Port of Seattle

SEPA ADDENDUM

January 24, 2000

This document is a SEPA Addendum to the *Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport* issued May 13, 1997 by the Federal Aviation Administration and the Port of Seattle. This Addendum has been prepared in accordance with Chapter 197-11-625 Washington Administrative Code, and Port of Seattle SEPA Policies and Procedures Resolution No. 3028. The purpose of this document is to describe and analyze the modification to the Master Plan Update Development Actions for the Third Runway Project that was made after the environmental documents were issued. These modifications include the quantity of wetlands affected, the design of the retaining wall for the runway embankment, and the design of the construction only-temporary interchange that is proposed to mitigate construction impacts. These modifications do not substantially change the analysis of significant impacts described in the *Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport.*

Project Name: Third Parallel Runway Wetland Fill, and Temporary Construction-Only Interchange at SR 509/South 176th Street POS SEPA No.00-02

Existing Environmental Documents:

Final Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport, FAA and Port of Seattle, February 1996

Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport, FAA and Port of Seattle, May 1997

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Project Description

The report *ADDENDUM To Final Environmental Impact Statement and Final Supplemental Environmental Impact Statement For Proposed Master Plan Update Development Actions At Seattle-Tacoma International Airport* prepared pursuant to the Washington State Environmental Policy Act (Ch. 43.21C RCW) provides a detailed explanation of the proposed changes.

Port of Seattle

In 1996, the Port of Seattle (Port) and the Federal Aviation Administration (FAA) issued the *Final Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport* (1996 FEIS). In 1997, the Port and the FAA issued the *Final Supplemental Environmental Impact Statement for the Master Plan Update Development Actions* (1997 FSEIS). This Addendum addresses new information that has come to light since the issuance of these EISs relating to: (a) wetlands and other aquatic resources that would be affected by the planned new runway and other improvements at Seattle-Tacoma International Airport; and (b) potential impacts of temporary construction-related interchanges on SR 509 to be used by trucks delivering fill material to the planned new runway site. This Addendum was prepared by the Port to report the Port's assessment of the new information and its determination that the existing environmental analyses under the Washington State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA) remain adequate.

Chapter I of the report contains an introduction and summary.

Wetland Impacts: Chapters II-VI relate to impacts on wetlands and other aquatic resources. They summarize identification of affected wetlands in the 1996 FEIS, the 1997 FSEIS, and the 1996 Joint Aquatics Resources Project Application (JARPA). They contain the refined identification of affected wetlands based on new information. They present a refined wetland impact analysis and recent changes to the project to minimize wetland impacts. They focus on the hydrologic and seismic impacts of the runway embankment and MSE retaining walls. Finally, they describe and explain the planned wetland mitigation measures, on-site and off-site.

The analysis of wetland impacts in the 1996 FEIS and 1997 FSEIS was based on wetland delineations that have been revised recently as the Port has acquired, and gained access to, approximately 390 parcels of land where Master Plan Update improvements will be located. The FSEIS identified a total of 12.33 acres of wetlands that would be affected by Master Plan Update improvements. Of this total, 7.38 acres were identified as affected by the Runway (including embankment and borrow sources), 2.34 acres by the Runway Safety Areas, and 2.51 acres by terminal and landside improvements.

Upon completion of the EIS process, the Port decided to proceed with the Airport improvements and received the approval of the FAA. The Port then initiated acquisition of property. As land was acquired and on-the-ground wetland studies were conducted, the Port found that the Third Runway project would affect more wetlands than previously identified in the 1997 FSEIS. Based on the refined identification of wetlands in the study area, a revised impact analysis was prepared. Under the revised wetland impact analysis, the wetland acreage affected by the project had increased from 12.23 acres to 18.33 acres. Of this revised total, 15.41 acres would be affected by the runway (including embankment borrow sources and off-site mitigation), 0.14 acre by the Runway Safety Areas and 2.78 acres by South Aviation Support Area (SASA) improvements. The refined analysis also identified 2.17 acres of wetlands that would be temporarily affected by construction activities and 16.46 acres of wetlands that would be modified, primarily beneficially, as a result of wetland mitigation measures. Because the value of wetlands is determined more by their environmental function than their acreage, the revised

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wetland impact analysis contained in this report focuses on impacts to wetland functions rather than simply the affected acreage.

Construction-Only Temporary Interchange: Chapter VII relates to the potential impacts of the temporary construction-related interchange on SR 509 to be used by trucks delivering fill material to the planned new runway site. It analyzes potential noise impacts from trucks on the interchange, considers the potential impacts of a temporary noise wall at the interchange on SR 509, and describes potential vibration impacts from the trucks.

The Final Supplemental EIS for the Master Plan Update improvements at Seattle-Tacoma International Airport evaluated the construction and use of temporary construction-only interchanges proposed for the purpose of mitigating traffic-related impacts from hauling fill to construct the Third Runway and Runway Safety Areas. Since the publication of the Final Supplemental EIS in May 1997, the Port has further refined the design for a temporary construction-only interchange facility and conducted additional coordination with the Washington State Department of Transportation. This addendum presents the evaluation of noise and vibration that was conducted based on the design and alignment for the interchange at SR 509 and South 176th Street. No other changes in effect are anticipated.

A vibration analysis was conducted to ensure that significant vibration effects would not occur to residential areas in the vicinity of the temporary construction-only interchange. As this analysis shows, only one home (the home on the north west corner of the SR 509/S.176th Street overpass) could experience vibration effects in excess of the DOT thresholds. As a result, the Port of Seattle proposes to offer to acquire and relocate this homeowner.

The noise analysis was conducted in a manner that considers the possible distribution of traffic haul that could occur. Until a contractor is selected to deliver fill material for the haul, it is not certain as to the location where fill will be obtained. As a result, it is not possible to predict whether or not night haul will be necessary. Consideration was given to four possible scenarios: 1) all haul during daytime hours; 2) 10% haul during nighttime hours; 3) 50% haul during nighttime hours and 4) 100% haul during nighttime hours. At this time the Port is not proposing to haul any portion of fill during nighttime hours. These scenarios were considered for the purpose of ensuring that adequate mitigation is provided. Based on this evaluation, this mitigation item has been refined slightly to include:

- A noise attenuation wall to ensure that the high volume of truck traffic does not create a significant noise effect on adjacent properties;
- Offer to acquire the residence closest to the southbound off-ramp (Home 1) at South 176th Street due to the potential for significant vibration effects if the off-ramp pavement becomes worn.
- Sound insulation of homes that would exceed the Washington State Department of Transportation sound level standard as a result of the proposed haul.

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SEPA Review

The Port of Seattle has reviewed this proposal and determined that it is a minor revision that is within the scope of the projects described in the Master Plan Update. The proposed revisions do not change the analysis of significant impacts provided in the *Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport*, Port of Seattle, May 1997.

Date Addendum Prepared: January 24, 2000

SEPA Lead Agency: Port of Seattle (POS File No. 00-02)

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ADDENDUM

To
Final Environmental Impact Statement and
Final Supplemental Environmental Impact Statement
for
Proposed Master Plan Update Development Actions
at
Seattle-Tacoma International Airport

Prepared pursuant to the Washington State Environmental Policy Act (Ch. 43.21C RCW)

PREPARED BY:
PORT OF SEATTLE

January, 2000

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Chapter I

INTRODUCTION AND SUMMARY

In 1996, the Port of Seattle (Port) and the Federal Aviation Administration (FAA) issued the Final Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport (1996 FEIS). In 1997, the Port and the FAA issued the Final Supplemental Environmental Impact Statement for the Master Plan Update Development Actions (1997 FSEIS). This Addendum addresses new information that has come to light since the issuance of these EISs relating to: (a) wetlands that would be affected by the planned new runway and other improvements at Seattle-Tacoma International Airport; and (b) potential impacts of temporary construction-related interchanges on SR 518 and SR 509 to be used by trucks delivering fill material to the planned new runway site. This Addendum was prepared by the Port to report the Port's assessment of the new information and its determination that the existing environmental analyses under the Washington State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA) remain adequate. As a result of this assessment, the Port, as lead agency under SEPA, has determined that no additional environmental analysis is required. This conclusion was based on the Port's findings that the newly discovered areas of adverse impacts to wetlands, and the potential impacts of the temporary construction interchanges, either were not environmentally significant, in light of project changes and mitigation measures, or were adequately covered by the analyses of wetland impacts in the 1996 FEIS and 1997 FSEIS.

Chapter I of the report contains an introduction and summary.

Chapters II-VI relate to impacts on wetlands. They summarize identification of affected wetlands in the 1996 FEIS, the 1997 FSEIS, and the 1996 Joint Aquatics Resources Project Application (JARPA). They contain the refined identification of affected wetlands based on new information. They present a refined wetland impact analysis and recent changes to the project to minimize wetland impacts. They focus on the hydrologic and seismic impacts of the runway embankment and MSE retaining walls. Finally, they describe and explain the planned wetland mitigation measures, on-site and off-site.

Chapter VII relates to the potential impacts of the temporary construction-related interchanges on SR 518 and SR 509 to be used by trucks delivering fill material to the planned new runway site. It analyzes potential noise impacts from trucks on the interchanges, considers the potential impacts of a temporary noise wall at the interchange on SR 509, and describes potential vibration impacts from the trucks.

Chapter VIII discusses the conclusion that a supplemental EIS is not necessary as a result of this new information.

1. Background

In the late 1980's, the Puget Sound Regional Council (PSRC) and the Port jointly initiated a regional study and decision-making process, known as the Flight Plan Project, to address the growing demand for air travel and impending shortfall in commercial transportation airport capacity in the Puget Sound region. In October 1992, the PSRC and the Port issued a Final Environmental Impact Statement (Flight Plan EIS) for the Flight Plan Project. This EIS was a non-project, programmatic EIS that comparatively analyzed the potential environmental impacts of a wide range of alternative strategies for addressing impending severe constraints on air travel capacity in this region.

The culmination of the Flight Plan Project, after nearly a decade of study, was a regional decision to pursue a new air carrier runway at Seattle-Tacoma International Airport (STIA or Airport), among other strategies. The Port (as operator of STIA), in cooperation with the Federal Aviation Administration (FAA), then initiated a planning process to develop and environmentally analyze a Master Plan Update for the Airport. In February 1996, the FAA and the Port issued the Final Environmental Impact Statement for Proposed Master Plan Update Development Actions (FEIS). The FEIS was a project-level, site-specific EIS that examined the potential environmental impacts of the planned development actions. Shortly thereafter, following review of new information regarding aviation forecasts, the FAA and the Port decided to prepare a supplemental EIS. Accordingly, in May 1997, the FAA and the Port issued the Final Supplemental EIS for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport (FSEIS). The 1996 Master Plan Update FEIS and 1997 FSEIS were prepared in accordance with the requirements of NEPA (42 U.S.C. §§ 4321 *et seq.*) and SEPA (Ch. 43.21C RCW).

In 1997, following the issuance of the FSEIS, the Port approved the Master Plan Update, and the FAA issued a Record of Decision authorizing development of the new runway and other improvements at STIA. The Port then initiated the process of acquiring the property necessary for the development of the Third Runway and other development actions, estimated in the Final EIS to be approximately 388 single family houses, 260 condominiums and apartments, and 105 businesses.

Prior to gaining access to the properties, the Port estimated the location and areas of wetlands and other waters to be affected by the development of the new runway and other Master Plan Update actions. These estimates were made by studying aerial photographs, National Wetland Inventory maps, and local government sensitive area maps, and by making observations from public rights-of-way. However, as documented in the FEIS and FSEIS, lack of access precluded on-the-ground wetland delineations in the acquisition area. The Port, as it acquired properties and conducted on-the-ground wetland delineations, discovered that the quantity of wetlands in the acquisition area potentially affected by the proposed airport improvements was greater than previously estimated. In addition, to avoid wetland impacts and relocation of a greater portion of Miller Creek, the Port has completed additional work regarding the embankment and MSE retaining walls, including new information regarding hydrology and seismic stability. This new information on affected wetlands and other aquatic resources since the 1996 FEIS and 1997 FSEIS were issued is described in detail below.

The FSEIS discussed the planned temporary interchanges on SR 518 and SR 509, to be used by trucks delivering fill material to the planned new runway site. Following issuance of the FSEIS, the Port has prepared more detailed plans on construction of the new runway and other Master Plan Update development actions. During this planning process, the Port has conducted more detailed review of the planned temporary construction-related interchanges, including potential noise and vibration impacts resulting from truck use of these interchanges.

The Port has assessed the new information regarding affected wetlands and the temporary interchanges under the standards of SEPA governing when supplementation of an FEIS for an ongoing proposal is required. The Washington SEPA Rules require a supplemental EIS if there are:

- substantial changes so that the proposal is likely to have significant adverse environmental impacts [not considered in the previous EIS]; or
- new information indicating a proposal's probable significant adverse environmental impacts.[1]

2. Summary of New Information on Affected Wetlands

The analysis of wetland impacts in the 1996 FEIS and 1997 FSEIS was based on wetland delineations that have been revised recently as the Port has acquired, and gained access to, approximately 390 parcels of land where Master Plan Update improvements will be located. The FSEIS identified a total of 12.33 acres of wetlands that would be affected by Master Plan Update improvements. Of this total, 7.38 acres were identified as affected by the Runway (including embankment and borrow sources), 2.34 acres by the Runway Safety Areas, and 2.51 acres by terminal and landside improvements.

Upon completion of the EIS process, the Port decided to proceed with the Airport improvements and received the approval of the FAA. The Port then initiated acquisition of property. As land was acquired and on-the-ground wetland studies were conducted, the Port found that the Third Runway project would affect more wetlands than previously identified in the 1997 FSEIS. Based on the refined identification of wetlands in the study area, a revised impact analysis was prepared. Under the revised wetland impact analysis, the wetland acreage affected by the project had increased from 12.23 acres to 18.33 acres. Of this revised total, 15.41 acres would be affected by the runway (including embankment, borrow sources, and off-site mitigation), 0.14 acre by the Runway Safety Areas and 2.78 acres by South Aviation Support Area (SASA) improvements. The refined analysis also identified 2.17 acres of wetlands that would be temporarily affected by construction activities and 16.46 acres of wetlands that would be modified, primarily beneficially, as a result of wetland mitigation measures. Because the value of wetlands is determined more by their environmental function than their acreage, the revised

[1] WAC 197-11-600(3)(b) and (4)(d).

wetland impact analysis contained in this report focuses on impacts to wetland functions rather than simply the affected acreage.

3. Summary of New Information on Temporary Highway Interchanges

The Final Supplemental EIS for the Master Plan Update improvements at Seattle-Tacoma International Airport evaluated the construction and use of temporary construction-only interchanges proposed for the purpose of mitigating traffic-related impacts from hauling fill to construct the Third Runway and Runway Safety Areas. Since the publication of the Final Supplemental EIS in May 1997, the Port has further refined the design for a temporary construction-only interchange facility and conducted additional coordination with the Washington State Department of Transportation. This addendum presents the evaluation of noise and vibration that was conducted based on the design and alignment for the interchange at SR 509 and South 176th Street. No other changes in effect are anticipated.

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- A noise attenuation wall to ensure that the high volume of truck traffic does not create a significant noise effect on adjacent properties;
- Offer to acquire the residence closest to the southbound off-ramp (Home 1) at South 176th Street due to the potential for significant vibration effects if the off-ramp pavement becomes worn.
- Insulation of homes where the sound generated by the construction activity using the temporary interchange would increase noise to sound levels above 67 DNL (the WSDOT land use criteria). It is anticipated that the number of homes to be insulated would depend on use of the interchange at night but would number less than a half dozen homes along South 176th Street west of the interchange.

Chapter VII of this report summarizes the analysis performed.

Chapter II

ORIGINAL IDENTIFICATION OF AFFECTED WETLANDS AND OTHER AQUATIC RESOURCES

1. Previously Identified Wetland Impacts

In 1996, the Federal Aviation Administration (FAA), as lead NEPA agency, and Port of Seattle (Port), as lead SEPA agency, issued the Final Environmental Impact Statement (FEIS) for the Master Plan Update Development at Seattle-Tacoma International Airport. Prior to issuance of the Record of Decision, the FAA revised its forecast of aviation demand at Sea-Tac. As a result of the revised aviation forecasts, the FAA prepared a Supplemental Environmental Impact Statement to assess the consequences of accelerating the development of terminal and landside improvements and delaying completion of the Third Runway until 2004. In May 1997, the FAA issued the Final Supplemental EIS (FSEIS) and, in July 1997, the Record of Decision.

In December 1996, the Port submitted an application to the Army Corps of Engineers for a permit to fill wetlands for the Master Plan Update improvements in compliance with the Clean Water Act, § 404. The § 404 permit application was submitted as part of a Joint Aquatic Resources Project Application (JARPA) and was accompanied by a report entitled "JARPA Application for Proposed Improvements at Seattle-Tacoma International Airport" dated December 1996. These documents are hereby incorporated by reference. Copies of these and all documents referenced herein are publicly available during regular business hours at the Port of Seattle, Aviation/Project Management Group, Suite 301, Kilroy Building, 17900 International Boulevard, SeaTac, WA 98188.

The purpose of this chapter is to summarize the analysis of wetland impacts contained in the 1996 Final EIS, JARPA, and the 1997 Final Supplemental EIS.

As shown in **Table 2-1**, the 1996 FEIS identified about 10.4 acres of wetlands that would be filled in order to complete the Master Plan Update improvements. Prior to issuance of the Final SEIS, the Port refined its evaluation of the projects affecting wetlands, documented its review of in-basin mitigation options, and further defined plans for development of an off-site wetland mitigation site in Auburn. As a result, the 1997 FSEIS identified 12.23 acres of wetlands that would be filled.

TABLE 2-1

Prior Studies – Wetland Impacts (acres)

Project Element	Final SEIS	Final EIS
Runway impacts		
Embankment	5.46	5.48
Borrow Source impacts	1.92	2.38
Runway Safety Areas 16L/R	2.34	Included above
Runway 34R Extension	0.00	0.00
Terminal/Landside		
N. Employee Parking lot	0.81	0.81
Development in SASA	1.70	1.70
Total	12.23	10.40

Source: *Final Supplemental EIS for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport*, FAA, May 1997.

The following sections summarize the wetland impact analysis contained in these previous environmental documents.

The 1996 Final EIS (Chapter IV, Section 16) stated:

> Approximately 40 percent of the detailed study area is occupied by Sea-Tac Airport and is characterized by frequently mowed grassland bisected by service roads and taxiways. This area provides little wildlife habitat value. Wildlife habitat surrounding the airfield consists of fragmented habitat, which is composed of forest, shrub, and grassland with scattered wetlands. These areas are subject to a variety of airport-related disturbances as well as increasing residential, commercial, and industrial development. Each of the "With Project" alternatives would remove approximately the same amounts of vegetation (about 712 acres total). Of that total, the majority is managed grassland (about 303 acres), which provides little wildlife habitat value. In addition, about 269 acres of forest, 78 acres of shrub, 52 acres of unmanaged grassland, *and 10 acres of wetlands would be removed* under each "With Project" alternative. *(Italics added)*

> About 3,700 feet of Miller Creek and its tributaries would require realignment and relocation to complete the runway. About 200 feet of Des Moines Creek would require relocation due to the 600 ft extension of Runway 34R. About 2,200 feet of open channel on Des Moines Creek would require relocation due to the South Aviation Support Area. The 200-foot section of Des Moines Creek that would be affected by the extension of Runway 34R is within the area that would be realigned as mitigation for SASA. Proposed mitigation would reduce potential impacts on the hydrology, water quality, and aquatic habitat and biota of Miller and Des Moines Creeks and Puget Sound.

Implementation of the improvements was identified as impacting all or portions of 36 wetlands. The total area of wetland impact was identified in the Final Supplemental EIS at 12.23 acres. Most impacts would occur during the first phase of implementation (then planned to occur before year

2000). Wetland mitigation would compensate for all anticipated wetland impacts attributed to full implementation of the Master Plan Update improvements.

The 1997 Final SEIS stated:

> "Due to similarities in vegetation, many of the affected wetlands serve similar physical and biological functions and have been grouped for ecological assessment. Wetlands within the impact area occur in the Des Moines Creek and Miller Creek drainage basins, where natural habitats (including wetlands) are fragmented by urban development. In addition to substantial fragmentation of habitat, the small size of most impacted wetlands suggests that they function independently rather than as a natural ecological system.
>
> According to the Washington State Natural Heritage Program information system and field studies, no rare plants, high-quality native wetlands, or high-quality native plant communities occur in the study area. Nineteen vegetation communities were identified in the proposed Master Plan Update study area, including nine (9) wetland and ten (10) upland vegetation communities. The wetland vegetation communities include forested wetland, shrub wetland, and emergent wetland."

In the 1997 Final SEIS, the functions and values of the wetlands to be affected were identified.

> "Impacts associated with the Master Plan Update improvements are to small (<0.5 acre) wetlands that are isolated from other significant aquatic or semi-aquatic habitat, and occur in a landscape fragmented by streets, commercial, residential, or airport development. Therefore, for most functions, the wetlands were not considered to provide high function. Emergent wetlands (some with associated shrub habitat) were rated low for the following functions: export of production; baseflow support; and control of floodflow. Forested wetlands (some with associated shrub habitat) received a low functional value for export of production and stormwater runoff storage functions.
>
> The wildlife habitat functions are generally significant to the local vicinity (rather than to a larger landscape or watershed) because urban development isolates the area for many species of wildlife, and the size of many of the wetlands are smaller than the habitat requirements of many mammal and bird species. The biological functions of wetlands are further limited by the lack of permanent open water, the short duration of seasonal ponding or soil saturation, and the high occurrence of non-native plant species in some emergent wetlands. The wildlife habitat value increases where trees and/or shrubs are adjacent to the grass-dominated emergent areas."
>
> Hydrologic functions (such as floodflow storage, groundwater discharge, and storm water detention) are potentially important at the watershed level, because, when present, they may affect hydrologic and habitat conditions in off-site locations, especially fish habitat in Miller and Des Moines Creeks. Forested wetlands, on groundwater seeps adjacent to Miller and Des Moines Creeks, help to support the baseflow of the creeks by providing seasonal or perennial sources of water. Some of the forested wetlands associated with the creeks temporarily store floodwaters, which alleviates the severity of downstream flooding, and streambank erosion. Other wetlands help reduce peak flows by collecting and storing storm runoff, reducing the rate and volume of water that reaches the stream systems during storms. The on-site wetlands have a limited ability to provide these functions, largely due to their small size, the lack of direct connections to the creeks, or topographic conditions that limit seasonal detention of stormwater.
>
> The groundwater recharge function of wetlands appears to be limited throughout much of the site. Many wetlands occur on compact till soils (Alderwood Series) above the Miller Creek and Des Moines Creek ravines. The wetlands have formed in shallow depressions where a perched water table has developed on low permeability till. Due to the low permeability of the till layer, it is unlikely these wetlands contribute significantly to recharge of groundwater."

2. Original JARPA Mitigation Program

In the JARPA and accompanying report, the Port proposed a mitigation program designed to add more wetland functions and values than would be lost as a result of the planned new runway and other Airport improvements. It was not possible to provide all such mitigation "on-site," that is, within the watershed where the affected wetlands were located, for three reasons:

- "Wildlife attractions" within 10,000 ft of the edge of any active runway are not recommended; and wildlife control activities in wetlands near the airport would conflict with wetland habitat mitigation goals.
- Land in the watersheds that is greater than 10,000 feet from the runways is unsuitable for mitigation because of steep topography, lack of water, or presence of forest vegetation (which agencies discourage removing for wetland mitigation).
- Beyond 10,000 feet from the runways, most of the area surrounding the Airport is developed, and not enough available land exists in the watershed to create compensatory mitigation wetlands without relocation of additional business and residences;

The off-site mitigation necessitated by potential wildlife attraction hazards would be provided on land owned by the Port located within the City of Auburn immediately west of the Green River. The undeveloped parcel has been farmed in the recent past and currently supports a mix of upland pasture grasses and forbs that are common to abandoned agricultural land in the Puget Sound basin. Approximately 4.3 acres of emergent wetland was delineated during previous site investigations and is included in the 47-acre portion of the site proposed for mitigation (only 0.27 acres of these wetlands would be affected by the mitigation). The wetland mitigation would be located a minimum of 200 ft west of the ordinary high water mark of the adjacent Green River.

The overall wetland mitigation goal on the Auburn site is to compensate for unavoidable wetland impacts by in-kind replacement of habitat. This would be accomplished by creating a diverse replacement habitat with a net gain in functional value and acreage. Specifically, this offsite mitigation of lost wetland habitat functions would attain the following goals:

1 Create about 21 acres of palustrine forested, scrub/shrub, and emergent wetland at an average replacement ratio of 1.5:1;

2 Consolidate impacts of many lower functioning wetlands into one large wetland ecosystem on a single site with long-term protection. Maximize habitat value of the new wetland by providing habitat connections or corridors to other significant habitat areas;

3 Provide in-kind wildlife habitat replacement while maximizing public safety and minimizing wildlife hazards to aircraft; and

4 Mitigate all adverse impacts on hydrologic functions (water quality, flood storage, and stormwater storage) within the Miller Creek and Des Moines Creek watersheds, with an overall replacement ratio of at least 1:1.

Table 2-2 lists the goals of the mitigation site. The off-site wetland mitigation site is designed to provide in-kind replacement of wetland habitat functions affected by the improvements.

Although not related to impacts of the Master Plan Update improvements, additional Green River floodplain storage capacity would be created as part of the design process.

In 1998, the Port completed a SEPA checklist, and a Determination of Non-Significance for the construction of the wetland mitigation site in Auburn.

3. Relocation of Miller Creek

The new runway embankment would directly affect three areas in the Miller Creek watershed. The Miller Creek basin encompasses about 8 square miles and includes a small portion of the Airport, as well as parts of the cities of SeaTac and Burien. The Airport covers an estimated 5 percent of the entire basin. The Miller Creek watershed consists of drainage channels that originate at Arbor, Burien, and Tub lakes; surface water and seep drainages from the north end of Sea-Tac Airport; and overflows from the Miller Creek Stormwater Detention Facility and Lora Lake. The creek generally flows south and southwest toward Puget Sound. The areas of this basin that would be affected include:

- Area 1: approximately 980 feet of Miller Creek. The affected portions extend approximately 1,000 feet south of Lora Lake.
- Area 2: Class III drainage channels totaling 2,080 feet, that originate as seeps in the Airport Operations Area (AOA) then flow west to Miller Creek.
- Area 3: 200 feet of the Class III headwaters of Walker Creek. These waters, which originate from seepage and storm water runoff at the corner of 12th Avenue South and South 176th Street, flow northwest to SR 509.

The primary mitigation goal is to replace lost values and functions of the three portions of Miller Creek and its associated drainage channels that would be affected by the airport improvements.

The original mitigation plan was designed to ensure that present beneficial uses of Miller Creek will not be reduced and that other beneficial uses will be added or enhanced. Beneficial use criteria provide design standards and require consistency with the overall mitigation plan. The following impact compensation goals were to be attained by the original mitigation program.

Miller Creek Goals

Goal 1:	The creek would continue to provide base flow conveyance.
Goal 2:	The new Miller Creek channel would provide improved fish habitat.
Goal 3:	The mitigation would accommodate peak flows up to the 100-year flow; no net reduction of 100-year floodplain storage or floodway conveyance.
Goal 4:	Minimum flow velocity should minimize fine sediment deposition.
Goal 5:	The channel would replace or increase riparian habitat.

TABLE 2-2

SUMMARY OF WETLAND IMPACTS AND COMPENSATORY DESIGN OBJECTIVES
(Extracted from the 1997 Final Supplemental EIS)

Project Impact	Compensatory Design Objectives	Potential Acreage Provided[1]	Compensation Ratio[1]
Fill of 7.34 acres of forested wetland and loss of associated wildlife habitat.	Provide in-kind replacement of forested wetland vegetation cover and increase overall wildlife habitat value.	14.68 acres of forested wetland	2.0:1
Fill of 2.01 acre of shrub wetland and loss of associated wildlife habitat.	Provide in-kind replacement of shrub wetland vegetation cover and increase overall wildlife habitat value.	2.01 acres of shrub wetland	1.0:1
Fill of 2.88 acres of emergent wetland and loss of associated wildlife habitat.	Provide in-kind replacement of emergent wetland vegetation cover and increase wildlife habitat value.	4.32 acres of emergent wetland	1.5:1
Loss of water quality functions.	On-site replacement of surface water functions would be included in the engineering design of the Master Plan Update improvements. The design features would include 3-celled wetponds (with a maximum 48-hour detention), wet vaults, bioswales, and detention, as necessary to meet or exceed all BMPs.	Best Management Practices for stormwater quality would be followed.	NA
	Additional mitigation to provide flood storage capacity in the Green River drainage basin.	Approximately 30 to 60 acre-ft of flood storage capacity.	NA
Loss of degraded wetland buffers.	In-kind replacement for upland buffer impacts and additional mitigation for wildlife using both wetland and non-wetland habitats.	Approximately 3 acres of forested upland buffer.	NA

[1] Acreages of mitigation and compensation ratios are identified as potential since verification of wetland impacts is in process and because ratios would be subject to negotiation.

NA = Not applicable.

Source: Parametrix, December 1996. As reported in the 1997 Final Supplemental EIS.

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Miller Creek Goals (continued)

Goal 6: The channel cannot include expansive, long-standing water pools or wetlands that could potentially attract wildlife.

Goal 7: The proposed Miller Creek corridor should accommodate passive recreational uses, such as walking trails

Drainage Channel Goals

Goal 1: The mitigation drainage channel would continue to provide adequate flow conveyance.

Goal 2: The mitigation drainage channel would collect seepage to maintain base flows.

Goal 3: The new drainage channel would provide an open channel of equivalent length as the existing drainage channels.

The creek relocation site was chosen because it is relatively close to the edge of the third parallel runway embankment, and therefore, requires the shortest stream relocation length. Also, extremely flat site conditions dictate that the proposed channel be as short as possible to provide the maximum possible channel slope. The proposed realigned creek would be located as close to the base of the fill slope of the Third Runway as possible. The downstream end of the channel would connect with the existing Miller Creek channel at the closest possible point to minimize stream relocation impacts. The channel edge would be a minimum of 25 feet from the base of the slope, to accommodate a riparian buffer. However, because of the limited space between Lora Lake and the embankment, narrower buffers might be required in this area. To compensate for the restrictive high flow area, flows in excess of channel capacity will be diverted from the main channel of Miller Creek into Lora Lake and then reintroduced at the lake outlet channel.

The drainage channel mitigation site was selected as the only appropriate option for recreating the equivalent drainage length for the filled drainage channels. The existing channels could not be left undisturbed or reconstructed on the fill slope because of fill stability requirements.

Approximately 9,630 cubic yards of floodplain storage would be lost in the fill area due to the Master Plan Update improvements. Approximately 10,000 cubic yards of floodplain storage and floodway conveyance would be created, not including storage for the proposed stream channel.

* * *

Potential environmental impacts of relocating Miller Creek and its tributaries were discussed in an attachment to the JARPA 404 permit application titled *"Miller Creek Relocation Plan for Proposed Master Plan Update Improvements at Seattle-Tacoma International Airport"* dated December 1996. This document, which included a detailed mitigation plan, was submitted as part of the § 404 permit for the wetland mitigation site and Miller Creek relocation.

Chapter III

REFINED IDENTIFICATION OF AFFECTED WETLANDS AND OTHER AQUATIC RESOURCES

Since the completion of the 1997 Final Supplemental EIS (FSEIS), the Port of Seattle has acquired parcels on which the embankment supporting the new runway will be placed and has conducted more precise on-the-ground delineations. This section summarizes new information on the nature and extent of the wetlands that would be affected by Airport improvements. **Table 3-1** compares the affected wetlands as presently identified with the affected wetlands identified in the 1997 FSEIS.

1. Wetland Identification Process

As is noted in the following description, the primary differences between the wetlands presently identified and those identified in the Final EIS/Final Supplemental EIS relate to access to property for purposes of identifying and delineating wetlands.

(A) Wetland Identification in 1996 Final EIS and 1997 Final Supplemental EIS

As is noted in the 1996 FEIS and 1997 FSEIS, the development of the Third Runway embankment necessitated the Port's acquisition of about 390 parcels of land located directly west of the existing airfield. To avoid public perception of prejudicing the outcome of the environmental review, the Port did not begin acquisition of these properties until after receipt of the FAA Record of Decision approving the proposed Airport improvements. As a consequence, access to the parcels for the purpose of surveying the conditions and delineating wetlands could not be conducted without permission from the property owners. During preparation of the 1996 Final EIS, letters were sent to such landowners seeking access for the purpose of identifying resources, including wetlands. Right-of-entry was not granted by nearly all of the property owners. As a result, no direct access was available at the time of the Final EIS/Final Supplemental EIS to nearly all of the potentially affected parcels. Therefore, the delineation of wetlands was based on interpretation of aerial photography, topographic maps, and visual inspection from public rights-of-way or other parcels owned by the Port.

(B) Refined Wetland Identification After Property Acquisition

In July 1997, the FAA issued the Record of Decision, and the Port initiated the acquisition process immediately thereafter. By mid 1998, the Port had gained possession of about 30 properties and had initiated a wetland delineation and survey process for these parcels. At that time, it became apparent that more or larger wetlands were present. The Port then initiated an accelerated program of gaining access agreements to the remaining parcels that were to be acquired. On-the-ground delineation of wetlands on these parcels was then conducted.

Field investigations for wetlands were completed for properties not previously accessible between March 1998 and February 1999. During these site visits, properties were inspected for wetland characteristics and other related drainage features. Project staff identified and delineated wetlands in the study area using the Routine Determination Method outlined in the *Washington State Wetland Identification and Delineation Manual* and the 1987 *U.S. Army Corps of Engineers Wetland Delineation Manual*. Throughout this document, the refined analysis reflects the delineations completed after access to most of the acquisition area had been obtained.

The U.S Army Corps of Engineers (Corps) has verified the wetland delineations on all properties within the impact area that are either currently owned by the Port, or to which the Port has been granted access. Note that as of December 31, 1999 wetland delineations have not been conducted on two parcels, comprising about 3.5 acres, where access has not been granted (parcels 305, and 177). (USACOE Memorandum for Record: Field Review and Jurisdictional Summary 1999) See **Tables 3-1 and 3-2**. To estimate probable wetland impacts on these parcels, wetland identification was conducted by visual inspection from adjacent properties, review of topography, and review of aerial photography. Wetlands on parcel 177 have been delineated but not surveyed, because access to the site was revoked following identification of wetlands on the parcel. Observations from off-site locations, and other information indicate low probability of wetland occurrence on Parcel 305. The wetland impact analysis assumes the existence of approximately one additional acre of affected wetlands to account for these uncertainties and ensure that wetlands are not underestimated.

2. Wetlands in the Study Area – Comparison of Original Identification of Affected Wetlands With Refined Identification of Affected Wetlands

The 1997 FSEIS delineated 55 wetlands in the Airport study area totaling about 140 acres and ranging in size from 0.02 acres to 30.3 acres. The refined delineation included more than ninety wetlands, ranging in size from 0.01 to 35.32 acres. Wetlands comprise a total of about 170 acres in the airport vicinity and include palustrine forested, scrub-shrub, emergent, and open-water wetland habitat.

Table 3-1 lists the wetlands identified in the Airport study area. During the refined delineation, the majority of new wetlands identified were small wetlands occuring on undeveloped portions of residential property that appear to have been filled by those residential owners. Wetlands 1 through 55 were identified during the earlier study. Fifty-five additional wetlands were identified by the refined study, ranging is size from 0.01 acres to 4.33 acres – the average being 0.22 acres. Ten of the wetlands identified were farmed wetlands. Eleven (11) of the already identified wetlands were found to be smaller than originally estimated, while twelve wetlands were found to be larger. Three wetlands dominate the increase in acreage in the refined delineation wetlands (Wetlands 18, 28, and 37). Other Waters of the U.S. within the study area include Miller and Des Moines Creeks, as well as several drainage channels that convey natural runoff to these creeks. While many of the wetlands are small, degraded by past and ongoing human disturbance, and isolated from significant habitat, they provide some ecological functions that will be replaced through mitigation.

Exhibits 3-1 and 3-2 show the location of each wetland listed in the table.

TABLE 3-1

COMPARISON OF WETLANDS IN STUDY AREA (Acres)

		Size of Wetland (Acres)		Project Fill	
Wetland	Classifications	Refined	Original FSEIS	Refined	Original FSEIS
	Other Waters of U.S.[a]	0.15	0.00	0.14	0.00
1	Forested	0.07	0.07	0.00	0.07
2	Forested	0.73	0.74	0.00	0.74
3	Forested	0.56	0.56	0.00	0.19
4	Forested	5.00	5.02	0.00	0.46
5	Forested/Scrub-Shrub	4.63	4.58	0.14	1.69
6	Scrub-Shrub	0.86	0.87	0.00	0.00
7	Forested/Open Water/Emergent	6.68	6.70	0.00	0.00
8	Scrub-Shrub/Emergent	4.95	4.95	0.00	0.00
9	Forested/ Emergent (40/60)	2.83	2.85	0.03	0.13
10	Scrub-Shrub	0.31	0.31	0.00	0.00
11	Forested/Emergent (80/20)	0.50	0.50	0.34	0.47
12	Forested/Emergent (20/80)	0.21	0.21	0.21	0.21
13	Emergent	0.05	0.05	0.05	0.05
14	Forested	0.19	0.19	0.19	0.19
15	Emergent	0.28	0.28	0.28	0.28
16	Emergent	0.05	0.06	0.05	0.06
17	Emergent	0.02	0.03	0.02	0.03
18	Forested/Scrub-Shrub/Emergent (50/20/30)	3.56	0.12	2.60	0.12
19	Forested	0.56	0.57	0.56	0.57
20	Scrub-Shrub/Emergent (90/10)	0.57	0.06	0.57	0.06
21	Forested	0.22	0.22	0.22	0.22
22	Scrub-Shrub/Emergent (10/90)	0.06	0.06	0.06	0.06
23	Emergent	0.77	0.78	0.77	0.78
24	Emergent	0.14	0.14	0.14	0.14
25	Forested	0.06	0.06	0.06	0.06
26	Emergent	0.02	0.02	0.02	0.00
28	Scrub-Shrub/Emergent/Open Water (65/15/20)	35.32	18.10	0.07	0.06
29	Forested	0.74	0.74	0.00	0.74

		Size of Wetland (Acres)		Project Fill	
Wetland	Classifications	Refined	Original FSEIS	Refined	Original FSEIS
30	Forested/Scrub-Shrub (80/20)	0.88	0.50	0.00	0.50
31	Emergent	0.05	0.05	0.00	0.00
32	Emergent	0.09	0.05	0.00	0.05
33	Forested/Shrub-Scrub/Emergent/Open Water	17.60	17.60	0.00	0.00
34	Open Water	1.40	1.40	0.00	0.00
35	Forested/Emergent (40/60)	0.67	0.21	0.67	0.18
36	Forested/Emergent	0.30	0.30	0.00	0.00
37	Forested/Emergent (70/30)[b]	5.76	2.41	4.08	1.68
38	Emergent/Shrub Scrub	0.00	0.00	0.00	0.00
39	Forested[c]	0.89	0.07	0.00	0.00
40	Scrub-Shrub	0.03	0.09	0.03	0.09
41a	Emergent/Open Water	0.35	NA	0.35	NA
41b	Emergent	0.09	0.09	0.09	0.08
43	Forested/Scrub-Shrub/Emergent (estimated -50/30/20)	30.30	30.30	0.00	0.00
44	Forested/Scrub-Shrub (70/30)	3.04	0.70	0.26	0.00
45	Emergent	5.00	5.00	0.00	0.00
46	Open Water	0.06	0.06	0.00	0.00
47	Open Water	0.20	0.20	0.00	0.00
48	Forested/Emergent (20/80)	0.46	0.02	0.14	0.00
49 [1]	Emergent	0.00	0.02	0.00	0.03
50 [1]	Shrub-Scrub	0.00	0.03	0.00	0.12
51	Forested	16.00	2.41	0.00	0.48
52	Forested/Scrub-Shrub/Emergent (80/20/20)	4.90	1.00	0.54	1.00
53	Forested	0.60	0.60	0.60	0.60
54	Shrub-Scrub/Open Water	25.70	25.70	0.00	0.00
55 [1]	Shrub-Scrub	0.00	0.04	0.00	0.04
A 1	Forested/Scrub-Shrub/Emergent (15/15/70)	4.51	NA	0.59	NA
A 2	Scrub-Shrub	0.05	NA	0.00	NA
A 3	Scrub-Shrub	0.01	NA	0.00	NA
A 4	Scrub-Shrub	0.03	NA	0.00	NA
A 5	Emergent	0.03	NA	0.03	NA
A 6	Forested	0.27	NA	0.27	NA

		Size of Wetland (Acres)		Project Fill	
			Original		Original
Wetland	**Classifications**	**Refined**	**FSEIS**	**Refined**	**FSEIS**
A 7	Forested	0.30	NA	0.30	NA
A 8	Forested/Scrub-Shrub (30/70)	0.48	NA	0.48	NA
A 9	Scrub-Shrub	0.04	NA	0.00	NA
A 10	Scrub-Shrub	0.01	NA	0.00	NA
A 11	Scrub-Shrub	0.02	NA	0.00	NA
A 12	Scrub-Shrub	0.11	NA	0.02	NA
A 13	Forested	0.12	NA	0.00	NA
B 1	Forested/Scrub-Shrub (30/70)	0.27	NA	0.00	NA
B 10	Forested	0.02	NA	0.00	NA
B 11	Emergent	0.18	NA	0.18	NA
B 12	Scrub-Shrub	0.07	NA	0.07	NA
B 14	Scrub-Shrub/Emergent (70/30)	0.78	NA	0.78	NA
B-15a	Shrub	0.21	NA	0.19	NA
B-15b	Shrub	0.02	NA	0.02	NA
B 4	Scrub-Shrub	0.07	NA	0.00	NA
B 5	Forested/Scrub-Shrub (40/60)	0.08	NA	0.00	NA
B 6	Forested/Scrub-Shrub (30/70)	0.55	NA	0.00	NA
B 7	Forested/Scrub-Shrub (30/70)	0.03	NA	0.00	NA
B 9	Forested	0.05	NA	0.00	NA
E 1	Forested	0.23	NA	0.00	NA
E 2	Forested	0.04	NA	0.04	NA
E 3	Forested	0.06	NA	0.06	NA
FW 1	Farmed Wetland	0.03	NA	0.00	NA
FW 2	Farmed Wetland	0.09	NA	0.00	NA
FW 3	Farmed Wetland	0.59	NA	0.00	NA
FW 5	Farmed Wetland	0.08	NA	0.08	NA
FW 6	Farmed Wetland	0.07	NA	0.07	NA
FW 8	Farmed Wetland	0.03	NA	0.00	NA
FW 9	Farmed Wetland	0.01	NA	0.00	NA
FW 10	Farmed Wetland	0.02	NA	0.00	NA
FW 11	Farmed Wetland	0.11	NA	0.00	NA
G 1	Emergent	0.05	NA	0.05	NA
G 2	Emergent	0.02	NA	0.02	NA
G 3	Emergent	0.06	NA	0.06	NA

		Size of Wetland (Acres)		Project Fill	
			Original		Original
Wetland	Classifications	Refined	FSEIS	Refined	FSEIS
G 4	Emergent	0.04	NA	0.04	NA
G 5	Emergent	0.87	NA	0.87	NA
G 6	Emergent	0.01	NA	0.00	NA
G 7	Forested/Scrub-Shrub (30/70)	0.50	NA	0.50	NA
G 8	Emergent	0.04	NA	0.00	NA
R 1	Emergent	0.17	NA	0.13	NA
R 10	Forested	0.03	NA	0.00	NA
R 2	Scrub-Shrub/Emergent (70/30)	0.12	NA	0.00	NA
R 3	Scrub-Shrub	0.02	NA	0.00	NA
R 4	Emergent	0.11	NA	0.00	NA
R 5	Emergent	0.05	NA	0.00	NA
R 6	Forested/Emergent (25/75)	0.21	NA	0.00	NA
R 7	Forested	0.04	NA	0.00	NA
R 8	Scrub-Shrub/Emergent (40/60)	0.06	NA	0.00	NA
R 9	Forested	0.38	NA	0.00	NA
W 1	Emergent	0.10	NA	0.10	NA
W 2	Forested/Emergent (20/80)	0.22	NA	0.22	NA
Auburn 4	Emergent	5.58	NA	0.02	NA

[a] Subsequent to publishing the functional assessment and natural resource mitigation plan, the Corps requested impacts to other waters of the U.S. be expressed in acres instead of linear ft. Impacts to Waters A, B, and W are reported as 0.13 acre in the Public Notice (September 30, 1999); however, actual impacts [refer to MFR dated June 1999 to September 1999 (ACOE 1999)] are 0.14 acre.

[b] The size of this wetland was reported as 5.74 acres in the 1999 re-evaluation document.

[c] These areas were incorporated into Wetlands B11, B4, and 52, respectively.

Table 3-2. Summary of wetland impacts for Seattle-Tacoma International Airport Master Plan Update improvements by construction project (all values are in acres).

Wetland	Ecology Rating	HGM Class	Classification	Fill Impact	Vegetation Types Impacted		
					Forested	Shrub	Emergent
Runway Safety Area							
5	III	Slope	Shrub	0.14	0.07	0.07	0.00
			Subtotal	**0.14**	**0.07**	**0.07**	**0.00**
New Third Runway							
9	III	Slope	Forested/Emergent	0.03	0.01	0.00	0.02
11	III	Slope	Forested/Emergent	0.34	0.27	0.00	0.07
12	III	Slope	Forested/Emergent	0.21	0.04	0.00	0.17
13	III	Slope	Emergent	0.05	0.00	0.00	0.05
14	III	Slope	Forested	0.19	0.19	0.00	0.00
15	III	Slope	Emergent	0.28	0.00	0.00	0.28
16	III	Depression	Emergent	0.05	0.00	0.00	0.05
17	III	Depression	Emergent	0.02	0.00	0.00	0.02
18	II	Slope	Forested/Shrub/Emergent	2.60	1.30	0.52	0.78
19	III	Slope	Forested	0.56	0.56	0.00	0.00
20	II	Slope	Shrub/Emergent	0.57	0.00	0.51	0.06
21	III	Slope	Forested	0.22	0.22	0.00	0.00
22	III	Slope	Emergent/Shrub	0.06	0.00	0.01	0.05
23	IV	Depression	Emergent	0.77	0.00	0.00	0.77
24	III	Depression	Emergent	0.14	0.00	0.00	0.14
25	III	Depression	Forested	0.06	0.06	0.00	0.00
26	IV	Depression	Emergent	0.02	0.00	0.00	0.02
W1	III	Depression	Forested/Emergent	0.10	0.00	0.00	0.10
W2	III	Depression	Forested/Emergent	0.22	0.04	0.00	0.18
35a-d	III	Slope	Forested/Emergent	0.67	0.27	0.00	0.40
37a-f	II	Slope	Forested/Emergent	4.08	2.86	0.00	1.22
40	III	Depression	Forested	0.03	0.00	0.03	0.00
41a and b	III	Depression	Emergent [a]	0.44	0.00	0.00	0.44
44a and b	II	Slope	Forested	0.26	0.18	0.08	0.00
A1	II	Depression, Riparian	Forested/Shrub/Emergent	0.59	0.09	0.09	0.41
A5	IV	Depression	Emergent	0.03	0.00	0.00	0.03
A6	III	Slope	Forested	0.27	0.27	0.00	0.00
A7	III	Slope	Forested	0.30	0.30	0.00	0.00
A8	III	Slope	Forested/Shrub	0.48	0.14	0.34	0.00
A12	III	Slope	Shrub	0.02	0.00	0.02	0.00

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Wetland	Ecology Rating	HGM Class	Classification	Fill Impact	Vegetation Types Impacted		
					Forested	Shrub	Emergent
FW5 and 6	IV	Depression, Riparian	Farmed Wetland	0.15	0.00	0.00	0.15
R1	III	Riparian	Emergent	0.13	0.00	0.00	0.13
			Subtotal	**13.94**	**6.8**	**1.60**	**5.54**
South Aviation Support Area (SASA)							
52	II	Slope	Forest/Shrub/Emergent	0.54	0.54	0.00	0.00
53	III	Depression	Forested	0.60	0.60	0.00	0.00
E2	III	Slope	Shrub	0.04	0.00	0.04	0.00
E3	III	Slope	Shrub	0.06	0.00	0.06	0.00
G1	IV	Slope	Shrub (Slope)	0.05	0.00	0.05	0.00
G2	IV	Slope	Emergent	0.02	0.00	0.00	0.02
G3	IV	Slope	Emergent	0.06	0.00	0.00	0.06
G4	IV	Slope	Emergent	0.04	0.00	0.00	0.04
G5	IV	Slope	Emergent	0.87	0.00	0.00	0.87
G7	III	Slope	Forest/Shrub	0.50	0.13	0.37	0.00
			Subtotal	**2.78**	**1.37**	**0.42**	**0.99**
Borrow Area and Haul Road							
28	II	Depression, Riparian	Emergent	0.07	0.00	0.00	0.07
48[b]	II	Slope	Forest/Emergent	0.14	0.03	0.00	0.11
B11	III	Depression	Emergent	0.18	0.00	0.00	0.18
B12	II	Slope	Forested	0.07	0.00	0.07	0.00
B14	III	Depression	Shrub	0.78	0.00	0.55	0.23
B15a and b[b]	III	Slope	Shrub	0.21	0.00	0.21	0.00
			Subtotal	**1.45**	**0.03**	**0.83**	**0.59**
Mitigation							
Auburn 4	III	Depression	Emergent	0.02	0.00	0.00	0.02
			Subtotal	**0.02**	**0.00**	**0.00**	**0.02**
TOTAL[c]				**18.33**	**8.27**	**2.92**	**7.14**

[a] Includes 0.18 acre of open water habitat

[b] These wetlands extend off-site.

[c] These values represent an increase of 0.05 acre of impacts to Wetland 53 made subsequent to completing the impact assessment and natural resource mitigation plan. The change is reflected in the ACOE public notice for the project.

Table 3-3. 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	8.10	4.87	0.97	13.94
Borrow Area 1	0.28	1.17	0.00	1.45
SASA	0.60	1.20[c]	0.98	2.78[c]
Mitigation	0.00	0.02[b]	0.00	0.02
TOTAL	**8.98**	**7.40[c]**	**1.95**	**18.33[c]**

[a] Ecology (1993)
[b] Impacts result from a permanent access road in an emergent wetland at the Auburn mitigation project.
[c] These values represent an increase of 0.05 acre of impacts to Wetland 53 made subsequent to completing the impact assessment and natural resource mitigation plan. The change is reflected in the ACOE public notice for the project.

Table 3-4. Summary of temporary construction impacts to wetlands in the proposed STIA Master Plan Update improvement area.

					Subtotal		
Wetland	Rating	HGM[a] Class	Vegetation Types	Total	Forest	Shrub	Emergent
Runway Safety Area Extension							
3	II	Slope	Forested	0.05	0.05	0.00	0.00
4	II	Slope	Forested	0.10	0.10	0.00	0.00
5	III	Slope	Shrub	0.10	0.05	0.05	0.00
Third Runway							
9	III	Slope	Forested/Emergent	0.03	0.01	0.00	0.02
11	III	Slope	Forested/Emergent	0.13	0.10	0.00	0.03
18	II	Slope	Forested/Shrub/Emergent	0.36	0.18	0.07	0.11
37	II	Slope	Forested/Emergent/Shrub	0.71	0.50	0.10	0.11
44	II	Slope	Forested	0.30	0.20	0.10	0.00
A1	II	Depression, Riparian	Forested/Shrub/Emergent	0.05	0.01	0.01	0.03
A12	III	Slope	Shrub	0.03	0.00	0.03	0.00
A13	III	Slope	Forested	0.01	0.01	0.00	0.00
Borrow Site 1 Wetlands							
48	II	Slope	Forested	0.10	0.10	0.00	0.00
B15	III	Slope	Shrub	0.10	0.00	0.10	0.00
South Aviation Support Area							
52	II	Slope	Forest/Shrub/Emergent	0.10	0.00	0.05	0.05
TOTAL				**2.17**	**1.31**	**0.51**	**0.35**

[a] Hydrogeomorphic classification system used to evaluate wetland functions.

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Table 3-5. Summary of wetlands subject to mitigation activities.

Wetland [a]	Rating	HGM Class	Vegetation Types	Total	Vegetation Type Impacted		
					Forest	Shrub	Emergent
Wetlands subject to temporary impacts associated with mitigation activities including excavation and replanting or restoration of temporary access roads							
A1 [b]	II	Depression, Riparian	Forested/Shrub/Emergent	3.74	0.56	0.56	2.62
A2 [b]	IV	Depression	Shrub	0.05	0.00	0.05	0.00
A3 [b]	IV	Depression	Shrub	0.01	0.00	0.01	0.00
A4 [b]	IV	Depression	Shrub	0.03	0.00	0.03	0.00
FW 1, 2, 3, 5, 6, 8, 10, and 11 [b]	IV	Depression	Farmed Wetlands	1.04	0.00	0.00	1.04
Auburn Area 1 [c]	IV	Depression	Emergent	0.29	0.00	0.00	0.29
Auburn Area 4 [c]	IV	Depression	Emergent	0.14	0.00	0.00	0.14
Auburn Area 5 [d]	IV	Depression	Emergent	0.09	0.00	0.00	0.09
Auburn Area 7 [d]	IV	Depression	Emergent	0.17	0.00	0.00	0.17
Auburn Area 8 [e]	IV	Depression	Emergent	2.20	0.00	0.00	2.20
Auburn Area 9 [d]	IV	Depression	Emergent	0.03	0.00	0.00	0.03
			Subtotal	**7.79**	**0.56**	**0.65**	**6.58**
Wetlands subject to temporary impacts resulting from mitigation enhancement plantings							
18 [f]	II	Slope	Forested/Shrub/Emergent	0.91	0.91	0.00	0.00
37a [f]	II	Slope	Forested/Emergent	1.71	1.71	0.00	0.00
A1 [f]	II	Depression, Riparian	Forested/Shrub/Emergent	0.34	0.34	0.00	0.00
A10 [f]	IV	Depression	Shrub	0.01	0.00	0.01	0.00
A11 [f]	III	Slope	Shrub	0.02	0.00	0.02	0.00
FW 9 [f]	IV	Depression	Farmed Wetland	0.01	0.00	0.00	0.01
R1 [f]	III	Riparian	Emergent	0.17	0.00	0.00	0.17
R2 [f]	III	Riparian	Shrub/Emergent	0.12	0.00	0.00	0.12
R3 [f]	III	Riparian	Shrub	0.02	0.00	0.02	0.00
R4 [f]	III	Riparian	Emergent	0.11	0.00	0.00	0.11
R5 [f]	III	Riparian	Emergent	0.05	0.00	0.00	0.05
R6 [f]	III	Riparian	Forested/Emergent	0.21	0.05	0.00	0.16
R7 [f]	III	Riparian	Forested	0.04	0.04	0.00	0.00
R8 [f]	III	Riparian	Shrub/Emergent	0.06	0.00	0.02	0.04
R9 [f]	III	Riparian	Forested	0.36	0.36	0.00	0.00
R10 [f]	III	Riparian	Forested	0.03	0.03	0.00	0.00
28 [g]	II	Depression, Riparian	Emergent	4.50	0.00	0.00	4.50
			Subtotal	**8.67**	**3.44**	**0.07**	**5.16**
TOTAL [b]				**16.46**	**4.00**	**0.72**	**11.74**

[a] Other Waters of the U.S. V1 and V2 (0.02 acre) not included in this table.
[b] Temporary impacts associated with restoration activities at the Vacca Farm site.
[c] Temporary impact resulting from constructing temporary roads to provide access to, and within the mitigation site in Auburn.
[d] These areas will be converted to shrub and emergent wetlands at the Auburn site.
[e] A maximum of 2.20 acre of existing ditches and farmed wetland at the Auburn site will be converted to a wetland drainage channel that connects the mitigation site to the 100-year floodplain to the north.
[f] Wetlands located within the proposed 100-ft Miller Creek buffer, south of the Vacca Farm site.
[g] Wetland located at the Tyee Valley Golf Course.
b Format of this table has been changed at the request of the ACOE subsequent to issuance of the reevaluation document, impact assessment, and mitigation plan.

[Exhibit 3-2]

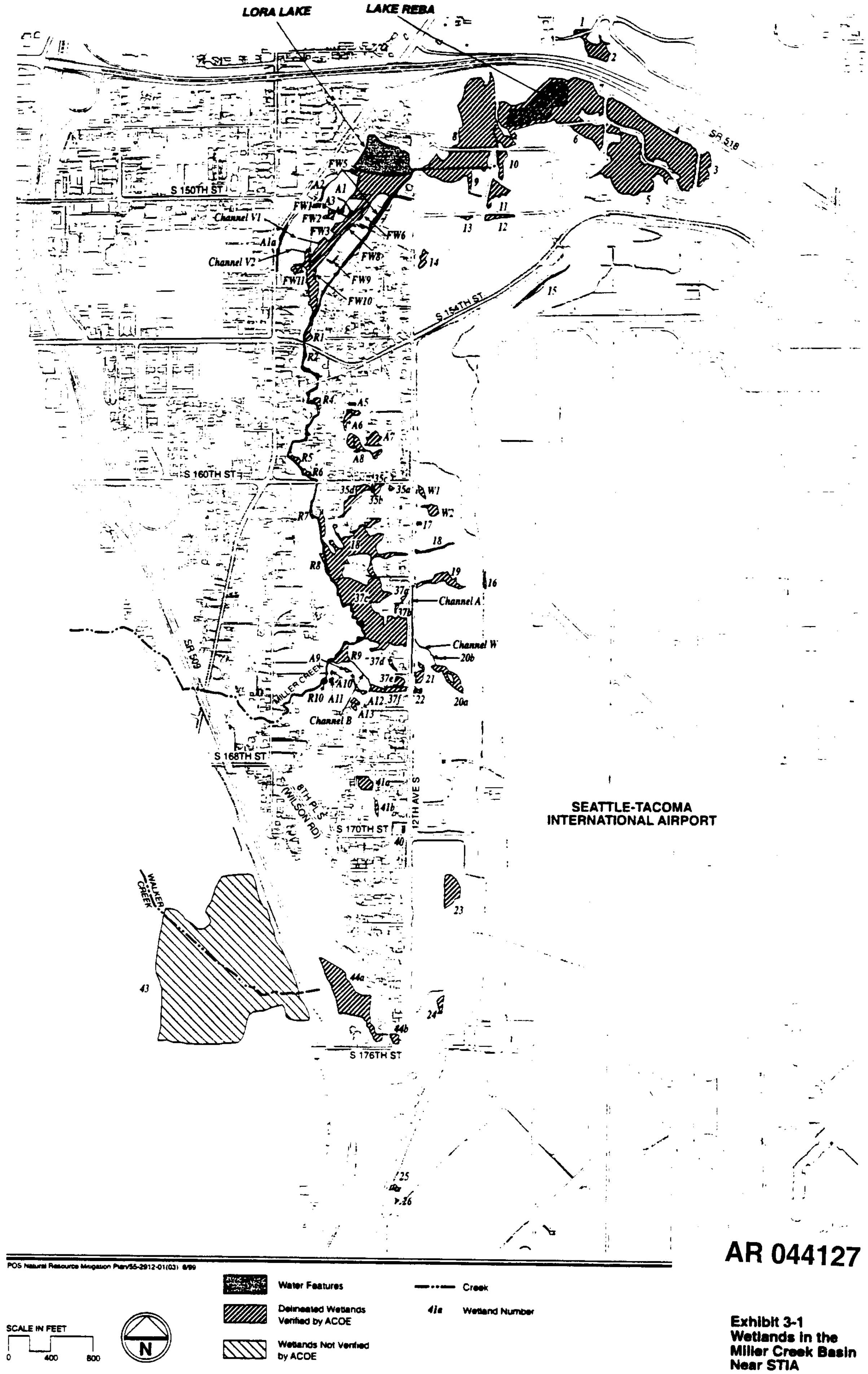

Exhibit 3-1 Wetlands in the Miller Creek Basin Near STIA

[Exhibit 3-1]

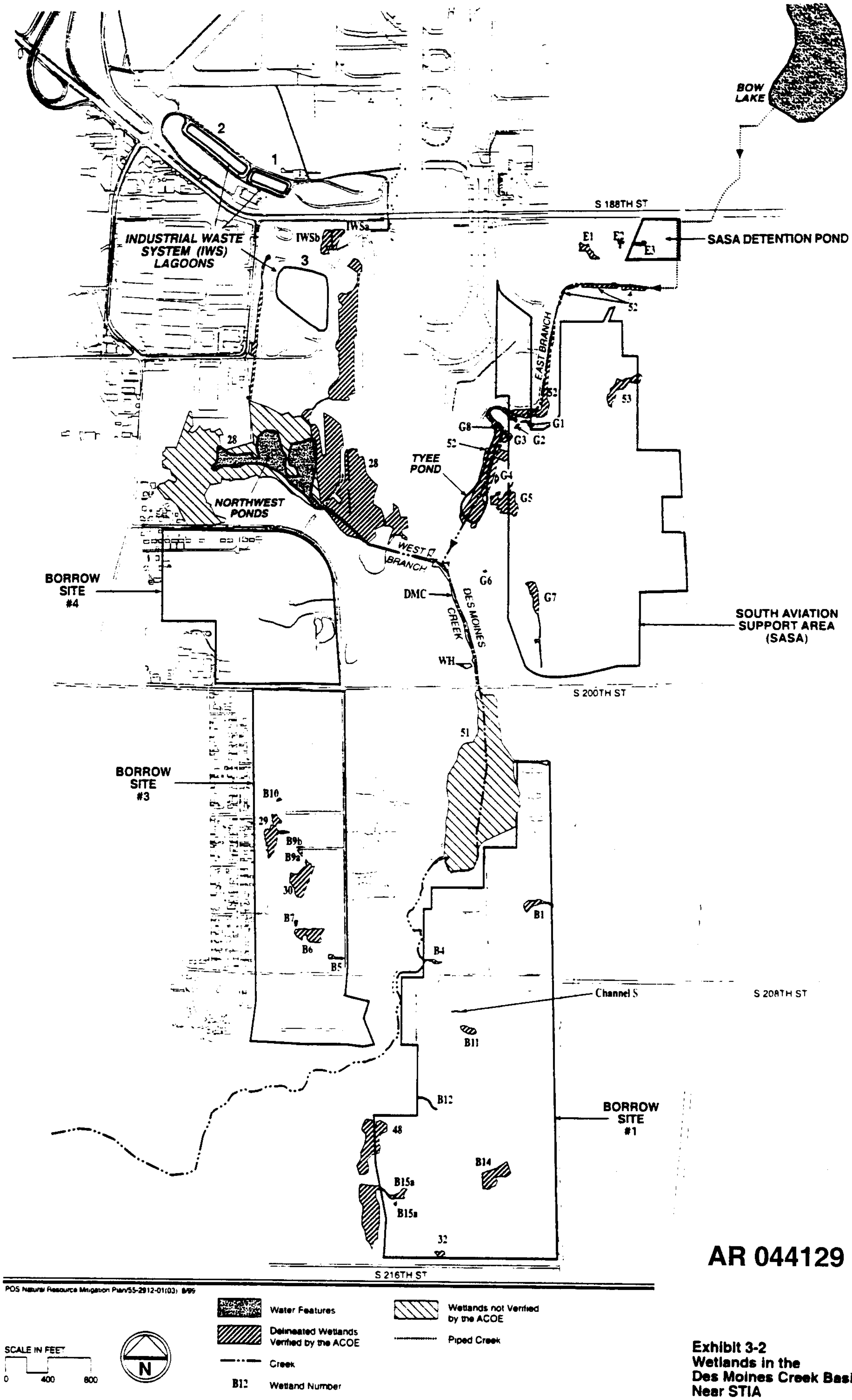

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Exhibit 3-2
Wetlands in the Des Moines Creek Basin Near STIA

3. Characterization of Wetlands

A variety of wetland conditions are present within the project impact area. These wetlands range from small highly modified wetlands, subject to on-going human disturbance, to less modified wetlands that are gradually recovering from past logging or farming activities and perform a variety of wetland functions. Moderate to high value habitat function occurs in larger wetlands (for example Wetland 37, A-1, and 30) where native vegetation is recovering from past disturbances. Low value habitat functions typically occur in numerous smaller wetlands that are subjected to ongoing disturbance. Hydrologic and water quality functions of wetlands vary depending on their landscape position and numerous site-specific factors. Several wetlands (Wetland 52, Wetland 37, and Wetland 44) appear to provide groundwater discharge functions that enhance baseflow in adjacent creeks. Wetland A-1 and Wetland 28 provide high function for reducing floodflow and for water quality enhancement.

The ecological functions of these wetlands are discussed in more detail below. In general, the functions and values of the affected wetlands remain the same as those identified in the EIS and FSEIS.

Biological Functions

The refined delineation identified additional affected wetlands but did not identify any new or unrecognized biological functions in the area. Wildlife use of the study area and its associated wetlands is largely limited to species tolerant to disturbance. The study area is fragmented by urban development, limiting access to the area for most large mammals. Faunal diversity is frequently limited in wetlands because they are too small to meet habitat requirements for many wildlife populations. The high degree of urbanization within the area may limit the numbers and diversity of amphibians present. No federal or state-listed threatened or endangered wildlife species use the areas planned for Master Plan Update improvements. Coho salmon, a federal candidate species, occurs in Miller Creek and Des Moines Creek.

The forested wetlands within the study area lack true aquatic habitat, and the wildlife function of these wetlands is similar to that of upland areas with comparable vegetation communities. Small passerine birds use forested habitat in the study area for nesting and feeding. Forested areas are also used by small mammals for breeding and cover. Some amphibians may use portions of the wetlands for resting, foraging, and breeding.

Habitat functions of shrub wetlands include nest and cover habitat for songbirds and small mammals. Shallow areas of seasonal ponding in shrub wetlands are uncommon, but, when present, they provide habitat for amphibian breeding. Shrub wetlands lack the woody debris that is desirable to terrestrial amphibians, such as ensatina.

Emergent wetlands in the study area provide habitat for songbird species that use the vegetation for nesting and foraging. Small mammals forage on emergent vegetation. In certain wetlands (Wetland A-1) amphibian species may use emergent vegetation that occurs in standing water for egg mass attachment. Many of the emergent wetlands in the study area are small, isolated, and recently disturbed by human activities. Wetlands located within the current airfield and Tyee Valley Golf Course are mowed several to many times per year. This mowing limits their function as wildlife habitat. Most emergent wetlands have intermittent surface flows or seasonal standing water which also limits the overall value of their habitat function.

The wildlife habitat functions of the affected wetlands are generally significant only to the local vicinity (rather than to a larger landscape or watershed) because urban development isolates the area from other large undeveloped habitat areas. The sizes of most of the wetlands are smaller than the habitat requirements of many native mammal and bird species. The biological functions of wetlands are further limited by the lack of permanent open water, the short duration of seasonal ponding or soil saturation, the high occurrence of non-native plant species in some emergent wetlands, and the fragmented habitats. The wildlife habitat function increases where trees and/or shrubs are adjacent to the grass-dominated emergent areas.

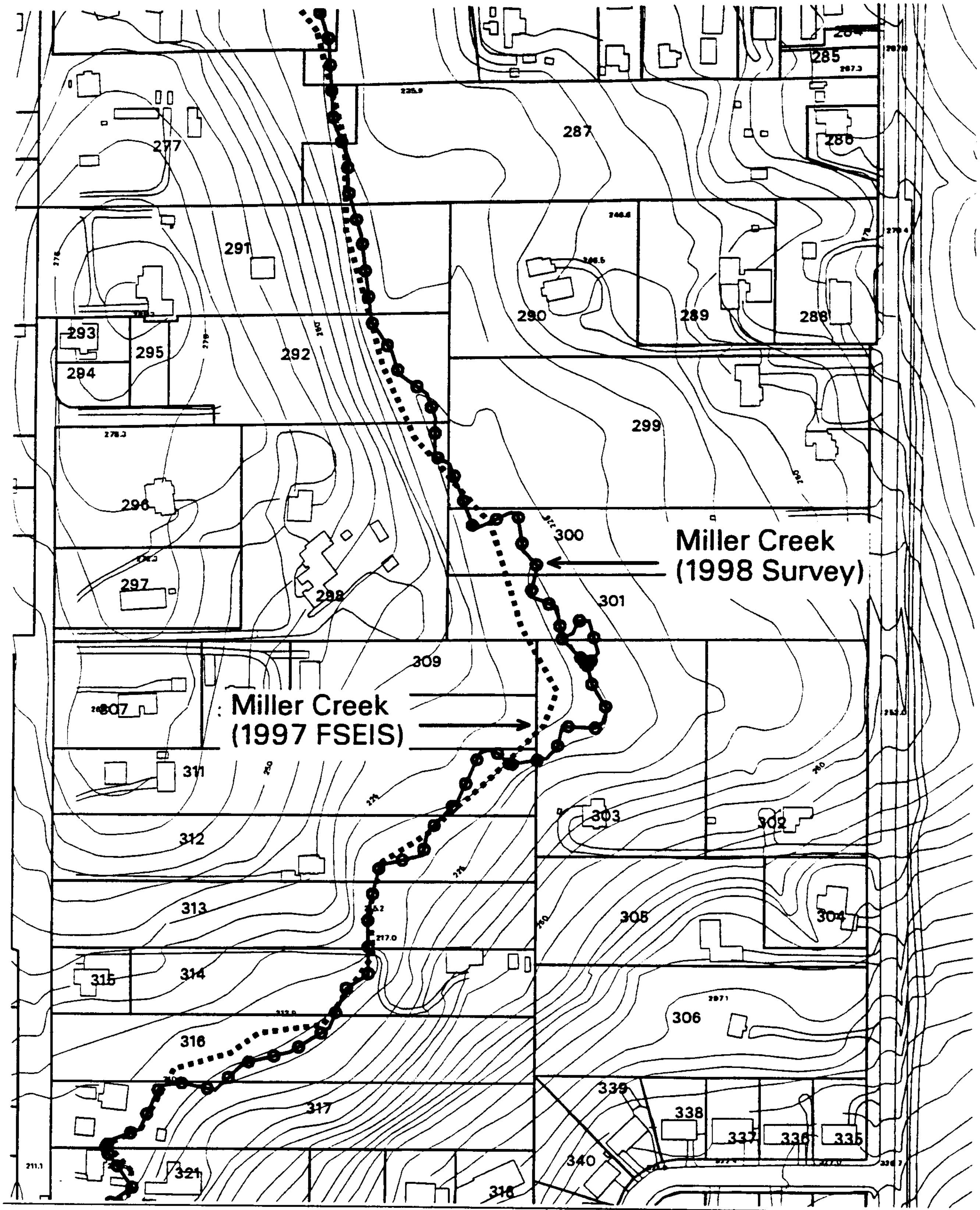
Physical Functions

The physical functions provided by the newly identified affected wetlands are of the same general quality and significance as those identified in the FSEIS. Hydrologic functions (flood storage, groundwater discharge, and storm water detention) affect hydrologic and habitat conditions in both on-site and off-site locations (especially fish habitat in Miller and Des Moines creeks). Riparian wetlands on groundwater seeps adjacent to Miller and Des Moines creeks support stream baseflow by providing seasonal or perennial sources of water and moderate stream temperatures. Wetlands associated with the Miller Creek Regional Detention Facility function by temporarily storing floodwaters, which may reduce downstream flooding and streambank erosion. Other wetlands help reduce peak flows by collecting and storing storm runoff, thereby reducing the rate and volume of water that reaches the stream systems during storms. Many of the isolated on-site wetlands have a limited ability to provide hydrological functions, because of their small size, lack of direct connections to streams, or topographic conditions that limit the amount and duration of seasonally detained stormwater.

The groundwater recharge function of most of the wetlands appears to be limited because many of them occur on low permeability till soils (Alderwood Series). The wetlands have formed in shallow depressions where a perched water table has developed. Due to the low soil permeability, evapo-transpiration, and the short duration of soil saturation, it is unlikely that these small wetlands contribute significantly to recharge of groundwater.

4. Location of Miller Creek

As noted in the 1996 FEIS and 1997 FSEIS, the northern end of the runway embankment requires the relocation of a portion of Miller Creek. Another portion of Miller Creek was identified in close proximity to the near center point of the runway embankment. The FSEIS (Section 5-5), concluded that a retaining wall would avoid relocation of the creek in that area. During the wetland survey for newly delineated wetlands, the location of Miller Creek throughout the acquisition area was also surveyed. The creek was found to be 83 feet closer to the runway embankment than previously indicated. **Exhibit 3-3** shows the original location of the creek relative to the Third Runway, and compares that location with the newly identified location. As a consequence of this new information on the creek's location, the Port undertook a detailed engineering study to examine various options for avoiding relocation of this portion of the creek and impacts to additional riparian wetlands. The following section discusses the changes that were made to the embankment to avoid relocating the creek.



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N

Feet
0 100 200
Scale 1 : 2,400

305 Parcel Number
Parcel Boundary
Contour Lines
Other features

Exhibit 3-3. Surveyed location of Miller Creek (1998) and location identified in the FSEIS (1997).

Chapter IV

REFINED WETLAND IMPACT ANALYSIS

The previous section described the new information on the nature and extent of wetlands and other waters of the United States that would be affected by the Airport improvements. The new information obtained after previously inaccessible properties became accessible was referred to as the "refined" wetland and stream "delineation" or "identification." The refined delineations of affected wetlands and streams were compared qualitatively and quantitatively to the "original" delineation in the 1997 FSEIS and 1996 JARPA. See **Table 3.1**.

This section reports the Port's re-evaluation of the environmental impacts associated with the new information on the nature and extent of wetlands and stream areas that would be affected by the Airport improvements. The re-evaluation analyzed permanent, temporary, indirect, and cumulative impacts on newly discovered wetland and stream areas.

Permanent impacts result from the direct filling of wetlands to transform their use. Temporary impacts result from short-term construction and will be rectified upon program completion. Indirect impacts are largely associated with potential changes to wetland hydrology, increased noise, and increased human disturbance in wetland areas. Cumulative impacts refer to impacts associated with this project in combination with other projects planned in the area.

Each of these categories of impact was analyzed on the basis of key elements of Airport improvements: the third runway, borrow areas, runway safety areas (RSA), south aviation support area (SASA), and mitigation areas. The general categories of impact also are subdivided on the basis of the various wetland and stream functions affected and the State Department of Ecology (Ecology) Wetland Categories.

The re-evaluation of wetland and stream impacts also explicitly takes into account several changes in the proposed project that were made in response to new information on the exact location of Miller Creek and certain wetlands in relation to the proposed third runway embankment. Actual on-the-ground surveys revealed that Miller Creek was closer to the proposed embankment than previously determined and identified additional wetlands near the embankment. As a result of this new information, to avoid relocating that portion of Miller Creek and to avoid wetlands, the Port decided to utilize a retaining wall to reduce the horizontal reach of the embankment. This design change avoided the necessity to relocate a portion of Miller Creek and eliminated impacts on the creek buffer and newly discovered wetlands. Utilizing the retaining wall also reduced the amount of fill needed for the third runway by 250,000 cy. **Table 4-1** compares the quantity of fill for the third runway estimated in the 1997 FSEIS with lower current estimates as a result of the design change incorporating the retaining wall.

Table 4-1

Runway Embankment Fill Quantity

	Current Estimated Quantity(CY)	FSEIS Estimated Quantity(CY)
1. **Project Requirements**		
Total Project Embankment	16,500,000	17,250,000
On Site Common Excavation	2,400,000	2,900,000
Total Project Import Required	14,100,000	14,350,000
2. **Material Imported To Date**		
1997 Stockpile Project	370,000	
1998 Embankment Project	870,000	
Stockpile North of 154th Street	* 200,000	
Total Imported Thu 1999	1,440,000	
Total Import Remaining (as of 1999)	12,660,000	

- Material is currently being placed at this site and therefore the quantity is an approximate estimate only.

Note: The estimated quantities are based on three-dimensional computer modeling and a review of material placed to date. All quantities are in-place and do not account for any material that may be imported from the Port-owned borrow sources.

The runway embankment fill quantity estimate contained in the FSEIS assumed 2:1 fill slopes without retaining walls. Since completion of the FSEIS estimate, the embankment requirements have been recalculated to incorporate current design concepts, including drainage benches along the 2:1 slopes and retaining walls in three locations along the embankment. Incorporation of the current design elements resulted in additions to and subtractions from the estimated fill requirements. However, as shown in the above table, the net result is a modest reduction in the quantity of fill.

In identifying the impacts to wetlands, the following Department of Ecology rating categories were used:

Category I
These wetlands are the "cream of the crop". Generally, these wetlands are not common and would make up a small percentage of the wetlands in the state. These are wetlands that: (1) provide life support function for threatened or endangered species that has been documented, and the wetland is on file in databases maintained by state agencies; (2) represent a high quality example of a rare wetland type; (3) are rare within a given region; or (4) are relatively undisturbed and contain ecological attributes that are impossible to replace within a human lifetime, if at all. We cannot afford the risk of any degradation to these wetlands. Examples of the latter are mature forested wetlands that may take a

century to develop, and bogs and fens with their special plant populations that have taken centuries to develop.

Category II
These wetlands are those that: (1) provide habitat for very sensitive or important wildlife or plants; (2) are either difficult to replace; or (3) provide very high functions, particularly for wildlife habitat. These wetlands occur more commonly than Category I wetlands, but still need a high level of protection.

Category III
These wetlands provide important functions and values. They are important for a variety of wildlife species and occur more commonly throughout the state than either Category I or II wetlands. Generally these wetlands will be smaller, less diverse, and/or more isolated in the landscape than Category II wetlands. They occur more frequently, are difficult to replace, and need a moderate level of protection.

Category IV
These wetlands are the smallest, most isolated, and have the least diverse vegetation. These are wetlands that we should be able to replace and, in some cases, be able to improve from a habitat standpoint. However, experience has shown that replacement cannot be guaranteed in any specific case. These wetlands do provide important functions and values, and should to some degree be protected. In some areas, these wetlands may be providing groundwater recharge and water pollution prevention functions and, therefore, may be more important from a local point of view. Thus, regional differences may call for a more narrow definition of this category.

Washington State Wetlands Rating System, Washington State Department of Ecology Publication 93-74, August, 1993, pp. 3-4.

1. **Permanent Impacts**

Permanent impacts will occur on about 18.33 acres of wetlands within the project area. Of the wetland subject to permanent impacts, 7.14 acres are emergent, 8.27 acres are forested, and 2.92 acres are scrub-shrub wetland. The permanent impacts are summarized by project elements and Ecology categories in **Table 4-2**:

TABLE 4-2

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	8.10	4.87	0.97	13.94
Borrow Area 1	0.28	1.17	0.00	1.45
SASA	0.60	1.20 [c]	0.98	2.78 [c]
Mitigation	0.00	0.02 [b]	0.00	0.02
TOTAL	**8.98**	**7.40 [c]**	**1.95**	**18.33 [c]**

a Ecology (1993)

b Emergent wetland impacts result from a permanent access road to the Auburn mitigation project.

c These values represent an increase of 0.05 acre of impacts to Wetland 53 made subsequent to completing the impact assessment and natural resource mitigation plan. The change is reflected in the ACOE public Notice for the project.

Taking into account the refined delineation of wetland and stream areas affected by the proposed Airport improvements, the permanent impacts on such areas were re-evaluated, as follows. The re-evaluation separately analyzed the permanent impacts of the various elements of the proposed Airport improvements and the wetland categories and functions affected.

Runway Safety Areas - Permanent wetland impacts associated with extension of the RSAs on existing runways are limited to about 0.14 acres of Wetland 5. This impact will remove forest from a Category III wetland and shrub vegetation that provides habitat for small mammals and songbirds. The affected portion of Wetland 5 is on a moderate slope where groundwater discharge occurs most of the year. Because of the slope of the wetland, this area does not detain or store stormwater. The groundwater discharge supports wetland hydrology in downslope portions of the wetland, and ultimately base flow in Miller Creek.

The design of retaining walls to minimize fill in Wetlands 3, 4, and 5 will incorporate internal drainage systems that allow groundwater to continue to discharge in this area, and this function will not be lost or significantly diminished. The area may provide limited water quality enhancement functions. However, stormwater runoff from upslope areas is channelized limiting the water quality functions this wetland may provide through biofiltration.

Third Runway - The embankment needed to support the Third Runway will have permanent impacts on about 13.94 acres of wetlands. These wetlands vary from lower quality Category IV farmed wetlands to higher quality Category II wetlands.

- Habitat Functions - About 8.98 acres of Category II wetlands will be permanently affected by the runway, including portions of Wetlands 18, 20, 37, 44, and A-1. These wetlands typically contain a mix of early successional forested, blackberry and willow dominated shrub, and non-native emergent wetland plant communities. With the exception of Wetlands 18, 37, and A-1, these wetlands are not riparian to Miller Creek. Portions of Miller Creek will be relocated in conjunction with the filling of a portion of Wetland A-1. The riparian wetlands protect and provide fish habitat in Miller Creek through shade and detrital input that supports invertebrate food production within the stream.

Several Category III wetlands will be permanently affected by the runway embankment. These wetlands are typically dominated by young deciduous forest, blackberry and willow shrubs, or non-native emergent plant species. The wetlands provide habitat to birds and small mammals, but because they are generally small in size, poorly buffered, and subjected to past or on-going disturbance, they represent lower quality habitat than the Category II wetlands. The wildlife habitat functions of these wetlands will be lost but replaced by mitigation measures.

Several Category IV wetlands (Wetlands 23, 26, A-5, FW-5, and FW-6) are dominated by non-native grasses or plowed. These wetlands typically provide habitat for a limited array of wildlife including waterfowl, pigeons, and crows (Wetlands FW-5 and FW-6). Most other Category IV wetlands are mowed lawn, and support fewer wildlife species that are typical of disturbed urban environments (robin, sparrow, starling).

- <u>Hydrologic Functions</u> - Wetlands permanently affected by the Third Runway embankment occur on gentle slopes, shallow depressions, and riparian areas along Miller Creek. These geomorphic positions control, in part, the hydrologic functions the wetlands provide. Some of these functions will be eliminated by the fill for the Third Runway embankment, and replaced by mitigation measures.

Most slope and depression wetlands are saturated during the winter and spring months when rainwater appears to perch on till soils. These wetlands provide winter baseflow support to Miller Creek, but do not support low summer base flows because they are dry by late summer and early autumn. The wetlands provide some detention functions and desynchronize stormwater runoff by reducing runoff rates. This function is limited by the small storage provided by the shallow depressions or the lack of storage in slope wetlands.

The wetlands also provide water quality functions in that they receive untreated runoff from adjacent streets and lawns and potentially remove pollutants. Depression wetlands are likely to provide high water quality functions due to longer storage times that promote contaminant removal. Slope wetlands have short retention times and provide fewer water quality benefits.

Several slope wetlands are areas of groundwater discharge (Wetlands 15, 18, 37) that are saturated throughout the year. These wetlands convey groundwater downslope to Miller Creek. The presence of surface water in the wetlands throughout the summer indicated the wetlands provide base flow support functions to Miller Creek. Wetland impacts from borrow site development are limited to Borrow Area 1, where small areas of Category II and Category III wetlands are altered. These wetlands are dominated by shrub and forest vegetation and provide habitat functions as described in **Table 4-3.** The largest wetland impacted in the borrow area (Wetland B-14) is a shrub dominated wetland that is in an abandoned residential neighborhood. This wetland provides limited habitat for small mammals and songbirds. Since standing water and saturation are of short duration, the wetland does not provide aquatic habitat for amphibians or other organisms.

Wetlands 48 and B-12 and B-15 occur on the west side of the borrow area and extend off-site and downslope to Des Moines Creek. These wetlands convey stormwater and other runoff from the previously developed areas of the borrow site downslope to Des Moines Creek. They provide some biofiltration functions. Due to the shallow depth of the depression, Wetland B-14 provides biofiltration and limited stormwater detention functions.

Table 4-3. Ratings for wetland functions impacted by fill for construction of Master Plan Update improvements at STIA.

Wetland	Resident/ Anadromous Fish	Passerine Birds	Waterfowl	Amphibians	Small Mammals	Exports Organic Carbon	Groundwater Exchange	Flood Storage	Nutrient/ Sediment Trapping
5	Low	Low	Low	Low-Moderate	Moderate-High	Low-Moderate	High	Low	Moderate
9	Low	Moderate-High	Low	Low-Moderate	Moderate-High	Low-Moderate	Low	High	Moderate
11	Low	Moderate-High	Low	Low	Low-Moderate	Low	Low	Low	Moderate
12	Low	Moderate-High	Low	Low	Low	Low	Low	Low	Low
13	Low	Low-Moderate	Low	Low	Low	Low	Low	Low	Low
14	Low	Moderate-High	Low	Low	Low	Low	Moderate	Low	Low
15	Low	Low-Moderate	Low	Low-Moderate	Low	Low	High	Low	Moderate
16	Low	Low-Moderate	Low	Low	Low	Low	Low	Low	Low
17	Low	Low-Moderate	Low	Low	Low-Moderate	Low	Low	Low	Moderate
18	Moderate	High	Low	Moderate	Moderate	High	High	Moderate	Moderate
19	Low	Moderate-High	Low	Moderate	Moderate	Moderate	High	Low	Moderate
20	Low	High	Low	Moderate	Moderate-High	High	High	Low	Low
21	Low	Moderate-High	Low	Low-Moderate	Low-Moderate	Low-Moderate	Low	Low	Low
22	Low	Moderate-High	Low	Low-Moderate	Low-Moderate	Low-Moderate	Low	Low	Low
23	Low	Low-Moderate	Low	Low	Low	Low	Low	Low-Moderate	High
24	Low	Low-Moderate	Low	Low	Low	Low	Low	Low-Moderate	High
25	Low	Moderate-High	Low	Low	Low	Low	Low	Low-Moderate	High
26	Low	Low-Moderate	Low	Low	Low	Low	Low	Low-Moderate	High
28	High	Low-Moderate	High	Moderate	High	Low	High	High	High
35	Low	Low	Low	Low	Low	Low-Moderate	Moderate	Low	High
37	High	High	Low	Moderate	Moderate-High	High	High	Low	Moderate-High
40	Low	Moderate	Low	Low-Moderate	Low	Low	Low	Low-Moderate	High
41	Low	Low-Moderate	Low	Low	Low	Low	Low	Low-Moderate	High
44	Low-Moderate	Moderate-High	Low	Moderate	Moderate-High	High	High	Low	Moderate-High
48	Low	Low-Moderate	Low	Low-Moderate	Low-Moderate	Low-Moderate	Moderate	Low	Low-Moderate

Wetland	Resident/ Anadromous Fish	Passerine Birds	Waterfowl	Amphibians	Small Mammals	Exports Organic Carbon	Groundwater Exchange	Flood Storage	Nutrient/ Sediment Trapping
52	Moderate-High	Low-Moderate	Low	Low-Moderate	Moderate-High	High	High	Moderate	Moderate-High
53	Low	Moderate-High	Low	Low	Moderate	Low	Low	Low-Moderate	High
A1	High	Moderate	Moderate	Low	Moderate-High	High	Low	High	High
A12	Low-Moderate	Low	Low	Low	Moderate	Low- Moderate	Moderate	Low	Low
A5	Low	Low	Low	Low	Low	Low	Low	Low	Low
A6	Low	Moderate-High	Low	Low	Moderate	Low	Moderate	Low	Low-Moderate
A7	Low	Moderate-High	Low	Low	Moderate	Low	Moderate	Low	Low-Moderate
A8	Low	Low-Moderate	Low	Low	Moderate	Low	Moderate	Low	Low-Moderate
B11	Low	Low-Moderate	Low	Low	Low-Moderate	Low	Low	Low-Moderate	High
B12	Low-Moderate	Moderate-High	Low	Moderate	Moderate	Low-Moderate	Moderate	Low	Low-Moderate
B14	Low	Low	Low	Low	Moderate	Low	Low	Low-Moderate	High
B15	Low-Moderate	Low	Low	Low	Moderate	Low-Moderate	Moderate	Low	Low-Moderate
E2	Low	Low	Low	Low	Low	Low	Moderate	Low	Low
E3	Low	Low	Low	Low	Low	Low	Moderate	Low	Low
FW5, 6	Low	Low	Moderate	Low	Low	Low	Low	High	High
G2	Low	Low	Low-Moderate	Low	Low	Low	Moderate	Low	Low-Moderate
G3	Low	Low	Low-Moderate	Low	Low	Low	Moderate	Low	Low-Moderate
G4	Low	Low	Low-Moderate	Low	Low	Low	Moderate	Low	Low-Moderate
G5	Low	Low	Low-Moderate	Low	Low	Low	Moderate	Low	Low-Moderate
G7	Low	Moderate	Low	Low	Low	Low	High	Low	Low-Moderate
R1	Low	Low-Moderate	Low	Low	Moderate	High	Moderate-High	High	Moderate-High
W1	Low	Low	Low	Low	Low	Low	Low	Low-Moderate	High
W2	Low	Moderate	Low	Low	Moderate	Low	Low	Low-Moderate	High

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South Aviation Support Area (SASA) - Wetlands in the SASA area are typically dominated by early successional deciduous forests and shrub wetlands, or are emergent wetlands plated as golf course greens. The golf course wetlands (Wetland 52, G-1, G-2, G-3, G-4, G-5, G-6, and G8) provide limited wildlife habitat to foraging waterfowl and songbirds.

Most wetlands affected by SASA are slope and depression wetlands that are seasonally saturated. They likely provide biofiltration to stormwater runoff and limited stormwater detention functions. They provide baseflow support to Des Moines Creek during the winter months, but are dry during the late summer months when low flows occur. An exception to this is Wetland 52 where groundwater discharges throughout the summer. This wetland provides baseflow support to the creek during low flow periods. Project impacts to the wetland are limited to a bridge crossing, and the groundwater discharge functions will not be impacted.

2. Temporary Construction Impacts

The re-evaluation of temporary (construction) impacts to wetlands are reported in this section. Specific construction activities that temporarily affect wetlands are summarized in **Table 4-4** by the wetland affected and the nature of the impact.

Runway Safety Area Extension - Wetlands 3, 4, and 5 are located near the north end of the existing runways where required runway safety area extensions will be constructed. Temporary disturbance to small portions of these wetlands (about 0.25 acres) could result from placement of silt fences and required temporary erosion and sediment control (TESC) actions. Minor siltation could occur within the 0.25-acre disturbance area during construction.[2]

During the relocation of S. 154th St., temporary disturbance to wildlife is likely to occur in Wetlands 3, 4, and 5. Wildlife in these wetlands, are tolerant of aircraft noise from existing runways and roadway noise from SR-518 and the existing S. 154th St. Additional disturbance to wildlife is likely to be minor, and limited to the south edges of the wetlands.

2 TESC BMPs are implemented prior to construction of all Master Plan projects and their effectiveness is strictly monitored. The adequacy of these BMPs is monitored under the reviewed and approved provisions of site-specific monitoring plans as are described in this report. During 1998-1999 embankment construction, no water quality violations (including sediment discharge to wetlands) occurred.

Table 4-4. Summary of temporary impacts to wetlands from the STIA Master Plan Update improvements.

Wetlands	Temporary Impacts
Runway Safety Area Extension	
Wetlands 3, 6, 7, and 10	Wildlife could possibly be disturbed by construction noise near Wetlands 3, 6, 7, and 10; however wildlife is already tolerant of air traffic and roadway (SR 518 and S 154th St.) noise.
Wetlands 4 and 5	Temporary disturbance is possible to small portions of wetland along southern border of Wetlands 4 and 5 adjacent to retaining wall. Siltation could cause impacts along southern wetland boundaries. Construction activity and noise could cause disturbance to wildlife.
Third Runway	
Wetlands 9 and 11	A small portion of Wetland 9 and the remaining portion of Wetland 11 could be disturbed. Siltation could cause impacts within the southern portion of Wetland 9 and the remaining portion of Wetland 11. Wildlife could be disturbed by construction activity and noise.
Wetlands R1, R2, R3, R4, R5, R6, R7, R8, R9, and R10	Construction impacts will be minimized because of a 50-foot setback from Miller Creek. Disturbance will be in limited areas including the S 156th St. bridge crossing area (Wetlands R1 and R2) and the stormwater outfall location (adjacent to Wetland R6). Siltation could cause impacts at the bridge crossing area (Wetlands R1 and R2). There could be disturbance to wildlife from construction activity and noise, especially in the bridge crossing area (Wetlands R1 and R2) and stormwater outfall location (adjacent to Wetland R6).
Wetlands A5, A9, A10, A11, A12, and A13	Temporary disturbance is possible to small portions of Wetland A12 outside the footprint of fill slope and Perimeter Road. Siltation is possible within portions of Wetlands A5, A6, A8, and A12 that are immediately adjacent to the footprint of fill slope and Perimeter Road. Construction activity and noise could cause disturbance to wildlife.
Wetlands 18 and 37	Disturbance (0.17 acres) is possible from the construction of temporary construction stormwater management facilities (e.g., detention pond) in Wetland 37. (Note: Permanent stormwater management facilities will be located outside of wetland areas.) A narrow band of temporary disturbance (0.38 acres) is immediately adjacent to the fill pad footprint and roadbed for the Perimeter Road (outside of temporary stormwater facility areas). This disturbance will come within 30 ft of Miller Creek in Wetland 37. There may be limited areas of siltation within Wetlands 18 and 37. Construction activity and noise could cause disturbance to wildlife. Temporary disturbance is possible to wetland drainage patterns/hydrology in Wetland 37 due to the construction of the temporary stormwater management facilities.

Wetlands	Temporary Impacts
Wetland 44a	Temporary disturbance of a limited area immediately adjacent to the fill pad footprint and the roadbed for the Perimeter Road is possible. Limited areas of siltation are possible immediately bordering the fill pad footprint. Construction activity and noise could cause disturbance to wildlife.
Staging Areas	No temporary impacts are expected. All staging areas will be a minimum of 50 ft from Miller Creek and placed outside of wetland areas. In wetlands bordering intended staging areas, wildlife may be disturbed by activity and noise during construction of each staging location.
Borrow Area 1	
Wetlands B1 and 32	Excavation will avoid Wetlands B1 and 32; all other wetlands will be permanently impacted by excavation or dewatering. Interruption in hydrology for Wetlands B1 and 32 is not anticipated; buffers will maintain seasonal perched water regime. Wildlife will be disturbed by excavation activities and noise.
Borrow Area 3	
Wetlands 29, 30, B5, B6, B7, B9, and B10	All wetlands are being avoided and 50-foot setback maintained. Wetland hydrology will be maintained by preserving conditions in watershed basin upgradient and immediately surrounding each wetland; no alteration to site hydrology will occur. Wildlife will be disturbed by excavation activity and noise.
South Aviation Support Area	
Wetland 52	Disturbance of wildlife from construction activity and noise. Potential minor sedimentation or water quality impacts.
Mitigation Area	
Farmed wetlands and Wetland A1 in Vacca Farm; emergent wetlands on the Auburn site.	Wetlands will be excavated, graded, and replanted with native vegetation. Temporary disturbance of wildlife due to human activity and construction noise. Temporary sedimentation and water quality impacts.

Third Runway: Wetlands 9 and 11 lie at the northern end of the Third Runway. During the relocation of South 154th St. for the runway safety area, small portions (0.03 acres) of Wetland 9 and the remaining portion (0.16 acres) of Wetland 11 will be disturbed by construction activity. Minor siltation within these wetlands during construction could occur. Wildlife will likely be eliminated from remaining portions of Wetland 11 during construction and be disturbed near the south edge of Wetlands 9 by construction activity and noise.

Temporary disturbance will occur in portions of Wetlands 18 (0.36 acres), 37 (0.71 acres), and 44 (0.30 acres)[3], located outside the footprint of the fillslope and the perimeter road. Minor siltation could occur in limited portions of these wetlands as a result of installing silt fences and up-slope construction. Physical disturbance to Wetlands A9, A10, A11, and A13

3 This area of 0.30 acre has been rounded up and differs from 0.29 acre reported in the reevaluation document.

is not proposed however temporary disturbance to wildlife could result from construction activity and noise.

Temporary impacts to Wetland 37, Wetland 18, and Wetland 44 include disturbance from the construction of temporary stormwater management facilities, including detention ponds, during the construction phase of the Third Runway. These stormwater facilities will be removed and the wetland area restored after the completion of the Third Runway. Permanent stormwater facilities will be located outside of wetland areas.

Disturbance to riparian wetland will occur in three limited areas: at the proposed S 156th St. bridge crossing (affecting the southern edge of Wetland R1 and the northern edge of Wetland R2, and a stormwater outfall that will lie adjacent to Wetland R6. Minor siltation could occur in the temporarily disturbed portions of Wetlands R1 and R2. Disturbance to wildlife from construction activity and noise could occur in all riparian wetlands, but is most likely in Wetlands R1, R2, and R6 because in these areas construction will be near the wetland edge.

Construction Staging Areas - Construction impacts to wetlands in the staging areas are not expected because all staging activity will be placed outside of any wetland areas and a minimum of 50 feet from Miller Creek. In wetlands bordering intended staging areas, wildlife will likely be disturbed by traffic activity and noise

Borrow Areas - Within Borrow Area 1, Wetlands B-1, B-4, and 32 will be avoided and protected with a minimum 50-foot buffer. Indirect impact to wildlife using these Category III wetlands may occur once the Third Runway is in operation. Other wetlands in Borrow Area 1 will be permanently affected by excavation. Borrow Area 3 has been redefined to protect all wetlands with a 50-foot buffer. Temporary impacts to wildlife using Category II (Wetlands 29, 30) and Category III (B-5, B-6, B-7, B-9, B-10) could result from construction noise and other human activity. Since the borrow areas will be greater than 200 feet from Des Moines Creek, no impacts to the creek are anticipated.

South Aviation Support Area - Wetland 52, a Category III wetland adjacent to the SASA, would be temporarily affected by construction. Impacts to this wetland would include temporary disturbance to wildlife due to construction noise and other human activities. Construction impacts to the wetland also could include minor sedimentation or soil disturbance resulting from construction of the taxiway bridge connecting SASA to the airfield.

Mitigation Impacts - Several wetlands would be temporarily affected during construction of on- and off-site wetland mitigation. In general, these impacts occur to Category III or Category IV wetlands that are farmed, or dominated by non-native vegetation, and would not displace significant numbers or types of wildlife. Wetland A-1 (a Category II riparian wetland would be temporarily disturbed by construction associated with the relocation of Miller Creek. Following implementation of the mitigation projects, wetland areas will be restored to higher quality Category II wetlands by improved hydrologic conditions and greater diversity of plant types.

3. Indirect Impacts

Indirect impacts include potential long-term effects of construction and operation of the Master Plan Update projects near wetlands. These include potential alteration of wetland hydrology and ongoing disturbance of wildlife by aircraft noise and human disturbance.

Runway Safety Area Extension -Eight wetlands (Wetlands 3, 4, 5, 6, 7, and 10) are near the north end of the existing runways. The relocation of S 154th St. to accommodate the RSAs will decrease the amount of wetland buffer. Increased traffic noise may disturb wildlife using these wetlands. This impact is not expected to be significant because wildlife species in these wetlands already are tolerant of high levels of noise from aircraft and automobile traffic on SR 518.

Other operational impacts could occur from changes to wetland hydrology as a result of construction near the wetlands. The retaining wall used to minimize wetland fill and creek relocation will include an internal drainage system that will allow ground water to continue to enter the wetland. Stormwater runoff (water quality and quantity) conditions will be improved because the new roadway will include detention and water quality treatment.

Third Runway: Wetlands near the north end of the Third Runway will be subjected to greater amounts of aircraft noise, which may cause increased disturbance of wildlife. The relocation of S 154th St will decrease the amount of wetland buffer, which could result in increased disturbance of wildlife using these wetlands because of greater traffic noise. This impact is not expected to be significant because wildlife species in these wetlands are tolerant of high levels of noise from aircraft and automobile traffic on SR 518. This potential impact would be offset by elimination of humans and pets from the overall area, which will improve the habitat value of the wetlands. The sparse vehicular traffic on the safety and perimeter roads will not adversely affect wildlife.

Operational impacts could occur from changes to wetland hydrology as a result of construction near the wetlands. Retaining walls will allow ground water to continue to enter the wetlands. Stormwater runoff (water quality and quantity) conditions will be improved because the new facilities will include detention and water quality treatment.

Long-term indirect impacts to several isolated Category III wetlands and three Category II wetlands could result from changes to the amount and timing of water entering the wetlands. The potential impacts to the hydrology of these wetlands will be minimized using several approaches that will maintain ground water flow to the wetlands, provide surface water flow to the wetlands, and allow flexibility in the amount of water directed to the wetlands. These measures are expected to provide ground and surface water necessary to maintain the wetlands.

Potential impacts to water quality in the wetlands would not occur. Any stormwater entering the wetlands will be treated using water quantity and water quality best management practices (BMPs). Since the existing area lacks water quality and quantity treatment BMPs, a net improvement may occur.

Wetlands occur on hillslopes immediately west of the existing fill that continue to be wet following the expansion of the airfield during the early 1970s. The wetlands (Wetlands 19 and 20) contain no field evidence that wetland size has been reduced since the 1970 airport expansion. For example, no relic hydric soils were observed and no remnant facultative-wetland or facultative plant communities dominate the area outside the existing wetland boundaries as would be expected if hydrologic conditions had been recently altered. This indicates that these wetlands have remained stable even with the excavation and fill activities immediately to the east.

Ten small wetlands (Wetlands R1, R2, R3, R4, R5, R6, R7, R8, R9, and R10) lie immediately adjacent to Miller Creek along the western periphery of the Third Runway expansion area. Negative impacts to the riparian wetlands will not occur because the wetlands will be protected with 50-foot minimum buffers. Most of these areas currently lack buffers. Moreover, runoff from all new facilities must include management for stormwater quality and quantity. Under current development, runoff is untreated. Impacts from humans and pets will be eliminated from the overall area, which will improve the habitat value of the area. The sparse vehicular traffic on the safety and perimeter roads will not adversely affect wildlife since it will be over 50-feet from the wetlands. No increased level of disturbance to wildlife is expected in Wetlands R1 and R2 at the new 154th St. bridge crossing since this new bridge will simply replace an existing bridge.

Staging Areas - Long-term impacts from construction staging would not occur since these are temporary land-uses that would be removed following project construction.

Borrow Areas - Two wetlands in Borrow Area 1 (Wetlands B-1 and 32) will be avoided. All remaining wetlands will be permanently impacted by excavation or dewatering (Wetland B-4). Setbacks will maintain the current seasonal perched water regime for Wetlands B-1 and 32. No long-term impacts are expected.

All wetlands in Borrow Area 3 will be avoided, and a 50-foot setback will be maintained. Wetland hydrology will be maintained by preserving conditions in the watershed basin upgradient and immediately surrounding each wetland. Groundwater analyses indicate that groundwater movement is from northwest to southeast. The areas west and northwest of the wetlands will remain undisturbed.

South Aviation Support Area (SASA) - The SASA will be designed to avoid significant impacts to Wetland 52 by avoiding the wetland and providing a 75-foot buffer. This wetland will be subjected to greater amounts of aircraft noise, which may increase disturbance of wildlife. This impact is not expected to be significant because wildlife species in these wetlands are tolerant of noise from aircraft.

Operational impacts to the wetlands could occur from changes to wetland hydrology as a result of construction near the wetlands. Stormwater runoff (water quality and quantity) conditions will be improved because the SASA facility would be built with water quantity and quality treatment BMPs that would replace golf course and parking areas that lack stormwater management facilities.

4. Cumulative Impacts

Additional impacts to wetlands could occur as a result of other projects planned in the vicinity of the Airport. These projects include Washington Department of Transportation's proposed SR-509/South Access Freeway, the Des Moines Creek Regional Detention Facility, the LINK light rail project, and potential redevelopment of Borrow Areas.

Each of these projects may have direct or indirect impacts to wetlands near the airport and result in some unknown cumulative loss of wetland area and functions. SEPA, NEPA, and § 404 review for these projects are required to evaluate options that avoid and minimize impacts to wetlands and the aquatic environment. Under § 404, mitigation must be provided for unavoidable impacts to wetlands.

5. Impact Avoidance and Minimization

To the extent feasible and practical, the development projects have been designed and redesigned to avoid and minimize impacts to wetlands. Over 170 acres of wetlands are known to exist near the Airport, and it is likely that un-inventoried wetlands exist on private property that will not be affected by the project. Un-inventoried wetlands are likely to include numerous small wetlands in developed and partially developed residential areas. These wetlands are likely to be similar in character and function to many of the smaller wetlands occurring within the acquisition area.

While a number of small wetlands would be affected or eliminated by the Master Plan improvements, several large wetland complexes would not be affected by the improvements. These wetlands contain physical and biological features that indicate a variety of wetland functions at high to moderate levels. A 30-acre wetland (Wetland 43) occurs between Des Moines Way and SR 509 immediately north of S 176 St. This wetland contains a diversity of vegetation types, including forested, shrub, emergent, and open water wetlands. Walker Creek flows through the wetland. The diversity of plant types, the presence of permanent open water, and hydrologic connections to Walker Creek indicate the wetland provides moderate to high biological functions for a variety of wildlife groups (resident fish, passerine birds, small mammals, amphibians, and waterfowl). Its location near the headwaters, the presence of adjacent developments, and topographic conditions in the depression the wetland occupies suggest it also provides substantial physical functions, including baseflow support, surface runoff storage, sediment trapping, and water quality benefits.

A 17-acre wetland (Wetland 33) occurs south of Sunset Park and includes Tub Lake. This wetland contains forested, shrub, emergent, and open water wetland classes, and Miller Creek flows through the wetland. The diversity of wetland classes, the presence of permanent open water connections to other undeveloped land, and hydrologic connections to stream habitat result in moderate to high biological function for a variety of wildlife groups (resident fish, passerine birds, small mammals, amphibians, and waterfowl). The location near the headwaters of Miller Creek, presence of upslope development, and topography of the basin indicate the wetland provides major physical functions, including baseflow support, surface runoff storage, sediment trapping, and water quality benefits.

Bow Lake is a 25-acre wetland (Wetland 54) located east of SR 99 and north of S 188th St. This wetland contains open water and shrub vegetation classes, and forms the headwaters of the East Branch of Des Moines Creek. The biological functions of the wetland are limited by the proximity of adjacent commercial and residential development. However, the wetland probably provides moderate biological function for passerine birds, small mammals, waterfowl, and amphibians. Likely physical functions provided by the wetland include groundwater recharge, storage of runoff, and water quality improvement.

Wetland 28 is adjacent to the Tyee Golf Course and is about 35 acres. The wetland is composed of open water, emergent, and shrub wetland habitat. A tributary of Des Moines Creek flows through the wetland. The presence of open water, habitat diversity, and hydrologic connections to stream habitat result in moderate to high function for a variety of wildlife groups (resident fish, passerine birds, small mammals, amphibians, and waterfowl). The wetland is a headwater of the West Branch of Des Moines Creek, is downslope of developed areas, and is in a favorable topographic setting to provide physical functions, including baseflow support, surface runoff storage, sediment trapping, and water quality benefits.

A series of wetlands (Wetlands 3, 4, 5,* 6, 7, 8, and 9) totaling about 25 acres comprise the Miller Creek Detention Facility. The wetlands consist of open water, emergent, shrub, and forested wetlands that are hydrologically connected to Miller Creek. The diversity of wetland classes, permanent open water, and hydrologic connections to stream habitat indicate the wetland provides moderate to high biological function to a variety of wildlife groups (resident fish, passerine birds, small mammals, amphibians, and waterfowl). The location near the headwaters, presence of adjacent developments, and topographic conditions suggest the wetland also provides physical functions such as baseflow support, surface runoff storage, sediment trapping.

* Minor fill impacts (0.14 acres) occur in this wetland. Because this fill will be located above the floodplain, near disturbed areas, and along the perimeter of the wetland, significant impact to the functions of this wetland is not expected.

Chapter V

HYDROLOGY AND SEISMIC STABILITY

Upon gaining access to the properties on which the embankment will be developed, the Port was able to conduct additional geotechnical explorations. These studies have clarified a number of issues that were raised in the public comments. The following subsections address the impact of the development of the embankment and associated retaining walls on area hydrology and slope stability, including:

- Mechanically Stabilized Earth
- Fill Zones and stability
- Impact on Hydrology
- Mitigation of Post-Construction Hydrogeology

1. Mechanically Stabilized Earth

During the past two years, Port staff and consultants have completed geotechnical, hydrologic and wetland studies, to identify alternatives and verify that proven mechanically stabilized earth (MSE) technology can provide safe and relatively cost-effective construction of retaining walls for soil conditions at the site. A large number of embankment slope and retaining wall alternatives were considered to avoid or reduce impacts to Miller Creek and adjacent wetlands. MSE retaining walls were selected as the recommended alternative to be developed, as follows:

- At the north end of the embankment, MSE walls will be used to limit the impact to Miller Creek and the extent of filling of Wetlands A-1 and 9.
- Near the middle of the west side of the embankment, an MSE wall will be used to avoid filling a significant part of Wetland 37a, and to avoid relocating part of Miller Creek.
- Near the south end of the new runway, an MSE wall will be built to limit the extent of filling of Wetland 44a.

MSE is a method of constructing earth embankments using a combination of compacted soil and reinforcing elements. MSE technology includes a range of steel and polymer (plastic) products (mesh, strips, and grids) used to retain and reinforce soil, and provides a number of advantages over other types of retaining walls. The MSE technology improves soil strength by incorporating reinforcing strips or sheets (geogrids or geotextiles) into the soil embankment.

2. Fill Zones and Stability

Native soils, which will provide a suitable foundation to support the embankment, have been observed at depths ranging from zero to around 20 feet below the existing ground surface across the site. Available information generally indicates very little subgrade preparation will be needed on most of the site. Wetland soils and other unstable soils in some specific areas will have to be improved or replaced to support the fill and MSE walls.

Existing subgrade soils which are unsuitable to provide structural support for the embankment (because they are soft, wet, or contain organic materials), will be removed and replaced with compacted structural fill, or improved in situ. The unsuitable subgrade material that is removed will be reused where possible in non-structural areas of the embankment, to minimize export and disposal of waste soils.

The Third Runway embankment will be designed as a zoned embankment, with different types of soil and/or degrees of compaction used in specific areas to meet strength, compressibility and drainage requirements. These zones include:

- **Pavement Subgrade.** High-strength, low-compressibility granular soil used in the upper few feet immediately below airfield pavements.
- **Drainage Material.** Free-draining fill used in the underdrain and in areas of overexcavation to improve foundation support.
- **Pavement Support Fill.** Low-compressibility embankment fill used below the pavement subgrade zone.
- **MSE Reinforced Backfill.** High strength granular soil used in the reinforced zone behind retaining walls.
- **Common Embankment Fill.** Moderate strength compacted fill.
- **Non-structural Fill.** Soil removed from foundation areas because it is unsuitable for foundation support.

Construction of a zoned embankment in this manner provides significant environmental benefits, including:

- Seasonal accommodation of high quality, low fine content material in wet weather will reduce erosion and sediment control problems;
- Regional conservation of high quality gravel resources by use of relatively silty soils as "fair weather fill" for common embankment construction during dry weather months; and
- Ability to construct an embankment underdrain which collects infiltration and seepage, for controlled discharge to promote infiltration, and preserve groundwater recharge to downgradient wetlands and Miller Creek.

In light of new retaining wall concepts, and further information about the soil stability in the area, the Port conducted "proof of concept analyses" of embankment slope stability, as well as representative MSE wall sections in, or adjacent to, wetlands for both the north and west areas. These analyses were conducted to re-verify suitability of the embankment slopes and retaining walls, and to assess base preparation required to avoid instability.

The analyses confirmed that the safety target factors could be attained for the Wetland 37 wall and, with proper soil replacement or *in situ* improvement, safety target factors could be attained for the wall slope combinations analyzed for the north end of the embankment (in the area where Miller Creek will be relocated).

3. Impact on Hydrology

Post-construction effects of the embankment on the Miller Creek drainage were analyzed. These effects include the extent to which infiltration into the new embankment and from the existing airfield will recharge groundwater. While the relative amount of runoff will increase in new paved areas and embankment slopes, infiltration is anticipated to increase on about 80 acres of relatively flat grassland between the runway and taxiway pavements.

In the area affected by construction, specific groundwater recharge contributions to Miller Creek will include:

- Infiltration into the top surface of the new embankment;
- Infiltration into the side slopes of the new embankment and management of runoff from the side slopes;
- Maintenance of existing shallow interflow below the embankment; and
- Flow from the Shallow Regional Aquifer into Miller Creek.

Infiltration into the unpaved portion of the top surface of the new embankment will exceed existing on-site infiltration in the same area for the following reasons:

- Large area (about 80 acres) of relatively flat grass land between runway and taxiway pavements will permit greater infiltration compared to pre-construction sloping ground in the same areas;
- Post-construction grass area between pavements will have less evapo-transpiration (ET) compared to scrub forest on the pre-construction slopes; and
- Soil conditions within the embankment will promote infiltration in some areas and have better average groundwater transmission characteristics compared with the underlying native soils (glacial till, glacially overridden silty advance sand, and hard silt units).

The depth of the embankment (ranging from essentially zero on portions of the western edge to a maximum height of about 165 feet) provides significant buffering of storm water infiltration, increasing the available groundwater recharge and short-term storage before seepage reaches Miller Creek.

Seasonal infiltration into the embankment soil mass will occur until the soil reaches a condition referred to by soil scientists as "field capacity." Additional infiltration will then percolate downward into the embankment. This percolating water will eventually intercept the embankment underdrain at the base of the fill, and most of this seepage will then flow to the west. About 10 percent of the total infiltration is expected to continue to percolate downward to recharge the Shallow Regional Aquifer directly below the embankment.

Infiltration into the new embankment side slopes (nominal 2 horizontal to 1 vertical) is anticipated to be slightly less than existing infiltration over the "foot print" area of the side slopes (38% of rainfall, down from 50% for pre-construction infiltration). The reduction is mainly the result of the increased slope causing increased runoff which is mitigated somewhat by improved infiltration capacity of the embankment fill relative to the existing glacially overridden soils, and reduced evapotranspiration.

Infiltration into the new embankment side slopes will percolate downward until it is also intercepted by the underdrain discussed above. This seepage will be increased slightly by additional infiltration along storm water swales that collect runoff from the embankment slopes.

In addition to intercepting seepage infiltration downward from the top of the embankment, the embankment underdrain also provides a means for existing seepage in the filled area to continue to flow downgradient to the west. The existing ground surface below the embankment will largely be left undisturbed prior to fill placement, as discussed later in this report. Shallow interflow seeps, expressed where silty soil perching layers outcrop on the slope, will be able to continue to discharge into the underdrain, or will continue to flow downslope below the underdrain.

Where soft soils need to be removed to provide embankment foundation support, these areas will be backfilled with free-draining sand and gravel hydraulically connected to the underdrain. In this way existing seepage into wetlands which are filled will continue to be available as seepage through the underdrain downgradient to the west.

The drain layer enables beneficial discharge of water that infiltrates into the embankment from above or below. The completed underdrain will be separated from the surface of the airfield by the full thickness of the embankment. In the event of a contaminant release (such as an airfield fuel spill), there would be substantial opportunity to accomplish source control and remediation because of the long flow path before any contaminants could reach Miller Creek.

A geotechnical analysis was used to assess whether the weight of the embankment would significantly reduce the amount of existing base flow from the Shallow Regional Aquifer to Miller Creek. Experience with earth dams shows seepage under an embankment is typically not reduced by the weight of the fill, and grout curtains or sheet pile cutoffs are typically constructed where control of seepage is necessary below embankments. None the less, the effect of the embankment on seepage below the new fill was calculated.

These calculations indicate that the void ratio within the Shallow, Intermediate, and Deep Aquifers in the area immediately underlying and adjacent to the embankment would be reduced by roughly 1 to 3 percent due to the maximum weight of the embankment. For perspective, this corresponds to about a 4-inch maximum change in thickness for the 50-foot-thick Shallow Aquifer. The magnitude of the change in void ratio would diminish rapidly both laterally and as a function of depth. There would be no effect in the Shallow Aquifer more than 50 feet from the edge of the embankment, and no effect in the Deep Aquifer more than about 500 feet from the edge of the embankment.

Reductions in permeability on the order of 2 to 5 percent corresponding to the change in void ratio are estimated immediately below the embankment, with the effects decreasing with depth.

The estimated 2 to 5 percent change is insignificant, given that differences in permeability are usually evaluated in terms of orders of magnitude (powers of 10).

Effects of the magnitude estimated could conceivably produce a slight groundwater mounding in the Shallow Regional Aquifer on the upgradient side of the embankment (i.e., below the existing airport), but this would probably not be measurable. Baseflow to Miller Creek located west of the embankment is not likely to be affected, since the effect of the mounding would be to locally increase the groundwater flow gradient resulting in no net loss of baseflow.

No impacts are anticipated to drinking water resources in the Intermediate and Deep Aquifers. The effect of the embankment weight diminishes with increasing depth and distance from the fill. There are no wells within the affected area.

4. **Mitigation of Post-Construction Hydrogeologic Impacts**

The following actions will be undertaken to minimize hydrogeologic impacts upon completion of construction:

Management of Storm Water Runoff - Storm water runoff from the embankment will be collected and handled as described in the following documents (which may be updated during the permitting process for the Master Plan Update Development Actions): (a) Natural Resource Mitigation Plan, Seattle-Tacoma International Airport Master Plan Update Improvements, prepared by Parametrix, dated August 1999; and (b) Comprehensive Stormwater Management Plan, Seattle-Tacoma International Airport Master Plan Improvements, by Parametrix, dated November 1999. Both of these documents are hereby incorporated by reference. Copies of these and other documents incorporated by reference, and their updates if any, are publicly available during regular business hours at the office of the Port of Seattle, Aviation/Project Management Group, Suite 301, Kilroy Building, 17900 International Blvd., SeaTac, Washington 98188. Storm water runoff from the sloping face of the embankment will be collected in a permanent swale alongside the security road and conducted to detention facilities below the toe of the slope. The swales provide some opportunity for infiltration. These swales will be rock-lined or otherwise protected against erosion along the toe of MSE walls. Infiltration in this area will recharge the Shallow Regional Aquifer and enhance groundwater discharge into wetlands and Miller Creek.

Discharge of Seepage from the Embankment Underdrain - Most seepage collected from the embankment via the underdrain will discharge into a collection swale at the toe of the slope or below the toe of the MSE wall. The remainder will infiltrate directly into the Shallow Regional Aquifer under the embankment footprint. Seepage into the swale is likely to occur discontinuously along the length of the embankment, with flow concentrating at topographic low spots or in areas where there are pre-existing seeps.

The purpose of the swale is to collect seepage from the underdrain and conduct it laterally along the toe of the embankment for surface discharge to wetlands. Additional infiltration to recharge shallow interflow and the Shallow Regional Aquifer, will occur along the swale. Facilities to enhance infiltration can be constructed at specific locations to augment water supplies for existing wetlands that are left undisturbed beyond the area of impact for the project. Facilities will be designed to infiltrate water from the drainage layer into the shallow subsurface soils that form the delineated wetlands.

Post-Construction Base Flow to Miller Creek and Riparian Wetlands - The embankment underdrain plays a key role in collecting percolating water that has infiltrated into the surface and facing slopes of the embankment. The underdrain intercepts percolation and enables some control of groundwater recharge for the Shallow Regional Aquifer beneath the embankment. Collecting and re-infiltrating seepage from the underdrain as described above, the impact of runway construction on baseflow to Miller Creek will be minimal.

Chapter VI

WETLAND AND AQUATIC RESOURCE MITIGATION PROGRAM

The Port has committed to comprehensive mitigation measures designed not only to fully compensate for adverse impacts to wetland and other aquatic resource functions, but also to positively augment, improve, and enhance the wetland and other aquatic resource functions. This is done by mitigating the acceptable wetland functions and values in the basin, and only mitigating those functions and values outside the basin that can not safely be mitigated in-basin. This section describes and explains all mitigation measures incorporated into the Master Plan Update improvement projects that will avoid, minimize, rectify, or compensate for adverse impacts to wetlands and other aquatic resources. Some of these mitigation measures have been developed and added to the Port's commitments very recently as a result of the new information on the nature, extent, and location of affected wetlands and other aquatic resources. **Table 6-1** summarizes such mitigation actions and their relationship to NEPA, SEPA, and the Clean Water Act. **Table 6-2** summarizes on-site and off-site compensatory mitigation for watershed, wetland, and stream impacts of the proposed Airport improvements.

As a result of the Port's mitigation commitments, including recent additional mitigation commitments in response to new information on affected wetlands and other aquatic resources, all significant adverse impacts to such resources will be mitigated below the level of significance.

It is not possible to mitigate most impacts on the avian habitat function of affected wetlands within the same watershed or basin. Wetland habitat attracts birds and, thus, presents potential aircraft dangers if located within 10,000 feet of active runways. Beyond 10,000 feet from the runways, but within the same watershed, adequate suitable land for the mitigation of adverse impacts on habitat functions is not available. Consequently, adverse impacts on most wetland functions (hydrologic, water quality, fish habitat) will be mitigated within the same watershed ("on-site" or "in-basin"). But most adverse impacts on wetland bird habitat functions must be mitigated outside of the watershed on a 69-acre parcel in the City of Auburn immediately west of the Green River and within 6 miles of the airport.

1. On-Site (In-Basin) Mitigation

In-basin mitigation to compensate for potential impacts to the hydrology and aquatic habitat of Miller and Des Moines creeks will create significant stormwater management facilities, restore riparian buffers, restore segments of the Miller Creek channel and streams, establish a watershed trust fund, and improve base flows. This mitigation plan focuses on potential in-basin stream impacts by improving hydrology, water quality, and aquatic habitat in both creeks.

Most mitigation for wildlife habitat (bird and small mammals) is provided out-of-basin in a large, high-quality wetland system in the City of Auburn. At this location the mitigation complies with

AR 044156

the FAA Advisory Circular regarding wildlife attractants near airports. In-basin mitigation in the Miller Creek and Des Moines Creek basins are summarized in the following Sections and **Tables 6-1 and 6-2**.

Miller Creek Floodplain Buffer Enhancements

A buffer area will be established along the east side of the relocated segment of Miller Creek between the creek and the new 154th Street. The buffer will be a minimum of 50 ft wide and will provide soil stabilization functions and also reduce human intrusion into the riparian zone.

A 25-ft buffer will be established around the west and north perimeter of Lora Lake. This mitigation action is intended to avoid existing impacts from residential uses (e.g., structures, lawn, and lawn chemicals) next to Lora Lake, and to establish woody vegetation around the lake. Existing features, such as houses, outbuildings, driveways, and other structures, will be removed. The 25-ft buffer will be established from the edge of ordinary high water mark (OHWM) landward surrounding the north and west sides of Lora Lake; it will be enhanced with native trees and shrubs to provide approximately 0.60 acre of shoreline buffer. This buffer will reduce waterfowl habitat by eliminating lawn areas used as foraging habitat.

A buffer between the floodplain enhancement area and Des Moines Memorial Drive will be established and enhanced. This area will be planted with native upland vegetation to provide a physical buffer between the road and the enhanced shrub floodplain wetland and relocated creek. The width of this buffer will vary between 20 and 50 ft.

The Miller Creek floodplain area in the vicinity of the Vacca Farm will be restored to a native shrub vegetation community. The restoration will convert the existing farmed area to native shrub wetland community. This conversion will reduce chemical runoff reaching aquatic environments and fish populations in Miller Creek, increase nutrient removal and recycling in the riparian zone, and decrease wildlife attractants within 10,000 feet of the airfield (as required by FAA).

Miller Creek Buffer Enhancement

Downstream of the floodplain enhancement areas, on the west side of Miller Creek a 100-ft buffer will be established along the west side of approximately 6,500 linear ft of Miller Creek (within the acquisition area). The buffer enhancements will improve creek habitat and eliminate yard chemicals, untreated stormwater runoff, and septage from reaching the creek. They will enhance water quality and aquatic habitat.

This buffer enhancement project will protect a total of about 24 acres of riparian habitat along Miller Creek. Buffer averaging will be used on the east side of the creek, where a minimum 50-ft buffer will be established. Where the embankment design allows, buffers will be increased so the average buffer width on the east side of the creek is 100 ft. Stormwater facilities will be included in the calculation of average buffer widths because they will receive infrequent human use and are protective of riparian functions.

The planting approach along the length of the buffer will vary depending upon the existing condition of the buffer, in sections of the buffer that are primarily lawn, areas will be planted with native trees and shrubs. Areas that contain some native and some non-native vegetation, would be enhanced by either inter-planting native species to produce a continuous tree canopy or under-planting native shrubs beneath an existing canopy that lacks understory vegetation. Some areas that contain invasive species (such as Himalayan blackberry and Japanese knotweed) will be cleared, graded, and also planted with native woody vegetation.

In-Stream Habitat Features

In-stream habitat enhancement will occur at four locations within Miller Creek (see Figure 4.1-1). The first will occur south of the Vacca Farm site, enhancement will include removal of rock riprap from portions of Miller Creek, removal of footbridges, and removal of trash. Large woody debris would be placed throughout these sections of the creek and ditch. The associated wetland and upland areas along the creek will be planted with native wetland and upland vegetation species.

Approximately 200 ft north of South 160th Street, the second enhancement project would consist of three primary actions. This would include installing large woody debris in the creek channel, grading a small section of the west bank of the creek to create a gravel bench in the flood plain, and planting the upland area with native trees and shrubs.

South of the South 160th Street culvert, the third enhancement project would consist of grading a section of the west bank to re-establish a floodplain along the creek. Additional enhancement in this location includes removing a rubber tire bulkhead and installing large woody debris in the creek and on its banks. The buffer areas will be planted with native trees and shrubs.

In the southern portion of Miller Creek, east of 8th Avenue S., enhancement will be similar to that described for the South 160th Street project, above, except that grading will occur on both the east and west banks. Footbridges and portions of concrete block walls will be removed.

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, large woody debris will be selectively placed throughout the creek to improve in stream habitat conditions.

Drainage Channel Mitigation

Approximately 1,290 linear feet of drainage channels located west of the airfield will be filled to accommodate the Third Runway embankment. The functions of these channels will be replaced by a drainage channel located between a perimeter road, and the Third Runway embankment. The drainage channels will be revegetated with native grass and low growing shrubs.

Restoration After Temporary Impacts

Approximately 2.71 acres of forested, emergent, and shrub 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 construction of the embankment and several retaining walls designed to minimize permanent impacts to these wetlands.

After construction activities are complete, fill material will be removed, pre-disturbance topography will be recreated, and the wetlands will be planted with native shrub vegetation. All of these areas will be monitored.

Tyee Valley Golf Course Wetland Restoration

To improve water quality and riparian habitat within the Des Moines Creek Basin, approximately 4.5 acres of an existing turf emergent wetland area, located within the existing and active Tyee Valley Golf Course, will be restored to a native shrub vegetation community. The restoration actions will be coordinated with plans to construct a regional detention facility (RDF) on the golf course. Shrub communities planned for the wetland will be tolerant of the planned hydrologic regime of the final RDF design. Planting a native shrub community on the golf course will reduce chemical runoff reaching aquatic environments and fish populations in Des Moines Creek, increase nutrient removal and recycling in the riparian zone, enhance water quality functions, and decrease wildlife attractants within 10,000 feet of the airfield (as required by FAA).

In-Basin 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 current flood peaks in these basins to further mitigate the impacts of airport stormwater discharges.

Stormwater Detention Based on Higher Stormwater Standards

Detention storage provided would exceed that normally required by local regulations, and result in additional mitigation of stormwater impacts from Master Plan Update improvement project areas. To reduce the peak stormwater runoff impacts on Miller and Des Moines creeks, the flow control standards adopted by the Port will comply with the approved Master Plan Update FEIS/FSEIS, the Governors Certificate, the King County Surface Water Design Manual, and SMMPS (Ecology 1992).

At a minimum, stormwater detention from Master Plan Update development projects will be designed to an enhanced Level 1 standard (e.g., control of the 2-, 10-, and 100-year peak flows to pre-developed conditions)[4], as measured at the points of discharge to the streams and at downstream locations on Miller and Des Moines creeks.

The total volume of proposed new stormwater detention storage is 76.6 acre-feet, to be constructed in 8 separate facilities.

Retrofit existing airport areas with stormwater detention

To further reduce stormwater peak flows and flow volumes, and to comply with the redevelopment provisions of Ecology's stormwater manual that requires retrofitting of stormwater detention to existing airport areas, the Port has committed to achieving Level 2-type streamflows in Miller and Des Moines Creeks (e.g., control of flow duration between 50 percent of the 2-year and 50-year events to pre-developed conditions).

On Miller Creek, storage in the existing Miller Creek Regional Detention Facility will be expanded by 16.4 acre-feet. This would achieve the target watershed flow regime for all areas draining to that facility. Stormwater detention facilities that drain to lower Miller Creek, which includes a large portion of the Third Runway, will be designed to King County's Level 2 standard because the Miller Creek Detention Facility cannot achieve the target watershed flow regime in that portion of the stream.

On Des Moines Creek, the proposed Des Moines Regional Detention Facility will retrofit detention storage to mitigate the impacts of past development. The facility also will achieve the target watershed flow regime in Des Moines Creek under full Master Plan Update development, through on-site facilities designed to the enhanced Level 1 standard. In cooperation with King County and the cities of SeaTac and Des Moines, the Port is providing financial assistance and property for the proposed regional facility.

4 All hydrologic analyses are performed using the Hydrologic Simulation Program – FORTRAN (HSPF) model.

Maintain base flows

To lessen the impacts of new impervious surfaces, which reduce groundwater recharge and result in decreased base flow rates, existing water rights along Miller Creek will be acquired to eliminate current surface water diversions from that stream. On Des Moines Creek, a flow augmentation project is planned, to provide supplemental water to the stream during critical low-flow summer months.

Provide infiltration at stormwater detention facilities

Further improvements to base flows can be achieved by infiltrating stormwater at the detention facilities. Because site conditions must be favorable for infiltration to be feasible, the Port will evaluate infiltration during the project design phase. Infiltration will be incorporated into constructed facilities when geologic conditions permit.

Watershed Basin Trust Funds

Watershed trust funds will be established, to enhance aquatic habit in Miller Creek and Des Moines Creek. These trust funds will provide $150,000 for restoration projects in each basin for projects that comply with the FAA Advisory circular regarding wildlife attractants near airports. Examples of projects eligible for trust fund monies will be defined by the Des Moines Creek Basin plan, the Stream Survey Report for Miller Creek, or other projects that meet the key criteria used to evaluate proposals. Requests for monies 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 interlocal agreements.

Water Quality Mitigation

The Master Plan Update improvements are not expected to affect existing water quality because:

1. the quality of runway stormwater has been shown to be comparable to or better than regional urban stormwater, and
2. in contrast to existing land uses, all projects will be served by BMPs in compliance with the Stormwater Management Manual for the Puget Sound (bioswales, filter strips, wet vaults, infiltration).

Since both Miller Creek and Des Moines Creek drain urban watersheds, both are subject to inputs of heavy metals, oils and grease from nearby urban highways, fecal coliforms from failing residential septic systems and adjacent farms, suspended solids and litter carried in urban runoff, and increased levels of phosphorus and nitrogen from fertilization of 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 implementing development 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.

The following actions will be undertaken by the Port to mitigate potential impacts to future water quality impacts.

- Employ source identification and control (sweeping, rooftop coatings, etc.) to reduce sources of particulates and the leaching of pollutants entering surface waters.
- Divert de-icing compounds in snowmelt to the Industrial Wastewater System (IWS).
- Construct erosion and sedimentation controls to reduce the impacts of suspended and settleable solids to the streams.
- Enhance wetlands in both Miller Creek and Des Moines Creek to improve water quality by trapping particulates and assimilating dissolved pollutants.
- Restore and enhance stream channels and buffers in Miller Creek to improve biofiltration of runoff from areas adjacent to the stream.
- Restore and enhance buffers in Miller Creek to provide shade that will reduce stream temperature and increase dissolved oxygen capacity.
- Implement level 2 hydrologic controls (larger stormwater detention volumes) to reduce erosive peak stream flows, thereby reducing sediment supply to downstream reaches.

2. **Off-Site Avian Habitat Mitigation**

Off-site mitigation of impacts to wetland avian habitat function is proposed because FAA regulations prohibit the siting of potential wildlife attractants (including wetland mitigation) within 10,000 ft of active runways. The Port has concluded that potential wetland habitat mitigation sites are not available in either the Des Moines Creek or Miller Creek watersheds. These watersheds are almost totally within the 10,000-foot exclusion area for wildlife habitat mitigation. The areas of the watersheds that are more than 10,000 feet from existing runways are not suitable for mitigation due to their small size, developed nature, forested condition, or the lack of hydrologic conditions necessary to support wetlands.

To mitigate loss of wildlife habitat on site, the Port will construct a 34.56-acre wetland mitigation area on a 67-acre parcel in the city of Auburn. This wetland mitigation area will replace lost wetland functions at a 2:1 ratio by providing a diverse wetland habitat. Approximately 26 acres of forest, 3.4 acres of shrub, 5.2 acres of emergent, and 0.1 acres of open water wetland habitat will be created at the Auburn site. In addition, about 6 acres of emergent wetland will be enhanced by planting native tree and shrub vegetation within the wetland. The wetland will be protected by a minimum of 15 acres of upland buffer.

Table 6-1. Summary of mitigation actions and their relation to NEPA, SEPA, 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-feet of Category II and III wetlands in Borrow Area 3. Avoid wetlands in Borrow Area 1 where practical.
Minimize the impact by limiting the degree or magnitude of the action.	Construct retaining walls at the northwest end of the runway to reduce impacts to Miller Creek and Category II wetlands (Wetlands 8, 9, and A-1) 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 relocation of Miller Creek. 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 200-foot minimum setback from Des Moines Creek to minimize potential impact to the creek 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 a 100-ft average (minimum 50-ft) buffer on the east side of Miller Creek with a 100-ft buffer on the west side of the creek to reduce potential construction and operational impacts to the creek. Provide water quantity and water quality mitigation to protect aquatic habitat in Miller Creek from stormwater impacts during operation.

Mitigation Requirement	Proposed Mitigation Action
Compensate for the impact by replacing, enhancing, or providing substitute resources.	Restore the Vacca Farm wetland/floodplain area, including creating new floodplain, restoring wetland vegetation, and providing protective buffers. Restore and enhance Miller Creek stream habitat in the Vacca Farm area. Enhance Miller Creek and Miller Creek buffers for fish habitat at three locations between S 160th St. and Des Moines Memorial Drive. Restore Miller Creek instream habitat south of the Vacca Farm site to Des Moines Memorial Drive. Restore wetlands on the Tyee Valley Golf Course including restoring wetland vegetation to reduce wildlife hazards and improve water quality. Provide a trust fund to enhance fisheries habitat in Miller Creek and Des Moines Creek. Create replacement wetlands at an off-site location for the loss of wildlife habitat within 10,000 feet of the airport runways.
Monitor the impact and take appropriate corrective actions.	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 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 a relocated S 154th St. 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 a relocated S 154th St. and reduce permanent fill and 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 temporary erosion and sediment control facilities.
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 feet from the airport runways at the Auburn site).

Mitigation Requirement	Proposed Mitigation Action
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.	Redesign the SASA footprint to avoid relocation of Des Moines Creek.
Minimize the impact by limiting the degree or magnitude of the action.	Redesign the SASA to avoid direct impacts to forested wetland (Wetland 52) that provides groundwater discharge functions.
Rectify the impact by restoring the affected environment.	Restore potential temporary impacts to Des Moines Creek and non-forested areas of Wetland 52.
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.
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 feet from the airport runways at the Auburn site). 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 sites 1 and 3 to avoid excavation of nine wetlands (Wetlands B1, B4, B5, B6, B7, B9, B10, 29, and 30).
Minimize the impact by limiting the degree or magnitude of the action.	Establish a minimum 100-ft buffer between Borrow site 1 and Des Moines creek to minimize impacts to creek hydrology. Follow a TESCP to eliminate siltation reaching wetlands or Des Moines Creek from excavation activities.

Mitigation Requirement	Proposed Mitigation Action
Reduce the impact over time by preservation and maintenance actions during the life of the action	Maintain Best Management Practices (BMPs) throughout the operating period to ensure adjacent wetlands will be protected from adverse construction related activities.
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 Des Moines Creek basin.
	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, 29, and 30 for potential indirect impacts to wetland hydrology from excavation activities.
	Monitor stormwater runoff and TESC for compliance with NPDES requirements.

NEPA = National Environmental Policy Act

SEPA = State Environmental Policy Act

Table 6-2. **Summary of on- and off-site compensatory mitigation for watershed, wetland, and stream impacts at STIA.**

Description of Impact	Mitigation Action	Explanation/Comment
On-Site Mitigation[a]		
Permanent Impacts		
Fill approximately 980 linear ft of Miller Creek channel to accommodate third runway embankment.	Relocate approximately 1,080 ft of Miller Creek channel.	Channel relocation will enhance aquatic habitat by providing stream buffers, instream habitat features, and increase channel length by approximately 100 ft.
		Establish a buffer around the channel relocation project with native trees and shrubs. (This buffer extends into the floodplain area.)
Fill drainage channels to accommodate third runway embankment.	Create new drainage channel and establish protective buffers.	Create approximately 1,290 ft of new drainage channel(s) with associated buffer habitat.
Fill approximately 8,500 cy of Miller Creek floodplain to accommodate third runway embankment and S 154[th] St. relocation.	Replace lost floodplain.	Excavate approximately 9,600 cy to achieve storage of 5.94 acre-ft from the Vacca Farm site, providing an excess of 0.7 acre-ft of floodwater storage.
Impact approximately 18.33[b] acres of wetland during construction of the third runway embankment and other construction related projects.	Restore Vacca Farm to historic floodplain shrub wetland.	Approximately 11 acres of prior converted wetland and farmed wetland will be planted with native trees, shrubs, and emergent species. Restoration of the area will stabilize soils, improve water quality, and enhance Miller Creek habitat. It will reduce wildlife habitat attractants and conform to FAA mandates regarding wildlife attractants for airport safety.
	Establish 50-ft buffer between the floodplain enhancement area and Des Moines Memorial Drive.	The buffer will be established and enhanced by planting native upland trees and shrubs to provide approximately 1.89 acres of upland buffer.
	Restore wetlands on the Tyee Valley Golf Course.	Plant approximately 4.5 acres of historic peat wetlands on the Tyee Valley Golf Course with native shrub communities. This enhancement will be coordinated with Des Moines Creek Basin Committee planned RDF. The enhancement and RDF will improve hydrologic functions of the watershed, reduce wildlife attractants near the airfield, and restore a peat wetland.
Temporary Impacts[a]		
Construct temporary stormwater management ponds and other construction impacts, which may impact up to 2.17 acres of wetland.	Restore wetland areas after construction is complete.	Wetlands that will be temporarily filled or disturbed will be restored. Restoration will include establishing pre-disturbance topography and planting with native shrub vegetation.

Description of Impact	Mitigation Action	Explanation/Comment
Indirect and Cumulative Impacts [a]		
Filled wetlands near Miller Creek that reduce aquatic habitat value of the creek.	Establish and enhance buffers along Miller Creek corridor between S 156th St. and Des Moines Memorial Drive.	Establish a 100-ft buffer on the west side of Miller Creek and a 100 ft average (50-ft minimum) buffer on the east side of the creek. These buffers will provide approximately 24 acres of riparian buffer habitat.
	Establish a 25-ft buffer around Lora Lake.	Approximately 0.60 acre of buffer around Lora Lake will be converted from lawn to native shrub vegetation.
Additional development in the watersheds could result in additional cumulative impacts.	Participate in developing and implementing Miller Creek and Des Moines Creek basin plans.	These planning processes will identify effective, long-term solutions to restore additional fish habitat to Miller and Des Moines creeks. The Port will contribute both staffing resources and funds, and work with other cooperating jurisdictions to plan and implement appropriate watershed restoration projects.
The runway fill may eliminate water sources that contribute to remaining wetlands down slope of the runway.	Design internal drainage and conveyance channels.	Subsurface and surface conveyance channels will continue to collect and distribute groundwater currently surfacing near 12th Ave. S to Miller Creek and associated wetlands.
	Monitor wetlands adjacent to the third runway embankment.	Wetlands subject to potential indirect impacts will be monitored to determine if unmitigated indirect impacts have occurred. If significant new wetland impacts are verified, corrective actions will be implemented.
Off-Site Mitigation		
Permanent Impacts		
Loss of approximately 18.33 acres [b] of wetland wildlife (avian) habitat	Replace avian habitat function off-site at an overall ratio of 2:1	Due to conflicts with avian habitat and aviation safety concerns, new wetlands habitat will be created in Auburn, Washington. This wetland creation will increase overall avian and other wildlife use and diversity in an area that will not compromise aviation safety.

[a] 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 of Seattle's Wildlife Hazard Management Plan for the management of wildlife and wildlife attractant areas.

[b] These values represent an increase of 0.05 acre of impacts to Wetland 53 made subsequent to completing the impact assessment and natural resource mitigation plan. The change is reflected in the ACOE public Notice for the project.

Chapter VII

TEMPORARY HIGHWAY INTERCHANGES

The Final Supplemental EIS for the Master Plan Update improvements at Seattle-Tacoma International Airport evaluated the construction and use of temporary construction-only interchanges proposed for the purpose of mitigating traffic-related impacts from hauling fill to construct the Third Runway and Runway Safety Areas. Since the publication of the Final Supplemental EIS in May 1997, the Port has further refined the design for a temporary construction-only interchange facility and conducted additional coordination with the Washington State Department of Transportation. The purpose of this section is to present the evaluation of noise and vibration that was conducted based on the design and alignment. Based on that analysis, this mitigation item has been refined slightly to include:

- A noise attenuation wall along the southbound off-ramp at SR 509 to ensure that truck traffic does not create a significant noise effect on adjacent properties;
- Offer to acquire the residence closest to the southbound off-ramp (Home 1) at South 176th Street due to the potential for significant vibration effects if the off-ramp pavement becomes worn.
- Insulation of homes where the sound generated by the construction activity using the temporary interchange would increase noise to sound levels above 67 DNL (the WSDOT land use criteria). It is anticipated that the number of homes to be insulated would depend on use of the interchange at night but would number less than a half dozen homes along South 176th Street west of the interchange.

This section summarizes the construction mitigation actions included in the Final Supplemental EIS as well as the noise and vibration analysis conducted based on this design.

I. Background

The Final Supplemental EIS (FSEIS) for the Master Plan Update improvements at Seattle-Tacoma International Airport evaluated the construction and use of temporary interchanges proposed for the purpose of mitigating traffic related impacts hauling fill for the Third Runway and Runway Safety Areas. As was noted, construction of these projects will require the import of fill material from one or more off-airport sites. Assuming a five-year construction period, the FSEIS assessed the impact of transporting the fill material that could require up to 1,600 one-way haul trips per day.[5] To facilitate the delivery of fill material and to further minimize impacts to local arterials, the Port proposes constructing temporary construction-only interchanges to reduce the impacts from construction traffic to the existing freeway system and the local arterial streets. Consideration was given to use of two interchange locations: 1) SR 509 at South 176th and 2) SR 518 at either Des Moines Memorial Drive or South 20th Street. Based on further discussions with the Washington

[5] *Final Supplemental Environmental Impact Statement for Master Plan Update Development Actions*, Federal Aviation Administration, May 1997 forecasts haul rates of between 26 and 66 trips/hour (624-1600 trips/day).

State Department of Transportation, the temporary interchange at SR 509 has been designed. This EIS Addendum analyzes the potential noise and vibration impacts associated with the use and operation of the temporary construction interchange at SR 509, and proposes a method for mitigating the identified impacts to nearby residences.

The impacts of the construction haul trips have been identified in previous environmental documents. The specific noise impacts of the construction-only interchanges were not analyzed at that time because neither the construction schedule nor the interchange alignments had been designed.

The Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions ("SEIS") reached the following conclusions regarding the impacts of the construction haul traffic:

> The regional highway system has the ability to accommodate the haul traffic associated with the Third Parallel Runway without significant impacts. Preferred access to the construction site is as identified in the Final EIS, by way of State Route 509 and State Route 518. At the reduced truck volumes now forecast, both State Route 509 and State Route 518 operate at LOS D or better throughout the day. Interstate 5, south of Interstate 405 has the ability during most periods of the day to carry additional truck traffic. Truck traffic on Interstate 5 should be avoided or be minimized during the PM peak period. Interstate 405, between Interstate 5 and Interstate 90 has congestion during the AM, Midday, and PM peak periods. Truck traffic on Interstate 405 should be avoided or be minimized during these peak periods.

The Port, in consultation with the Washington State Department of Transportation ("WSDOT") and other agencies, proposed numerous measures to mitigate the general impacts of construction traffic. These mitigation measures were published in the Final SEIS and include:

- Compliance with legal load limits and other hauling requirements on State Highways. In addition to weight requirements, this requires that the tops of loads are 6 inches or more below tops of the truck bins or that the loads are covered.
- Coordinating with Washington State Department of Transportation to establish the haul routes and for approval for all traffic control plans to be implemented on State Routes.
- Maintaining coordination with the Construction Traffic Office to minimize conflicts between Port construction activities and any WSDOT projects along the haul routes.
- Restricting hauling activities, if feasible, during peak hours through congested areas of the State Highway System.
- Repairing identified damage to pavement near the Airport access points for haul.
- Establishing a system to handle complaints of broken windows and other damage to vehicles caused by flying debris from the trucks. Additionally, the contractor should be required to use some system to dislodge and wash away material on the body and undercarriage of the trucks.
- Avoiding or minimizing the use of arterial routes with afternoon peak hour congestion of LOS E or LOS F, which include State Route 99 between State Route 518 and State Route 516, South 188th Street, and South 200th Street.
- Avoiding or minimizing the use of arterial routes during evening and night conditions with abutting residential land use, which would include South 188th Street, South 200th Street, South 154th Street/Southcenter Boulevard/Grady Way, and Des Moines Memorial Drive.

- Avoiding or minimizing the use of roadways that are under construction. The contractor should be required to coordinate activities with contractors working on roadway projects.
- Coordinating with WSDOT and surrounding communities on the proposed schedule of area roadway improvements.

Exhibit 7-1 shows the location and alignment of the proposed temporary construction-only interchange from SR 509 at South 176th Street. As was noted earlier, the Port of Seattle has refined its design for this interchange in consultation with the Washington State Department of Transportation (WSDOT). The interchange will be constructed within the WSDOT right-of-way in the south and northbound locations. In the SR 509 Southbound lane, a ramp accessing the interchange will exit SR 509 about 1,300 feet north of South 176th Street and rise to the elevation of the overpass. In the northbound lane, the ramp will merge empty trucks about 1,200 feet north of the overpass. As a result, the grade change will provide a natural deceleration brake for full trucks leaving SR 509 as they travel over the incline to reach the overpass, before proceeding east on the overpass. Because acquisition will have been completed to the area west of the Third Runway embankment, as defined in the Final EIS and Final Supplemental EIS, S.176th will be closed to through traffic at the easterly edge of the overpass (this will be done so as to not affect public access to the residential area west of SR 509). As a result, trucks exiting SR 509 will not be required to stop before turning east over the overpass.

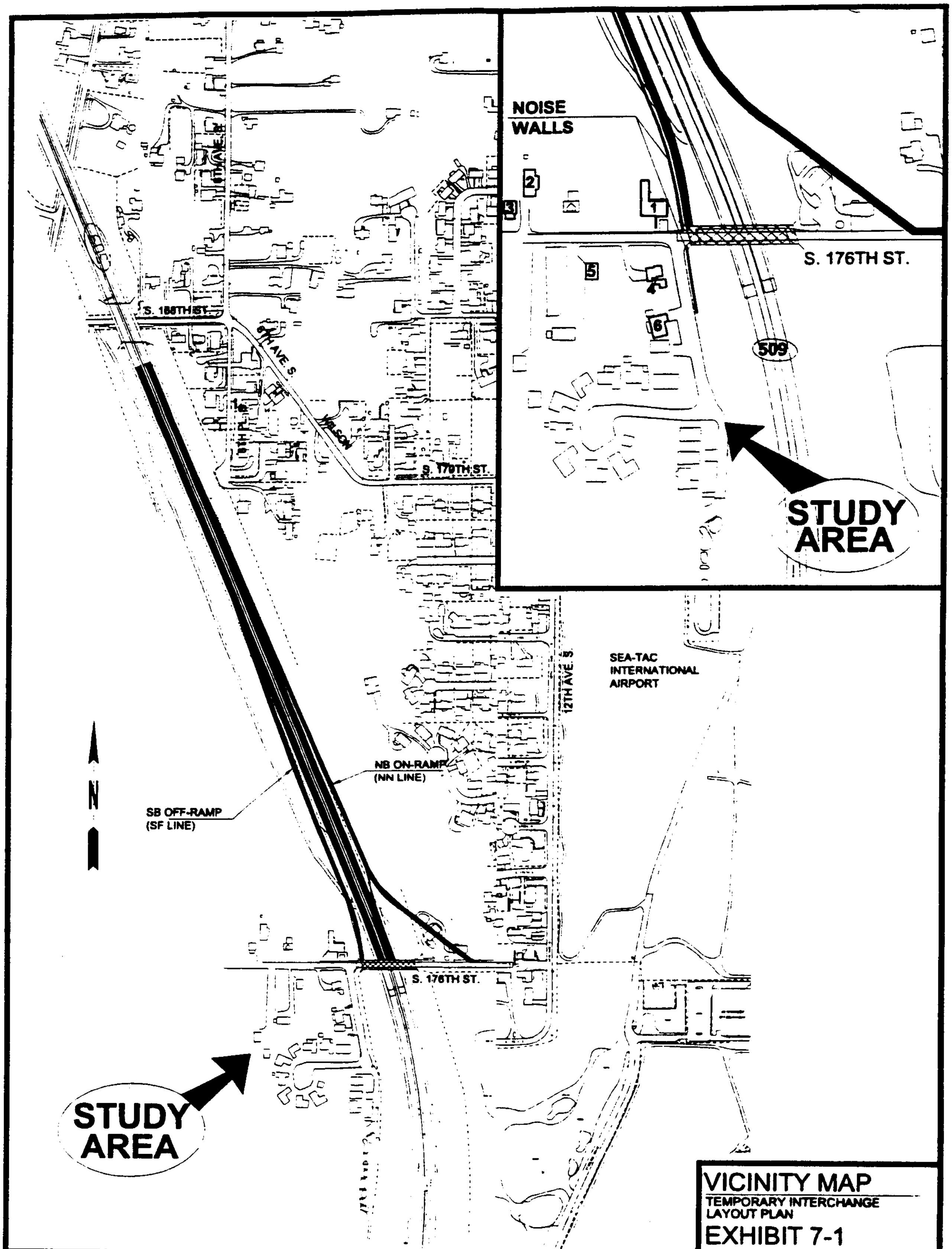
II. Vibration Analysis

The potential for vibration impacts generated by construction truck use of the interchange was examined. To evaluate vibration effects, two techniques were used: measurements of ground-borne vibration at the site to obtain a site signature, and evaluation of the site signature based on known vibration from construction truck traffic. This subsection briefly summarizes the results of the analysis the led to the conclusion that the home located closest to the ramp off SR 509 should be acquired on a voluntary basis due to potential vibration effects from haul trucks existing the expressway using the temporary interchange.

The U.S. Department of Transportation has established criteria for evaluating the impact from ground-borne vibration. To determine the significance of the potential vibration from traffic using the interchange, projected vibration was compared with these thresholds. The criteria for acceptable ground-borne vibration are expressed in velocity levels in decibels (VdB). DOT has found that significant impacts to residential locations can occur at 72 VdB for frequent events, or 80 VdB for infrequent events. This threshold represents a significant amount of vibration for residences and buildings where people normally sleep. For purposes of this evaluation, the frequent event threshold was used, as it is more conservative and during the haul periods, the truck trips are expected to be frequent.

The analysis of vibration effects found the following for the home closest to the ramp:

- DOT threshold of effect to residential buildings – vibration equal to or above 72 to 80 VdB


NOISE
WALLS
S. 176TH ST.
509
STUDY
AREA
S. 188TH ST.
8TH AVE. S
S. 170TH ST.
SEA-TAC
INTERNATIONAL
AIRPORT
12TH AVE. S
NB ON-RAMP
(NN LINE)
SB OFF-RAMP
(SF LINE)
N
S. 176TH ST.
STUDY
AREA
VICINITY MAP
TEMPORARY INTERCHANGE
LAYOUT PLAN
EXHIBIT 7-1

- Smooth surface road – house without a crawl space – 57 VdB
- Smooth surface road – house with a crawl space – 63 VdB
- Rough surface road – house without a crawl space – 67 VdB
- Rough surface road - house with a crawl space – 73 VdB

As the bullets above show, the only potential significant vibration effects that could result would be to the home closest to the southbound off-ramp presuming that the home has a crawl space; the vibration effect at House 1 with a rough road surface would reach 73 VdB, which is greater than the DOT threshold of 72 VdB.

The analysis, as documented in **Appendix A**, shows that soils at the site are loose and sandy which is an inefficient conductor of vibrational energy. Based on the site characteristics and published vibration data for construction trucks, the predicted ground-borne vibration level at the nearest residence is 57 VdB with no mitigation treatments. Because homes in the area often have a crawl space located underneath the home, which could increase the effect, consideration was also given to this type of structure. An elevated structure could experience 63 VdB.

To evaluate a higher vibration condition, consideration was also given to the truck traveling over a worn surface, associated with a rough road service. While it is anticipated that the interchange will initially be developed with a smooth surface, it is possible with a maximum amount of truck travel predicted by the Master Plan Final and Supplemental EIS, that over time, the surface of the road could become rough. With a rough surface, the vibration effect could increase 10 dB, placing impacts at 73VdB, or 1VdB in excess of the DOT threshold. This impact would only be experienced at the home closest to the exit ramp of the interchange, and as a result, the Port will offer to acquire that property. Because other homes are located further from the ramps, the impacts would be below the DOT thresholds.

III. <u>Noise Analysis</u>

Based upon the proposed alignment, and the peak traffic levels identified in the Final Supplemental EIS, a construction traffic noise analysis was performed. **Appendix B** documents the detailed analysis prepared for this addendum, which is summarized in the following section.

A. <u>Noise Level Descriptors</u>

Noise is defined as unwanted sound. Noise and sound are physically the same, the difference being the subjective opinion of the receiver. Sound is measured by its pressure or energy in terms of decibels (dB). The decibel scale is a logarithmic scale. The scale runs from zero to 120 and covers the range of most common sounds. When the decibel count increases by ten, the perceived sound is twice as loud.

The "equivalent sound level" (Leq) is a noise descriptor for environmental noise. It is a measurement of the total average noise level during a specific period of time. Leq measured over a one-hour period is termed the hourly Leq (Leq (h)). The hourly Leq is used by the WSDOT for highway noise and abatement analysis. The "day-night sound level" ("DNL") is also used to describe community noise, including noise from highway traffic. DNL is the Leq averaged over a

24-hour period, with a 10-decibel penalty added to noises that occur during nighttime hours of 10 p.m. to 7 a.m., to account for increased sensitivity to nighttime noise. This descriptor is labeled DNL/Leq in this Addendum. DNL is included for purposes of differentiating the amount of haul traffic that could occur during the nighttime hours.

B. Methodology and Existing Conditions

The evaluation of the effects of the temporary interchange included actual measurements of current noise conditions in the vicinity of the temporary interchange off SR 509. These measurements enabled quantification of current sounds without the presence of the proposed temporary interchange and associated traffic. Measurements were taken over three (3) 24-hour periods between January 3 and 7, 2000. Measurements were conducted at three separate residences near the site: 1) southeast corner of House 2 (40 feet from S. 176th Street), northeast corner of House 4 (45 feet from S. 176th Street); and the northeast corner of House 6 (1,000 feet from S. 176th Street).

Results of the measurements include:

- The DNL levels ranged from 63.2 at the home furthest from SR 509 (House 4) to 68.1 DNL at Home 4
- Maximum sound levels were 88 at House 4, 89.5 at House 6 and 89 at House 2

C. Conditions with Use of the Temporary Construction-Only Interchange

To assess the effect of the temporary interchange on sound levels, the sound associated with actual construction trucks was quantified. To evaluate the construction-traffic noise, sound level measurements were taken from trucks exiting a gravel pit, with a full load. Actual measurements were taken on January 4, 2000 at the intersection of Mountain Loop highway and Gun Club Road in Granite Falls Washington. Four types of truck movement sound were recorded: 1) accelerating full trucks, 2) decelerating full trucks, 3) accelerating empty trucks, and 4) decelerating empty trucks. The purpose of the measurements was to obtain a representative sound pressure level (SPL) to use in traffic noise prediction for the proposed interchange. The results ranged from 73.6 dBA for decelerating empty truck to 79.0 dBA for an accelerating full truck.

To evaluate the impact of the construction truck traffic using the temporary interchange, the overall sound level energy from the measured dump truck activity was used to calculate the effect on the homes in the vicinity of the proposed interchange. By extrapolating the average energy of the measured data to the number of possible daily truck trips, as identified in the Final Supplemental EIS, the DNL levels at each of the nearby homes was calculated. This sound level was then added to the to ambient sound level.

The noise analysis was conducted in a manner that considers the possible distribution of traffic haul that could occur throughout the day. Until a contractor is selected to deliver fill material for the haul, it is not certain as to the location where fill will be obtained. As a result, it is not possible to predict whether or not night haul will be necessary. Therefore, consideration was given to four possible scenarios: 1) all haul during daytime hours; 2) 10% haul during nighttime hours; 3) 50% haul during nighttime hours and 4) 100% haul during nighttime hours. These scenarios were considered for the purpose of ensuring the adequate mitigation is provided.

As **Exhibit 7-1** shows, Home 1 is located closest to the ramp at about 37 feet. This residence is located immediately west of the proposed ramp alignment, and is north of S. 176th Street. Because Home 1 is proposed to be acquired due to vibration the noise analysis is not presented in this summary, but is available in the Appendix. The second closest home, Home 4, is located almost 3 times are farther than Home 1, and is located on the south side of S. 176th across the street from Home 1. Home 2 is located about 235 feet from the proposed ramp and is located west of Home 1.[6/]

To enable the evaluation to differentiate between possible scenarios that would have some of the haul traffic occur at night, the DNL levels were calculated at the two closest sites. The following DNL levels were calculated:

TABLE 7-1

Sound Levels With the Proposed Temporary SR 509 Interchange (no mitigation)

DNL based on peak traffic haul of 1,600 daily truck trips

	Home 2		Home 4		Home 6	
Day/Night Traffic Levels	Existing	With Interchange	Existing	With Interchange	Existing	With Interchange
All haul during daytime	66.4	67.6	68.1	69.9	63.2	65.4
10% of haul at night	66.4	68.5	68.1	71.5	63.2	66.5
50% of haul at night	66.4	70.7	68.1	74.5	63.2	69.7
100% of haul at night	66.4	72.4	68.1	76.8	63.2	71.8
Range of change with project	1.2 - 6.0		1.8-8.7		2.2-9.6	

In evaluating the noise impacts, the criteria established by the Washington State Department of Transportation were used. WSDOT has established guidelines for roadway noise levels based on the Equivalent Sound Level (Leq) noise measurement. WSDOT considers an increase caused by a project in average sound level of 10 dBA or greater to be a significant impact. The Leq over a 24-hour period would be the same as the DNL, if a sound level penalty was not applied to nighttime traffic levels. Therefore, the DNL levels were then compared to the WSDOT criteria to ascertain if the sound level caused by the temporary interchange is significant, and represent a conservative/protective approach. As the table above notes, even with all hauling occurring at night, the interchange will not create a significant change in noise exposure, as none exceed 10 dBA.

In addition, WSDOT has established land use compatibility guidelines for roadway noise. These guidelines indicate that residences, parks, schools, churches and similar noise sensitive areas are sensitive to roadway noise at or above an hourly Leq of 67 dBA. As the table above shows, existing levels currently are in excess of Leq 67 at home 4, the home closest to SR 509. Homes 2 and 6 are currently less than the WSDOT land use guideline. With the proposed interchange, noise levels would being to exceed the WSDOT guideline regardless of the hourly distribution of traffic at Home 2 if no mitigation is included in the interchange. Sound levels with the interchange would

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6/ Sound levels are not presented for Home 3 (west of Home 2) as sound decreases with distance, and as such, sound levels would be less at homes west of Home 2. Similarly, sound levels are not presented for homes south/southeast of Home 6, as the project-related effects would be less than predicted for Home 5.

exceed the WSDOT guideline at Home 6 with a night haul greater than 10% if the interchange does not include mitigation.

D. Proposed Mitigation: Construction of a Noise Attenuation Wall at the Interchange

Based on the evaluation of noise conditions with the temporary interchange, mitigation was considered. An industry accepted means of mitigating surface traffic noise includes the development of noise walls. A noise wall is a man made structure that blocks the most direct path of the sound transmitting to the receiver. By increasing the distance that noise must travel to reach the receiver, sound is reduced. Noise walls are used frequently throughout the Puget Sound Region to reduce noise to residential areas from highway traffic. In this evaluation, a Type 15D WSDOT standard noise wall is evaluated and proposed. At a height of 10 feet, such a barrier would achieve a maximum 7 dBA noise level reduction for properties closest to the barrier. Because the benefits of the barrier would decrease as the distance away from the barrier increases, the barrier would be less effective further way from the ramp.

TABLE 7-2

Sound Levels With the Proposed Temporary SR 509 Interchange (With Mitigation)

DNL based on peak traffic haul of 1,600 daily truck trips

	Home 2		Home 4		Home 6	
Day/Night Traffic Levels	Existing	With Interchange and wall	Existing	With Interchange and wall	Existing	With Interchange and wall
All haul during daytime	66.4	67.1	68.1	68.5	63.2	63.7
10% of haul at night	66.4	67.6	68.1	69.0	63.2	64.1
50% of haul at night	66.4	69.3	68.1	70.3	63.2	65.5
100% of haul at night	66.4	70.8	68.1	71.7	63.2	66.7
Range of change with project	0.7-4.4		0.4-3.6		0.5-3.5	

As is shown above, the noise wall would provide substantial reduction in sound level (reducing the project related peak sound level reduction from 9.6 at Home 6 to 3.5 dBA). However, sound levels at Home 2 would continue to exceed the land use guideline regardless of the amount of night haul. To mitigate the sound level effects, the Port will sound insulate the homes where the traffic associated with the use of the temporary construction-only interchange causes sound levels to reach or exceed the WsDOT land use criteria of 67 dBA, as measured with the DNL. The number of homes that would be insulated would depend on the amount of night haul, but as the table above indicates, these homes would be limited to those along S. 176th Street in the immediate vicinity of the interchange. With the construction of the noise wall, it is anticipated that this would be less about a half dozen houses west of house 2.

Chapter VIII

CONCLUSION

The recently refined wetland delineation, on the basis of on-the-ground inspections and surveys of previously inaccessible properties, identified some previously unobserved isolated wetlands and ascertained that some previously identified wetland areas were larger and some smaller than had been determined by the earlier delineations. The net result of the more refined delineation and several project design modifications, was an increase in wetlands that would be affected by the planned Airport improvements. Quantitatively, the area of affected wetlands increased from 12.23 to 18.28 acres plus temporary and indirect impacts. Qualitatively, the affected wetlands virtually all fell into the poor to average categories of wetland function established by the state Department of Ecology.

The Port, in the interest of assuring a systematic "hard look" at the new information and providing a public record, has conducted a study re-evaluating wetland impacts in light of the refined wetland delineations. After this systematic reassessment of wetland impacts, the Port, as SEPA lead agency, has concluded that preparation of a new SEIS is not required by SEPA or NEPA.

While the new information reveals that a greater total area of wetlands would be affected by the projects, the functions of the additional wetlands are essentially the same as those analyzed in the 1996 FEIS and 1997 FSEIS. Most importantly, the Port's extensive mitigation commitments, including new mitigation measures and project design-modifications in response to the new information, will fully compensate for all impairment of wetland functions and may result in a net increase in wetland functions. Since the project incorporates mitigation measures that will avoid or compensate for all significant adverse wetland impacts, including those related to the new information, there will be no net significant adverse impacts to wetlands and no warrant for preparation of a new SEIS.

To aid in mitigating traffic related impacts from haul assocaited with the Third Runway, the Port proposed to develop temporary construction-only interchanges. Based on the final design of the temporary construction-only interchange at SR 509/South 176th Street, to ensure that adequate mitagation is provide, the Port proposes to complete the following:

- A noise attenuation wall along portions of the temporary interchange to ensure that truck traffic does not create a significant noise effect on adjacent properties;
- Offer to acquire the residence closest to the southbound off-ramp (Home 1) at South 176th Street due to the potential for significant vibration effects if the off-ramp pavement becomes worn.
- Insulation of homes where the sound generated by the construction activity using the temporary interchange would increase noise to sound levels above 67 DNL (the WSDOT land use criteria). It is anticipated that the number of homes to be insulated would depend on use of the interchange at night but would number less than a half dozen homes along South 176th Street west of the interchange.

Appendix A

Vibration Analysis of Temporary Construction-Only Interchange

INTRODUCTION

An environmental noise study of the SR509 construction-only traffic interchange was conducted between January 3rd and January 11th, 2000 in Burien and Sea-Tac, Washington. The study included taking measurements of existing noise levels at three residences next to the interchange site. Measurements of noise levels from dump trucks were also taken on January 4th, 2000 in Granite Falls, Washington. Noise levels from the interchange were then predicted for select residences, accounting for dump truck volume, topography, building heights, and distances from the roadway. Using the same conditions, noise levels were then predicted at the same properties with the addition of a noise barrier. Resultant noise levels with and without a barrier were then compared to pertinent guidelines in order to determine whether criteria were met.

SITE DESCRIPTION

The construction-only traffic interchange connects SR509 and South 176th Street in Sea-Tac, Washington. The interchange site is bordered on the east by residential property, on the west by the construction site, on the north by SR509 and South 176th Street, and on the south by SR509.

Currently, the primary sources of noise at the interchange site are SR 509 and aircraft noise from Seattle-Tacoma International Airport. Other minor sources of noise include occasional traffic on South 176th Street and residential noise from the property east of the site.

AMBIENT MEASUREMENT DESCRIPTION

Three 24-hour measurements of ambient noise levels were taken between January 3rd and January 7th, 2000 using a Larson Davis 700 sound level meter. Two one-half hour measurements were also taken during the same time with a Bruel & Kjaer 2231 sound level meter. The measurements were taken at three separate residences near the site. Measurements 1 and 4 were taken at the southeast corner of House #2, 40 feet from

South 176th Street. Measurements 2 and 5 were taken at the northeast corner of House #4, 45 feet from South 176th Street. Measurement 3 was taken at the northeast corner of House #6, 1000 feet from South 176th Street. All house numbers correspond to the same house numbers described in previous reports and are shown in Figure 1. For all measurements, the microphones were placed 5 feet from the ground and were pointed toward SR509. All measurements were calibrated before and after to ensure the quality of the data.

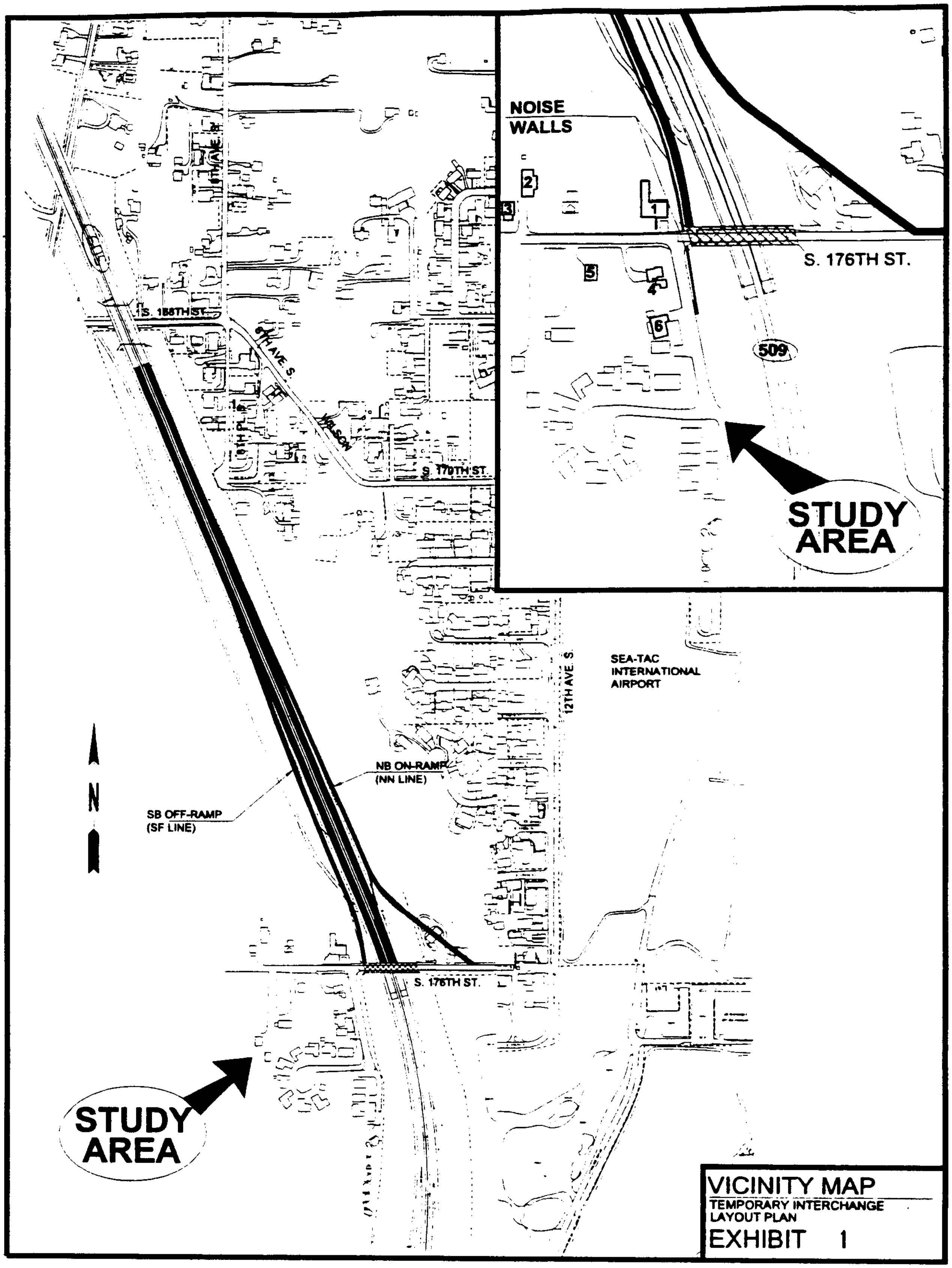
AMBIENT MEASUREMENT RESULTS

The acoustical data presented in this report uses "A-weighted" sound level descriptors which are frequency weighted to account for the human ear's perception of noise. L_{eq} is the energy average sound pressure level, dB re 20 micropascals. L_{max} is the maximum sound pressure level (rms) and L_{min} is the minimum sound pressure level (rms), also dB re 20 micropascals. L_{dn} is the Day-Night Equivalent Noise Level, which is a 24-hour continuous sample of L_{eq}, with a 10 dB(A) penalty added to sound occurring between 10:00 pm and 7:00 am. L_n is the noise level which is exceeded n percent of the time. See Appendix I for a more detailed discussion of noise descriptors.

The purpose of the measurements was to obtain an ambient L_{DN} level at each residence. The sound pressure level (SPL) data measured at the residences are presented in Appendix II. The calculated ambient L_{DN} levels are listed below.

Table 1: Calculated Ambient L_{DN} Levels

Measurement Location	Calculated L_{DN} (dB(A))
House #2	66.4
House #4	68.1
House #6	63.2


NOISE
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S. 176TH ST.
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STUDY
AREA
S. 168TH ST.
8TH AVE S
S. 170TH ST.
12TH AVE. S
SEA-TAC
INTERNATIONAL
AIRPORT
NB ON-RAMP
(NN LINE)
SB OFF-RAMP
(SF LINE)
N
S. 176TH ST.
STUDY
AREA
VICINITY MAP
TEMPORARY INTERCHANGE
LAYOUT PLAN
EXHIBIT 1

DUMP TRUCK NOISE MEASUREMENT DESCRIPTION

In order to accurately represent the noise levels expected from dump truck traffic, measurements of dump truck noise were taken. The measurements were taken on January 4, 2000 with a Bruel & Kjaer 2231 sound level meter, at the intersection of Mountain Loop Highway and Gun Club Road in Granite Falls, Washington. Noise levels were ascertained for four types of truck events: accelerating and decelerating full and empty trucks. The microphone was placed fifty feet from the intersection, fifty feet from the road, and five feet above ground for all measurements. The sound level meter was calibrated before and after the set of measurements to ensure the quality of the data.

DUMP TRUCK NOISE MEASUREMENT RESULTS

The purpose of these measurements was to obtain a representative sound pressure level (SPL) to use in traffic noise predictions for the interchange. The sound pressure level data measured for each condition are presented in Appendix III. The representative sound pressure levels used in the predictions are listed in Table 2.

Table 2: Representative Sound Pressure Levels For Dump Truck Traffic

Measurement Condition	SPL (dB(A))
Accelerating, Full Truck	79.0
Accelerating, Empty Truck	78.2
Decelerating, Full Truck	74.7
Decelerating, Empty Truck	73.6

For most cases, 3 events per measurement condition were recorded. The numbers above represent an average of the highest and lowest measured SPL for each condition. The arithmetic average of the measured sound pressure levels per condition is slightly lower than the high/low average. This makes the representative sound pressure levels in Table 2 conservative.

RECOMMENDED NOISE LEVELS FOR RESIDENTIAL LAND USE

The impact of ambient and dump truck noise levels on the residential area can be determined by comparing them to pertinent criteria. In this case, three different guidelines may be used. The Washington State Department of Transportation (WSDOT) has established criteria for roadway traffic which are based on the energy average sound pressure levels, or L_{eq}. These guidelines state that noise sensitive areas, such as residences, are perceptive to traffic noise at or above an hourly L_{eq} of 67 dB(A). WSDOT also considers an impact to occur if the increase in ambient noise levels at a residence due to a project is 10 dB(A) or more.

Federal government recommendations can also be used to assess residential noise levels near busy streets or highways. Noise levels recommended by the Federal Government are given in a report written by the Federal Interagency on Urban Noise (FICUN) [1]. The recommended noise levels and corresponding land uses documented in the FICUN report, in agreement with HUD guidelines, are as follows:

Exterior Noise levels L_{dn}	*Recommended Land Use*
0-55 dBA	Residential without restrictions.
55-65 dBA	Residential property generally acceptable. The guidelines note that some people may find noise levels in this category objectionable, but considering the cost of mitigating measures, these noise levels are generally acceptable for residential use.
65-75 dBA	Generally unacceptable for residential use. Acceptable for commercial use. Residential use in this environment requires special construction techniques to achieve a minimum Noise Level Reduction (NLR) of 25 dB for noise levels between 65 dBA and

[1] The Federal Interagency Committee on Urban Noise members included HUD, the Environmental Protection Agency, and the Department of Veteran Affairs. Guidelines for acceptable residential noise Development (HUD).

	70 dBA and a NLR of 30 dB for noise levels between 70 dBA and 75 dBA.
Interior Noise levels L_{dn} (windows closed)	*Recommended Land Use*
Less than 45 dBA	Acceptable for residential use.
Greater than 45 dBA	Unacceptable for residential use.

Lastly, noise levels at residential locations may be evaluated using EPA Region 10 guidelines. These guidelines are similar to the impact statement in the WSDOT criteria. The EPA guidelines consider a slight impact to occur if the increase in ambient noise levels at a residence due to a project is 0-5 dB(A). A significant impact will occur if the increase is between 5 and 10 dB(A). For a significant impact, mitigation measures are suggested. Any increase in ambient noise levels over 10 dB(A) results in a serious impact at the residential location. Mitigation measures are required for a serious impact.

Using these guidelines, one should note that measured ambient L_{DN} levels at houses #4 and #2 are already considered generally unacceptable for residential use by HUD guidelines. The ensuing interchange construction noise levels will only add to this already high ambient level.

PREDICTION OF INTERCHANGE NOISE

To evaluate the impact of increased construction traffic on neighboring properties a computer simulation was used. This simulation takes measured overall energy levels from a reference dump truck event and calculates the acoustic energy from that event at the residential receiver. By extrapolating the average acoustic energy of one truck event to the number of daily truck events, the hourly L_{eq} and 24-hour L_{DN} levels from the dump trucks can be accurately predicted at the receiver location. The L_{DN} levels from the dump trucks were finally added to the ambient L_{DN} levels to obtain a total noise level at the residential receiver location.

L_{DN} levels were calculated for four scenarios: 0% night haul, 10% night haul, 50% night haul, and 100% night haul. It was assumed there would be 1600 daily one-way dump truck events per day. The breakdown of hourly truck events is shown in Table 3. Daytime hours are considered between 7:00 AM and 10:00 PM.

Table 3: Breakdown of dump truck events

Condition	Trucks per Day/Night	Trucks per Hour
0% Night Haul	1600 - Day	106 - Day
10% Night Haul	1440 – Day 160 – Night	96 – Day 18 - Night
50% Night Haul	800 – Day 800 – Night	53 – Day 89 - Night
100% Night Haul	1600 – Night	177 - Night

Table 4 shows the measured ambient and calculated interchange L_{DN} levels for three residential receivers, without barriers, for all four scenarios of truck haul. Again one should note the ambient levels seen in the table are already generally unacceptable for residential use and the increased interchange traffic only adds to the ambient level.

Table 4: L_{DN} results at receiver locations without noise barrier.

Scenario	Measured Ambient L_{DN}	Calculated Interchange L_{DN}	Combined L_{DN}
House 2			
No night haul, no wall	66.4	61.4	67.6
10% night haul, no wall	66.4	64.3	68.5
50% night haul, no wall	66.4	68.6	70.7
100% night haul, no wall	66.4	71.2	72.4

Scenario	Measured Ambient L_{DN}	Calculated Interchange L_{DN}	Combined L_{DN}
House 4			
No night haul, no wall	68.1	65.4	69.9
10% night haul, no wall	68.1	68.8	71.5
50% night haul, no wall	68.1	73.3	74.5
100% night haul, no wall	68.1	76.2	76.8
House 6			
No night haul, no wall	63.2	61.4	65.4
10% night haul, no wall	63.2	63.8	66.5
50% night haul, no wall	63.2	68.6	69.7
100% night haul, no wall	63.2	71.2	71.8

PREDICTION OF BARRIER IMPACT ON INTERCHANGE NOISE LEVELS

To evaluate the impact of noise barriers on neighboring properties another computer simulation was used. Predictions were made using the Federal Highway Administration Traffic Noise Model version 1.0a, TNM, noise simulation package. To calibrate the prediction model, reference dump truck noise levels were entered and a run was made with 0% night haul and no barrier. The results of this run were then compared with the previous acoustic energy calculations. The two results were within 1dB(A) of each other and showed excellent agreement between noise levels. Barrier predictions were then made for the same four scenarios of night haul.

As in the previous calculations, predicted L_{DN} levels from the dump trucks with noise barriers were added to the ambient L_{DN} levels to obtain a total noise level at the residential receiver location. No decrease in ambient noise level due to the barrier was considered in the prediction. This makes the final noise levels at the receiver locations conservative. The noise barrier will decrease the ambient traffic noise from SR509 however it will have no effect on the overhead aircraft noise.

Table 5 shows the measured ambient and calculated interchange L_{DN} levels for three residential receivers, with barriers, for all four scenarios of truck haul.

Table 5: Final L_{DN} results at receiver locations with noise barrier.

Scenario	Measured Ambient L_{DN}	Calculated Interchange L_{DN}	Combined L_{DN}
House 2			
No night haul, with barrier	66.4	58.8	67.1
10% night haul, with barrier	66.4	61.6	67.6
50% night haul, with barrier	66.4	66.2	69.3
100% night haul, with barrier	66.4	68.8	70.8
House 4			
No night haul, with barrier	68.1	58.4	68.5
10% night haul, with barrier	68.1	61.8	69.0
50% night haul, with barrier	68.1	66.3	70.3
100% night haul, with barrier	68.1	69.2	71.7
House 6			
No night haul, with barrier	63.2	54.4	63.7
10% night haul, with barrier	63.2	56.8	64.1
50% night haul, with barrier	63.2	61.6	65.5
100% night haul, with barrier	63.2	64.2	66.7

CONCLUSIONS AND MITIGATION

As shown in Table 4, residential noise levels resulting from the SR509 construction-only traffic interchange with no noise barrier are within the threshold of the WSDOT impact criteria of an increase of 10 dB(A) over ambient levels. However, because of the high ambient noise levels, the WSDOT criterion of 67 dB(A) is only met at House #6 during 10% night haul or less. L_{DN} levels at all receivers are above a L_{DN} of 65 dB(A) during all conditions of night haul and therefore exceed the FICUN residential acceptable levels. When compared with EPA guidelines, the construction traffic provides a 5 to 10 dB(A) increase in ambient level which is considered a significant impact.

Table 5 shows that residential noise levels resulting from the construction interchange with a noise barrier are also within the threshold of the WSDOT impact criteria. However, the WSDOT criterion of 67 dB(A) is only met at House #6 for all conditions of night haul and at House #2 for no night haul. L_{DN} levels are above a L_{DN} of 65 dB(A) for all receivers during 50% and 100% night haul and therefore exceed the FICUN residential acceptable levels. For Houses #2 and #6, the 65 dB(A) criteria is met for 0% and 10% night haul. For House #4, the guideline is met for only 0% night haul. When compared with EPA guidelines, the construction traffic provides a 0 to 5 dB(A) increase in ambient levels which is considered a slight impact.

Mitigation measures for the residences should take a two step approach. First, the noise barrier should be constructed as shown. The barrier will not only help to decrease the noise from the construction interchange, but will also reduce the existing traffic noise from SR 509. With the barrier in place, a threshold for further mitigation should be applied to all residences with noise levels over 67 dB(A). The WSDOT criterion of 67 dB(A) should be used for the mitigation threshold for the following reasons:

- A significant part of the existing noise at the residential site is traffic noise, making traffic noise or WSDOT standards the most appropriate to use.

- Ambient noise levels at the residential sites are already above FICUN guidelines of 65 dB(A). This makes these guidelines difficult to apply to the current project.
- The WSDOT standard of 67 dB(A) is more restrictive and therefore more conservative than EPA Region 10 guidelines. It therefore provides a reasonable compromise between the FICUN guidelines and the EPA Region 10 guidelines.

Appendix B

Noise Analysis of Temporary Construction-Only Interchange

GROUND-BORNE VIBRATION STUDY

CONSTRUCTION ACCESS ROAD SR-509

December 17, 1999

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HNTB Architects Engineers Planners
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Bellevue, Washington 98004

Prepared by:
The Greenbusch Group, Inc.
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Seattle, Washington 98119

EXECUTIVE SUMMARY

Measurements were made of Ground-borne vibration levels at the site of the proposed temporary construction access road off of State Route (SR) 509 in SeaTac, Washington. The results of these measurements were used to develop the "signature" associated with the ground response to a known impulse force. These signatures were then applied to vibration levels produced by construction truck traffic to predict vibration levels for residences in the proximity of the new access road. The predicted vibration response was then evaluated for the potential of "impact" and structural damage to the nearby residences.

The generally accepted threshold for determining ground-borne vibration impact is 72 VdB as defined by the U.S. Department of Transportation and the Federal Transit Authority (FTA) for residences and buildings where people normally sleep. The threshold for minor cosmetic damage to buildings is 100 VdB as defined by USDOT.

Soils at the site of the proposed off ramp are loose and sandy which is an inefficient conductor of vibrational energy. The predicted ground-borne vibration level at the nearest residence, for haul trucks traveling 45 MPH and slowing on the off ramp, is 57 VdB, 37 feet from the ramp with no mitigation treatments implemented.

A structure raised off of the grade, with a crawl space beneath, could add 6 dB to the response inside of the home. This could raise the level to 63 VdB. This also falls below the accepted threshold impact level of 72 VdB defined by the Federal Transit Authority (FTA).

An additional 10 dB vibration level could result from a rough road surface While we would encourage the construction of a smooth road surface for the off ramp, it is likely that the predicted volume of traffic over an extended construction period will cause the road surface to deteriorate from the smooth surface of the newly constructed ramp to a rougher road surface. This could increase the intermittent level to 73 VdB, triggering the FTA threshold for impact at the nearest residence. However, the 73 VdB falls below the threshold for causing minor structural damage.

In conclusion, the predicted ground-borne vibration levels at the residences included in this study show "no impact", based on FTA guidelines, for all but the nearest residence. The 73 VdB predicted for the nearest property reflects a worst case condition including a rough road surface along the off ramp route. A potential property buy-out may warrant consideration at this one location.

1.0 INTRODUCTION

1.1 General Introduction

Measurements were made on November 15, 1999 at the site of the proposed temporary construction access road (SR 509). Vibration velocity levels were

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measured to document the amount of vibration energy transferred through the ground at the proposed access road site. Levels of energy associated with a known impulse force and from general highway traffic were measured for the analysis and ground-borne vibration predictions.

The proposed construction route is located near the South 176th Street exit off of SR-509 as shown in the enclosed site map. The proposed temporary access road is located within 37 feet of the nearest residence, labeled as location 1 on the site map.

1.2 Study Objectives

The purpose of this study was to predict the levels of ground-borne vibration energy associated with the operation of a temporary construction access road off of SR-509 and to evaluate the potential for intrusion into the neighborhood around the new construction route. The analysis also included evaluating ground-borne vibration levels from existing activities on SR-509.

2.0 NOMENCLATURE

2.1 Ground-borne Vibration

Vibration is an oscillatory motion which can be measured in a variety of ways: displacement, velocity or acceleration. The displacement is a measure of the distance that a point moves away from its resting position. The velocity represents the instantaneous speed of the movement and acceleration is the rate of change of the speed. The response to this vibration by humans, buildings and equipment is more accurately described using either velocity or acceleration. Standards for vibration studies involving transportation vehicles are typically defined in terms of velocity, so for the purposes of this study, velocity levels are reported.

Decibel notation is also the standard method of reporting levels of vibration due to the logarithmic nature of the descriptor and its ability to compress the wide range of numbers required to describe vibration. VdB is the common notation for decibels describing vibration to minimize the confusion with sound decibels.

Typical background velocity levels are well below the threshold of human perception. Enclosed in Table 1 are common vibration sources and human response to them.

The frequencies of interest for ground borne vibration are typically between 8 Hz and 200 Hz.

Table 1 Common Ground Borne Vibration Sources

Typical Sources, 50 Ft. from the Source	RMS Velocity Level in VdB	Human/Structural Response
Blasting from construction projects	100	Threshold, minor cosmetic damage to fragile buildings
Bulldozers and other heavy tracked construction equipment	92	
	90	Difficulty with tasks such as reading a VDT screen
Commuter Rail, upper range	84	
Rapid Transit, upper range	80	
Commuter Rail, typical	75	Dividing line between barely perceptible & distinctly perceptible
Bus or Truck over bump	72	Residential Annoyance with frequent events
Rapid Transit, Typical	70	
	65	Approximate threshold for human perception
Bus or Truck, typical	62	
Typical Background Vibration	52	

Source: FTA, 1995

3.0 CRITERIA

The U.S. Department of Transportation has established criteria for environmental impact from ground-borne vibration. The criteria that is presented in Table 2 accounts for variation in project types as well as the frequency of events, which differ widely among projects. The criteria for acceptable ground-borne vibration are expressed in terms of rms velocity levels in decibels (VdB). The limits are specified for the three land use categories below.

Table 2. Ground-Borne Vibration Impact Criteria

Land Use Category	*Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/second)*	
	Frequent Events [1]	*Infrequent Events* [2]
Category 1: Buildings where low ambient vibration is essential for interior operations.	65 VdB	65 VdB
Category 2: Residences and buildings where people normally sleep	72 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	83 VdB

Notes:
1. "Frequent Events" is defined as more than 70 Vibration events per day
2. "Infrequent Events" is defined as fewer than 70 vibration events per day

Source: *U. S. Department of Transportation, "Transit Noise and Vibration Impact Assessment April 1995"*

The 72 VdB criteria has been used as the basis for this study.

4.0 ANALYSIS

4.1 General

Vibration levels were recorded on November 15, 1999, at the site of the construction access road along State Route 509. The weather during the measurement period was overcast and rainy with damp soil due to earlier rains. The prediction method used in this analysis is outlined in chapter 11 of the FTA "Transit Noise and Vibration Impact Assessment Final Report", April 1995.

4.2 Test Support Hardware

Sony PC208AX, 8 channel DAT Recorder

Larson Davis 2900, 2 channel Spectral Analyzer

IMI 626A02, Industrial Piezoelectric ICP Accelerometers

PCB 480E09, ICP Sensor Power Unit

PCB 086C50, Calibrated Impact Hammer

4.3 Ground Borne Vibration Measurements

4.3.1 Test Description

The approach taken to assess ground-borne vibration levels involved two test configurations. The first configuration was a vertical array directed away from the source of vibration. The second configuration was a horizontal array of transducers directed perpendicular from the source of vibration. The test procedure was consistent with Chapter 11 of the FTA, "Transit Noise and Vibration Impact Assessment Final Report" of April 1995.

4.3.2 Test Measurements

4.3.2.1 Transducer Locations

The impulse source was located 10 feet away from State Route 509. The accelerometers wete mounted on 12 inch wooden stakes driven into the soil at distances described below.

4.3.2.1.1.1 Accelerometers in a vertical array

Accel. 1: 20 feet from the impulse source

Accel 2: 32 feet from the impulse source

Accel 3: 44 feet from the impulse source

Accel 4: 66 feet from the impulse source

As shown in the sketch below (Figure 1).

The Greenbusch Group, Inc.
p) 206 378 0569 f) 206 378 0641 www.greenbusch.com
1900 West Nickerson Street, Suite 201 Seattle, WA 98119

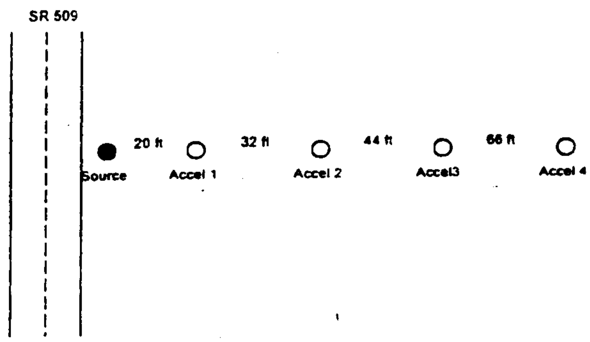


Figure 1. Sketch of the Vertical Transducer Array.

4.3.2.1.1.2 Accelerometers in Horizontal Array

Accel 1: Located 30 feet from accelerometer 4

Accel 2: Located 20 feet from accelerometer 4

Accel 3: Located 10 feet from accelerometer 4

Accel 4: Located 66 feet from the impulse source

As shown in the sketch below (Figure 2).

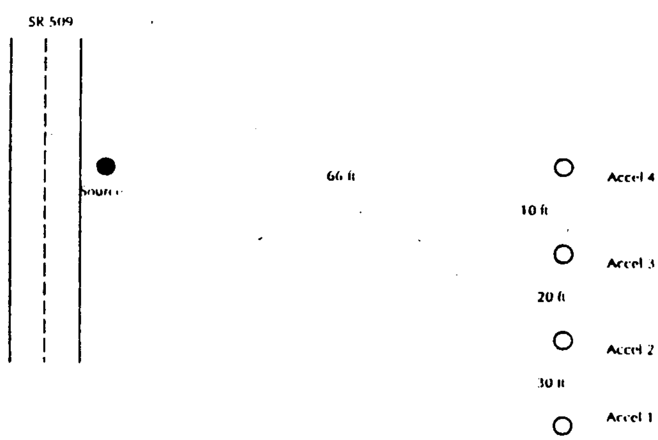


Figure 2. Sketch of Horizontal Transducer Array

4.3.3 Ground-Borne Vibration Measurement Procedure

Transducer positions were selected based on preliminary field data. The force gauge and accelerometers were calibrated at the beginning and at the end of the test period. Both, the 12 LB impact hammer (impulse excitation) and highway traffic, were used to excite the ground where the accelerometers were planted. Recordings were made for ground-borne vibration as well as the impulse forces. Ground-borne vibration data and impact force data were stored on an 8 channel Sony DAT Recorder (PC208).

The data was reduced in the laboratory using a Larson Davis 2900 Analyzer. Transfer functions between the calibrated impact hammer and the accelerometers were performed using a 400 line FFT over a period of 20 spectra averages.

The transfer functions were then plotted to produce the transfer mobility curves for each 1/3 octave band between 20 and 200 Hz. The transfer mobility curves are presented in this document as Figures 3 thru 13. The transfer mobility curves were applied to the baseline force, derived from the measured traffic vibrations and presented in Figure 14, as a means of predicting the vibration levels at the nearby residence. The projected ground-borne vibration at a distance of 37 feet (nearest residence) is presented in Figure 15 and represents an overall vibration level of 57 VdB re 1 micro in/sec.

5.0 EVALUATION & RESULTS

The predicted level of 57 VdB at position 1, which is the residence nearest to the access road, falls well below the 72 VdB threshold for the ground-borne vibration impact criteria outlined in Table 2 (Land Use Category 2: residences and buildings where people normally sleep).

The soil conditions have a strong influence on the transmission of vibrational energy. Stiff clay or rock concentrate the energy near the surface and efficiently translate the energy for greater distances. Layering or loose sandy soil provides some damping of the energy. Soil conditions at this site are loose and sandy.

The receiving structure is also a key component in the evaluation since the perception of ground-borne vibration occurs inside the building as the energy propagates through the foundation, potentially exciting resonances in various building components. Rattling of dishes or windows may be the perceptible manifestation of the energy. In lighter structures, a low rumble may be audible as the ground motion energizes the wall and floor plates, causing them to act as diaphragms re-radiating the sound as audible airborne energy. This added response due to resonance in the receiving structure could potentially increase the predicted level of 57 VdB by 6 dB, resulting in an overall level of 63 VdB.

Road surface will also have an effect on the source energy transmitted. An additional 10 dB can be added by a rough surface. This additional 10 dB could increase the vibration level at the nearest residence to 73 VdB. A level of 73 VdB would be an absolute maximum with two added conditions: a resonant structure and a rough road surface. This level exceeds the FTA threshold for impact by 1 dB for more than 70 events per day. We anticipate that peak volume will include 90 trucks per hour. We would highly recommend that care is exercised in constructing the road surface and that regular maintenance be scheduled to ensure a smooth surface throughout the period of use. However, the high volume of traffic anticipated for this roadway is likely to continually cause deterioration of the road surface, potentially triggering the "impact" condition over time at Home 1.

Vibration levels at Homes 2 through 10, due to truck activity on the off ramp, fall below 45 VdB. Typical ambient conditions are normally around 52 VdB. This could potentially increase to a worst case condition of 61 VdB with structural resonance and rough roadway conditions. This level is well below the 72 VdB FTA threshold for impact. The threshold of 100 VdB for cosmetic or structural damage is also not met at any of the 10 properties in this study.

In conclusion, there is no impact at Homes 2 through 10 due to vibration levels associated with truck activity on the proposed temporary construction off ramp on SR-509. Worst case conditions with floor resonances and rough roadway surfaces could potentially trigger the "impact" threshold defined by FTA for Home 1.

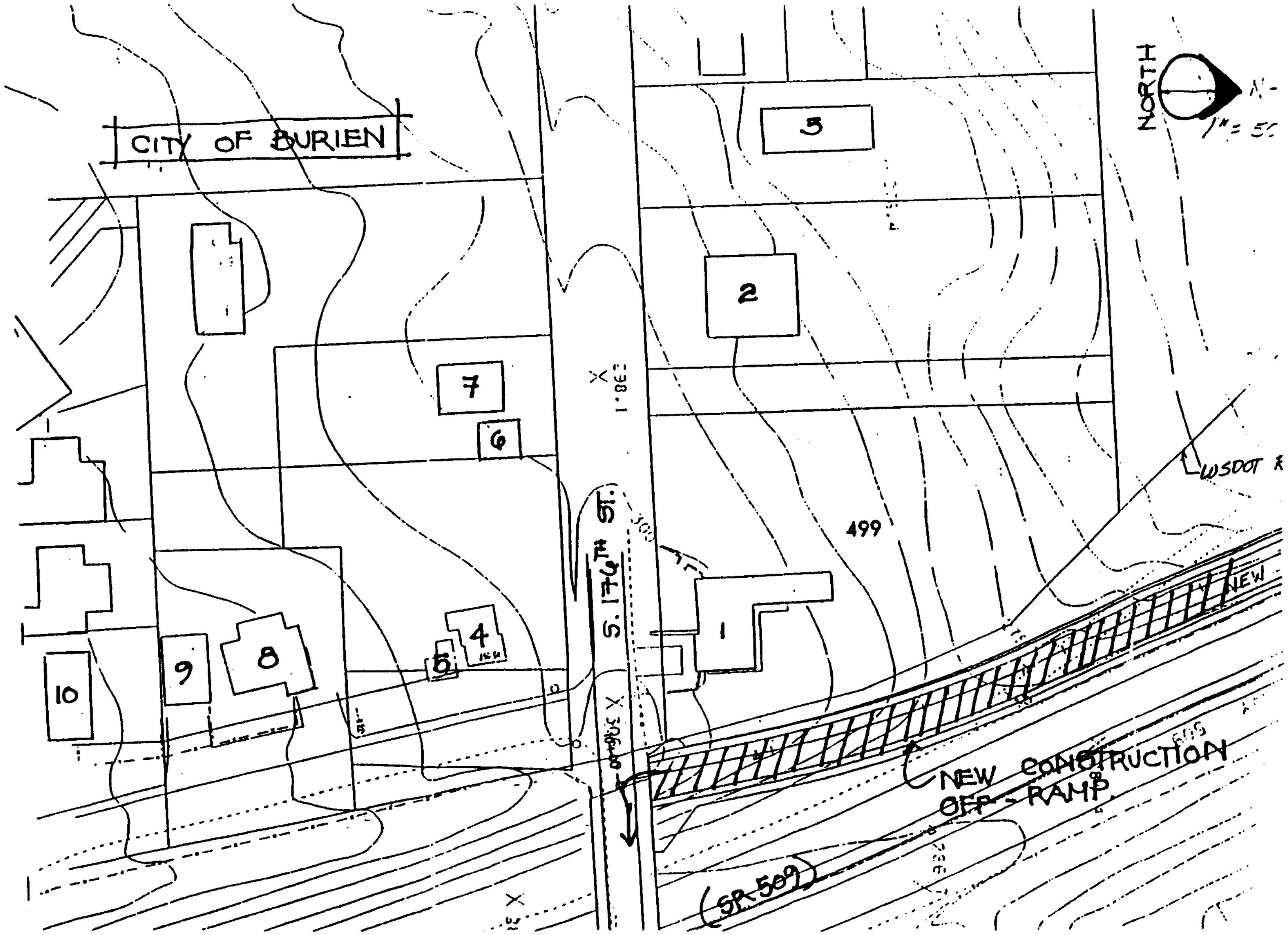


FIGURE 2 - SITE MAP
LOCATION OF RESIDENCES INCLUDED
IN THE VIBRATION STUDY
(NOT TO SCALE)

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)

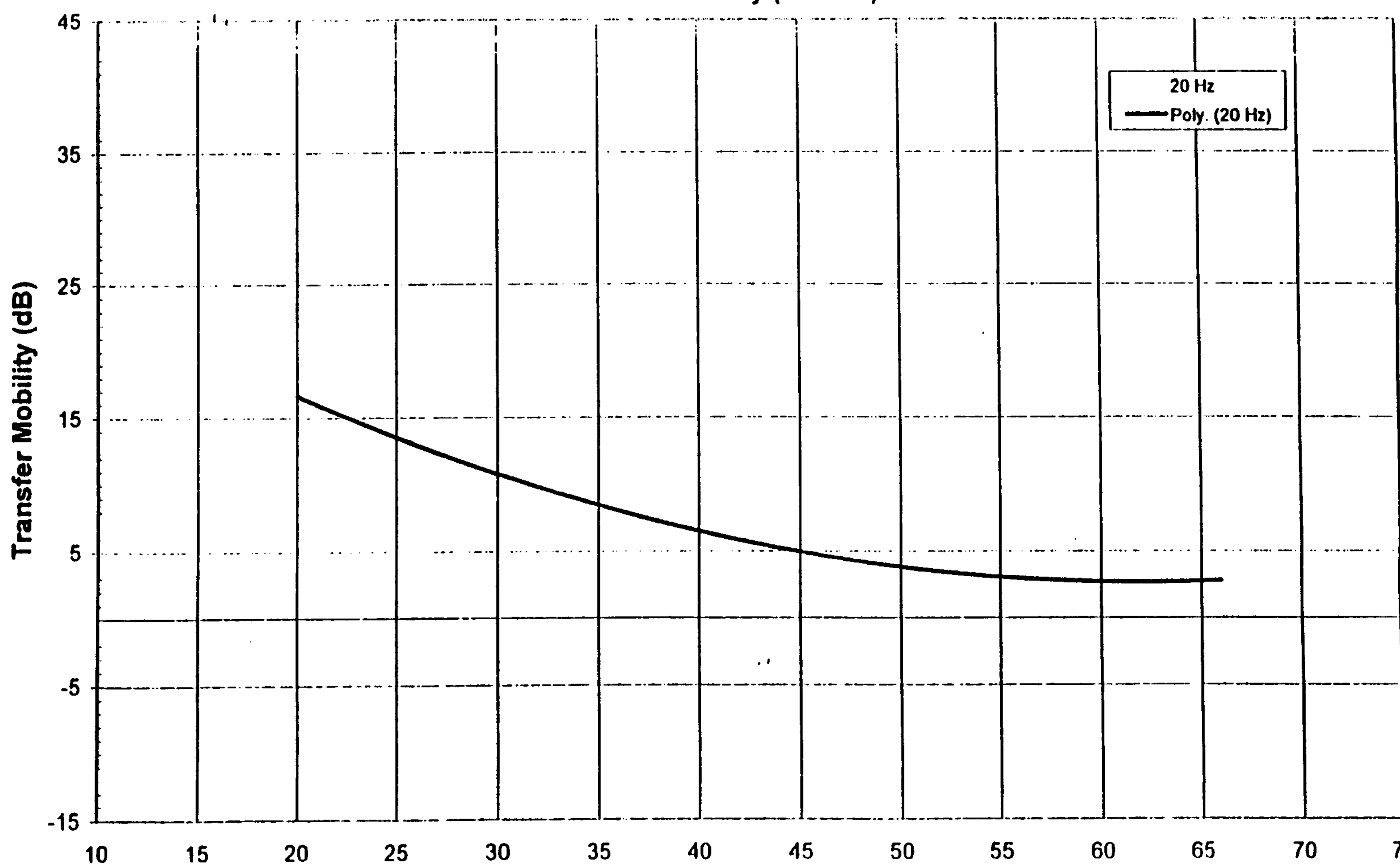


Figure 3.

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)

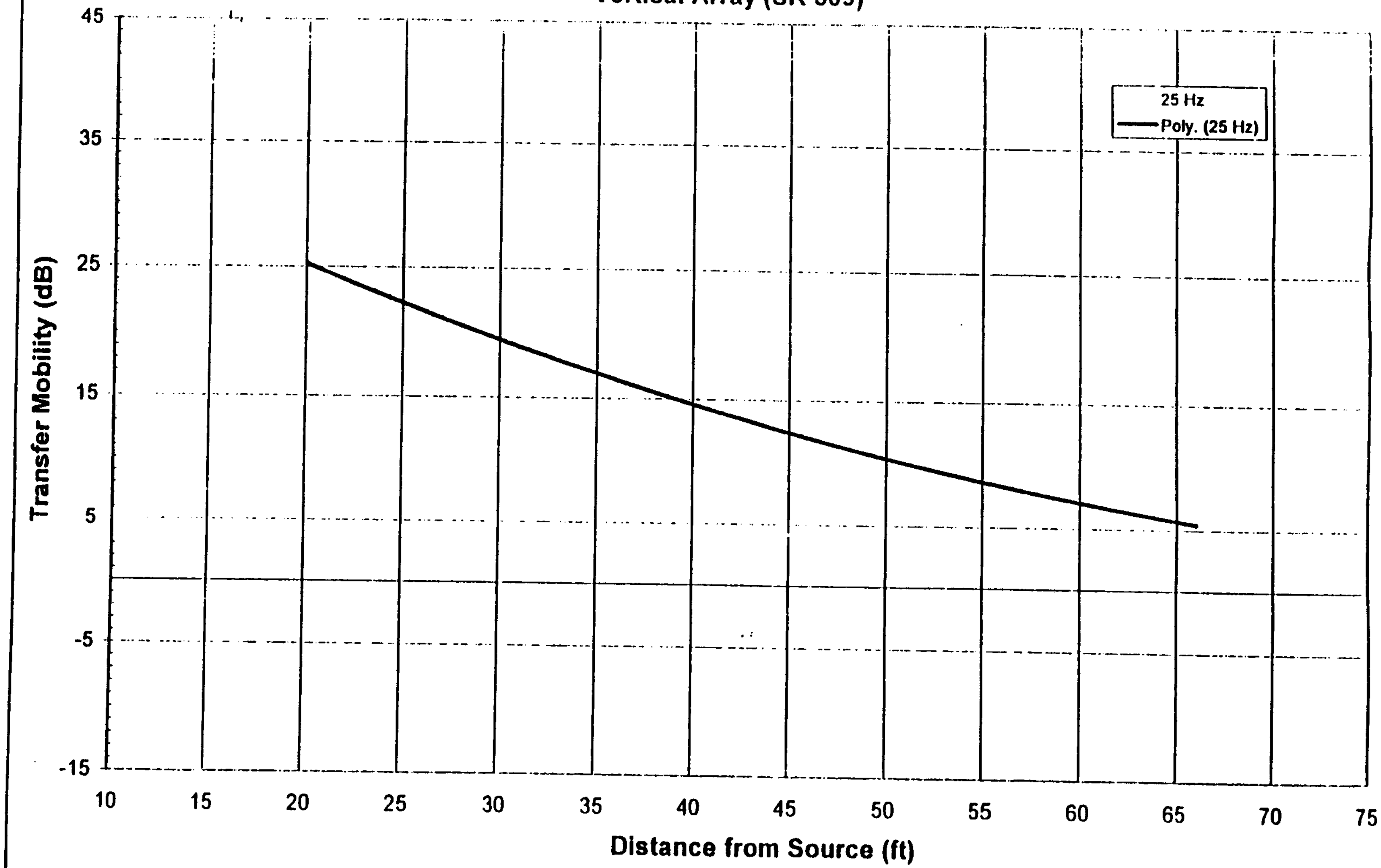


Figure 4.

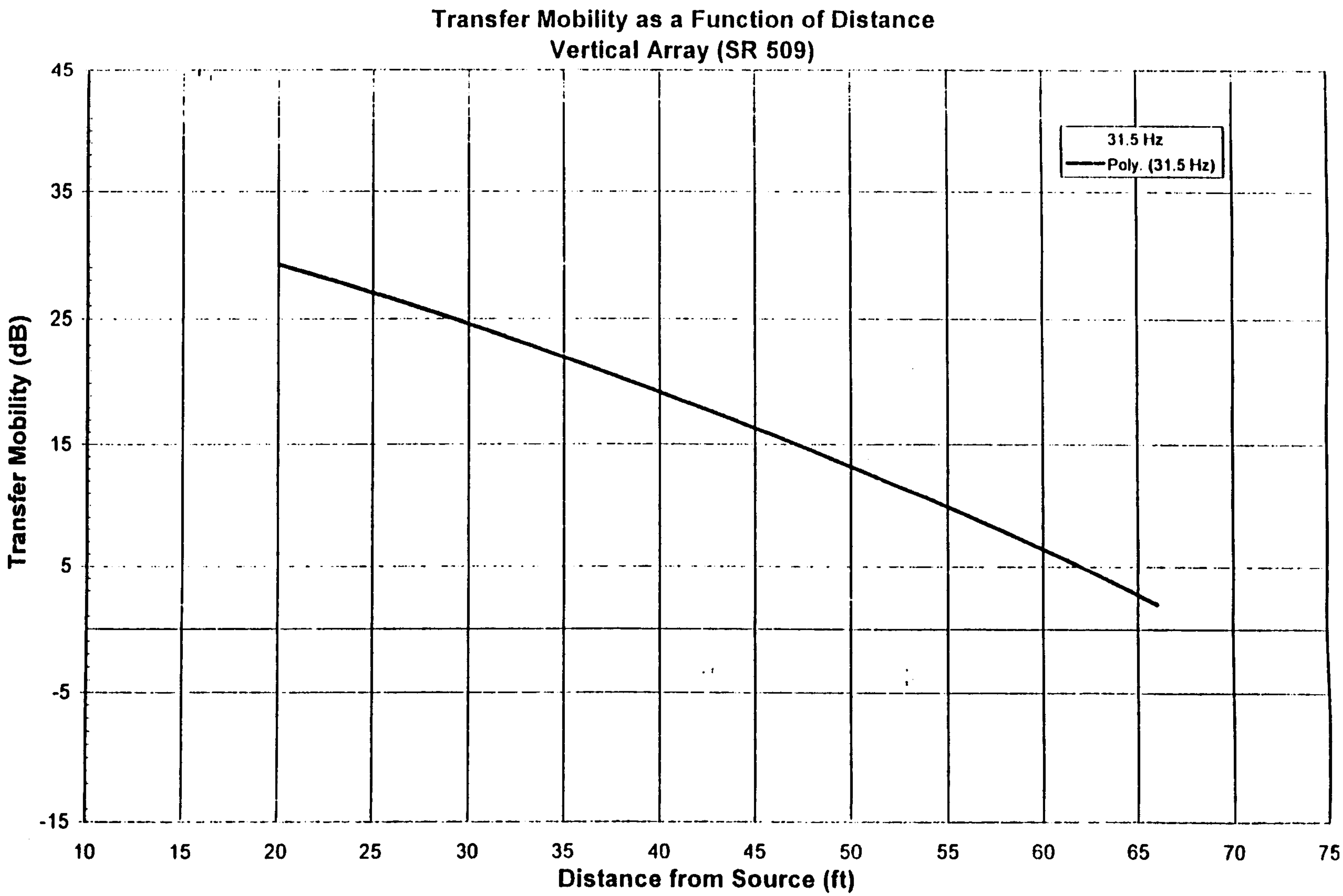
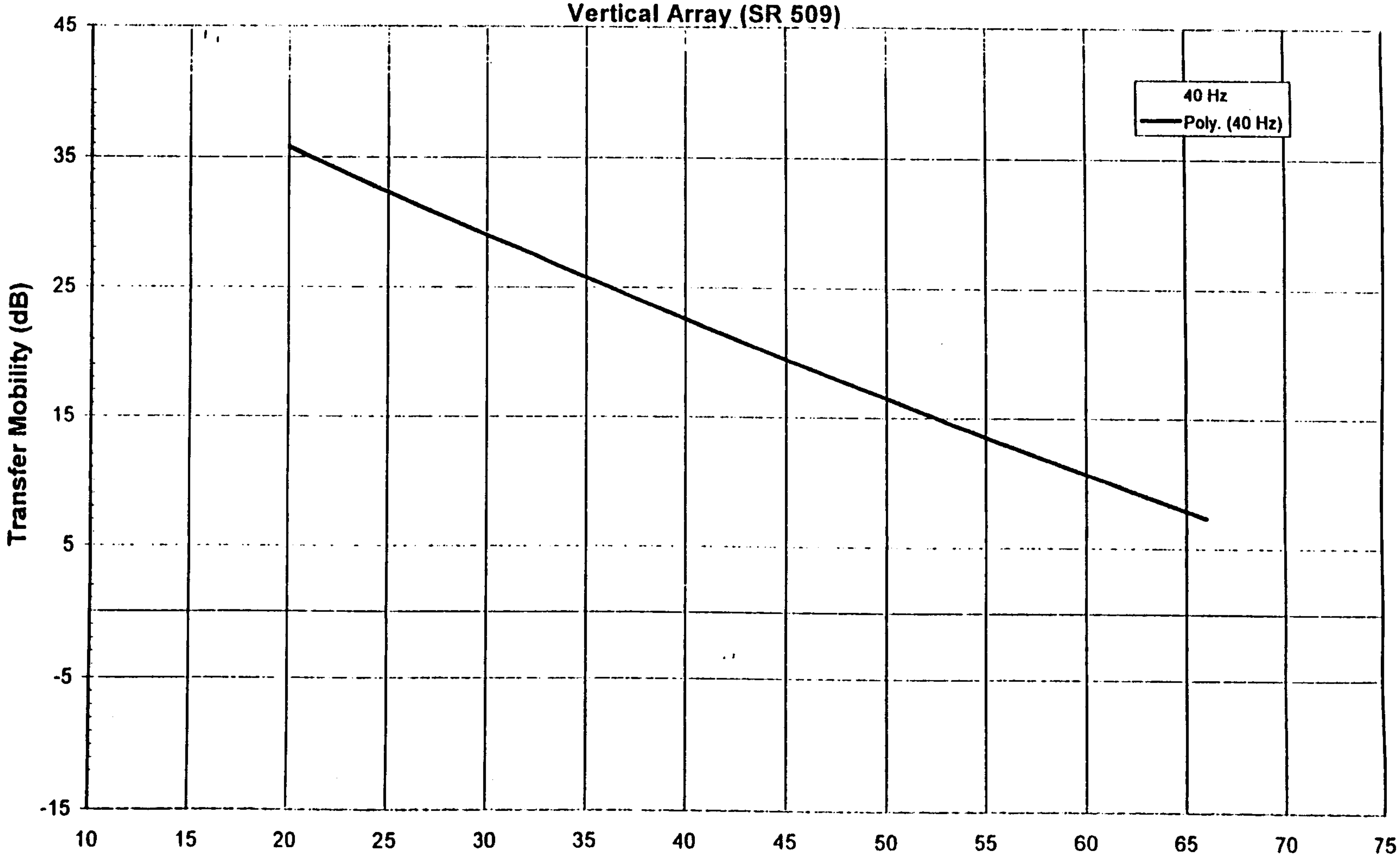


Figure 5.

AR 044203

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)



Distance from Source (ft)

Figure 6.

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)

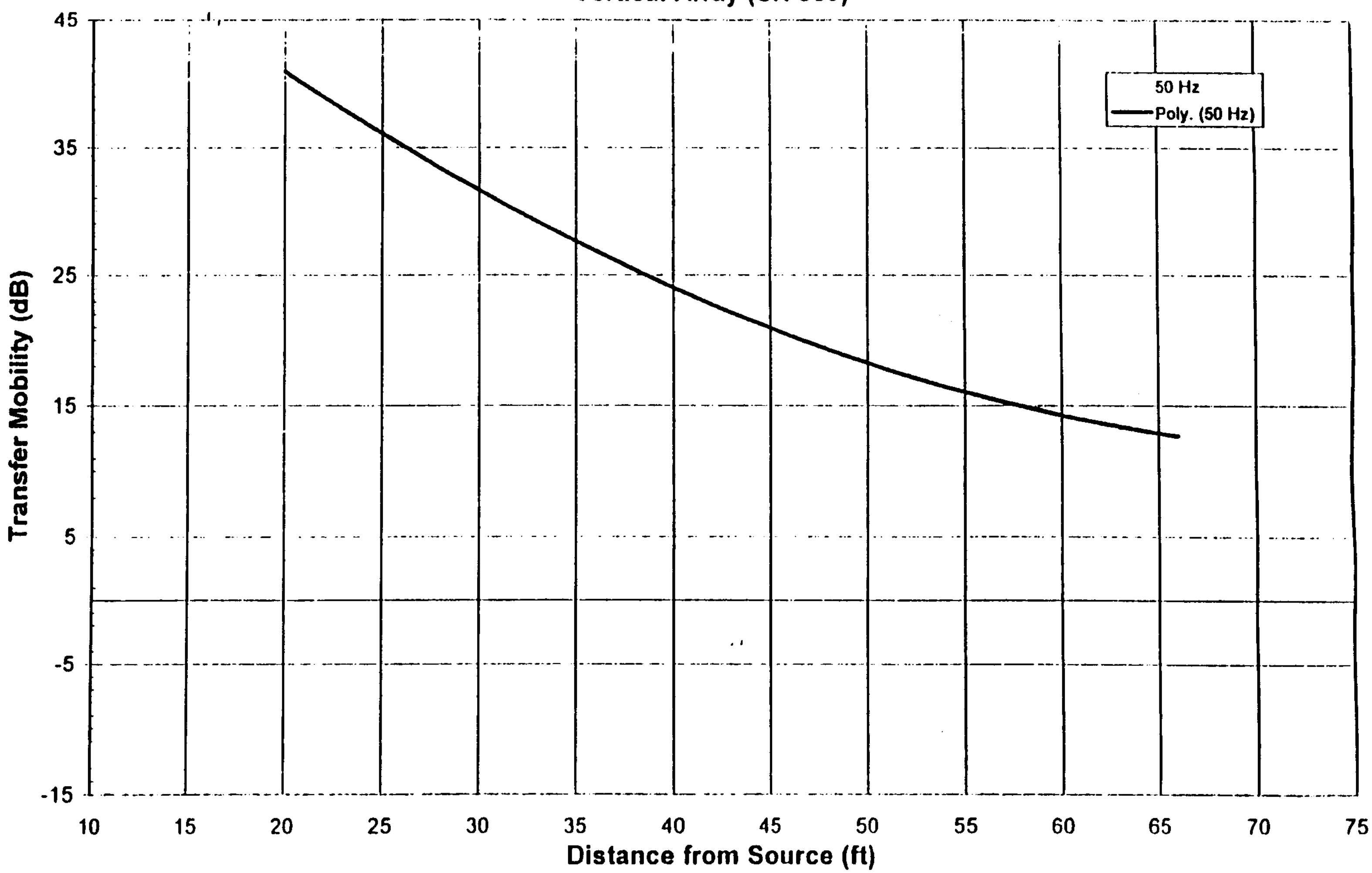
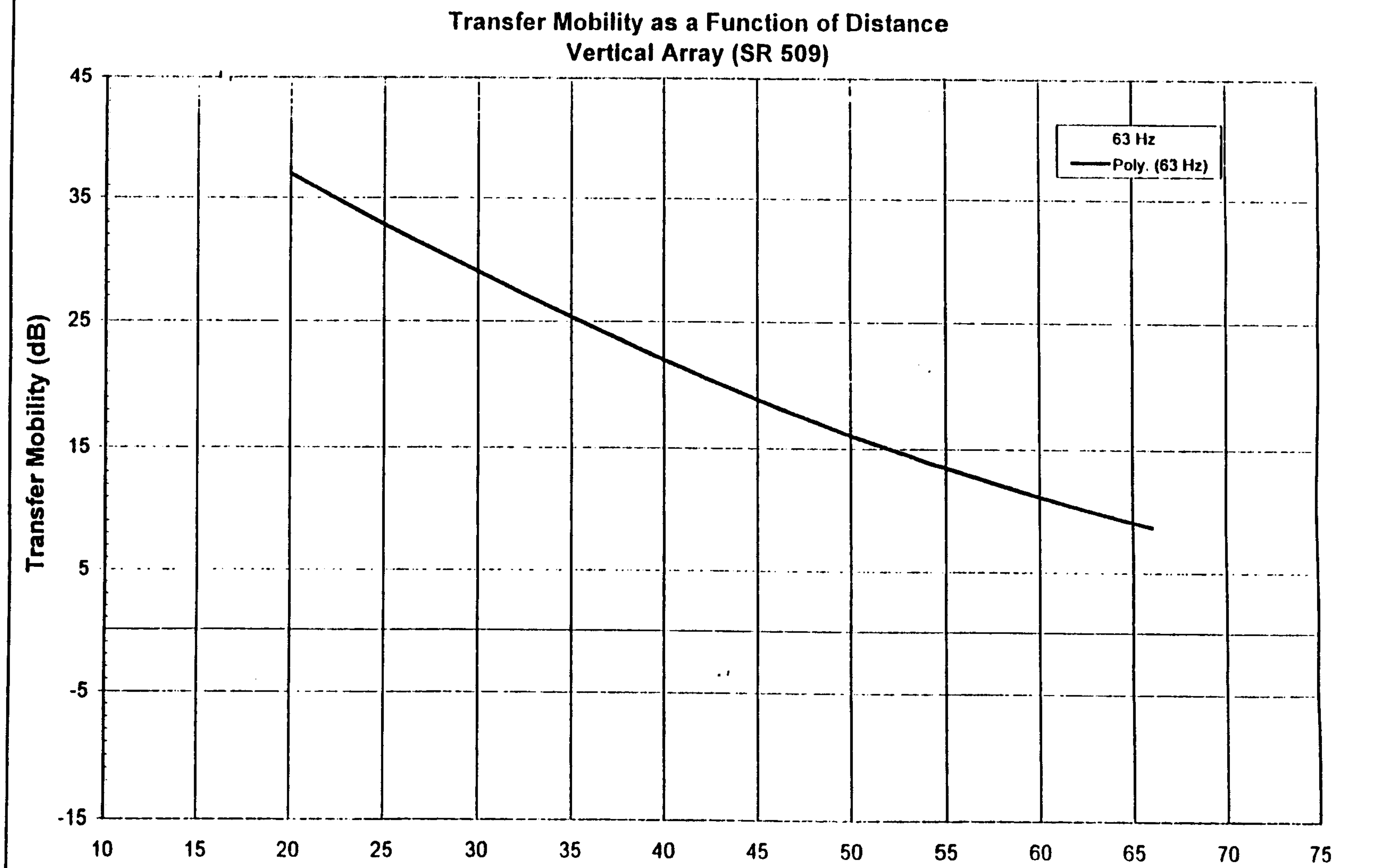


Figure 7.


Transfer Mobility as a Function of Distance
Vertical Array (SR 509)
45
35
25
15
5
-5
-15
Transfer Mobility (dB)
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance from Source (ft)
63 Hz
Poly. (63 Hz)
Figure 8.

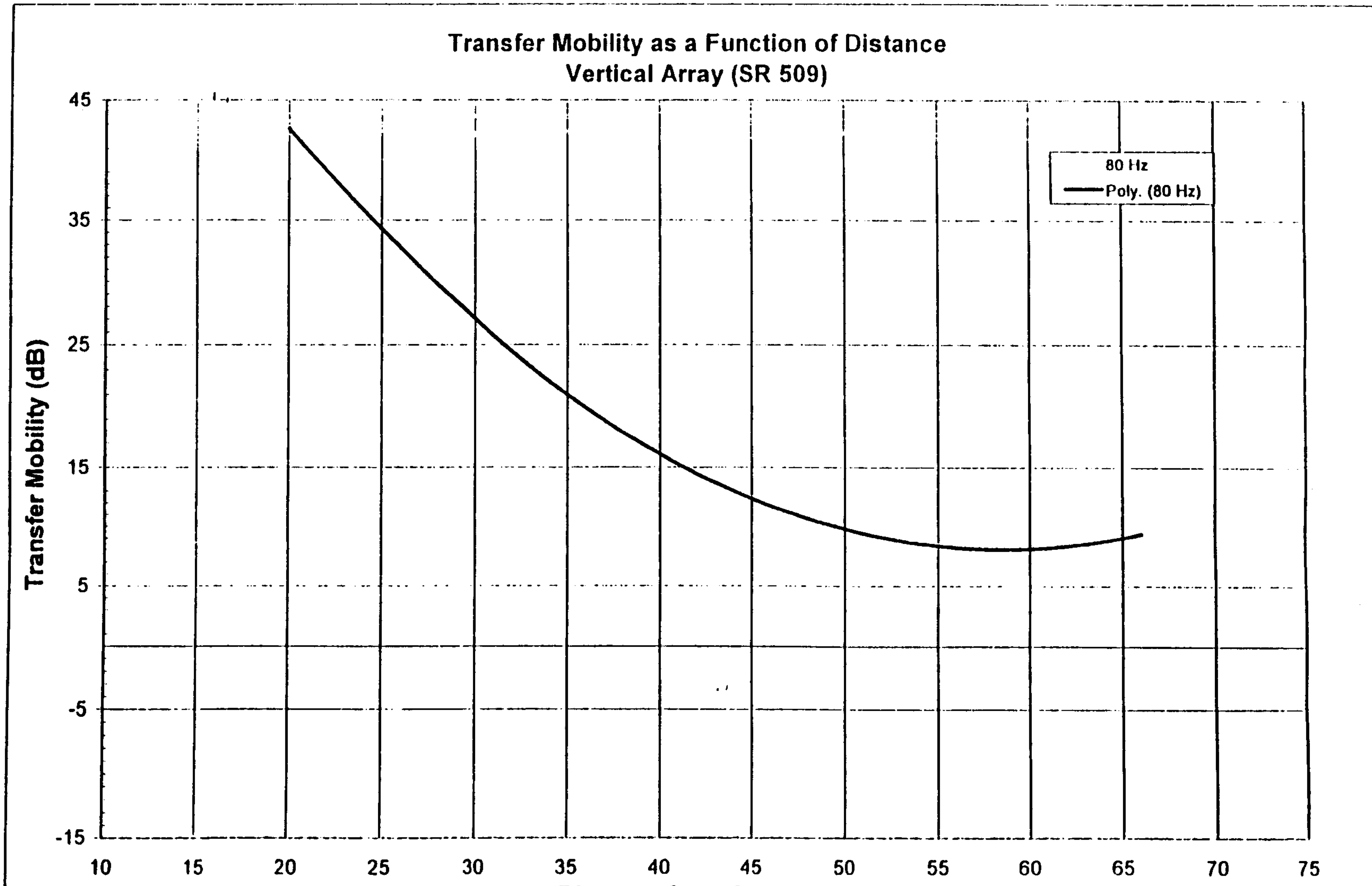

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)
45
35
25
15
5
-5
-15
Transfer Mobility (dB)
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance from Source (ft)
80 Hz
Poly. (80 Hz)

Figure 9.

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)

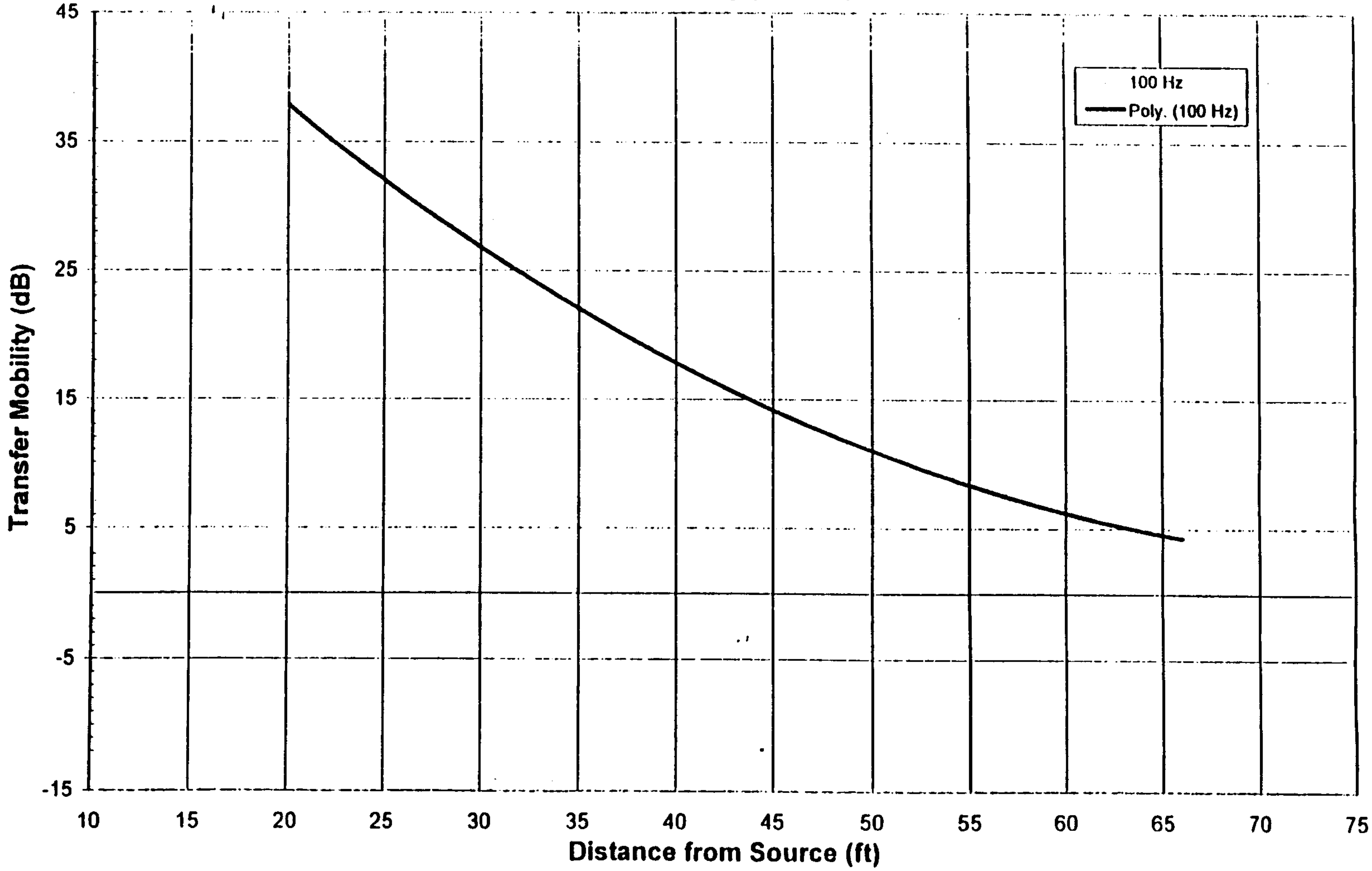
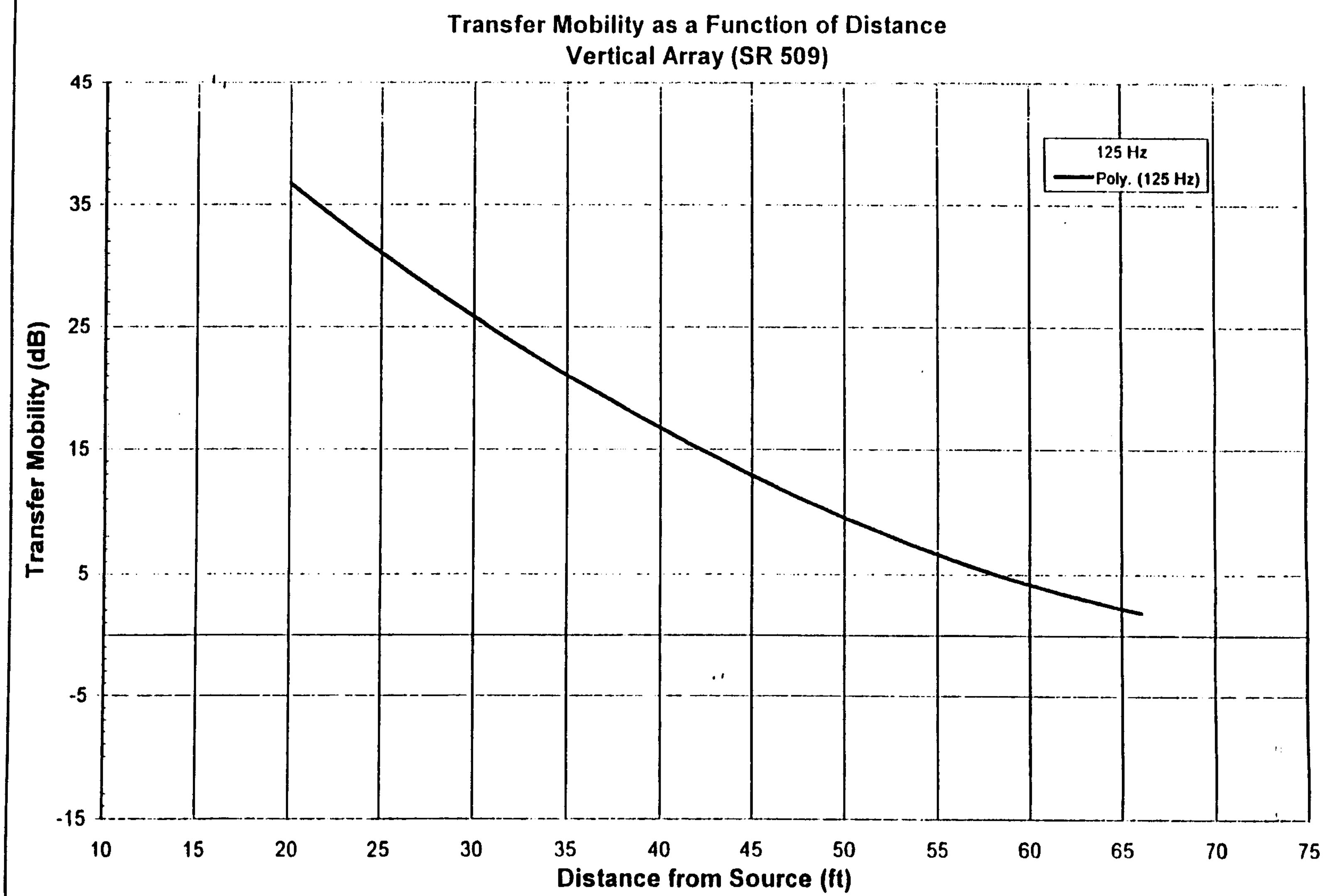


Figure 10.



Transfer Mobility as a Function of Distance
Vertical Array (SR 509)
Transfer Mobility (dB)
45
35
25
15
5
-5
-15
125 Hz
Poly. (125 Hz)
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance from Source (ft)

Figure 11.

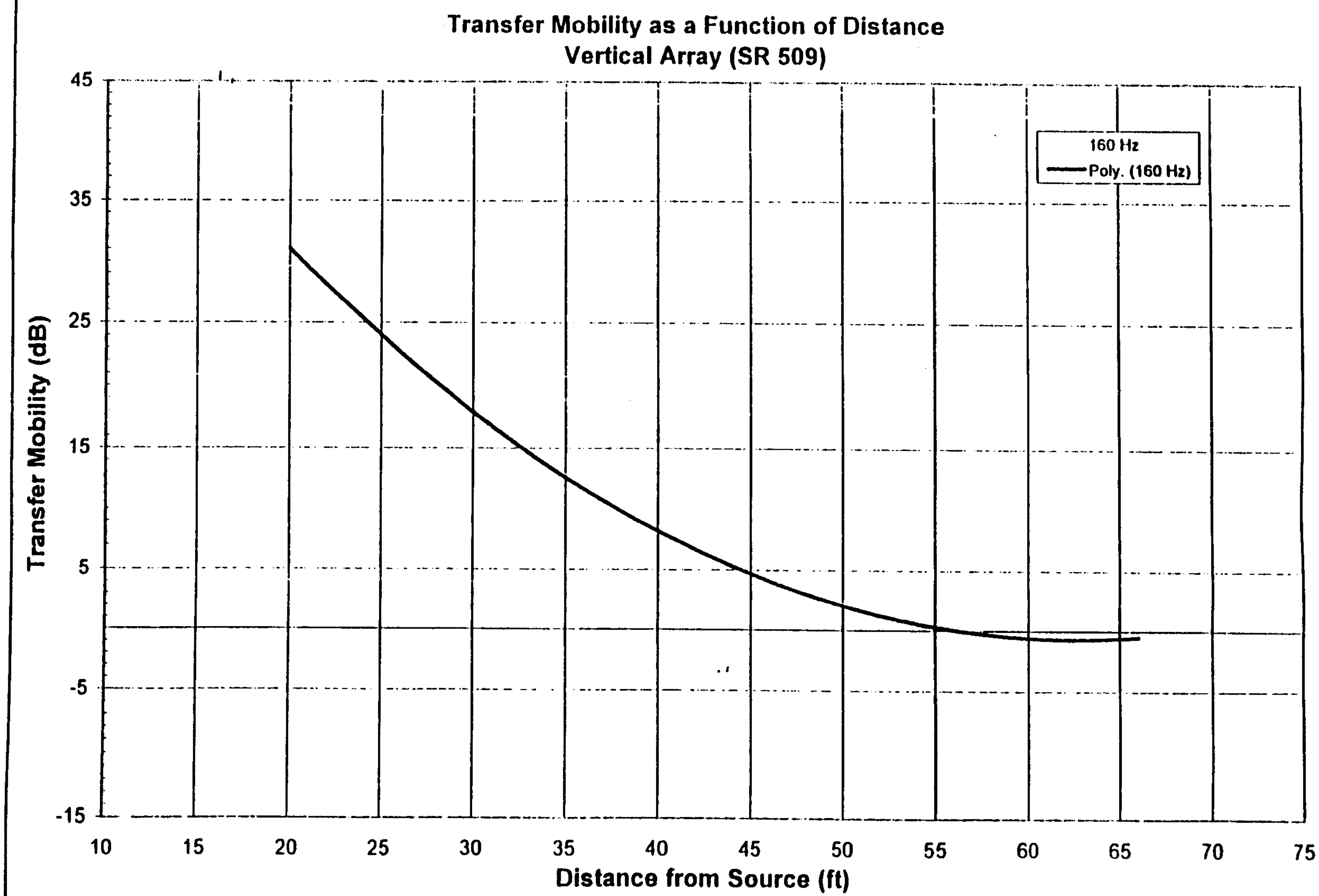
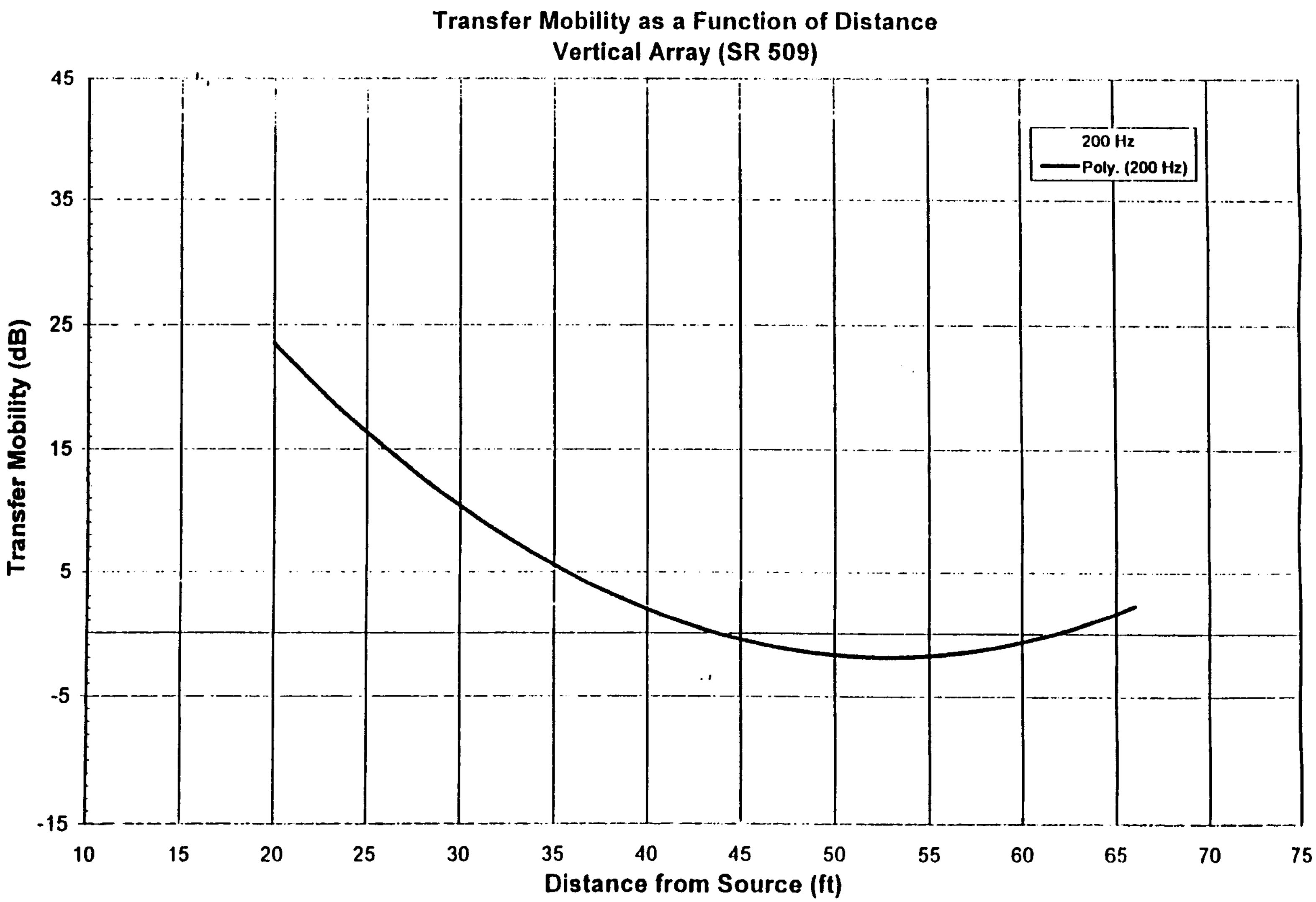
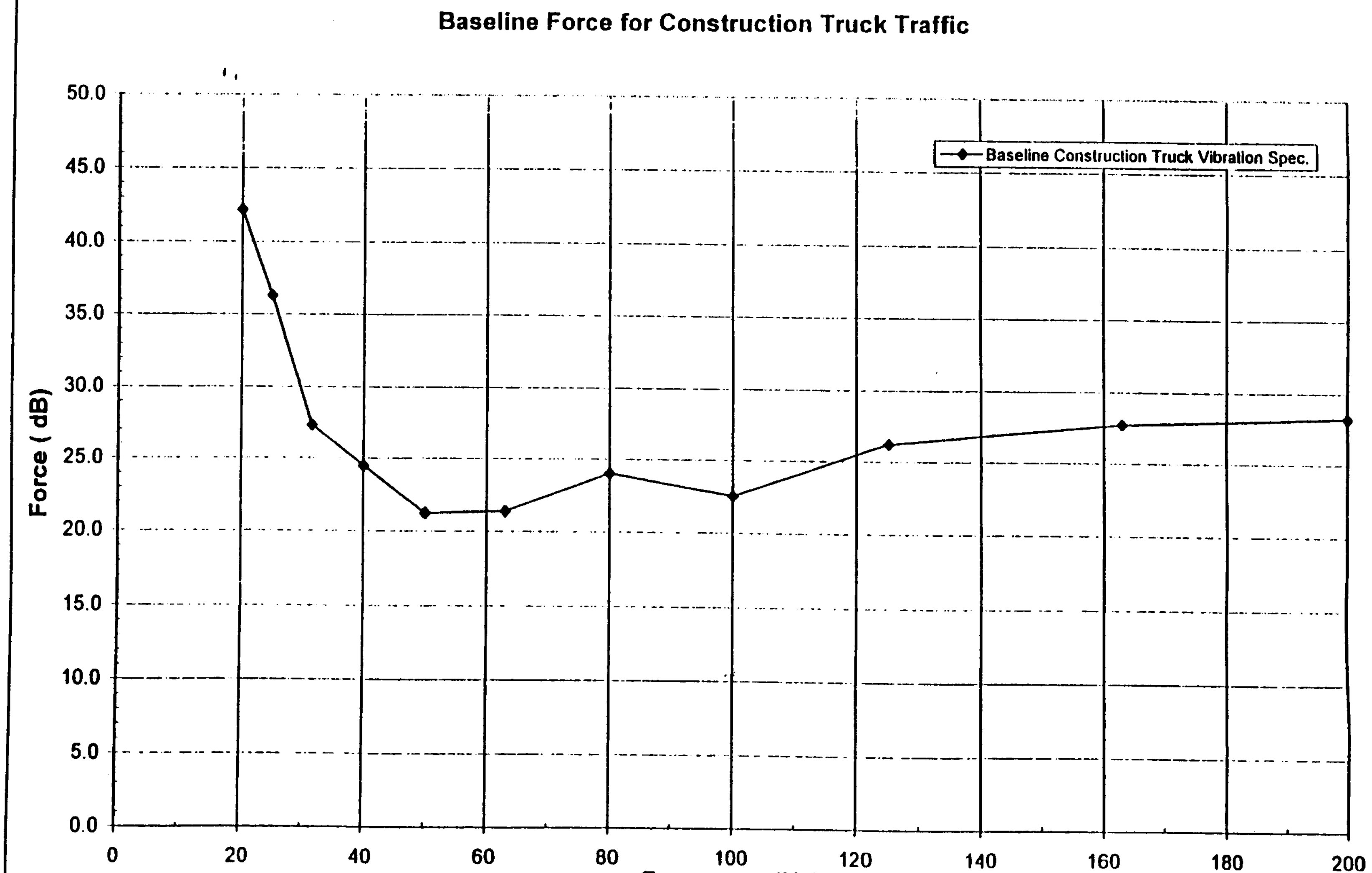

Transfer Mobility as a Function of Distance
Vertical Array (SR 509)
Transfer Mobility (dB)
45
35
25
15
5
-5
-15
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance from Source (ft)
160 Hz
Poly. (160 Hz)

Figure 12.



Transfer Mobility as a Function of Distance
Vertical Array (SR 509)
45
35
25
15
5
-5
-15
Transfer Mobility (dB)
200 Hz
Poly. (200 Hz)
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance from Source (ft)

Figure 13.



Baseline Force for Construction Truck Traffic
Baseline Construction Truck Vibration Spec.
Force (dB)
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
20
40
60
80
100
120
140
160
180
200
Frequency (Hz)

Figure 14.

Predicted Velocity Level
Nearest Residence 37 Feet from Access Road

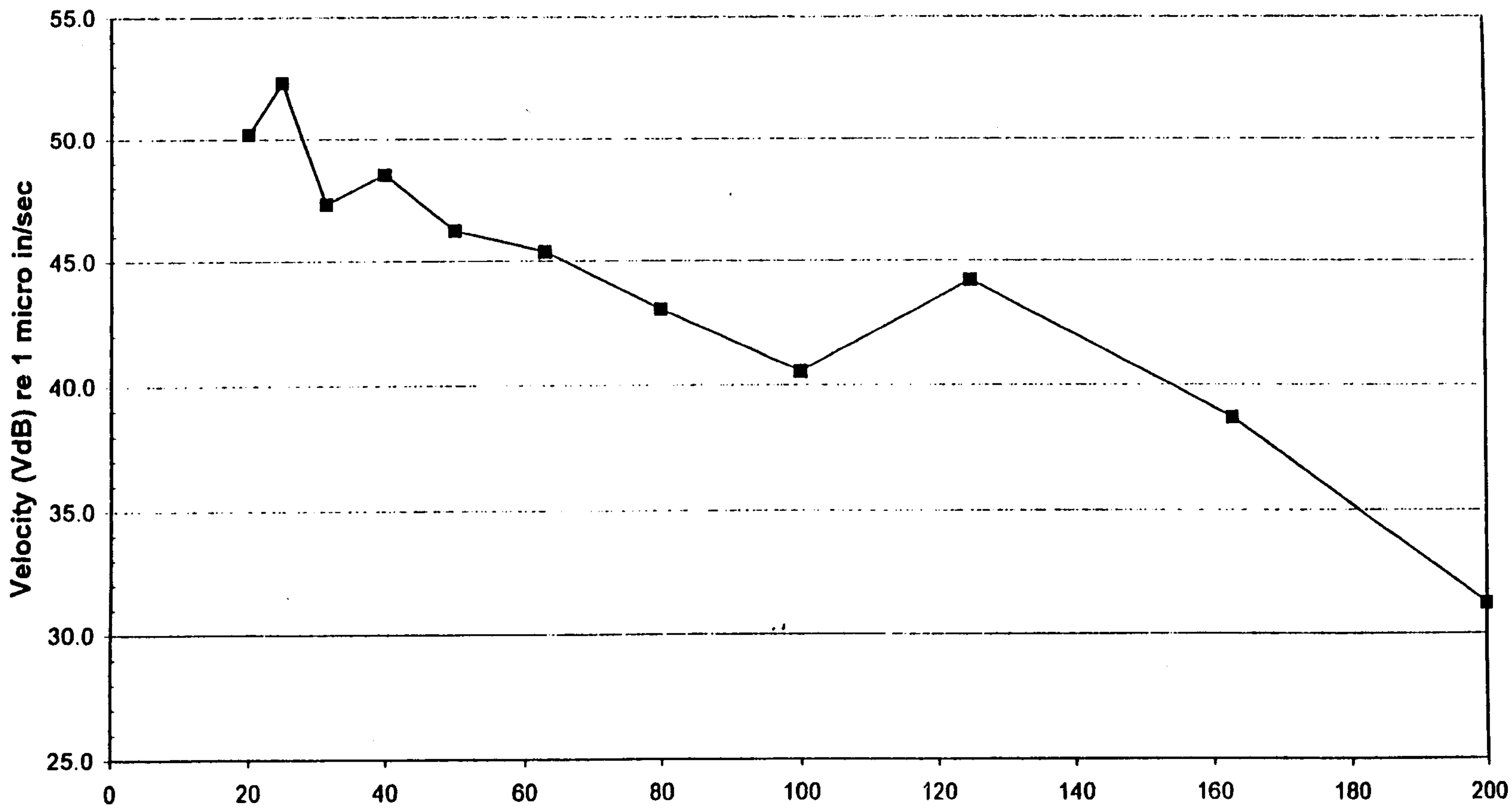


Figure 15.