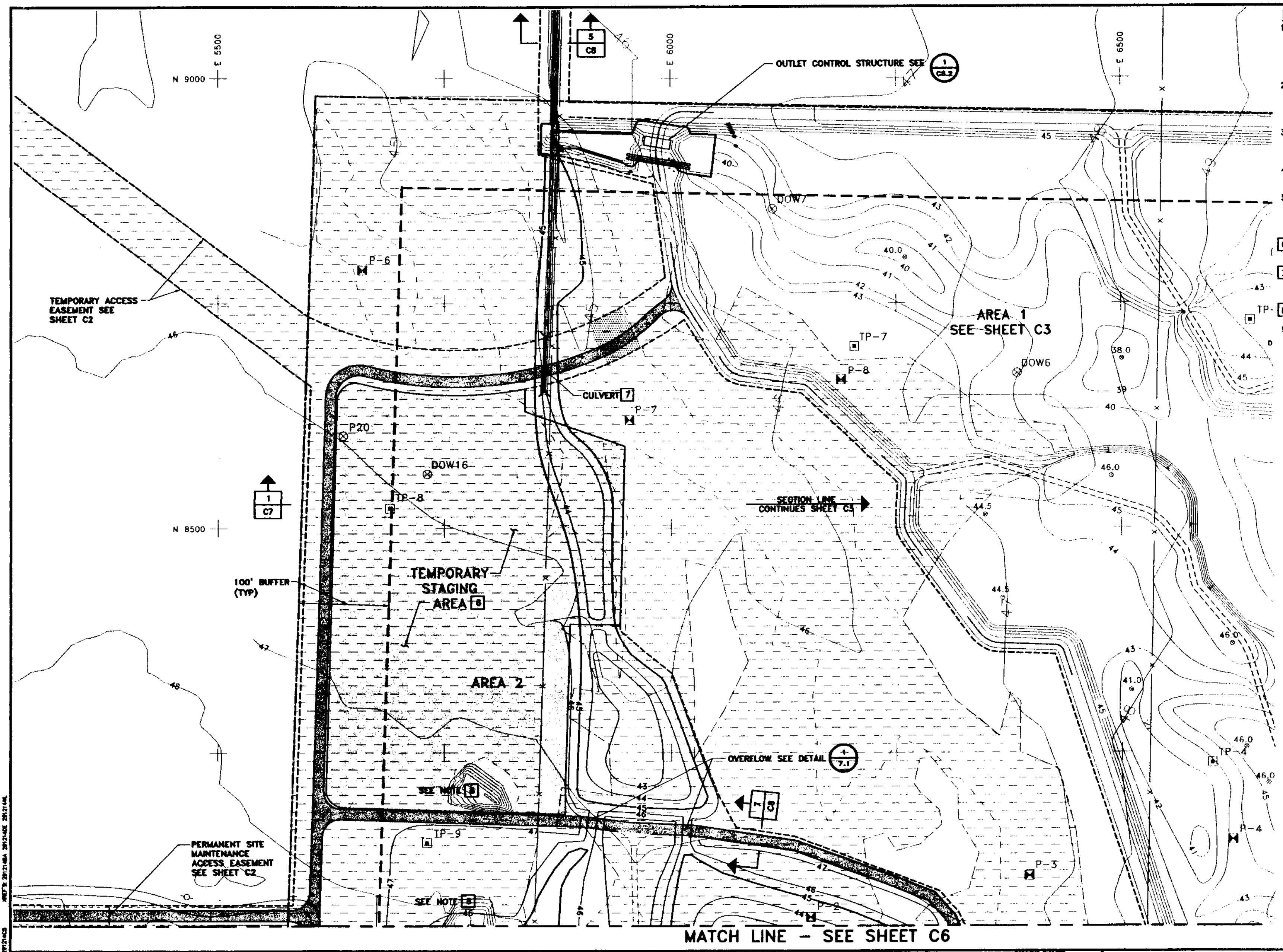
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PHASE I GRADING PLAN SE**

291214C4
STIA-9804-C4

DATE: 11/12/01 FILENAME: 291214C4

291214BA
291214DE

APPENDIX E



NOTES:

1. PROPOSED CONTOURS AS SHOWN INDICATE FINISH GRADE. FINISH GRADE INCLUDES 12" WETLAND SOIL. SEE DETAIL 1/C7
2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.
4. PHASE 2 GRADING LIMITS TO BE FIELD STAKED BY THE ENGINEER.
5. MICROTOPOGRAPHIC FEATURES WILL BE ADDED IN GRADED AREAS. SEE PLAN 4/C8.2

6. STAGING AREA TO BE GRADED LEVEL AND GRAVELLED.

7. 60 FOOT CULVERT IS REQUIRED DURING CONSTRUCTION AND WILL BE CUT TO ABOUT 20 FT FOR THE MAINTENANCE ROAD.

8. HUMMOCK WILL BE REMOVED.

9. GRADED AREAS SHALL BE HYDROSEEDED WITH ONE OF THE FOLLOWING THREE SEED MIXES;
-WET ZONE SEED MIX FROM THE 42 FT TO 44 FT ELEVATION.
-TRANSITION SEED MIX FROM THE 44 FT TO 49 FT ELEVATION.
-UPLAND SEED MIX ABOVE THE 49 FT ELEVATION.
SEE SHEET L10 FOR SEED MIXTURE.

LEGEND:

— — —	MATCH LINE
☐	EXISTING WETLAND
▨	WETLAND CROSSING AREA WITH CULVERTS
- - - -	GRADING LIMITS
— — —	100' BUFFER
—·—·—	PROPERTY BOUNDARY
······	EXISTING WETLAND BOUNDARY
═ ═ ═	GRAVEL PATH
	SLOPE INDICATOR
▨	MAINTENANCE ROAD
⊗ DOW12	EXISTING DEWATERING OBSERVATION WELL
● DWT-4	EXISTING DEWATERING TEST WELL
P-10	EXISTING MONITORING WELL
▣ TP-5	TEST PIT LOCATION

50 0 50 100
SCALE FEET

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REVISIONS

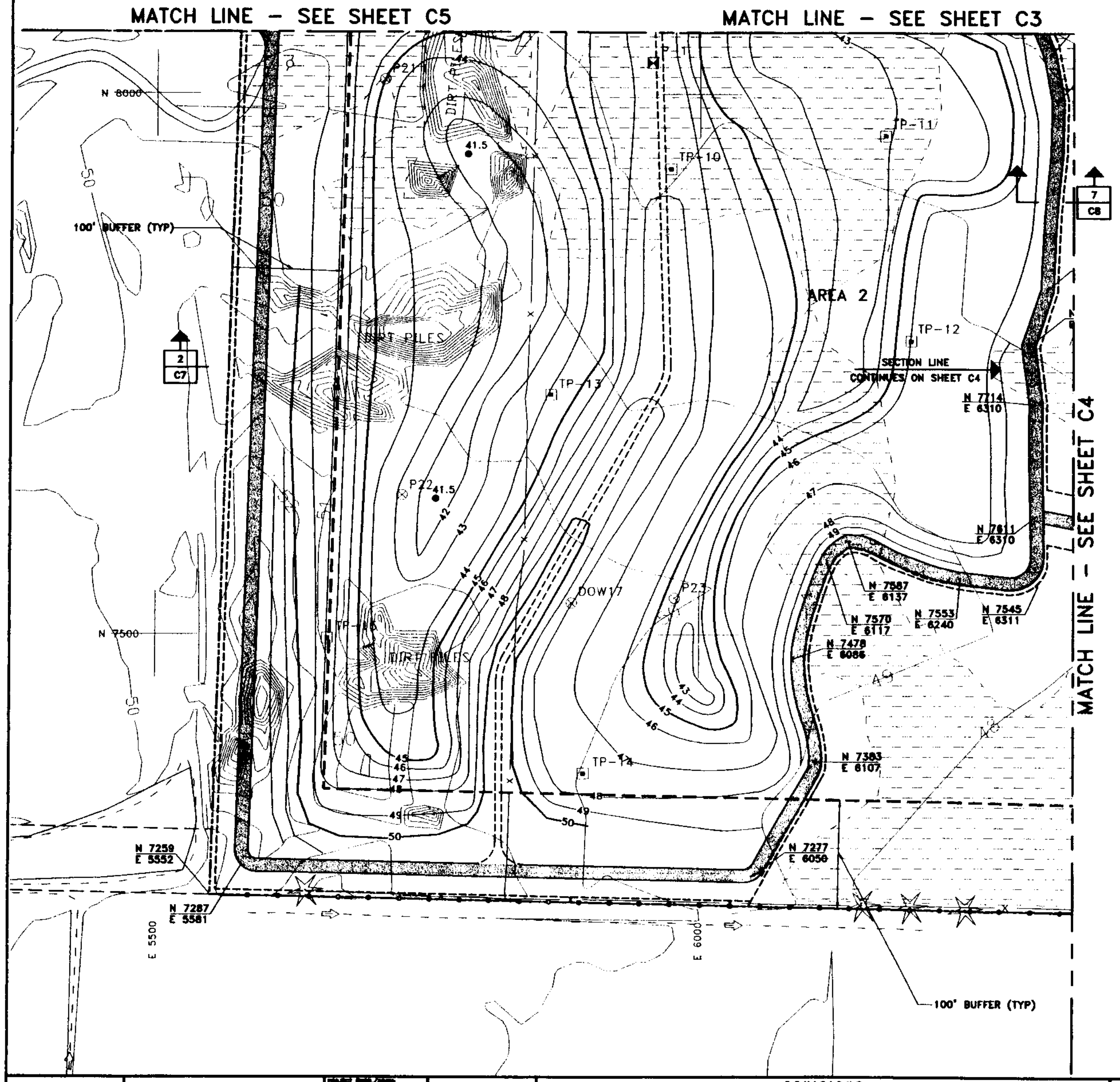
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
AUBURN WETLAND MITIGATION

PHASE 2 GRADING PLAN NW

291214C5
STIA-9804-C5

DATE: 11/14/01 FILENAME: 291214C5 IMAGES: XREF'S: 291214BA 291214DE 291214ML

291214BA
291214DE
APPENDIX E



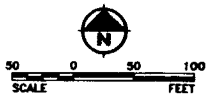
NOTES:

1. PROPOSED CONTOURS AS SHOWN INDICATE FINISH GRADE. FINISH GRADE INCLUDES 12" WETLAND SOIL. SEE DETAIL 1/C7
2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.
4. PHASE 2 GRADING LIMITS TO BE FIELD STAKED BY THE ENGINEER.
5. MICROTOPOGRAPHIC FEATURES WILL BE ADDED IN GRADED AREAS. SEE PLAN 4/C8.2
6. GRADED AREAS SHALL BE HYDROSEEDED WITH ONE OF THE FOLLOWING THREE SEED MIXES:
   - WET ZONE SEED MIX FROM THE 38 FT TO 41FT ELEVATION.
   - TRANSITION SEED MIX FROM THE 41 FT TO 45 FT ELEVATION.
   - UPLAND SEED MIX ABOVE THE 45 FT ELEVATION.

   SEE SHEET L10 FOR SEED MIXTURE.

LEGEND:

— - - —	MATCHLINE
▭	EXISTING WETLAND
▨	WETLAND CROSSING
- - - - - -	GRADING LIMITS
— — — —	100' BUFFER
—·—·—	PROPERTY BOUNDARY
· · · · · ·	EXISTING WETLAND BOUNDARY
═════	GRAVEL PATH
⌒	SLOPE INDICATOR
▨	MAINTENANCE ROAD
N 8824 E 7104	CONTROL POINT FOR GRADING
⊗ DOW12	EXISTING DEWATERING OBSERVATION WELL
◉ DWT-4	EXISTING DEWATERING TEST WELL
⋈ P-10	EXISTING MONITORING WELL
▣ TP-5	TEST PIT LOCATION



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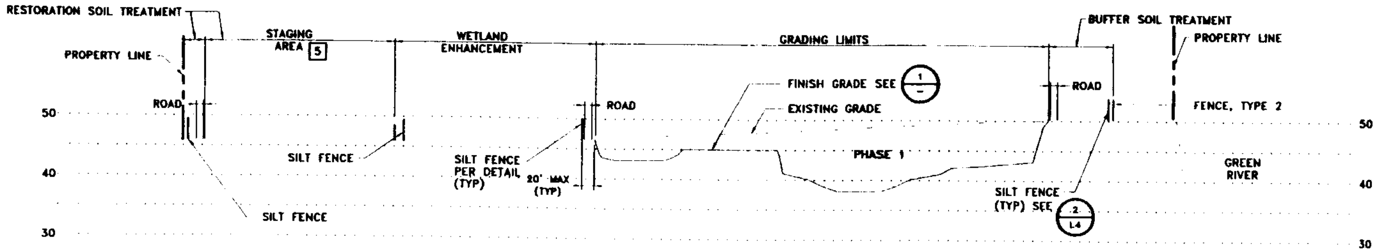
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PHASE 2 GRADING PLAN SW**

291214C6
STIA-9804-C6

291214BA
291214DE

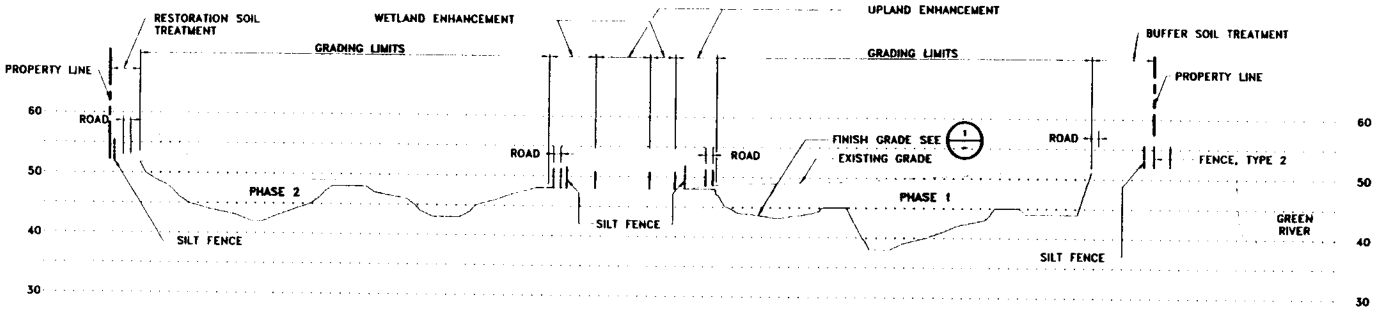
DATE: 11/14/01 FILENAME: 291214C6 IMAGES: XREF'S: 291214BL 291214BA 291214DE

APPENDIX E



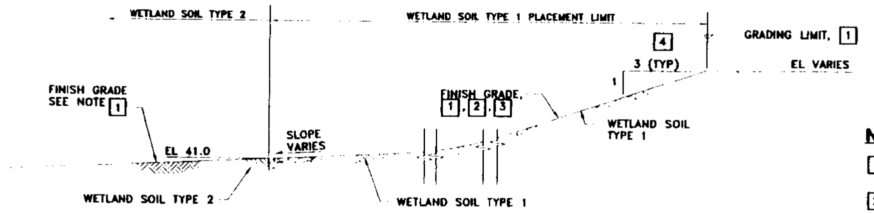
SECTION 1 / C3 C5

HORIZ: 1"=100'
VERT: 1"=10'



SECTION 2 / C4 C6

HORIZ: 1"=100'
VERT: 1"=10'



DETAIL 1 / – C3, C4, C5, C6, L5, L6, L7, L8

TYP. WETLAND SOIL PLACEMENT
SCALE: 1" = 5'

NOTES:

1. GRADING LIMIT AND FINISHED GRADE AS SHOWN ON SHEETS C3, C4, C5, & C6.
2. WETLAND SOIL TYPE 1 SHALL BE USED AT ELEVATION 41.0 AND ABOVE FOR ALL AREAS WITHIN THE GRADING LIMITS. WETLAND SOIL TYPE 2 SHALL BE PLACED BELOW ELEVATION 41.0 WITHIN THE AREA SHOWN ON THE PLAN.
3. HYDROSEED PER SHEET C9. PLACE EROSION CONTROL MATTING ON ALL 3H:1V SLOPES OR STEEPER SLOPES WITHIN THE GRADING LIMITS.
4. GRADE SHOWN AT 3H:1V BUT WILL VARY BETWEEN 3H:1V AND 5V:1V TO PROVIDE VARIATION IN UPLAND/WETLAND BOUNDARY.
5. WETLANDS MODIFIED IN STAGING AREA WILL BE RESTORED THEN ENHANCED AFTER CONSTRUCTION IS COMPLETE.

AGENCY REVIEW
NOT FOR CONSTRUCTION

DATE 11/14/01 FILENAME 291214C7 IMAGES XREFS

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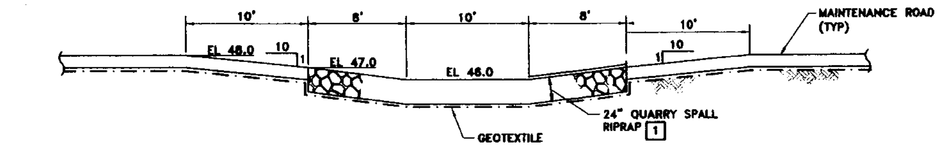
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: SECTIONS AND DETAILS

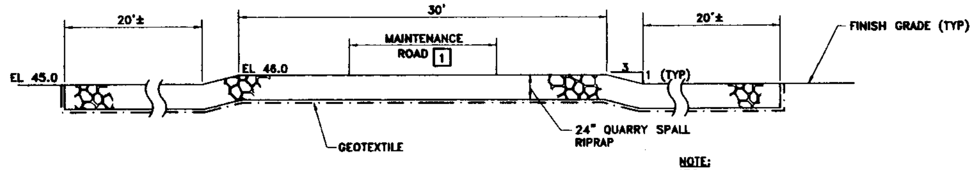
291214C7
STIA-9804-C7

APPENDIX E



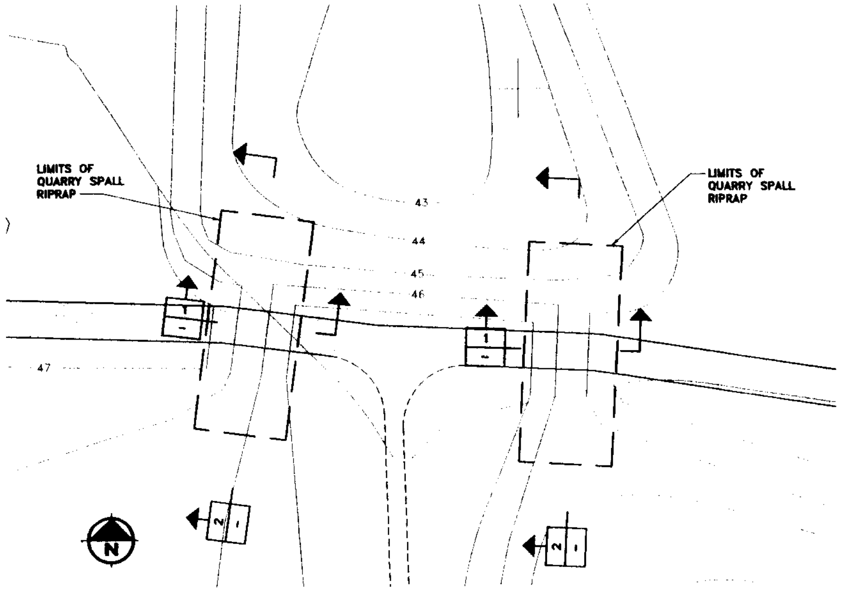
SECTION 1 –
SCALE: 1"=5'

NOTE:
1 CHOKE THE UPPER 3" OF QUARRY SPALLS WITHIN THE MAINTENANCE ROAD WITH CRUSHED SURFACING.



SECTION 2 –
SCALE: 1"=5'

NOTE:
1 CHOKE THE UPPER 3" OF QUARRY SPALLS WITHIN THE MAINTENANCE ROAD WITH CRUSHED SURFACING.



DETAIL 1 C5
OVERFLOW – PLAN
SCALE: 1"=20'

DATE: 11/13/01 FILENAME: 291214C7-1 IMAGES: XREF'S:

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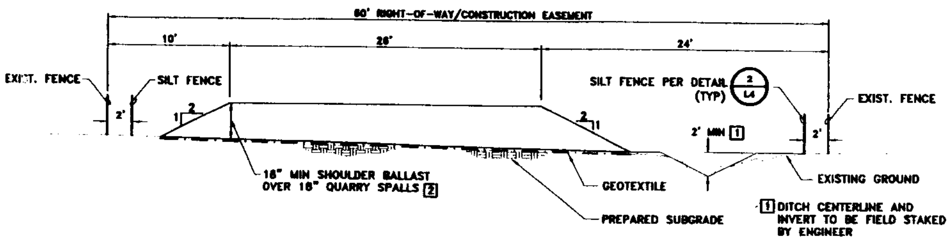
SHEET TITLE: OVERFLOW SECTIONS AND DETAILS

100052
291214C7-1
STIA-9804-C7.1

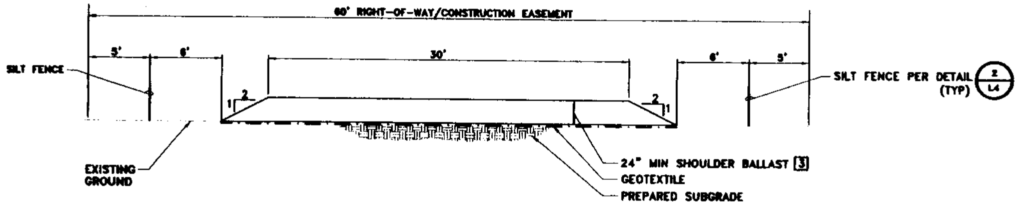
APPENDIX E



1 DITCH CENTERLINE AND INVERT TO BE FIELD STAKED BY ENGINEER

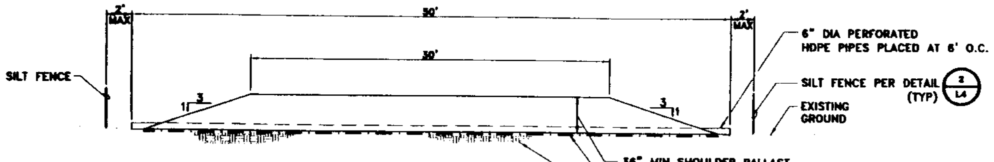
2 ASPHALT PAVED SURFACE MAY BE ADDED TO REDUCE THE POTENTIAL FOR TRACKING DIRT AND MUD OFF SITE.

SECTION 1/C2
N.T.S.
TEMPORARY 49TH STREET CONSTRUCTION ACCESS



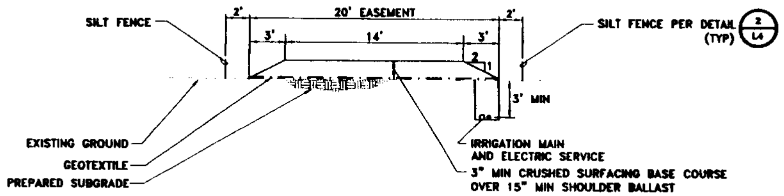
SECTION 2/C2
N.T.S.
TEMPORARY CONSTRUCTION ROAD

3 ASPHALT PAVED SURFACE MAY BE ADDED TO REDUCE THE POTENTIAL FOR TRACKING DIRT AND MUD OFF SITE.

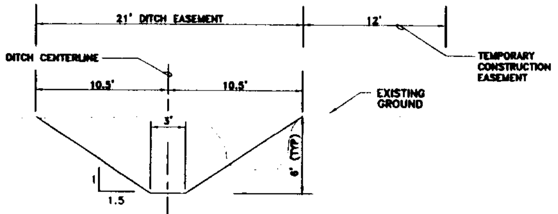


NOTE
6 SUBGRADE PREPARATIONS MEET ENGINEERING DESIGN REQUIREMENTS FOR CULVERT SUPPORT.

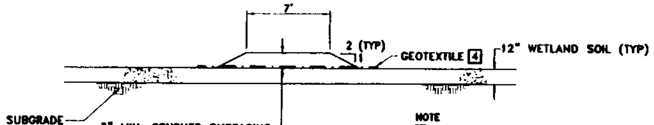
SECTION 3/C2
N.T.S.
TEMPORARY WETLAND CROSSING



SECTION 4/C2
N.T.S.
SITE ACCESS AND UTILITY EASEMENT

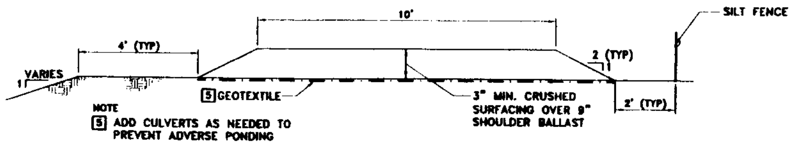


SECTION 5/C2 C5
N.T.S.
WETLAND OUTLET DITCH



NOTE
4 ADD CULVERTS AS NEEDED TO PREVENT ADVERSE PONDING ON UPSLOPE SIDE.

SECTION 6/C3 C4, C9
N.T.S.
GRAVEL PATH



NOTE
5 ADD CULVERTS AS NEEDED TO PREVENT ADVERSE PONDING ON UPSLOPE SIDE.

SECTION 7/C3 C5, C6
N.T.S.
MAINTENANCE ROAD

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PJT/SBM
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NOVEMBER 2001

REVISIONS

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SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: GRADING SECTIONS AND DETAILS

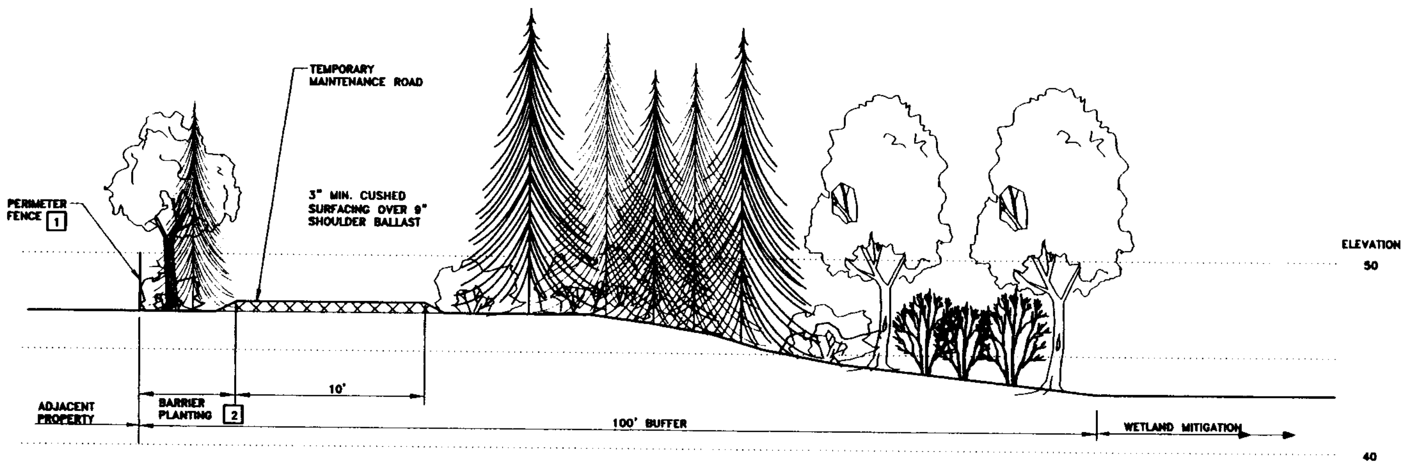
291214C8
STIA-9804-C8

APPENDIX E

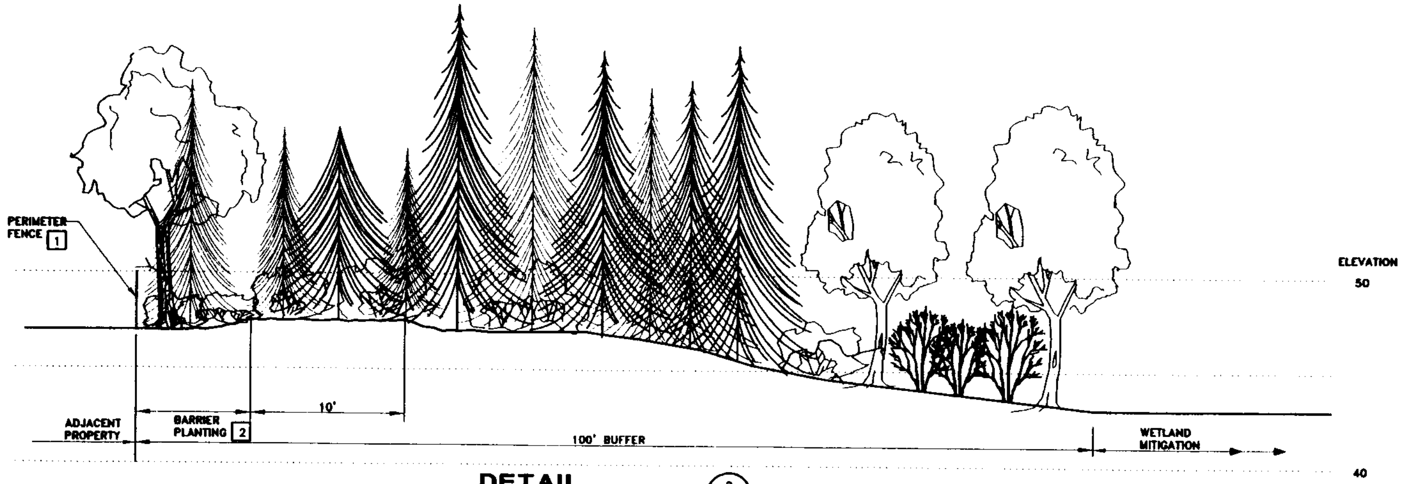
DATE: 11/09/01 FILENAME: 291214C8

NOTE:

1. TEMPORARY SECURITY FENCE WILL BE INSTALLED DURING CONSTRUCTION AND INITIAL PLANTING. PERMANENT FENCE WILL BE INSTALLED AFTER CONSTRUCTION AND INITIAL PLANTING.
2. BARRIER PLANTINGS TO INCLUDE 20 PERCENT MORE SHRUBS THAN OTHER BUFFER AREAS.



DETAIL 1 TYP
BARRIER PLANTING AND
100' WETLAND BUFFER
NOT TO SCALE



DETAIL 2 TYP
POST CONSTRUCTION BARRIER
PLANTING AND
100' WETLAND BUFFER
NOT TO SCALE

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NOVEMBER 2001

REVISIONS

DECEMBER 2000

Port of Seattle
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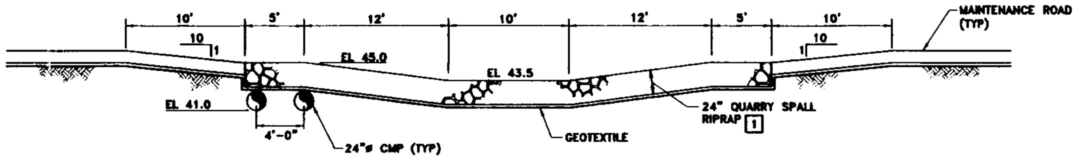
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **BUFFER AND TEMPORARY MAINTENANCE ROAD PROFILE**

100052
291214C8.1
STIA-9804-C8.1

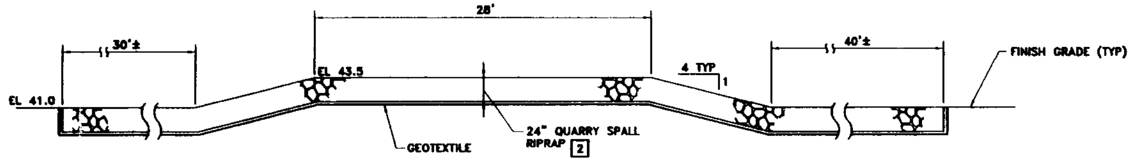
APPENDIX E

DATE: 11/14/01 FILENAME: 291214C8



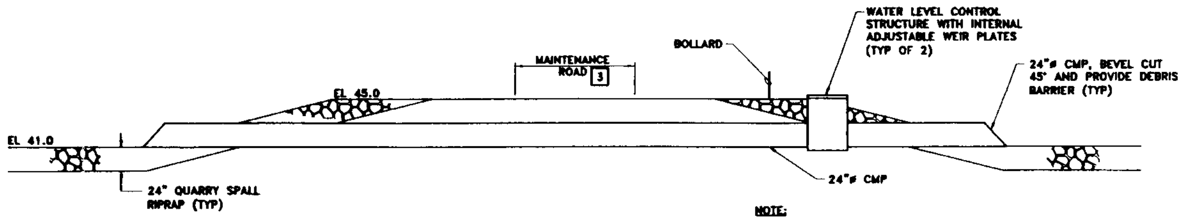
NOTE:
1 CHOKE THE UPPER 3" OF QUARRY SPALLS WITHIN THE MAINTENANCE ROAD LIMITS WITH CRUSHED SURFACING. TAPER MAINTENANCE ROAD INTO QUARRY SPALL LIMITS.

SECTION
OVERFLOW SPILLWAY
1"=5'
1
–



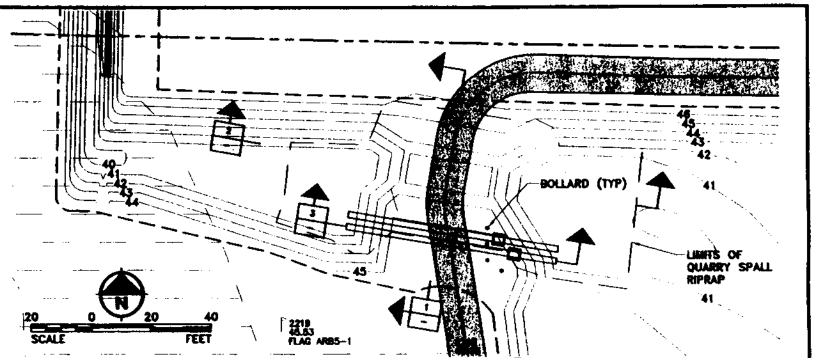
NOTE:
2 CHOKE THE UPPER 3" OF QUARRY SPALLS WITHIN THE MAINTENANCE ROAD LIMITS WITH CRUSHED SURFACING. TAPER MAINTENANCE ROAD INTO QUARRY SPALL LIMITS.

SECTION
OVERFLOW SPILLWAY
1"=5'
2
–

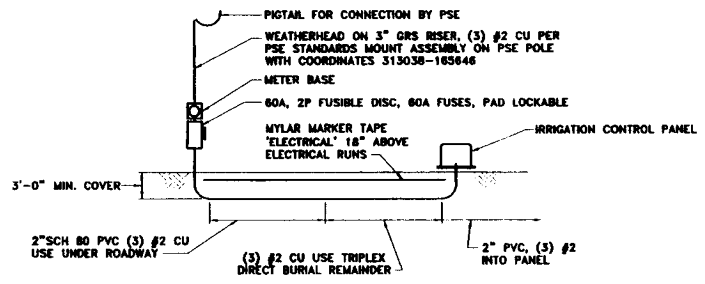


NOTE:
3 CHOKE THE UPPER 3" OF QUARRY SPALLS WITHIN THE MAINTENANCE ROAD LIMITS WITH CRUSHED SURFACING. TAPER MAINTENANCE ROAD INTO QUARRY SPALL LIMITS.

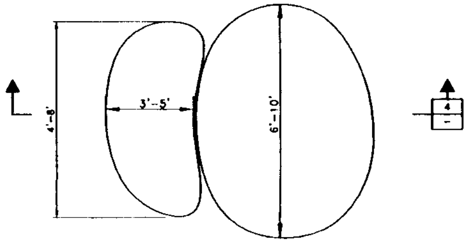
SECTION
WATER LEVEL CONTROL STRUCTURE (TYP)
1"=5'
3
–



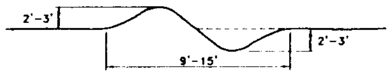
DETAIL
OVERFLOW AND WATER LEVEL CONTROL STRUCTURES – PLAN
1"=20'
1
C3
C5



DETAIL
ONE LINE DIAGRAM
'ELECTRICAL'
NOT TO SCALE
2
L7
L8



PLAN
MICROTOPOGRAPHIC FEATURE
N.T.S.
4
C3
C4, C5, C6



NOTE:
1. APPROXIMATELY 4 MICROTOPOGRAPHIC FEATURES PER ACRE.

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SECTION
MICROTOPOGRAPHIC FEATURE
N.T.S.
4
–

DATE: 11/14/01 FILENAME: 291214C8 IMAGES: XREFS: 291214BA 291214DE

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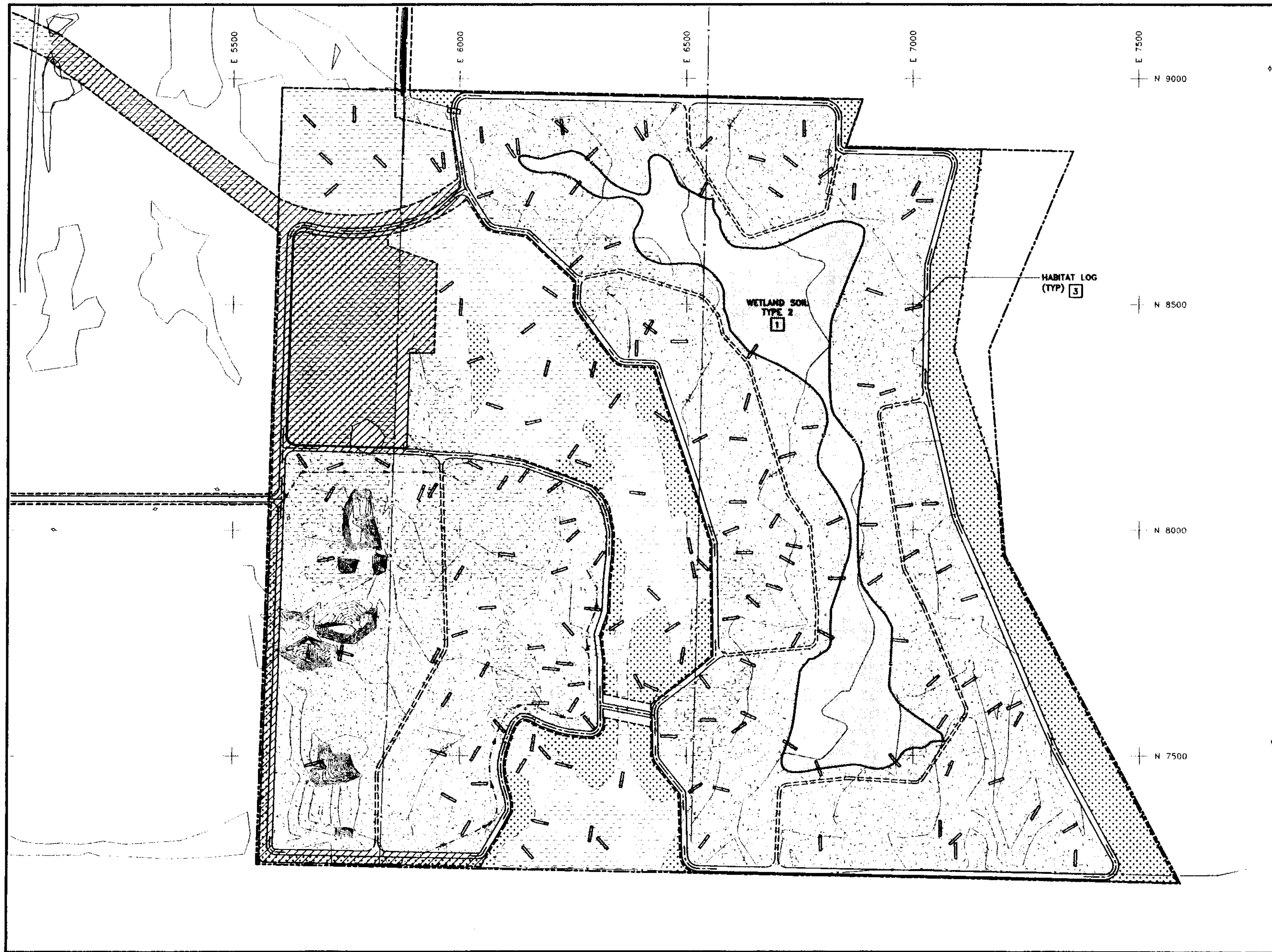
SHEET TITLE: SECTIONS AND DETAILS

100052
291214C8-2
STIA-9804-C8.2

291214BA
291214DE
APPENDIX E



NOTES:

1. WETLAND SOIL TYPE 2 BOUNDARY GENERALLY CORRESPONDS TO CONTOUR ELEVATION 41 AS SHOWN ON SHEETS C3 AND C4.
2. FOR WETLAND SOIL PLACEMENT ALONG GRAVEL PATH SEE SECTION 6/C8
3. HABITAT LOG CAN BE STANDING SNAG, ROOT WAD OR HORIZONTAL LOG. SEE DETAILS 3/L4 4/L4 8/L4

LEGEND:

☐	USE EXISTING WETLAND SOILS
▨	WETLAND SOIL TYPE 1
☐	WETLAND SOIL TYPE 2
▨	EXISTING UPLAND SOIL
▨	RESTORATION SOIL TREATMENT
/	APPROXIMATE NUMBER AND LOCATION OF LOG (TYP) TO BE FIELD LOCATED BY ENGINEER
======	GRAVEL PATH
----------	GRADING LIMITS
—·—·—	PROPERTY BOUNDARY
	EXISTING WETLAND BOUNDARY

100 0 100 200
SCALE FEET

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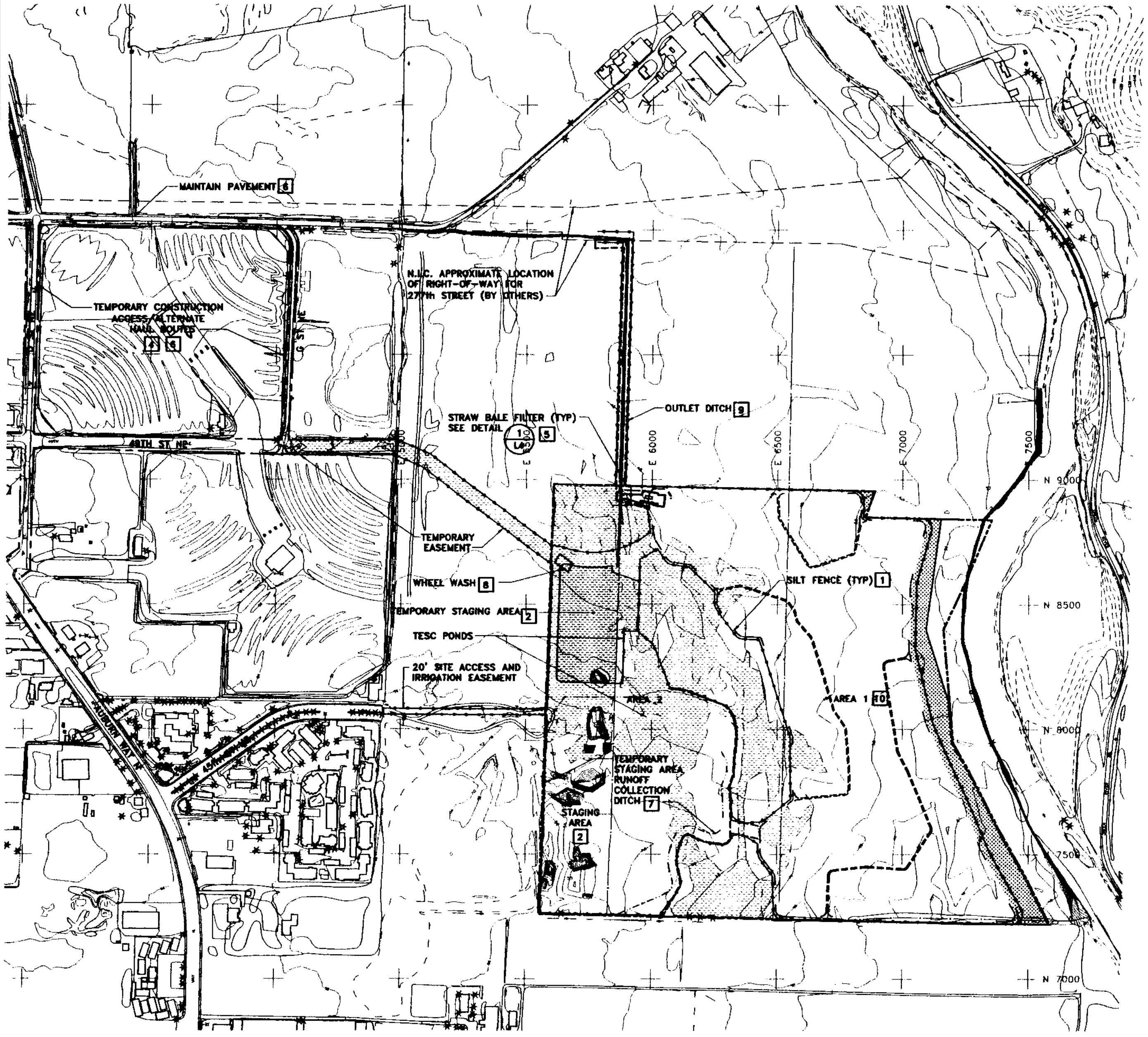
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **SOIL AND HABITAT FEATURES PLAN**

291214C10
STIA-9804-C9

DATE: 11/12/01 FILENAME: 291214C10 XREF'S: 291214BA 291214DE
291214BA
291214DE
APPENDIX E



TEMPORARY EROSION AND SEDIMENT CONTROL REQUIREMENTS:

1. PRIOR TO CONSTRUCTION ACTIVITIES, INSTALL SILT FENCE AROUND PROJECT LIMITS INCLUDING TEMPORARY ACCESS ROADS, STAGING AREA, AND GRADING LIMITS AS SHOWN. LOCATION OF SILT FENCE SHALL BE AS SHOWN ON CROSS SECTIONS ON SHEET C8 OR AS DIRECTED BY THE ENGINEER.
2. WITHIN THE STAGING AREA, PROVIDE ADDITIONAL SILT FENCE, TEMPORARY DITCHING, STRAW BALES, HYDROSEED, MULCH, AND PLASTIC SHEETING, AS NEEDED TO PROTECT TEMPORARY MATERIAL PILES AND CONTROL EROSION AND RUNOFF FROM STAGING OPERATIONS.
3. INSTALL HYDROMULCH SEEDING AND EROSION CONTROL MATTING AS SPECIFIED AND CONSISTENT WITH THE CITY OF AUBURN GRADING PERMIT.
4. UNPAVED TEMPORARY CONSTRUCTION ACCESS ROAD SURFACES SHALL BE KEPT CLEAN, WATERED AND MAINTAINED AT ALL TIMES TO CONTROL FUGITIVE DUST, AND TO PREVENT DIRT AND MUD FROM BEING TRACKED OFF SITE. APPLY WATER AS NEEDED TO CONTROL DUST DURING ALL ON-SITE EXCAVATION, HAUL, STOCKPILE, COMPACTION, AND OTHER APPLICABLE CONSTRUCTION OPERATIONS.
5. STRAW BALE FILTERS TO BE FIELD LOCATED BY ENGINEER.
6. MAINTAIN PAVEMENT IN GOOD REPAIR. CLEAN WITH VACUUM EQUIPMENT DAILY AND AS NEEDED TO PREVENT TRACKING OF DIRT AND MUD OFF SITE.
7. CONSTRUCT AND MAINTAIN A TEMPORARY RUNOFF COLLECTION DITCH DURING ALL CONSTRUCTION STAGING OPERATIONS. DITCH SHALL COMPLETELY ENCOMPASS STAGING AREA AND BE GRADED TO DRAIN TO TESC PONDS.
8. PROVIDE WHEEL WASH AT SITE ENTRANCE. ROUTE ALL OUTBOUND TRAFFIC THROUGH WHEEL WASH.
9. LINE OUTLET DITCH WITH GEOTEXTILE FABRIC AS NEEDED TO PREVENT EROSION OR TURBIDITY FROM CONTRACTOR'S DEWATERING DISCHARGE.
10. TESC PONDS FOR AREA 1 ARE TO BE LOCATED IN THE EXCAVATION AREA. WATER COLLECTED BY THESE PONDS WILL BE ROUTED TO AN ON-SITE WATER TREATMENT FACILITY.
11. MAJOR CONSTRUCTION ACTIVITIES WILL NOT OCCUR BETWEEN OCTOBER 31 AND MARCH 31 TO AVOID IMPACTS TO OVER WINTERING BALD EAGLES.

LEGEND

—·—·—	PROPERTY BOUNDARY
—+—+—	SILT FENCE
▨	EXISTING WETLANDS WITHIN PROPERTY BOUNDARY
- - - - -	GRAVEL PATH

N

200 0 200 400
SCALE FEET

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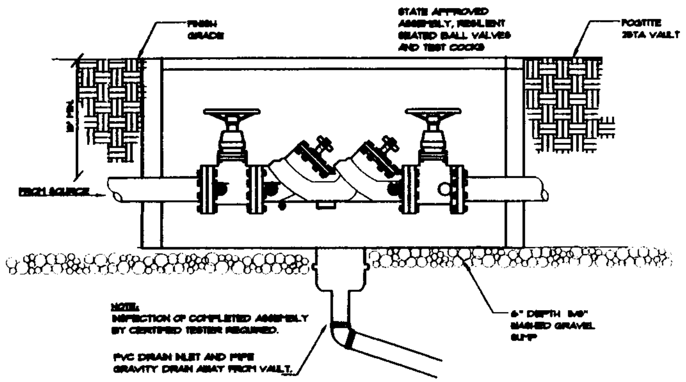
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **TESC PLAN**

291214C9
STIA-9804-TE1

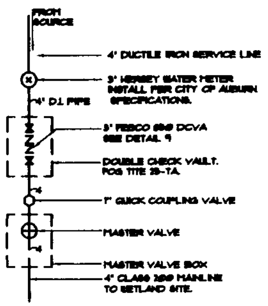
DATE: 11/14/01 FILENAME: 291214C9 XREF'S: 291214BA 291214DE 291214XL IMAGES:

291214BA
291214DE

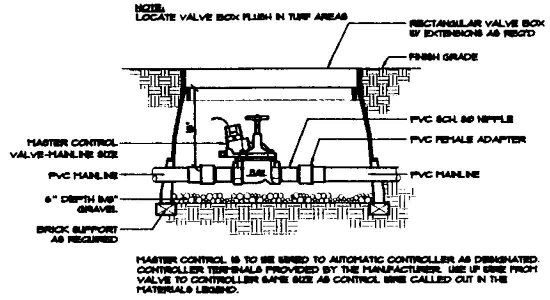
APPENDIX E



① DOUBLE CHECK VALVE ASSEMBLY
SCALE: N.T.S.

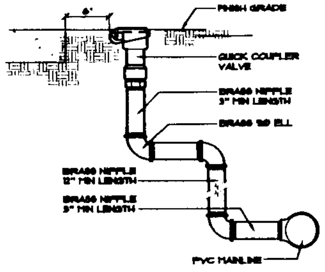


② P.O.C SCHEMATIC
SCALE: N.T.S.

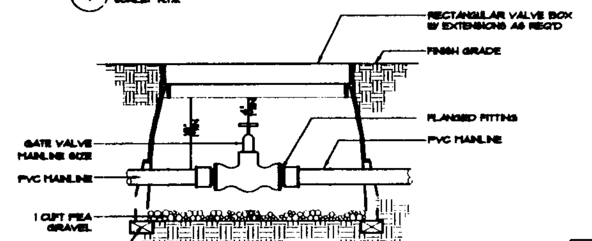


MASTER CONTROL IS TO BE WIRED TO AUTOMATIC CONTROLLER AS DESIGNATED. CONTROLLER TERMINALS PROVIDED BY THE MANUFACTURER. USE UF WIRE FROM VALVE TO CONTROLLER SAME SIZE AS CONTROL WIRE CALLED OUT IN THE MATERIALS LEGEND.

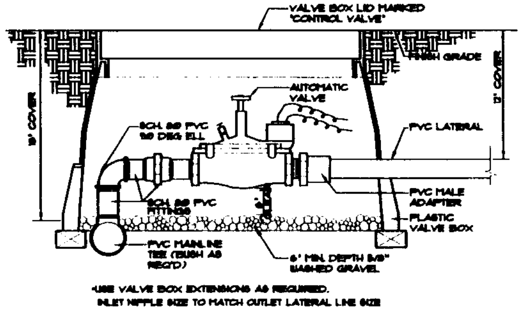
③ MASTER VALVE
SCALE: N.T.S.



④ QUICK COUPLER VALVE
SCALE: N.T.S.

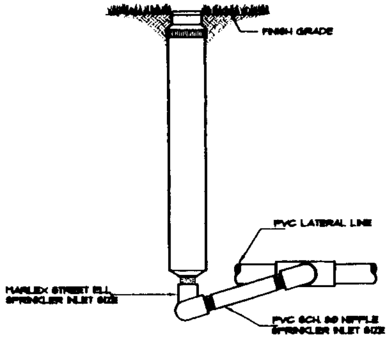


⑤ MAINLINE GATE VALVE
SCALE: N.T.S.

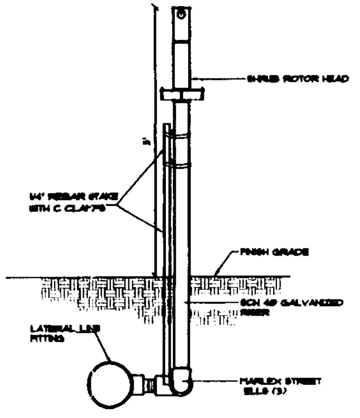


*USE VALVE BOX EXTENSIONS AS REQUIRED.
INLET NIPPLE SIZE TO MATCH OUTLET LATERAL LINE SIZE

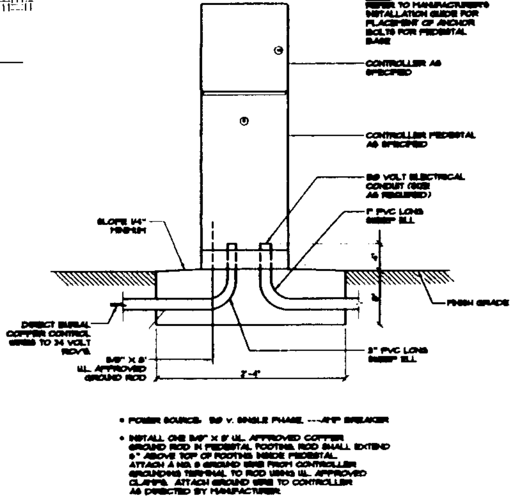
⑥ REMOTE CONTROL VALVE
SCALE: N.T.S.



⑦ HI-POP ROTOR
SCALE: N.T.S.



⑧ SHRUB RISER
SCALE: N.T.S.



- POWER SOURCE: 120 V. SINGLE PHASE, ---AMP BREAKER
- INSTALL ONE 5/8" X 8' UL APPROVED COPPER GROUND ROD IN PEDESTAL FOOTING. ROD SHALL EXTEND 6" ABOVE TOP OF FOOTING INSIDE PEDESTAL. ATTACH A NO. 8 GROUND WIRE FROM CONTROLLER GROUNDING TERMINAL TO ROD USING UL APPROVED CLAMPS. ATTACH GROUND WIRE TO CONTROLLER AS DIRECTED BY MANUFACTURER.

⑨ PEDESTAL MOUNT CONTROLLER
SCALE: N.T.S.

GENERAL NOTES

1. PRIOR TO THE COMMENCEMENT OF WORK, CONTRACTOR MUST VERIFY A MINIMUM OF 50 LBS/PSI STATIC WATER PRESSURE AT POINT OF CONNECTION. NOTIFY ARCHITECT OF ANY DISCREPANCY.
2. IRRIGATION CONTRACTOR IS RESPONSIBLE FOR LOCATING AND PROTECTING ALL UTILITIES ENCOUNTERED THROUGH THE SCOPE OF HIS WORK.
3. ALL DRAWINGS ARE DIAGRAMMATIC, FIELD VARIANCES MAY OCCUR. NOTIFY ARCHITECT OF ANY DISCREPANCY.
4. MAINLINE LAYOUT IS DIAGRAMMATIC, IT HAS BEEN SHOWN OUTSIDE WETLAND PERIMETER FOR PURPOSES OF CLARITY. LOCATE INSIDE WETLAND LIMIT OF WORK.
5. CONTRACTOR IS RESPONSIBLE TO PROVIDE ALL NECESSARY SLEEVING UNDER WEIR AND ANY TEMPORARY ROADWAYS, WHETHER SPECIFICALLY INDICATED ON THE DRAWINGS OR NOT. SLEEVING SHOULD EXTEND 6" BEYOND HARDSCAPE EDGE.
6. CONTRACTOR IS TO INSTALL 4" DUCTILE IRON SERVICE LINE AND 3" HERSEY WATER METER PER CITY OF AUBURN SPECIFICATIONS.
7. PIPING SHOWN IN PARALLEL MAY BE INSTALLED IN A COMMON TRENCH. ALLOW A MINIMUM OF THREE (3") INCHES BETWEEN PARALLEL PIPE LINES. LOCATE TRENCHES TO AVOID CONFLICT WITH INSTALLATION OF TREES & SHRUBS.
8. ALL UNSIZED TERMINAL LATERAL LINES SHALL BE 1" PIPE.
9. COORDINATE PLANTING AND SPRINKLER HEAD LOCATIONS TO AVOID CONFLICT AND POTENTIAL PLANT DAMAGE. INSTALL ROTORS AS PER DETAILS.
10. CONTRACTOR IS RESPONSIBLE TO FINE TUNE ALL NOZZLES ON SITE TO INSURE COVERAGE AND MINIMIZE OVERSPRAY.
11. VERIFY CONTROLLER LOCATIONS WITH OWNER.
12. CONTRACTOR IS RESPONSIBLE FOR WINTERIZATION OF SYSTEM. SYSTEM MUST BE WINTERIZED BY BLOWING OUT WITH COMPRESSED AIR.
13. INSTALL LATERAL LINE PIPE IN WETLAND AREAS ABOVE GROUND AS INDICATED ON DRAWING.
14. MAINLINE AND VALVES ARE SHOWN IN HARDSCAPE FOR PURPOSES OF CLARITY. LOCATE IN 4 FOOT SECTION ADJACENT TO INSIDE OF ROAD.

IRRIGATION LEGEND

SYMBOL	DESCRIPTION	GPM
◔ ◑ ◓	ROTOR, HUNTER I-20-HP-ADV HI-POP ROTOR--NOZZLE #	8
◔ ◑ ◓ ◕ ●	ROTOR, HUNTER I-10 SERIES SHRUB ROTOR--NOZZLE #	8
⊕	WEATHERMATIC 8000CR SERIES ELECTRIC REMOTE CONTROL VALVE PLASTIC -- SIZE AS INDICATED ON DRAWING.	
⊖	VALVE DETAIL---ZONE NUMBER GPM VALVE SIZE	
M ⧗	POINT OF CONNECTION 3" HERSEY WATER METER--4" D.I. SERVICE LINE 3" FEBCO 850T DOUBLE CHECK VALVE ASSEMBLY 3" WEATHERMATIC 8000 CR MASTER VALVE BUCKNER 1" QUICK COUPLER VALVE	
●	MAINLINE GATE VALVE--SIZE TO MATCH MAINLINE	
⬡	BUCKNER 1" QUICK COUPLER VALVE	
A B C	RAINBIRD ESP-MC SERIES SOLID STATE CONTROLLER--48, 32, 32 STATIONS INPUT REQUIRED: 120 VOLT AC, 60 HZ. OUTPUT: 26.5 VOLT AC, 60 HZ, 3 AMP. UL LISTED AND TESTED.	
	MAINLINE-- CLASS 200 PVC- SIZE AS NOTED ON DRAWING	
—	LATERAL LINE---CLASS 200, SIZE AS NOTED ON DRAWING	
- - -	SLEEVING--CLASS 200 PVC--MIN. 2X DIAMETER OF INTERIOR PIPE MINIMUM 18" COVER OVER ALL SLEEVING UNDER ROADWAYS AND DRIVEWAYS.	

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DRAGONFLY
IRRIGATION DESIGN
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BELLEVUE, WA [illegible]
[illegible]

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DEL
DEL
N.T.S.
NOVEMBER 2001

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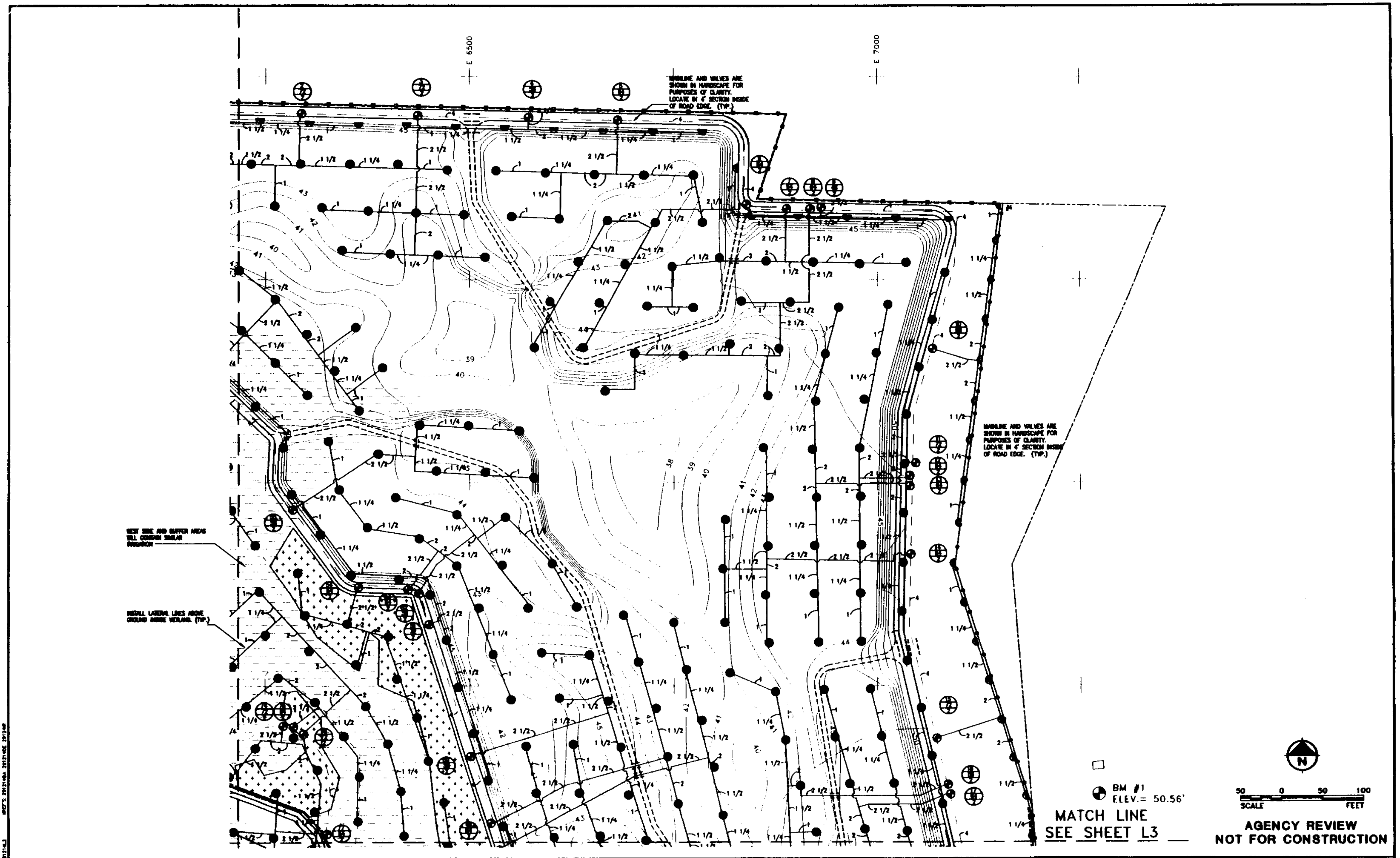
SHEET TITLE: IRRIGATION DETAILS & LEGEND

291214L1
STIA-9804-L1
APPENDIX E

DATE: 11/15/01 FILENAME: 291214L1 IMAGES: XREF'S:



MATCH LINE
SEE SHEET L3

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DRAGONFLY
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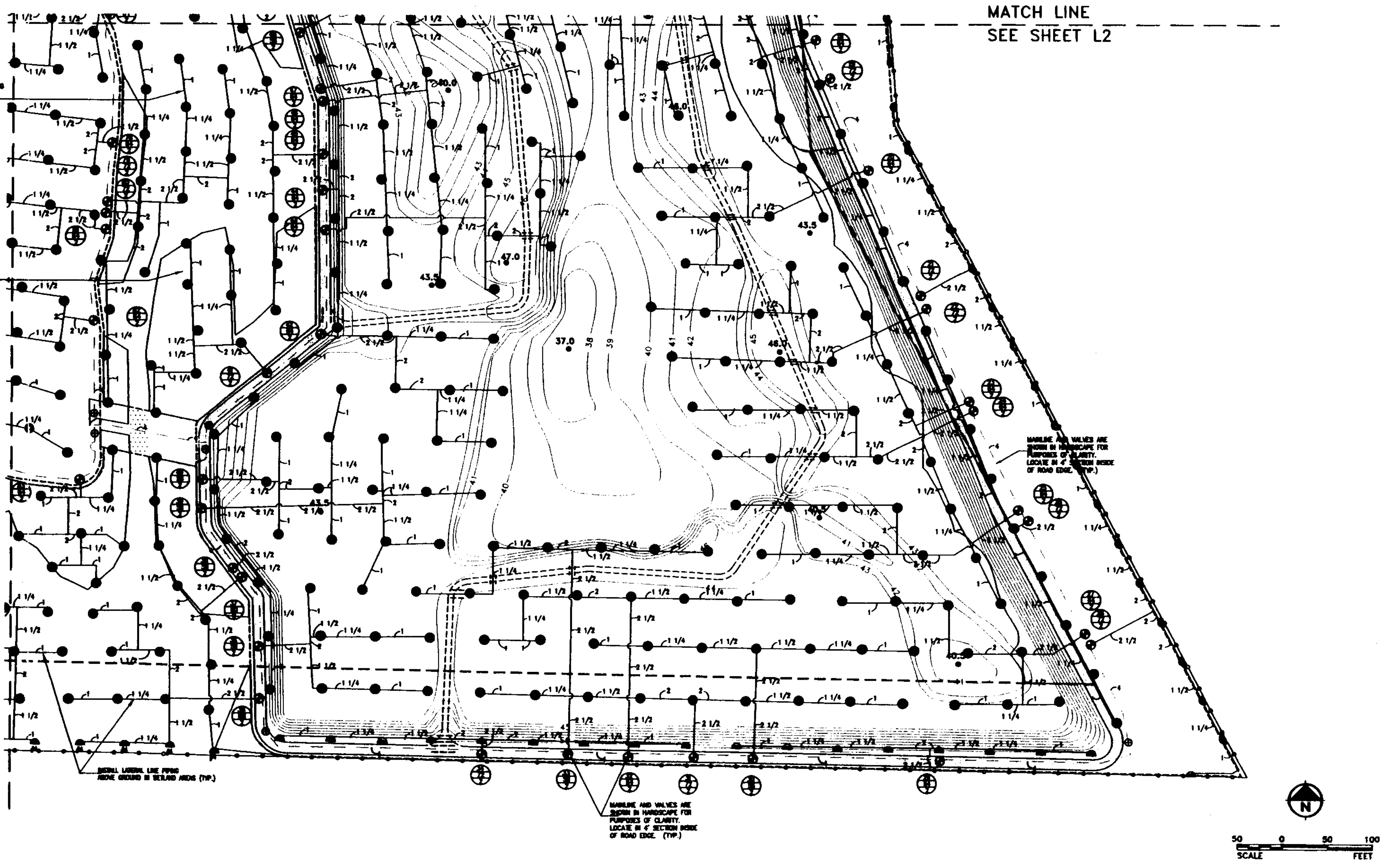
SHEET TITLE: **PHASE I IRRIGATION PLAN NE**

291214L2
STIA-9804-L2

DATE: 11/14/01 FILENAME: 291214L2

291214BA 291214DE 291214IR

APPENDIX E



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PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PHASE I IRRIGATION PLAN SE**

291214L3
STIA-9804-L3

DATE: 11/14/01 FILENAME: 291214L3

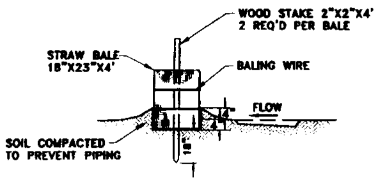
291214BA 291214DE 291214R

APPENDIX E

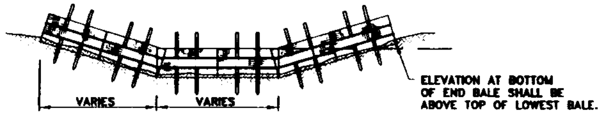
NOTES:
1. LOCATION OF ALL STANDING SNAGS, HABITAT LOGS, AND ROOT WADS SHALL BE STAKED BY THE ENGINEER.

2 BACKFILL IN 12" LIFTS AND ROD TO COMPACT AROUND LOG.

3 LOGS WILL RANGE FROM APPROXIMATELY 8' TO 40' IN LENGTH. TREE WIDTH WILL RANGE FROM APPROXIMATELY 8" TO 36".

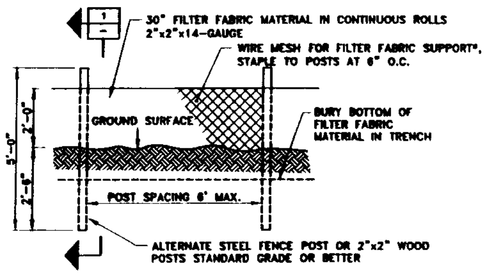


SECTION

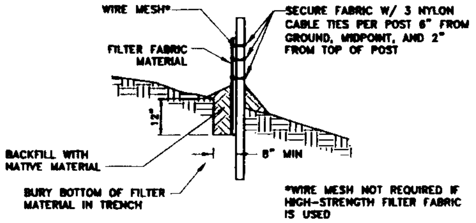


ELEVATION

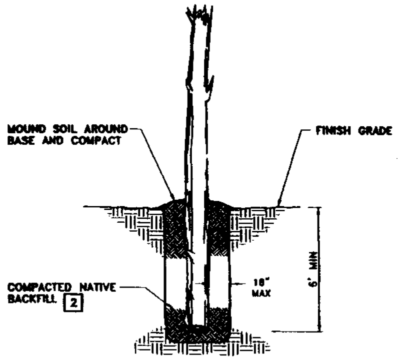
DETAIL 1 TE1
NO SCALE
STRAW BALE FILTER



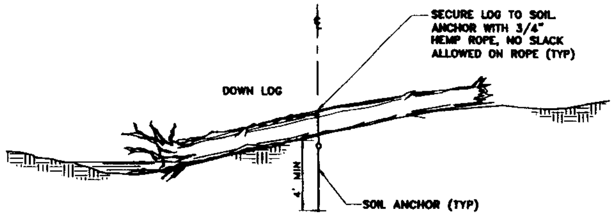
DETAIL 2 C7 C8
SILT FENCE
N.T.S.



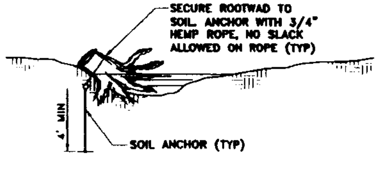
SECTION 1 –
SILT FENCE
N.T.S.



DETAIL 3 C9
NO SCALE
STANDING SNAG 3
(TYPICAL)



DETAIL 4 C9
NO SCALE
HABITAT LOGS
(TYPICAL) 3



DETAIL 5 C9
NO SCALE
ROOT WAD
(TYPICAL)

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NOVEMBER 2001

0 1"
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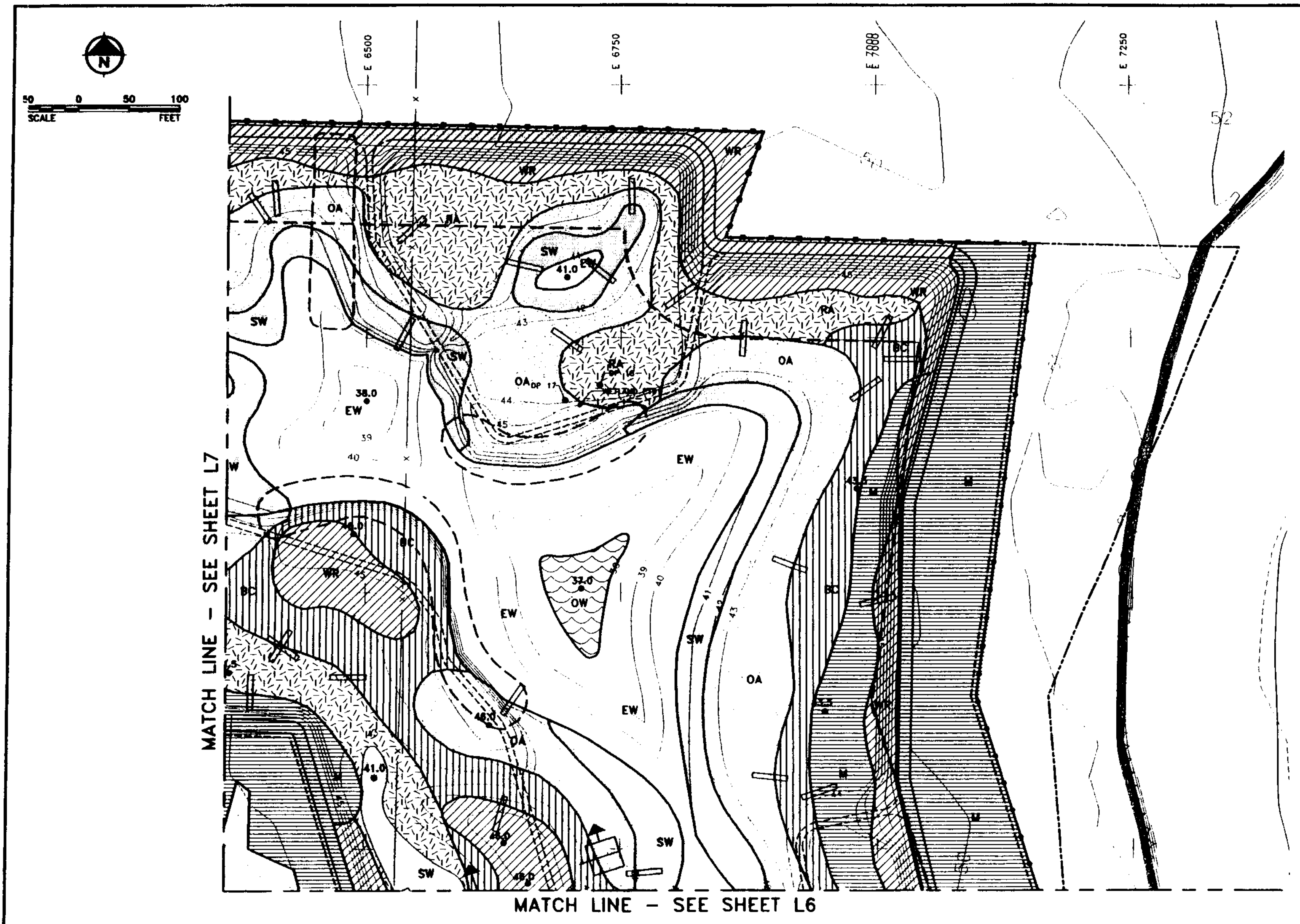
REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **MISCELLANEOUS CONTRUCTION DETAILS**

100052
291214L4
STIA-9804-L4

APPENDIX E



NOTES:

1. PROPOSED CONTOURS AS SHOWN INDICATE FINISH GRADE. FINISH GRADE INCLUDES 12" WETLAND SOIL. SEE DETAIL 1/C7
2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.
4. MAINTENANCE ROADS WILL BE PLANTED BY THE END OF THE MONITORING PERIOD UNLESS THE ACOE AND ECOLOGY DETERMINE IT IS DESIRABLE TO LEAVE ALL OR PORTIONS OF THEM IN PLACE.

LEGEND:

BC	BLACK COTTONWOOD/WILLOW
RA	RED ALDER/SALMONBERRY
OA	OREGON ASH/SLOUGH SEDGE
M	MIXED FOREST
WR	WESTERN REDCEDAR
SW	SHRUB WETLAND
EW	EMERGENT WETLAND
OW	OPEN WATER/NON-VEGETATED
▨	WETLAND CROSSING
⬚	PLANT PATTERN LAYOUT REFERENCE AREA (SEE SPECIFICATIONS)
▭	LOG
-------	GRADING LIMITS
=======	GRAVEL PATH
═══	MAINTENANCE ROAD
—·—·—	PROPERTY BOUNDARIES
— — —	100' BUFFER

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REVISIONS

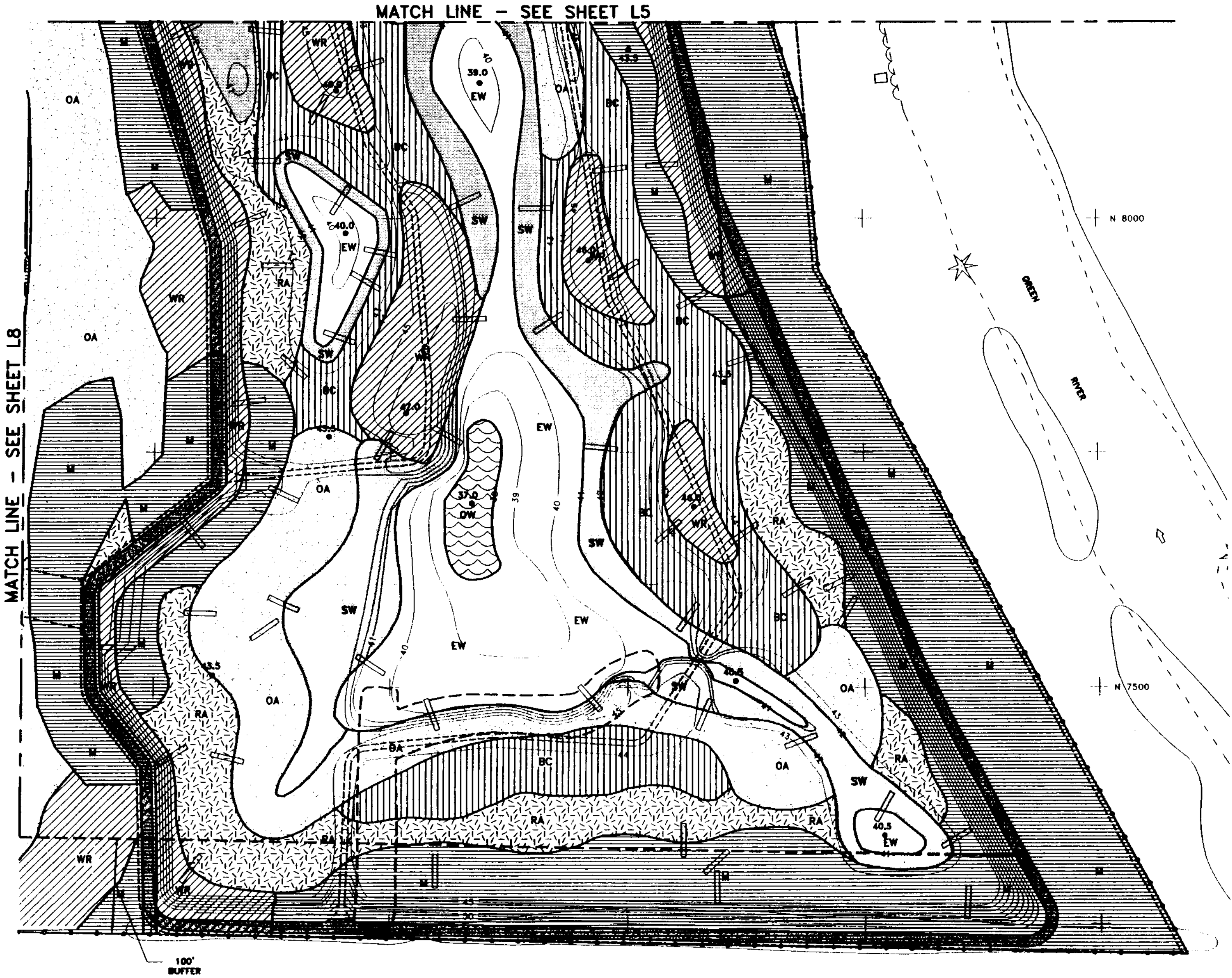
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PLANTING PLAN NE**

100052
291214L5
STIA-9804-L5

L 11/12/01 FILENAME: 291214L5 IMAGES: XREF'S 291214LA 291214BA 291214RL 291214DE

"148A 291214DE 291214LA

APPENDIX E



NOTES:

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2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.

N

50 0 50 100
SCALE FEET

LEGEND:

BC	BLACK COTTONWOOD/WILLOW
RA	RED ALDER/SALMONBERRY
OA	OREGON ASH/SLOUGH SEDGE
M	MIXED FOREST
WR	WESTERN REDCEDAR
SW	SHRUB WETLAND
EW	EMERGENT WETLAND
OW	OPEN WATER/NON-VEGETATED
░	WETLAND CROSSING
┌ ┐	PLANT PATTERN LAYOUT REFERENCE AREA (SEE SPECIFICATIONS)
▭	LOG
- - - -	GRADING LIMITS
═ ═ ═	GRAVEL PATH
▨	MAINTENANCE ROAD
——	PROPERTY BOUNDARIES
— — —	100' BUFFER
–o–o–	FENCE

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Port of Seattle
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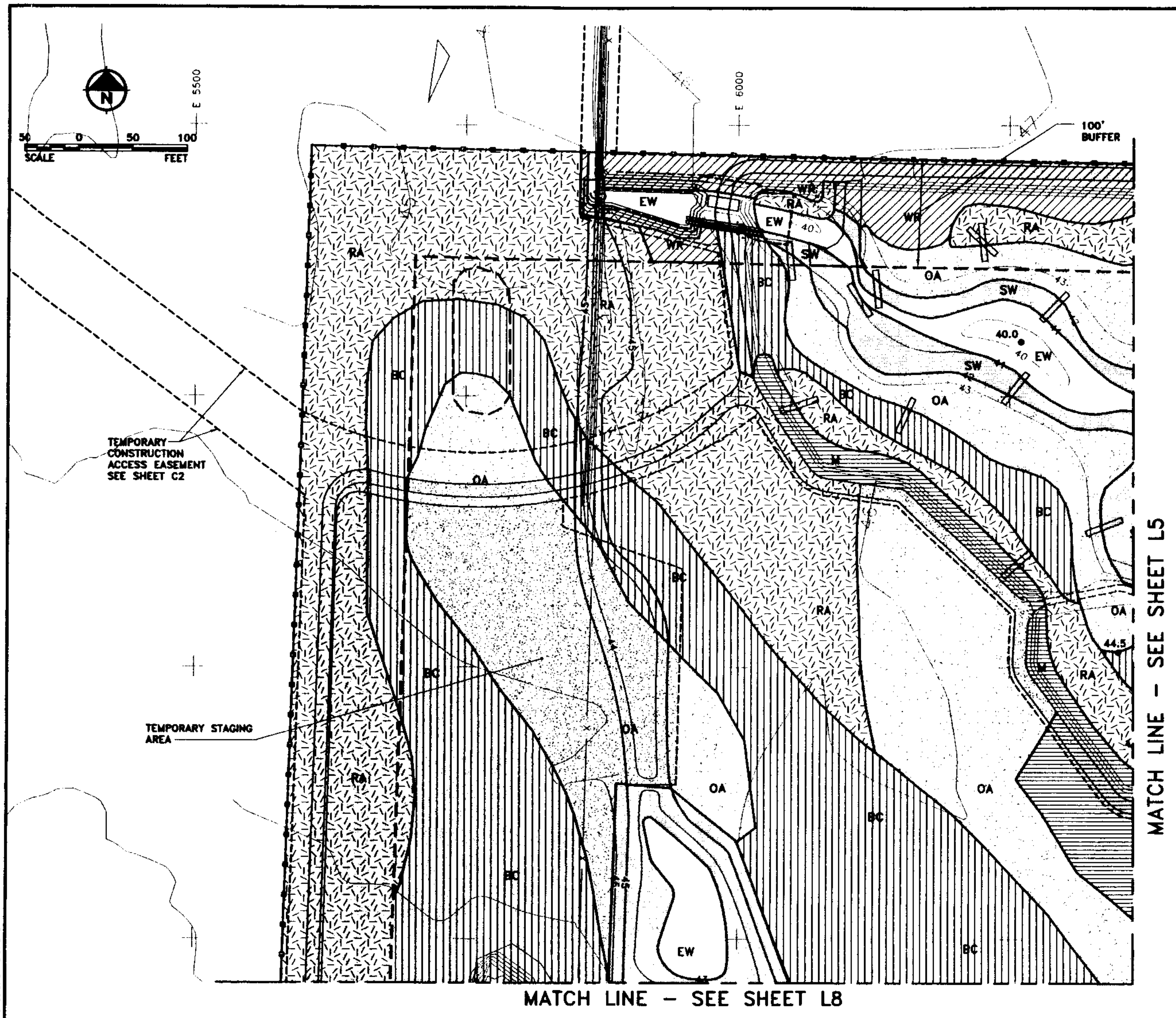
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PLANTING PLAN SE**

100052
291214L6
STIA-9804-L6

DATE 11/19/01 FILENAME 291214L6

291214RA 291214DE 291214LA

APPENDIX E



NOTES:

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2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.

LEGEND:

BC	BLACK COTTONWOOD/WILLOW
RA	RED ALDER/SALMONBERRY
OA	OREGON ASH/SLOUGH SEDGE
M	MIXED FOREST
WR	WESTERN REDCEDAR
SW	SHRUB WETLAND
EW	EMERGENT WETLAND
OW	OPEN WATER/NON-VEGETATED
▨	WETLAND CROSSING
⬚	PLANT PATTERN LAYOUT REFERENCE AREA (SEE SPECIFICATIONS)
▭	LOG
- - - - - -	GRADING LIMITS
=======	GRAVEL PATH
▬	MAINTENANCE ROAD
—·—·—	PROPERTY BOUNDARIES
— — —	100' BUFFER

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PLANTING PLAN NW

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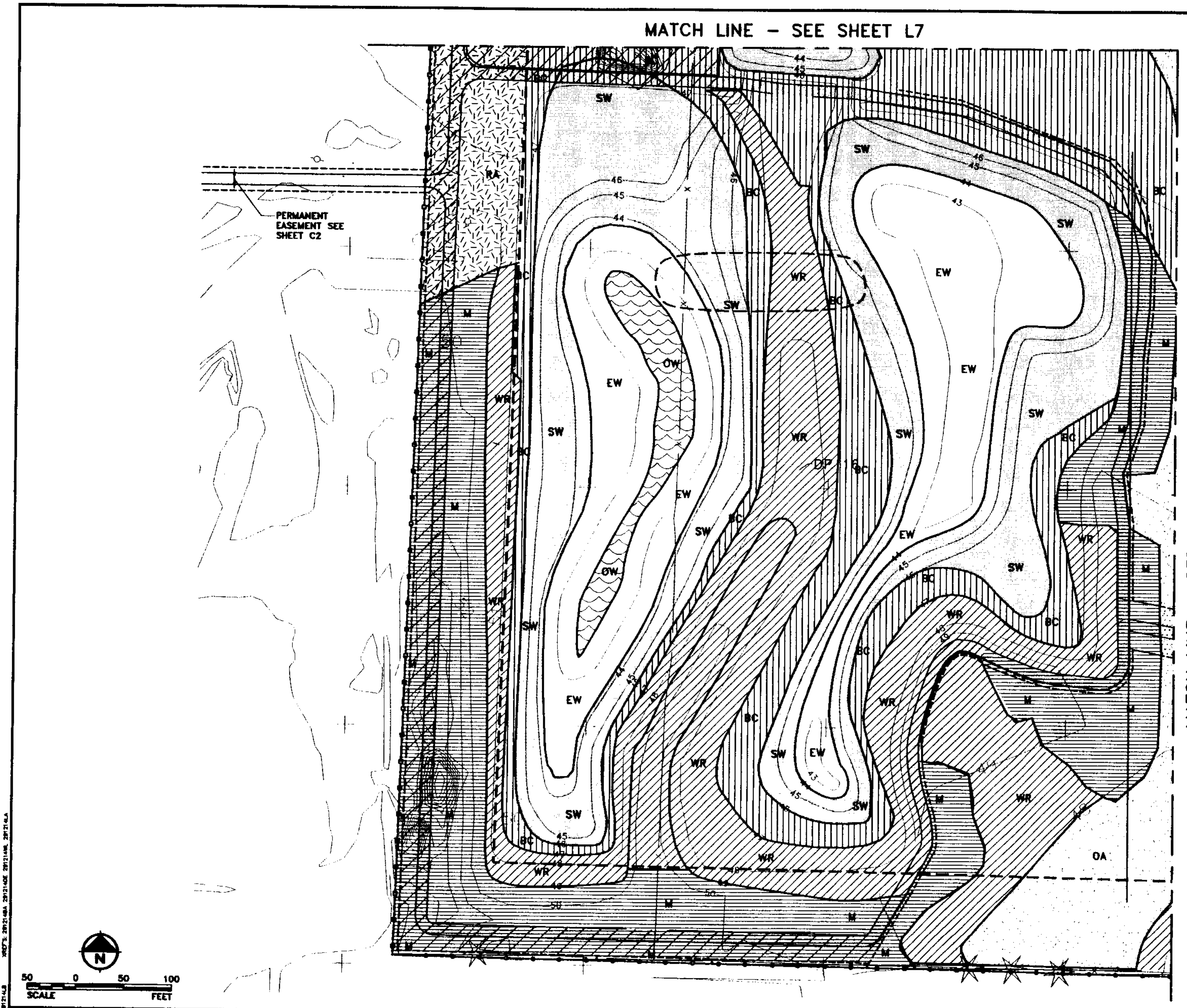
291214L7
STIA-9804-L7
APPENDIX E

DATE: 11/12/01 FILENAME: 291214L7

291214BA 291214DE 291214LA



NOTES:

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2. FINISH AND SUBGRADE GRADES SHALL CONFORM TO THE GENERAL SHAPES AND ELEVATIONS AS SHOWN. MEET GRADING TOLERANCE PER SPECIFICATIONS.
3. EROSION CONTROL MATTING SHALL BE PLACED ON ALL 3:1 OR STEEPER SLOPES WITHIN THE GRADING LIMITS.
4. PHASE 2 GRADING LIMITS TO BE FIELD STAKED BY THE ENGINEER.

LEGEND:

BC	BLACK COTTONWOOD/WILLOW
RA	RED ALDER/SALMONBERRY
OA	OREGON ASH/SLOUGH SEDGE
M	MIXED FOREST
WR	WESTERN REDCEDAR
SW	SHRUB WETLAND
EW	EMERGENT WETLAND
OW	OPEN WATER/NON-VEGETATED
░	WETLAND CROSSING
┌ ┐	PLANT PATTERN LAYOUT REFERENCE AREA (SEE SPECIFICATIONS)
▭	LOG
- - - -	GRADING LIMITS
═ ═ ═	GRAVEL PATH
▬	MAINTENANCE ROAD
—·—·—	PROPERTY BOUNDARIES
— — —	100' BUFFER

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SHEET TITLE: **PLANTING PLAN SW**

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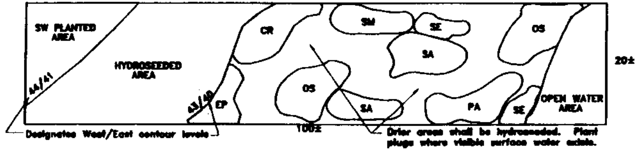
291214L8
STIA-9804-L8

DATE: 11/12/01 FILENAME: 291214L8

291214BA
291214DE
291214LA

APPENDIX E

EW - Emergent



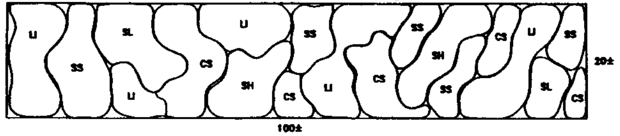
Designates West/East contour levels

Drier areas shall be hydroseeded. Plant plugs where visible surface water exists.

Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Herbs				
CR - Carex rostrata	beaked sedge	plug	10,000 Plants Per Acre	12" O.C.
EP - Eleocharis palustris	common spike-rush	plug		12" O.C.
OS - Oenanthe sarmentosa	water parsley	container		12" O.C.
PA - Polygonum amphibium	water smartweed	container		12" O.C.
SA - Scirpus acutis	hardstem bulrush	plug		12" O.C.
SM - Scirpus microcarpus	small-fruited bulrush	plug		12" O.C.
SE - Sparganium emersum	narrow-leaf burreed	plug		12" O.C.

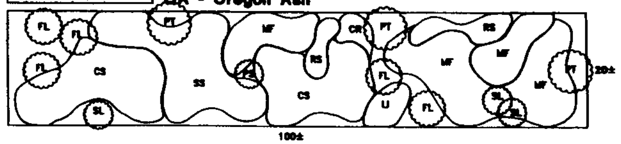
NOTE:
The perimeter of emergent wetlands will be hydroseeded with native seed mix (See Table 7.3-2 in NRMP report). Flooded areas will be planted with plug or containerized material listed above.

SW - Willow/Red Osier Dogwood Shrub



Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Shrubs				
LI - Lonicera involucrata	twinberry	container/bare root /live stake	Area Total 2,100 Plants Per Acre	4 ft
CS - Cornus stolonifera	red-osier dogwood	bare root/live stake		6 ft
SH - Salix hookeriana	Hookers willow	live stake		5 ft
SL - Salix lasiandra	Pacific willow	live stake		5 ft
SS - Salix sitchensis	Sitka willow	bare root/live stake		6 ft

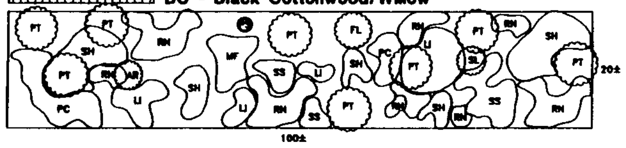
OA - Oregon Ash



Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Trees			Area Total - 280 Trees Per Acre	
FL - Fraxinus latifolia	Oregon ash	container/bare root	112 Per Acre	20 ft
PT - Populus trichocarpa	black cottonwood	container/bare root	70 Per Acre	12 ft
SL - Salix lasiandra	Pacific willow	bare root/live stake	70 Per Acre	12 ft
PS - Picea sitchensis	Sitka spruce	container	28 Per Acre	6 ft
Shrubs				
LI - Lonicera involucrata	twinberry	container/bare root	Area Total 1,800 Plants Per Acre	4 ft
RS - Rubus spectabilis	salmonberry	container/bare root		4 ft
CS - Cornus stolonifera	red-osier dogwood	container/live stake		6 ft
SS - Salix sitchensis	Sitka willow	container/live stake		6 ft
MF - Malus fusca	Pacific crabapple	container/bare root		20 ft

NOTE:
Sitka spruce shall be planted in a second phase after year 3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

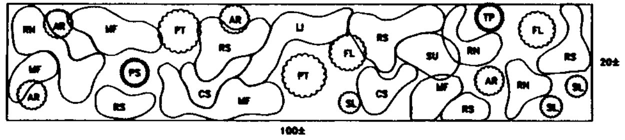
BC - Black Cottonwood/Willow



Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Trees			Area Total - 280 Trees Per Acre	
FL - Fraxinus latifolia	Oregon ash	container/bare root	28 Per Acre	20 ft
PT - Populus trichocarpa	black cottonwood	container/bare root	168 Per Acre	12 ft
AR - Alnus rubra	red alder	container/bare root	28 Per Acre	12 ft
SL - Salix lasiandra	Pacific willow	bare root/live stake	28 Per Acre	12 ft
PS - Picea sitchensis	Sitka spruce	bare root/container	28 Per Acre	20 ft
Shrubs				
LI - Lonicera involucrata	twinberry	container/bare root	Area Total 1,800 Plants Per Acre	4 ft
RN - Rosa nutkana	Nootka rose	container/bare root		3 ft
SS - Salix sitchensis	Sitka willow	bare root/live stake		6 ft
PC - Physocarpus capitatus	ninebark	container/bare root		5 ft
SH - Salix hookeriana	Hookers willow	live stake		5 ft
MF - Malus fusca	Pacific crabapple	container		8 ft

NOTE:
Planting zones will be hydroseeded with either wet transition, or low-grow seed mix (See Table 7.3-2 in NRMP report). Sitka spruce shall be planted in a second phase after year 3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

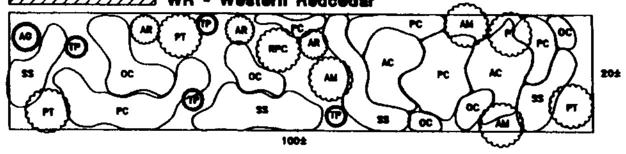
RA - Red Alder/Salmonberry



Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Trees			Area Total - 280 Trees Per Acre	
PT - Populus trichocarpa	black cottonwood	container/bare root	42 Per Acre	20 ft
FL - Fraxinus latifolia	Oregon ash	container/bare root	42 Per Acre	20 ft
AR - Alnus rubra	red alder	container/bare root	84 Per Acre	12 ft
SL - Salix lasiandra	Pacific willow	bare root/live stake	56 Per Acre	12 ft
TP - Thuja plicata	western redcedar	bare root/container	28 Per Acre	20 ft
PS - Picea sitchensis	Sitka spruce	container	28 Per Acre	
Shrubs				
LI - Lonicera involucrata	twinberry	container/bare root /live stake	Area Total 1,800 Plants Per Acre	4 ft
CS - Cornus stolonifera	red-osier dogwood	container/bare root /live stake		5 ft
RS - Rubus spectabilis	salmonberry	container/bare root		8 ft
RN - Rosa nutkana	Nootka rose	container/bare root		3 ft
MF - Malus fusca	Pacific crabapple	container		6 ft
SU - Salix scouleriana	Scouler's willow	bare root/live stake		6 ft

NOTE:
Western red cedar and Sitka spruce shall be planted in a second phase after year 3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

WR - Western Redcedar



Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typical Spacing
Trees			Area Total - 280 Trees Per Acre	
PT - Populus trichocarpa	black cottonwood	container/bare root	56 Per Acre	20 ft
AR - Alnus rubra	red alder	container/bare root	56 Per Acre	12 ft
AG - Abies grandis	grand fir	bare root/container	14 Per Acre	20 ft
AM - Acer macrophyllum	bigleaf maple	container/bare root	56 Per Acre	16 ft
RPC - Rhamnus purshiana	cascara	container/bare root	14 Per Acre	12 ft
TP - Thuja plicata	western redcedar	bare root/container	84 Per Acre	20 ft
Shrubs				
AC - Acer circinatum	vine maple	container/bare root	Area Total 1,800 Plants Per Acre	8 ft
PC - Physocarpus capitatus	ninebark	container/bare root		6 ft
SS - Salix scouleriana	Scouler willow	bare root/live stake		8 ft
OC - Oemleria cerasiformis	Indian plum	container/bare root		5 ft

NOTE:
Western red cedar shall be planted in a second phase after year 3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture is present.

90% AGENCY REVIEW SUBMITTAL
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REVISIONS

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PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: **PLANTING SCHEDULE**

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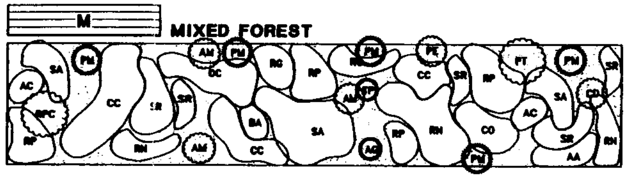
STIA-9804-L9

APPENDIX E

DATE 11/14/01 FILENAME 291214L9

AR 030056



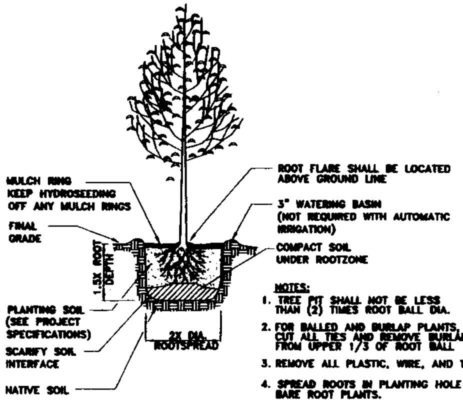
Salix scouleriana/Scoulers willow

Scientific Name	Common Name	Condition	Density - Plants Per Acre	Typ Spacing
Trees				
AG – Abies grandis	Grand fir	container/bare root	Area Total – 280 Trees Per Acre	20 ft
PT – Populus trichocarpa	Black cottonwood	container/bare root		18 ft
PM – Pseudotsuga menziesii	Douglas-fir	container/bare root		20 ft
AM – Acer macrophyllum	Bigleaf maple	container/bare root		18 ft
RPC – Rhamnus purshiana	Cascara	container/bare root		12 ft
TP – Thuja plicata	Western redcedar	container/bare root		20 ft
CD – Crataegus douglasii	Black hawthorn	container/bare root		12 ft
PE – Prunus emarginata	Bitter cherry	container		----
Shrubs				
AC – Acer circinatum	Vine maple	container/bare root	Area Total 1,800 Plants Per Acre	4 ft
AA – Amelanchier alnifolia	Serviceberry	container/bare root		3 ft
RG – Rosa gymnocarpa	Bald-hip rose	container/bare root		3 ft
RP – Rubus parviflorus	Thimbleberry	container/bare root		4 ft
CS – Cornus stolonifera	Red osier dogwood	container/live stakes		6 ft
CC – Corylus cornuta	Hazelnut	container/bare root		5 ft
OC – Oemleria cerasiformis	Indian plum	container/bare root		5 ft
BA – Berberis aquifolium	Tall Oregon grape	container/bare root		5 ft
RN – Rosa nutkana	Nootka rose	container		3 ft
SR – Sambucus racemosa	Red elderberry	container		5 ft
SA – Symphoricarpos albus	Snowberry	container		4 ft

NOTE:
BLACK HAWTHORN AND BALD-HIP ROSE TO BE PLANTED AT HIGH DENSITY BY THE OUTER EDGE OF THE BUFFER. WESTERN REDCEDAR TO BE PLANTED IN A SECOND PLANTING PHASE. THESE PLANTS SHALL BE LOCATED BY THE WETLAND BIOLOGIST IN LOCATIONS WHERE PARTIAL SHADE AND FAVORABLE SOIL MOISTURE IS PRESENT.

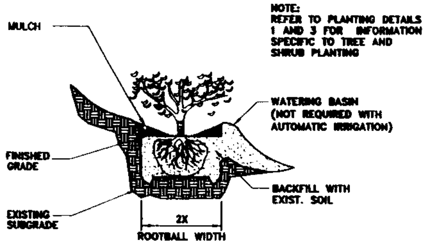
HYDROSEED MIXTURES.

COMMON NAME	SCIENTIFIC NAME	% BY WEIGHT
WET ZONE SEED MIX – FOR USE IN AREAS DESIGNATED AS EMERGENT WETLAND		
TALL MANNAGRASS	GLYCERIA ELATA	15
WATER FOXTAIL	ALOPECURUS GENICULATUS	10
WATER PARSLEY	OENANTHE SARMENTOSA	10
SLOUGH SEDGE	CAREX OBNUPTA	10
BEAKED SEDGE	CAREX ROSTRATA	15
SMALL-FRUITED BULRUSH	SCIRPUS MICROCARPUS	15
WOOLGRASS	SCIRPUS CYPERINUS	10
DAGGER LEAF RUSH	JUNCUS ENSIFOLIUS	5
TAPER TIP RUSH	JUNCUS ACUMINATUS	5
SLOUGH GRASS	BECKMANIA SYZIGACHNE	5
TRANSITION ZONE SEED MIX – FOR USE IN AREAS DESIGNATED AS FORESTED OR SHRUB WETLAND AND WET BUFFERS		
BLUE WILDRYE	ELYMUS GLAUCUS	25
WESTERN MANNAGRASS	GLYCERIA OCCIDENTALIS	8
TALL MANNAGRAS	GLYCERIA ELATA	10
TUFTED HAIRGRASS	DESCHAMPSIA CESPITOSA	10
ANNUAL RYEGRASS	LOLIUM MULTIFLORUM	15
CHEWINGS RED FESCUE	FESTUCA RUBRA	10
MEADOW FOXTAIL	ALOPECURUS PRATENSIS	10
BENTGRASS	AGROSTIS TENUIS	10
ALSIKE CLOVER	TRIFOLIUM HYBRIDUM	2
NATIVE BUFFER SEED MIX – FOR USE IN UPLAND BUFFER AREAS		
BARKLEY'S PERENNIAL RYEGRASS	LOLIUM PERENNE	30
RED FESCUE	FESTUCA RUBRA	35
AURORA HARD FESCUE	FESTUCA LONGIFOLIA	35



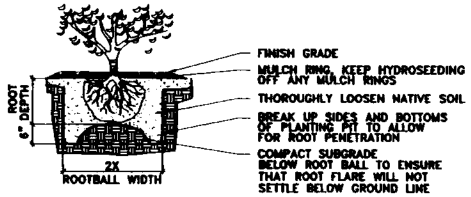
NOTES:
1. TREE PIT SHALL NOT BE LESS THAN (2) TIMES ROOT BALL DIA.
2. FOR BALLED AND BURLAP PLANTS, CUT ALL TIES AND REMOVE BURLAP FROM UPPER 1/3 OF ROOT BALL
3. REMOVE ALL PLASTIC, WIRE, AND TWINE
4. SPREAD ROOTS IN PLANTING HOLE FOR BARE ROOT PLANTS.
5. WATER THOROUGHLY AFTER PLANTING.
6. SEE SPECIFICATIONS FOR FERTILIZER.

DETAIL ① TYP
TREE PLANTING
(TYPICAL)

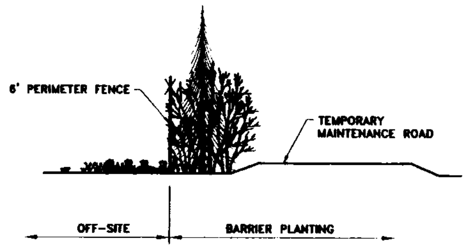


NOTE:
REFER TO PLANTING DETAILS 1 AND 3 FOR INFORMATION SPECIFIC TO TREE AND SHRUB PLANTING

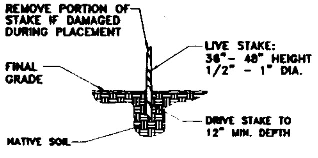
DETAIL ② TYP
PLANTING ON SLOPES
N.T.S.



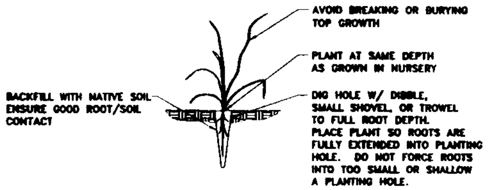
DETAIL ③ TYP
SHRUB PLANTING
(TYPICAL)



DETAIL ④ TYP
BARRIER PLANTING
(TYPICAL)



DETAIL ⑤ TYP
LIVE STAKE
(TYPICAL)



DETAIL ⑥ TYP
PLUG/DIVISION PLANTING
(TYPICAL)

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Kirkland, WA 98033
Ph:(425) 822-8880
"Quality Service Through Employee Ownership"

P. FORDT
C. WAGNER
PJT/CRW
AS SHOWN
NOVEMBER 2001

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: AUBURN WETLAND MITIGATION
SHEET TITLE: PLANTING SCHEDULE AND DETAILS

100052
291214L10
STIA-9804-L10

APPENDIX E

DATE: 11/14/01 FILENAME: 291214L10

Port of Seattle
Aviation Division

APPENDIX F

DES MOINES WAY
NURSERY WETLAND RESTORATION
SEATTLE-TACOMA INTERNATIONAL
AIRPORT

AGENCY REVIEW
NOT FOR CONSTRUCTION

SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE	SHEET NO.	SHEET TITLE
STIA-9805-T1	TITLE SHEET				
STIA-9805-C1	VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS				
STIA-9805-C2	EXISTING CONDITIONS				
STIA-9805-C3	GRADING AND DEMOLITION				
STIA-9805-C4	GRADING AND DEMOLITION CROSS SECTION				
STIA-9805-L1	LANDSCAPE PLAN				
STIA-9805-L2	PLANTING SCHEDULE AND DETAILS				

DATE: 11/19/01 FILENAME: 2912038T1
XREF'S
IMAGES

MAJOR CONTRACT

RECOMMENDED FOR APPROVAL

DATE

DATE

DATE

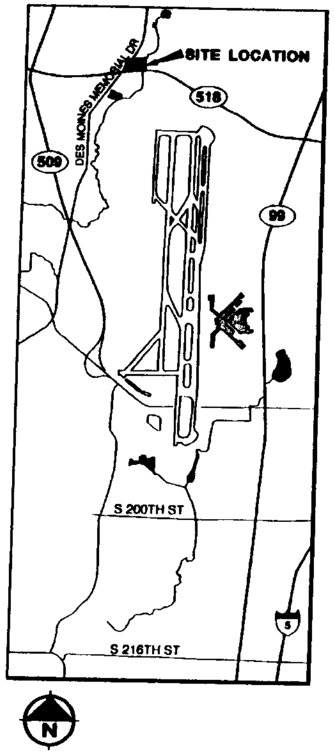
APPROVED BY

DATE

WORK ORDER NO.	PROJECT NO.
100051	STIA-9805-T1

APPENDIX F

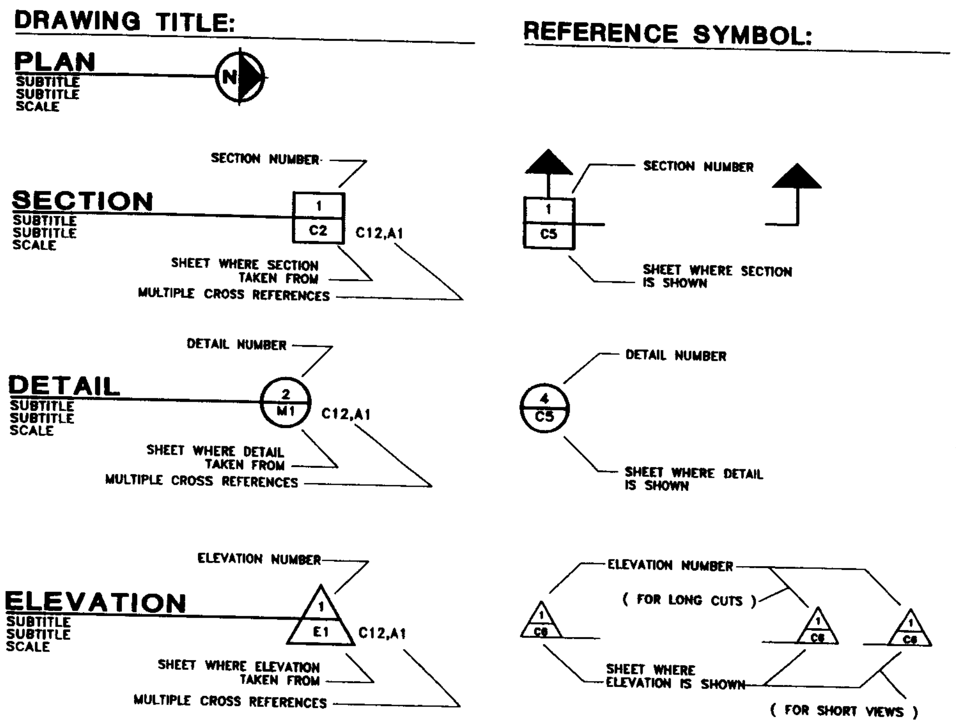
VICINITY MAP



LEGEND

- - -	CULVERT
265	SPOT ELEVATION
1	KEY NOTE NUMBER REFERENCE
——·——	SURFACE WATER DITCH
- - -	EXISTING CONTOUR
—285—	PROPOSED CONTOUR
— — —	EXISTING GRADE (SECTION)
▨	SPAWNING GRAVEL (SECTION)
▨	CRUSHED SURFACING BASE COURSE (SECTION)
▨	QUARRY SPALLS
▨	CONCRETE
▨	EMBANKMENT
▨	NATIVE SUBGRADE
▨	GRAVEL
▨	PAVEMENT (PLAN)
⊥	SLOPE INDICATOR
N 8100 E 5800	CONTROL POINT
—S—S—	SILT FENCE
—+—+—	SILT CURTAIN
—·—	GEOTEXTILE
—EM—	EROSION CONTROL MATTING
▭	STRAW BALE BARRIER
P-1 ⊗	EXISTING MONITORING WELL
—X—	CHAIN LINK FENCE
	PRIVATE PROPERTY BOUNDARY
▼	POINT OF INTERSECTION
┬┬┬	BERM
- - ‡ - -	CHANNEL CENTERLINE AND STATION
	EXISTING SANITARY SEWER LINE
—SS—	PROPOSED SANITARY SEWER LINE
—— — ——	LIMIT OF CONSTRUCTION (PROJECT)
⌖	SURVEY CONTROL POINT
— — —	LIMIT OF RESTRICTED AREA
	EXISTING STORM DRAIN

GENERAL LEGEND



GENERAL ABBREVIATIONS

&	AND	N	NORTH/NORTHING
ACP	ASPHALT CONCRETE PAVEMENT	NO.	NUMBER
APPROX.	APPROXIMATE	N.T.S.	NOT TO SCALE
℄	CENTERLINE	O.C.	ON CENTER
CMP	CORRUGATED METAL PIPE	PP	POWER POLE
DIA	DIAMETER	R	RADIUS
E	EAST/EASTING	RCP	REINFORCED CONCRETE PIPE
EL OR ELEV	ELEVATION	S	SOUTH
EXIST	EXISTING	SD	STORM DRAIN
FT	FOOT (FEET)	S.F.	SQUARE FOOT/FEET
GAL	GALLON	SS	SANITARY SEWER
HORIZ/H	HORIZONTAL	STA	STATION
HT.	HEIGHT	TYP	TYPICAL
I.E.	INVERT ELEVATION	W/	WITH
LF	LINEAR FEET/FOOT	WD	WOODY DEBRIS
MAX	MAXIMUM	VERT/V	VERTICAL
MIN	MINIMUM		
MISC	MISCELLANEOUS		

SURVEY CONTROL POINTS

9704-2 = REBAR WITH YELLOW CAP MARKED PMX CONTROL NEAR THE SOUTHEAST CORNER OF LORA LAKE. 11.0' SOUTHERLY OF A DOUBLE TRUNK (12" & 10") ALDER TREE WHICH IS @ THE TOP OF THE BANK & 21.0' NORTHWESTERLY FROM A SANITARY SEWER MANHOLE.

9704-3 = REBAR WITH YELLOW CAP MARKED PMX CONTROL NEAR THE SOUTHWEST CORNER OF LORA LAKE. 6.0' SOUTHERLY OF THE TOP OF BANK & 33.2' WEST SOUTHWEST OF A DOUBLE TRUNK (12" & 12") ALDER TREE.

9704-4 = REBAR WITH YELLOW CAP MARKED PMX CONTROL IN THE NORTHWESTERLY MARGIN OF THE DIRT ROAD THAT RUNS BETWEEN THE PUMPKIN PATCHES, @ THE EASTERLY END OF A BLACKBERRY PATCH, 82' +/- EASTERLY OF THE MOST NORTHWESTERLY CORNER OF A WOODEN STORAGE SHED.

NOTE: SEE C2 FOR SURVEY CONTROL POINT COORDINATES AND ELEVATIONS.

GENERAL NOTES

1. CALL "DIG-SAFE" (1-800-425-5555) PRIOR TO COMMENCING ANY GRADING OR EXCAVATION WORK ON THE SITE.
2. INSTALLATION OF TEMPORARY EROSION AND SEDIMENT CONTROLS SHALL BE COMPLETED PRIOR TO SITE WORK.

TE: 11/14/01 FILENAME: 2912038C1 IMAGES: [illegible] XREF'S:

CALL 48 HOURS
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5808 Lk. Washington Blvd. NE
Kirkland, WA 98033
Ph: (425) 822-8880
"Quality Service Through Employee Ownership"

P. FENDT
J. LEAVITT/K. LUDWA
PJT/SNH
AS SHOWN
NOVEMBER 2001
-
P. FENDT

REVISIONS

AGENCY REVIEW
NOT FOR CONSTRUCTION

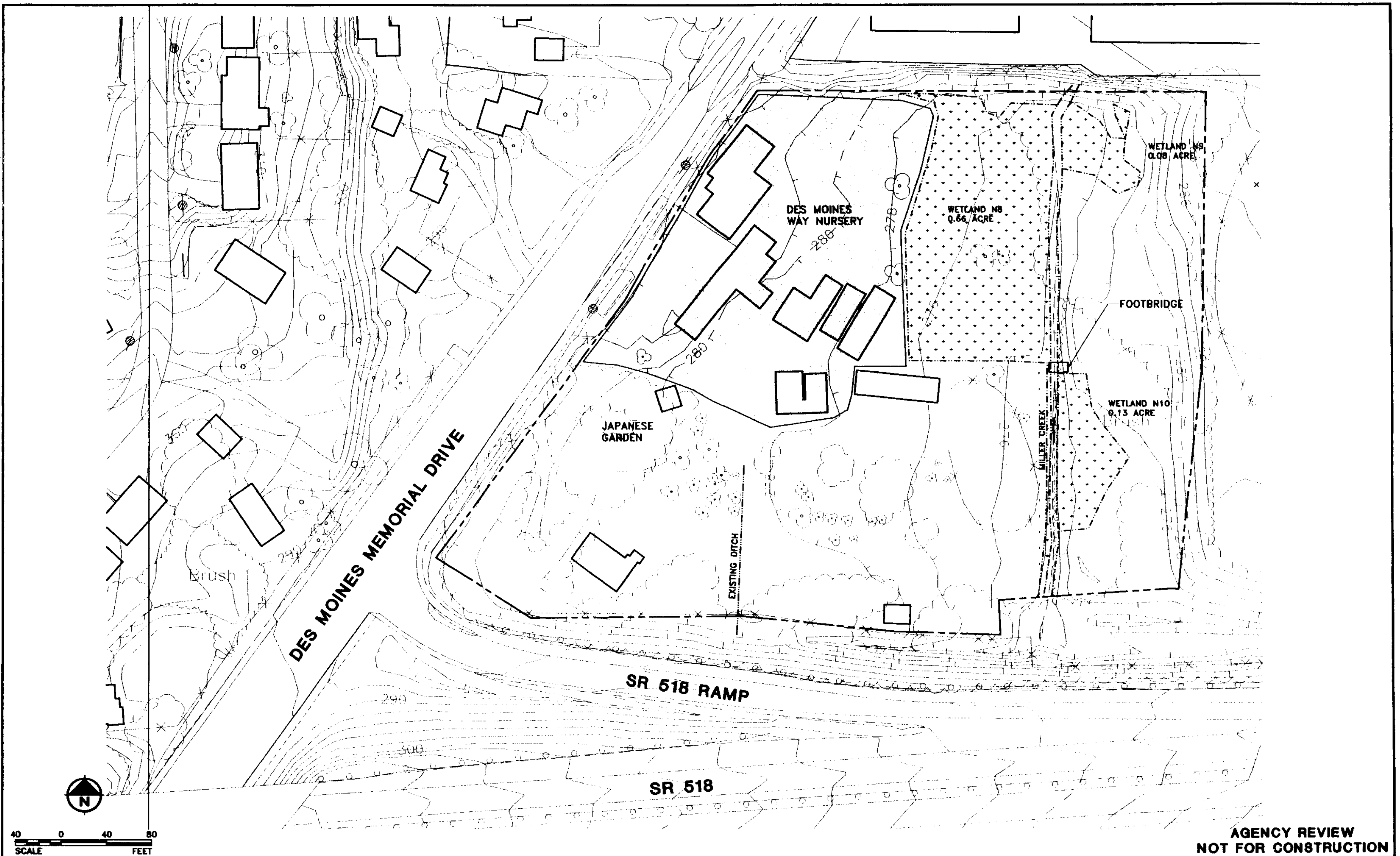
Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT

PROJECT: DES MOINES WAY
NURSERY WETLAND RESTORATION

SHEET TITLE: VICINITY MAP, SYMBOLS, NOTES AND ABBREVIATIONS

-
2912038C1
STIA-9805-C1

APPENDIX F



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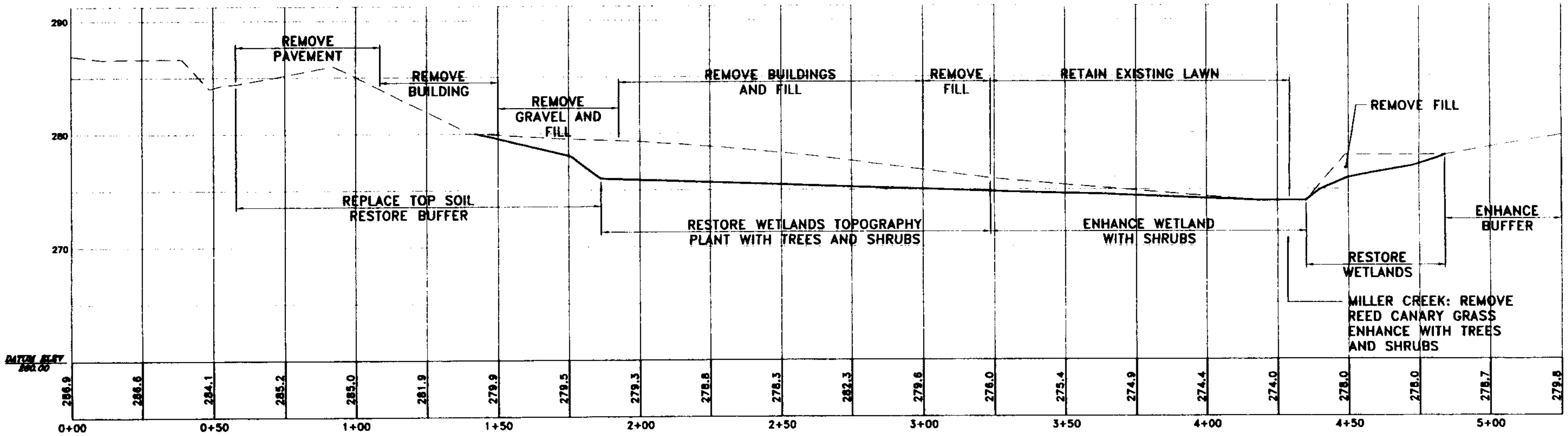
P. FENDT
J. KELLEY
S. NEWELL
1"=40'
NOVEMBER 2001
S. HARRIS
P. FENDT

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
DES MOINES WAY
NURSERY WETLAND RESTORATION
EXISTING CONDITIONS

-
2912038C2
STIA-XXXX-C2
APPENDIX F

DATE: 11/16/01 FILENAME: 2912038C2 IMAGES: XREF'S: 2912038BA POS-C01 POS-C02 POS-C08 POS-C07 LA



SECTION
EXISTING AND PROPOSED GRADE
SCALE: H. 1"=20', V. 1"=5'

A
C2

20 0 20 40
SCALE FEET

AGENCY REVIEW
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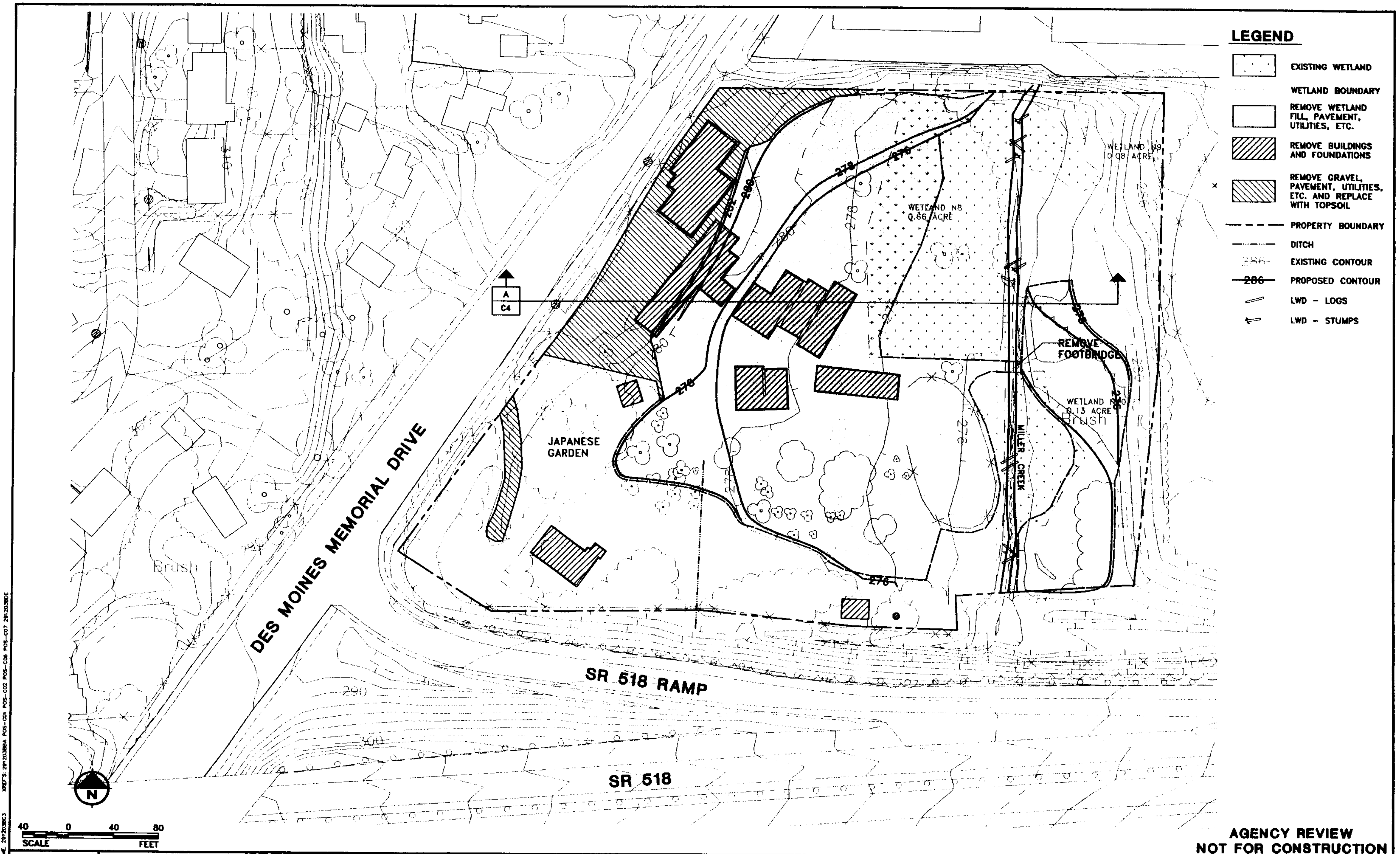
P. FENDT

REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: DES MOINES WAY
NURSERY WETLAND RESTORATION
SHEET TITLE: DEMOLITION AND GRADING
CROSS SECTION

-
291203BC4
STIA-XXXX-C4
APPENDIX F

DATE 11/16/01 FILENAME 291203BC4 IMAGES XREF'S



AGENCY REVIEW
NOT FOR CONSTRUCTION

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S. HARRIS
P. FENDT

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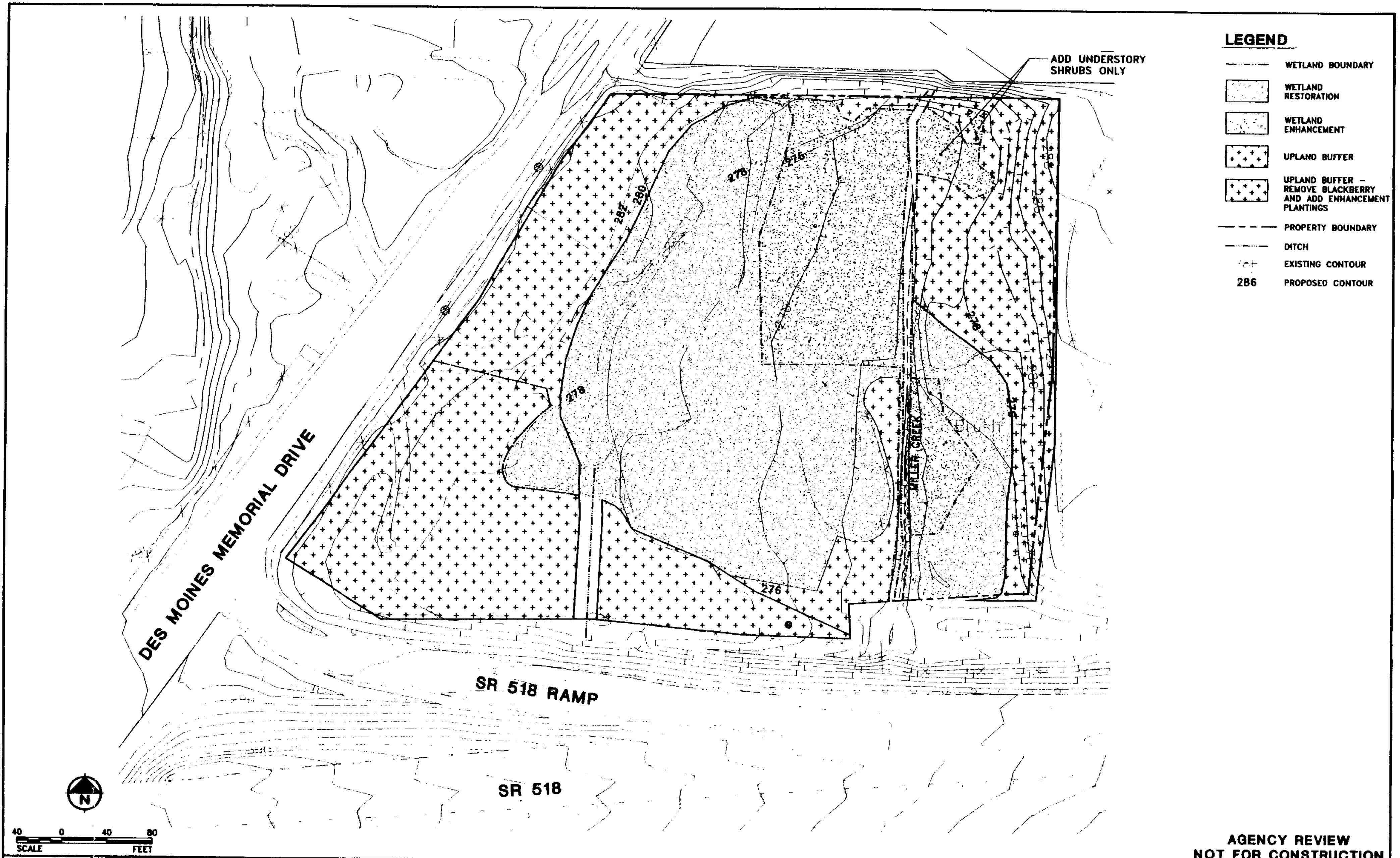
NO.	DATE	BY	DESCRIPTION	APP'D	NO.	DATE	BY	DESCRIPTION	APP'D

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: DES MOINES WAY
NURSERY WETLAND RESTORATION
SHEET TITLE: GRADING AND DEMOLITION

291203BC3
STIA-XXXX-C3
APPENDIX F

DATE: 11/16/01 FILENAME: 291203BC3
IMAGES:
XREFS: 291203BBA POS-C01 POS-C02 POS-C08 POS-C07 291203BDE



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Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT

PROJECT: DES MOINES WAY
NURSERY WETLAND RESTORATION

SHEET TITLE: LANDSCAPE PLAN

–

291203BL1

STIA-XXXX-L1

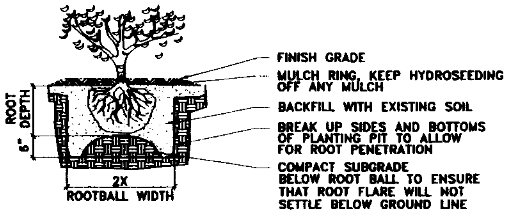
APPENDIX F

DATE 11/16/01 FILENAME 291203BL1 IMAGES: XREF'S: 291203BBA POS-C01 POS-C02 POS-C08 POS-C07 291203BDE LA

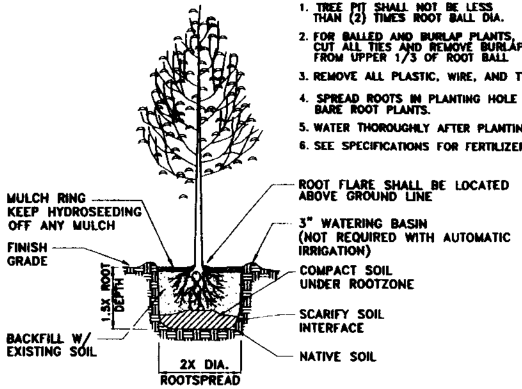
DES MOINES WAY NURSERY WETLAND RESTORATION

Symbol	Botanical Name / Common Name	Size	Density (Plants Per Acre)	Condition / Remarks
	WETLAND RESTORATION/ENHANCEMENT			
	Trees		80	
☐	*Picea sitchensis*/Sitka spruce *	3'–4' ht		– Container or B&B. Rooting to sides and bottom of can or burlap.
	Thuja plicata/western redcedar *	3'–4' ht.		
	Shrubs - Single Species Groups of 3 to 7		2,100	
	Physocarpus capitatus/Pacific ninebark	1 gal.		– Container. Rooting to sides and bottom of can. Live stakes shall be 36"–48" ht., 1/2"–1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3–4 buds shall be below grade. – Space 4.5' O.C. typical.
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		
	Spiraea douglasii/hardhack spiraea	1 gal.		
	UPLAND BUFFER ZONE			
	Trees		280	
▨	*Abies grandis* / grand fir	4'–6' ht.		– Container or B&B. Rooting to sides and bottom of can or burlap.
	Acer macrophyllum / big leaf maple	4'–6' ht.		
	Alnus rubra/red alder	2 gal.		
	Picea sitchensis/Sitka spruce *	3'–4' ht		
	Populus trichocarpa/black cottonwood	4'–6' ht.		
	Pseudotsuga menziesii/douglas fir	3'–4' ht.		
	Thuja plicata/western redcedar *	3'–4' ht.		
	Tsuga heterophylla/western hemlock *	3'–4' ht.		
	Shrubs - Single Species Groups of 3 to 7		2,100	
	Acer circinatum/vine maple	2 gal.		– Container. Rooting to sides and bottom of can. – Space 4.5' O.C. typical.
	Rosa nutkana/Nootka rose	1 gal.		
	ENHANCED EXISTING WETLAND		2,100	
	Shrubs			
▲	*Acer circinatum*/vine maple	2 gal.		– Container. Rooting to sides and bottom of can. Live stakes shall be 36"–48" ht., 1/2"–1" dia., with a minimum of 10 viable, undamaged buds on each stake. 3–4 buds shall be below grade. – Space 4.5' O.C. typical.
	Philadelphus lewisii/mock orange	1 gal.		
	Rosa nutkana/Nootka rose	1 gal.		
	Rosa pisocarpa/Clustered rose	1 gal.		
	Salix lucida spp. lasiandra/Pacific willow	1gal/Live stake		
	Salix scouleriana/Scoulers willow	1gal/Live stake		
	Salix sitchensis/Sitka willow	1gal/Live stake		

* Western redcedar, Western hemlock and Sitka spruce shall be planted in a second planting phase, to follow year–3 monitoring. These plants shall be located by the wetland biologist in locations where partial shade and favorable soil moisture are present.



DETAIL 3 TYP
SHRUB PLANTING
(TYPICAL)



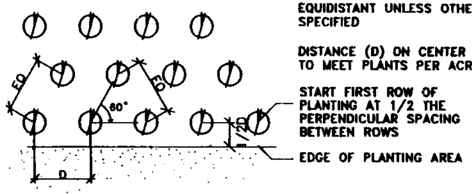
NOTES:
1. TREE PIT SHALL NOT BE LESS THAN (2) TIMES ROOT BALL DIA.
2. FOR BALLED AND BURLAP PLANTS, CUT ALL TIES AND REMOVE BURLAP FROM UPPER 1/3 OF ROOT BALL
3. REMOVE ALL PLASTIC, WIRE, AND TWINE
4. SPREAD ROOTS IN PLANTING HOLE FOR BARE ROOT PLANTS.
5. WATER THOROUGHLY AFTER PLANTING.
6. SEE SPECIFICATIONS FOR FERTILIZER.

DETAIL 2 TYP
TREE PLANTING
(TYPICAL)

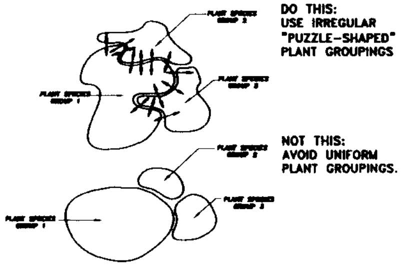
NOTE:

ALL SHRUB SPACING SHALL BE EQUIDISTANT UNLESS OTHERWISE SPECIFIED

DISTANCE (D) ON CENTER AS REQUIRED TO MEET PLANTS PER ACRE STANDARD.

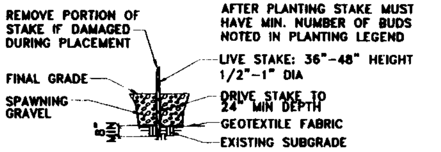


DETAIL 4 TYP
TRIANGULAR SHRUB SPACING
(TYPICAL)



DETAIL 5 TYP
SHAPES OF PLANTING MASSES
N.T.S.

NOTE:
AFTER PLANTING STAKE MUST HAVE MIN. NUMBER OF BUDS NOTED IN PLANTING LEGEND



DETAIL 6 TYP
LIVE STAKE PLANTING
N.T.S.

NOTES:

1. Preserve and protect all trees and shrubs not designated for removal. Provide, erect, and maintain barricades necessary to prevent access to areas within drip lines of existing trees. Allow no vehicular or pedestrian traffic, or stacking and/or storage of construction materials within barricades.
2. For each planting zone Contractor shall lay out a 10,000 s.f. test plot, in which the positions of all plants shall be staked with flags that are color coded to represent specific species. Layout for each zone shall be inspected and approved prior to commencement of planting. Approved staking shall serve as the plant layout standard for the remainder of each zone.
3. Shrub masses shall consist of multiple single–species groups (see detail 5). Contractor shall ensure that these single–species groups have a variety of sizes and shapes, and that shrub masses have a variety of species. See planting schedule for numbers of plants in single–species groups.
4. Hydroseed all planting areas. Re–seed areas that are disturbed by subsequent work. Keep hydroseeding off any mulch circles except where needed to protect roots of conifers.

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REVISIONS

Port of Seattle
SEA-TAC INTERNATIONAL AIRPORT
PROJECT: DES MOINES MEMORIAL WAY
NURSERY WETLAND RESTORATION
SHEET TITLE: **PLANTING SCHEDULE AND DETAILS**

100051
291203BL2
STIA-9805-L2
APPENDIX F