The Flight Plan Project

Final Environmental Impact Statement

October 1992

Puget Sound Regional Council

Port of Seattle

1060

October 6, 1992

Re: Flight Plan: Non-Project (Programmatic) Final Environmental Impact Statement (FEIS)

Dear Reader:

The central Puget Sound region is faced with growing demand for commercial air transportation services and a limited capacity at the existing Seattle-Tacoma International Airport (Sea-Tac). Without expansion of airport capacity or other steps to address the increase in mid- to long-range travel needs, the result will be delays for air travelers, which could ultimately affect the region's economy. The solution to this challenge must strike a balance between environmental impacts, quality of life factors, and the travel needs of the region's populace.

The Flight Plan Project has been a joint effort of the Puget Sound Regional Council and the Port of Seattle. The project was initiated by the Puget Sound Council of Governments (predecessor to the Puget Sound Regional Council) and the Port of Seattle to research airport system alternatives to meet the region's long-term air transportation needs. (On October 1, 1991 the Puget Sound Council of Governments (PSCOG) was dissolved and replaced by the Puget Sound Regional Council.) The PSCOG and the Port established the Puget Sound Air Transportation Committee (PSATC), which was composed of citizens, elected officials and private sector interests, to propose solutions to the region's air transportation needs. The Flight Plan's Draft Report, prepared by the Regional Council and the Port of Seattle and issued on January 7, 1992, included a non-project, draft environmental impact statement (DEIS) regarding the PSATC's advisory recommendations. Section 1.1.3 of this FEIS describes the changes from the DEIS incorporated into the final EIS.

The Regional Council and Port of Seattle then sponsored eleven public hearings to solicit comments from private citizens on the DEIS and draft proposal of the PSATC. Responses to the oral and written comments from the public review process are reflected in this Final Environmental Impact Statement as refinements and modifications to the presented alternatives, supplemental information and factual corrections. The public review comments are reproduced in three supplemental volumes to this FEIS. (These comments are responded to by cross-referencing from the letters in the supplements to the appropriate section of the FEIS or by cross-referencing to a set of supplemental responses contained in Appendix E.) Following the public review process, the PSATC adopted its final recommendation. See Section 1.5 and Appendix A.

It is important to note that there is no agency-preferred alternative in this non-project FEIS. The purpose of the FEIS is to present and compare system-level alternatives for meeting forecasted travel needs. Additional site specific information will be developed (and subsequently presented in project-level EISs) after a system-level alternative has been selected. The Regional Council does provide for an optional administrative appeal process for reconsidering the adequacy of its FEISs.

The following key issues are addressed in the FEIS.

1. **What are the major implications and trade-offs between the regional alternatives?**

Section 1.0 summarizes the implications and trade-offs of the system-level alternatives. Section 2.0 presents the problems statement; Section 3.0 describes the system-level alternatives; and Section 4.0 describes the significant environmental impacts and identifies potential mitigation measures.

2. **What is the probable long-term demand for commercial transportation?**

The Flight Plan Project addresses future commercial air transportation demand and capacity. The forecasts establish thresholds from which a preferred future can be selected from a family of alternative futures. However, in terms of making a system-level decision, it is not as important to know when these thresholds will be reched as it is to know that there will be capacity limitations in the future. Section 1.1 summarizes both the population and employment forecasts for the region and the air passenger and aircraft operation forecasts derived from the regional forecasts. Section 2.0 discusses in detail the demand forecasts and related points.

3. **What are the alternative regional air transportation systems?**

Alternatives range from no-action, to building a new airport, to phased distribution of service to Sea-Tac and other existing or new airport sites. Mitigation, demand management, and institutional elements may also be part of a comprehensive action package. Section 1.2 briefly presents the system-level alternative airport configurations; Section 3.0 describes them in detail. The evaluation methodology is described in Section 3.7.

4. **What are the impacts with respect to noise, air quality, land use, and other community factors?**

The environmental impacts of the system alternatives are summarized in Section 1.3. More detailed analyses for each assessment are presented in the corresponding parts of Section 4.0, including the discussion of potential mitigation measures and the identification of unavoidable adverse impacts.

5. **How does commercial air transportation capacity planning relate to other regional planning activities?**

Regional air transportation decisions must be compatible with other regional decisions regarding the economy, high capacity transit, high-speed ground transportation, intermodal transportation planning required under new federal legislation, and especially comprehensive growth management planning required under the state Growth Management Act. Two fundamental considerations in this planning are the use of common growth forecasts and the importance of airport site identification and preservation to meet long-term needs. Many of the planning and timing relationships are explored in Sections 3.8 and 4.4.6, and Appendix B.

The Regional Council is scheduled to adopt an amendment to the Regional Airport System Plan (RASP) for the long-term commercial air transportation capacity needs of the region in March 1993. Major considerations will be the Flight Plan FEIS, public comment, review by the Washington State Air Transportation Commission of the PSATC's demand and capacity assessment, research by the High Speed Ground Transportation Commission, and additional information to be developed by the Council between now and when it makes its decision. In addition, subsequent site and project level analyses and actions are required of several other agencies, depending upon the regional system-level action taken.

Sincerely,

Gerald D. Dinndorf

Gerald D. Dinndorf, Responsible SEPA Official
Puget Sound Regional Council

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FACT SHEET

BRIEF DESCRIPTION	This non-project Final Environmental Impact Statement (FEIS) evaluates the impacts of five different airport system alternatives and a variety of options within each alternative to provide for the long-term commercial air transportation needs of the central Puget Sound region. The FEIS does not identify an agency preferred alternative.
TENTATIVE DATE OF IMPLEMENTATION	The Regional Council plans to submit an amendment to the Regional Airport System Plan (RASP) for long-term commercial air transportation capacity needs of the region to the Executive Board and General Assembly for approval in February and March 1993, respectively. The Port of Seattle Commission is scheduled to consider the PSATC recommendations this fall.
LEAD AGENCY	The Regional Council and the Port of Seattle are co-lead agencies for the FEIS, which is published in partial fulfillment of the requirements of the State Environmental Policy Act (SEPA)(Chapter 43.21C RCW) and the SEPA Rules (Chapter 197-11 WAC). The Regional Council holds nominal lead responsibility (WAC 197-11-944). The Regional Council is lead agency for the Regional Transportation Plan (the Regional Airport System Plan is a component). The Port of Seattle is the lead agency for decisions and actions at Seattle-Tacoma International Airport. Puget Sound Regional Council (nominal lead agency) 216 First Avenue South Seattle, Washington 98104 Port of Seattle (co-lead agency) Seattle-Tacoma International Airport P.O. Box 68727 Seattle, Washington 98168
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DRAFT EIS DATE OF ISSUE	7 January 1992

FINAL EIS DATE OF ISSUE	October 6, 1992
COMMENTS	The period for public comment on the Draft Environmental Impact Statement (DEIS) occurred between 7 January 1992 and 23 March 1992.
TIME AND PLACE OF PUBLIC HEARINGS	The Regional Council and Port of Seattle received public comments on the DEIS at eleven public hearings held during the public review period at the following locations: Everett, Mukilteo, Seattle, SeaTac, Bremerton, Tacoma, Lakewood, Olympia, Tumwater, Federal Way, and Arlington.
FINAL ACTION	The Regional Council plans to submit an amendment to the Regional Airport System Plan (RASP) for long-term commercial air transportation capacity needs of the region to its Executive Board in February and its General Assembly in March 1993. This date is subject to change. The Assembly's approval of the amendment constitutes the final action of the Council. The Port of Seattle Commission plans to submit the FEIS to its Commission in Fall 1992 .
SUBSEQUENT ENVIRONMENTAL REVIEW	The Flight Plan Project is considered to be a "nonproject proposal" (WAC 197-11-442). It describes a regional program, a broad package of proposed policies for implementing agencies to follow in meeting future commercial air transportation system needs. The sponsoring agencies recognize that subsequent siting and project-level environmental reviews will be necessary. The Regional Council and the Port of Seattle have not determined when these reviews will take place, but have addressed in the FEIS how all of this work relates to a range of regional and local planning activities in the service area.
COST	The FEIS is distributed to those agencies and others listed on the Distribution List (Appendix F), including public libraries throughout the region. Additional copies of the FEIS may be purchased from the Regional Council Information Center (206-464-7532) or the Port of Seattle Noise Remedy Office at the Maywood School (206-431-5913) for $10.00. Supporting documents can also be purchased for additional cost at these same locations.

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1.0 SUMMARY and DECISION CONTEXT

The Final Environmental Impact Statement (FEIS) is divided into four major sections. These are: (1.0) the **Summary and Decision Context**; (2.0) the **Problem Statement: Air Capacity Issues**; (3.0) the **System-level Alternatives**; and (4.0) the **Affected Environment, Significant Impacts and Mitigation.**

The commercial air transportation capacity planning alternatives presented in this FEIS are discussed within the context of several other new regional planning activities affecting land use and surface transportation. Activities in these other areas contribute to the uncertainty of the long-term impacts, but also provide substantial opportunities for mitigation.

The system level alternatives included in the FEIS present a range of actions: capacity improvements at Seattle-Tacoma International Airport, the development of a multiple airport system, the replacement of Sea-Tac with a new airport, and the no action alternative. The major implications of these actions are summarized below:

- Improvements at the existing Sea-Tac International Airport focus on operational concerns. At present aircraft are limited to using a single runway during bad weather conditions. Actions to resolve this situation could also reduce other problems related to inefficient operations, such as near-term noise.

  There are three main options related to improvements at the present Sea-Tac site: (1) **broad system management**, (2) a new **dependent third runway**, and (3) a **remote airport** operated in tandem with Sea-Tac.

  1) A **broad system management** strategy at Sea-Tac includes (a) **demand management** strategies, (b) the development of **new technologies**, and (c) the use of **high speed rail** in the I-5 corridor. **Demand management** includes a range of pricing and regulatory techniques. Such management techniques may be effective in moderating the impact of increased commuter traffic at Sea-Tac and may defer the need for other actions for some time. **New technologies** can play an important role in making the most efficient use of existing airport facilities, but are not a solution to capacity needs. **High speed rail** would reduce the number of commuter flight operations in the I-5 corridor. The estimated cost for a rail system is $10 billion. Projections indicate that rail would reduce total forecasted operations by about eight percent in the year 2020.

  2) A new **dependent third runway** at Sea-Tac would allow two staggered streams of aircraft to land during bad weather. A third runway would increase capacity and reduce noise, since fewer operations would spread into early morning and later nighttime hours.

  3) A **remote airport** such as Boeing Field or Moses Lake (Grant County Airport) requires a ground link on dedicated right-of-way to work, and is most effective when there are large numbers of connecting passengers. Since Sea-Tac has a low number of connecting passengers, this alternative is not as effective in meeting capacity needs. A remote airport at Boeing Field would likely be used for commuter flights, while a remote airport at Moses Lake would likely be used for transcontinental or overseas international flights.

- The **multiple airport** system alternative includes Sea-Tac and supplemental passenger service airport(s) to the north and/or the south of Sea-Tac. The alternative adds new noise to the supplemental sites.

- A **replacement airport** dismantles the existing Sea-Tac Airport. The major trade-off is between reducing community impacts at the present site versus creating large air quality impacts on a regional basis. These air quality impacts would be due to the increased vehicle miles that would be traveled to reach a potential replacement site. Additional impacts include loss of open space and impacts to the natural environment.

- The **no-action** alternative brings economic risks and exposes the greatest number of people to moderately loud noise. Next to the replacement airport, this alternative produces the greatest amount of air pollutants. Economic impacts are not the subject of this FEIS, but should be weighed alongside the environmental impacts of the alternatives.

1.1 PROBLEM STATEMENT

The purpose of the Flight Plan Project is to plan for the future air transportation needs of the central Puget Sound region through the year 2020 and beyond. Without demand mitigation strategies, the increasing popularity of air travel and growing population of the region will create a demand that is forecasted to saturate the existing operational capacity at Sea-Tac Airport before the year 2000. (Efficient capacity is defined in Section 2.3, and illustrated in Figures 1-1, and 1-2.) Increasing demand without increasing airport capacity in the region will result in longer and longer delays for air travelers and ultimately will hurt the trade-oriented regional economy.

The Flight Plan Project addresses future commercial air transportation demand and capacity. Alternatives are evaluated against forecasted future demand, but are not dependent upon precise dates as to when these activity levels will be achieved. The need to make a regional decision regarding future regional commercial air transportation service is driven by both the demand forecasts and, equal to this, the possible loss due to inaction of available long-term alternative sites.

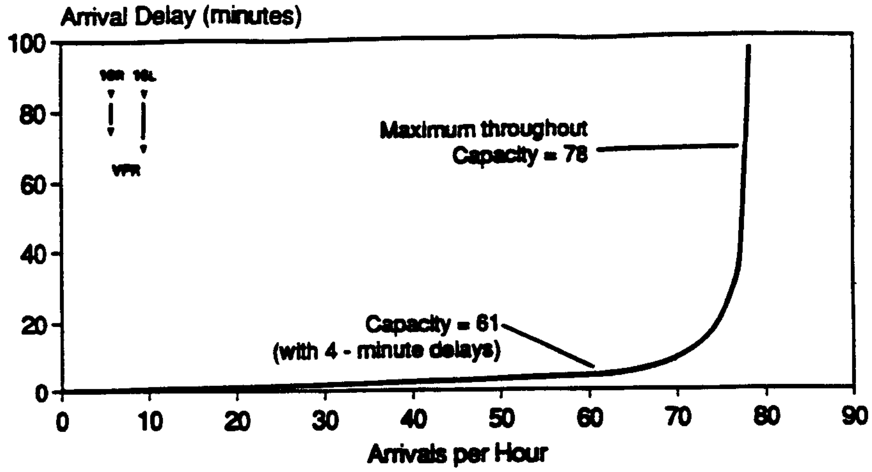
In addition, the relationship between commercial air transportation decisions and other growth management decisions needs to be understood. The current reduction in aircraft capacity at Sea-Tac Airport during poor weather conditions also is addressed. Finally, the relationship between commercial air transportation planning and other regional growth management decisions is discussed.

Regional Growth Forecasts

Regional population and employment forecasts developed during the Puget Sound Council of Governments' (PSCOG) VISION 2020 planning process were used in Flight Plan. VISION 2020 has subsequently been adopted as the Regional Growth and Transportation Strategy by the succeeding agency and current participant in the Flight Plan Project, the Puget Sound Regional Council (Regional Council). These forecasts for the four-county region (King, Kitsap, Pierce, and Snohomish counties) projected a 61 percent increase in population and a 72 percent increase in employment between 1988 and 2020. These numbers were used as input to the air travel demand forecasts produced during Phase I of

Figure 1-1

Airport Delay Curve, Current Runway Configuration

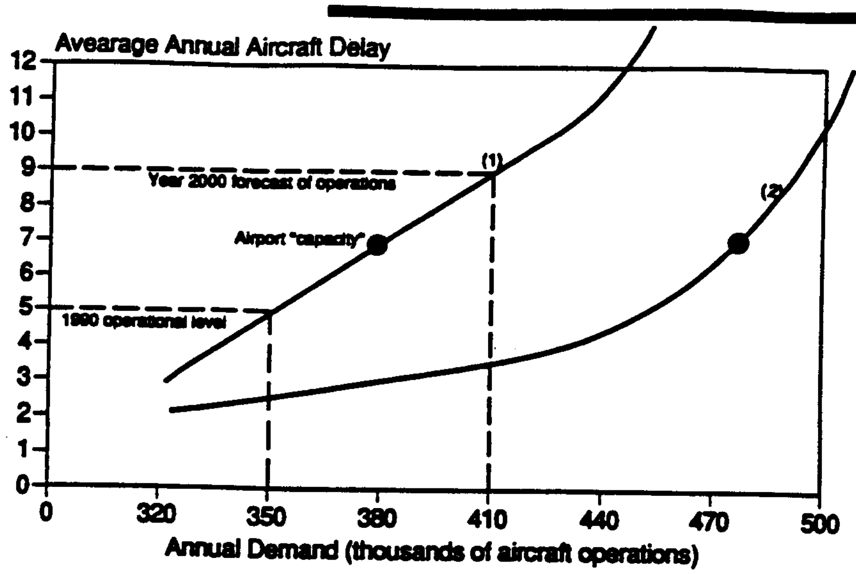


Source: Seattle-Tacoma International Airport Capacity Enhancement Plan, June 1991, Figure 11.

Note: As dramatic increases in delay continue, system management actions moderate this curve. These include adjustments by the airlines and delayed departures (to Seattle) at other airports. This is presented in Section 3.2.1.1.

Figure 1-2

Annual Demand
(thousands of aircraft operations)



Source: Operational Analysis - Capacity Estimates for Airport Options, Flight Plan Options Subcommittee Working Paper, Turner Collie & Broden Inc., February 22, 1991.

Notes: (1) existing runways
(2) new air carrier runway

the Flight Plan Project (ended in July 1990). The forecasts indicate strong regional growth over the next several decades. The current population of 2.7 million is forecasted to grow by 1.3 million for a total of 4.0 million in 2020.

Flight Plan Air Passenger and Aircraft Operations Forecasts

Commercial air passenger demands are forecasted by Flight Plan to increase more rapidly than population or employment. Passenger demand is forecasted to nearly triple between 1990 and 2020, from 16.2 million annual passengers to 45 million annual passengers. This is not only driven by population and employment growth, but also by rising overall per capita demand. A state commission is currently reviewing the Flight Plan forecasts. Their report is due December 1, 1992.

Between 1970 and 1990, passenger volumes more than tripled from 4.6 million annual passengers to today's level of over 16 million. This represented nearly a doubling in per capita demand. Due to anticipated increases of average commuter and heavy passenger aircraft size, the total aircraft operations (landings and takeoffs) needed to accommodate the forecasted passengers are expected to increase from 355,000 arrivals and departures in 1990 to 411,000 in the year 2000 and 524,000 in the year 2020. However, Sea-Tac only has adequate capacity to handle 380,000 aircraft operations per year with minimal delay and related impacts. Above this level, average delay will rise rapidly and could routinely exceed one hour. Sea-Tac with Broad System Management may serve to alter the actual dates when these activity levels will be reached, although the forecasts do include the use of larger aircraft.

With the current runway configuration, the airplane arrival delay increases rapidly beyond a certain level of operations. This is shown in Figure 1-1 for those times when aircraft are arriving and departing in a south direction (71 percent of the time, see Table 2-5). While many variables come into play, average annual delay can also be modeled for existing and possible runway configurations. Figure 1-2 shows that as annual operations increase, the average annual delay could nearly double between 1990 and 2000 (for example, rising from five minutes to nine minutes). It also illustrates that if a new air carrier runway were built (one component of several regional airport system alternatives presented in Section 3.2.2), delays would be held to a lower level (seven minutes) even as average annual operations increase (to 480,000). The average delay figures mask the individual flight delays of over one hour which can be expected during peak travel periods and during bad weather if no action is taken.

1.1.1 The Regional Airport System Plan (RASP) and the FEIS

The proposed action of the Puget Sound Regional Council and the Port of Seattle is to comprehensively address and resolve the commercial air transportation capacity issues. The solution should also acknowledge other community capacity measures.

One of the purposes of the Flight Plan project is to provide input for updating and amending the Regional Airport System Plan (RASP). The RASP is part of the Regional Transportation Plan (RTP) maintained by the Regional Council to meet the near- and long-term transportation needs of the region. The RASP was last amended in 1988. The airport system plan is important not only to the region, but also to the entire Pacific Northwest.

1.1.1.1 What is Flight Plan?

As part of the commercial air transportation capacity planning effort, in 1989 the Puget Sound Council of Governments and the Port of Seattle appointed and co-sponsored a broad advisory committee, the Puget Sound Air Transportation Committee (PSATC). The Committee was a 39-member volunteer group made up of citizens, local and state elected officials, representatives of the business and aviation communities, and environmental interests from King, Snohomish, Pierce, Kitsap and Thurston counties. The PSATC researched air transportation needs, identified a wide range of possible solutions, and developed a PSATC recommendation to the sponsoring agencies. Numerous documents and study products were developed for flight plan (including a draft final report and draft EIS). Those products were used to help develop this FEIS and are hereby incorporated by reference.

The PSATC study products, findings, and recommendations comprise the Flight Plan Project and are hereby incorporated by reference.

The PSATC recommendation was completed and transmitted to the sponsoring agencies on June 17, 1992. The Flight Plan work, of which the PSATC recommendation is a component, provides a long-term planning perspective for addressing capacity requirements and air carrier system capacity thresholds starting with the year 2000 and then well beyond (e.g., 2020 to 2050), with a range of alternative system-level solutions. The PSATC recommendation calls for a multiple airport system which includes a new dependent third runway at Sea-Tac.

In addition to a RASP amendment (in March 1993), the implementation of a commercial air transportation capacity decision will require amendments to the plans of the Port of Seattle and possibly to the master plans of other airport owners/operators (under the possible multiple airport system alternatives). The Flight Plan Project and the PSATC advisory recommendation are input to this regional decision process. The RASP is to be integrated with broader transportation and growth management planning activities now required under recent state and federal legislation. (These are identified and addressed in Section 4.4.6 of this FEIS.) Permit actions will be addressed in the project EISs and are not addressed in this FEIS.

1.1.2 Flight Plan Objectives and Relationships to the Regional Airport System Plan (RASP)

The proposed action of the Puget Sound Regional Council and the Port of Seattle is to comprehensively address and resolve regional commercial air transportation capacity issues. The solution should be a balance between complex and sometimes conflicting community goals such as community character and regional economic vitality. The RASP is one component of the Regional Transportation Plan maintained by the Regional Council, under federal and state statutes. The Flight Plan Project serves as input to possible amendments to the RASP and the RTP. These functional plans, in turn, are part of a broader comprehensive planning program initiated under Washington state's Growth Management Act (GMA). These planning efforts are related to other planning required of the Port of Seattle and other airport operators in the region.

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1.1.3 Description of the Flight Plan Final Environmental Impact Statement (FEIS)

The State Environmental Policy Act (SEPA) requires public agencies to consider environmental impacts in making public policy decisions. The specific purpose of this non-project (Programmatic) Final Environmental Impact Statement (FEIS) is to evaluate the regional environmental impacts of various airport system alternatives (see Sections 1.2.1 and 3.0). This will enable regional decision makers to consider environmental issues along with economic, operational, and institutional issues when choosing a solution for our long-term air travel needs.

This is a non-project EIS.

Section 197-11-442 of the Washington Administrative Code (WAC) allows agencies to prepare non-project environmental impact statements (EISs). This is a non-project EIS and part of a phased environmental review process (WAC 197-11-060(5)). According to the SEPA rules (WAC 197-11-774), "'non-project' means actions which are different or broader than a single site-specific project, such as plans, policies, and programs." In other words, non-project studies (also referred to as "programmatic" studies) deal with general solutions or plans rather than specific actions at specific sites. Since Flight Plan was intended to examine general commercial air travel solutions (also called "system alternatives") instead of specific plans at given airport sites, this FEIS is prepared at the non-project (programmatic) level of analysis and represents the first level of study of our region's future air travel needs.

This Flight Plan non-project FEIS must be followed by a second level of specific siting and project-level analyses (e.g., project EISs) and actions by other agencies. One of the project EISs may be prepared jointly for Seattle-Tacoma International Airport by the Federal Aviation Administration (FAA) and the Port of Seattle, under the National Environmental Policy Act (NEPA). Further siting studies and site master plans for other airports may be required.

The likelihood of needing to reevaluate the regional alternatives in site-level studies is minimized since this FEIS retains more than one site option for each of the regional alternatives and for the Sea-Tac Airport component of these alternatives.

What Changes are Reflected in the FEIS?

The FEIS incorporates or refines information presented in the DEIS. Public review comments received at hearings and in writing between January 7, 1992, and March 23, 1992, have influenced the content of this comprehensive FEIS. Responses to comments include refinements and modifications to the presented alternatives, supplemental information and factual corrections.

The refinements and modifications made in this FEIS include:

- An agency "preferred" alternative is not yet identified. Although the PSATC's final recommendations are discussed in Section 1.5 and Appendix A, the purpose of this FEIS is to present and compare system-level alternatives for meeting our forecasted future air travel needs.

- A clear distinction is made between the general level of analysis done for this Flight Plan FEIS and the need for specific analyses to be done in subsequent project-level EISs once a system level alternative has been selected. For example, regionwide air pollution emissions are addressed in this FEIS, but site-level impacts are deferred to the project level.

- A range of capacity actions is presented for Sea-Tac, and multiple site options are considered for supplemental and replacement airports.

- The No Action alternative (Section 3.6) does not include imposed demand management actions, and a more developed demand management alternative has been added (Section 3.2.1).

- Supplemental information is provided on agency decision making (Section 1.2.2), institutional needs (Appendix B), project forecasts (Section2.2), impacts for the years 2000 and 2010 as well as 2020 (parts of Section 4.0), integration with other regional transportation and land-use planning activities (Section 4.4.6), mitigation (summarized in Section 1.3 and presented in Section 4.0), phasing of program elements (Section 3.8), and safety and energy (Sections 4.8 and 4.9, respectively).

- Comments received during the public review process are reproduced in three "Supplements" to this Non-Project FEIS. These comments are responded to by cross-referencing from the letters in the Supplements to the appropriate sections of the FEIS, or by cross-referencing to a set of supplemental responses contained in Appendix E.

1.2 ALTERNATIVES

Air transportation solutions examined in Flight Plan are general in nature and are referred to as "system-level" alternatives. They are designed to represent a range of non-site-specific solutions to the Puget Sound Region's future commercial air transportation needs. Analysis of system alternatives does not address all of the concerns with specific sites or specific site improvements, but represents rather a broad look at the question "What are our choices and how do they compare to one another?" However, in order to evaluate system alternatives, a range of test sites for each must be used. These test sites are referred to in Flight Plan as "site options." Project-level studies to be conducted following Flight Plan will look at the questions of where exactly should we implement a chosen system alternative (other than No Action) and specifically how will it be operated? Section 3.0 identifies the site options used for the System alternatives and Section 4.4 discusses potential airport related impacts.

1.2.1 System Alternatives and Agency Actions

All of the system-level alternatives acknowledge the importance of (a) demand management, (b) mitigation, and (c) timing, phasing and implementation of a selected regional airport system configuration decision, and institutional tools. The demand management alternative is listed as part the Broad System Management alternative and is addressed in Section 3.2.1. Some demand management strategies would be included in any future regional course of action. Possible mitigation actions are consolidated in Section 1.3. Timing, phasing, and institutional needs are addressed in Appendix B and 3.8.3.

The system-level alternative airport configurations are:

- **Sea-Tac Airport Capacity Enhancement Measures.**

  1) **Sea-Tac with Broad System Management:** This is an alternative that attempts to meet our region's future travel needs without building any new runways. It includes the use of demand management, new technologies, and high-speed rail (upgraded Amtrak, high-speed rail or magnetic levitation trains).

  2) **Sea-Tac with a new dependent third runway:** This runway would be able to accommodate both landings and takeoffs of commuter and jet aircraft.

  3) **Sea-Tac in conjunction with a remote airport:** A remote airport is a second airport such as Boeing Field or Moses Lake (Grant County Airport) that would be functionally linked and operated in tandem with Sea-Tac. (It would not be oriented toward local origin and destination traffic, as is the case with the supplemental airports in the Multiple Airport System alternatives.)

- **Two-Airport Multiple Airport System:** One supplemental passenger-service airport would either be located to the north or south of Sea-Tac. Sea-Tac would either retain its current airfield configuration or would be expanded.

- **Three-Airport Multiple Airport System:** Two supplemental passenger-service airports, one located north of Sea-Tac and one located south of Sea-Tac, would be developed. Sea-Tac would either retain its current airfield configuration or would be expanded.

- **Replacement Airport:** Sea-Tac Airport would be closed and a new, larger airport with three runways would be constructed in a new location.

- **No Action:** Sea-Tac would continue to be the region's only passenger-service airport. No capacity improvements related to commercial passenger service would be made to any Puget Sound area airports.

The PSATC recommended a phased three-airport multiple airport system including a dependent third runway at Sea-Tac. The importance of demand management and mitigation was researched and acknowledged, but not detailed in the final recommendation. This FEIS adds additional information on demand management and mitigation. The PSATC assumed that demand management and mitigation would be part of any alternative selected. The PSATC was also concerned with both the limited bad weather arrival capacity at Sea-Tac now, and the forecasted long-term operational needs of the region. See Section 1.5 and Appendix A.

1.2.2 Decisions by Public Agencies

A regional airport system will involve many interrelated actions by public agencies. The presentation of agency decisions, required in EISs, is very involved. An integrated decision calendar is provided in Section 4.4.6. An analysis of the consequences of only partially implementing any of the possible regional alternatives is presented in Section 3.8. If inability to implement all of a selected alternative results in a need to select a different regional alternative, this FEIS would be reviewed, augmented with an addendum or a supplement if necessary, and then used in making a second regional selection.

In summary, current statutes and authorities are adequate for public agencies to jointly accomplish the siting and operational elements of a regional air transportation package. However, if all of the affected agencies are not willing to jointly implement a regional alternative, this is not likely to occur. The Regional Council is scheduled to take action in March 1993 on an amendment to the 1988 Regional Airport System Plan (RASP). A complete presentation of public agency decisions and institutional needs is presented in Appendix B.

1.3 TRADEOFFS/ENVIRONMENTAL IMPACTS/POSSIBLE MITIGATION MEASURES

The environmental impacts of the system alternatives are summarized below and in Table 1-1. More detailed analyses for each topic is presented in the corresponding parts of Section 4 of this FEIS. A discussion of the tradeoffs and potential mitigation measures for the impacts follows. The goal of mitigation is to hold impacts to a minimum, rectify adverse impacts, reduce impacts over time, or in some way compensate for impacts. It is important to note that negative environmental impacts cannot always be mitigated. Site-specific EISs may reveal such impacts, with the result that a site or sites could be discarded as an alternative for air carrier capacity.

The Regional Council intends to identify the most appropriate and effective mitigation and abatement actions that might be addressed at the regional level, and how the actions might vary among the regional alternatives. This is scheduled to be done prior to the March 1993 action date mentioned in the cover letter to this FEIS and presented in Section 4.4.6.

- Noise: In all cases, modeling indicates that the use of quieter Stage 3 aircraft by the year 2000 will result in declining average daily nose levels over Sea-Tac. Supplemental Airport sites impact the fewest number of residents with moderately loud noise. However, the supplemental sites expose large numbers of people to new aircraft noise.

- Air Quality: Aircraft emissions are highest for alternatives that rely on existing capacity at Sea-Tac since aircraft delays result in higher levels of emissions. Alternatives that allow the airport to operate more efficiently reduce emissions. Vehicle emissions are least for those alternatives that reduce travel distance to airport sites.

- Transportation: Vehicle miles of travel are lower for alternatives that have airport sites that are closer to the users and are higher for alternatives that are more remote. Correspondingly, air quality and traffic impacts are generally lower for the close-in sites and higher for the more remote sites.

- Land Use/Natural Environment: The most significant land use impacts result from construction of new facilities or closure of existing facilities. Impacts to the natural environment are greater at undeveloped sites than at existing airports.

    - Construction of a new dependent runway at Sea-Tac ;would displace populations in neighborhoods immediately west of the airport.

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Table 1-1 ENVIRONMENTAL IMPACTS MATRIX (Year 2020)*

ALTERNATIVE	NOISE (Section 4.1)	AIR QUALITY (Section 4.2)	SURFACE TRANSPORTATION (Section 4.3)	LAND USE (Section 4.4)	PUBLIC SERVICES AND UTILITIES (Section 4.5)	NATURAL ENVIRONMENT (Section 4.6)
Million Annual Passengers & Total Operations (Figures for supplemental & remote airport site options are commercial operations only)	Total affected population in thousands**	Total aircraft & vehicle emissions (tns/day). [Vehicular emissions % of regional vehicle emissions]	Daily Passenger-Miles & Peak-Hour Passenger			
NO ACTION 35.8 MAP 460,000 operations	55 LDN = 175 65 LDN = 25 80 SEL = 120	CO = 36 NOx = 8.7 HC = 7.8 [CO = 1.3 %] [NOx = 1.5 %] [HC = 1.4%]	DPM = 1.54 million PHP = 5,600	No significant changes to community character and no direct displacement of homes. Additional commercial and light industrial growth may occur as passenger levels increase.	All public services would require some expansion due to increased direct and induced activity levels. Impacts are not signficant and could likely be accommodated in capital improvement plans.	No direct impacts to wetlands, vegetation or wildlife.
SEA-TAC AIRPORT						
w/ System Mgmt (Demand management, high-speed ground, and new technologies) 38.0 MAP 380,000 operations	55 LDN = 135 65 LDN = 12 80 SEL = 120	CO = 25 NOx = 6.5 HC = 4.6 [CO = 1.3 - 1.4 %] [NOx = 1.5 - 1.6 %] [HC = 1.4 - 1.5 %]	Passenger miles and peak-hour passengers less than "w/ New Dependent Runway" option, but greater than "No Action" (passenger miles needed to access high-speed rail not included).	Impacts similar to "No Action."	Impacts similar to "No Action."	No direct impacts to wetlands, vegetation or wildlife.
w/ New Dependent Runway 41.8 MAP 480,000 operations	55 LDN = 162 65 LDN = 22 80 SEL = 120	CO = 26 NOx = 8.1 HC = 4.5 [CO = 1.3 - 1.4 %] [NOx = 1.5 - 1.6 %] [HC = 1.4 - 1.5 %]	DPM = 1.68 million PHP = 6,600	Approximately 230 or more homes displaced. Additional commercial and light industrial growth may occur as passenger levels increase.	Impacts similar to "No Action."	Some loss of wetlands and shrub-land habitat. Potential moderate encroachment into Miller Creek floodway.

* For year 2000 and 2010 environmental impacts, please see the referenced sections of this FEIS.

** LDN is the 24-hour, time-weighted annual average noise level. SEL is the Sound Exposure Level of an individual aircraft overflight.

NOTE: Mitigation measures are summarized in Section 1.3 and are discussed throughout Section 4.0.

Table 1-1 ENVIRONMENTAL IMPACTS MATRIX (Year 2020)*

ALTERNATIVE	NOISE	AIR QUALITY	SURFACE TRANSPORTATION	LAND USE	PUBLIC SERVICES AND UTILITIES	NATURAL ENVIRONMENT
w/ Remote Airport ***Sea-Tac*** 32 MAP 380,000 operations ***Remote*** 13 MAP 144,000 operations	***Sea-Tac*** Impacts similar to lower end of "2-Airport System." ***Remote*** Impacts depend on types of aircraft in operation.	***Sea-Tac*** Impacts similar to lower end of "2-Airport System." ***Remote*** Impacts depend on types of aircraft in operation.	***Sea-Tac*** Impacts similar to lower end of "2-Airport System." ***Remote*** Impacts depend on amount of locally-generated origin and destination passengers. Ground link to Moses Lake would also cause impacts.	***Sea-Tac*** Impacts similar to "No Action." ***Remote*** Community character could be significantly changed at Moses Lake. No character change at Boeing Field. No direct displacement of homes anticipated at either site.	***Sea-Tac*** Impacts similar to "No Action." ***Remote*** Additional services necessary at Moses Lake. Services could be expanded at Boeing Field without significant impacts.	***Sea-Tac*** Impacts similar to "No Action." ***Remote*** Conflicts may exist with waterfowl at Moses Lake. No significant impacts to natural environment at Boeing Field.
2-AIRPORT SYSTEM *[System impacts shown at right; site option impacts are shown below. Note: system ranges are not a direct sum of each range below.]*	55 LDN = 139 - 181 65 LDN = 12.1 - 20.2 80 SEL = 129 - 213	CO = 25 - 39 NOx = 7.3 - 9.8 HC = 4.8 - 6.4 [CO = 1.2 - 2.2 %] [NOx = 1.4 - 2.7 %] [HC = 1.4 - 2.6%]	DPM = 1.9 - 2.17 million			
Sea-Tac 32 - 41.8 MAP 380,000 - 480,000 operations ***Supplemental*** 3.2 - 13 MAP 33,000 - 271,000 operations	***Sea-Tac*** 55 LDN = 135 - 137 65 LDN = 12 - 15 80 SEL = 120 - 121 ***Supplemental*** 55 LDN = 4 - 39 65 LDN = 0 - 2 80 SEL = 9 - 81 Noise impacts lower for outlying sites.		***Sea-Tac*** DPM = .97 - 1.91 million PHP = 3,900 - 6,200 ***Supplemental*** DPM = .12 - 1.20 million PHP = 700 - 3,000	***Sea-Tac*** Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen. ***Supplemental*** Impacts greater at undeveloped sites than at existing airports. Specific impacts vary by site, but are greater for 2 runway options than for 1 runway options.	***Sea-Tac*** Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen. ***Supplemental*** Impacts greater at undeveloped sites than at existing airports. Specific impacts vary by site.	***Sea-Tac*** Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen. ***Supplemental*** Impacts greater at undeveloped sites than at existing airports. Specific impacts vary by site, but are greater for 2 runway options than for 1 runway options.

ALTERNATIVE	NOISE	AIR QUALITY	SURFACE TRANSPORTATION	LAND USE	PUBLIC SERVICES AND UTILITIES	NATURAL ENVIRONMENT
3-AIRPORT SYSTEM *[System impacts shown at right; site option impacts are shown below. Note: system ranges are not a direct sum of each range below.]*	55 LDN = 149 - 180 65 LDN = 12.3 - 19.1 80 SEL = 164 - 252	CO = 23 - 32 NO_x = 7.2 - 8.5 HC = 4.1 - 5.6 [CO = 1.1 - 1.7 %] [NO_x = 1.3 - 2.0%] [HC = 1.2 - 1.7 %]	DPM = 1.51 - 2.05 million			
Sea-Tac 32 - 41.5 MAP 380,000 - 477,000 operations	*Sea-Tac* 55 LDN = 135 - 137 65 LDN = 12 - 15 80 SEL = 120 - 121		*Sea-Tac* DPM = .97 - 1.45 million PHP = 3,900 - 5,400	*Sea-Tac* Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen.	*Sea-Tac* Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen.	*Sea-Tac* Impacts similar to "No Action" or " w/ New Dependent Runway" depending on configuration chosen.
North Supplemental 2.2 - 7.6 MAP 35,000 - 210,000 operations	*North Supplemental* 55 LDN = 4 - 24 65 LDN = 0 - 1 80 SEL = 36 - 67 Noise impacts lower for outlying sites.		*North Supplemental* DPM = .15 - .51 million PHP = 800 - 1,600	*North Supplemental* Specific impacts vary by site, but are greater for 2 runway options than for 1 runway options.	*North Supplemental* Specific impacts vary by site.	*North Supplemental* Specific impacts vary by site, but are greater for 2 runway options than for 1 runway options.
South Supplemental 1.3 - 7.1 MAP 151,000 - 211,000 operations	*South Supplemental* 55 LDN = 1 -21 65 LDN = 0 - 1 80 SEL = 9 - 53		*South Supplemental* DPM = .15 - .57 million PHP = 800 - 1,600	*South Supplemental* Same as North Supplemental. Impacts greater at undeveloped sites than at existing airports.	*South Supplemental* Same as North Supplemental. Impacts greater at undeveloped sites than at existing airports.	*South Supplemental* Same as North Supplemental. Impacts greater at undeveloped sites than at existing airports.
REPLACEMENT AIRPORT 45 MAP 524,000 operations	55 LDN = 81 - 101 65 LDN = 3.8 - 4.7 80 SEL = 86 - 108	CO = 59 NO_x = 14.1 HC = 8.3 [CO = 4.0%] [NO_x = 4.9%] [HC = 4.6%]	DPM = 5.10 million PHP = 6,900	Significant decline in viability of commercial and light industrial uses could occur around Sea-Tac, depending on how it is redeveloped. Changes in land use at the replacement site would be very significant (including displacement of homes).	Substantial development of new or greatly expanded public services and utility infrastructure would be required.	Large impacts to wetlands, vegetation, and wildlife due to development of relatively undisturbed sites.

EARTH: (Section 4.7) Earth impacts are site dependent. All of the site options examined appear to have suitable soils for airport construction. The Replacement Airport alternative would require the largest amount of cut and fill, Sea-Tac with a new dependent runway would require a large, but lesser amount of imported fill, and one runway supplemental airports would require the least.

ENERGY: (Section 4.8) There are no significant differences between the alternatives in terms of energy consumption. The primary consideration relates to the differences in vehicle miles traveled (passenger miles under transportation above).

PUBLIC SAFETY: (Section 4.9) There are no significant differences in public safety among the alternatives presented above.

- Construction of a replacement airport would result in significant land use changes at the replacement site, and displacement of population.

- Closure of Sea-Tac would have a severe negative impact in the near term on the businesses around Sea-Tac.

- The use of Moses Lake would result in significant changes in community character.

- A replacement airport would result in large impacts to wetlands, vegetation, and wildlife due to development of relatively undisturbed sites.

1.3.1 Noise

Tradeoffs

One of the most significant conclusions of the noise analysis is that improved technology is making aircraft quieter. The Federal Government has mandated that older, noisier "Stage 2" aircraft will not be allowed to operate in the U.S. after the year 2003. Beyond this, the Mediated Noise Agreement in effect at Sea-Tac Airport sets a schedule for phase-out of Stage 2 aircraft by 2001. As more Stage 2 aircraft are replaced with the quieter Stage 3 type, the noise impacts from single airplane flyovers and noise measured on an average daily basis will be reduced. Maps of impacted areas are shown in Appendix C.

The noise analysis in this FEIS uses several measures in addition to the federally recognized 65 Ldn (day-night noise level). The 65 Ldn contour represents a compromise between noise impacts and mitigation costs.

Dispersal of airplane flight paths to new airports spreads noise from airplane flyovers over an increased population, in exchange for improved system operational capacity and efficiency. The year 2020 population within the 65 Ldn noise contour is greatest under No Action (25,000). The number within the more inclusive 55 Ldn contour could be 175,000 under No Action, and between 135,000 and 181,000 under the other alternatives. The number within the 80 sound exposure level (SEL) is 120,000 with No Action, and between 120,000 and 252,000 under the other alternatives. The locations of impacts vary with each alternative. (For the definition of Ldn and SEL, please refer to Section 4.1 and the Glossary.)

Noise impacts from Flight Plan actions could combine with ground noise or other factors at some sites. This is not included in the results of aircraft noise simulation models reported in this non-project FEIS. For example, in south King County and in Pierce County, the flight paths in and out of Sea-Tac interact with military operations at McChord by confining the military flights to lower altitudes. Also, at Sea-Tac Airport, noise from a possible third runway could be 1700 feet closer to residential communities west of the airport than is now the case.

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Potential Regional and Site Specific Actions

- Continue implementation of the 1990 Noise Mediation Program at Seattle-Tacoma International Airport to achieve 100 percent Stage 3 aircraft by 2001 but also protect other reliever airport sites in the region.

- Amend the FAA Four-Post Plan (this Plan mandates a four-cornered pattern of airplane arrival and departure routes and climb rates for Sea-Tac Airport) in order to minimize low-altitude overflights of residential areas. Regional cooperation would be required, beginning with a collective recommendation to the FAA submitted through the Regional Council. (Regional Council, FAA)

- Accelerate and fund implementation of multifaceted noise mitigation, supported all or in part by current funding sources such as Passenger Facility Charges (PFCs). PFCs are a federally authorized surcharge that can be added to the cost of individual airplane tickets; See Appendix B.) This is a complex issue involving the Airport Noise and Capacity Act of 1990, the Federal Aviation Regulations (FAR) Part 150 Noise Control Program, reviewing noise mediation and compensation area boundaries, and limiting the encroachment of local land uses into impacted areas. (FAA, Port of Seattle and adjacent communities)

- Develop regionally consistent operational restrictions (e.g., affecting types of aircraft, late night operations, takeoff and climb-out procedures, steeper descents prior to final approaches, rolling takeoffs during late hours, preferential use of runways, and cumulative flight and ground noise). (FAA and airport operators)

  (Note: The noise analysis in Appendix C assumes local controls at the Supplemental airport sites. Long Beach and John Wayne Airports in California are two present examples. Noise limitations result in a larger assumed aircraft passenger load, and reduce the number of flights by approximately 30 percent.)

- Implement new technology such as Microwave Landing Systems (MLS) and possibly Global Positioning Systems (GPS) which might allow curved flight tracks and water approaches at Sea-Tac with improved accuracy and safety. The Flight Track Management System (FTMS) is operational, but is dependent upon equipment located on the airplane. The Airport Noise Operation and Management System (ANOMS) will improve airport noise enforcement capabilities. A test MLS project is currently under consideration for implementation at Sea-Tac in accordance with the noise mediation program.

- Install additional noise monitoring equipment off the airport sites, to verify information developed indirectly through modeling. Consider measured impacts as a basis for working with impacted communities. (Airport operators)

1.3.2 Air Quality

Tradeoffs

Under the different alternatives, ground transportation emissions in 2020 would be a small share of the regional total (1.8 to 2.5 percent of carbon monoxide, 3.4 to 8.1 percent of

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nitrogen oxides, and 3.1 to 6.9 percent of hydrocarbons). Dispersal of some ground traffic to supplemental airport sites results in fewer air pollution emissions at the regional level than if Sea-Tac remains the only passenger service airport. Site-level analysis will focus more on the local level and localized congestion, and the project-specific air quality requirements of the federal and state Clean Air Acts. Pollutant emissions rise dramatically as travel speeds decline.

Demand management steps that increase airline efficiency (average airplane capacity and load factors) and improved airport capacity moderate the increase in air pollutants from aircraft. Improved aircraft engines (Stage 3) dramatically reduce pollutants on a per aircraft basis from earlier technologies.

Potential Regional and Site-Specific Actions

- Implement federal statutes (the 1991 Intermodal Surface Transportation Efficiency Act--ISTEA, the 1990 Clean Air Act Amendments, and the Washington State Clean Air Act). Include airport surface transportation and access plans in the air quality State Implementation Plan, thereby ensuring that aviation capacity is not overlooked. (Regional Council, local governments and state agencies)
- Reduce aircraft delays and excessive idle/taxi times by controlling landing and departure times, utilizing "gate hold" procedures, and other steps to be identified and reviewed at the site level. (FAA, airport operators)
- Improve surface transportation network providing access to airport facilities. (Regional Council, local governments and state agencies)
- Select a regional airport system that minimizes automobile trip length and congestion.

1.3.3 Transportation

Tradeoffs

Unless the goal of greater urban densities includes very serious efforts to alter travel behavior and upgrade existing facilities, the accessibility of all urban services, including airports, will continue to deteriorate. In this case the supplemental airport sites offer a tradeoff between convenient airport locations for local service and resulting noise events beyond those otherwise experienced in the areas served (e.g., ground noise from the TRAMCO airplane maintenance facilities at Paine Field).

Ground transportation to the airports may account for 2 to 5 percent of total ground transportation in the region and a much larger share of peak travel near the airport(s).

Overall regional passenger mileage is the least for the multiple airport systems. This advantage is gained at the cost of greater local congestion, particularly at Sea-Tac and in the urban areas containing candidate supplemental airport facilities. This is among the issues to be detailed in the site-level studies called for by this FEIS.

The replacement alternative imposes the greatest ground mileage requirement, but avoids adding to congestion at airport sites in urban areas and reduces activity at the present Sea-

Tac location. The system management alternative offers the potential to substitute High-Speed Ground Transportation in place of some short-haul flights, probably north and south to Portland and to Vancouver, B.C., but its huge capital costs and the amount of traffic that could be served raises questions about its viability.

Potential Regional and Site-Specific Actions

- Through ISTEA, coordinate ground access for the selected alternative with High-Speed Ground Transportation (HSGT) (possibly over the long term), local rapid transit and (with local governments) GMA land-use actions. In this region, this includes, for air quality purposes, a Congestion Management System to be accomplished by the Regional Council, the state, and transit operators. (Regional Council, state Department of Transportation)

- Continue to implement broad transportation-system-management and transportation-demand-management programs within the region. (Employers and local governments)

- Work to expand and improve service presently provided by airport buses, transit buses, taxis, shuttles and limousines serving the region's airport(s), and aggressively examine the merits of remote passenger check-in terminals. (Port of Seattle, airport operators, private transportation companies)

- Assign high priority (in the Regional Transportation Plan and its funding elements, and state plans) to funding of airport-access facilities, and generally to local facilities impacted by siting of commercial airport services. (Regional Council, state Department of Transportation)

1.3.4 Land Use

Tradeoffs

The major land-use tradeoff is between the protection of widespread residential communities from aircraft noise at existing sites and the protection of sparsely developed areas outside of the urban growth areas from new airport development. Depending upon severity, aircraft noise from flyovers might contribute to pressures for residential development at the urban fringe because of land removed from residential development adjacent to the urbanized airport sites.

Secondary tradeoffs involve impacts on alternative sites within the developed parts of the region, specifically between Sea-Tac and supplemental airport sites, and between alternative supplemental sites north and south of Sea-Tac, respectively. Supplemental airport sites can serve as additional centers within the VISION 2020 regional growth strategy. The Growth Management Act does allow for new fully contained communities outside the initially designated urban growth boundary, provided that the respective county has established a process for reviewing proposals and that the proposal meets certain criteria.

The land-use impacts involve induced activities near existing or new airport sites, changes in property values for residential and other land uses, and the relationship between airport siting decisions and broader planning required by the state Growth Management Act. The greatest number of homes directly affected (acquired) occurs under the replacement alternative site options in Pierce County, and to a lesser degree, at Sea-Tac Airport in those alternatives involving a third runway. Total reduction in residential property values can be calculated in site-level studies, using methods in information begun in this non-project FEIS.

Potential Regional and Site-Specific Actions

- Develop and implement a regional policy on relocation assistance and compensation for areas directly displaced or subject to noise impacts, consistent with FAA guidelines. Non-federal agencies also have the latitude to go beyond what is funded under federal programs (i.e., mitigation within the 65 Ldn contour). (FAA, Regional Council, and airport operators)

- Encourage compatible land-use planning and regulation for areas subject to noise and transportation system impacts over the long term. Where appropriate, local governments can adjust local permitting in light of already existing noise impacts. (Countywide GMA planning)

- Directly address the issue of offensive and incompatible land uses and activities in areas adjacent to airports. (Countywide GMA planning policies, state legislation)

- Help finance, through FAR Part 150 and other sources, school sound insulation at least within the 65 Ldn contour, and purchase aviation easements from existing incompatible land uses. (Airport operators, local jurisdictions, and school districts)

- Work toward a comprehensive regional noise management program addressing traditional noise contours and flight track single-event noise. (FAA, Regional Council, and airport operators)

- Directly address airport siting in GMA countywide and multi-county planning policies. (Local governments)

1.3.5 Public Services, Utilities and Schools

The local infrastructure costs of growth are a topic to be systematically addressed as part of local comprehensive planning requirements under the GMA and project-level airport EISs. This FEIS is not required to provide a benefit/cost analysis for meeting the objectives of Flight Plan. General information on impacts is provided.

Tradeoffs/Environmental Impacts

The major concern is impacts at the site level. This analysis is deferred. The range of site options includes urban and relatively rural locations.

Potential Regional and Site-Specific Actions

- Local plans done under the GMA must meet statutory concurrency requirements rf provision of services. (Local governments)

- Through state legislation, earmark some state-level revenues generated by statewide air travel capacity (involving siting of facilities of regional and statewide significance) to help local governments meet their concurrency requirements under the GMA. (Counties and the state)

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- Include airport-related needs in the capital elements of plans done under the GMA, and possibly in the six-year capital element required of the state Office of Financial Management.

- For noise impacts on schools, please see Sections 4.1.2.1 and 4.1.2.6.

1.3.6 Natural Environment

The natural environment includes two categories of resources. These are wetlands and water, and plants and animals.

Tradeoffs/Environmental Impacts

The primary natural environment tradeoffs involve reducing the impact to undisturbed areas by developing airport facilities within the existing urban area. Although natural environment impacts may be reduced by doing this, impacts to humans in the form of noise and air pollution may be increased.

Potential Regional and Site-Specific Actions

- Deal with important site issues at the site level. Address hazardous waste and solid waste management concerns. Proper timing of construction activities might reduce direct wildlife impacts. Site clearing and grading should not be done during the spring and early summer. And for sites with threatened or endangered species of plants and animals, additional site specific biological assessment and mitigation work would be necessary. (Airport operators, local governments)

- Selection of sites that are already developed or otherwise disturbed would reduce the extent of natural habitat that would be lost.

- Within any given site option, the actual layout of the facilities could be planned to avoid the most valuable wildlife habitats. In particular, wooded areas and wetlands should be left undisturbed to the extent possible.

- Develop in VISION 2020 a regional natural systems element that is supportive of local comprehensive plans. (Local governments working through the Regional Council)

- Review water quality issues at the site level. (U.S. Fish and Wildlife Service, Ecology, Corps of Engineers)

- At the site level, address runoff volume and quality, and groundwater protection, in drainage plans. (Airport operators, local governments)

1.3.7 Earth

Tradeoffs/Environmental Impacts

A major concern to be addressed at the site level is the impact of earth preparation (cut and fill), both on natural systems and on local traffic. The Sea-Tac site requires the transport of a large amount of fill to the site if a third runway option component is part of the selected regional alternative. The replacement airport site involves the largest amount of site preparation (on-site cut and fill).

Potential Regional and Site-Specific Actions

Mitigation measures of impacts to earth movement will be addressed at the site level.

1.3.8 Energy

Energy consumption per capita varies between modes of transportation, but is comparable. Fuel prices influence choices between transportation systems and how much they are used. In addition, airport and air system management alternatives entail differences in energy consumption due to idling times on the ground and delays in the air.

Tradeoffs

Based on mileage, energy consumption traveling to and from the airport(s) is least for the multiple airport systems. However, the share that this energy saving is of total energy consumption for all ground travel in the region is insignificant. The replacement airport alternative is the most energy intensive due to the greater average travel distance involved.

The possibly significant energy tradeoff over the long term is between modes of transportation. These are High Capacity Transit (HCT), local rapid transit in the urban region, High-Speed Ground Transportation (HSGT) in major state corridors, and the private automobile. Energy efficiency is improving in all categories. Tradeoffs are also involved between different kinds of energy sources. It is beyond the scope of this air carrier FEIS to document these relationships between different modes of transportation. As planning evolves, this may be a task to be assigned to the state Energy Office.

Potential Regional and Site-Specific Actions

- Implement new mandated federal and state transportation planning requirements. (Regional Council and local governments)
- Implement the multimodal aspects of the federal ISTEA legislation. (Regional Council, the state, and local governments)
- Work toward greater airport capacity and efficiency of operations, and continue to develop multimodal passenger and cargo handling capabilities. (Port of Seattle)

1.3.9 Public Safety

Safety trends are improving yearly for air carrier and commuter aircraft. Accidents are due to several causes. Safety data are not significant in ranking regional airport system alternatives. Airspace reconfiguration (related to safety) is addressed as part of Sections 1.3.10 and 4.10. The No Action alternative does reduce the margin of safety as flights increase in number.

Tradeoffs/Environmental Impacts

Air travel safety is improving every year for both commuter and jet aircraft. Safety actions involve personnel, technology and operations. Improved navigational and airplane equipment can increase the capacity of existing facilities. Mitigation of some alternatives involves moderate reconfiguration of airspace, depending upon the system plan selected. The FAA 1990 Four-Post Plan--which can be amended--trades improved efficiency (involving safety) for a widened dispersal of flight track noise over the region. This arrival and departure pattern was put in place by the FAA and addressed in a federal Environmental Assessment.

Potential Regional and Site-Specific Actions

Safety will be addressed in the project-level studies; e.g., height clearances of surrounding buildings. A variety of improvements nationally and locally are evident in training, equipment, and procedures. See also Section 1.3.10.

1.3.10 Airspace Management and General Aviation

Following selection of a regional airport system alternative, regional airspace can be modified to accommodate this action and to provide mitigation. Additionally, general aviation needs can be addressed.

Tradeoffs/Environmental Impacts

A broad regional task force should be formed to systematically resolve airspace issues within the region. Key issues include the interaction between possible multiple airports, the interactions with military and with general aviation, and noise impacts.

Potential Regional and Site-Specific Mitigation Actions

- Convene local governments, the general aviation community and the public to refine the general aviation element of the Regional Airport System Plan. (Regional Council, Federal Aviation Administration)
- Limit practice Instrument Flight Rules (IFR) approaches by general aviation aircraft during peak IFR traffic periods. Divert practice IFR approaches to relief airports located outside of heavy air traffic areas. (The adopted 1988 Regional Airport System Plan recommends these actions, consistent with local airport master plans.)
- Continue to give priority to air carrier IFR operations over general aviation and commuter service during peak periods in heavily used airspace.
- Work toward the regional consensus necessary to distribute regional air traffic including traffic from military operations. This might moderate net noise impacts as air carrier service increases in the region. (For example, relocation of the National Guard unit from Paine Field to either Whidbey Island Naval Air Station or Fort Lewis, co-location and operation of smaller Air Force planes at Fort Lewis, and limiting C-141 touch-and-go training to Moses Lake.)

1.4 PUBLIC PARTICIPATION AND REVIEW PROCESS

The Flight Plan Project public review process included informational steps and a formal public review process. The formal process applied to both the draft proposal of the PSATC and the non-project DEIS of the sponsoring agencies. The informational steps included a newspaper supplement distributed through 15 newspapers in the greater Puget Sound region, newsletters, slide shows, briefings, press releases and media contacts, focus groups, public opinion surveys, and the use of a full-time public involvement coordinator. Open houses and scoping meetings were held in November of 1990.

Following the selection of a PSATC draft preferred alternative (4 December 1991), the public review process involved eleven formal public hearings and receipt of written public comments during an extended 75-day public review period (7 January 1992 through 23 March 1992). The most frequent comments are reflected in the revised format and content of this FEIS. Over 2,100 written comments were received and nearly 650 people gave verbal testimony. All of the written comments and verbatim transcripts of the hearings are reproduced in three "Supplements" to this FEIS. "Supplement 1" contains comments and hearings from Snohomish and Island Counties, "Supplement 2" contains comments and hearings from King County and areas outside the Puget Sound region, as well as comments from state agencies, and "Supplement 3" contains comments and hearings from Pierce, Kitsap, and Thurston Counties.

Issues raised in the comments on the DEIS and the PSATC's draft recommendations are responded to in one of three ways: 1) by cross-referencing from the letters in the comment Supplements to the appropriate section of the FEIS which addresses the concern, 2) by cross-referencing to a set of specific supplemental responses which are presented in Appendix E, or 3) with the note "comment acknowledged."

The public also has the opportunity to broadly address air carrier issues and other related growth management issues in the public review processes established in each county under the GMA. Future planning processes of the Regional Council--including amendment of the Regional Airport System Plan (RASP)--also will involve further public participation.

The Regional Council provides a process for requesting the Responsible Official to reconsider the adequacy of this FEIS. The process is optional. Failure to use it does not preclude use of any other appeal rights. But using the process does improve the ability of the Regional Council and ultimately the entire community, to make the best decision possible based on the best information available.

A request for reconsideration must be received by the Regional Council within thirty days of the issuance of this FEIS. The request will be considered either by the Responsible Official or, at his or her option, by a Hearing Examiner who shall make recommendations to the Responsible Official. The process is further set out in PSRC's SEPA Resolution Section 18(6).

A judicial challenge to the adequacy of the FEIS must be commenced within ninety days of the second newspaper notification of a "Notice of Action Taken". Amendment of the Regional Airport System Plan by the Regional Council would prompt the publication of a "Notice of Action Taken."

State law also provides for judicial challenges to the substantive decisions made under authority granted by SEPA. Appeals regarding the use of SEPA's substantive authority must be filed within this same 90 day period.

If significant new information about the proposal or its impacts becomes available, a supplemental EIS may be required. See WAC 197-11-600(3)(b). If a person believes that a supplemental EIS is required, the person has an obligation to inform the Responsible Official and give him or her a chance to consider the request. See PSRC SEPA Resolution Section 18(7) for the procedures for requesting a supplemental EIS. Failure to use this administrative process for requesting a supplemental EIS may preclude the right to bring a judicial appeal on the issue.

1.5 PUGET SOUND AIR TRANSPORTATION COMMITTEE (PSATC) FINDINGS AND RECOMMENDATIONS

The Puget Sound Air Transportation Committee (PSATC) devoted two-and-one-half years of study and extensive public review to the region's commercial air transportation needs. They developed a mission statement, reviewed alternatives, and prepared a final recommendation. Documentation of their work is provided in three reports cited throughout this FEIS: Phase I: Forecasts (July 1990), Phase II: Development of Alternatives (June 1991), and the Phase III: Draft Final Report (January 1992). The Draft Final Report included several appendices documenting the PSATC decision criteria. One of these appendices was the agency DEIS.

This section presents the PSATC vision statement, recommendations and findings. The complete statement of PSATC Findings and Recommendations is included as Appendix A. The reader is encouraged to read Appendix A for a thorough discussion of PSATC findings.

1.5.1 Vision Statement

The Flight Plan vision statement identified a broad range of PSATC goals. The PSATC Vision Statement was approved by the sponsoring agencies. The summary reads as follows:

We have an integrated air, land, and sea transportation system that will serve the region's travel worldwide to the year 2050 and thereafter. The transportation system enhances the livability and environmental integrity of the Pacific Northwest, is convenient and accessible to its users, promotes the economic vitality of the state, and serves as a gateway to all domestic and world markets. This transportation system is recognized worldwide as a leading model of transportation development.

1.5.2 Final Recommendation

The PSATC final recommendation of 17 June 1992 is summarized as follows:

Whereas, the complete work of the PSATC stresses the region's need to prepare to meet future demand and acknowledges the importance of:

(a) reasonable demand management techniques,

(b) mitigation measures,

(c) phasing of regional and site-specific decisions and actions addressing airport operational capacity and the impact and benefits to the served community;

Now therefore be it resolved, that the Puget Sound Air Transportation Committee has completed its deliberations; and hereby transmits its findings and recommendations to the

Puget Sound Regional Council and the Port of Seattle, calling for the phased implementation of a Multiple Airport System including the addition of:

- a dependent air carrier runway at Seattle-Tacoma International Airport before the year 2000, and
- the introduction of scheduled air carrier service to Paine Field before the year 2000, and
- the identification of a two-runway supplemental airport site in Pierce County for development by the year 2010 in collaboration with the military, and failing that, the identification of a suitable location in Thurston County.

During its two-and-one-half years of work, the PSATC developed and examined the alternatives presented in this FEIS (See Section 3.0). Variations of the Multiple Airport System alternatives reflected in this FEIS are narrowed from the longer list studied by the PSATC. The alternative recommended by PSATC is one option within the "Three Airport System" alternative. Differences between the presentation of regional alternatives in this FEIS and the earlier DEIS are identified in Section 1.1.3.

1.5.3 Findings Relative to the Other Alternatives

The PSATC evaluated their final recommendation and compared it to the other alternatives. The evaluation in Appendix A considers operational, economic, and environmental factors. With regard to the recommended alternative, the PSATC discussion highlights three criteria: environmental quality and livability, regional economic vitality, and integrated transportation systems (all components of the PSATC vision statement).

The alternatives comparison focuses on several evaluation points reviewed by the PSATC during the entire Flight Plan Project. Much of their work was assisted by expert panels convened specifically to address economic factors, demand management, forecasting and institutional issues. Perspectives developed by the PSATC are indicated here, but should be read in their entirety (Appendix A).

- The No Action alternative results in increasing airline delays and declining service as passenger levels continue to rise, and will hurt the region economically. Air quality and noise impacts (within the federally recognized mitigation boundaries) are also worse under No Action than under several of the other alternatives.

- The PSATC concluded that demand management is a short-term strategy, and that it does not add to current capacity. Similarly, high speed ground transportation (a component of the Broad System Management alternative, together with demand management and improved airplane and airport technology) would not address the major share of forecasted air passenger demand and also involves very high capital costs.

- Construction of a third runway at Sea-Tac, by itself, would not be able to meet the capacity needs of our region to the year 2020. Sea-Tac operated in conjunction with a remote airport is either impractical or very costly, depending upon whether Boeing Field or Moses Lake is considered.

- The three-airport system is reported as offering greater benefits over the long term than the two-airport system.
- The replacement airport alternative is rejected because of the ground travel distances involved, the impact on the regional urban pattern and the natural environment, and high capital costs.
- The recommended specific multiple airport system is compatible with the proposed regional high capacity transit system.

2.0 PROBLEM STATEMENT: AIR CAPACITY ISSUES

This Section presents the forecasts of future air carrier demand. Sections 3.0 and 4.0 define and evaluate alternative solutions. This section also provides information on periodic restrictions to current air carrier capacity. It concludes with a discussion of capacity in terms of ground access (treated in detail in Section 4.3) and airspace system management (introduced in Section 4.10).

2.1 OVERVIEW

Forecasts of future airport needs are expressed in terms of either passenger levels or the expected number of aircraft arrivals and departures (operations). These figures are based in part on independently developed population and employment forecasts. Both steps involve statistical work and modeling.

Assumptions feeding into both efforts reflect judgments and uncertainties about the future, and result in a range of expectations.

Forecasts help to establish activity thresholds and their likely timing and lead time opportunities. The purpose of the operations forecasts is not necessarily to predict activity levels and dates of occurrence. Rather, forecasts can enable the selection of a preferred future from a range of alternative futures. Forecast-driven solutions were specifically not favored by the advisory PSATC as the forecasting phase of the work concluded. However, the forecasted passenger and operational levels for the region are characterized as "unconstrained". That is, the demand forecasts exceed present capacity and, therefore, show that demand will exceed capacity and that congestion will worsen.

A range of existing industry and other passenger forecasts were considered (Phase 1 Report, p. ES-15). The Flight Plan Project forecasts were in the middle. The PSATC concluded that the range bracketed the dates at which the year 2020 passenger level might be reached. In other words, high and low forecasts could meet this activity level between 2015 and 2035 without necessarily discrediting a selected system alternative (see Phase 1 Report, p. ES-15).

The forecasting report recommended a program of monitoring aviation activity growth to provide guidance on the timing of airport development decisions. "Because of possible variations," it comments, "the forecasts are best considered as activity levels that should trigger decisions regarding airport development" (pp. ES-17 and -18). The great lead time requirements of some actions, such as reservation of new sites, becomes as much a factor in proactive decision-making as any set of possible forecasts. This is especially true given the several long-term regional planning activities now underway under new federal and state statutes (see Section 4.4.6).

Without demand management, Sea-Tac Airport is forecasted to reach its efficient operational capacity in the near term (before the year 2000), and even with the recommended dependent third air carrier runway, it would not be sufficient to efficiently serve passenger demand forecasted far into the next century. Demand management could marginally enhance operational capacity at Sea-Tac and may delay the time at which other improvements will be needed.

The forecasts and underlying assumptions will be reviewed by the Washington State Air Transportation Commission. Their report is to be completed by December 1, 1992.

2.2 DEMAND FORECASTS AND HOW THEY ARE USED

The Flight Plan passenger and operational forecasts were prepared in the first steps of the Project and are reported in the Phase I Forecasts (July 1990). The operational forecasts were modified downward in the Phase II Report (Appendix J, July 1991). The modified forecasts are shown in the following subsections. An update of these operational forecasts and new draft federal forecasts are also presented. In addition to the forecasts of passengers and demand, this section also discusses the forecasts' uncertainties and the manner in which these forecasts are to be used in making regional decisions.

The air passenger and operational forecasts are based in part on separately developed regional growth forecasts. Regional growth forecasts developed during the VISION 2020 planning process for population and employment were used for the Flight Plan Project (1988 Population and Employment Forecasts, Puget Sound Council of Governments, 1988). These forecasts projected a 61 and 72 percent increase in population and employment, respectively, between 1988 and 2020.

Once established, passenger and operational forecasts help to determine activity thresholds and their likely timing and lead time opportunities. The purpose of the operations forecasts is not necessarily to predict activity levels and dates of occurrence. Rather, forecasts can enable the selection of a preferred future from a family of alternative futures. Forecast-driven solutions were specifically not favored by the advisory PSATC as it concluded the forecasting phase of the work.

Seattle-Tacoma International Airport is forecasted to reach its efficient operational capacity of 380,000 annual operations in the near term (before the year 2000), and even with a possible third air carrier runway, it is not sufficient to serve passenger demand forecasted far into the next century.

This conclusion reflects a family of unconstrained passenger forecasts available in 1990 (Phase I Report, p. ES-15). The Flight Plan Project forecasts were in the middle. The PSATC concluded that the range would alter the dates at which the year 2020 passenger level might be reached. High and low forecasts would meet this activity level between 2015 and 2035 without necessarily discrediting a selected regional airport system alternative.

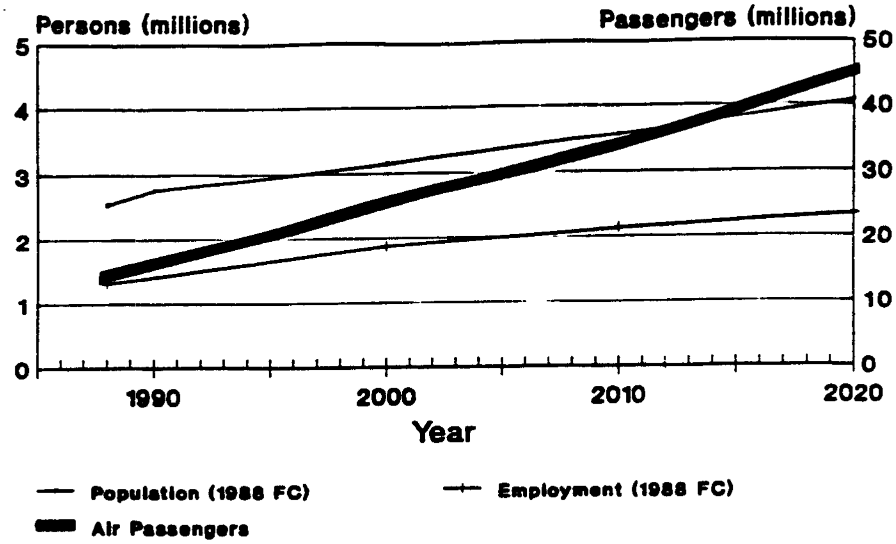
The Flight Plan Project forecasting report recommended a program of monitoring aviation activity growth to provide guidance on the timing of airport development decisions. "Because of possible variations," it comments, "the forecasts are best considered as activity levels that should trigger decisions regarding airport development." (pp. ES-17 and -18). The great lead time requirements of some actions -- such as reservation of new sites -- becomes as much a factor in proactive decision making as any set of possible forecasts. This is especially true given the several long-term regional planning activities now underway under new federal and state statutes (see Section 4.4.6).

2.2.1 What are the future regional air transportation needs?

Air carrier passenger demand increased eightfold, from under 2 million in 1960 to 16.2 million in 1990. This trend coincides with a long period of rapid population and economic growth and the beginning of the age of jet travel. Between 1990 and 2020, air carrier passenger demand is forecasted to almost triple (175 percent increase), from 16.2 million annual passengers (MAP) in 1990 to 45 MAP in 2020. Figure 2-1 shows the growth in air

Figure 2-1

Population, Employment and Air Travel Demand Forecasts



Sources: Phase I Demand and Forecasts, Flight Plan, July 1990 (as amended in Phase II Development of Alternatives, Appendix J, June 1991)

1988 Population and Employment Forecasts, Puget Sound Council of Governments, 1988.

carrier passenger demand between 1990 and 2020 relative to population and employment growth for the same period.

Actual aircraft departures and arrivals (operations) are forecasted to increase at a lesser rate, from 315,944 in 1988 to 524,000 in 2020 (a growth rate of 66 percent). There were 338,600 operations in 1991. The values used are summarized in Table 2-1 and Figure 2-2. More detail and recent comparative figures are shown in Table 2-2 and Figure 2-5. Data on per capita flights and on aircraft load factors (percent of occupied seats) are illustrated in Figures 2-3 and 2-4. If market penetration into middle income groups moderates in the future, then the trend in per capital trips will follow an "s" shaped curve (rather than a straight line) more characteristic of mature consumer markets.

Table 2-1

1990 - 2020 SUMMARY OF FORECASTS, (in thousands)

Factor	1988-2020 1988*	2020	(Percent Change)
Population	2,530	4,070	(61)
Employment	1,330	2,290	(72)
Air Carrier Passengers	**16,200.****	**45,000**	**(178)**
Total Operations	**315.9**	**524.0**	**(66)**

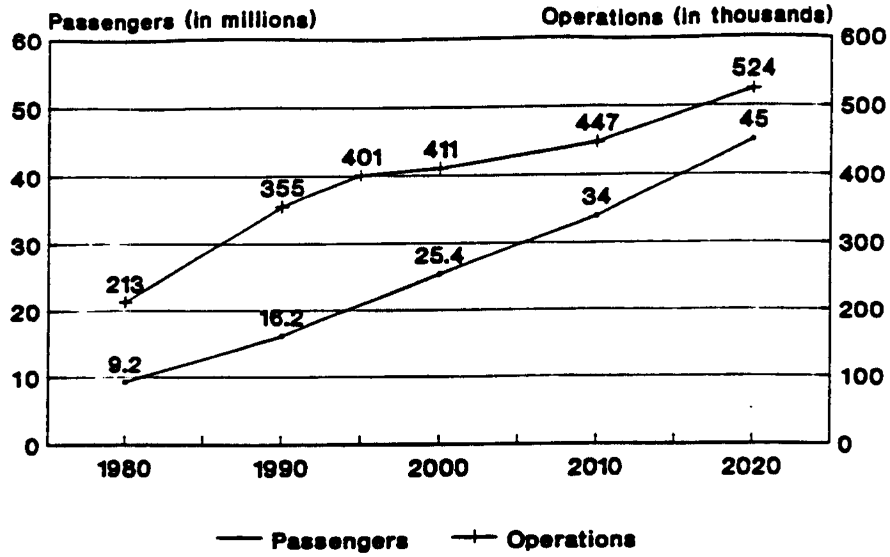
Source: Phase I Forecasts, Flight Plan, July 1990.

Notes (*): 1988 population and employment figures shown here are annual estimates prepared prior to the 1990 census.

(**): This is a 1990 value.

Figure 2-2

Forecast of Air Travel Demand Passenger and Operations

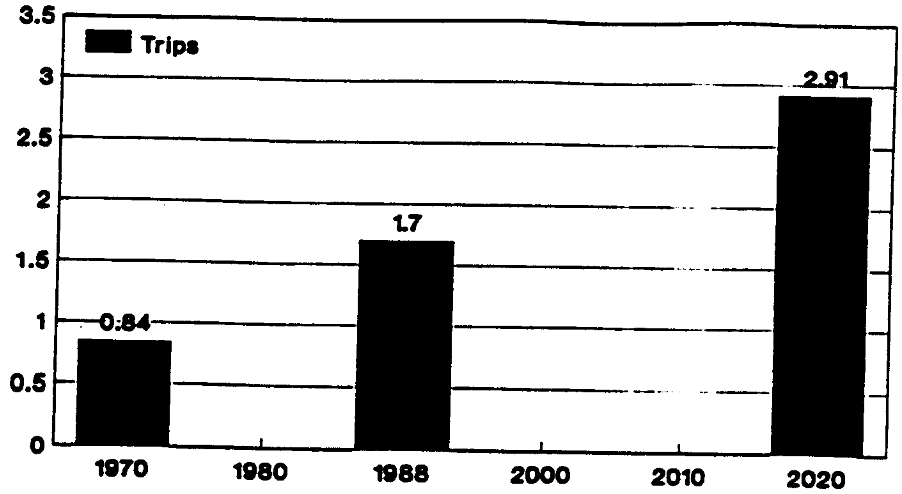


Source: Phase I Demand and Forecasts, Flight Plan, July 1990 (as amended in Phase II Development of Alternatives, Appendix J, June 1991)

Note: Efficient Sea-Tac operating level is 380,000 operations per year.

Figure 2-3

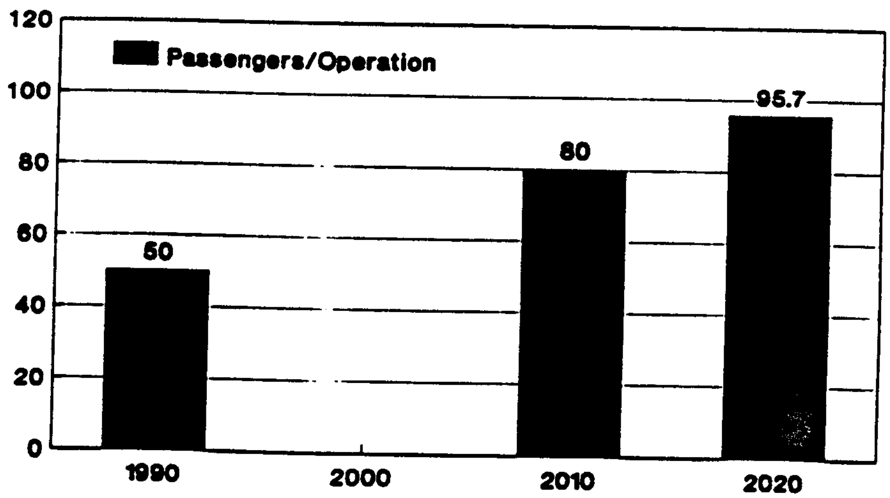
Per Capita Air Trips



Source: Phase I Demand and Forecasts, Flight Plan, July 1990 p. ES-10.

Figure 2-4

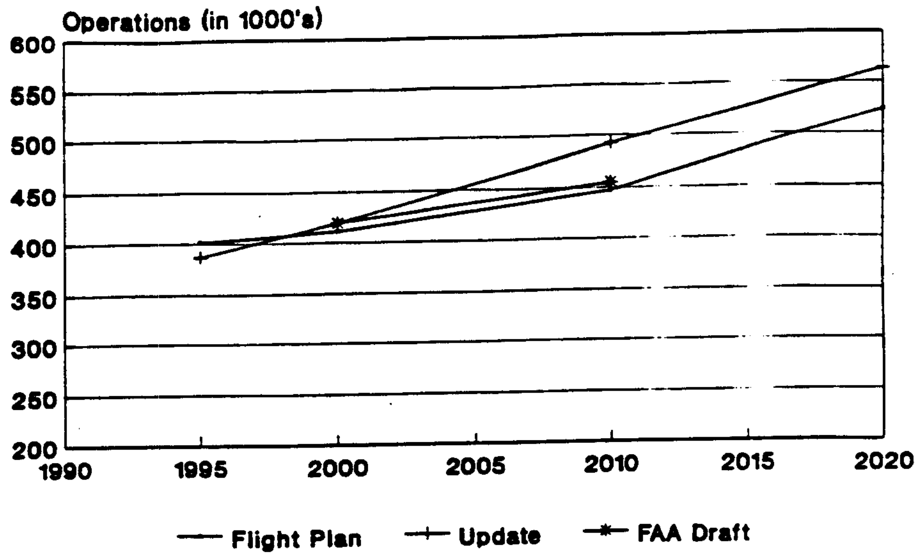
Passengers per Operation



Source: Flight Plan Draft Final Report, 17 January 1992, Appendix B-71.

Figure 2-5

Range of Forecasts of Operations



Sources: Flight Plan Draft Final Report, 17 January 1992, Appendix B-71.

Flight Plan: Phase I Report, Phase II Report (Appendix J), and Airport Activity Report, Port of Seattle, 1990, p. 24.

Update: "Update of Passenger and Operations Forecasts for Seattle Tacoma Intenational Airport", P & D Aviation, March 11, 1992.

FAA Draft: "Seattle-Tacoma Hub Forecast" (Draft), FAA Office of Aviation Policy and Plans, June 1992.

Table 2-2

FORECASTS for DISTRIBUTION OF POPULATION AND EMPLOYMENT
(in thousands)

POPULATION

County	1990	2000	2010	2020	1990-2020 Change	1990-2000 (Percent Change)
King	1,507	1,730	1,845	1,963	456	(30)
Kitsap	190	236	270	305	115	(61)
Pierce	586	708	803	902	316	(54)
Snohomish	466	603	697	793	327	(70)
TOTAL	2,749	3,277	3,615	3,963	1,214	(44)

EMPLOYMENT

County	1990	2000	2010	2020	1990 to 2020 Change	1990-2000 (Percent Change)
King	969	1,157	1,300	1,412	443	(46)
Kitsap	79	89	98	107	28	(35)
Pierce	227	281	322	357	130	(57)
Snohomish	162	223	264	298	136	(84)
TOTAL	1,437	1,750	1,984	2,174	737	(51)

Source: Puget Sound Subarea Forecasts: Model Calibration and Forecasts, Regional Council, April 1992.

Note: The source report also identifies a less likely high and low range of population, 3.0 million and 5.0 million for the year 2020. These forecasts refine those done in 1988, based in part on the results of the 1990 U.S. Census.

Air carrier demands are driven in part by the demographic trends summarized in the above two tables. The Flight Plan Project forecasts are summarized in Table 2-3.

Business passengers -- with an average of 3.9 trips per year -- accounted for 46 percent of total trips in 1990. Non-business passengers (leisure, personal) account for 54 percent of all trips -- with an average of 1.7 trips per year per passenger. The figures in 1991 were slightly different. Business trips dropped to 40 percent of the total, and the frequency of trips by individual business travelers dropped to 3.0. Non-business travelers (60 percent of the total trips) flew an average of 1.4 trips, also down from 1990 (Annual Activity Report, Port of Seattle, 1990 and 1991). Nationally, airline travel in 1991 was affected by the Persian Gulf War and the national economy.

Air cargo flights are unlikely to contribute significantly to any possible need for new runways in the region (see the end of Section 2.2.3).

Table 2-3

FORECAST OF TOTAL ORIGINATING PASSENGERS (in millions)

Service	1988	1995	2000	2010	2020
Major Domestic	4.30	6.20	7.30	9.30	11.80
Commuter	0.29	0.44	0.59	0.96	1.42
Canada	0.14	0.22	0.29	0.45	0.67
International	0.22	0.35	0.47	0.77	1.14
TOTAL	4.95	7.21	8.65	11.48	15.03

(Source: Phase I Forecasts, Table 20.)

2.2.2 How certain is the passenger trend?

The Flight Plan Project developed forecasts for air carrier, commuter airlines, international travel, and Canadian traffic. Air carrier travel was by far the largest component and was developed through state-of-the-art modeling techniques. This technique forecasts originating passengers (passengers who begin their air trip at Sea-Tac Airport) first, and then adds other categories based in part on these figures. Connecting passengers (passengers changing planes at Sea-Tac Airport) were assumed to remain at one-third of the total traffic (more exactly, connecting passengers are now 27 percent of major domestic travel, 44 percent of commuter, 50 percent of Canadian, and 54 percent of international).

International travel is subject to many uncertainties, but was assumed to grow by a declining rate, from 7 percent per year between 1988 and 1995 to 4 percent per year between 2010 and 2020. International factors now changing the air transportation industry are the emergence of continental blocs (the North American Free Trade Zone, the European Community), new technologies, and possible open skies agreements. Under open skies, city destinations like Seattle can become destinations for a vastly expanded range of cities through new city-pair direct routes. New aircraft design may produce the needed intermediate size long-haul planes still capable of carrying both cargo and passengers. (These and related factors were discussed in the Flight Plan Draft Final Report, Working

Paper No. 8, and were presented to the Washington State Air Transportation Commission. See WSATC meeting minutes for 27 May 1992.)

Analysis of the forecasts show that the 45 million annual passenger total for 2020 is the sum of 30 million annual passengers (15 million originating passengers and 15 million destination passengers) and 15 million connecting passengers. Air carrier passenger forecasts are shaped primarily by two factors: (a) population and per capita income, and (b) yield and elasticity of demand (yield is a measure of revenues expressed in cents per passenger mile). Some uncertainty is attached to each of these components. This uncertainty is greater in the long term than in the near term and is discussed below.

2.2.2.1 Population and Employment

Regional population forecasts are based on assumptions related to the economy, family size, migration patterns and other factors. The 1991 Regional Council forecasts show more moderate growth than was estimated in the 1988 regional forecasts. The more recent regional forecasts prepared by the Regional Council are based in part on the results of the 1990 Census. The Census indicates that the population grew faster during the 1980s than was previously estimated. Due to the higher 1990 figures and other factors (e.g., lower projections for in-migration), the Regional Council forecasts show a more moderate increase of 44 percent and 51.2 percent in population and employment, respectively, between 1990 and 2020. (See Table 2-2.)

The Flight Plan forecast work preceded the 1990 Census. The 1988 total regional population figures are 8.5 percent lower than those for 1990. In 1990 the regional population was 2.749 million and the employment level was 1.546 million. Regional forecasts following the 1990 Census show a regional population of 3.963 million in 2020 (44 percent increase) and an employment level of 2.174 million (51 percent increase). (See Table 2-2.) Snohomish and Pierce counties are forecasted to grow at greater rates than King County, although the greatest absolute increases remain in King County. The new Regional Council forecasting models and results are explained in STEP 91: Central Puget Sound Regional Economic Model and Regional Economic and Demographic Forecasts for 1990-2020: Technical Documentation (September 1991).

Per capita income is widely used as one important factor in developing long-term air passenger demand forecasts. It is a mathematical result based on forecasts for the population and for the regional economy. However, for the leisure component of airline travel (54 percent of the total passengers at Sea-Tac), discretionary income may be a more specific measure of travel behavior than per capita income. However, trends in discretionary income have not been a traditional statistical tool. Nevertheless, because these trends have flattened in recent years, they are a growing concern in economic analyses. With new technologies such as conference calls and fax machines, business travel also may become more discretionary. The PSATC acknowledged this in reviewing the Flight Plan forecasts and presenting the system management alternative (see Section 3.2.1).

The FAA also warns that trends in income, and discretionary income, must be reviewed carefully. If the wealth of the national economy becomes increasingly committed to necessities such as rising national medical expenses, then this:

> "...could have a significant impact on the aviation industry, regardless of overall trends in economic activity." (FAA Aviation Forecasts Fiscal Years 1992-2003, p 24).

2.2.2.2 Yield

Yield is another major factor in forecasting future air passenger demand. Yield is a measure of airline costs expressed in cents per available seat mile and, as such, can be an indirect indicator of related airline ticket prices. Passenger demand is influenced by prices.

Since 1990, the airline industry has been significantly affected by fluctuations in oil costs, international events and changes in the national economy. Highly leveraged airlines (e.g., TWA, Northwest) have been unable to retire debt and, under Chapter 11 bankruptcy protections, have maintained ticket prices at below-cost-recovery levels. Some other airlines are no longer in operation. Competitive pricing by individual airlines to maintain market share has had the additional indirect effect of restoring or even increasing total passenger levels.

In the future ticket prices may rise to more closely match the costs of airline operations--yield. The FAA forecasts a slight real increase in yield from 13.35 cents per passenger-mile in 1991 to 13.61 cents per passenger-mile in 2003, a 2 percent increase (FAA Aviation Forecasts, p. 57). The Flight Plan forecasts completed in June 1990 assumed that yield would remain constant after the year 2000.

Generally, forecasting models reveal a demand elasticity of 0.7 (conversation with Jack Smith, FAA Forecast Branch, Office of Aviation Policy and Plans). Elasticity refers to the consumer response to changing prices, and in this case means that for every 10 percent *increase* in real airline ticket cost, forecasted total passenger demand will *be reduced* by 7 percent. In this instance, each 10 percent increase (or decrease) in real ticket prices between 1990 and 2020 could result in a reduction (or increase) of 3 million annual passengers (MAP) from the forecasted 45 MAP in 2020.

2.2.2.3 Other Assumptions

The Flight Plan Project forecasts are "unconstrained", that is, they reflect what the level of demand would be if facilities are not withheld when needed. Some regional alternatives do not achieve this level of service, most notably the no-action and the demand management alternatives.

Other assumptions are identified in the Flight Plan Phase I Report (pages ES-1 through ES-12) and Chapter 4:

- The report acknowledges that if airline competition triggered by deregulation in 1978 diminishes, the forecasted increase in airline traffic demand will tend to be reduced.
- Airline fuel prices were assumed to remain constant in real dollars.
- It was noted that any constraints imposed by the capacity of the national air traffic control system or by the nation's airport capacity could affect traffic demand at individual airports such as Sea-Tac.
- The consultant was explicit that the forecasts are dependent upon the assumptions stated in the report.

It is also assumed that the total number of future aircraft operations is not altered by the regional airport system finally selected. A different view is that accessible supplemental airports can stimulate additional passenger demand or tap unmet latent demand. On the other hand, less convenient service can affect real demand levels.

Other sources of uncertainty are less applicable to this region than many other regions. Sea-Tac is not an airline hub airport. Financially troubled airlines account for only 6 or 7 percent of the passengers that used Sea-Tac in 1988 (derived from Flight Plan Phase I Report, Table 4). By comparison, TWA alone accounts for 85 percent of the operations at St. Louis Airport. Airports with a large percentage of connecting passengers, Denver, Atlanta, and O'Hare, have experienced temporary but sharp drops in annual operations, due to the fortunes of some of their hubbed airlines. In contrast, passenger demand at Sea-Tac is 69 percent local origin and destination travel.

Further, while the large share of commuter operations at Sea-Tac is expected to continue, this level of commuter operations declines to 23 percent of the total by the year 2020. Finally, while the number of international passengers is difficult to predict, this demand component is only 3 percent of enplaned passengers (excluding Canadian passengers) and could increase manyfold without influencing the overall forecasts. Enplaned passengers are the total of originating passengers and those transferring from connecting flights.

2.2.3 Operational Forecasts

The passenger demand forecasts are translated into aircraft arrivals and departures (operations) presented on Table 2-4. Generally, the assumption that average airplane size will increase leads to a trend in operations less than that for future passenger levels and similar to trends shown in regional population and employment forecasts.

Operations are expected to increase from 355,000 in 1990 to 524,000 in 2020 (48 percent increase). The efficient "capacity" of Sea-Tac is 380,000 operations, based on an average operational delay of four or five minutes per aircraft (see Figure 1-2). The demand management action of using larger planes is accomplished directly by the market in this case, and is already built directly into the forecasts used in Flight Plan for future operations.

National load factors (the percent of airplane seats occupied) averaged 61.7 percent in 1991. The most active airlines in our region had these national load factors for domestic flights: Continental (62.1), Northwest (62.9), Pan American (62.2), United (64.2), Alaska (56.3), Horizon (51.8). (Source: Air Transport World, June 1992).

The Flight Plan Project projected that the number of passengers per operation would rise from 50 in 1988 to 95.7 in 2020 (Flight Plan Draft Final Report, 17 January 1992, Appendix B-71). See Figure 2-4. This is an important, but uncertain, conversion factor between forecasted passenger volumes and airline operations. Related to this, the noise analyses in Section 4.0 of this FEIS assumes that site controls such as noise limitations will be in place. Site controls can increase the number of local passengers per flight. The resulting local passenger level per flight at supplemental airports can be comparable to what occurs at the primary airport (Sea-Tac). This is the pattern at John Wayne and Long Beach Airports in California.

A separate set of national and subarea air carrier forecasts is prepared nationally by the FAA. A draft report is under review. The draft results for this region are included in Table

2-4. Under this national forecasting process, national totals for the year 2003 are distributed to major airports across the nation. The share allocated to this region is translated into aircraft operations. The resulting national aircraft *operation* forecasts for this region are very close to those developed regionally; however, they are accompanied by a caveat at the national level regarding the *passenger* forecasts for the 1992-2003 period.

> "Although the FAA does not develop high/low scenarios, it is felt that, based upon the assumptions which underlie the forecasts (i.e., 2.5 percent growth in real GNP and 0.2 percent growth in real yields), the forecasts represent not only a best case scenario but potentially, a high scenario as well. In other words, it is believed that most of the risk is on the downside, i.e., U.S. economic growth is likely to be lower than projected and domestic real yields are likely to increase at a higher rate than assumed. Therefore, users of these forecasts should be aware that the long-term growth projections contained herein could be significantly lower than projected." FAA Aviation Forecasts, Fiscal Years 1992-2003, February 1992, FAA-APO 92-1, p. 77.

The range of forecasts in Table 2-4 and the above discussion, will be reviewed by the Washington State Air Transportation Commission acting under recent state legislation (ESHB 2609). This review is due to be completed on December 1, 1992 and will be available in time for consideration by the Regional Council before it amends the RASP in March of 1993.

The forecast of operations is dependent upon trends in average airplane size, fleet mix, and load factors. From a demand management perspective, the forecasts assume an increase in average airplane size. This change assumes the use of larger wide-body jets, and a significant replacement of the smaller regional commuter planes with larger aircraft. A range of documented forecasts is provided in the above table. Note that there is a large difference between the Flight Plan and update forecasts for commuter operators in the year 2020. This is an area where demand management could be used to achieve the flight plan estimate. Improved load factors would be difficult to achieve through regulation, but might be achieved through gate controls imposed directly by airport operators, rather than through other possible actions of the FAA.)

In addition, consultants vary on whether the method of addressing demand results in a change in the number of operations. Specifically, evidence suggests that the multiple airport systems increase the total number of operations by perhaps 16 percent as new markets are tapped (Phase II Report, p. 43). This was not corroborated by statistical studies done for the final phase of Flight Plan (Flight Plan Draft Final Report, Appendix: Working Paper No. 5).

Among the four categories of airlines modeled in Phase I (air carrier, commuter, international, and Canadian), commuter showed the most dramatic increase in operations in recent years. At the national level, commuter revenue miles increased dramatically between 1978 and 1990, from 0.3 billion to 2 billion (FAA Aviation News, May/June 1991, p.1). This is due mostly to the restructuring of airline service into a hub and spoke system following deregulation of the airlines in 1978. (Note: the hub and spoke system refers to the new airline service structure--consisting of regional flights to and from a network of major airports served by major airlines.) Between 1986 and 1989, commuter operations at Sea-Tac Airport grew by 144 percent, from 21 percent of the 1986 total to 42 percent of the much larger 1989 total. However, commuter airlines accounted for only 7.9 percent of

Table 2-4

ALTERNATIVE FORECASTS OF OPERATIONS
(in thousands)

Item	1995	2000	2010	2020
Air Carrier				
Flight Plan	**226**	**257**	**302**	**375**
Update	238	260	299	338
FAA Draft		265	301	
Regional/Commuter				
Flight Plan	**158**	**136**	**124**	**126**
Update	138	148	182	214
FAA Draft		143	143	
General Aviation				
Flight Plan	**16**	**17**	**20**	**22**
Update	10	10	10	10
FAA Draft		10*	10*	
Military				
Flight Plan	**1**	**1**	**1**	**1**
Update	1	1	1	1
FAA Draft		1*	1*	
TOTALS				
Flight Plan	**401**	**411**	**447**	**524**
Update	387	419	492	563
FAA Draft	-	419	455	-

Sources:

Flight Plan: Phase I Report, Phase II Report (Appendix J), and Airport Activity Report, Port of Seattle, 1990, Page 24.

Update: "Update of Passenger and Operations Forecasts for Seattle Tacoma International Airport", P & D Aviation, March 11, 1992.

1. This Update anticipates that the year 2020 passenger level will be 41 MAP rather than 45 MAP, and finds that the number of operations will be somewhat higher. The conversion to larger average aircraft size is less optimistic than Flight Plan. See additional comment in Section 3.2.1.1.
2. FAA Draft "Seattle-Tacoma Hub Forecast" (Draft), FAA Office of Aviation Policy and Plans, June 1992.
3. (*) Assumed here. The included figures are required to produce the FAA total.

passengers in 1988 (Phase I Report, Table 4 and Exhibit B). Commuter flights actually dropped in 1991 by nearly 5 percent from 150,000 to 143,000. (Sea-Tac Traffic and Operations Report, December 1991). The Flight Plan forecasts show commuter flights as dropping to 23 percent of the total operations by 2020 (Table 2-4).

If total passenger demand increases more moderately than forecasted, the trend to larger planes could also be delayed. The trend in operations -- the basis for evaluating the regional alternatives -- could remain accurate even as passenger demand varies from the forecasts. This outcome is reflected in new work by a consultant for the Port of Seattle (shown in Table 2-4 as the "update") and was not available in time to be fully reviewed by the PSATC. It assumes commuter flights will continue to rise, from 138,000 in 1995 to 214,000 in 2020, but also predicts that the number of passengers per flight will increase less rapidly than forecasted in Phase I (41 MAP in 2020, instead of 45 MAP).

Air cargo flights are unlikely to contribute significantly to aircraft delays at Sea-Tac and should not contribute to the need for new runways (Phase I Report, p. 69). However, generally increasing delays for all operations would affect reliability of cargo plane schedules. Of 156,000 planes carrying cargo in 1989, less than three percent were all cargo or package express (the rest were passenger planes already accounted for in the forecasts). Two-thirds of the air cargo tonnage is transported by passenger planes.

2.3 CURRENT CAPACITY CONSTRAINTS

Capacity is a concept which is difficult to measure. Essentially it can be thought of as the total number of aircraft that can take off or land from an airport within a given time period and with a minimum of delay. For long-range planning and airport design a period of one year is used, but since this number averages the number of landings and takeoffs under both good and foul weather conditions for an entire year, it is only an approximation. Beyond a point, higher volumes mean rapidly rising delay.

An alternate measure is hourly capacity. Using this shorter time period, one can analyze how specific weather conditions impact the actual number of takeoffs and landings that an airport can handle.

2.3.1 Long-Term Capacity

The Flight Plan Project estimates that delays are expected to increase from an average of five minutes per aircraft to nine minutes in 2000. Operational capacity is stated to be 380,000 operations per year. (Passenger capacity was originally stated to be 25 MAP, but with the assumption of increasing passenger levels--at the cost of rapidly increasing delays--and larger average plane size, Flight Plan adjusted this figure to as much as 35.8 MAP in 2020.)

2.3.2 Loss of Present Capacity

During peak hours of activity and during instrument flight conditions, delays could exceed an hour. Delays after the year 2000 were reported as "excessive." When these jeopardize airline profitability, this will lead to rescheduling and diversions of aircraft to other airports, and a reluctance by the airlines to add additional service (Phase I Forecasts, p. 47).

The current runway capacity at Sea-Tac is reduced from the two dependent (closely spaced) runways to one runway during poor weather conditions. The airport is reduced to one arrival stream approximately 44 percent of the total hours in a year. This information is displayed in Table 2-5 (Seattle-Tacoma International Airport Capacity Enhancement Plan, June 1991, p. 16). Of this 44 percent, probably one-third is during low activity nighttime periods (between 10:00 p.m. and 6:00 a.m.), when the single runway is sufficient. However, when airport arrival acceptance rates drop below 42 aircraft per hour, metered flow conditions are triggered. This delays flights into later hours and periods of normally low activity. Fortunately for Sea-Tac, most Instrument Flight Rule weather occurs during the off-peak months so total delays are not as great as might initially be expected (Phase II Report, p. 64).

State-of-the-art radar and ground equipment at Sea-Tac increases the capacity of the airport to receive and handle aircraft (See parts of Section 4.9). However, these do not enlarge the capacity to handle the growing number of waiting flight departures. This limitation also applies to Boeing Field, which is considered in Section 3.0 as part of a regional action alternative.

Table 2-5

AIRFIELD WEATHER AND RUNWAY UTILIZATION

Weather Condition (Arrival Paths)	(notes)	Operational Use of Runways (Percent of Time Used) (Southflow)	(Northflow)	(Total)
VFR1	2	34%	22%	56%
VFR2	1	15	4	19
IFR1	1	15	3	18
IFR2	1	5	0	5
IFR3	1	2	0	2
TOTAL		71%	29%	100%

Source: Seattle-Tacoma International Airport Capacity Enhancement Plan, June 1991, Table 8 and Figure 10.

Notes:

1. VFR is Visual Flight Rules. VFR 1 is 5000/feet ceiling, and five miles visibility. VFR 2 is 2500 to 5000 feet, with more than 3 miles.
2. IFR is Instrument Flight Rules. IFR 1 is 650 to 2500 feet, with 1800 feet runway visual range. IFR2 is below 650 feet, with more than 1200 feet runway visual range. IFR 3 is zero ceiling, with less than 1200 feet runway visual range.
3. Total operations are reduced from 98 per hour in VFR1 to 65 and 55 operations per hour under VFR2 and IFR conditions, respectively.

2.4 GROUND TRAVEL AND AIRSPACE MANAGEMENT

Airport system management may provide partial solutions to problems identified at Sea-Tac or other airports in the regional system. A comprehensive airspace study should follow completion of the regional commercial air transportation capacity decision. Based on informal discussions with the FAA, it is assumed here that the airspace issues can be adjusted around the more difficult siting issues addressed in this non-project FEIS and in later siting studies and project EISs.

2.4.1 Airport Access

Ground access to the airport site(s) raises the major growth management issue of whether airports should be located where the users are, or in more remote locations where the noise will affect fewer people.

The system alternatives in Section 3.0 cover the range of possibilities. Some alternatives confine all capacity expansion to the existing site at Sea-Tac Airport. Ground congestion during peak periods would be serious, even with presently planned improvements. This congestion is important as both an airport impact and an obstacle to reliable surface access to the airport. Replacement airports are also considered. Multiple airport options can use supplemental sites phased to serve growing airline markets north and south of the current site. These can be sized to serve only locally generated passenger demand, or greater demand associated with possibly capped service at Sea-Tac. Capped service at Sea-Tac would involve greatly increased regional ground mileage to reach air service, as well as disrupted passenger connections between airplanes.

The alternatives assume that international traffic would remain at Sea-Tac. The exception is Sea-Tac operated in conjunction with a Moses Lake wayport (wayports are defined in Section 3.8.3.2)

2.4.2 Airspace Management

In the broadest sense, the air carrier alternatives available to the region are limited by constrained geography and resulting airspace issues. Major factors are the two confining mountain ranges east and west and the corner location of the region to the rest of the United States. Airspace management options related more specifically to the Flight Plan alternatives (summarized from Section 4.10) include, but are not limited to, these issues:

- Distribution of air traffic among all airports. Past examples include the shifting of air carrier from Boeing Field to Sea-Tac and the shift of general aviation from Sea-Tac. Control of Instrument Flight Rules (IFR) is under the exclusive authority of the FAA, not the airport operators, but collaborative solutions are not precluded.
- Interaction with military operations south of Sea-Tac, interaction of arrival and departure routes if a multiple airport system is selected.
- Interaction between Sea-Tac and Boeing Field (addressed in Flight Plan Draft Final Report, Working Paper No. 1).
- Possible amendments to the Four-Post Plan (as a mitigation action).
- The flight track implications of new technology such as the Microwave Landing System. (Curved flight tracks could help orient some approaches and departures over water, as was more the pattern prior to the Four-Post Plan.)
- The relation between air carrier and general aviation (see Section 2.4.3), and the relation between flight tracks and the noise capacity of the impacted communities on the ground.

A broadened review of these factors will be useful following policy action on the air carrier alternatives. This is addressed in Section 4.10.

2.4.3 General Aviation Impacts

The Regional Airport System Plan (RASP) sets policy for air carrier service and for general aviation. The 1988 plan adopts a planning sequence which phases possible revisions to the general aviation element after the air carrier element addressed in Flight Plan is completed.

The FAA is primarily responsible for this broader airspace management issue. In addition, the State Airport System Plan addresses general aviation. The Washington State Air Transportation Commission is required to complete its evaluation of state-level air transportation policy options by July 1993. The following relationships to general aviation are identified in the 1988 RASP and are acknowledged here for consideration as an air carrier decision is made.

2.4.3.1 General Discussion

General aviation is a small share of operations at Sea-Tac (4 percent), but a very large share of total operations in the region. This is one reason for a general airspace study as proposed in Section 4.10 of this non-project FEIS.

General aviation aircraft operations within the region take place primarily at five FAA towered airports -- Boeing Field, Renton Municipal, Seattle-Tacoma International, Paine Field and Tacoma Narrows -- and 16 non-towered airports. In 1990 the total number of operations at the five towered airports was 1.2 million. Total operations is air carrier, commuter/air taxi, general aviation and military.

General aviation was 69 percent of this total, while air carrier was less than 17 percent and commuter/air taxi was 14 percent. The number of general aviation operations dropped 7 percent between 1970 and 1980, but accounts for the vast majority of operations in the region. General aviation operations in 1991 for selected airports were: Arlington (117,000), Auburn (184,000), Boeing Field (397,000 in 1990), Thun Field in central Pierce County (72,000), Renton Municipal (181,000), Paine Field (166,000), Tacoma Narrows (111,000). By comparison, the larger general aircraft serviced by TRAMCO at Paine Field in 1990 involved 675 operations (less than half of one percent of the Paine Field total) (from TRAMCO FEIS, 3 February 1992, p. 2-8). These are important figures to recall when reviewing the system-level air carrier alternatives that involve supplemental airports. (In addition, military operations at McChord are highly variable, averaging 60-65,000 per year and peaking in 1982 at 100,000, PSATC Site Tour, September 1991.)

The FAA anticipates that general aviation will grow moderately in the future, remaining at 72 percent of total operations in 2010 (1.7 million). (Seattle-Tacoma Hub Area Forecasts, Draft, FAA, summer 1992.)

2.4.3.2 Findings of the 1988 RASP

The general aviation findings of the 1988 RASP are summarized here:

- General aviation demand flattened in the 1980s, due to such economic factors as product liability insurance and rising operating and maintenance costs. (Total operations actually dropped from 1.8 million to 1.6 million.)

- The 1988 RASP develops high and low forecasts of general aviation basing requirements, to the year 2020. Capacity was reported to be adequate except for possibly a slight need in Pierce County and up to 1,154 aircraft spaces in King County (1988 RASP, Table 6). The high forecast was based on an assumed constant ownership rate as population increases.

- Pressures exist to remove general aviation out of congested airspace, namely the airspace around Sea-Tac and Boeing Field. Smaller airports might not be able to handle this redistribution of traffic (a potential element of the system management regional air carrier alternative).

- Supplemental airport sites could involve direct or indirect tradeoffs (rising prices for ground services and required navigation equipment) between air carrier and general aviation.

- The 1988 RASP recommended studies to address the need, feasibility, action steps and permanent service restrictions for a new general utility airport in the region (p. 46).

3.0 ALTERNATIVES

3.1 OVERVIEW

System alternatives developed for the Flight Plan Project were designed to represent a range of possible non-site-specific solutions to the Puget Sound Region's future commercial air transportation needs. System alternatives are generic in nature and serve as broad answers to the question "What are our regional choices and how do they compare to one another?" However, specific sites were identified for purposes of assessing impacts. Site-specific studies to be conducted later will address the more-specific questions of "Where should we implement the chosen system alternative and how will we make it work?"

The system alternatives developed in the Flight Plan Project cover a wide scope of possible actions to address forecasted airport capacity limitations at Seattle-Tacoma International Airport (See Sections 2.2 and 2.3). Although they represent potential courses of action, there are environmental, operational, economic, and institutional tradeoffs that must be considered for each of them. They also differ in their ability to meet the forecasted air travel demands of our residents and visitors to the region.

This section of the EIS describes each of the system alternatives and how each would work in the Puget Sound Region. In addition, the evaluation methodology is presented (Section 3.7), and a discussion of what would probably happen under each regional alternative if implementation is only partly completed (Section 3.8). For an in-depth analysis of the various environmental impacts and mitigation measures associated with the alternatives, please see Section 4. A discussion of the findings of the Puget Sound Air Transportation Committee regarding each alternative is presented in Section 1.5. and in Appendix A.

The system-level alternative airport configurations are:

- **Sea-Tac Airport Capacity Enhancement Measures**

    1) **Sea-Tac with Broad System Management:** This is an alternative that attempts to meet our regions's future travel needs without building any new dependent air carrier runways. It includes the use of demand management, new technologies, and high-speed ground transportation.

    2) **Sea-Tac with a New Dependent Third Runway:** This runway would be able to accommodate both landings and takeoffs of commuter and jet aircraft.

    3) **Sea-Tac in Conjunction with a Remote Airport:** A remote airport is a second airport such as Boeing Field or Moses Lake Airport that would be functionally linked and operated in tandem with Sea-Tac. (It would not be oriented toward local origin and destination traffic, as is the case with the supplemental airports in the Multiple Airport System alternatives).

- **Two-Airport Multiple Airport System:** One supplemental passenger-service airport would either be located to the north or south of Sea-Tac. Sea-Tac would either return its current airfield configuration or would be expanded. Northern site options include Arlington and Paine Field. Southern site options include Central Pierce, McCord Air Force Base, Loveland and Thurston county (Olympia Black Lake).

- **Three-Airport Multiple Airport System:** Two supplemental passenger-service airports, one located north of Sea-Tac and one located south of Sea-Tac, would be developed. Sea-Tac would either retain its current airfield configuration or would be expanded. Northern and southern site options are the same as described above for the two-airport multiple airport system alternative.

- **Replacement Airport:** Sea-tac Airport would be closed and a new, larger airport with three runways would be constructed in a new location. Site options to evaluate the replacement airport are Fort Lewis and Central Pierce.

- **No Action:** Sea-Tac would continue to be the region's only passenger-service airport. No capacity improvements related to commercial passenger service would be made to any Puget Sound area airports.

These potentially feasible site options were identified for purposes of providing a comparative evaluation of the system alternatives. Project level studies could add to or delete from the options listed above.

3.2 SEA-TAC AIRPORT CAPACITY ENHANCEMENT MEASURES

Several of the alternatives explored in this FEIS would retain Sea-Tac as the focus for air transportation in the region while providing means to either increase its capacity or to accommodate additional passenger demand without new dependent air carrier runway construction. The options within this alternative are described below.

3.2.1 Sea-Tac With Broad System Management

The broad system management alternative (Figure 3-1A) is a combination of several aviation-related and non-aviation-related means for increasing our region's ability to transport inter-city passengers and cargo. It is intended to shape demand to fit existing facilities rather than building additional runways in the region. Broad system management is composed of three types of actions: 1) Implementation of demand management, 2) Use of new technologies, and 3) Construction of some type of high-speed ground transportation system between Seattle; Portland, Oregon; and Vancouver, B.C.

Instead of all being implemented at once, each of the above three components would likely be implemented in phases as demand warrants. Since demand management could marginally enhance operational capacity, it would delay the time for which other improvements will be needed. It would be the first component brought on line, followed by new technologies, and then the construction of a high-speed ground transportation system in about 15 to 20 years. Taken as a whole, the three components of the broad system management alternative would be able to accommodate a maximum of 38 million passengers and 380,000 operations per year. This is less than the 45 million annual passengers forecasted for the year 2020.

3.2.1.1 Demand Management

Demand management (Figure 3-1B) covers a broad range of pricing and regulatory techniques that are intended to allow an airport to serve a greater number of passengers by deferring the need to build new facilities. Possible measures may include: (1) discouraging air travel to reduce demand; (2) diverting airline passengers to some other mode of

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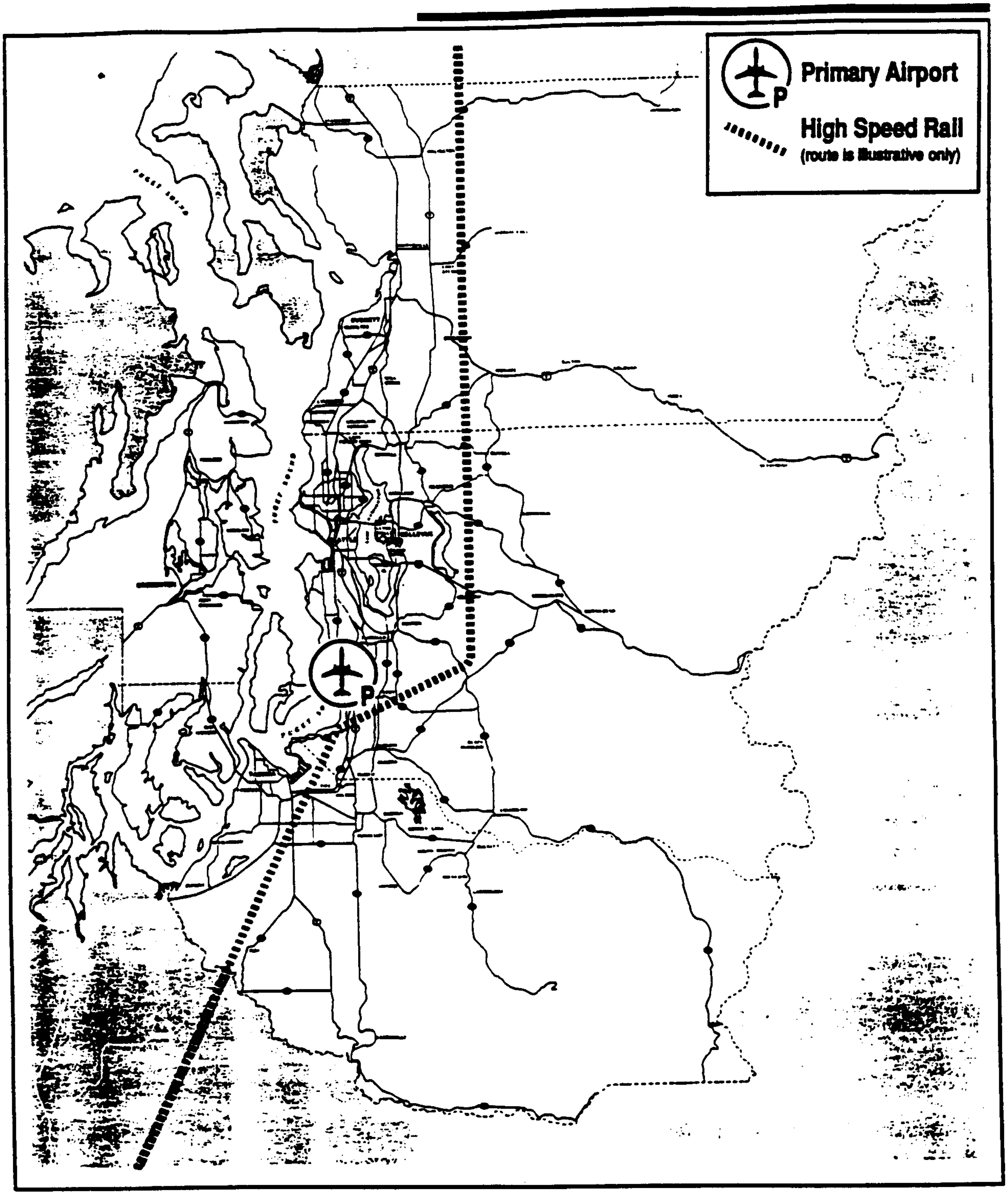
Figure 3-1A

Broad System Management
(Rail, technology, demand management)



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DEMAND MANAGEMENT SUMMARY

Figure 3-1B

TECHNIQUE	JURIS-DICTIONAL RIGHTS	THOSE ADVERSELY AFFECTED	KEY CONSIDERATIONS	COMPARATIVE REDUCTION IN CONGESTION	ALTERNATIVE ASSUMPTIONS: SEA-TAC	MULTI-AIRPORTS	REPLACE-MENT	MAXIMUM DEMAND MGMT.
DO NOTHING (NO SEA-TAC EXPANSION)								
NO BUILD	PROPRIETOR	ALL USERS	MOST SEVERE ECONOMIC CONSEQUENCES EASIEST TO IMPLEMENT, INCREASES CONGESTION	NONE	✓			✓
SUPPLEMENTAL AIRPORTS	PROPRIETOR	POSSIBLE AIRLINES	AVOIDS CONGESTION, IMPROVES ASSESSIBILITY	LARGE		✓		
CONTROL GATES	PROPRIETOR	AIRLINES	GREATER PROPRIETOR RIGHTS, CAN INDIRECTLY CONTROL AIRSIDE CAPACITY	MODERATE				✓
YIELD MANAGEMENT	AIRLINES	PASSENGERS	CONTROLS LOAD FACTORS	SMALL	✓	✓	✓	✓
LARGER AIRCRAFT	AIRLINES	SMALLER AIR-CRAFT OWNERS	NATURAL TREND, HIGH REPLACEMENT COST	SMALL MED.	✓	✓	✓	✓
TECHNOLOGICAL ADVANCES	FEDERAL/ INDUSTRY	COST RECIPIENTS	MINIMAL IMPROVEMENTS FROM FORESEEABLE TECHNOLOGICAL ADVANCES, MUST BE IMPLEMENTED INDUSTRYWIDE	SMALL				✓
ALTERNATIVE MODES	REGIONAL	AIRLINES	RAIL MOST EFFECTIVE IN HIGH DENSITY MARKETS WITH POOR ROAD SYSTEMS, LESS EFFECTIVE FOR SHORT HAUL TIME SENSITIVE TRIPS	SMALL				✓
PRICING SCHEMES								
LANDING FEES	PROBABLE PROPRIETOR	SMALLER OPERATORS	LEGAL IMPEDIMENTS GA AND COMMUTERS MOST AFFECTED, MINIMUM AFFECT ON CARRIERS	SMALL				✓
GATE FEES	PROPRIETOR	OPERATORS	GREATER PROPRIETOR RIGHTS	SMALL				✓
TERMINAL FEES	PROPRIETOR	OPERATORS/ PASSENGERS	SUBJECT TO LEASE AGREEMENTS	SMALL MED.				✓
PEC'S	PROPRIETOR	PASSENGERS	MUST BE APPLIED UNIVERSALLY, COULD GENERATE SUPPLEMENTAL AIRPORT FUNDS					
ADMINISTRATIVE MANAGEMENT								
SLOT RATIONING	FEDERAL	NEW ENTRANTS	FEDERAL RELUCTANCE, CONTRARY DEREGULATION TRENDS	LARGE				
QUOTAS	PROBABLE PROPRIETOR	NEW ENTRANTS	MUST NOT UNDULY LIMIT INTERSTATE COMMERCE	MODERATE				
CENTRAL FLOW CONTROL	FEDERAL		AIRLINES SET SCHEDULES, CONVERTS AIR DELAYS TO GROUND HOLDS	MODERATE	✓	✓	✓	✓

transportation (see high-speed ground transportation discussion below); (3) shifting a class or classes of aircraft such as commuters, cargo-only or general aviation within the system of regional airports; (4) encouraging the use of aircraft with larger average seating capacity (especially in the commuter market category); (5) requiring higher load factors (percentage of seats filled on each flight); and (6) shifting aircraft operations to non-peak periods of the day. Demand management would be effective in moderating the increased commuter traffic indicated in the updated forecast figures shown in Table 2-4.

Several demand management measures are already in place at Sea-Tac Airport which affect the number and peaking of aircraft operations. For example, the airlines, have practiced "yield management" which is a ticket pricing strategy that not only increases profits, but also increases load factors. Fundamental changes in fare structures introduced in April 1992 may represent a change to this approach. The Federal Aviation Administration (FAA) operates a "central flow control" system which helps control congestion by holding aircraft on the ground at their origination until an opening for landing is available at Sea-Tac. In addition, general aviation operations have already been minimized at Sea-Tac since these users prefer Boeing Field due to its proximity to downtown. It is also important to note that the Flight Plan forecasts themselves assume that the average aircraft size will increase in the future. Thus, the forecasted number of aircraft operations needed to carry future passenger levels are already lower than they would be otherwise.

However, further demand management strategies could be implemented. These include variable pricing of aircraft gates, on space in the terminal building, and/or landing fees to either shift some flights to non-peak hours or encourage the use of larger aircraft. The greatest number of passengers that could be accommodated by doing this has been factored into the 38 million annual passenger limit of the system management alternative.

Demand management may best be used as part of a balanced package of management and construction actions and a short-term strategy to help buy time while capacity improvements are made. (This was the conclusion of the demand management expert panel assembled for the project.) It may be part of a balanced package of actions and can be used to help run an airport more efficiently. Moreover, it can seldom be used as the only solution. This is due to complex airline economics and the limited ability of airports to regulate airline schedules and operating procedures. Figure 3-1B lists the demand management strategies that were examined in Flight Plan. For more information, please see Working Paper #4 "Demand Management" in the PSATC Draft Final Report.

3.2.1.2 New Technologies

Potential technological improvements in aircraft design and/or navigation aides could possibly be used to enhance Sea-Tac's passenger-handling capability. Future airplane types explored in Flight Plan included new generations of super-sized passenger jets and tilt-rotor aircraft. The former would allow for more passengers to be carried per aircraft operation while the latter might be able to use unused portions of the airport's shorter runways already in existence at small airports in the region. Other technological advances such as microwave landing systems (MLS), global positioning systems (GPS), and other new navigational tools are expected to enhance airport capacity and increase safety. It is assumed that while the current runway spacing standards for independent instrument operations may be reduced from the current 4300 feet to 3000 feet, it is not expected that this trend will affect the 2500-foot spacing discussed under Alternative 3.2.2.

Like demand management, new technologies will play an important role in making the most efficient use of existing airport facilities. However, none of the technology options examined in Flight Plan would be able to provide significant capacity relief for the long term. For example, wake turbulence detection systems might allow closer spacing of aircraft, however this would provide only an estimated five percent increase in operational capacity. (*Phase II, Development of Alternatives*, June 1991).

Improved navigational aides such as microwave landing systems (MLS), global positioning systems (GPS), wake turbulence detection systems, etc., will be important for increasing safety, mitigating noise impacts, and enhancing capacity. However, the overall capacity benefits are small. They are able to minimally increase airport capacity by decreasing the amount of space required between runways and between planes in flight (while maintaining the same margin of safety). However, even as the technologies become increasingly advanced, there is a point beyond which runway spacing and aircraft separations cannot be further reduced. The limiting factor for runway spacing is human reaction time for arriving pilots. The limiting factor for planes in flight is the wake of turbulent air created behind aircraft from which other aircraft need to be separated for safe flight. Use of fewer small planes, combined with new navigation technologies, could yield greater benefits than would be expected from these actions taken separately.

As a side note, non-aviation related new technologies such as teleconferencing and advanced telecommunications were also examined. It is unclear what effect these would have on air travel demand. Researchers have examined the possibilities that they could either slow or increase the growth in intercity business travel. A slowing could occur if such technologies are used in place of actual trips.

3.2.1.3 High-Speed Ground Transportation

Approximately one-fifth of Sea-Tac's flights are to either Portland, Oregon or Vancouver, B.C. If some form of fast and reliable ground transportation existed between Seattle and these cities, passengers would have an alternative to flying and the demand on Sea-Tac's facilities might be lessened. Such a system could potentially use upgraded Amtrak service similar to the existing system between New York and Washington, D.C. (traveling approximately 80 to 120 mph), high-speed rail similar to the French TGV or the Japanese "Bullet Trains" (100 to 180 mph), or very-high speed (possibly above 200 mph) magnetic levitation (mag-lev) trains which are now being tested and developed.

By 2020, the Flight Plan forecasts predict that flights between Sea-Tac and Portland, Vancouver, B.C. and Bellingham will account for approximately 80,000 annual aircraft operations. The assumption used in Flight Plan is that high-speed ground transportation, if implemented, could reduce the amount of air service between Sea-Tac and these cities by half (40,000 operations). This represents about eight percent of the total forecasted operations for the year 2020.

(Total commuter passengers at Sea-Tac in 1988 were less than 8 percent of total passengers). Under this case, there would be a capacity shortfall in 2020 of 104,000 operations.

The Washington State High Speed Ground Transportation Commission estimated that such a system would cost over $10 billion to construct.

3.2.2 Sea-Tac With A New Dependent Third Air Carrier Runway

Under this alternative, a third dependent runway that could be used by both propeller and jet aircraft would be built at Sea-Tac (Figure 3-2). A dependent runway is one that would allow two staggered streams of aircraft to land at Sea-Tac during bad weather as opposed to only one arrival stream today because the existing runways are only separated by 800 feet. Such a runway would be approximately 7000 feet long and located along the western boundary of the existing airport property about 2500 feet west of the existing easternmost runway. Additional property would need to be acquired and filled to implement this alternative. Although the runway could technically be used for either take-offs or landings in both good and bad weather, the primary capacity benefit it provides is for bad weather landings (the main capacity bottleneck at Sea-Tac). The annual capacity of this alternative is 41.8 million passengers per year and 480,000 operations.

3.2.3 Sea-Tac in Conjunction With a Remote Airport

A remote airport is a second airport which would be functionally linked and operated in tandem with Sea-Tac (Figure 3-3). Remote airport sites examined in Flight Plan included Moses Lake (Grant County Airport) and Boeing Field.

To make the system work, some form of ground transportation link such as dedicated busways, light rail transit, high-speed rail or magnetic levitation (mag-lev) trains would need to connect the two airports. Passengers would arrive at one airport and then travel to the second airport to make connections. Passengers could also arrive at the remote airport and take the ground transportation link to their final destination within the Puget Sound region. The expected aircraft fleet mix at a close-in remote airport like Boeing Field would be quite different than that found at a more distant airport such as Moses Lake. A remote airport at Boeing Field would likely be used for commuter flights while a remote airport at Moses Lake would likely be used for transcontinental or overseas international flights. Remote airport proposals could be effective in relieving airports serving a large share of connecting passengers (over half). These include Atlanta, Denver, St. Louis and others. At Sea-Tac, only 30 percent of these passengers are making connections to other destinations.

A remote airport, unlike the supplemental airports within a multiple airport system (Sections 3.3 and 3.4), would not focus on serving the communities immediately near it because their populations would be too small to support the service on their own.

For the remote airport alternative, the assumption was made that once Sea-Tac reached capacity, with or without demand management, the additional growth in aircraft operations would occur at the remote airport. Under this scenario, the combination of Sea-Tac and a remote airport at Moses Lake would provide adequate capacity through the year 2020. This capacity would handle 630,000 to 880,000 generations per year. Demand is estimated to be 524,000 operations and 45 million passengers per year. However, Sea-Tac would continue to have a capacity shortfall during bad weather which would result in moderate to severe delays. The severity of the delays depends on how many operations are relocated to the remote airport.

A remote airport at Boeing Field could provide only limited capacity enhancement to Sea-Tac. The problem with using Boeing Field for commercial airline service is that it has significant airspace conflicts with Sea-Tac due to the proximity of the two airports and the alignments of their runways. The current airspace interaction caused by these factors has

Figure 3-2

Sea-Tac with a New Air Carrier Runway

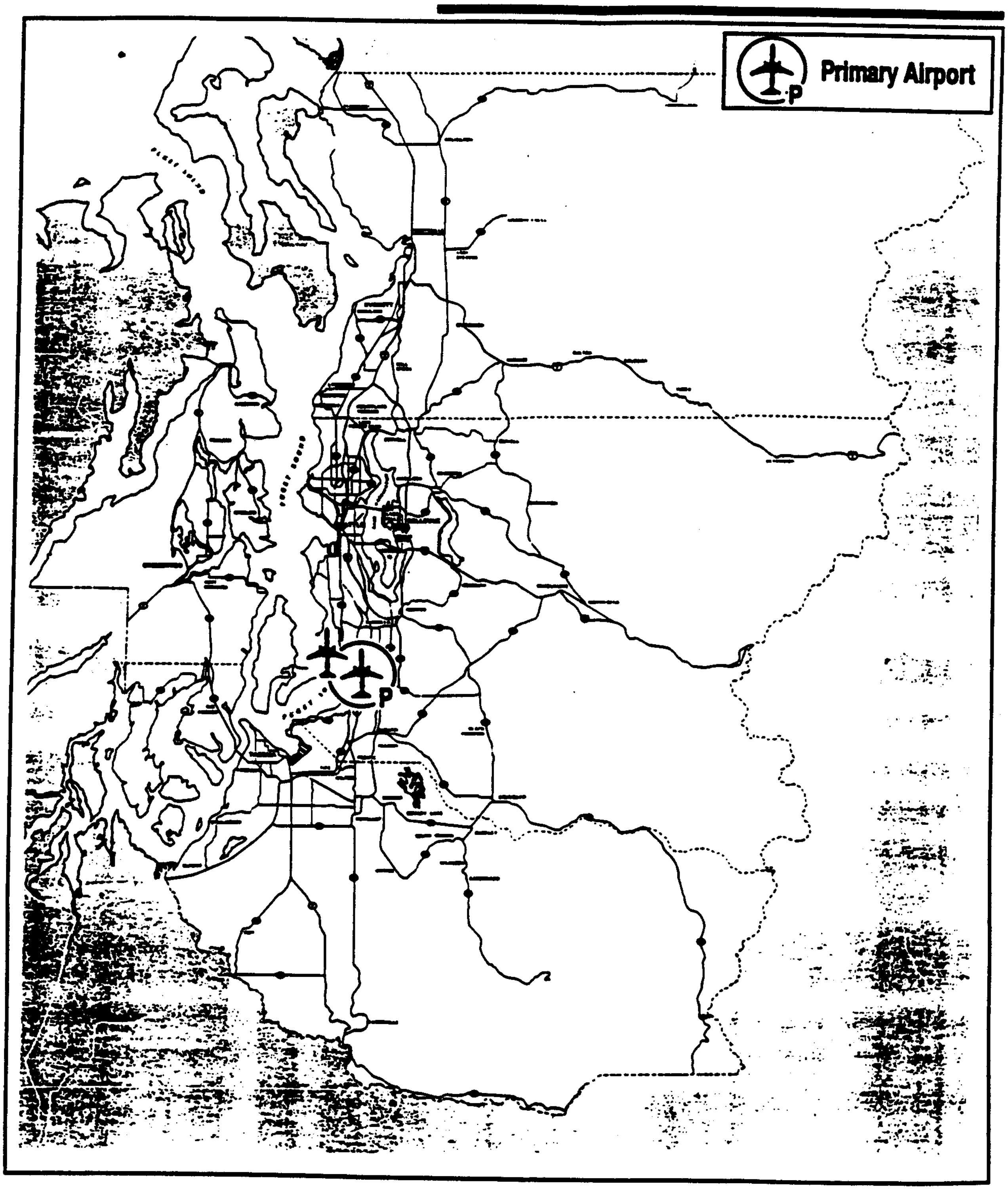

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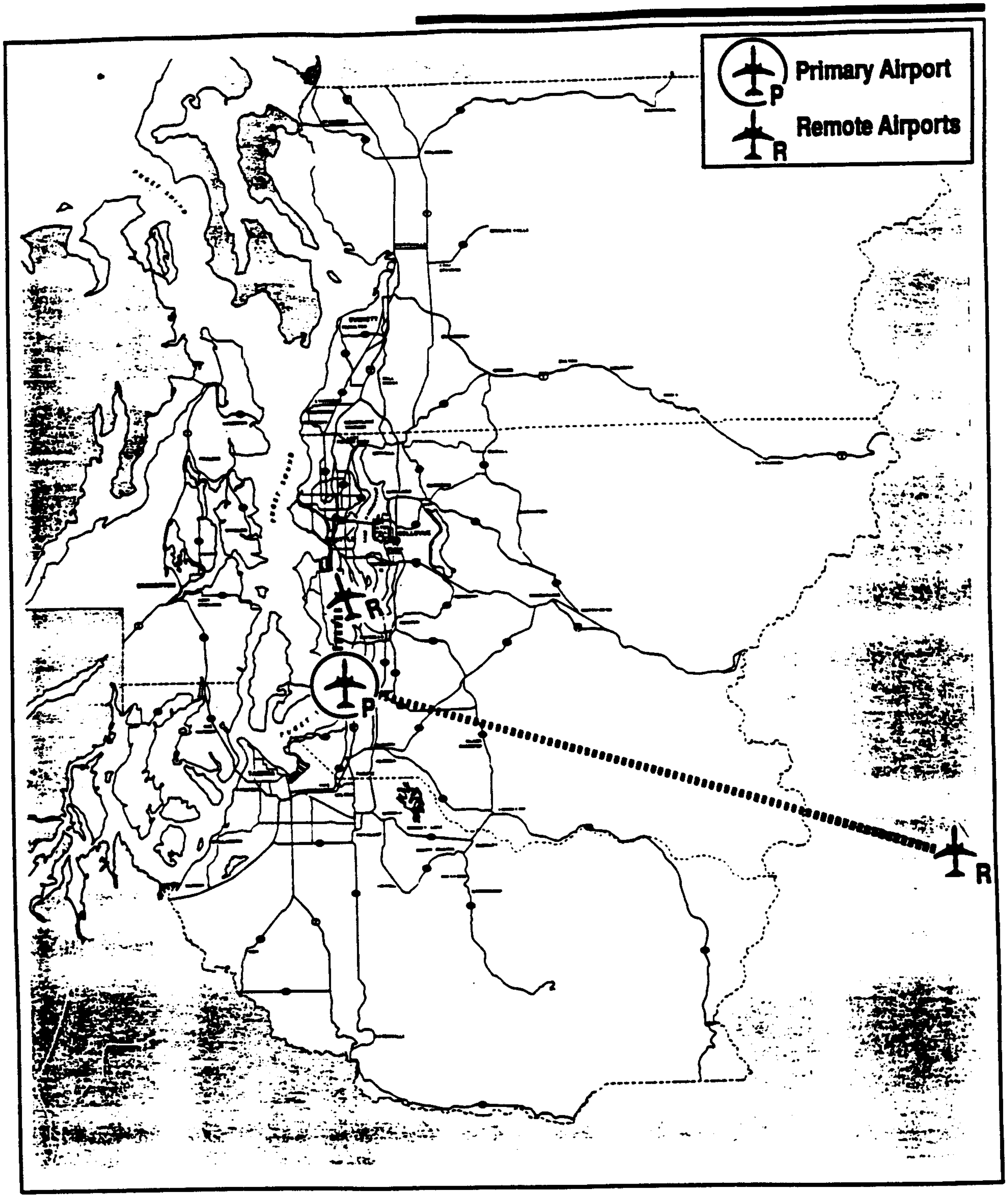
Figure 3-3

Sea-Tac with a Remote Airport



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resulted in the development of air traffic control procedures that are unique to this region. In certain visual flight rules (VFR) conditions, an extra air traffic controller in the Boeing tower maintains visual separation between Boeing and Sea-Tac traffic. This helps accommodate present traffic volumes, but future effectiveness with commercial traffic into Boeing is highly uncertain. Since it is a newly developed, site-specific procedure, the possibility of it being abandoned by the Federal Aviation Administration is greater than for standard procedures commonly applied to other airports. These uncertainties create an element of risk which diminishes the attractiveness of investing in commercial service at Boeing Field. However, the risks do not apply to Sea-Tac expansion since the flight patterns would not likely be altered significantly due to a new dependent air carrier runway.

In many regards, Boeing Field already operates as a reliever airport for Sea-Tac. Many of the smaller general aviation planes that otherwise would be located at Sea-Tac choose to use Boeing Field instead. Also, Boeing Field is already heavily used and does not have adequate capacity to provide for future increases in commercial air travel demand unless general aviation operations were relocated to another airport.

3.3 TWO-AIRPORT MULTIPLE AIRPORT SYSTEM

A multiple airport system consists of a primary commercial service airport with one or more supplemental airports within the same urban area (Figures 3-4 and 3-5). The primary airport provides the bulk of the airline service including transcontinental and overseas international flights and is the only airport in the region to offer significant late night service. Supplemental airports provide a convenient alternative to driving all the way to the primary airport. Since supplemental airports primarily are designed to serve passengers who are traveling to and from the airport vicinity, there is no need for any ground link between the supplemental and the primary airport.

The two-airport multiple airport system studied in Flight Plan would retain Sea-Tac as the primary airport and would have one supplemental airport located either to the north or the south. Sea-Tac would either remain as it is or have a new air carrier runway (Section 3.2.2). If Sea-Tac's capacity is not increased through demand management or by adding another runway, then the supplemental airport sites may serve more passengers than they would otherwise.

The main type of service at a supplemental airport would likely be commuter flights to cities within Washington and the Pacific Northwest. Jet service to California and to Western U.S. hub airports like Salt Lake City and Denver would also be likely.

Other than the three-airport multiple airport system, the two-airport system alternative provides the greatest amount of future capacity. The capacity of 630,000 to 980,000 operations per year exceeds forecasted demand for the year 2020 and depends on the configuration of the primary and supplemental airports). This would be adequate to meet the forecasted air travel demands to 2020 with some reserve for years beyond.

The dynamics of the airline industry are fundamental to the likelihood or timing of a multiple airport system. New service does not result from declarations of public policy but is largely dependent on airline marketing decisions. This FEIS does not address the implementation steps needed assure a multiple airport system. Changes in the airline industry (consolidation of carriers, increased activity by foreign carriers under open skies agreements, etc.) might affect the level and nature of air passenger demand.

Figure 3-4

Two-Airport Multiple Airport System (north)

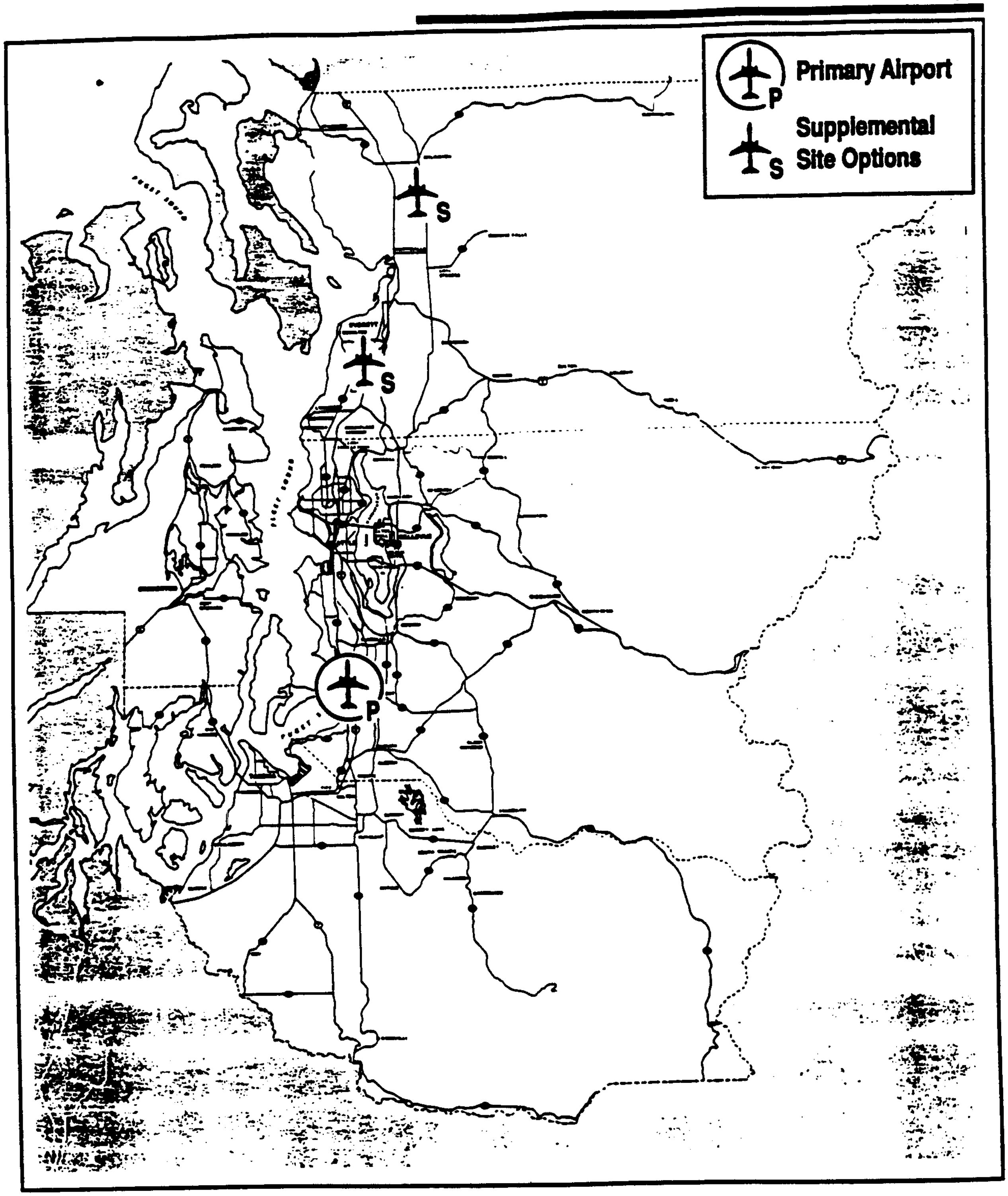

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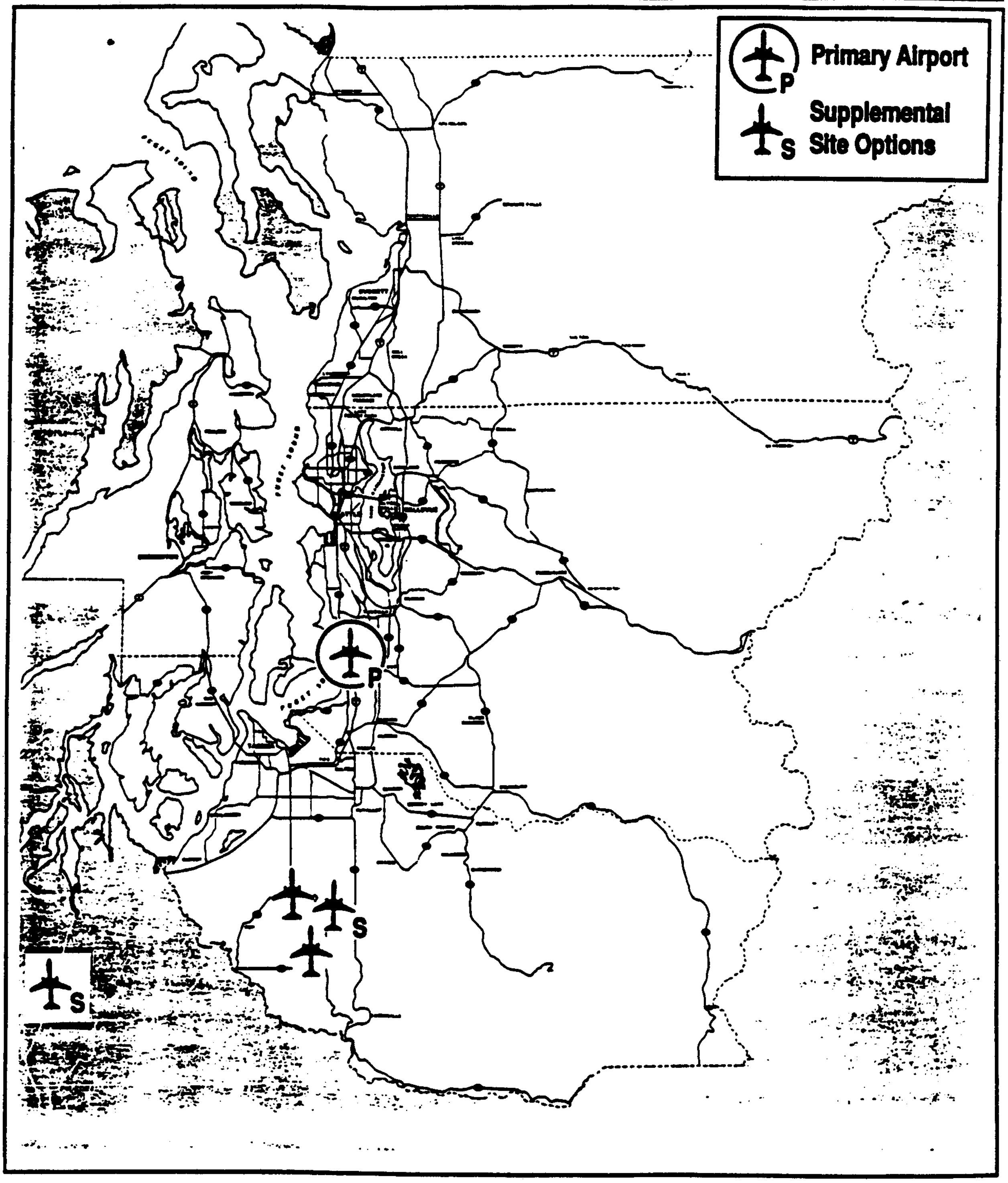
Figure 3-5

Two-Airport Multiple Airport System (south)



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Supplemental airport sites examined include Paine Field, McChord Air Force Base, Arlington Airport, Central Pierce County, Loveland, and Thurston County (e.g., Olympia/Black Lake).

3.4 THREE-AIRPORT MULTIPLE AIRPORT SYSTEM

A three-airport multiple airport system would work the same as the two-airport system described above (Figure 3-6). Under this alternative, Sea-Tac would remain the primary airport and two supplemental airports would be added, one to the north and one to the south. Under this alternative, each of the two supplemental airports are expected to handle between 1.3 and 7.6 million annual passengers (depending on the sites chosen). Sea-Tac would accommodate the remaining forecasted passengers (32 to 41.5 million annual passengers). The estimated distribution of daily operations to supplemental airports is presented in Table 3-2.

An important aspect of this alternative is the need to phase in each of the supplemental airports in a timely fashion in order to avoid over-providing or under-providing future capacity. One of the supplemental airports would be brought into operation first, then as demand warranted, the second supplemental airport would be brought on line. The timing for implementation of each supplemental airport depends on the actual demand levels reached in future years.

With a capacity between 880,000 and 1,480,000 operations per year (depending on airport configurations used), this alternative offers the greatest capacity of all of the system alternatives.

Supplemental airport sites examined include Paine Field, McChord Air Force Base, Arlington Airport, Central Pierce County, and Olympia/Black Lake.

The Puget Sound Transportation Committees's (PSATC) final recommendations called for a three-airport system. See Section 1.5 and Appendix A for more details.

3.5 REPLACEMENT AIRPORT

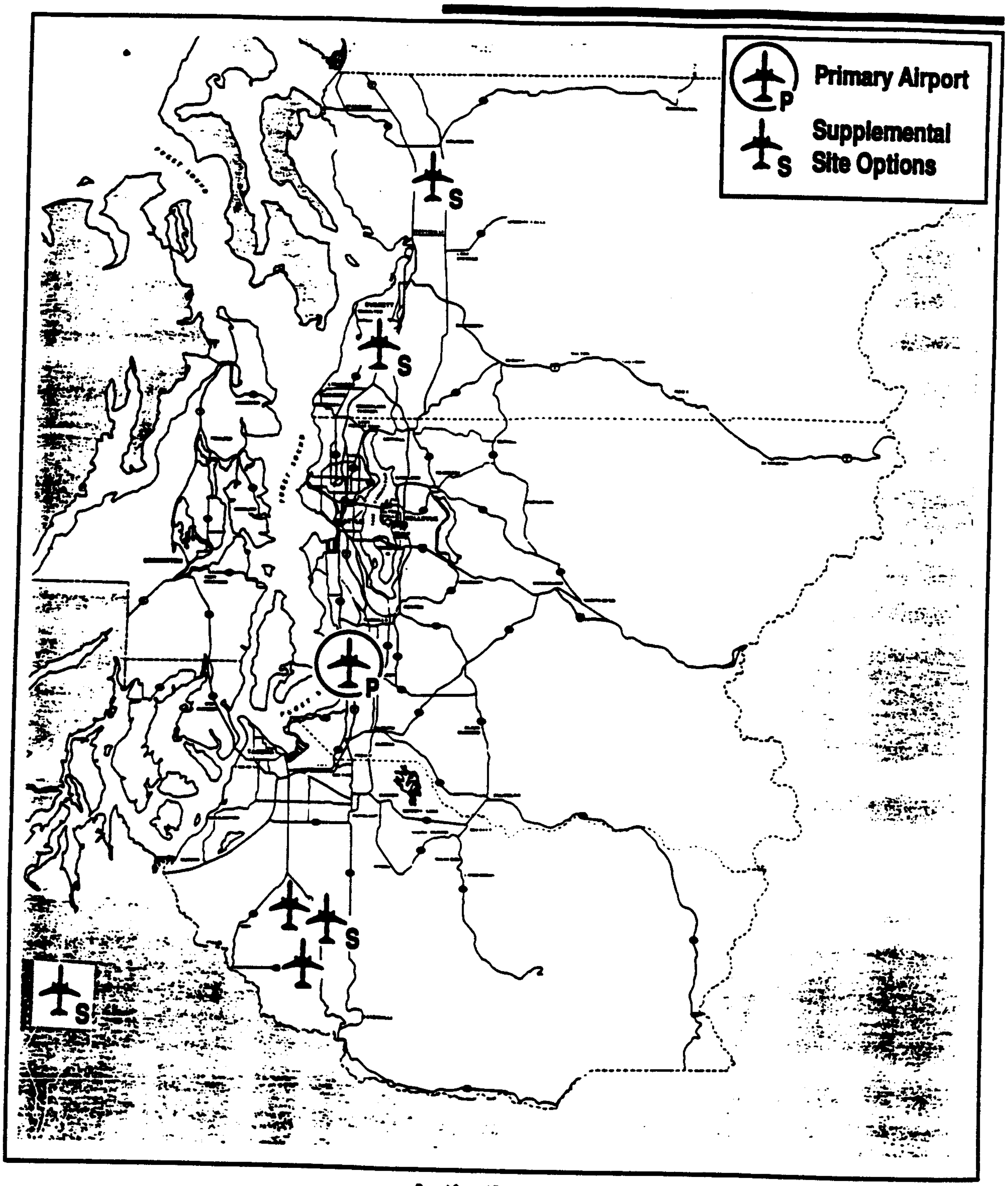
Sea-Tac airport would be closed and a new, larger airport in a new location would be built (Figure 3-7). The replacement airport would have three independent runways that would allow for three simultaneous streams of air traffic in all weather conditions. It would be large enough to provide all of our region's needed commercial airport capacity to the year 2020 and beyond at a single site. All types and sizes of aircraft could be accommodated.

The replacement airport envisioned in the Flight Plan project could be able to handle 750,000 take-offs and landings and 64 million passengers per year. It would have the lowest airline delay costs of any of the system alternatives.

Replacement Airport sites examined include Fort Lewis and Central Pierce County.

Figure 3-6

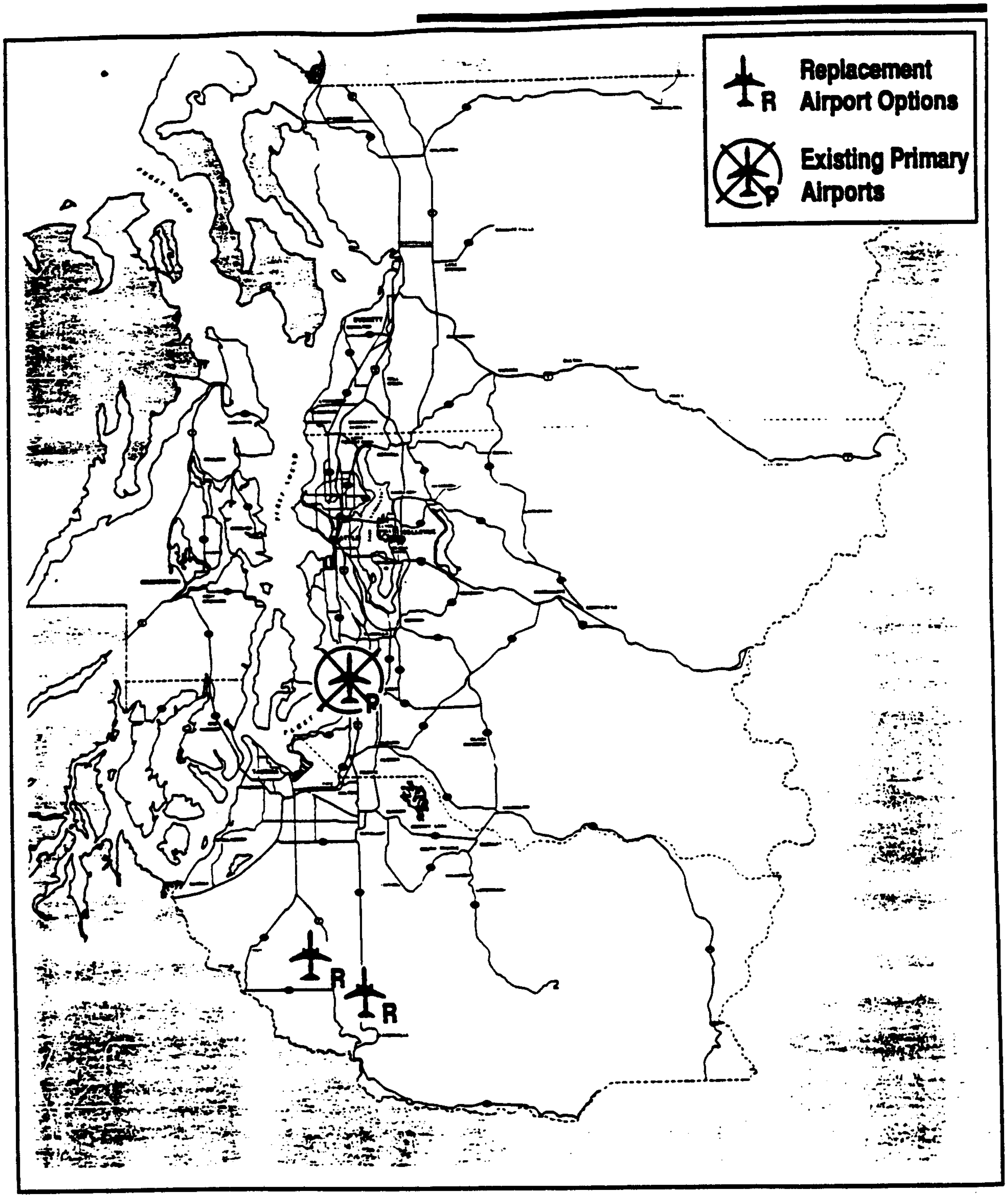
Three-Airport Multiple Airport System (north and south)



Puget Sound Regional Council

Figure 3-7

Replacement Airport



Puget Sound Regional Council

3.6 NO ACTION

The no action alternative serves as a baseline from which the other alternatives can be compared (Figure 3-8). It assumes that Sea-Tac continues as the region's only commercial service airport and that the existing airfield configuration would remain unchanged. No facility improvements related to commercial service would be made to any other Puget Sound area airports except those already underway.

Based on even the most conservative estimates, Sea-Tac Airport will reach its efficient capacity either before or soon after the year 2000. As more and more passengers demand airline service, the resulting increase in the number of flights vying for limited runway capacity will cause average annual aircraft delays to escalate. By 2000, delays exceeding one hour may become common, especially during peak travel times and bad weather conditions (See also 2.3.2 and 3.8.3.1). The efficient operating capacity of the airport is 380,000 operations per year. By extending operations into late evening and early morning hours and with increased average delay, the airport can handle up to 460,000 operations per year.

The economic implications of no-action are not the subject of this FEIS. The importance of air transportation to the region and state are reported in The Economic and Social Importance of Air Transportation for Washington (Washington State Air Transportation Committee, Discussion Draft Report, May 27, 1992). The economic impacts of the Flight Plan alternatives are presented in the Draft Final Report, Appendix C (January 7, 1992).

3.7 EVALUATION METHODOLOGY

Development of the alternatives displayed in this FEIS involved an iterative process of screening, re-examining and refining the alternatives, using increasing detail. All of the alternatives are reported in this FEIS.

The major points in this complex process are:

- The broadest evaluation criteria are those given in the adopted vision statement, developed by the PSATC and accepted by the sponsoring agencies (presented in Appendix A and summarized in Section 1.5).
- The system-level alternatives are studied in terms of a range of siting options, but full information on site selection and site impacts is to be completed in site-specific analysis phased to follow the regional decision and is beyond the scope of this non-project FEIS. Tables 1-1, 3-1, and 3-2 show annual operations for all alternatives and site options.

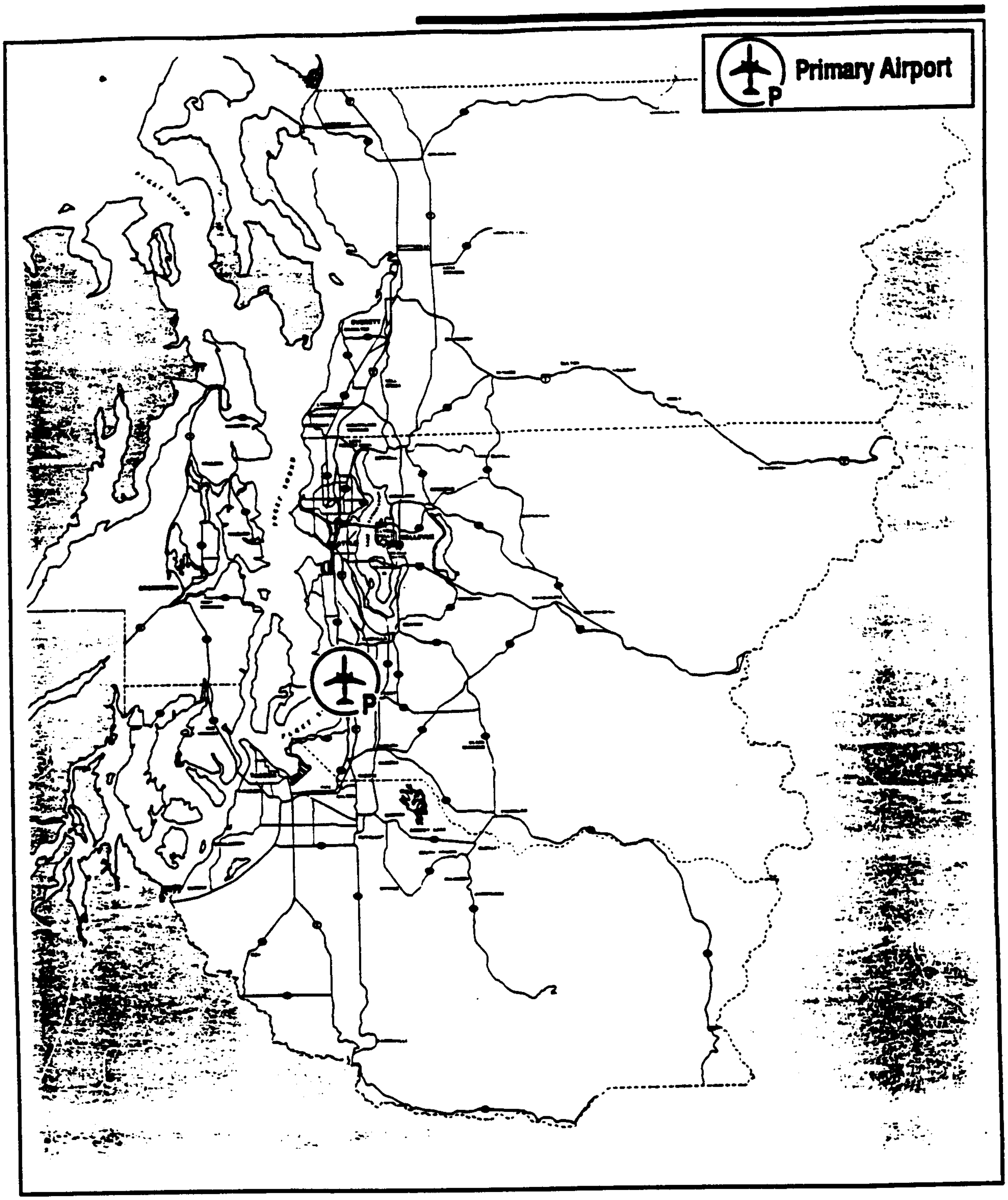
One important caveat is that demand at the more distant sites might not support the levels shown. The less convenient service can affect real demand levels, holding these levels below the unconstrained forecasts used here.

Table 3-2 presents daily operations for each of the sites.

Note: This FEIS maintains the system-level evaluation for a possible agency action (an amendment to the Regional Airport System Plan) by including *more than one* supplemental airport site under each system alternative. The southern locations identified in this FEIS now include multiple sites in Pierce County. However, the PSATC recommendation (and the DEIS) makes reference to contingency site options

Figure 3-8

No Action



Puget Sound Regional Council

Table 3-1

ANNUAL COMMERCIAL OPERATIONS IN 2020
(in thousands of operations)

Alternative	Sea-Tac	Supplemental Site Options				Total
		Paine	Arlington	C. Pierce/McChord	Other	
No-Action	437	(with greatest congestion delay)				437
Sea-Tac Capacity Expansion						
(Demand Management)	356					356
(Third Runway)	426					426
(Remote Airport)	380				109 (Boeing Field or Moses Lake)	489
Replacement				500		500
Multiple (2)						
(Sea-Tac w/o RW) (Arlington 2 RW)	356		133			489
(Sea-Tac w RW) (Arlington 2 RW)	456		33			489
(Sea-Tac w RW) (C. Pierce 2 RW)	455			34		489
Multiple (3)						
(Sea-Tac w/o RW) (Arlington 1 RW) (C. Pierce 1 RW)	356		60	73		489
(Sea-Tac w/o RW) (Paine 1 RW) (C. Pierce 1 RW)	356	67		67		489
(Sea-Tac w/o RW) (Arlington 1 RW) (Thurston 1 RW)	356		72		61 (Thurston)	489
(Sea-Tac w RW) (Paine 1 RW) (C. Pierce 1 RW)	416	35		34		485

Source: Table 2-4 (Air Carrier plus Regional Commuter), and Appendix C, Table C-3.

Table 3-2

DAILY OPERATIONS AT THE SUPPLEMENTAL AIRPORTS

Alternatives and Options	2000	2010*	2020
Multiple Airport System (one supplemental airport) Sea-Tac w/o new RW			
Arlington 2 RW	96-137	172-246	358
Sea Tac with new RW			
Arlington 2 RW	64-91	52-75	89
Central Pierce 2RW	100-143	83-118	91
Multiple Airport System (two supplemental airports) Sea-Tac w/o new RW			
Arlington 1 RW	48-68	102-146	176
Central Pierce 1 RW	75-107	70-99	212
Paine 1 RW	75-107	86-123	195
Central Pierce 1 RW	78-112	89-127	200
Arlington 1 RW	48-68	96-137	210
Thurston 1 RW	31-45	76-109	180
Sea-Tac with new RW **			
Paine 1 RW	75-107	83-118	102
Central Pierce 1 RW	73-105	80-114	96

Notes: Passengers per plane in 2000 are assumed to be 35 to 50. The year 2010 assumption is 56 to 80. The year 2020 assumption is 96. See text and Figure 2-4.

(**) Because these figures show a range, some figures exceed those estimated for the more efficient airplane operations shown for the year 2020.

(*) The PSATC recommendation envisions a lower number of operations at the supplemental sites in the early years. Paine Field would begin to be to receive some commercial flights in 2000, and Central Pierce would begin commercial service in about 2010. No Action outside of the region and the jurisdiction and membership of the Regional Council. This element is not a necessary part of the planning methodology of the Regional Council and the Port of Seattle. In May 1991, the sponsoring agencies concurred with the Phase II Report that sites outside of the three-county region should not be considered unless no sites were available within the region. This is due largely to the distances involved.

If a Thurston County site remains part of the system decision, then institutional issues will have to be addressed beyond those examined in this FEIS. The Thurston Regional Planning Council (TRPC) is a Metropolitan Planning Organization equivalent to the Regional Council. Delegates from the TRPC did take part in the later stages of the advisory PSATC's work. Direct coordination was limited to a staff presentation given to the TRPC in late 1991.

- The PSATC study involved a screening process to identify regional alternatives and a family of supporting site options. This FEIS expands on some of these screening criteria which were: airspace (see Section 4.10), capacity, ground access (see Section 4.4), investment requirements, economic impacts, and implementation feasibility and environmental considerations. The Final Phase of Flight Plan began after a series of hearings in mid 1991, and the addition of a demand management alternative (presented in this FEIS as Section 3.2.1).

- The evaluation criteria for the system-level alternatives are: (a) operations, (b) regional economics and program financing, (c) environmental, and (d) institutional issues. Working papers were developed for each of these. The environmental working papers led to the non-project DEIS and this revised FEIS. The institutional issues were developed by the PSATC to serve as a final screening device to possibly adjust the technical ranking of system alternatives. The institutional element is addressed in Working Paper No. 10 and is incorporated in different sections of this FEIS (Sections 1.2.2, 4.3, 4.4.6 and 4.10 and Appendix B).

- In its advisory capacity to the PSRC and the Port of Seattle, the PSATC prepared a draft recommendation (7 January 1992). Combined public hearings were conducted on this draft and all of its working paper attachments, including the DEIS which is required for future agency action (an EIS is not a required part of any advisory committee recommendation). The PSATC final recommendation was completed at the last meeting of the committee on 17 June 1992. Future agency action must consider information in this FEIS, which includes responses to the public review comments.

- The agency evaluation methodology also includes specific coordination with the Washington State Air Transportation Commission pursuant to recent state legislation (ESHB 2609).

- This non-project FEIS can be revised by an addendum or supplement based on significant new information, especially from project EISs and completion of the local plans now underway pursuant to the state Growth Management Act.

- The Multiple Airport System alternatives introduce new commercial air operations at the supplemental site options. If there are approximately 489,000 commercial operations in the year 2020 (out of 524,000 total operations shown on Table 2-4), then there are about 1622 commercial operations each day. Table 3-2 shows the daily operations for each supplemental site in 2020, and for the years 2000 and 2010. The supplemental sites would handle 12 to 25 percent of the commercial operations, depending upon the alternative selected.

Note: Table 3-2 is developed in the following way. Tables 4-15 and 4-16 show the daily number of passengers for each site option (based on Appendix C-1 in this FEIS). For the year 2020 the average number of passengers per airplane operation at the supplemental airport(s) is assumed to be the same as for the primary airport (Sea-Tac). This assumption does not result in the same size planes, however, since no connecting passengers are involved and since the load factor (percent of filled seats) can be higher than average. Airport noise or operational controls, such as now exist at John Wayne Airport or Long Beach Airport, have this result. For the years 2000 and 2010 a range is shown on Table 3-2. This reflects the less efficient airport operation as airlines develop the new passenger markets. The number of passengers per plane is between 70 percent and 100 percent of that at the primary airport.

All of the figures shown on Table 3-2 are preliminary and based on stated assumptions. A major assumption is the timing of service at possible new sites. As an example, the PSATC recommends one of the three-airport systems, but would add service at a southern site (i.e., Central Pierce) only as demand warrants, probably in 2010 or later (see Section 1.5 and Appendix A). Also, the no-action alternative accommodates a relatively large number of annual flights, but this entails rapidly increasing congestion and delay.

Table 3-3 compares the demand for each alternative with the capacity available. System capacities were obtained from working #7, "Airspace Capacity and Delay" from the Flight Plan Draft Final Report, January 1992. System Demand is the forecasted aircraft operating prepared for flight Plan and presented in Table 2-4. Capacities presented in Table 2-4 are average annual capacity which takes into account hourly variation in capacity due to weather conditions.

3.8 POSSIBLE SEQUENCES OF ACTION

The distant future always presents uncertainties for infrastructure decisions that involve major threshold actions and investments. Uncertainty applies to the long-term need, to surrounding conditions, and to implementation efforts under any selected system alternative. Urbanization is one of the factors affecting possible airport siting and is now addressed through the GMA process.

The most significant factors which might entail later revisions to a regional alternative, once selected, are identified here. As a strategy, concurrent site-related actions under a selected regional airport system plan should be considered because of uncertainties associated with each and all sites (this is suggested in the Flight Plan Draft Final Report, 7 January 1992, Working Paper No. 10). This strategy would apply especially to the local site options examined under the possible multiple airport system alternatives. At the Sea-Tac site, the strategy could influence the phasing of near-term and long-term capacity options (see Sections 3.2.1, 3.2.2, and 3.2.3).

3.8.1 Forecasts

Actions based on erroneous long-term forecasts (e.g., future travel demand or airplane operation levels that are either too high or too low) could result in either an oversupply or

Table 3-3

DEMAND VS. AIRCRAFT OPERATIONAL CAPACITY

Alternative	2020 Forecasted Aircraft Operations	System Capacity (operations/year)
No Action	524,000	380,000
Sea-Tac Capacity Enhancement		
(W/ System Management)	524,000	380,000
(W/ Third Runway)	524,000	480,000
(W/ Remote Airport)	524,000	630,000 - 880,000*
Replacement	524,000	750,000
Two-Airport System	524,000	630,000 - 980,000
Three-Airport System	524,000	880,000 - 1,480,000

* Capacity of the remote airport itself is assumed to be the same as that for either a one or a two runway supplemental airport as discussed in Working Paper #7, "Airspace, Capacity, and Delay."

Source: Table 2-4 (Flight Plan 2020 Total Operations forecast); Table 1, Working Paper #7, "Airspace, Capacity, and Delay," Flight Plan Draft Final Report, January 1992 (System Operational Capacities)

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an undersupply of airport capacity. An oversupply at existing sites can provide flexibility for the future and reductions in some operational impacts, but also can effectively foreclose new long-term alternatives involving a threshold decision to develop new sites. The Flight Plan forecasts are "unconstrained", meaning that supply is assumed to keep pace with forecasted demand. However, the forecasted demand would not be met under the no-action and the system management alternatives.

With these factors in view, Flight Plan develops a forecast of future needs. But it is more focused on decision thresholds (e.g., the current capacity of Sea-Tac and long-term system alternatives) than it is on the specific dates at which the passenger demand will reach these capacity thresholds. (See Sections 2.2.2, and 2.2.4.) Most broadly, if the passenger demand forecasts are too high, this might alter only the action dates for additional capacity.

These factors might not affect the forecasted 66 percent increase in operations (1988 to 2020). The trend in airline operations could remain intact since the transition to larger average airplane size will respond to increased passenger demand. A lower passenger demand level would probably result in a delayed increase in average airplane capacity (estimated to increase from 48 local passengers per flight in 1988 to 80 in 2020), and a more rapid increase in passenger demand would probably result in a more rapid transition to a larger average airplane size.

3.8.2 Siting

The continued loss of possible new airport sites points to the possible need for early site preservation steps, if the region decides to develop new airport capacity. The ability to expand the system in the future depends upon retaining expansion options even if they are not implemented until years later when demand is validated. This may be a more compelling argument for regional decisions than the passenger forecasts, especially considering other rail and land-use planning now underway in the state and region.

Because of the difficulty of siting a facility of several thousand acres, Flight Plan assumed a planning horizon of 2020 to 2050. This is well beyond the 20-year growth management planning horizon prescribed in the GMA. However, the GMA now might be used as the vehicle for considering and acting on regional siting needs. The urgency for an air carrier decision would be lessened if the only possible sites were those already devoted to airport use. Even in this case compatible land-use planning--and the size of possible future mitigation costs--counsels early decisions.

The Flight Plan alternatives are not shaped by (and do not consider) the siting and site design implications of supersonic transport planes conjectured for the long-term future in some of the literature.

The siting or expansion of an airport involves another major concern to the regional citizenry. If siting decisions that may be needed are prolonged, this may, because of the uncertainty, influence housing prices and the actual ability to sell homes near one or more of the site options. This uncertainty can affect large numbers of families at all candidate sites in the region.

3.8.3 Effects on the System Alternatives

Following selection of a regional airport configuration (expected from the Regional Council in March 1993), potential difficulties in implementation could alter the actual results, phasing or timing of implementation. (The PSATC prepared a partial catalogue of potential impediments to most regional alternatives. Comments are classified under these headings: Institutional, Long-Range Planning, Public Reaction, Finance, and Market Forces. These are discussed in the Phase II Report, 107-20).

Impediments to each regional alternative could lead to an unintended course of events. Following is a discussion of the most likely scenarios for the regional system alternatives. If full implementation of a selected regional alternative does not occur, then a second regional alternative would be selected (and if necessary, this FEIS would be amended with either a supplement or an addendum).

3.8.3.1 No Action

The no-action alternative (see Section 3.6) is the consequence of failing to decide or to act. This course results in increasing aircraft delays, some airline scheduling efficiencies (moving operations outside of the peak delay periods and using larger planes), and eventually a reduction of service and reliability for our region. No action would force greater demand management as a near-term strategy, such as increased activity during non-peak periods.

Possible siting options--especially in the instance of sites not yet devoted to airport use--will continue to diminish with the passage of time. (To generally address difficulties in siting new public facilities, the Governor's Growth Strategies Commission recommended in 1991 that a state Siting Council be created under the GMA.)

Airline responses to no action would involve growing delays and diminished air schedule reliability. Airlines would also reschedule routes, convert to larger planes, and possibly use available seats more efficiently (load factors rising above the 60 to 65 percent average). These actions are with other "demand management" actions in the system management alternative (see Section 3.2.1). Anecdotal evidence (e.g., Seattle to San Francisco and Boston to New York) also shows, however, that delays on the ground are often simply compensated by increased speeds in the air. In some other instances, it appears that airlines adjust their published airline schedules to absorb delay. On a national scale, the Central Flow Control System holds departures at the airport of origin until a landing slot is assured at the receiving airport.

Thus, congestion at any airport begins to affect delays at other airports.

Note: Forecasters estimate hours of delay at major airports in three categories: 20,000 to 50,000; 50,000 to 100,000; and greater than 100,000. They anticipate that if no action were taken to address airport congestion across the nation, between 1988 and 1998 the number of airports experiencing 20,000-50,000 hours of aircraft delay would increase from 15 to 22 (including Sea-Tac by 1998).

The number experiencing 50,000-100,000 hours would increase from 5 to 15. Chicago O'Hare has over 100,000 hours now, and would be joined by Dallas-Fort Worth, Atlanta and Denver (included in Challenge 2010, by J. Donald Reilly, February 4, 1992, prepared for but not approved by the FAA).

The new Denver Airport illustrates the interdependence of airport delays. Some estimates suggest that the new Denver airport will reduce total nationwide airline delay by 4.5 percent. (However, this figure is questioned by the Government Accounting Office.)

Airport expansions in specific locations might be less than expected if the system as a whole remains constrained due to inaction elsewhere in the national airport system. The Central Flow Control System would hold planes at the enlarged airports because of a lack of landing slots at congested destination airports. Arrivals at enlarged airports might also be affected by backups in the system as a whole.

Another possibility is that failure to act would lead to enough delay that airlines would directly seek landing rights at airports in the region other than Sea-Tac Airport (e.g., Paine Field). This is how multiple airport systems have nearly always begun, rather than through deliberate public policy (as is proposed in some of the Flight Plan alternatives). In this event, a market-driven decision might be made by the FAA in the absence of a regional plan. Such a decision could include regional mitigation, demand management, and coordination with other regional and local planning activities. However, this default approach lessens the ability of the region to achieve desired objectives through an agreed upon plan.

The following actions were voluntarily taken by airlines to alleviate delays to their operations--at one or more of seven airports interviewed:

- Adding flights during off peak periods rather than peak periods,
- Operating earlier and later in the day, thus spreading the operations over more hours,
- Increasing aircraft size, including a trend towards wide-body aircraft,
- Increasing their schedules to include more delay time in the scheduled flight time,
- Shifting flights to other airports within the region,
- Coordinating of schedules by two or more airlines to "de-peak" operations,
- Increasing average load factors.

(Source: Analysis of Maximum Passenger Limits at Sea-Tac Airport Under the No New Runway Alternative, P and D Aviation, Draft, May 19, 1992)

3.8.3.2 Seattle-Tacoma International Airport

There are three alternative capacity-related options at the Sea-Tac site: broad system management, Sea-Tac with a new third dependent runway, and Sea-Tac in conjunction with a remote airport. Each would have different consequences.

- Broad System Management

If system management (see Section 3.2.1) is selected, increasing demand can be satisfied in the near term without addressing the forecasted need for additional sites. If and when additional sites are needed, or requested by the airlines (typically in the absence of a formal multiple airport strategy), siting complications will be worse than under a more proactive multiple airport system approach. The inadequate arrival capacity at Sea-Tac during bad weather would remain unresolved.

Public review comments suggest that demand management actions would make physical expansion more acceptable to the affected public.

- Sea-Tac with New Dependent Third Runway

If a new dependent third runway at Sea-Tac Airport is selected as part of any regional alternative, and then not actually implemented, the results will probably be the same as for the demand management alternative (Section 3.2.1) or no-action (Section 3.8.3.1). This could accelerate airline requests to use other airports in the region, or eventual airline actions to reroute Seattle bound flights to Vancouver, B.C., or Portland.

Construction of the dependent runway at Sea-Tac would answer the current and projected bad weather arrival capacity shortfall at Sea-Tac, but would be only part of the answer to long-term regional demand. The likelihood of supplemental airports being initiated within a multiple airport system will depend upon effective regional or state actions. (See "Multiple Airport System," below.)

Failing such regional and state actions, service could and would likely remain concentrated at Sea-Tac, due to the resulting 30 percent increase in annual capacity. It is unlikely that use of a new runway, even if restricted, would be confined to only times of poor weather. It is also unlikely that airlines would request access to supplemental sites until expanded Sea-Tac capacity is absorbed or until other incentives are provided. A familiar pattern nationally is one of airlines protecting market share within the existing airport system. It is possible that a new airline might seek access to the regional market by requesting service at an airport other than Sea-Tac.

If a previously proposed commuter runway (a 5,000-foot runway limited to commuter aircraft) were constructed at Sea-Tac and well within the western property line, it would then be converted to a taxiway when the new dependent third runway was completed. If runway spacing requirements for independent operations are reduced below the current 4,300 feet, and even below 3,000 feet in the long term, this could affect the operational capacity of Sea-Tac beyond what is analyzed in this FEIS.

- Sea-Tac in Conjunction with a Remote Airport

If Sea-Tac is combined with a remote airport (see Section 3.2.3) (Boeing Field or Moses Lake), several courses of action are possible. Airspace conflicts with Boeing Field are likely to continue, prompting a threshold capacity decision in a few years. Either general aviation operations would have to be restricted from Boeing Field (at least during poor weather conditions) or further action would be needed at Sea-Tac, or both. In addition, it is uncertain how increased activity at Boeing Field--or a shift toward a larger share of commercial operations--could be accommodated with increased commercial operations also at Sea-Tac.

The Moses Lake wayport option (a wayport serves connecting passengers rather than origin/destination passengers) would probably be inconvenient for the connecting passengers from the Puget Sound region. Any rail connection is not likely until the year 2005 or much later. Therefore, passengers from the Puget Sound region would likely fly from Seattle to Portland or Vancouver, B.C. for connecting flights. The wayport option is dependent upon a passenger connection from Sea-Tac Airport, probably high-speed ground transportation (under study by the state).

Note: The main purpose for a possible wayport system in the United States would be to relieve congested airports of connecting passengers, so that they can concentrate on serving origin and destination passengers. The use pattern at Sea-Tac is *already* oriented to origin and destination passengers, who are 67 percent of the total. In contrast, at some hub airports over half of the passengers are connecting passengers (e.g., 65 percent in Atlanta).

If Boeing Field were to serve as a remote airport, its market niche would probably consist of freight, general aviation and passenger travel within the Pacific Northwest. The multiple airport system would differ from the supplemental airports under other regional alternatives. The supplemental airports would serve local demand as their market niche (although some of the options examined in this FEIS would attempt to relocate some regional service by capping service at Sea-Tac.)

While it has been suggested that over the very long term, Seattle, Portland and Vancouver, B.C., could share a Pacific Northwest wayport--perhaps at Moses Lake--this is extremely speculative and does not address either capacity needs within the next several decades or political issues. Wayports are suggested for research in connection with airports having a high ratio of connecting traffic to local traffic. These include O'Hare, Atlanta, Denver, Raleigh-Durham and St. Louis where less than half of the arriving passengers are destined for these cities. (Wayports are mentioned in Airport System Capacity, Transportation Research Board Special Report 226, 1990.)

The remote airport alternative would depend upon this long-term possibility at the expense of serving known regional needs. A long-term wayport does not match the travel patterns at Sea-Tac Airport (two-thirds origin and destination traffic), but is not precluded by the other system alternatives.

3.8.3.3 Multiple Airport System

Locally oriented air carrier service located at a supplemental airport could possibly be precluded by construction of a third runway or delayed by other capacity actions at Sea-Tac. The reverse is probably not true. A reasonable level of supplemental airport service would not be sufficient to eliminate the need for capacity expansion at Sea-Tac. The multiple airport system options in this FEIS that do not include a new dependent third runway for Sea-Tac could involve movement of connecting passengers from Sea-Tac to the supplemental airport site, and greater total ground travel for passengers in the region. Under the multiple airport system, if a third runway cannot be completed at Sea-Tac, displacement of more commuter flights above those shown in Table 3-2 might result.

The possible exception to this would be the evolution of a second regional airport at a supplemental site. The theoretical option might involve long-term changes in the level of military operations at McChord Air Force Base and the release by the military for joint operations of a one- or two-runway capability. This could involve financial arrangements between the commercial airlines and the military.

Rather than evaluating Sea-Tac as a supplemental airport with international and connecting flights scheduled for a second and large new airport, this FEIS reviews the replacement alternative. However, some multiple airport system alternatives attempt to cap the level of Sea-Tac operations by omitting a Sea-Tac third runway.

Questions regarding the system

Depending upon the affected sites, possible obstacles to the multiple airport system could involve:

- Institutional challenges with implementing commercial service at Paine Field,
- Inability to secure coordination or a joint operating agreement with the military with regard to the southern site, or
- Litigation challenging potential capacity enhancements of the Sea-Tac site. (See Appendix B).

The GMA does not require actual airport siting decisions, but does require that airport use not be precluded. Uncertainty may leave satisfaction of demand in the hands of the airlines. Airlines can trigger the access issue by requesting access to a local market at some point in the future. This in turn could occur as a result of declining service conditions at Sea-Tac, e.g. long-term ground access issues and operational delays.

The multiple airport system alternatives may depend upon new institutional tools, either to select supplemental airport sites or to transfer funds generated at Sea-Tac (Passenger Facility Charges) to subsidize the supplemental airport sites.

Implementation requirements within the state should be addressed by the Washington State Air Transportation Commission in its governance studies and possible recommendations to the Legislature in 1994. Similarly, unless the federal law could be amended to allow the transfer of funds from Passenger Facility Charges between independent airports within a regional system a regional authority may be required. Interlocal agreements could be used under existing authorities to transfer non-federal funds.

Possible outcomes if the multiple airport system is accepted

If supplemental airport sites are placed in service, difficulties in implementation could lead to three different system consequences:

- New local service is sufficiently restrained that the supplemental airport provides some local short-haul and medium-haul service without solving the larger capacity issues at Sea-Tac.
- New service covers a larger share of total demand than is generated locally, and new capacity actions at Sea-Tac can be scaled back. In this case, a larger share of Sea-Tac traffic would have to relocate. This would be disruptive due to the needs of connecting passengers to stay at Sea-Tac, growing ground access problems (see Section 4.3.2), and

the likely interests and financial conditions of the airline industry. An efficient and speedy ground link (high capacity transit) might not solve connecting passenger needs.

- The service level must continue to grow at Sea-Tac before the transition to a multiple airport market is feasible. It may be that while the capacity at Sea-Tac may soon be surpassed (e.g., in the year 2000), the regional demand still might not be sufficient to cross the threshold that may be needed to support a multiple airport system. In this case, the noise impact or the elongated urban pattern (along Interstate 5) may make this region an exception to this general observation. If so, deliberate implementing steps, rather than market forces alone, might be helpful to achieve a multiple airport system, if this is selected.

Note: Federally supported research concludes that a multiple airport system is not likely until a threshold market size is achieved. This is 10 million total originations (passengers embarking from the region). (Multiple Airport Systems in Metropolitan Regions, for FAA by Richard de Neufville, March 1986). This threshold is not achieved under the Flight Plan forecasts until after 2005. (See Figure 3-9).

A second view is that the threshold level is not such a precise number. Lower levels of traffic may be sufficient if strong future growth is likely or if capacity at the larger airport is limited. The linear geography of the Seattle region also suggests that increasingly congested ground access to Sea-Tac from the north (or south) might be an important factor.

The Flight Plan Project consultants did show that a supplemental airport with 1.5 MAP could be economically feasible and that this could be achieved at Paine Field around the year 2000. Additional analysis would take place at the master planning stage (PSATC meeting minutes). This FEIS acknowledges both of these positions, one regarding market feasibility of the multiple airport system (Figure 3-9), the other regarding airport financing (Flight Plan Draft Final Report, Working Paper No. 11, January 1992).

Phasing of north and south sites

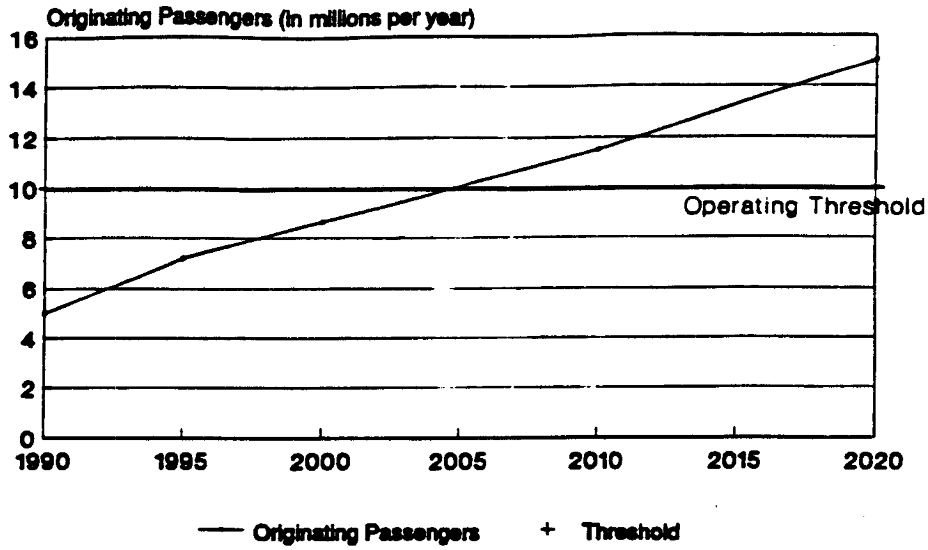
Within the multiple airport system, if a northern site cannot be selected or if Sea-Tac Airport cannot be expanded, the southern site (e.g., McChord) might be accelerated in its place. Depending upon its capacity (potentially two runways), this could result in a dual airport system for long-haul travel since local service needs south of Sea-Tac are less than for the north service area. Possibly this could be augmented by a remote terminal as an incremental step to serve the region north of Sea-Tac (e.g., at Paine Field). Remote terminal(s) could give access to high-occupancy vehicle lanes, especially during periods of peak airport use and peak ground congestion. The PSATC recommendation phases a northern site (Paine Field) first, due to the larger market north of Sea-Tac and in part due to ground transportation difficulties through Seattle during peak travel periods.

3.8.3.4 Replacement Airport

If the Replacement Airport alternative is selected, but a site cannot be found within the region, then a search for more distant sites would follow. This would have implications for state agencies and for the GMA. The Replacement Airport alternative would become dependent upon a rail ground connection from the urban market area. This could lead to

Figure 3-9

Probable Operating Threshold for Multiple Airport System



Sources: Probable threshold: Multiple Airport Systems in Metropolitan Regions, Richard de Neufville, March 1986.

Trendline: Phase I Demand Forecasts, Flight Plan, July 1990.

either a package proposal with additional state involvement or, depending upon rail economic feasibility, a need to start over in the airport decision process.

A partly successful attempt to create a replacement airport and remove Sea-Tac could result in two major airports serving a demand insufficient to support this redundant airport pattern and airline investment. Theoretically, major airlines could focus on either one or the other airport (as at Dallas, Houston and Chicago). Reliable high capacity transit connections between the two airports (Sea-Tac and probably central Pierce County) might be part of this dispersed configuration.

Of all the system alternatives, a replacement airport is most dependent upon the accuracy of the higher long-term demand forecasts. The replacement alternative calls for the most decisive threshold action (e.g., Denver's replacement of Stapleton by a new airport; or in our region, the gradual replacement of Boeing Field by Sea-Tac Airport beginning in 1942), and cannot be so easily phased in as needed. Redundant investments by the airlines would be a very serious obstacle.

3.8.3.5 Demand Management

As part of any alternative, demand management could defer the date at which action on other parts of the regional decision would be needed. For all alternatives, the Flight Plan operational forecasts already assume an increasing average airplane size. With additional demand management actions, noise impacts would be concentrated at Sea-Tac as up to 32-38 million annual passengers, mostly on larger planes, landed and departed on the existing runways. Demand management would require investment to provide adequate terminal facilities and ground access.

Under demand management, the date for site identification could be deferred or could be part of a package decision. Potential sites could be eliminated as new development encroaches upon or disqualifies the few remaining possible sites near the populations to be served.

Construction of high-speed ground transportation could improve access to possible distant sites. It could also help relieve some demand for short-haul air carrier traffic serving the Interstate 5 corridor. Forty-two percent of flights to and from Sea-Tac are commuter flights, but this ratio is forecasted to decline. Commuter flights account for only 6 to 8 percent of Sea-Tac originating passengers (Phase I Report, Table 20 and Exhibit B).

Note: Building new airport facilities might not be a decisive factor in the economic viability of any competing or complementary high-speed ground transportation system (not to be confused with high capacity transit). Diverted north-south air traffic (1.4 million annual passengers (MAP)) would comprise only a small part of the 6 million passenger trips per year that might be needed to support a high-speed rail system. Less than five percent of 45 MAP in 2020 would be Interstate-5 corridor commuter passengers, and roughly one-half of these might divert to rail (less than 1.4 MAP).

More detail on high-speed rail will be available in the report to the Legislature from the High-Speed Ground Transportation Commission, due on 15 October 1992.

4.0 AFFECTED ENVIRONMENT, SIGNIFICANT IMPACTS, AND MITIGATION MEASURES

A regional airport system decision raises tradeoff issues often expressed in technical terms. However, the issues are often questions of values.

In simple terms, public decision bodies and the broad public within the region are responsible for reconciling or ranking the economic benefits of expanded air carrier service with all the other impacts. These impacts—both positive and negative—would affect large numbers of people now and in the future, the general community character and economy, and the natural environment that sets this region apart from other parts of the country. Alternatively, we must also fully consider the economic impacts of taking no action.

Throughout Section 4.0, supplemental airport site options are used to test the multiple airport system alternatives. The list of site options may not include all possible sites identified and researched following a regional system level decision. Site screening criteria are provided in Flight Plan Draft Final Report, Appendix B-1, January 1992. The mitigation actions identified in each of the following subsections (e.g., noise, air quality) are assembled together in Section 1.3 of the Summary of this FEIS.

4.1 NOISE

4.1.1 Overview

The potential noise impacts associated with each of the airport system alternatives under consideration have been analyzed and compared with the projected future population surrounding Sea-Tac and all the other airport sites. This section summarizes and updates the significant findings of the "Noise Assessment Study" by Mestre Greve Associates/P&D Aviation, which is reproduced as Appendix C of this FEIS and incorporated by reference. Appendix C contains more detailed information on the noise study, including background information on the description of noise, potential health effects of noise, noise metrics, assessment guidelines recommended by various agencies, and aircraft operational assumptions. The appendix also includes a more in-depth discussion of the methodology used in the analysis, examples of noise contours for each of the airport sites, and population exposure results. This section, as well as Appendix C, also includes updated and supplemental information that was requested during the spring public hearing process by various interest groups and individuals.

To effectively evaluate and explain potential noise impacts well into the future, this study utilized methods and criteria that consider noise impacts much farther from the airport sites than is usual for traditional airport noise studies. The methods and data assumptions were selected to be conceptually uncomplicated and capable of treating all systems alternatives as equally as possible.

- The study utilized standard industry-wide methods of computer modeling and noise assessment analysis such as the 65 Ldn criteria (Ldn is a 24-hour time weighted average annual noise metric). Additional noise assessment criteria not usually found in traditional airport studies were also included so that the potential noise impacts could be more thoroughly evaluated.

- The analysis identified the population that would be exposed to a less significant level of aircraft noise (55 Ldn) and to a level of single event noise (80 SEL - Sound Exposure Level). Information on individual overflights is particularly responsive to community concerns about aircraft noise.

- Populations that would be newly exposed to noise (55 and 65 Ldn) were also evaluated.

The total population contained within the projected noise level contours was estimated for each of the regional system alternatives. The noise contours are based on operational assumptions for the years 2000, 2010 and 2020. The population analysis has been updated from that completed in the Flight Plan DEIS. The FEIS analysis used the PSRC's VISION 2020 existing plans scenario which was completed in April 1992. Please refer to Section 4.4.6 for more discussion on future planning and development scenarios. Data for Thurston County were based on population projections from the Thurston Regional Planning Council and the State Office of Financial Management. In order to present a worst case analysis, protective zoning and land use planning practices are assumed not to be employed around the airport site options.

4.1.2 Affected Environment

The description, analysis, and reporting of community sound levels from aircraft are made difficult by the complexity of human response to sound and the myriad of sound-rating scales and metrics that have been developed for describing acoustic effects. For example, community noise is generally not constant but varies with time. Therefore, some type of statistical metric is necessary to mathematically express a varying noise level that can be correlated to community response. As a result of the complexity of describing noise, several noise metrics have been developed to account for characteristics of noise such as loudness, duration, time of day, and cumulative effects of multiple noise events.

Certain types of noise, particularly continuous exposure to high volumes, are known to have several adverse effects on health and to cause disruption in human activities. Aircraft noise is intermittent, with each event rising to a peak level and then rapidly diminishing. The identified adverse effects of noise on people include communication interference, sleep interference, annoyance, and various physiological responses. Many factors influence how a sound is perceived and whether it is considered annoying to the listener. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. A more detailed discussion of factors that describe human response to sound in terms of both acoustic and non-acoustic factors, and rating scales developed to account for human response, are presented in Appendix C. Based upon these identified effects of noise and the factors that influence annoyance, noise metrics and criteria have been established to help protect the public health and safety by gauging the potential for disruption of certain human activities.

4.1.2.1 Noise Assessment Criteria and Health Impacts

Different types of nationally accepted noise level measurements were used to indicate the relative noise impacts for each of the system alternatives. It was desirable to utilize nationally accepted metrics that would best predict the potential community response to aircraft noise in the neighborhoods surrounding the airport sites and were defensible in their application to the aircraft noise issues in the Puget Sound area. These noise metrics and criteria were developed to account for the identified health effects of noise.

Noise has often been described as unwanted sound and it is known to have several adverse effects on people. From these known effects of noise, criteria have been established to help protect the public health and safety and prevent disruption of certain human activities. These criteria are based on such known effects of noise on people as hearing loss (not a factor with community noise), communication interference, sleep interference, physiological responses and annoyance. Each of these potential noise impacts on people is briefly discussed in the following narrative. While specific studies have not been made for this non-project FEIS, references are made to project research studies on these issues.

The majority of the respected research on the effects of noise on people has been conducted under the sponsorship of the FAA, the EPA and the US Air Force. Much of this research is summarized in two documents: "Noise Effects Handbook", Environmental Protection Agency, Office of Noise Abatement and Control, EPA 550-9-82-106, July 1981 and "Aviation Noise Effects", Office of Environment and Energy, Federal Aviation Administration, (FAA)-EE-85-2, 1985. Additional references are listed in the Bibliography.

- **Hearing Loss** is, in general, not a concern in community airport noise problems. The potential for noise-induced hearing loss is more commonly associated with occupational noise exposures in heavy industry or very noisy work environments with long-term exposure. The Occupational Safety and Health Administration (OSHA) identifies a noise exposure limit of 90 dB(A) for 8 hours per day to protect from hearing loss (for a definition of adjusted decibel scale db(A), see Appendix C Subsection "Description of Noise"). Noise levels in neighborhoods, even in very noisy airport environs near major international airports, are not sufficiently loud to cause hearing loss. The potential noise environments at each of the airport sites is below the level at which hearing loss is a concern.

- **Communication Interference** is one of the primary issues in environmental noise problems. Communication interference includes speech interference and disturbance of activities such as watching television or talking on the phone. Normal conversational speech is in the range of 60 to 65 dB(A) and any noise in this range or louder may interfere with speech. There are specific methods of describing speech interference as a function of distance between speaker and listener and voice level. Speech interference is assessed in terms of single-event maximum noise levels and not the cumulative noise level such as Ldn.

  In general, speech interference occurs around most airports and is a primary cause of annoyance. For this study, the typical peak indoor maximum noise level from jet aircraft at the 65 Ldn noise contour will range from 55 to 75 dB(A). At the 55 Ldn noise contour, the peak maximum indoor noise level will range from 45 to 65 dB(A). Based upon this data, speech interference results from most aircraft events at the 65 Ldn noise contour and occasionally at the 55 Ldn contour.

- **Sleep Interference** is a major concern in aircraft noise assessment and, of course, is most critical during nighttime hours. Sleep disturbance is one of the major causes of annoyance due to community noise. Noise makes it difficult to fall asleep and creates momentary disturbances of natural sleep patterns by causing shifts from deep to lighter stages and may cause awakening. Such awakenings may or may not be recalled. Extensive research has been conducted on the effect of noise on sleep disturbance. Recommended values for desired sound levels in residential bedroom space range from 25 to 45 dB(A) with 35 to 40 dB(A) being the norm.

The National Association of Noise Control Officials has published data on the probability of sleep disturbance with various single-event noise levels. The research has shown that the higher the noise level, the higher the probability for sleep disturbance. (National Association of Noise Control Officials, "Noise Effects Handbook", New York, 1981.). For this study, the typical peak indoor maximum noise level from jet aircraft at the 65 Ldn noise contour will range from 55 to 75 dB(A). At the 55 Ldn noise contour the peak maximum indoor noise level will range from 45 to 65 dB(A). Based upon this data, sleep disturbance will occur in 10 to 30 percent of the population at the 65 Ldn and at 0 to 15 percent at the 55 Ldn contour (note that these percentages represent sleep disruption. The percent of population that would be awakened would be less.)

- **Physiological Responses** are those measurable effects of noise on people such as changes in pulse rate, blood pressure, etc. While such effects can be induced and observed, the extent to which these physiological responses cause harm or are a sign of harm is not known. Generally, physiological responses are a reaction to a loud short term noise such as a rifle shot or a very loud jet overflight.

  Research conducted in the vicinity of Amsterdam Schiphol Airport indicates that exposure to aircraft noise in the vicinity of an airport increases risk of hypertension as well as other stress-related symptoms. Most studies of long-term effects of noise on human cardiovascular health have been either epidemiological or field studies in which it is difficult to determine a direct correlation between noise and any identified physiological responses. Although there may be some correlation between cardiovascular health and aircraft noise, it is unclear as to the degree of the correlation and at what threshold of noise it occurs.

- **Annoyance** is the most difficult of all noise responses to describe. Annoyance is an individual characteristic and can vary widely from person to person. What one person considers tolerable can be quite unbearable to another of equal hearing capability. The level of annoyance, of course, depends on the characteristics of the noise (i.e., loudness, frequency spectra, time, and duration), and how much activity interference (e.g., speech interference and sleep interference) results from the noise. In addition, many non-acoustic factors contribute to the level and variability of annoyance.

  Individual human response to noise is subject to considerable natural variability. Knowledge of the existence of these factors helps to understand why it is not possible to state simply that a given noise level from a given noise source will elicit a particular community reaction or have a certain environmental impact. These factors have been the subject of psychoacoustic research and summarized in a number of documents ("Aviation Noise Effects," Office of Environment and Energy, FAA-EE-85-2, 1985). These factors include: Necessity or preventability of the noise; judgment of the importance or value of the activity which is producing the noise; cumulative noise exposure from other noise sources; belief about the effect of noise on health; past experience or adaption to noise; inability for any control over the noise; and feeling of fear associated with the noise. In any community there will be a given percentage of the population highly annoyed, a given percentage mildly annoyed and others who will not be annoyed at all. These acoustic and non-acoustic factors will result in variations to the percentages within each response category.

  The EPA, in the "Levels" document, (Environmental Protection Agency, "Information on Levels on Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", U.S. Environmental Protection Agency, Office of Noise Abatement and Control, March 1974.), states that history of prior exposure to the noise source is one of factors used to judge the probable community reaction to noise. Annoyance from aircraft noise may be greater for a population newly exposed to aircraft noise than that which has long-term exposure. Past experience or adaptation is one of the identified non-acoustic factors that will influence the level of annoyance. This is not to say that a newly exposed population will find the noise to be worse than a population with long-term exposure, or that annoyance will decrease with length of exposure, but that a higher percent of the population will find new noise to be annoying. An example of this effect is the increase in noise complaints that occurred from the east turn flight test that was conducted at Sea-Tac back in the 1980s.

Personal sensitivity to noise also varies widely. It has been estimated that 2 to 10 percent of the population is highly susceptible to noise not of their own making, while approximately 20 percent are unaffected by noise.

Review of Health Effects Data from Noise Exposure

The PSATC retained the services of Dr. Michael S. Morgan, from the University of Washington, to review potential health effects from noise around airports. The following paragraphs summarize the findings from his review.

The most severe effect of noise exposure on humans is loss of hearing acuity, which is firmly associated with exposures on a regular basis to levels of 85 dB(A) or more. In the airport noise setting, there is little evidence that anyone other than airport employees is exposed to noise levels which threaten hearing. At lower levels of exposure, the effects in humans include sleep deprivation, speech interference, annoyance complaints of a general nature, and a range of changes in function of the central nervous system (Kryter, 1985). When subjected to these disturbances, the majority of people adapt to them and do not report serious long-term problems. There is increasing evidence, however, that portions of the general population have greater sensitivity to noise-induced stress, and it is these groups to which attention must be addressed in assessing and minimizing noise exposure. One such group are those with a variety of mental illnesses, whose response to noise has been described in several recent studies of psychiatric hospital admissions and of the clinical course of mentally ill patients (Meecham, 1977; Abey-Wichrama, 1969; Herridge, 1972; Gotten, 1973; Jenkins, 1979; Jenkins 1981; Hand, 1980; Tarnopolsky, 1980). There is remarkable consensus that when Ldn levels reach about 65 dB(A), these persons respond with increasing need for professional care, and in situations of continuing exposure their recovery is prolonged in comparison to unexposed patients.

An equally important sensitive portion of the population is children in the ages of the primary grades of elementary school. One of the apparent consequences of speech interference and behavioral effects due to noise exposure is disruption of learning, which has been described by several investigators, and measured by comparison of the performance of school children on standardized tests (Karagodina, 1969; Cohen, 1980; Cohen, 1981; Crook, 1974; Ko, 1979; Bronzaft, 1975; Bradley, 1986). It is not yet clear from the existing literature at what levels of noise exposure these effects become important, but they are demonstrable at Ldn levels of 70 dB(A), and may occur at lower levels as well.

Beyond the two sensitive groups mentioned, there is limited evidence in the literature for effects of noise exposure on fetal development. In a study near Amsterdam airport

(Knipschild,1981), birth weights in female infants were lower than in matched control group without exposure when Ldn levels were above 65 dB(A). This report must be confirmed by additional investigation, but may reinforce the notion that exposures above that level should be reduced to the greatest degree possible.

Concerning noise exposure at Sea-Tac, there is a large population (estimated at 67,000) within the 65 dB(A) Ldn noise contour, of which a vocal group of unknown size registers regular complaints of annoyance, sleep disturbance, speech interference and less well-defined forms of stress. In addition, there is evidence (non-quantitative) that visits to physicians for a wide variety of symptoms and use of prescription drugs are elevated in this region of noise impact, confirming that these residents show effects of moderately higher disruption of their daily lives. That these increases are due solely to airport operations is not established, however, since demographic factors in this population also play a role. There was also an indication that the members of the public who report these signs of stress also perceive a lack of sensitivity to their concerns on the part of Port of Seattle officials. This situation is likely to be a strong factor in exacerbating any direct consequences of airport noise exposure in the residents.

Quantitative measures of public health effect related to noise exposure have not been made in the population. No systematic evaluation of the incidence of physician visits or hospital admissions has been done. This is necessary in order to determine whether, and by how much, the incidence exceeds that found in residents of other parts of the region where no airport noise exposure occurs. In addition, no data have been collected from this exposed population on measure of response which have recently been reported in the scientific literature in other studies of noise exposure to the public. These measures include academic performance of elementary school students and morbidity of patients with various forms of mental illness.

In summary, effects on health and welfare due to noise from airport operations are probably occurring, but their severity and frequency have not been determined. Based on published surveys from other airport studies, it seems likely that effects are confined to the area enclosed by the 65 dB(A) Ldn contour, but there may be sensitive individuals exposed at lower levels who also are adversely affected. The future reductions in area and population exposed at 55 Ldn and 65 Ldn will lead to corresponding reductions in any potential public health impact. In particular, strong efforts should be made to reduce to the greatest possible extent the number of persons exposed to Ldn levels of 65 dB(A) or above, and to eliminate exposure of schools to these levels.

4.1.2.1.1 Cumulative Noise Measures (Ldn Metric)

The cumulative noise metric, Day Night Noise Level (Ldn), was the primary noise metric selected to assess the noise impacts from aircraft operations. The Ldn metric is useful because it combines the loudness of each aircraft overflight, the duration of these events, the total number of overflights, and the time of day these events occur into one single number rating scale. The Ldn scale is specified by most government agencies, including the FAA and the EPA, for the assessment of the noise impacts around airports. In 1976, the EPA recommended that the FAA adopt the Ldn as the standard aircraft noise descriptor. In 1980, the Federal Interagency Committee on Urban Noise recommended the Ldn as the main descriptor for land-use planning and site review. This interagency committee included the EPA, HUD, the Department of Defense, and the FAA. The FAA guidelines for the preparation of Environmental Impact Statements are that the noise impact from airport development is considered significant if the Ldn noise levels increase by 1.5 dB(A) or greater within the 65 Ldn noise contour.

Extensive research using the Ldn index has been conducted on human responses to exposure of different levels of aircraft noise. Community noise standards are derived from tradeoffs between the impacts expressed in community response surveys and economic considerations for achieving these levels. Examples of the results of these surveys, expressed in terms of community reaction versus Ldn noise level, are presented in Appendix C. These interpretations of noise response are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response.

The support of use of this metric to assess the potential impacts from aircraft noise is based upon research sponsored by the EPA and the FAA with many of the findings published in the EPA "Levels" document. (Environmental Protection Agency, "Information on Levels on Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", U.S. Environmental Protection Agency, Office of Noise Abatement and Control, March 1974.). The use of this metric is supported in urban environments as well as quieter rural areas such as is the case with many of the areas within the Puget Sound Region. Ldn has been used in all airports around the country, many in environments much the same as the Puget Sound. The bibliography lists a number of government agencies and research into the use of Ldn in the prediction of annoyance from aircraft noise.

The 55 Ldn noise level can be used as an indicator for when impacts from aircraft noise will likely begin to occur. The EPA has identified 55 Ldn as the noise level desirable for protecting the public health and welfare with an adequate margin of safety. This includes both residential land use with outdoor use areas and recreational land uses. This criterion does not constitute EPA regulations or standards. Rather, it is intended to identify a goal of safe levels of environmental noise exposure without consideration for economic cost for achieving these levels. Although it is not feasible as a mitigation level in developed areas, the 55 Ldn is indicative of a desired goal for the noise environment within the communities of the Puget Sound region.

The 65 Ldn noise level is utilized by the Federal Aviation Administration and most government agencies throughout the country as the threshold level for determining compatibility of aircraft noise with residential land use. This reflects a balance between a desired sound environment and the economic costs for obtaining this level. A local land-use authority can adopt its own guidelines and use its own standards, however federal funding for noise abatement is limited to the 65 Ldn level. The EPA has no formal position in terms of the 65 Ldn standard. However, in comments on airport EISs, they have supported the assessment of noise impacts beyond the 65 Ldn and in the use of Sound Exposure Level (SEL) data.

For the purposes of this SEPA non-project FEIS, population exposure to noise levels in excess of 65 Ldn is recognized as the traditional threshold for determining a significant adverse impact. The 55 Ldn is considered for comparative evaluation of the potential noise impacts around each of the airport sites.

4.1.2.1.2 Single Event Measures (Sound Exposure Level-SEL Metric)

While it has been demonstrated that cumulative noise metrics correspond well with overall community ratings of the noise environment, a number of researchers have suggested supplementing the Ldn analysis with single-event data. While the total noise exposure as described by the cumulative noise metric serves as the basis for a person's judgment of the noise environment, it is often a single-event interference with some activity that people will use to express their immediate concern over noise. In such cases, single-event metrics can be used to supplement the analysis.

Sound Exposure Level (SEL) is a "single event" descriptor of an individual overflight and is often used to supplement the Ldn analysis. An SEL level of 80 dB(A) corresponds to the level at which sleep disturbance and speech interference start to occur in the general population. A single-event SEL of 80 dB(A) was thus selected as one of the evaluation criteria for this study.

The SEL differs from Ldn in that it does not take into account the number of operations that take place through the day or the time of day they occur. It does not vary from year to year but only with the type of aircraft and the flight procedures used.

The MD82 aircraft on departure was used to model the single-event noise levels in that it is representative of the loudest of aircraft that are anticipated to be operating in the post 2000 time frame. A more detailed description of the SEL noise methodology is presented in Section 4.1.

The SEL noise metric is a single-event metric that takes into account the loudness and duration of an aircraft noise event. There are no criteria or standards in terms of SEL. However, the FAA and the Air Force use SEL noise data in the INM and NOISEMAP computer programs to generate Ldn noise contours around airports. In addition, much of the health effects research presented in the previous subsection are in terms of single-event noise such as SEL. The bibliography lists a number of documents which further discuss the SEL metric.

In a number of recent airport Environmental Impact Statements, the EPA and other commentors have suggested the use of SEL noise data to supplement the Ldn analysis. This includes the International Airports in Dallas, Columbus and Louisville.

4.1.2.2 Existing Aircraft Noise Levels

Indications of community response information obtained from studies around Sea-Tac confirm that the 55 Ldn and 80 SEL are good indicators of the overall noise levels at which complaints and annoyance from aircraft start to occur. In the general population, the 65 Ldn represents the threshold used by governmental agencies for significant impacts from cumulative noise exposure.

The existing noise conditions around Sea-Tac are based on noise exposure data produced for the Port of Seattle's Federal Aviation Administration (FAR Part 150) *Noise Exposure Map Update: 1991*. Within the 1991 existing 65 Ldn noise contour area of 22.1 square miles, an estimated 63,453 people reside in 27,621 units that are considered *noncompatible* land uses (as defined by FAA Part 150, Appendix A, Table 1), plus approximately 3,547 people who live in 1,498 *compatible* residential units. Residential uses designated as compatible have undergone sound insulation treatment either through the Port of Seattle Noise Remedy Program or through current building code requirements. Within the 1991 existing 70 Ldn noise contour area of 11.1 square miles, noncompatible residential uses included a population of 27,792 people in 11,357 units, plus an estimated 1,187 people in 538 compatible units. The FAA defines all residential uses within the 75 Ldn noise contour as noncompatible (except transient lodgings). Within the 1991 existing 75 Ldn noise contour area of 5.1 square miles, the resident population was estimated to be 7,357 people in 3,291 units. The size of the 1991 existing 55 Ldn noise contour was 45 square miles.

The five-year forecast operations at Sea-Tac show a reduction in future noise levels around the airport. This decrease in noise impacts will result primarily from the changes to quieter aircraft that will use Sea-Tac airport. Also, by 1996, an additional 1,244 residences within the 1996 future 65 Ldn noise contour area are projected to have undergone sound insulation treatment through the Noise Remedy Program. Thus, the area within the 1996 future 65 Ldn noise contour will be reduced to 14.8 square miles, and noncompatible residential uses would total 36,477 people in 15,677 units, assuming no net migration.

With the exception of Olympia/Black Lake and the Central Pierce/Fort Lewis area, all of the other site options are at existing airport sites which currently experience some significant level of aircraft noise. For example, Paine Field has a mix of general aviation activity including business jets and test flights for commercial aircraft. Since McChord is an active military airfield, and military aircraft are generally much noisier than commercial carriers, its surrounding population currently experiences relatively higher Ldn and SEL noise levels.

At Paine Field, the most recent noise contours are for 1987 and include a 55 and 65 Ldn noise contour of 6.6 and 0.8 square miles, respectively. There are currently an estimated 10,600 residences within the 55 Ldn noise contour for Paine Field. The five-year forecast in operations at the airport show an increase in future noise levels. The projected 1996 future 55 Ldn noise contour cover 7.8 square miles with an existing population of 11,700 residences.

4.1.2.3 Overview of Noise Impact Analysis

The noise impact analysis estimated the total population noise exposure for each of the airport system alternatives (Table 4-1). The following noise assessment criteria were used in the analysis: (1) population exposed to cumulative noise levels in excess of 55 Ldn, (2) population that would be newly exposed to cumulative noise levels in excess of 55 Ldn, (3) population exposed to cumulative noise levels in excess of 65 Ldn, (4) population that would be newly exposed to cumulative noise levels in excess of 65 Ldn, and (5) population that would be exposed to single-event SEL noise levels in excess of 80 SEL. Rationales for use of these various noise assessment criteria are further explained below:

1. **Residential population exposed to aircraft noise of 55 Ldn or greater.** A noise level of 55 Ldn and greater indicates the population to which the aircraft noise will be noticeable and some degree of annoyance or adverse community response would be expected to occur. Experience at Sea-Tac showed most areas (but not all) where noise complaints occurred were exposed to Ldn levels of 55 or greater. For a new airport site, the 55 Ldn represents that area in which future residential land use development may consider land use zoning, and other land use control measures to avoid significant noise-related residential land use impacts.

2. **Residential population newly exposed to 55 Ldn or greater.** A newly exposed population consists of those people experiencing new exposure to aircraft noise as a direct result of the alternative. In accordance with many studies, this category reflects that around a new airport or an airport which previously had very few operations, the

Table 4-1

2020 Populations within 2020 Noise Contours

System Alternatives	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*	Population Newly Exposed to 80 SEL (000)*
NO ACTION **						
Existing Sea Tac No Action (Unconstrained Sea-Tac Only)	175		25		120	
EXISTING SEA-TAC AIRPORT SYSTEM						
Existing Sea Tac w/System Management (Constrained)**	135		12		120	
Sea Tac w/New AC Rwy (Unconstrained Sea-Tac Only) **	162		22		120	
Sea-Tac In Conjunction With A Remote Airport	....	....	See Text	....	....	....
TWO AIRPORT SYSTEMS						
Existing Sea Tac + Supp(1 Rwy)**	139-172	4-37	12.1-13.5	0.1-1.5	129-186	9-67
Existing Sea-Tac + Supp(2 Rwy)	140-174	5-39	12.1-13.9	0.1-1.9	134-200	14-81
Sea-Tac with new AC Rwy + Supp(1 Rwy) Mitigated Sea-Tac with new AC Rwy + Supp(1 Rwy)	166-177 (139-150)	2-13 (2-13)	20-20.2 (15.1-15.3)	0-0.2 (0-0.2)	141-199 (130-188)	9-67 (9-67)
Sea Tac with new AC Rwy + Supp(2 Rwy) Mitigated Sea-Tac with new AC Rwy + Supp(2 Rwy)	165-181 (138-154)	1-17 (1-17)	20-20.1 (15.1-15.2)	0-0.1 (0-0.1)	146-213 (135-202)	14-81 (14-81)
THREE AIRPORT SYSTEMS						
Existing Sea Tac + 2 Supp(1 Rwy)	149-176	14-41	12.3-12.9	0.3-0.9	164-240	45-120
Sea-Tac with new AC Rwy + 2 Supp(1 Rwy) Mitigated Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	168-180 (142-183)	5-26 (5-26)	18.2-19.1 (15.1-15.3)	0-0.2 (0-0.2)	177-252 (168-241)	45-120 (45-120)
REPLACEMENT AIRPORT SYSTEM						
Replacement	81 - 101	81 - 101	3.8 - 4.7	3.8 - 4.7	86 - 108	86 - 108

** Denotes systems that include alternatives which do not meet system capacity demands population newly exposed is likely to exhibit a higher level of annoyance to the new aircraft noise. See "Annoyance" discussion under Section 4.1.2.1.

3. **Residential population exposed to aircraft noise of 65 Ldn or greater.** The 65 Ldn indicates the population that is significantly affected by aircraft noise. This is the FAA's mitigation compatibility of residential land use with aircraft noise levels.

4. **Residential population newly exposed to aircraft noise of 65 Ldn or greater.** Since a population that is newly exposed to aircraft noise has been shown to exhibit higher annoyance to aircraft noise than a population that has had a long-term exposure to the noise, this measure indicates a significantly affected population that will most likely need special action.

5. **Residential population exposed to single-event aircraft noise of 80 SEL or greater.** The 80 SEL single-event noise contour is an indicator for when speech interference and sleep disturbance start to occur. The 80 SEL single-event contour is, therefore, considered a good indicator of where single-event disturbance is likely to result in annoyance from aircraft operations for a segment of the population. Experience at Sea-Tac has shown that most noise complaints occur in areas where the SEL noise level exceeds 80 dB(A).

4.1.2.4 Noise Contour and Flight Track Analysis

Noise contour maps for the 55 and 65 Ldn, and 80 SEL, were generated for each of the airport alternatives using the FAA's Integrated Noise Model. Noise contour maps for each of the airport development alternatives are presented in Appendix C. These exhibits present the noise contours for the highest operational assumptions for one, two and three runway scenarios for each airport site. The operational assumptions used in developing the noise contours are explained in Appendix C.

The primary time period for analysis was 2020, which is representative of the long term noise environment. Analyses of the years of 2000 and 2010 were also completed to present the projected noise environment during the interim time periods. The analysis of the interim years was completed for Sea-Tac and the north airports site options only, in that an airport site to the south is not anticipated until the post-2010 time frame.

The aircraft fleet forecast to be operating in the post-2000 time frame is composed of all Stage 3 aircraft. Stage 3 refers to the quietest category of aircraft as defined by the FAA Federal Aircraft Regulation 36 which regulates the noise levels generated by jet aircraft. FAA certification of Stage 3 aircraft is based on engine weight and noise. The federal government has recently passed legislation that mandates the phasing out of the louder Stage 2 aircraft by the year 2003. The analysis assumes that the aircraft fleet will continue the trend of quieter aircraft after 2000 as the older and loudest of the Stage 3 aircraft are retired from the fleet due to aging. This includes such aircraft as the DC10, L1011, B747-200 and retrofitted B727s. An example of the comparative noise levels from these different types of aircraft is presented in Figure 4-1. In terms of perceived loudness, most individuals will perceive new Stage 3 aircraft to be 1/4 as loud as a typical Stage 2 aircraft.

The aircraft that are assumed to operate in the post-2010 time frame generate similar noise levels as those of the quietest of the new generation aircraft that are being built today. The

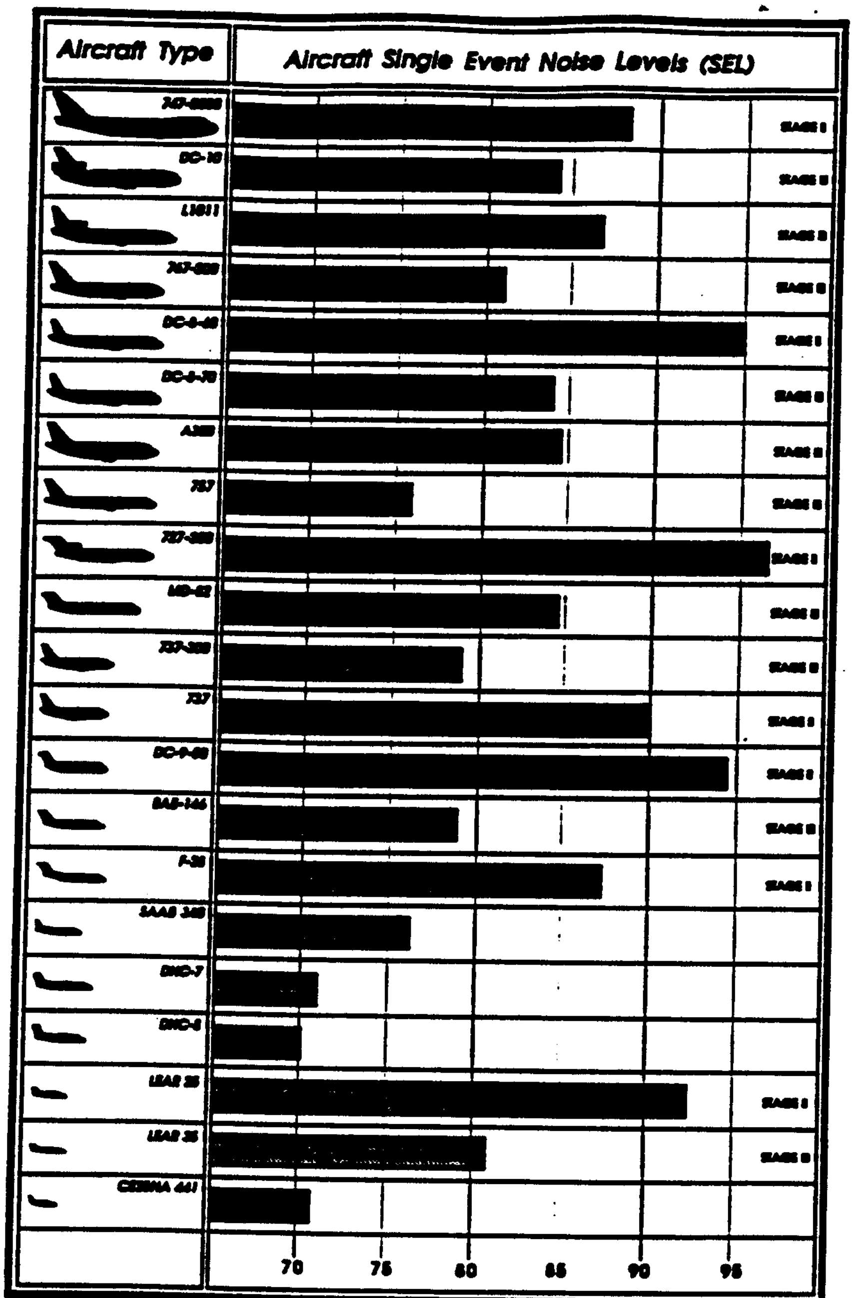


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Figure
4-1

AIRCRAFT DEPARTURE NOISE LEVELS

post-2010 contour analysis assumes all Stage 3 aircraft such as the MD80, MD90, B737-300, B757, B767, MD-11, B747-400 as well as other new generation aircraft.

Given the 25 to 30 year life span for commercial aircraft, these aircraft would be expected to still be in service by 2020. Although these aircraft are significantly quieter than many of the current fleet of aircraft such as the B727, they still generate noticeable levels of noise. New aircraft currently under development utilize similar technology that is expected to result in noise levels similar to the Stage 3 generation of quieter aircraft. Any significant future reductions in noise will require new developments in engine technology or noise control and therefore are not anticipated by this study.

Single-event noise contours for aircraft types and procedures expected to be in operation in post-2000 were generated and mapped (see maps in Appendix C). The departure noise levels were used because aircraft departures generate the highest single-event noise level. The aircraft selected to represent the single-event noise levels is the McDonnell Douglas MD-82. The MD80 series aircraft was the first narrow body Stage 3 commercial aircraft, and while quieter than Stage 2 aircraft, does not include the latest engine technology associated with the new generation of Stage 3 aircraft. The MD82 aircraft was used for the single event analysis to present a worst case analysis. The MD82 is representative of the loudest aircraft expected to be in operation through the early part of the 21st century. The associated contour maps present a composite of the singe-event noise levels to all of the primary flight tracks and are intended to reflect typical single-event noise levels in different communities.

Air traffic control (FAA) has established paths for aircraft arriving and departing the Sea-Tac, Paine Field and McChord airspace. These paths have been developed from ATC procedure requirements and specific noise abatement procedures that have evolved over a number of years. These paths are not precisely defined ground tracks, but represent a broad area over which the aircraft will generally fly. These paths were used for this study. For example, twenty-one flight tracks were used for both Sea-Tac and Paine Field. Sea-Tac aircraft flight paths include the Four-Post plan that was implemented by the FAA in 1990 (A discussion of the Four-Post Plan, and the effects of the new Microwave Landing System (MLS), is presented in Appendix C). The Paine Field tracks were based upon recently obtained radar flight tracking data from existing turbo jet aircraft operations. New airport sites such as Olympia/Black Lake assume straight arrival and departure paths. The flight tracks used for Sea-Tac and Paine Field are presented in Appendix C.

4.1.2.5 Population Impact Analysis

The noise contour analysis was used to determine the population that would be exposed to certain noise levels. Population data is from the Puget Sound Regional Council (PSRC) which maintains a population data base by travel analysis zones (TAZs). For King, Pierce, Snohomish, and Kitsap Counties, there are nearly 800 TAZs that are similar in size to census tracts and thus tend to be smaller in urbanized areas and larger in rural areas. The noise contour maps were entered into the PSRC computer data base. The computer calculated the percentage area of each TAZ covered by a given contour and multiplied by the total TAZ population to obtain the proportionate population within the noise contour. These proportionate population figures were then summed to obtain the total population within each contour (see Appendix C for further explanation). Suitable population data by sub area was not available for Thurston County. Instead, a general population density figure was multiplied by the area under each noise contour to estimate the impacted population.

The noise contours are based on operational assumptions for the years 2000, 2010 and 2020. The population analysis is based on PSRC population projections or by Thurston Regional Planning Council and State Office of Financial Management data for each year under study. In order to present a worst case analysis, protective zoning and land use planning practices are assumed not to be employed around the selected airport site(s).

Projected population data indicate that people will be living around nearly all of the specific airport sites selected for evaluation of impacts. The most densely populated areas are expected to be around Sea-Tac and Paine Field Airports. The least densely populated area would be around Olympia/Black Lake and Arlington. Also, no private homes are located to the south of the McChord or Fort Lewis sites because that area is part of the Fort Lewis Army Base.

The results of the 2020 population analysis for each of the system alternatives are summarized on Table 4-1. This table presents the range in populations for each of the assessment criteria. Additional data for each airport site alternative is presented in Tables 4-2 and 4-3. These tables show both the total population exposed to each of the noise level metrics and the areas within the Ldn noise contours.

The results of the interim year analysis are presented in Table 4-4. This table shows the size of the noise contours and the population within each contour for the years of 2000 and 2010. The data is presented for Sea-Tac, Paine Field and Arlington airports. Section 4.1.2.1 present information on the impacts of aircraft noise on residential populations.

4.1.2.6 School Impact Analysis

The noise contour analysis was also used to estimate the number of schools and students located within the 65 Ldn noise contours. Schools refer to public and private facilities for elementary, middle, high schools and community colleges. Enrollment data was collected for Highline School District, South Central School District, Federal Way School District, and each of the individual private schools. The total number of schools located within the 65 Ldn noise contour is presented in Table 4-5. This data is presented for Sea-Tac, Paine Field and Arlington.

The number of students attending schools within the 65 Ldn noise contour was also estimated. The 1991/1992 enrollment for schools located within the 1990 existing 65 Ldn noise contour at Sea-Tac is 17,600 students. This includes 8,326 students enrolled at Highline Community College. Note that the school districts do not have any long-range forecasts in terms of student populations. Five-year forecasts range from 5 to 68 percent growth in student populations, depending upon the district.

Potential noise impacts on schools are primarily an effect on the interior noise levels for classrooms. Potential impacts include teacher/student communication interference and disruption of learning concentration of students. Young children are especially susceptible to learning disruption from noise. A common noise mitigation measure is to provide for noise insulation within the classrooms.

Table 4-2

Population Summaries within 2020 Noise Contours

Does Not Include Mitigation Measures for Sea-Tac w/Dependent R/W

Alt		Airport System Siting Options	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	**	Sea-Tac Only with Existing Runways (Constrained)	135		12.0		120
3	**	Alternate 1 + Arlington 1 R/W	152	17	12.7	0.7	156
4		Alternate 1 + Paine 1 R/W	172	37	13.5	1.5	186
5		Alternate 1 + McChord 1 R/W	164	29	13.0	1.0	176
6	**	Alternate 1 + Central Pierce 1 R/W	163	28	13.2	1.2	173
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	139	4	12.1		129
8		Alternate 1 + Arlington 2 R/W	158	23	12.7	0.7	173
9		Alternate 1 + Paine 2 R/W	174	39	13.9	1.9	200
10		Alternate 1 + McChord 2 R/W	165	30	13.0	1.0	186
11		Alternate 1 + Central Pierce 2 R/W	173	38	12.8	0.8	193
12		Alternate 1 + Olympia/Black Lake 2 R/W	140	5	12.1		134
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	169	5	20.2		168
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	177	13	20.0		199
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	177	13	20.1		189
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	177	13	20.1		186
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	166	2	20.0		141
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	170	6	20.0		186
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	178	14	20.0		213
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	177	13	20.1		198
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	181	17	20.0		206
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	165	1	20.0		146
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	165	30	12.8	0.8	208
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	176	41	12.9	0.9	240
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	149	14	12.3		164
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	161	26	12.5	0.5	195
27		Alternate 13+ Central Pierce 1 R/W	175	17	18.2		221
28	†	Alternate 14+Central Pierce 1 R/W	180	26	18.2		252
29		Alternate 13+Olympia/Black Lake 1 R/W	168	5	19.0		177
30		Alternate 14+Olympia/Black Lake 1 R/W	174	14	19.1		208
31		Central Pierce 3 R/W	101	101	4.7	4.7	108
32		Central Pierce/Fort Lewis 3 R/W	81	81	3.8	3.8	86
33	**	Alternate 1 + Demand Management	135		12.0		120
34	**	No Action (Unconstrained Sea-Tac Only)	178		25.0		120
35	**	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	182		22.0		120

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

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Table 4-3

Size of LDN Noise Contours (Square Miles) 2020

Does Not Include Mitigation Measures for Sea-Tac w/Dependent R/W

Alt.		Airport System Siting Options	Seatac Airport 55 LDN	Seatac Airport 65 LDN	North Airports 55 LDN	North Airports 65 LDN	South Airports 55 LDN	South Airports 65 LDN
1	**	Sea-Tac Only with Existing Runways (Constrained)	30.9	5.1				
3	**	Alternate 1 + Arlington 1 R/W	30.9	5.1	12.8	1.8		
4		Alternate 1 + Paine 1 R/W	30.9	5.1	14.6	2		
5		Alternate 1 + McChord 1 R/W	30.9	5.1			15.7	2.2
6	**	Alternate 1 + Central Pierce 1 R/W	30.9	5.1			12.8	1.8
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	30.9	5.1			12.8	1.8
8		Alternate 1 + Arlington 2 R/W	30.9	5.1	17.6	2.3		
9		Alternate 1 + Paine 2 R/W	30.9	5.1	15.1	2.3		
10		Alternate 1 + McChord 2 R/W	30.9	5.1			15.8	2.3
11		Alternate 1 + Central Pierce 2 R/W	30.9	5.1			17.6	2.4
12		Alternate 1 + Olympia/Black Lake 2 R/W	30.9	5.1			17.6	2.3
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	35.9	6.5	5.5	0.7		
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	35.9	6.5	5.5	0.8		
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	35.9	6.5			6.7	1
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	35.9	6.5			5.5	0.7
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	35.9	6.5			5.5	0.7
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	35.9	6.5	6.9	0.8		
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	35.9	6.5	6	0.9		
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	35.9	6.5			7	1.1
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	35.9	6.5			6.9	0.9
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	35.9	6.5			7	0.8
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.2	1.1	9.3	1.3
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	6	0.9	8.7	1.2
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	30.9	5.1	9.1	1.2	8.2	1.1
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	30.9	5.1	6	0.9	7.7	1
27		Alternate 13+ Central Pierce 1 R/W	34.7	6.4	4.3	0.6	5.5	0.7
28	†	Alternate 14+Central Pierce 1 R/W	34.5	6.4	6	0.9	5.5	0.7
29		Alternate 13+Olympia/Black Lake 1 R/W	35.4	6.5	4.3	0.6	3.3	0.5
30		Alternate 14+Olympia/Black Lake 1 R/W	35.3	6.5	6	0.9	3.3	0.5
31		Central Pierce 3 R/W					59.2	8.5
32		Central Pierce/Fort Lewis 3 R/W					59.2	8.5
33	**	Alternate 1 + Demand Management	30.9	5.1				
34	**	No Action (Unconstrained Sea-Tac Only)	46.3	8.4				
35	**	Sea-Tac w/Dep R/W (Unconstrained Sea-Tac Only)	41.3	8.1				

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

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Table 4-4
Year 2000 and Year 2010 Area and Population Estimates

	Year 2000		Year 2010	
	55 LDN	65 LDN	55 LDN	65 LDN
Area Impacts (Sq. Mi.)				
Sea-Tac				
NO ACTION (Unconstrained Sea-Tac Only)	55.1	12.1	34.0	5.9
SEA-TAC WITH NEW AC RWY (Unconstrained Sea-Tac Only)	-	-	35.6	6.2
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	49.8	11.1	33.4	6.1
MITIGATED SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	-	-	32.0	5.5
Paine				
SEA-TAC WITH NEW AC RWY + PAINE(1 RWY) + SUPP(1 RWY)	4.3	0.6	4.8	0.7
Arlington				
SEA-TAC WITH NEW AC RWY + ARLINGTON(1 RWY) + SUPP(1 RWY)	2.6	0.4	3.4	0.5
Population Impacts				
Sea-Tac				
No Action (Unconstrained Sea-Tac Only)	190,700	39,500	128,700	14,900
SEA-TAC WITH NEW AC RWY (Unconstrained Sea-Tac Only)	-	-	132,600	15,000
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	172,400	35,500	124,300	14,600
MITIGATED SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	-	-	122,700	12,400
Paine				
SEA-TAC WITH NEW AC RWY + PAINE(1 RWY) + SUPP(1 RWY)	6,100	0	8,800	0
Arlington				
SEA-TAC WITH NEW AC RWY + ARLINGTON(1 RWY) + SUPP(1 RWY)	1,800	0	2,500	0

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Table 4-5. Number of schools within 65 Ldn noise contour.

Scenario	1990	2000	2010	2020
Multiple Airport System				
Sea-Tac	28	13	2	4
Paine Field	0	0	0	0
Arlington	0	0	0	0
No Project				
Sea-Tac	28	14	3	9

4.1.3 Significant Impacts

The noise analysis compared the total population that would be exposed to various noise assessment criteria for each of the airport system alternatives. The noise assessment criteria used in the analysis included:

1. Population exposed to cumulative noise levels in excess of 55 Ldn.
2. Population that would be newly exposed to cumulative noise levels in excess of 55 Ldn.
3. Population exposed to cumulative noise levels in excess of 65 Ldn.
4. Population that would be newly exposed to cumulative noise levels in excess of 65 Ldn.
5. Population that would be exposed to single event SEL noise levels in excess of 80 SEL. For more information on these measures, please see Section 4.1.2.3.

In assessing the relative difference in noise impacts between the system alternatives, it is important to point out the inherent difference between the community response to noise associated with an airport that has existed for many years and the response to noise that will occur at a new airport. It is very difficult to compare the relative noise impacts between these two different environments and the criteria used in this analysis attempts to account for the difference.

One of the most important conclusions from the noise analysis is that the future noise environment at Sea-Tac for all of the system alternatives represents an improvement over that which exists around Sea-Tac today. The aircraft that are forecast to be operating at these airports in 2020 are significantly quieter and will result in reductions in both the overall Ldn noise levels as well as the single-event SEL levels. Even though the number of aircraft events will increase, the overall Ldn noise level will decrease. While these noise levels are a significant improvement over the aircraft noise levels that exist at Sea-Tac today, it may be expected that some level of adverse community response to aircraft noise would still be experienced with any alternative. This adverse response is likely to occur at any of the potential airport sites.

Another important conclusion is that no one alternative stands out as far superior to the other alternatives. Each of the alternatives results in similar impacts in terms of the population within each noise contour.

4.1.3.1 Sea-Tac Airport

The analysis of noise impacts at Sea-Tac must be based on an understanding of what is predicted for noise exposure in the future. For example, over the next ten years the noise levels at Sea-Tac will be significantly reduced over current levels due to the Sea-Tac Noise Budget and nighttime Stage 2 restrictions. These programs, and the national noise policy, require the airlines to replace Stage 2 aircraft with the quieter Stage 3 equipment.

Improvements to the noise environment around Sea-Tac will continue into the 21st Century as the airline fleets further modernize with the quietest Stage 3 equipment as the older Stage 2 aircraft are retired. Older Stage 2 aircraft that are anticipated to be replaced during this time frame include the B747-200, DC10, L1011 and hushkitted Stage 2 aircraft. New replacement aircraft include the B747-400, MD11, and A340 that are quieter than these older aircraft. Therefore, the most significant conclusion of the noise analysis is that the future noise environment for all of the system alternatives represents a significant improvement over that which exists around Sea-Tac today.

The aircraft forecast to be operating in the post-2010 time frame are significantly quieter, resulting in reductions in both the overall Ldn noise levels and the single-event SEL levels over what exists today. For example, a total of 67,000 people currently reside in Sea-Tac's existing 65 Ldn noise contour. By 2020, the population within Sea-Tac's 65 Ldn noise contour will range from 12,000 to 25,000 people.

A detailed census block analysis of the neighborhoods immediately surrounding Sea-Tac conducted for the (FAR Part 150 Update) Noise Exposure Map Update: 1991, estimated a resident population of 7,357 within the 1991 75 Ldn noise contour of 5.1 square miles. By the year 2000, all homes within the 75 Ldn noise contour are forecast to be purchased or acoustically treated by the Noise Remedy Program. Thus, the noncompatible population noise exposure of the no-action alternative would depend on land use changes in the immediate vicinity surrounding Sea-Tac.

Sea-Tac With Broad System Management

The potential noise impacts for this system alternative are lower than other alternatives that include Sea-Tac. The total 2020 population within the 65 Ldn noise contour is estimated to be 12,000 people. However, this alternative by itself does not meet region's future air travel needs. Measures have included demand management and rail high-speed that may result in other sources of noise that are not accounted for in this analysis.

Sea-Tac With New Third Dependent Air Carrier Runway

The total 2020 population within the 65 Ldn noise contour is estimated to be 22,000 people. The contours are similar to the No Action alternative until 2020 where the No Action alternative contours are larger. This is because with the addition of the new dependent air carrier runway, the airport will operate more efficiently, with less operations anticipated to spread into the early morning or nighttime hours as is forecast with the No-Action alternative. This is not assumed to occur until the post-2010 time frame. Potential mitigation measures such as use of a "side-step" approach maneuver are discussed in Section 4.1.4.

Sea-Tac With Remote Airport

The potential noise impacts for the remote airport alternative are dependent upon the potential sites and the types of aircraft operations that would utilize each site. Boeing Field as a remote airport site would likely be used by commuter type operations; thus the potential noise impacts would be less at that airport. However, little relief would be expected to occur at Sea-Tac. Boeing Field is also located in an urban area such that there is more residential land use in close proximity to the airport. The noise impacts associated with the use of Moses Lake will be dependent upon the aircraft that would service that airport. The airport is located in a remote area, thus, the airport could carry a higher level of traffic without significant noise impacts, thereby providing more benefits at Sea-Tac.

4.1.3.2 Two-Airport System

The "Two Airport System" refers to use of Sea-Tac along with the development of one additional supplemental airport. The range of the total population experiencing 65 Ldn noise levels under the Two-Airport system alternatives is estimated at between 12,000 and 20,000 residents (see Tables 4-1, 4-2 and 4-3; and Appendix C). In these cases, operational controls are assumed to be in place. This assumption entails efficient passenger loading and results in perhaps a 30 percent reduction in the number of operations. Examples are Long Beach and John Wayne Airports.

4.1.3.3 Three-Airport System

The alternative recommended by the PSATC is represented under "Three Airport Systems" at the bottom of Table 4-1 as Sea-Tac with new air carrier runway and two supplemental airports (1 runway each). The first line of data for this alternative presents the worst case population noise exposure estimates. A "mitigated" version of this alternative is also presented (beneath it in parentheses) which incorporates demand management and restricted use of the new dependent runway to less noise-sensitive time periods for arrival traffic only.

No increase in capacity at Sea-Tac would result in more significant growth and noise at the supplemental airport sites. With restricted use of a new dependent runway at Sea-Tac, a multiple airport system would be more favorable from an overall noise management perspective than a multiple airport system without improvements to Sea-Tac. This reflects a balance of some growth at Sea-Tac with limited growth at supplemental airport sites.

4.1.3.4 Replacement Airport

The system alternative that is rated the most favorable for noise is the replacement airport system. The replacement airport alternative results in less people located within the noise contour zones. However, it is very important to point out that this is very site dependent. Replacement airports would only be favorable for a new airport site outside of the urbanized area where the population around the proposed site is likely to be minimal. For sites with a significant population near the airport site, such as central Pierce County, this alternative is less favorable. (Note: favorable development of replacement airport sites is dependent upon strong land use controls designed to discourage or prevent residential development. Also, replacement airports in remote areas encourage new urban development and sprawl.)

4.1.3.5 No-Action Alternative

By the year 2000, the new Federal Airport Noise and Capacity Act of 1990 will result in reductions in noise as noisier aircraft are phased out of service. This will occur at Sea-Tac at a faster rate and at a guaranteed rate due to the noise budget and nighttime Stage 2 aircraft prohibitions. Given the reduction in noise levels that will occur in the future, the noise environment at Sea-Tac will be quieter in the future with or without the proposed project.

A detailed assessment of the No-Action alternative was completed for the years 2000, 2010 and 2020. The no-action alternative at Sea-Tac results in a 65 Ldn contour area of 12.1, 6.0 and 8.5 square miles for 2000, 2010 and 2020 years respectively. An estimated population of approximately 25,000 residences will be within the 2020 no-action noise contours. This compares to a 65 Ldn contour size of 6.0 square miles and 12,500 residences for Sea-Tac 2020 assuming a new dependent air carrier runway and a multiple airport system.

4.1.4 Mitigation Measures

A number of additional measures could be designed to minimize the potential noise impacts from the airport development. However, the most effective noise control measures are those that are tailored to the wishes and needs of the local communities and generally are accomplished through a process such as the FAA Part 150 program. Any adopted airport system recommendation would include a noise mitigation planning process that would include the communities', airport operators' and airlines' input.

4.1.4.1 Noise Mitigation

According to FAA Part 150 guidelines, specified levels of structural noise insulation can be used as a mitigation measure within the 65-70 Ldn and the 70-75 Ldn contour intervals to achieve compatibility of residential land use with these levels of aircraft noise exposure. The Port of Seattle is actively engaged in an FAA-funded Noise Remedy Program to provide neighborhood reinforcement and noise insulation for residences surrounding Sea-Tac. Noise insulation provides for a quieter interior noise environment that reduces sleep disturbance, speech interference and interruption of household activities. Thus, by the year 2020, a substantial portion of the residential housing stock within the currently established Noise Remedy Program boundaries would be compatible land uses within the 65 Ldn noise level. Further information on the Noise Remedy Program can be obtained by contacting the Port of Seattle Noise Remedy Office.

4.1.4.2 Noise Abatement Measures

The following is a brief list of a number of the noise abatement measures that should be considered for minimizing the noise impacts around each of the airports.

- Preferential Runway Use
- Preferential Runway Direction
- Flight Track Modifications
- Special Nighttime Procedures
- Nighttime Operational Restrictions
- Aircraft Use Restrictions
- Noise Abatement Arrival and Departure Procedures
- Alternative Runway Development Plans
- Nighttime Ground Noise Control Measures

For example, the potential noise impacts from construction of the dependent runway at Sea-Tac could be minimized for the long term by restricting the use of that runway for arrivals and only during the less noise-sensitive time period through a noise abatement policy. When noise abatement measures are included, alternative airport systems that include Sea-Tac with the dependent runway would lessen the noise exposure impacts estimated.

Additional mitigation measures, such as those listed above, were not included in this non-project EIS because of the complexity in applying mitigation to a large number of new airport sites with varying layouts and operational levels. Also, many of the potential mitigation measures restrict the operational characteristics of an airport and it was necessary to first analyze the potential noise impacts without constraints to the operations. Thus, unless explicitly stated otherwise, the noise exposure analysis presents operationally comparable worst case estimates.

The noise impacts of the southern supplemental sites could be reduced through a preferential runway program that maximizes the amount of time the operations are in south flow, as there is very little development south of these airport sites. The noise impacts at the remaining supplemental airport sites could be minimized through the restriction of nighttime operations, especially in a multiple airport system with Sea-Tac as the primary airport. However, under the existing laws, it is very difficult to implement new restrictions on Stage 3 aircraft, therefore, it may not be possible to legally restrict nighttime operations in the future. Yet, this is one issue that could potentially be explored further.

The potential for mitigating the noise impacts for the supplemental airport sites was analyzed for a number of sample alternatives. Although it was not feasible to analyze all of the alternatives, the preliminary results of analyzing sample alternatives show that the potential noise impacts at the supplemental sites themselves could be reduced by approximately 10 percent through mitigation measures.

As an example, an analysis of Paine Field operations was conducted assuming restrictions on nighttime commercial operations. The analysis assumes that there are no commercial operations between 10 pm and 7 am. The results of the analysis show that the contours are approximately 40 percent smaller. The total population within the 55 Ldn noise contour is reduced from 15,800 to 9,400 residences in the 2020 time frame.

It is recommended that noise control measures be included in the planning process as part of any implementation plan. Once a specific system alternative, airport sites, and layouts are determined, specific mitigation measures can be presented. For any alternative, a site specific EIS would require a thorough discussion of mitigation and the ability to legally restrict nighttime operations.

4.1.4.3 Operational Management

The operational assumptions for a dependent runway at Sea-Tac include arrivals, departures and nighttime operations. Should these assumptions be changed to arrivals only, as might occur with anticipated use primarily during low-visibility weather conditions and during less noise-sensitive time periods, then the noise impacts would be lessened considerably.

4.1.4.4 Operational Effects of Side-Step Maneuvering

One operational mitigation procedure for restricted use of the dependent runway utilizing a side-step maneuver. A side-step maneuver is an FAA authorized approach procedure in which an aircraft executes an initial approach to one of two or more parallel runways followed by a final approach and landing on the adjacent runway. Pilots would commence the side-step maneuver as soon as the runway was in sight. The results of implementing a side-step maneuver would likely be to narrow the noise contours on the western margin of Sea-Tac such that the 2020 projected 55 Ldn noise contour would closely approximate the 1991 existing 65 Ldn noise level.

The following technical description outlines the concept of a side-step maneuver employed as part of the mitigation for restricted dependent runway operation, which would involve the use of a new dependent air carrier runway utilized only during less noise-sensitive hours by commuter aircraft and air carrier aircraft.

For the noise model, aircraft were assumed to commence the side-step maneuver at four nautical miles from the approach end of the landing runway at an altitude of 1,100 feet above ground level (AGL) and conclude the maneuver at 1.6 nautical miles from the approach end of the landing runway at an altitude of 500 feet AGL utilizing a twenty degree heading change. A minor increase in engine thrust due to aircraft maneuvering required by this procedure was also considered in the noise contour modeling.

Since the side-step maneuver is a visual procedure, higher landing weather minimums are required. Considering the prevailing meteorological conditions of the Seattle area, this procedure was modeled to be available and used by 20 percent of daytime air carrier arrivals. At this level of analysis, the Four-Post Plan was not modified. This issue may be potentially addressed as part of future airspace management work discussed in Section 4.10.

4.1.5 Unavoidable Adverse Impacts

Any of the airport system alternatives, including the no-action alternative, decrease aircraft noise impacts over those which exist today. This is a result of noise control programs at Sea-Tac, federal legislation and the technological improvements that reduce the noise levels in future generation aircraft. However, new cumulative and single-event noise will occur at potential supplemental airport sites if implemented.

4.2 AIR QUALITY

4.2.1 Overview

This section addresses potential regional impacts to air quality resulting from aircraft air pollutant emissions and from airport-related vehicular air pollutant emissions. Other air pollutants attributable to airport operations (such as fueling, boiler room operations in airport buildings and other sources) comprise a small percent of the total air pollutant emissions associated with airports and were not considered critical for this level of analysis in that they are primarily site dependent. Aircraft and vehicular traffic air pollutant levels were used to compare the impacts of each system alternative on regional air quality.

This section summarizes the significant findings of the Air Quality Assessment by Mestre Greve Associates/P&D Aviation, which is reproduced as Appendix D of the FEIS and incorporated by reference. Appendix D contains more detailed information on the air quality study, including a description of the methodology used for determining aircraft and vehicular emissions data on all of the criteria pollutants. Additional supplemental information that was requested as part of the public hearing process is reflected in this section and in the updated Appendix D. This section also summarizes the review of the potential health effects from air pollutant emissions that was conducted by Dr. Michael Morgan from the University of Washington.

Based on the federal Clean Air Act Amendments of 1990, the State of Washington, in accordance with Section 107, has designated the central Puget Sound region, which includes Snohomish, King and Pierce counties, as non-attainment for ozone emissions (See Section 4.2.2.2 for a discussion of these pollutants). The urbanized portions of these counties have been designated non-attainment areas for carbon monoxide. Additionally, portions of Seattle, the Tacoma tide flats and the City of Kent are in non-attainment for particulate matter (PM10). Non-attainment refers to not meeting applicable state/federal air quality standards. The EPA classifies the ozone concentrations as "marginal"; the carbon monoxide as "moderate"; and the PM10 (PM10 refers to small airborne particulate matter less than 10 microns in diameter) as "moderate". A discussion of these pollutants is presented in Section 4.2.2.2.

As a result, a State Implementation Plan (SIP) required under the Federal Clean Air Act, is being updated by the Washington State Department of Ecology (Ecology) to bring the region into compliance with state and federal standards. A revised 1992 SIP is being prepared by updating the transportation components. The revised 1992 SIP will be approved by the Governor and forwarded to the U.S. Environmental Protection Agency in November 1992. The planning process for a major SIP amendment for 1993 will begin at this time. This amendment will include transportation control measures that not only reduce air pollution but are also consistent with comprehensive plans and VISION 2020. This amendment, including technical and policy process and approval, will be completed by November 1993 (Attachment A). The amended SIP will detail how to meet the attainment goals for carbon monoxide, ozone and particulate matter. Future project-level analysis will model impacts at sites, to compare air quality to state and federal standards. The SIP would address any resulting issues. This non-project FEIS looks at the share that emissions are to total regional emissions.

Under the new Washington State Clean Air Act, transportation plans, programs and projects will have to meet the test of "conformity," meaning they will have to conform with SIP standards within a specific time period. This applies most directly to project-level proposals and not this regional analysis (Section 1.1.3). Conformity could affect transportation projects within a non-attainment area (due to potential impacts on air quality in an area that is not meeting current standards) and will be subject to close scrutiny. Ecology has not yet developed the criteria to make conformity determinations.

4.2.2 Affected Environment

4.2.2.1 Existing Air Quality

Three agencies have air quality jurisdiction in the Puget Sound region: the United States Environmental Protection Agency (EPA), Washington State Department of Ecology and the Puget Sound Air Pollution Control Authority (PSAPCA). Each agency has established its own standards. Unless the state or local agency has adopted a more stringent standard, the EPA standards apply.

Ecology and PSAPCA maintain a network of monitoring stations throughout the Puget Sound area. In general, these stations are located where agencies believe there might be an air quality problem. Other stations are located in more remote areas to measure regional or background air pollution levels. These stations measure particles, carbon monoxide, sulfur dioxide, arsenic, lead, and ozone. Of these substances, carbon monoxide is predominantly generated by transportation sources.

Of the 6 criteria pollutants discussed below, the Puget Sound region is in attainment with three of them: sulfur oxides, nitrogen oxides and hydrocarbons. A downward trend in the ambient concentration of air pollutants generated by motor vehicles, especially carbon monoxide, has been observed in the Puget Sound area over the past decade. The replacement of older vehicles with newer, cleaner ones, and the increase in the number of vehicles meeting the requirements of the Inspection and Maintenance (I/M) program, been the major factors for reducing the carbon monoxide emissions. Carbon monoxide emissions have been reduced by 13 percent in Seattle due to the I/M program; however, increasing traffic levels may begin to erode these gains after the year 2000. (Environment 2010, State of Washington, Oct. 1989.)

The Puget Sound Air Pollution Control Agency uses the National Pollutant Standards index to report daily air quality (1990 Air Quality Data Summary, PSAPCA, September 1991). The values provide a way to summarize the air quality for the entire year. The index ranges from good, moderate, unhealthful to very unhealthful. Any pollutant measurement exceeding the short-term national primary standard causes the index value to be in the unhealthful or worse category. The 1990 results were:

Everett:	166 good, 197 moderate and 2 unhealthful days
Seattle:	239 good, 126 moderate and zero unhealthful days
Tacoma:	289 good, 75 moderate and 1 unhealthful days

The Puget Sound region is designated a "non attainment" area for carbon monoxide, ozone, and particulate matter. In 1990, the CO non-attainment areas were in Seattle (downtown and University District), Bellevue (downtown), and Tacoma (downtown). In 1987, the Puget Sound region attained the ozone standard, but monitored data during the summer of 1990 indicated the region may have been out of compliance with the standard.

In 1988 there were exceedances of the PM10 standard at four of twelve monitoring stations that measure PM10. Three of the stations were located in Tacoma and had a total of six days of exceedances. The other station was the Seattle, Duwamish location that exceeded the standard two days. In 1991 here were no exceedances of the PM10 standard at any of the monitoring stations.

In 1988 eight stations measured carbon monoxide levels greater than the eight-hour standard. Four of those stations were located in Seattle and the others were located in Everett, Bellevue, Tacoma, and Bremerton. Everett exceeded that standard eight days while the other stations had three or fewer less days of exceedances. In 1991, only two stations, Tacoma and Everett, experienced exceedances of the eight-hour carbon monoxide standard for one day each. In 1991 there were no exceedances of the ozone, sulfur oxide and nitrogen oxide standards at any of the monitoring stations.

Current aircraft operations at Sea-Tac Airport are a major source of air pollutant emissions in the local area. Based on a Department of Ecology emissions inventory (May 1991), Sea-Tac Airport contributes approximately 8 percent of the carbon monoxide and 5 percent of the nitrogen oxide emissions in King County. This includes vehicular operations in the local area, and aircraft operations below 3,000 feet, as well as other on-site airport emissions.

Some communities have expressed concern about fuel dumping and fuel misting from aircraft in flight. Due to the relatively high cost of jet fuel, dumping is a rare procedure which is only used in emergency situations. Typically, it is only necessary soon after take-off when a plane has to return to make an emergency landing. In order to land safely, a pilot may choose to dump fuel to lighten the aircraft. The dumping usually occurs at higher altitudes away from populated areas and because of the speed and area over which the fuel is released, it is well-dispersed. The jet fuel "mist" that residents refer to may be the particulates from the exhaust and small quantities of unburned fuel from jet engines. These emissions occur during take-off and landing and are most notable near the ends of the runways. These emissions are quantified and further described (along with their impacts to health) in the following sections and in Appendix D. It should be noted that these types of emissions are not unique to jet operations and are common along major roadways or freeways. The most significant source of these emissions in an urban area are motor vehicles, especially diesel trucks.

4.2.2.2 Criteria Pollutants and Health Effects

The nature of pollutants emitted from airports is the same as those emitted from other transportation sources. Carbon monoxide, sulfur and nitrogen oxides (SOx and NOx), and unburned hydrocarbons are common pollutants emitted from the combustion processes. Six criteria pollutants regulated by federal standards are ozone, carbon monoxide, particulate and nitrogen dioxide, sulfur dioxide and hydrocarbons. These pollutants are described below.

Ozone (03) is a colorless gas resulting from the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. Although ozone is the air contaminant for which standards are set, its precursors, hydrocarbons and nitrogen oxides, are the pollutants which must be controlled. Ozone results in eye irritation, damage to lung tissues, and reduced resistance to colds and pneumonia. It also aggravates heart disease, asthma, bronchitis and emphysema.

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Carbon monoxide (CO) is a colorless, odorless toxic gas produced by incomplete combustion of carbon-containing substances. The highest ambient concentrations of CO occur near congested roadways and intersections during periods of low temperatures, light winds, and stable atmospheric conditions. CO, which has been shown to interfere with oxygen transport in the blood, produces cardiovascular disease, and decreases visual perception. CO has also been associated with lower birth weight and increased death of infants in highly polluted areas. Note that CO emissions are a very localized dispersion pattern. For CO, violations at the monitoring locations cannot be interpreted as a health exposure threat to the general population at locations other then the monitoring site.

Particulate matter is classified as Total Suspended Particles (TSP) and the inhalable subgroup of TSP, which is comprised of particles 10 microns or less in diameter (PM10). Suspended particles aggravate chronic heart and lung disease and often transport toxic elements such as lead, arsenic, nickel, vinyl chloride, asbestos and benzene compounds which then enter the respiratory, digestive , and lymphatic systems.

Hydrocarbons result from the release of unburned fuel or incomplete combustion of fuel. Hydrocarbons can be gases or particulate . Volatile organic compounds (VOC) are gaseous hydrocarbons which can react with oxidizing pollutants in the atmosphere to produce photochemical smog. VOC are also precursors of ozone. Hydrocarbon particulates of concern to human health are those with diameters ranging form 0.1 to 3 microns. Particulates of this size can enter the small passageways in the lungs and deposit there.

Sulfur Dioxide (SO2) is a nonflammable, non-explosive, colorless gas. It reacts in the atmosphere to form sulfur trioxides (SO3) and sulfuric acid. SO2 and sulfuric acid have been shown to produce asthma which decreases human respiratory functions both at the acute and chronic levels. These air pollutants are commonly grouped as sulfur oxides (SOx).

Nitrogen oxides (NOx), which include nitrogen oxide (NO) and nitrogen dioxide (NO2), result from the high temperature oxidation of nitrogen in the presence of air. In the presence of moisture, NO can form particulate by coalescing, thereby reducing visibility and contributing to acid deposition. NO2, like sulfur dioxide, is also a bronchoconstrictor that can cause irritation and injury to the lungs. The primary concern with nitrogen oxides is that they are a component in the generation of secondary pollutants such as ozone.

4.2.2.3 Health Effects from Air Pollutant Exposure

The PSATC retained the services of Dr. Michael S. Morgan from the University of Washington to review potential health effects from air quality emissions around airports. The following paragraphs summarize the findings from his review.

Concerning exposure to air pollutants emitted by airport operations, the attribution of health effects by members of the public and by local health care specialists is based entirely on anecdotal reports of cases or clusters of cases. Evidence to support this relationship, though indirect and very speculative, should not be dismissed. The emissions from jet aircraft engines and from fuel handling operations on the ground include compounds with known toxic effects. These effects are all dependent on the exposed person receiving a sufficient dose of the agent. Small doses produce no measurable response, while increasingly larger doses produce responses of increasing severity.

Known responses to sufficient doses of components of aircraft and fuel handling emissions are respiratory irritation, reduced resistance to infectious organisms, aggravation of chronic heart and lung disease and, less frequently, cancer at various parts of the body. It is important to note here that the chemicals involved in the health outcomes mentioned are also emitted by many other sources, including motor vehicles, dry cleaning establishments, paint factories, automobile repair shops and numerous other industries. The consequence is that the contribution of airport operations to public exposure must be distinguished from that of the other source categories. However, techniques for doing this are only now being developed.

In order to evaluate the health consequences of air pollutant emissions from an airport, a systematic program of data collection would need to be carried out. This is especially important in the assessment of cancer cases, including those described in residents and former residents of the area near the airport. These cancers all have many possible causes including diet, heredity, cigarette smoking, and alcohol consumption, as well as hydrocarbon exposure from the atmosphere. The incidence of cancer would have to be measured in the exposed population, and compared to the same incidence measured in another group of people similar in every way except for exposure to air pollutants form the airport. However, given the inexact methods now available to do this, it is not likely that small clusters of cancer will be attributed to airport operations. For other health consequences such as respiratory irritation and illness, such systematic surveys should reveal any contribution from airport emissions, provided that a corresponding careful program of exposure measurement is included.

To summarize, effects on health and welfare due to air pollutant emissions are much less likely than are effects due to noise. This is primarily due to the relatively small contribution of airport operations to the total air pollutant emissions in the area, and to the fact that the health effects associated with air pollutants are also caused by many other important factors. While a systematic evaluation of air quality effects on public health would be of value, it appears that much more effort should be expended in characterizing noise exposure and mitigating its effects in preference to dealing with the air pollutant emissions.

Worldwide there have been few reports published dealing with the impact of airport-generated air pollutants on health and welfare. This may be due in part to the difficulty in distinguishing airport emissions from those of other sources in the same region (Naugle, 1981). However, techniques for estimating the impact of airport operations on air quality have been described, and their accuracy in comparison to ambient air monitoring is improving. Several reports have described refined techniques for developing an inventory of emissions from aircraft and ground operations at airports (Wayson, 1988; Bowlby, 1990; Clark, 1985; Clark 1983). One early report suggested that a "signature" exists for aviation fuel, making it possible to measure the contribution to airborne levels of hydrocarbons (Tsani-Bazaca, 1982).

To help control on-site emissions, Sea-Tac Airport has installed vapor recovery systems on the storage tanks and on the fueling pumps in the rental car area. In addition, an aircraft fuel hydrant system is planned for the mid 1990s. These measures represent significant improvements over prior fuel storage and handing procedures. An inventory of on-site emission sources and the application of specific emission control strategies should be part of any subsequent project-level analysis.

The health effects of the criteria air pollutants, carbon monoxide, ozone, sulfur dioxide, oxides of nitrogen and lead, are well documented in publications of the U.S. Environmental Protection Agency. They include exacerbation of existing cardiovascular and respiratory disease, reduced resistance to lower respiratory infection, reduced ability to do exercise, and slower growth of the respiratory systems of young children. None of these effects is specifically related only to air pollutants, and moreover there is no method available to determine the portion of these health effects attributable to airport emissions. A recent report from Sweden (Olin, 1987), however, may be relevant to one of the concerns raised about air pollution exposure in the area surrounding Sea-Tac airport. In that report, persons with brain cancer reported working at an airport at some time in their adult lives with greater frequency than persons matched for characteristics other than cancer. This must be viewed only as preliminary evidence suggesting a relationship between brain cancer and living near an airport, particularly since other exposures were also reported more frequently by the persons with cancer, including living near a petroleum refinery. All such case-control investigations suffer from weaknesses which make firm conclusions impossible without additional studies in different locations. Nonetheless, this outcome makes the claim that cancer is occurring in residents near the airport at higher than expected frequencies one which cannot be dismissed without systematic investigation.

4.2.3 Significant Impacts

The quantity of pollutants emitted into the atmosphere from aircraft operations is a function of the type of aircraft and engine, mode of operation, and how long the engine is operated in each mode. The analysis and the applicable federal air quality regulations and data apply to aircraft emissions below 3,000 feet (information on emission on a global level are presented in Appendix D).

Aircraft engines emit CO, hydrocarbons, NOx, SOx, and particulates as by-products of the combustion process. CO and hydrocarbons are produced at a higher rate during low engine power settings, such as idling or startup, because of incomplete combustion, while the amount of NOx produced during startup or idle is small compared to that produced during takeoff. SO2 is a result of the oxidation of sulfur compounds in the aircraft fuel, which has very low sulfur content. Particulate matters emitted from the aircraft engines, particularly turbine engines, are extremely small in diameter ranging between 0.04 and 0.12 microns. (The methodology for estimating the aircraft emissions is presented in Appendix D.)

The results of the emission inventory for 2020 vehicle and aircraft operations are presented in Table 4-6 (for the system alternatives). Table 4-7 presents aircraft emissions by site option. The results indicate that the aircraft emissions are similar for all alternatives. This would be expected in that the alternatives are based on the same levels of aircraft activity. The exception is that the emissions are less for those alternatives that do not meet system capacity demand for 2020 (noted in Table 4-6). Emissions levels for these alternatives are less because the number of operations is less.

Of all the alternatives which meet the system capacity demand, the difference between the alternatives is the amount of aircraft delays that may occur under each scenario. Idling time for aircraft increases as delays increase; this can significantly affect the daily tonnage of aircraft emissions. This increase in emissions as a result of increases in delays is most prominent in terms of CO emissions.

Table 4-6

Emissions Comparison for Each System Alternative 2020

(Tons/Day)

Alternatives	*Traffic Emissions*			*Aircraft Emissions*			*Total Emissions*		
	CO (Tn/dy)	NOX (Tn/dy)	HC (Tn/dy)	CO (Tn/dy)	NOX (Tn/dy)	HC (Tn/dy)	CO (Tn/dy)	NOX (Tn/dy)	HC (Tn/dy)
NO ACTION **									
Existing Sea-Tac No Action (Unconstrained Sea-Tac Only)	16	2.9	1.9	20	5.8	5.9	36	8.7	7.8
EXISTING SEA-TAC AIRPORT SYSTEM									
Existing Sea-Tac w/System Management (Constrained)**	16	2.9	1.9	9	3.7	2.8	25	6.5	4.6
Sea-Tac w/New AC Rwy (Unconstrained Sea-Tac Only) **	17	3.1	2.0	9	5.0	2.5	26	8.1	4.5
Sea-Tac In Conjunction With A Remote Airport	See Text								
TWO AIRPORT SYSTEMS									
Existing Sea-Tac + Supp(1 Rwy)**	15-26	2.7-4.8	1.8-3.1	10-11	4.6-4.6	3-3.2	25-37	7.3-9.4	4.8-6.3
Existing Sea-Tac + Supp(2 Rwy)	15-28	2.7-5.2	1.8-3.4	10-11	4.6-4.6	3-3	25-39	7.3-9.8	4.8-6.4
Sea-Tac with new AC Rwy + Supp(1 Rwy)	17-20	3.1-3.7	2-2.4	10-11	4.8-4.8	3-3.1	27-31	7.8-8.5	5-5.6
Sea-Tac with new AC Rwy + Supp(2 Rwy)	17 - 21	3.1 - 3.8	2 - 2.5	10-11	4.8-4.8	3-3.1	27 - 32	7.8 - 8.6	5 - 5.6
THREE AIRPORT SYSTEMS									
Existing Sea-Tac + 2 Supp(1 Rwy)	14 - 21	2.5 - 3.8	1.6 - 2.5	10-11	4.6-4.7	3-3.1	24 - 32	7.2 - 8.5	4.7 - 5.6
Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	16-18	2.8-3.4	1.9-2.2	8-10	4.5-4.8	2.2-3	23-29	7.3-8.1	4.1-5.2
REPLACEMENT AIRPORT SYSTEM									
Replacement	51	9.4	6.1	7	4.7	2.1	59	14.1	8.3

** Denotes systems that include alternatives which do no meet system capacity demands.

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Table 4-7

Aircraft Emissions (Year 2020)
(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
1	** Sea-Tac Only with Existing Runways (Constrained)	9.4	3.7	0.4	0.1	2.8
3	** Alternate 1 + Arlington 1 R/W	11.3	4.6	0.4	0.1	3.2
4	Alternate 1 + Paine 1 R/W	10.4	4.6	0.4	0.1	3.0
5	Alternate 1 + McChord 1 R/W	10.4	4.6	0.4	0.1	3.0
6	** Alternate 1 + Central Pierce 1 R/W	11.3	4.6	0.4	0.1	3.2
7	** Alternate 1 + Olympia/Black Lake 1 R/W	11.3	4.6	0.4	0.1	3.2
8	Alternate 1 + Arlington 2 R/W	10.5	4.6	0.4	0.1	3.0
9	Alternate 1 + Paine 2 R/W	10.4	4.6	0.4	0.1	3.0
10	Alternate 1 + McChord 2 R/W	10.4	4.6	0.4	0.1	3.0
11	Alternate 1 + Central Pierce 2 R/W	10.5	4.6	0.4	0.1	3.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	10.5	4.6	0.4	0.1	3.0
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	10.7	4.8	0.4	0.1	3.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	10.4	4.8	0.4	0.1	3.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	10.6	4.8	0.4	0.1	3.1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	10.5	4.8	0.4	0.1	3.1
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	10.7	4.8	0.4	0.1	3.1
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	10.6	4.8	0.4	0.1	3.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	10.4	4.8	0.4	0.1	3.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	10.4	4.8	0.4	0.1	3.0
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	10.5	4.8	0.4	0.1	3.1
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	10.6	4.8	0.4	0.1	3.1
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	10.6	4.6	0.4	0.1	3.1
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	10.5	4.6	0.4	0.1	3.0
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	10.6	4.7	0.4	0.1	3.1
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	10.5	4.6	0.4	0.1	3.0
27	Alternate 13+ Central Pierce 1 R/W	8.4	4.6	0.4	0.1	2.4
28	† Alternate 14+Central Pierce 1 R/W	7.6	4.5	0.4	0.1	2.2
29	Alternate 13+Olympia/Black Lake 1 R/W	10.3	4.8	0.4	0.1	3.0
30	Alternate 14+Olympia/Black Lake 1 R/W	9.1	4.7	0.4	0.1	2.6
31	Central Pierce 3 R/W	7.4	4.7	0.4	0.1	2.1
32	Fort Lewis/ Central Pierce 3 R/W	7.4	4.7	0.4	0.1	2.1
33	** Alternate 1 + Demand Management	9.4	3.7	0.4	0.1	2.8
34	** No Action (Unconstrained Sea-Tac Only)	20.2	5.8	0.7	0.2	5.9
35	** Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	8.8	5.0	0.4	0.1	2.5

** Denotes alternatives which do no meet system capacity demands.
† Alternative Recommended by PSATC on June 17, 1992

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Note that the analysis assumes that delay emission reduction measures are included as part of all of the system alternatives. These measures reduced the potential emissions by more than one half. It would not be reasonable to assume that for the very high delays that are forecast for many of the alternatives, every minute of delay would result in a minute of aircraft engine idling emissions. Economic factors and the air quality districts would require special measures to minimize the amount of time that aircraft are idling. Types of measures that can be used to reduce delay emissions include gate holds and using tractors to take aircraft to holding areas. Therefore, a significant level of delay emission reduction measures is already included in this analysis.

The primary time period for analysis was 2020, which is representative of the long-term trends in pollutant emissions. An analysis of the years 2000 and 2010 was also completed to present the emissions during the interim time periods. The analysis of the interim years was completed for Sea-Tac and the north airports sites only, in that an airport site to the south is not anticipated until after 2010. The results of the interim year analysis is presented in Table 4-8. If a southern airport site was developed first, the results would be similar to those presented for the northern airports.

An analysis of the emissions that may occur during the peak hour was also completed. For Sea-Tac, the current peak hour of aircraft operations occurs between 9 am and 11 am. This is anticipated to not change in the future. Peak hour auto traffic emissions usually occur between 7 am to 9 am or 4 pm to 6 pm during the periods of heaviest traffic. It is important to note that the peak hour emissions for aircraft and auto traffic do not occur at the same time. This means that the pollutants are emitted more evenly over the period of a day. The results of this analysis are presented in Appendix D.

An inventory of vehicular emissions relating to the airport was also completed. Vehicle emissions are based on vehicle miles traveled and are a function of airport location and passenger volume. Emissions by vehicles are a major component of the emissions associated with airports. Estimates of the emissions relating to estimated vehicular traffic to and from each of the airport development alternatives were projected. The vehicle miles traveled per day were based on the Flight Plan O/D (Origin/Destination) passenger forecast and the average trip lengths for passengers traveling to each of the airports. The average trip length was determined from the PSRC travel area zones and is presented in the traffic analysis (Section 4.3.2 and 4.3.3). The methodology for estimating the vehicular emissions is presented in Appendix D. Note that emissions associated with employee trips are not included in this estimate, but are discussed in the Traffic Analysis report.

The results of the emission inventory for 2020 vehicular travel are presented in Table 4-6 (for the system alternatives) and Table 4-9A (for each airport development alternative). Table 4-9B supplements the data in Table 4-9A and updates the vehicular emissions for ten sample alternatives based on updated passenger-mile figures prepared by the Puget Sound Regional Council as part of this FEIS (See Section 4.3). Note that the emissions would be less for those alternatives that did not meet system capacity demand for 2020 because the number of passengers served are less. Note also that given the complexity of the vehicular travel demand, this data should not be used to draw precise comparisons between alternatives but only for rough comparison of general trends.

An analysis of the years of 2000 and 2010 was also completed to present the emissions during the interim time periods. The results of the interim year analysis is presented in Table 4-8. An analysis of the emissions that may occur during the peak hour was also

Table 4-8

Total Aircraft and Vehicular Emissions for Interim Years (2000 & 2010)

Airport Alternative	CO (Tn/dy)	NOx (Tn/dy)	SOx (Tn/dy)	Part (Tn/dy)	HC (Tn/dy)
YEAR 2000					
Aircraft Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	4.4	2.8	0.2	0.1	1.5
Sea-Tac w/Dependent R/W + Paine 1 R/W	4.4	2.8	0.2	0.1	1.5
No Action (Unconstrained Sea-Tac only)	6.3	3.3	0.3	0.1	2.1
Sea-Tac w/Dependent R/W (Unconstrained Only)	5.0	3.2	0.3	0.1	1.7
Vehicular Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	11.0	1.7	0.3	0.2	1.2
Sea-Tac w/Dependent R/W + Paine 1 R/W	10.3	1.6	0.3	0.2	1.1
No Action (Unconstrained Sea-Tac only)	14.2	2.2	0.4	0.3	1.5
Sea-Tac w/Dependent R/W (Unconstrained Only)	14.2	2.2	0.4	0.3	1.5
Total Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	15.4	4.5	0.5	0.3	2.6
Sea-Tac w/Dependent R/W + Paine 1 R/W	14.6	4.4	0.5	0.3	2.5
No Action (Unconstrained Sea-Tac only)	20.4	5.4	0.7	0.4	3.6
Sea-Tac w/Dependent R/W (Unconstrained Only)	19.2	5.4	0.7	0.4	3.2
YEAR 2010					
Aircraft Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	5.6	3.5	0.3	0.1	1.3
Sea-Tac w/Dependent R/W + Paine 1 R/W	5.6	3.5	0.3	0.1	1.3
No Action (Unconstrained Sea-Tac only)	9.4	4.2	0.4	0.1	2.7
Sea-Tac w/Dependent R/W (Unconstrained Only)	6.3	4.0	0.3	0.1	1.8
Vehicular Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	12.4	2.2	0.4	0.3	1.5
Sea-Tac w/Dependent R/W + Paine 1 R/W	11.1	2.0	0.4	0.3	1.3
No Action (Unconstrained Sea-Tac only)	15.5	2.8	0.6	0.4	1.8
Sea-Tac w/Dependent R/W (Unconstrained Only)	15.5	2.8	0.6	0.4	1.8
Total Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	17.9	5.7	0.7	0.4	2.7
Sea-Tac w/Dependent R/W + Paine 1 R/W	16.6	5.5	0.7	0.4	2.6
No Action (Unconstrained Sea-Tac only)	24.8	6.9	0.9	0.5	4.6
Sea-Tac w/Dependent R/W (Unconstrained Only)	21.8	6.7	0.9	0.5	3.7

Note, only the northern airport site options were evaluated for the year 2000 and 2010 since a southern airport is not anticipated to operate until after 2010.

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Table 4-9A
Vehicle Traffic Emissions (Year 2020)
(Tons/Day)

Alt #	Airport System Siting Options	CO (Tn/dy)	NOx (Tn/dy)	SOx (Tn/dy)	Part (Tn/dy)	HC (Tn/dy)
1	** Sea-Tac Only with Existing Runways (Constrained)	15.6	2.9	0.6	0.4	1.9
3	** Alternate 1 + Arlington 1 R/W	20.4	3.7	0.7	0.5	2.4
4	Alternate 1 + Paine 1 R/W	14.8	2.7	0.5	0.4	1.8
5	Alternate 1 + McChord 1 R/W	20.4	3.7	0.7	0.5	2.4
6	** Alternate 1 + Central Pierce 1 R/W	20.1	3.7	0.7	0.5	2.4
7	** Alternate 1 + Olympia/Black Lake 1 R/W	26.1	4.8	0.9	0.6	3.1
8	Alternate 1 + Arlington 2 R/W	21.2	3.9	0.8	0.5	2.5
9	Alternate 1 + Paine 2 R/W	14.8	2.7	0.5	0.4	1.8
10	Alternate 1 + McChord 2 R/W	20.4	3.7	0.7	0.5	2.4
11	Alternate 1 + Central Pierce 2 R/W	21.4	3.9	0.8	0.5	2.6
12	Alternate 1 + Olympia/Black Lake 2 R/W	28.2	5.2	1.0	0.7	3.4
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	17.7	3.2	0.6	0.4	2.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	16.7	3.1	0.6	0.4	2.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	18.4	3.4	0.7	0.4	2.2
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	18.4	3.4	0.7	0.4	2.2
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	20.3	3.7	0.7	0.5	2.4
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	17.7	3.2	0.6	0.4	2.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	16.7	3.1	0.6	0.4	2.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	18.3	3.4	0.7	0.4	2.2
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	18.4	3.4	0.7	0.4	2.2
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	20.3	3.7	0.7	0.5	2.4
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	16.2	3.0	0.6	0.4	1.9
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	13.7	2.5	0.5	0.3	1.6
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	19.2	3.5	0.7	0.5	2.3
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	16.3	3.0	0.6	0.4	2.0
27	Alternate 13+ Central Pierce 1 R/W	16.5	3.0	0.6	0.4	2.0
28	† Alternate 14+Central Pierce 1 R/W	15.5	2.8	0.6	0.4	1.9
29	Alternate 13+Olympia/Black Lake 1 R/W	18.4	3.4	0.7	0.4	2.2
30	Alternate 14+Olympia/Black Lake 1 R/W	17.1	3.1	0.6	0.4	2.0
31	Central Pierce 3 R/W	51.2	9.4	1.8	1.2	6.1
32	Fort Lewis/ Central Pierce 3 R/W	51.2	9.4	1.8	1.2	6.1
33	** Alternate 1 + Demand Management	15.6	2.9	0.6	0.4	1.9
34	** No Action (Unconstrained Sea-Tac Only)	19.6	3.6	0.7	0.5	2.4
35	** Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	19.6	3.6	0.7	0.5	2.4

** Denotes alternatives which do no meet system capacity demands.
† Alternative Recommended by PSATC on June 17, 1992

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Table 4-9B (Supplement)

Vehicle Traffic Emissions (Year 2020)

(Based upon Updated Traffic Forecasts from PSRC for Selected Alternatives)

(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
8	Sea-Tac w/o RW + Arlington 2 R/W	22.0	4.0	0.8	0.5	2.6
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	19.2	3.5	0.7	0.5	2.3
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	20.5	3.8	0.7	0.5	2.5
23	Sea-Tac w/o RW + Arlington 1 R/W + Cen. Pierce 1 R/W	17.5	3.2	0.6	0.4	2.1
24	Sea-Tac w/o RW + Paine 1 R/W + Cen. Pierce 1 R/W	15.3	2.8	0.5	0.4	1.8
25	Sea-Tac w/o RW + Arlington 1 R/W + Olym./Blk. Lake 1 R	20.7	3.8	0.7	0.5	2.5
28	† Sea-Tac W/Dep. RW + Paine 1 RW + Central Pierce 1 R/W	17.7	3.2	0.6	0.4	2.1
32	Fort Lewis/ Central Pierce 3 R/W	51.6	9.4	1.9	1.2	6.2
34	No Action (Unconstrained Sea-Tac Only)	15.6	2.9	0.6	0.4	1.9
35	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	17.0	3.1	0.6	0.4	2.0

† Alternative Recommended by PSATC on June 17, 1992

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completed. Note that this is a different time period then the peak of aircraft operations. The results of this analysis are presented in Appendix D.

The vehicle travel analyses are based on average travel speeds, and that local congestion may have additional effects then is presented in this non-project FEIS. Ground congestion is a site specific variable that may alter the emissions. In general, multiple airport sites tend to disperse travel and can reduce ground congestion.

The Department of Ecology is currently preparing an emission inventory for the Puget Sound area as part of the State Implementation Plan. This is currently not complete but should be available in Fall 1992. These emissions can be compared to the total regional emissions for the Puget Sound area that was prepared by PSRC as part of the VISION 2020 study that was completed in 1990/91. The VISION 2020 study forecasts the total mobile (Vehicle) CO, NOx and HC emissions for year 2020. These forecasts in vehicle emissions were compared with the vehicle emissions for each of the system alternatives. The results in percentage of tons per day are presented in Table 4-10.

This table presents the range of emissions for each of the system alternatives under study. The results show that the emissions estimates for the airport related vehicular travel account for less than 6 percent of the regional total for CO, NOx, and HC emissions for system alternatives that include multiple airport uses. The replacement alternatives comprise a much higher percent of the regional vehicular emissions.

4.2.3.1 Sea-Tac Airport

The two factors that influence the relative level for emissions of the system alternatives are the amount of aircraft delays and the vehicular travel distances. Since the total number of operations and passengers are similar for all alternatives, those alternatives that result in the least amount of aircraft delays and the shortest travel distances will result in the lowest emissions.

System alternatives that rely on Sea-Tac have higher delay emissions because of the high aircraft delays that are forecast for that airport. System alternatives that include the development of the dependent runway at Sea-Tac have lower emissions because the additional runway significantly reduces the delays.

Vehicular emissions system alternatives that include Sea-Tac have less emissions than the replacement alternative because the airport is more centrally located than the replacement sites, and therefore the travel distances are less. The Two-Airport and Three-Airport System Alternatives have less emissions than Sea-Tac alone in that these alternatives locate supplemental airport sites throughout the region so that the net travel distances are less than with one central airport.

Sea-Tac With Broad System Management

Emissions for this system alternative are the lowest of all the system alternatives. This is the case for both vehicular and aircraft emissions. However, this alternative does not meet the region's future air travel needs. Measures for demand management including potential rail lines may result in other sources of emissions that are not accounted for in this analysis. However, emissions associated with mass transit rail systems have less emissions per passenger than aircraft.

Table 4-10
Comparison to Regional Mobile Emissions 2020
(Vision 2020)

Alternatives	*Alternatives % of Regional Mobile Emissions*		
	CO	NOX	HC
VISION 2020 REGIONAL VEHICULAR EMISSIONS Tons per day	1260	190	132
NO ACTION	1.3%	1.5%	1.4%
EXISTING SEA-TAC AIRPORT SYSTEM	1.3 -1.4 %	1.5 - 1.6%	1.4 - 1.5%
TWO-AIRPORT SYSTEMS	1.2 -2.2%	1.4 - 2.7%	1.4 - 2.6%
THREE-AIRPORT SYSTEMS	1.1 - 1.7%	1.3 - 2.0%	1.2 - 1.9%
REPLACEMENT AIRPORT SYSTEM	4.0%	4.9%	4.6%

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Sea-Tac With New Third Dependent Air Carrier Runway

This alternative has more vehicular emissions than multiple airport alternatives as a result of the greater overall travel distances. This alternative has less emissions than the no project alternative in that with the new air carrier runway, the delay emissions are less.

Sea-Tac With Remote Airport

The potential emissions for the remote airport alternative are dependent upon the potential sites and the types of aircraft operations that would utilize each site. Use of Boeing Field as a remote airport site is likely to have similar emissions levels as with the use of Sea-Tac with a New Air Carrier Runway. The airport is closely located to Sea-Tac so that the vehicular travel emissions will be the same, and the delay emissions will be reduced as a result of fewer operations at that airport. The emissions associated with the use of Moses Lake will be dependent upon the modes of travel that are available for access to that airport. If a mass transit system is not part of the Moses Lake alternative, then the emissions would be high. If a mass transit system were part of the site alternative, then the emissions would be comparable to the other multiple airport system alternatives.

4.2.3.2 Two-Airport System

Two-Airport System Alternatives have lower emission levels than single airports in that generally the total vehicle miles traveled are less since more airport sites are located near population centers. Regional aircraft emissions are also slightly lower in that the emissions caused by delay at Sea-Tac are reduced since more aircraft will be able to use the supplemental airport site. This has the effect of reducing the average delay per operation at Sea-Tac and more operations of aircraft at an airport site where delays are minimal.

4.2.3.3 Three-Airport System

The least amount of vehicular emission would be generated by the two-airport and three-airport systems. In general, these systems have the advantage of location. Since passengers are located closer to more airports, shorter average auto trip lengths are anticipated. Options such as Paine Field and McChord which are located closer to major population areas would result in fewer automotive emission impacts than options such as Arlington or Olympia/Black Lake which are located in outlying areas.

Vehicle emissions are tied to passenger allocations among the different airports. More passengers will utilize the closer supplemental site options (e.g., Paine Field or Central Pierce) over the more distant options (e.g., Arlington or Olympia/Black Lake) based on their greater accessibility. Consequently, for several system alternatives, total vehicle emissions would actually be greater even though the travel distance for some individual airports is less when compared to other alternatives.

As a result of lower aircraft delays, aircraft emissions for the Three-Airport System Alternative are less for those alternatives that include the dependent runway at Sea-Tac. The lowest total emissions are for the Three-Airport System Alternatives that include the dependent runway at Sea-Tac.

4.2.3.4 Replacement Airport

Replacement-airport alternatives would generate the highest vehicle emissions because the average trip length to these airports is much longer when compared with the other airport alternatives. For example, the average trip length to Sea-Tac is 25 miles, while the average trip length to central Pierce is 45 miles.

Aircraft emissions for the Replacement Airport System Alternative are less as a result of the low aircraft delays that would be anticipated with a new airport. However, the total emissions are still the highest as a result of the higher vehicular emissions.

4.2.3.5 No Action

This refers to Sea-Tac only with the existing runway system. The No Action alternative has the second highest overall air pollutant emissions after the replacement airport system. This is a result of the very high aircraft emissions that would be associated with the long delays.

4.2.4 Mitigation Measures

The most significant reductions in regional and local air pollutant emissions are attainable through programs which reduce the vehicular travel associated with the project. Support and compliance with the VISION 2020 plan is the most important measure to achieve this goal. The plan includes the improvement of mass transit facilities, implementation of vehicular usage reduction programs, and transportation demand management programs. This plan is designed to reduce project trips by automobiles and thus reduce overall traffic congestion and total emissions. Measures that provide for mass transit access to the airport sites will have the most significant effect on reducing potential vehicular emissions associated with the airport system project.

Emissions associated with aircraft delays are also another major source of potential emissions. Note that the analysis assumes that delay emission reduction measures are included as part of all of the system alternatives. Economic factors and the air quality districts would require special measures to minimize the amount of time that aircraft are idling. Types of measures that are used to reduce delay emissions include gate holds, and using tractors to take aircraft to holding areas. New dependent air carrier runway at Sea-Tac could also be considered a mitigation measure to minimize emissions associated with delays.

4.2.5 Unavoidable Adverse Impacts

Development of any of the airport system alternatives will result in increased air pollutant emissions and a decrease in overall air quality in the Puget Sound region. This is true for the No-Action Alternative as well. However, all system alternatives, except for the replacement airport alternative result in less emissions than the no action alternative. The most significant site-level impacts will be considered in the site-specific EISs.

4.3 SURFACE TRANSPORTATION

4.3.1 Overview

Section 4.0 of this FEIS addresses the tradeoffs between ground accessibility, new aircraft noise, and related costs to the served community. Local cumulative ground mileage traveled and congestion are significant questions to be addressed. Local congestion will be addressed further in subsequent siting analyses and project EISs. The system alternatives could add about 2 to 5 percent of total regional vehicle-miles traveled and 10 to 50 percent to local traffic, depending upon the alternative and the related site options.

Within the regional planning context, possible mitigation actions for congestion should include assignment (through the Regional Council) of high priority for funding of access improvements to the selected alternative under the requirements of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). Significant improvements would be needed at all sites, especially at Sea-Tac, under all alternatives.

4.3.2 Affected Environment

Travel on the regional highway system continues to increase more rapidly than the population and the number of jobs. Not only has vehicle ownership increased per capita, but the number of trips per person has increased over time. Eighty percent of annual regional mileage is for trips other than the commute to work. In the region, the percent of households without vehicles has declined from over 18 percent to less than 8 percent since 1960. The average number of daily person trips increased from 2.6 in 1961 to 4.25 in 1987 (U.S. Census, and Household Travel Surveys, PSCOG, June 1990).

Useful measures of surface transportation performance are vehicle miles traveled, peak-hour average speed, and hours of delay. Between 1990 and 2020, daily vehicle miles traveled (VMT) on the regional highway system are estimated to increase dramatically (68 percent), from 62.3 million daily vehicle miles traveled to 104.9 million.

As a benchmark, the average peak-period speed in 1990 was 31 mph. And, hours of surface transportation delay in 1990 (based on the difference between posted and actual speeds) were estimated at 200,000 vehicle hours per year. In addition, while the transportation model results reflect the results of "non-recurring" events such as inclement weather or accidents, these averages do not report the unreliability of travel that results on given days. This is an important consideration to airline passengers trying to make connections at Sea-Tac.

The year 2020 figures on Table 4-11 show moderate changes in vehicle speed and delay. This is based on heavy utilization of roadways (Level of Service E), and therefore, reflects a spreading of traffic across alternative arterial routes, and a moderate shift to mass transit. As congestion worsens (under the Existing Plans scenario) the share of peak period traffic on mass transit begins to increase by the year 2020. The share to be carried by transit is expected to increase more dramatically under scenarios that include greater investments in high capacity transit (See Section 4.4.6.5). Projected trends in highway network congestion are shown in Table 4-12.

Table 4-11

TRANSPORTATION SYSTEM AND PERFORMANCE

Criteria	1990	2020 Existing Plans
Daily Vehicle-Miles Traveled (millions)	62.3	104.9
Average Peak Period Vehicle Speed (Mph)	31.0	28.0
Total Daily Vehicle Hours of Delay (millions)	0.29	0.35

Source: Puget Sound Regional Council, Existing Plans scenario (April 1992).

During the past ten years, transit ridership has climbed in absolute numbers; however, the overall regional trend between 1980 and 1990 has been toward the single-occupancy vehicle. The percentage of workers using public transit in King County has declined from 11.2 percent to 8.7 percent, and carpooling has dropped from 17.6 percent to 11.3 percent. The single-occupancy vehicle share has increased during this period from 62.6 percent to 71.4 percent of the total. This pattern varies across the region (Table 4-13). For Seattle residents, 28 percent use buses or carpools to commute to work. In Bellevue the number drops to 16 percent. In the rest of the region the figures are generally much lower. (U.S. Census)

Programs and projects contained within current local comprehensive plans and the more aggressive VISION 2020 will partially mitigate the worsening ground congestion in this region. High Capacity Transit will address some of the peak period travel needs, but by itself is not a solution to total regional congestion. Even assuming construction of a High Capacity Transit system, vehicle miles traveled are still projected to double by the year 2020.

4.3.2.1 Planned Improvements

General Framework

For purposes of system-level regional airport planning, the impact analyses in this FEIS are based in part on the Puget Sound Regional Council's baseline Existing Plans scenario. The Existing Plans scenario assumes the commercial air transportation services will be located at Seattle-Tacoma International Airport, and this is the assumption currently reflected in the adopted VISION 2020. However, VISION 2020 includes the statement that any amendments to the Regional Air Transportation Plan (RASP) will be amended into VISION 2020 which could change this assumption. This is presented in more detail in Section 4.4.6.

Table 4-12

PERCENT OF REGIONAL HIGHWAY NETWORK MILEAGE WITH SEVERE CONGESTION
(Level of Service D or worse)

System	Freeway	Arterial	Regional
1990	32.4	5.2	7.5
2020			
(No Action)	75.1	25.7	30.2
(Existing Plans)	46.0	17.1	20.6
(VISION 2020)	45.2	16.5	20.3

(Source: VISION 2020 FEIS, Table 5.1.4-2)

Table 4-13

TRENDS IN TRAVEL MODES BY COUNTY
TRIPS TO WORK (1980-1990)
(Figures Express Percentages)

Mode	Year	King	Pierce	Snohomish
Alone	1980	62.6	67.2	69.3
	1990	71.4	75.9	77.0
Carpool	1980	17.6	18.8	20.9
	1990	11.3	13.2	12.4
Transit	1980	11.2	2.7	2.8
	1990	8.7	2.0	3.2
Average travel time to work (min.)	1980	23.0	21.4	23.5
	1990	24.2	24.0	25.4

(Source: 1990 U.S. Census)

The VISION 2020 FEIS of 1990 anticipated that 40 percent of new employment growth would locate in existing urban centers. It assumes that urbanization will be focused on an additional 400 square miles of land, rather than 1,000 square miles under a dispersed growth scenario (VISION 2020 FEIS, p. 73).

VISION 2020 assumes a threefold increase in transit ridership compared to 44 percent increase in population and a 51 percent increase in employment. More than half of future transportation funds would go to public transit. Recent federal legislation allows greater flexibility in allocation of federal funds than has ever been possible in the past [Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

For comparison purposes in this FEIS, surface traffic and air quality information reflects currently adopted local plans. The results of the GMA and High Capacity Transit (HCT) planning processes will refine VISION 2020. In general, planned improvements contained within existing plans and VISION 2020 include freeway and arterial widenings or additions, new arterials, and regional transit and ferry improvements, and transportation demand strategies. The Existing Plans scenario used in this FEIS includes the phased introduction of new surface facilities shown in Table 4-14.

Inclusion of 90 to 150 miles of High Capacity Transit would offer additional benefits to users, especially during the peak travel periods. As envisioned in VISION 2020, other possible improvements to be considered in the GMA process are: more HOV lanes, 200 miles of widened freeway lanes, 84 miles of new freeway, 53 interchange improvements, 500 lane-miles of widened arterials, and 40 miles of new arterials. With the exception of new HOV lanes, these projects are not fully reflected in the Existing Plans scenario summarized in Table 4-14. Plans for Thurston County and areas outside of the Central Puget Sound region are beyond the scope of this FEIS.

Congestion Management

ISTEA requires, for air quality purposes, a multimodal Congestion Management System (CMS). It requires clear prioritization of projects for federal funding and allows flexible shifting of federal funds to fit these priorities. This CMS requirement is to be addressed by the State, the Regional Council, and transit operators. Congestion management requires efficient use of the existing system and an analysis of all reasonable demand reduction and operational management strategies in studied transportation corridors. It also requires a commitment by the State and the Regional Council to the implementation of other appropriate management strategies (e.g., carpool/vanpool).

The degree to which existing standards can or should be maintained is the subject of current planning under the GMA. Table 4-14 displays one of a range of staff-level working scenarios used by regional and local agencies in land-use and transportation modeling. It shows cumulative future roadway lane miles. (For a discussion of this technical work leading to policy-level decisions under the GMA, see Section 4.4.6).

A Cost Scenario

VISION 2020 estimates that the cumulative cost to maintain the current level of service on the regional road system through the year 2020 would be roughly $4.5 billion (cumulative for 30 years). This includes $850 million for new regional arterial lanes, $1.4 billion for new freeway lanes, $280 million for operation and maintenance of new regional arterials, $500

Table 4-14

CUMULATIVE FUTURE ROADWAY LANE-MILES
USED IN MODELING EXERCISE
(Existing Plans Scenario, April 1992)

Facility	1990	2000	2010	2020
Freeway				
(Non-HOV)	711	880	974	1059
(HOV)	61	211	307	390
Expressway				
(Non-HOV)	418	434	479	488
(HOV)	2	12	40	49
Urban Arterials				
(Non-HOV)	1144	1159	1195	1216
(HOV)	0	0	11	25
One Way	41	42	42	42
Rural Arterials				
(Non-HOV)	4951	4997	5025	5100
(HOV)	0	11	21	89
TOTALS				
(Non-HOV)	9398	9597	7805	9992
(HOV)	63	234	379	553

Source: Puget Sound Regional Council, work in process on the Existing Plans scenario with local governments, pursuant to the Growth Management Act, June 1992.

million for operation and maintenance of new freeway facilities, and perhaps another $1.5 billion (estimated as a 50 percent increase over the preceding figures) for new lanes on local roads. New regional arterial lanes would total 1,550 lane-miles, and new freeway and expressway lanes would total 470 lane-miles. (VISION 2020, Table 5.1.9-3). ISTEA authorizes $413 million to Washington State in 1992 (one year). The Puget Sound region would receive about $307 million of this total.

4.3.2.2 New Ground Transportation Systems

High Capacity Transit

The goals of the Regional Transit Project are to reduce dependence on private vehicles, improve air quality, limit urban sprawl, reduce energy consumption, and protect and enhance the region's communities and neighborhoods. High Capacity Transit (HCT) is unlikely to reduce total auto use but could reduce the rate of increase in auto use.

The Regional Transportation Plan includes a comprehensive package of transit improvements: expanded and improved bus services, expanded priority facilities for buses and carpools (e.g., more high-occupancy vehicle lanes), and construction and operation of a regional High Capacity Transit system using separate right of way, either in the form of a transitway for buses or a rail system.

Analysis of the connection between High Capacity Transit (HCT) and airport system plan alternatives highlights these general points:

- Exclusive or expanded reliance on Sea-Tac International would benefit from HCT access by providing partial mitigation to worsening traffic bottlenecks in the region. HCT service would be reliable.

  The rail version of HCT would be capable of attaining speeds of 65 mph, but the average line-haul speed would be much slower because of scheduled stops. The average speed of the system would be 35-40 mph. The estimated travel time from Everett to Sea-Tac would be 68 minutes, and from Tacoma to Sea-Tac, 32 minutes (Phase II Report, pp. 79 and 81).

- The multiple airport system alternatives are not dependent upon rapid ground connections between the supplemental airports and the continued primary airport at Sea-Tac. The supplemental airports would provide origin-and-destination local service; they would not serve airline passengers making connections between airplanes landing at the supplemental airports and other airplanes operating through Sea-Tac.

- Air travelers are not generally inclined to use HCT; however HCT would serve employees destined for the large and growing activity center at Sea-Tac International Airport and the surrounding area. Remote airport terminals are integrated with mass transit in other parts of the country (see Section 4.3.4, Mitigation Measures).

High-Speed Ground Transportation

The High-Speed Ground Transportation Commission will report to the Legislature on October 15, 1992. The Commission is studying two corridors, one between Vancouver, B.C., and Portland, and the other from Seattle to Spokane by way of Moses Lake. These routes are essential components of two of the regional airport system plan alternatives. The Broad System Management alternative would combine demand management and new technologies with a high-speed ground transportation route running north and south. One "remote" airport alternative would combine use of Sea-Tac with a wayport located at Moses Lake and accessible by high-speed ground transportation. The HSGT elements, if built, should have station locations coordinated with the HCT system expected to be decided by 1993, and should be compatible with long-term airport siting decisions.

The HSGT consultants reported (Commission Minutes, August 1992) that a minimum break-even ridership is 5.5 million passenger trips per year. Eastern Washington may not have the population to support HSGT in 2020. The Vancouver, B.C., to Portland route would likely have enough population in 2020. Estimated costs for steel wheel technology are 5.5 to 7.3 billion dollars for an east-west route, and 9.0 to 12 billion for the north-south route. (The cost of Maglev technology is higher.) Variables that could alter these preliminary findings could include actions by the federal government (that is, increased passenger rail subsidies). Ridership projections remain marginal, suggesting some level of public subsidy may be necessary.

Note: Success of the TGV (train a grand vitesse: "very fast train") train in France is due in part to the more favorable comparison of costs between alternative modes of transportation. Air and auto travel costs offer less of a relative advantage over rail than is the case here.

The Flight Plan Project includes estimates on the possible HSGT costs and on potential passenger ridership from travelers who would otherwise use short-haul commuter planes. The HSGT considerations and schedule and those for airport implementation are included in Sections 3.8 and 4.4.6 of this FEIS.

The PSATC did not draw conclusions about the feasibility of a high-speed ground transportation system. If built, such a system was seen as an important element of the region's transportation system in the 21st century (Phase II Report, p. 140). Some factors relevant to airport planning included an additional 45 to 90 minutes of travel time to reach a remote airport site, intervals between departures, and the estimated added cost. Because of these factors, the longest flights would appear to be the most likely candidates to use a distant airport (a possible wayport).

Conventional Rail

As part of a separate set of recommendations, the Washington State Department of Transportation supports selective physical improvements to existing railroad track and signal systems, particularly from Portland to Seattle and Seattle to Vancouver, B.C. Train times between Seattle and Portland could be reduced by 40 minutes (15 percent), and between Seattle and Vancouver by over an hour (27 percent). Other improvements aimed at improving marketability and competitiveness with other modes of transportation are also identified. (Statewide Rail Passenger Program, Department of Transportation, January 1992).

4.3.2.3 Access to Airport Locations

User Patterns

A recent survey of passengers at Sea-Tac reveals that on that day 69 percent of total passengers were from King County, 8 percent from Pierce County, 8 percent from Snohomish County, and 3 percent each from Thurston County and Kitsap County. Of originating passengers (connecting passengers not included), 63 percent were from King County, and with 10 percent each from Pierce and Snohomish Counties. (Evans/McDonough Survey, 20 November 1991). Independent from Flight Plan, studies are underway for ground transportation projects that could make Sea-Tac's accessibility from the south (e.g., SR- 509 extension, a new link to Interstate 5) similar to accessibility from the north.

Types of Passengers

The air carrier passenger activity levels forecasted for 2000, 2010 and 2020 include three categories of travel. These are (a) short-haul trips of less than 700 miles (22 percent of locally generated boardings), (b) medium-haul trips from 700 to 1,100 miles (32 percent), and (c) long-haul trips above 1,100 miles (46 percent). In 2020, origin and destination passengers could total 30 million annual passengers (MAP). Including connecting passengers (assumed to remain one-third of the total), Flight Plan forecasts 45 MAP in 2020. Connecting passengers who nearly always remain on the airport site are not included in the passenger counts for the surface transportation section of this document.

Method for Calculating Access

Table 4-15 shows the number of passengers who will travel to and from the airport(s) under the different system alternatives, and their ground access mileage. It was developed by first calculating the share of local residents in the assumed airport catchment areas (see note below) who would use the airport on a typical day. Forecasted annual demand is translated to daily passenger figures drawn from each assumed airport service area. Then, this daily passenger level is then distributed throughout the region (to the 850 transportation analysis zones that are part of the Regional Council transportation model). The number of passengers in each zone, multiplied by the distance to the airport(s), gives a mileage subtotal. Daily passenger miles are then totalled for each regional alternative.

Note: The catchment model of traffic distribution is seriously questioned by some analysts. This model assumes that passengers choose airports based on some measure of accessibility (e.g., travel time) if airports offer the same service. In violation of the catchment model, some highly congested airports (Kennedy, La Guardia) continue to be selected over the equally accessible Newark Airport (Multi-Airport Systems in Metropolitan Regions, Richard de Neufville for the FAA, March 1986). The limited role of the supplemental airports in the Puget Sound region, and the linear geography through Seattle from the north, especially, could tend to support use of the catchment model in this region for most of the multiple airport options.

This approach assumes that ground travel distance is the principal factor for airport selection by airline passengers. This working assumption is appropriate at this level of analysis, for two reasons. First, the local airports in the multiple airport system alternatives may serve a specific market niche (local short-haul and medium-haul flights), rather than using airport accessibility to decide the market. Secondly, many of the supplemental airport options do not depend upon capturing all of these locally generated trips. That is, the supplemental airports could serve most local origin and destination traffic, and are generally assumed (in Flight Plan) to serve only three-fourths of the local short-haul demand and one-half of the local medium-haul demand in the year 2020. Remaining trips, including all long-haul trips, would be served at Sea-Tac International Airport (see Figure 4-2)

Limitations of the catchment model are more applicable to those multiple airport options that would attempt to limit the capacity at Sea-Tac. A persuasive incentive package appears to be an essential part of such a proposal. Incentives could involve airline schedules or ticket prices, or significant differentials in aircraft landing fees.

Those multiple airport system options that exclude a third runway at Sea-Tac would attempt to redirect passengers toward the supplemental airport sites. This assumes strong gate controls at the airports and other incentives for the airlines to artificially redistribute market forces. The additional regional ground mileage involved in limiting capacity at Sea-Tac is not reflected by the methodology used here and cannot be determined. That is, potential passengers may forego trips altogether if service or prices at the supplemental sites are not attractive. The larger issue is whether redistribution would occur, or whether congestion would simply increase at Sea-Tac.

Surface Passenger Travel To and From the Airports

Passenger travel to and from the airport site(s) is examined in terms of total daily surface person-miles (Table 4-15) and peak-period trips (Table 4-16). These calculations apply to only local passengers; the one-third of the total passengers who are connecting passengers are first removed from the demand forecasts presented in Section 2.0.

The mileage estimates in the following tables use selected site options to gain a general perspective on regional system-level alternatives. In the year 2020, total daily person-miles vary from 1.54 to 5.10 million. (The passenger capacity also is lower in the Sea-Tac Capacity Expansion alternative.) In addition, induced land uses and employment may add 25 percent to these figures depending upon sites. Peak-hour traffic involves a range of site-level congestion impacts. These impacts depend in large part on local facilities and circumstances and will be evaluated at the site level of analysis. The possible range at the regional level includes 3,900 to 6,600 autos per hour at Sea-Tac, depending upon the alternative selected, and 700 to 3,000 at the various supplemental sites. Employment at the sites and induced land uses could increase these peak-hour levels by an additional 10 to 50 percent, depending upon the alternative.

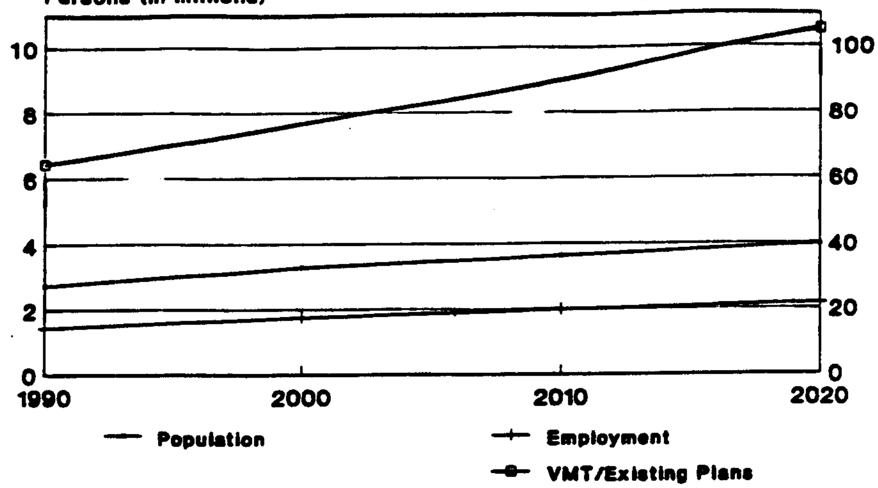
The figures in Table 4-15 are also based on the assumption that passengers depart for the airport from their homes rather than places of work (etc.). A regional survey conducted in late 1990 found that 92 percent of airline travelers leave for the airport from homes rather than from their places of work ("An Analysis of Public Opinion in the Puget Sound Region," Flight Plan, December 1990; and a separate survey done by Evans/McDonough and reported to the Port of Seattle on 20 November 1991 shows that 59 percent of all travelers begin from residences and 26 percent from hotels and motels).

An Important Qualification

Cross-hauling of passenger ground travel between catchment areas, contrary to the catchment travel model, is not accounted for in Table 4-15 and is beyond the information and modeling capabilities now available. (It would combine completed GMA decisions and available ground travel modeling, and unavailable information on future airline schedules and competing prices which might be offered at the different competing airport sites.) This issue is discussed in Section 4.3.2.3, but further information is deferred to the site-specific studies. Market studies by the airlines might be a direct path to this kind of information.

Figure 4-2

Population, Employment, and Ground Travel Forecasts



Sources: Step 91: Central Puget Sound Regional Economics Model and Regional Economics and Demographics Forecasts for 1990-2020: Technical Documentation, September 1991.

Puget Sound Regional Council Existing Plans Scenario (April 1992).

The mileage estimates in Table 4-15 are based in part on the Current Plans scenario (April 1992) in use by the Regional Council and the local governments as they continue to work under the GMA. While the distribution of airports is judged to be a much larger factor in the relative mileages than future land-use management refinements under the GMA, these figures are subject to revision as broader local comprehensive plans are developed under the GMA. (See Section 4.4.6)

4.3.3 Significant Impacts

Table 4-15 shows the daily passengers and passenger miles for each of the alternatives. Total future daily passengers are quite similar for each of the alternatives except for the No-action alternative. Daily passenger information was not available for the Replacement Airport alternative. Daily passenger ground miles are highest for the Replacement Airport because of its remote location. Passenger miles are lower initially for the Multiple Airport System alternative than the No-action but exceed it by the year 2020 since passenger demand at Sea-Tac is limited under the No-action alternative.

The impact on local surface transportation during periods of peak airport use is generally shown in Table 4-16. Site-specific EISs would more precisely identify these impacts.

In addition to passenger ground mileage, new jobs induced in the airport areas by increased airport activity could generate 20 percent more mileage on a daily basis as a result of commute trips over the total passenger traffic mileage shown in Table 4-15. During peak periods, the traffic generated due to new work commuters would increase mileage by up to 25 percent. Together, these passenger and employee loads could add between 10 and 50 percent to peak traffic volumes near airport sites in the year 2020.

The greatest increase in roadway use applies to Sea-Tac, where most of the travel is expected and where the incremental (i.e., compared to existing capacity) planned improvements in highway facilities (over those existing in 1990) are small. However, planning for improvements to SR-509 and for a south access route is currently underwar. "However planning for improvements to SR-509 and for a south access route is currently underway." The replacement airport alternative does not result in impacts at Sea-Tac since Sea-Tac would be removed. With regard to the replacement alternative, the PSATC noted that only 10 of the nation's 30 largest airports are located more than 12 miles from the primary central business district (Flight Plan Phase II Report, p. 80).

Table 4-16 shows estimated daily and peak-hour traffic to the airport areas. The most significant volumes are the peak-hour figures. Site-specific analysis can compare these estimates to the peak hour or peak period (a three-hour interval) traffic at the various site options. This would result in a picture of the added travel as compared to travel that would otherwise occur at the sites.

4.3.3.1 Sea-Tac Capacity Enhancement

Sea-Tac's central location makes it much more accessible than any other single airport location for the region's residents. This is true for trips made by automobile and by transit. Other airport locations are less accessible, because other than Paine Field near Everett, they are all less centrally located to the region's population and employment centers. (Supplemental airport service under the multiple airport system alternatives is scaled to serve only the smaller local population base.)

Table 4-15

ESTIMATED DAILY PASSENGERS AND THEIR GROUND MILEAGE TO AND FROM THE AIRPORT(S)

System Alternative	Daily Passengers(1) (thousands)			Daily Passenger Miles (millions)		
	2000	2010	2020	2000	2010	2020
Sea-Tac Capacity Expansion (2)	**45.1**	**60.5**	**76.0**	**1.13**	**1.51**	**1.68**
Multiple Airport System (one supplemental)						
(Sea-Tac w/o new RW (3)	39.9	46.2	44.9	.84	.97	.97
plus Arlington 2 RW)	4.8	13.8	34.3	.10	.23	1.20
Subtotal	44.7	60.0	79.2	.94	1.20	2.17
(Sea-Tac w new RW	41.5	55.7	70.8	.95	1.28	1.72
plus Arlington 2 RW)	3.2	4.2	8.5	.05	.06	.18
Subtotal	44.7	59.9	79.3	1.00	1.34	1.90
(Sea-Tac w new RW	39.7	53.4	70.6	.99	1.28	1.91
plus C. Pierce 2 RW)	5.0	6.6	8.7	.07	.09	.12
Subtotal	44.7	60.0	79.3	1.06	1.37	2.03
Multiple Airport System (two supplementals)						
(Sea-Tac w/o new RW (3)	36.2	45.9	44.6	.76	.96	1.00
plus Arlington 1 RW	3.2	5.5	15.6	.06	.11	.40
plus C. Pierce 1RW)	5.0	8.2	18.7	.05	.12	.33
Subtotal	44.4	59.6	78.9	.87	1.19	1.73
(Sea-Tac w/o new RW (3)	34.2	45.6	44.3	.68	.91	.98
plus Paine 1 RW	5.0	6.9	17.2	.06	.07	.22
plus C. Pierce 1 RW)	5.2	7.1	17.7	.07	.10	.31
Subtotal	44.4	59.6	79.2	.81	1.08	1.51
(Sea-Tac w/o new RW (3)	39.3	46.1	44.8	.79	.92	.97
plus Arlington 1 RW	3.2	7.7	18.6	.05	.15	.51
plus Thurston 1 RW)	2.1	6.1	15.9	.04	.10	.57
Subtotal	44.6	59.9	79.3	.88	1.17	2.05
(Sea-Tac w new RW (4)(5)	34.8	47.0	61.8	.76	1.03	1.45
plus Paine 1 RW	5.0	6.6	9.0	.07	.09	.15
plus C. Pierce 1 RW)	4.9	6.4	8.5	.09	.10	.15
Subtotal	44.7	60.0	79.3	.92	1.22	1.75
Replacement Airport (6)						**5.10**
No Action (7)	45.1	60.5	64.0	1.13	1.51	1.54

Source: Based on Puget Sound Regional Council model forecasts, Current Plans scenario, April 1992.

Notes:

(1) Figures exclude share of total passengers who are connecting passengers remaining on the airport property, approximately 30 percent of the forecast totals for 2000, 2010 and 2020.

(2) This is the Sea-Tac third runway option and is the worst case of the three Sea-Tac options. The other two options are system management and Sea-Tac operated in conjunction with a remote airport. In these latter two options, the total number of passengers at Sea-Tac would be less.

(3) The number of daily passengers at Sea-Tac in 2020 declines from the 2010 figure. This reflects the continued use of Sea-Tac by connecting passengers (one third of the total) and, therefore, a greater allocation of remaining passengers to new capacity at other locations.

(4) This is the PSATC recommendation, except that the PSATC would phase Central Pierce service to begin after 2010 (not in 2000).

(5) The total daily passenger miles (1.75 million) would be less than for the Multiple Airport System (one supplemental) option that does not have a new Sea-Tac third runway, although mileage to and from the Sea-Tac component (1.45 million) would be greater. (See also Section 4.3.3.3.)

(6) Data shown is for the Central Pierce site. Sites outside of the four-county region would involve greater mileage figures.

Under the replacement alternative, impacts at the new site and at Sea-Tac would depend upon timing of construction and service. It is assumed that a replacement airport could not be implemented until after 2010.

(7) The no-action alternative accommodates fewer passengers than the remaining alternatives.

(8) In addition to airline passenger ground traffic, the airport(s) also generate employee traffic at the airport and in the general vicinity. Based on the direct/indirect jobs calculated for the levels of airline activity for the alternatives (for 2000, 2010, and 2020), the figures shown are estimated to increase by 25 percent for Sea-Tac International Airport and by 10 to 15 percent for the supplemental airport sites. This assumes that employee trips on average would be one-half as long as passenger trips to the airport(s).

Table 4-16

DAILY TRAFFIC GENERATION NEAR THE AIRPORT SITES

Alternative	Passengers--thousands					
	2000 (daily/peak hour)		2010 (daily/peak hour)		2020 (daily/peak hour)	
Sea-Tac Expansion	45.1	3.9	60.5	5.3	76.0	6.6
Multiple Airport (one supplemental)						
Sea-Tac w/o new RW	39.9	3.5	46.2	4.1	44.9	3.9
plus Arlington 2 RW	4.8	0.4	13.8	1.2	34.3	3.0
Sea-Tac w new RW	41.5	3.6	55.7	4.9	70.8	6.2
plus Arlington 2 RW	3.2	0.3	4.2	0.4	8.5	0.7
Sea-Tac w new RW	39.7	3.5	53.4	4.7	70.6	6.2
plus C. Pierce 2 RW	5.0	0.4	6.6	0.6	8.7	0.8
Multiple Airport System (two supplementals)						
Sea-Tac w/o new RW	36.2	3.2	45.9	4.1	44.6	3.9
plus Arlington 1 RW	3.2	0.3	5.5	0.5	15.6	1.4
plus C. Pierce 1 RW	5.0	0.4	8.2	0.7	18.7	1.6
Sea-Tac w/o new RW	34.2	3.0	45.6	4.1	44.3	3.9
plus Paine 1 RW	5.0	0.4	7.1	0.6	17.2	1.5
plus C. Pierce 1 RW	5.2	0.4	6.9	0.6	17.7	1.5
Sea-Tac w/o new RW	39.3	3.5	46.1	4.1	44.8	3.9
plus Arlington 1 RW	3.2	0.3	7.7	0.7	18.6	1.6
plus Thurston 1 RW	2.1	0.2	6.1	0.5	15.9	1.4
Sea-Tac w new RW (1)	34.8	3.0	47.0	4.1	61.8	5.4
plus Paine 1 RW	5.0	0.4	6.6	0.6	9.0	0.8
plus C. Pierce 1 RW	4.9	0.4	6.4	0.6	8.5	0.8
Replacement Airport (2)					79.3	6.9
No Action	45.1	3.9	60.5	5.3	64.0	5.6

NOTES: (1) This is the PSATC final recommendation except that the PSATC recommends phasing of Central Pierce service after 2010 rather than in 2000.

(2) Under the replacement alternative, impacts at the new site and at Sea-Tac would depend upon timing of construction and service. It is assumed that a replacement airport could not be implemented until after 2010.

Local ground congestion will be severely worsened at Sea-Tac, given the tripling of passengers and only marginal planned improvements (compared to the large existing investments) on existing facilities. This traffic load could also affect more distant major facilities in the region, including growing bottlenecks on the Interstate system.

4.3.3.2 Two-Airport System

Access measured on a mileage basis is better if the supplemental airport is located near the population it will serve. Selection of a more distant rural-area supplemental airport reduces overall system access, but does not involve the same immediate local congestion issues as are involved in developed areas.

4.3.3.3 Three-Airport System

The multiple airport system involving two supplemental airports and a new dependent runway at Sea-Tac offers the best overall ground access for the region's residents. This is because a relatively small number of passengers who would otherwise travel the largest distances to Sea-Tac are given local service, while passengers nearer to Sea-Tac are afforded continued adequate service (the total level of service and airline scheduling) at this primary airport site.

The ground travel advantage increases as the local population and market demand grows, supplying all of the intended passenger level for the supplemental site(s).

4.3.3.4 Replacement Airport

All replacement airport sites are much less accessible to the region's residents than Sea-Tac Airport. Possible future access via High-Speed Ground Transportation technology is problematic. (See Sections 3.2.1)

4.3.3.5 No Action

See Section 4.3.3.1.

4.3.4 Surface Transportation Mitigation Measures

Mitigation of ground transportation will be provided under recent federal and state legislation. The realistic balance between individual travel freedom and resulting congestion in urban areas is a cultural issue which can only partially be addressed through incentives or statute. Potential regional and site-specific actions are:

- Through ISTEA coordinate ground access for the selected alternative with High-Speed Ground Transportation (possibly over the long term), High Capacity Transit and (with local governments) GMA land-use actions. In this region, this includes, for air quality purposes, a Congestion Management System to developed by the Regional Council, the State, and transit operators. (Regional Council)

- Continue to implement broad transportation-system-management and transportation demand-management programs within the region. (Employers and local governments)

- Work to expand and improve service presently provided by airport buses, transit buses, taxis, shuttles and limousines serving the region's airport(s) and aggressively examine the merits of remote passenger check-in terminals. (Port of Seattle, Airport Operators, private transportation companies)

  Notes:

  (1) Parking
  Seattle Tacoma International Airport currently provides half of the parking spaces that are often needed. Private parking operators are apparently reluctant to install costly structures because their investment would be vulnerable to possible capacity or pricing actions of the Port of Seattle. The Port of Seattle might work toward remote parking and terminal strategies, as an alternative to more parking spaces--either public or private--at the airport location.

  A large share of the Sea-Tac revenues are generated by airport parking charges.

  (2) Off-Airport Terminals
  Off-airport terminals are used in Atlanta, Connecticut and Los Angeles, and more recently have been supported in Boston, New York and Washington, D.C. These can provide access to high-occupancy vehicle service, especially during periods of growing peak travel congestion. Remote airport terminals can be an incremental step toward locating local air service in outlying areas, or a permanent element of the Sea-Tac capacity expansion alternatives.

- Assign high priority (in the Regional Transportation Plan and its funding elements) to funding airport-access facilities, and generally to local facilities impacted by siting of commercial airport services. (Regional Council, state Department of Transportation)

  Particularly important is the funding of High-Occupancy Vehicle Lanes. Existing plans and funding are presented in Washington State Freeway HOV System Policy, Washington Department of Transportation, November 1991.

4.3.5 Unavoidable Adverse Impacts

As part of a larger ground transportation action plan, growing airport access needs can be mitigated. But there is no assurance that worsening congestion can be avoided. The multiple airport system alternatives may offer, to communities to the north and south of Sea-Tac Airport, an alternative to contributing to and experiencing regional and Sea-Tac area congestion. The controversial local tradeoffs for this course of action are part of the focus of this non-project FEIS and later project EISs.

Local comprehensive plans completed under the GMA can be a vehicle for mitigation once a system alternative is selected. Further, all the regional air transportation capacity alternatives would benefit from HCT which, for its patrons, would offer a bypass around auto congestion. (The alternative recommended by the PSATC, a multiple airport system using Paine Field, is the most compatible with alignments now under consideration.) Remote passenger terminals could offer similar advantages to air passengers if they would offer access to high-occupancy vehicle lanes.

4.4 LAND USE

4.4.1 Overview

Changes in air passenger and aircraft activity levels can impact both directly and indirectly the type, location, density, and character of land uses within an airport vicinity. This section broadly examines the potential airport-related and airport-induced land use impacts of each of the system alternatives. In response to public comments on the Draft EIS, the existing land uses and zoning at each of the site options studied in Flight Plan are also discussed. The purpose of the analysis is to provide a comparative evaluation of the system alternatives from a regional perspective. More detailed study of local land use impacts near airports will be conducted in subsequent project-level environmental impact statements (EISs). These project-level EISs would be the basis for recommending needed changes to city and county comprehensive plans, zoning, and other regulations.

Several important land use-related topics which were raised in public comments are also addressed. These include: the possible effects on land use of both the Puget Sound Regional Council's VISION 2020 Growth Strategy and Transportation Plan and the state Growth Management Act; recent development activity around airports in light of existing airport noise control programs; potential impacts to property values and property tax revenues due to aircraft overflights; and objectional land uses. Potential impacts to schools due to airport noise are presented in the Noise Analysis discussion, Section 4.1.2.6.

4.4.2 Affected Environment/Existing Conditions

4.4.2.1 Significant Issues (including Property Values, and 1978 Agreement)

This section includes a discussion of significant isses related to development activity and noise mediation, and property value and property tax revenue impacts. Section 4.4.2.1.1, dealing with the relationship among regional planning programs has been renumbered as 4.4.6.

4.4.2.1.2 Development Activity and Noise Mediation

The Puget Sound region has experienced substantial growth. The relative growth of population around each of the candidate locations is reflective of their differing local characteristics. Of particular interest, however, has been the effect of noise mediation programs on development trends surrounding existing airport locations.

Population trends surrounding Sea-Tac Airport have included selective outmigration from the higher noise level areas adjacent to the airport property. However, immediately outside the 1991 existing 65 Ldn noise contour area, population has increased with the development of higher density multifamily and apartment complexes corresponding to the area's accessibility to nearby employment centers. As a result of the Federal Aviation Administration (FAA) FAR Part 150 noise abatement program, noise mitigation measures have been developed for the communities surrounding Sea-Tac with the participation of local citizens and municipalities (Port of Seattle 1992, Draft *Sea-Tac International Airport Noise Exposure Map Update: 1991*). Residences in highest noise areas are being acquired by the Port and an ongoing program of home noise insulation is in place. Also, since 1987, several local area jurisdictions (including the cities of Sea-Tac and Des Moines and King

County) have adopted more stringent building code requirements that incorporate noise insulation in all new construction.

In the vicinity of Paine Field, a substantial amount of new residential and commercial development has taken place over the last decade, transforming the general character of the area to that of a more urbanized area. In particular, several new residential developments have been constructed near Paine Field since the 1978 adoption by the Board of Snohomish County Commissioners of the Paine Field Community Plan. This plan stated that Paine Field's primary role should be to provide for "general aviation" activities. The Board subsequently amended its action in January 1979 to include supporting recommendations of the Paine Field Mediation Panel. The principal aviation objectives of the "General Aviation" role, as defined in the 1978 resolution, "would be to retain and enhance light aircraft general aviation as the dominant aeronautical activity at Paine Field (Board of County Commissioners, Snohomish County, Washington, 1978, *Role for Development of Paine Field Selected*, April 11, 1978)." In addition, the 1978 resolution stated existing aviation activities at Paine Field which would be strongly discouraged from expanding because of their "inconsistency" with the airport's primary aviation role, as well as their unavoidable adverse impact on the surrounding community, including supplemental/charter air passenger service, large transport crew training operations, air cargo aviation, and military aviation. It also specified the staffing of an Airport Noise Mitigation Program.

Also, a stated premise at the time of the Board of Commissioners' 1978 resolution was that: "There is no clear justification for providing additional large transport air carrier or air cargo facilities at Paine Field, or at any airport in the region other than Sea-Tac, during the foreseeable future."

Future land use actions were among the specific strategies recommended by the Mediation Panel, including guidelines for future zoning and noise abatement construction techniques which should be used in developments. One aspect of this goal is stated as follows: "Any new or proposed residential developments within this area should be carefully reviewed for noise compatibility, and prospective buyers should be notified by the developer and the seller that they are in a noise-impacted area (Paine Field Mediation Panel 1979)."

In February 1989, the Snohomish County Council reaffirmed the general Aviation Role for Paine Field.

Since 1978, this area has experienced substantial growth, apparently fueled in part by the understanding that Paine Field would not be used in the future by commercial air carriers. Comments received for the Flight Plan Project indicate that some local residents believed that the Board of Commissioners 1978 resolution, and the subsequent recommendations adopted by the Mediation Panel and others, prohibited commercial airline use of Paine Field. Such locally imposed use restrictions appear contrary to established FAA policies and grant funding restrictions and covenants in deeds applicable to Paine Field. Such policies generally require an airport operator to keeps its facilities open to "all types, kinds, and classes of aeronautical use without discrimination." Local actions would be considered alongside other factors. These factors are federal prohibitions against discrimination, specific FAA grant conditions attached to previous Paine Field construction, and federal conditions resulting from the transfer of Paine Field to Snohomish County. These and other institutional issues are addressed further in Appendix B.

4.4.2.1.3 Property Value and Property Tax Revenue Impacts

Based on empirical studies, airport noise may contribute to a decrease or a lessening of the growth rate of residential property values. While the actual level of impact depends on many factors, including the strength of the housing market and location of the home, the likely range of impact is 0.5 to 0.9 percent decline in value for each 1 decibel (db) increase of noise over ambient noise levels (see Section 4.1). However, in terms of net impact on property values, the negative effect on residential values in an airport noise impact area is more than offset by increases in the value of other types of property such as commercial and industrial. This increase is due to economic growth and would likely hold true to all of the site options considered in Flight Plan. As a result of the net positive benefit to property values, property tax revenues would also be increased.

Residential Property Value Impacts

It is commonly perceived that, with all other factors being equal, residential property values should be lower in an area affected by airport noise than in a comparable area outside the noise impact area. Empirical studies generally support this perception; however, they are inconclusive regarding the magnitude of this impact. Specific information for impacts in the Puget Sound area depends in part on project-level analysis to follow this non-project FEIS.

As noted in Table 4-17, the current level of impact to residential properties is most likely in the range of 0.5 percent to a 0.9 percent decline in value for each 1 decibel (db) increase over background noise levels. Assuming a background noise level of 50 db (ambient community noise levels are generally between 45 and 55 db on the LDN scale) (see Section 4.1 for more discussion on aircraft noise), a home within the 65 LDN noise control of an airport would be 7.5 percent to 13.5 percent less in value over a similar home outside of the noise impact area. The actual difference depends on the average change in noise level, the value of the included property. The magnitude of the difference depends upon the number of affected homes and the number of properties affected. There are several important caveats which apply to the general range of impacts discussed above.

First, the strength of the housing market appears to affect the level of impact. The "Long Beach Municipal Airport Economic Impact Studies" prepared for the City of Long Beach by P&D Aviation in October 1989 indicated a direct relationship between the strength of the housing market and the impact of airport noise on residential property values. Potential buyers have a greater freedom of choice in markets with an adequate supply of housing relative to demand. This greater freedom of choice in housing product, location, and price allows prospective buyers to be more selective in the units they purchase. However, the impact of aircraft noise was found to be significantly less (or insignificant) in strong housing markets which have a limited supply of housing. The impacts will also be less in areas with unique locational advantages such as proximity to employment centers or to recreational amenities.

Property Value Impacts

Residential property values in the airport noise impact area are negatively affected but are usually more than offset by increases in the value of other types of property (such as commercial or industrial properties) surrounding the airport, but outside of the noise impact area.

Table 4-17. Impact of aircraft noise on residential property values.

Study Area	Year	Impact/1 db Change in LDN
New York	1960	1.90%
Los Angeles	1960	1.80%
Dallas	1960	2.30%
Average		2.00%
Minneapolis	1967	0.60%
San Francisco	1970	1.50%
San Jose	1970	0.70%
Boston	1970	0.60%
Toronto	1969-1973	0.90%
Dallas	1970	0.60%
Washington	1970	1.00%
Average		0.84%
Burbank	1977-1988	0.00%
San Diego	1977-1988	0.67%
Orange County	1977-1988	0.00%
Ontario, CA	1977-1988	0.59%
Vancouver, BC	1980-1990	0.96%
Average		0.44%
AVERAGE		**0.94%**

Source: P&D Technologies.
Note: LDN is a 24-hour, time-weighted annual average noise level. It is a measure of the overall noise experienced during an entire day. See Section 4.1 for more information on aircraft noise measurements and noise impacts.

Property Tax Revenue Impacts

The net effect that an airport will have on local property tax revenues is dependent on two factors: 1) the net impact of the airport on residential and commercial property values and

2) the amount of land occupied by the airport which is removed from the tax roles (assuming that the airport is owned by a government agency).

Relative to the first factor noted above, the <u>net</u> effect of an airport on surrounding property values is most often positive. Thus, the impact on property tax revenues would also be positive. This net effect could hold true for all of the site alternatives considered in Flight Plan and should be estimated in the subsequent site-level studies.

With respect to the land occupied by the airport, the effect on property tax revenues is directly related to the type and amount of land use which is displaced by the airport. Of the site options examined in Flight Plan, four are already publicly owned airports (Sea-Tac, Paine Field, McChord Air Force Base, and Arlington Municipal). In many cases, little land would be removed from property tax roles and the impact on property tax revenues would be minimal. In addition, new leasehold taxes applied to property which is converted to airport uses will further offset any loss in property tax revenues.

For site options not now developed as airports (e.g., Central Pierce), we can assume that portions are currently on the tax roles and generating property tax revenues. The negative impact on property tax revenues of developing an airport at either of these sites would likely be greater than the publicly owned airport site options which are already developed as airports. Yet, there is insufficient data at this program level of analysis to determine the actual net effect on property tax revenues for these sites. Further analysis is needed at the site-specific level to determine the extent and nature of such impacts.

4.4.2.2 Existing Conditions and Current Land Use and Zoning

The following discussion briefly summarizes the current land use and zoning at and around each of the site options for new or expanded airport facilities. This non-project FEIS presents information only to help evaluate the system-level alternatives under consideration (see Section 3.0).

Sea-Tac Related Options

These options are situated on and adjacent to the 2,500 acre Sea-Tac International Airport property. Development of the new dependent runway would encompass at a minimum a residential area approximately between 9th and 12th Avenues South (immediately west of the airport runways) and between SR 518 and South 176th Street. Sea-Tac International Airport is surrounded by the five municipalities of Sea-Tac, Normandy Park, Des Moines, Burien and Tukwila. Sea-Tac is located roughly in the center of these communities.

On a percentage basis, King County has experienced less relative growth than either Pierce or Snohomish since 1970 (see Section 2.2.1). Population increased by 10 percent in the 1970's and by 15 percent in the 1980's. Between 1990 and 2000 population is expected to increase by 16 percent and by 25 percent between 2000 and 2020.

The immediate area around Sea-Tac Airport has experienced little population growth since 1970. In fact, between 1970 and 1980, population in the general vicinity declined by 8 percent. Between 1980 and 1990, population increased slightly by 7 percent, leaving the total below what it had been in 1970. The PSRC forecasts population to increase at about 8 percent until the year 2000, and by about 6 percent between 2000 and 2020.

Land uses around Sea-Tac reflect the general range of land uses expected in an urban environment, such as commercial, industrial, and residential development. Land immediately to the north and south of the airport, however, is mainly open space as a result of the acquisitions under the Port of Seattle's Noise Remedy Program. Natural areas with steep topography, creeks, and several small lakes can also be found near the airport. Tub Lake and Lake Reba, both tributaries of Miller Creek, are located to the north and Des Moines Creek is located to the south. Still within the airport impact area, but further from the airport, are single-family and multi-family residential areas. Mobile home parks are prominent in the southeastern portion of the area west of 28th Avenue South.

From the north end of the airport north to approximately Southwest 128th Street and from the south end of the airport south to approximately South 210th Street, the zoning is generally Airport Open Space. This zone reflects FAA guidelines which discourage incompatible land uses within runway-clear zones as well as high noise exposure areas. Zoning along SR 99 is generally commercial with some multi-family residential. Farther out from the airport, zoning includes Single-Family and Multi-family Residential, General Commercial/Community Business, and Manufacturing Light Industrial zones.

Remote Airport Site Options

One of the system alternatives under consideration is a remote airport at either Boeing Field or Moses Lake operated in conjunction with Sea-Tac. These site options are discussed below.

King County International/Boeing Field occupies 647 acres and functions primarily as a general aviation facility. The facility is also used by the Boeing Corporation. Generally fully developed commercial and industrial land uses are adjacent to all sides of Boeing Field. Urban and suburban residential development characterizes the remaining land uses within six miles of the airport. Zoning under this option falls under the jurisdiction of the City of Seattle. Overall zoning along the airport corridor is manufacturing and industrial. East and west of the airport, the zoning is varied but generally reflects the type of zoning found in residential neighborhoods such as single-family and multi-family residential and neighborhood commercial. North of the airport is the Seattle Central Business District (CBD) (City of Seattle Zoning Maps, 1992).

Grant County Airport is operated by the Port of Moses Lake and serves primarily as a jet crew training and aircraft research and development center. The airport occupies approximately 4,500 acres and includes two major runways. The airport is surrounded primarily by open space and ranch lands to the north. Some scattered rural residential uses can be found near the airport. The community of Moses Lake is approximately 3 miles south of the airport. Zoning contiguous to the airport is generally H-I, Heavy Industrial and L-I, Light Industrial. In addition, there are areas of G-C, General Commercial, P-F, Public Facilities, and R-1, Single-family Residential. These zones are primarily located in the southwest portion of the airport (Grant County and City of Moses Lake Zoning, 1992).

Northern Site Options

Site options discussed below include both multiple airport and replacement airport alternatives. The multiple airport system alternatives involve the use of a site north of Sea-Tac. Northern site options used to review these system-level alternatives were the existing airports at Arlington and Paine Field.

Snohomish County has experienced rapid growth since 1970. From 1970 to 1980, population in this county grew by 27 percent, and by 1990 population grew by another 27 percent. In the 1990s, the population is expected to grow by 30 percent, and from 2000 to 2020 it is forecasted to grow by 32 percent (from 603,000 to 793,00).

Population growth rates have been higher in Snohomish County than in any of the other Puget Sound counties. In the area of Paine Field, population has grown faster than the county average. During the 1970s, the population grew by 63 percent. The area experienced a 59 percent increase in population in the 1980s. This rapid population increase is expected to slow slightly and only grow by 45 percent between 1990 and 2000, however, between 2000 and 2020, the area population is expected to grow by 53 percent.

The Arlington site option is situated on and adjacent to the existing Arlington Municipal Airport. The Airport provides general aviation activities such as recreational flying, pilot training, charter and air taxi services, and corporate operations. The airport currently contains approximately 1,160 acres. Land use in the Arlington area varies from commercial activities, in Arlington's CBD, to more mixed land uses around the city, particularly in the airport vicinity. The overall character of the area can be described as agricultural and rural-residential.

Land uses contiguous to the airport consist of agricultural, residential, and industrial uses. The south and northwest portions of the airport are dominated by agricultural uses. Undeveloped property can be found on all sides. The highest concentration of residential development is found 0.25 mile from the airport's southwest boundary. Other residential developments include Prospect Point north of the airport and Shoultes Green Acres south of the airport. Both of these developments are located just west of the extended centerline of the existing north-south runway.

Industrial land uses dominate east of the airport. Boat building, logging and cement/concrete products are the major activities within this industrial area. A 40-acre industrial park occupies the airport's northwest corner. The closest commercial uses are located less than one mile to the west at Smokey Point.

Light manufacturing and industrial zoning designations are generally found immediately east and west of the airport. Further west near Smokey Point and Interstate 5, the predominant zoning is generally single-family residential and freeway commercial. North and east of the airport, zoning is generally rural and rural conservation with the exception of the City of Arlington. South of the airport south of 172nd Street Northeast, the zoning is a mix of single-family residential and agriculture (City of Arlington and Snohomish County Zoning, 1992).

The Paine Field airport option is located in Snohomish County just south of the Everett city limits. Paine Field also includes U.S. Navy Housing and National Guard facilities. Activities on the airport include major aircraft maintenance facilities operated by TRAMCO. The Boeing 747 and 767 assembly plant is also located immediately adjacent to the airport. The study area around the Paine Field option includes part of the City of Mukilteo, southwest Everett, northwest Lynnwood and Edmonds, as well as the unincorporated communities around the airport. Land use in the area is mixed urban uses, with predominantly single-family residential on moderate-sized lots. Master-planned communities in the study area include Harbour Pointe west of the airport, and Kennilworth Hills north of the airport in Southwest Everett. Other major concentrations of new, single-family residential units are located south of Mukilteo in the vicinity of 84th Street Southwest and the Mukilteo Speedway, the Lake Serene area, and along Holly Drive between 112th and 100th Streets Southwest. Mobile homes and multiple-family units are scattered throughout the study area. Other major land uses include industrial, commercial, and recreational/open space activities and are more concentrated within the study area. Industrial uses adjoin Paine Field include the Boeing 747 Assembly Plant and TRAMCO. Other areas of significant industrial use are along SR99 and along the Mukilteo Speedway as part of the Harbour Pointe master-planned community.

Retail and commercial land use in the area is limited mainly to the SR99 corridor, the City of Mukilteo and the Alderwood Mall.

Southern Site Options

The replacement airport alternatives and the three-airport multiple airport system alternatives consider sites south of Sea-Tac Airport. Site options to evaluate the replacement airport are Fort Lewis and central Pierce County. Site options used to review the three-airport multiple airport system are central Pierce, McChord, Loveland and Olympia/Black Lake.

Population growth in Pierce County has increased at a slower rate than Snohomish County, but faster than King County. In the 1970's, the population grew by 18 percent. This rate slowed slightly between 1980 and 1990 to 16 percent. An increase of 21 percent was forecast for the period between 1990 and 2000, and between 2000 and 2020 the population was projected to increase by 27 percent.

The Central Pierce site option is located a few miles east of the Fort Lewis Military reservation in the vicinity of the 152nd Street East/SR161 intersection. Depending on the alternative, the layout would encompass a large residential subdivision and park-and-ride lot west of SR161, the Paul Bunyan Rifle and Sportsmans' Club, several residences along SR161, and Thun Field, a small air field located on the east side of SR161. The Hidden Valley landfill is located east of SR161 south of Thun Field and is within the area for the replacement airport option. Previously disposed waste would probably have to be removed from this specific site.

Land use in the vicinity of this site option is characterized by rural, semi-rural, and suburban residential development with scattered commercial, home business, agricultural, and manufacturing uses. Much of the area is developed with housing tracts. Similar to the central Pierce County site options, the vicinity is an area in transition from rural or semi-rural to medium-density residential, commercial, and industrial land uses.

Residential development predominates in the area directly north and northeast of the site option. Scattered single-family residences occur south of the option along SR161. Further south is the community of Graham. The vicinity becomes more densely developed to the north and northwest. The SR 161 corridor, located a few miles north of the option area, has the largest and densest concentration of commercial uses in the area. A major residential development, Rainier Terrace, is in its first stages of development on a 1,467 acre site approximately 2 miles south of the site. At completion, this planned community will accommodate 3,225 single-family residences and 585 to 975 multi-family residences. A manufacturing and business park will be part of the development.

The McChord site options are situated on the existing McChord Air Force Base. The new dependent air carrier runway option would utilize the eastern portion of the base, east of the main runway. This portion of the base includes a fire training area and an area used for hazardous cargo loading and unloading. The vicinity can be characterized as suburban. The area includes a portion of the Lakewood Community in unincorporated Pierce County, South Tacoma, McChord Air Force Base and Fort Lewis Military Reservation, and the Parkland-Spanaway area east of the airfield. Pacific Lutheran University is located just east of the base.

In the immediate area around the McChord Air Force Base, population declined between 1970 and 1980 by 1.5 percent, but increased in the 1980s by 12 percent and is expected to increase at a rate of 17 percent in the 1990s. Between the years 2000 and 2020, populations are forecast to increase by 26 percent.

Growth in many communities around the base has included the subdivision of large properties and extensive redevelopment and expansion of commercial centers. Increasing multiple-family construction has caused a shift in housing development away from single-family, owner-occupied residential development. In general, the area lies within a growth sector of Pierce County. Most commercial development is located along Pacific Avenue with major concentration points at 112th Street, 136th street, Military Road, and 176th Street. The area is bisected by two major transportation corridors. Pacific Avenue, or State Route 7, is the main north-south thoroughfare linking Tacoma and Mt. Rainier National Park. SR 512 serves as the area's major east-west link.

Another site option, referred to as "the Fort Lewis site," lies within the boundary of the Fort Lewis Military Reservation just south and west of the community of Elk Plain. Part of the option (airport clear zones) falls outside of the military reservation. The site encompasses training areas 11, 14, and 15 on the military reservation. These are considered heavy-use areas by the military, particularly area 14 which includes the Thirteenth Division Prairie used for mechanized battalion and tank battalion operations. The unincorporated areas around the site are rural and semi-rural residential.

Other military training areas including areas 8, 9, 10, 12, and 13; they are located north, northwest, and west of the site. These are also considered heavy training areas by the military. Significant marshlands can also be found west of the site. Single-family rural and semi-rural residential development can be found south of the option. The area east and northeast of the option near Loveland, Fredrickson, and South Spanaway, is rapidly growing with new and proposed residential developments.

Another site option referred to as the Loveland option is located near the communities of Loveland and Elk Plain a few miles south of Tacoma, south and east of the Fort Lewis Military Reservation. Much of the layout is developed with single-family residential subdivisions interspersed with pasture land and woodlands. Bethell High School is located in the southeast portion of the site area.

The Loveland vicinity can be characterized as semi-rural residential to the south, generally suburban to the north (particularly the Spanaway area), rural to the east and open space to the west (over the Fort Lewis Military Reservation).

One other southern site option referred to as Olympia/Black Lake is located a few miles outside of the growth boundary, south of Tumwater and is generally bounded by Interstate

5 on the east, Little Rock Road on the west, Lathrop Road on the north and Aldrich Road on the south. Most of the site area is undeveloped farmland, rural residential and forest land. Blooms Ditch, Allen Creek and Salmon Creek flow across the site. Electrical powerlines traverse part of the area. Southeast of the site, near Scott Lake, is a moderately dense residential development. Further east is Millersylvania State Park. A few miles northeast of the site is Olympia Municipal Airport.

The site and site vicinity is zoned rural residential. An area zoned for medium density residential is located north of the site approximately between 81st Avenue Southwest and 56th Avenue Southwest. Immediately northeast of the site around the interchange of I-5 and 93rd Avenue Southeast, is an area zoned for planned industrial development. Another area zoned for planned industrial development is located south of the site around the I-5/ Maytown Road Interchange (Thurston County Zoning 1992).

4.4.2.3 Induced Land Use

Comprehensive plans and zoning regulations can be revised to accommodate new or expanded airport facilities. These regulatory mechanisms can control the type, location, density, and character of land use around a new or expanded airport to meet both local and regional needs. The estimates presented here represent a general range of impacts that could occur.

The extent of commercial land use change brought about by an airport is a function of both the passenger volume using the facility and the amount of similar activity already in place. Flight Plan research of airports on the west coast found the area of land use directly influenced by an airport ranges from 1.5 to 3 miles from the facility. These studies also find a direct association between airport passenger volumes and office space and hotel rooms in the influence area (see Working Paper No. 8 in PSATC Draft Final Report and Technical Appendices).

If an airport is located in an area with substantial commercial land use, some increases in activity and density may be expected. However, a considerable portion of airport-induced activity would be absorbed in the existing commercial areas. The net change would be an increase in activity, but most of the change would be in the type, rather than the amount, of commercial land use. In contrast, an airport located in an area with relatively little commercial land use would experience a much greater change in character since no similar developments would be present to receive the new activity. In these types of areas, there could be a substantial change in the amount of activity.

The Sea-Tac Airport vicinity has already been strongly affected by airport activity. Continued use of the airport, with or without a dependent runway, will carry on this pattern with increases due to the higher passenger volumes. The general character of the area would not be substantially changed. Development of a replacement airport and the resulting closure of Sea-Tac to commercial air travel could dramatically alter the character of the area as most of the current commercial and industrial uses would relocate to the new airport.

Of the supplemental airport locations under discussion, both Paine Field and McChord Air Force Base already have considerable commercial and residential activity in their vicinity, and both are already significant employment centers. The Central Pierce area is growing rapidly at present and will likely have substantial development in place by the time a new airport could be built. The addition of commercial air traffic to these areas could result in some additional development, possibly in the range of 10 to 30 acres of combined office, light industrial, and hotel uses.

The Arlington and Loveland areas are presently on the urbanizing fringe of the Puget Sound region. Although they will likely see increasing commercial activity in the future, development of a supplemental airport would likely result in substantially more activity than would otherwise occur. Two-runway supplemental airports could result in roughly 30 acres of combined office, light industrial and hotel uses at Loveland, and 30 to nearly 100 acres at Arlington depending on whether a dependent runway is added at Sea-Tac.

Both the Fort Lewis and Olympia/Black Lake areas are mostly undeveloped at present and would experience substantial increases in activity if a supplemental airport were developed at these locations. Supplemental airports could result in an additional 30 to 50 acres of combined office, light industrial and hotel uses in these areas.

Replacement airports would become major regional activity centers, similar to the present Sea-Tac area. This type of facility, if located in southern Pierce County, could result in large amounts of commercial development. Depending on the type and extent of land use controls, from 100 to 250 acres of new commercial areas could be developed.

4.4.2.3.1 Objectionable Land Uses Activities

Substantial concern was raised during the public comment period on the Flight Plan DEIS over the potential for airports to attract what was generally termed "objectionable land uses". Objectionable land uses in this context refers to illegal activities such as pornography, drug dealing, and prostitution. In the Puget Sound region, as in other regions, these activities can be found in highly trafficked urbanized areas.

In the Puget Sound region, there does not appear to be a necessary connection between airports and objectionable land uses. For instance, in the Seattle area there is extensive strip development along SR 99 not only around Sea-Tac Airport but also in north King County and in southern Snohomish County where there are no commercial airports. Both sections of SR99 contain objectionable land uses and have been the periodic focus of police and community efforts to reduce illegal activity.

The City of Sea Tac has attempted local action to restrict objectional activities near Sea-Tac Airport. Action was also taken in the late 1970's by the City of Renton which is removed from the Airport. This case was eventually heard by the U.S. Supreme Court where the municipal action was successfully defended. Other areas in Puget Sound have had similar problems, including Lake City Way, Rainier Valley, and areas in the Green River Valley, none of which are near a commercial airport. To compare the pattern of activity found in the Puget Sound region with other urbanized areas and their airports, the planning departments in five western cities were contacted for their experience with airport-related land use patterns and objectionable activities. Discussions with San Diego, Sacramento, Oakland, Phoenix, and Portland Airport planning department's found no reports of increases in illegal activity or objectionable land uses related to their airports.

4.4.3 Significant Impacts

Because of system level analysis used in Flight Plan, the environmental impacts discussion presented in this section is general and comparative in nature. Specific impacts would be analyzed in project-level environmental impact statements (see Section 1.1.3).

4.4.3.1 Sea-Tac Airport

With Broad System Management

The existing population and land use trends around Sea-Tac would probably intensify even with no airport expansion and with broad system management. Overall community character would not change significantly. Additional commercial and light industrial growth may occur because of higher passenger levels. Maintaining Sea-Tac as the single focus for airline travel would result in an increased need for ground transportation and parking.

With New Third Dependent Air Carrier Runway

Airport expansion for a new carrier runway would displace populations in neighborhoods immediately west of the airport and affect some areas corresponding to the new dependent runway approach. The overall land use character of the area would continue to intensify in designated growth areas. Additional commercial and light industrial growth may occur because of higher passenger levels.

With Remote Airport

If the remote airport were at Moses Lake, this alternative would result in a negligible change in the impacts on population and land use surrounding Sea-Tac. The land use changes in the Moses Lake area would be a substantial change in community character, but would impact a comparatively small existing resident population. No direct displacement impacts are anticipated. The existing airport facilities at the Grant County Airport appear to meet the requirements for a distant remote airport. The high-speed ground transportation link between Seattle and Moses Lake could impact development in the corridor.

No significant changes in land use are anticipated around the Boeing Field site if it were selected as a remote airport. The area is heavily urbanized. No significant displacement impacts are anticipated, except for what might be required to complete a ground link between the two airports.

4.4.3.2 Two-Airport System

Impacts at Sea-Tac Airport would be similar to those discussed above. A two-airport system incorporating Paine Field with Sea-Tac could be developed. Impacts to the Paine field site are discussed in Section 4.4.3.3, Three Airport System. Impacts at other potential locations are discussed below.

Northern Site Options

A two-runway supplemental airport to the north in the rural area near Arlington with no expansion at Sea-Tac would likely result in the greatest change in community character due to airport development. Along with the corresponding ground transportation development, this alternative could result in a substantial northerly shift in regional population and land use changes, perhaps extending to the Canadian boarder. The tradeoffs would include direct noise and displacement impacts on a relatively small resident population and dispersing the focus of regional ground transportation. Direct displacement impacts from airport development would generally affect wooded and pasture areas. The wooded portions are located west of the airport runway near Smokey Point. The City of Arlington intends to use these areas for industrial and commercial uses in the future. Pasture/open space areas are found north and south of the airport runway and are generally free of development per FAA clear zone requirements.

If a dependent runway were added to Sea-Tac, the capacity would be increased, and the relative focus of regional air travel would probably not shift to the north quite as dramatically as described above. A one-runway supplemental airport in the rural area to the north would still substantially alter community character, but may not result in as extensive alterations in ground traffic and regional population patterns. Direct displacements would be less under this option.

Southern Site Options

Any two runway supplemental airport to the south would continue the region's southward transportation focus for commercial air travel needs. At all the locations investigated in Pierce County, with the exception of the military reservations of McChord and Fort Lewis, the recent population growth has been so rapid that airport development would have the potential to displace a large amount of population and substantially alter the developing area land use patterns. The Central Pierce option would directly displace several single-family residential areas and commercial areas west of Highway 161.

The character of the urbanized area immediately surrounding McChord would probably not be altered greatly and the existing airport-related land use patterns would continue to develop. Direct displacements from the two-runway option would occur adjacent to the airport runway and would include a fire training area and a hazardous cargo loading area.

Construction on new facilities on the Fort Lewis reservation would not directly displace many people. Some single-family residences would be displaced due to clear zone requirements. The population in the area immediately off the military base in Pierce County is growing rapidly, however, and planning restrictions would be needed to reduce land use conflicts from the development of an airport. The layout would displace military training areas 11, 14, and 15. Several open space areas would also be displaced. In addition, a military hazard site, and an underground pipeline would be displaced. An overhead electrical transmission line that traverses the location would have to be relocated.

Because of recent increases in the number of military families stationed at Fort Lewis, substantial residential development is expected in the surrounding vicinity, especially in the area immediately off-base. Thus, in the Loveland area, direct land use conflicts and displacement would be likely with residential development related to Fort Lewis. Direct displacements would also include Bethell High School.

The PSATC considered Thurston County as a contingent site for a southern airport if a suitable site could not be found in Pierce County. Thurston County is outside the jurisdiction of the Puget Sound Regional Council. Development in Thurston County (e.g., the Olympia/Black Lake airport option) would change the overall land use character of the area significantly. Overall population displacements would be small. The site lies well outside established urban growth boundaries as designated in Thurston County's Comprehensive Land Use Plan.

4.4.3.3 Three Airport System

Without capacity expansion at Sea-Tac, the two supplemental airports under this alternative would experience a greater amount of air and ground traffic. A one-runway airport at Arlington would still have a substantial impact on local community character, but less so than the two-runway alternatives, and the number of residences affected would be relatively low. A one-runway supplemental at Paine Field would have a different broad impact on community character. This area is already more urban and the existing airport already has a long enough runway to accommodate commercial flights. Little population displacement would occur at Paine Field, but increased noise would effect a greater resident population. Much of this population is in relatively new residential developments. Boeing and TRAMCO facilities would not be displaced if Paine Field were to assume commercial activity on the existing runway.

If the southern leg of a three airport system without Sea-Tac expansion were to incorporate a one-runway supplemental airport at McChord, the population and land use impacts would likely be relatively low, however, no expansion at Sea-Tac would mean relatively more air and ground traffic at the McChord site. In the Ft. Lewis location, new development would not displace existing population, but immediate planning restrictions would be needed to avoid future land use development conflicts. At either of these military base locations, the land use trends would most likely shift toward civilian uses and attract more commercial growth. Airport development at the other Pierce County locations evaluated would displace burgeoning local residential growth patterns. Direct displacements for these options would be similar to those described in Section 4.4.3.2.

The three airport system alternative combined with a new air carrier runway at Sea-Tac would result in the largest overall land use impacts. These impacts would result from direct displacement or induced growth at the site options for this alternative.

4.4.3.4 Replacement Airport

Closure of the Sea-Tac Airport would have substantial economic impacts to the area around the airport. Much of the existing commercial and industrial activities around the airport depend either directly or indirectly on commercial air traffic. The greatest impact of replacing Sea-Tac on existing uses would likely be on the hotels that have developed to serve the airport. Without airport-created demand, most of these hotels would not be viable. The extent of impact would depend on the use made of the airport site and the timing of its replacement. Given the high level of services available and relatively central regional location, Sea-Tac has considerable potential for other commercial or industrial use. Whatever future use would be developed, replacement of Sea-Tac would need to occur relatively slowly to avoid sudden dislocations and to allow for market adjustments.

Fort Lewis Three-Runway

The change in the land use patterns in Pierce County would be very significant. The rapidly growing population in Pierce County, particularly the growing residential developments in the immediate off-base vicinity, would be directly effected. Commercial development would most likely displace residential uses along the major access routes and the substantial adjustments required in the regional transportation system would potentially result in significant land use conflicts. Direct displacement impacts to the Fort Lewis area under this option would be similar to those described for Fort Lewis under the two-runway option.

Central Pierce Three-Runway

Construction of a replacement airport would result in very significant changes to surrounding land use patterns, similar in character to development at Fort Lewis, but substantially greater since direct displacement would affect a large resident population. A commercial airport would directly displace Thun Airfield and Highway 161 would have to be relocated farther east. Since this area has been growing rapidly, significant displacement impacts would occur on both established and recent residential development. Secondary development would create similarly significant land use conflicts.

4.4.3.5 No Action

Land use impacts of the No Action alternative would be similar to Sea-Tac Airport with Broad System Management discussed above. Activities would be contained within the existing Sea-Tac site and would not involve a new third runway. Without system management techniques, however, impacts due to air traffic congestion would be more severe.

4.4.4 Mitigation Measures

A variety of mitigation measures could be implemented to reduce land use impacts resulting from increased airport activity or development of a new facility. These mitigation measures include: (See Section 4.4.6.2.1, State Statutes, for discussion of multicounty and countywide planning policies references below.)

- Develop and implement a regional policy on relocation assistance and compensation for areas directly displaced or subject to noise impacts consistent with FAA guidelines. Non-federal agencies also have the latitude to go beyond what is funded under federal programs (i.e., mitigation within the 65 Ldn contour) (FAA, Regional Council, and Airport Operators).

- Require compatible land-use planning and regulation for areas subject to noise and transportation system impacts over the long term. Where appropriate, local governments can adjust local permitting in light of already existing noise impacts (Countywide planning policies).

- Directly address the issue of offensive and incompatible land uses and activities in areas adjacent to airports (Countywide planning policies).

- Help finance, through FAR Part 150 and other sources, school sound insulation at least within the 65 Ldn contour, and purchase aviation easements from existing incompatible land uses (airport operators, local jurisdictions, and school districts).

- Work toward a comprehensive regional noise management program addressing traditional noise contours and flight track single-event noise (FAA, Regional Council, and airport operators).

- Directly address airport siting in countywide and multicounty policy plans (cities and counties).

4.4.5 Unavoidable Adverse Impacts

Development of airport ground and access facilities will displace any land uses within the acquisition area. Increased activity at any airport location will increase the potential for congestion from increased traffic and overall activity levels in the airport vicinity.

4.4.6 Relationship to Regional Planning Issues

Expansion of regional commercial air transportation capacity is one of several major planning and infrastructure decisions needed to serve the long-term growth needs of the Puget Sound region, and of the state. The complex relationship among regional planning programs is briefly outlined here.

4.4.6.1 Vision 2020

Completed in mid-1990, the Vision 2020 Growth Strategy and Transportation Plan is a long-range plan for the central Puget Sound area, including King, Kitsap, Pierce, and Snohomish Counties. The Plan calls for a containment of growth and concentration of employment into about 15 centers connected with a regional rapid transportation system. A range of central places is described by the Vision 2020 Plan as a means of identifying where various levels of growth and types of transportation could be located. Within the range described, higher order places are expected to receive relatively high growth and be well connected to their regional transportation system. Lower level places are those oriented to providing local services with relatively low growth and limited connections to regional rapid transportation. As an important activity center, an airport is most consistent with higher level central places. A comparison of the Vision 2020 candidate central places with airport options is shown in Table 4-18. Local governments will be completing comprehensive plans by 1993 in conformance with the Growth Management Act (GMA). The Vision 2020 Plan should help guide the densities and transportation system improvements designated during the planning process and will be amended based on GMA results.

Comparison of Vision 2020 Candidate Central Places with New Airports

Subregional Center -
Classification guidelines consistent with airport:
- Focus of regional growth
- Mixed-use employment
- Strong existing market
- Served by regional and rapid transit

Activity Cluster -
Classification guidelines consistent with airport:
- Some growth expected
- Linked to regional and rapid transit (express service)

Classification guidelines not consistent with airport:
- Growth should be local, not regional

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- Employment should serve local residential area

Small Towns -
Classification guidelines not consistent with airport:
- Small share of regional growth
- Employment to serve local area
- Local transit (daily service)

Table 4-18. Comparison of VISION 2020 Candidate Central Places with Potential Airport Sites.

Airport Location	Vision 2020 Candidate Designation
Sea-Tac	Subregional Center
Paine Field (Mukilteo)	Activity cluster, small town
Arlington	Small town
McChord (Parkland, Spanaway)	Activity cluster
Central Pierce (South Hill)	Activity cluster
Fort Lewis and Loveland	Outside Urban/Rural boundary
Olympia/Black Lake [1]	Outside long-term Urban Growth Management Area

[1] Thurston County is not included in the Vision 2020 Growth Strategy and Transportation Plan. The Thurston County Comprehensive Plan establishes short and long term Urban Growth Management Area boundaries similar to the Urban/Rural boundary described in Vision 2020.

4.4.6.2 Relationship to GMA and Other Statutes

Planning requirements are set forth in several new state and local statutes. In general, these add a new requirement for areawide coordination previously lacking in local planning enabling acts and much of the 1970 State Environmental Policy Act (SEPA), which has a project-level focus.

Statutes

Federal Statutes

New Federal and Washington state legislation sets forth important new requirements for air quality and transportation planning, growth management planning and coordination, and high capacity ground transportation and airport planning.

- The 1990 Clean Air Act Amendments (CAAA) require areas not achieving National Ambient Air Quality Standards to link facility decisions to the achievement of these standards according to a mandated schedule. The central Puget Sound region is one of these areas and must satisfy a 1995 deadline.

  The 1991 federal Clean Air Act Amendments require estimation of regional surface vehicle miles traveled (VMT) in the Puget Sound region (a moderate non-attainment area) in the years 1993, 1994 and 1995. The Act further requires ensurance that growth does not exceed this trend. VMT generated by the selected airport alternative should be included in this estimate and reported to the Federal Highway Administration and the state for the State Implementation Plan (SIP) for air quality.

  Later, site-specific studies for airport(s) will be required to demonstrate compliance with air quality standards. This level of detail requires site-specific modeling and is deferred to the site-specific EISs.

- The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) requires broad transportation planning and allows comprehensive allocation of federal funds to different kinds of prioritized projects (e.g., from roads to mass transit). This is a major change from the categorical funding programs of the past. ISTEA is the federal statutory basis for the broad system planning work of the Regional Council, including the Regional Airport System Plan, and allocation of federal funds to transportation projects (for example, those serving airport locations).

- A collaborative approach to Washington's decision making is supported by ISTEA and independently mandated by the state GMA. The majority of projects for ISTEA funding are to be selected by the Regional Council as MPO in cooperation with the state. Projects funded with Bridge Interstate Completion and Interstate Maintenance funds or included in the National Highway System are selected by the state in cooperation with the MPO.

State Statutes

The 1990 GMA and 1991 amendments require broad growth management planning at the local level. Local plans must be coordinated at the countywide level and with adjacent counties. The GMA requires local governments to address significant siting needs and to develop county-wide policies. King, Pierce, and Snohomish counties must also develop multi-county policies.The Regional Council includes the three counties required to develop multi-county policies. The GMA also requires the Regional Council to certify that the transportation elements of local plans are consistent with the Regional Transportation Plan. The regional plan will be based largely on the local results of the GMA process.

- Countywide policy plans, to be completed in July 1992, are to provide "policies for siting public capital facilities of a countywide or statewide nature". The local comprehensive plans, to be completed in July 1993, are to include a "process for identifying and siting essential public facilities."

Other state statutes address high capacity ground transportation and airport planning.

- High Capacity Transit (HCT) legislation has been passed for the central Puget Sound region (1990 and 1992). Other relevant 1991 state legislation created the Washington State Air Transportation Commission (ESHB 2609) and the High-Speed Ground Transportation Commission.

- Planning supported by the Federal Aviation Administration (airport master plans, the state airport system plan) is linked to the GMA by ESHB 2609) which requires the Washington State Air Transportation Commission to develop air transportation policy options by July 1993 (a key GMA deadline for local and regional agencies) and to transmit these to regional planning organizations, including the Regional Council.

  The general thrust of this statute was to ensure that regional airport planning was performed in a manner consistent with statewide interests and the GMA. Any runway construction is not to commence prior to the end of 1994. As a practical matter, the advisory committee did not recommend action prior to this date, and lead time requirements made it a moot issue.

  The statute also applies this restriction to the possible introduction of commercial service at Paine Field. Again, as a practical matter this would not occur prior to 1994, and depends finally upon the interests of the airlines. If an airline were to request access to Paine Field, for example, this action would trigger the unresolved question of how growth-related decisions under the GMA and local policies might interact with statutes governing interstate commerce and the use of federally funded facilities.

  This same legislation also requires the commission to complete a review of the Flight Plan Project forecasts by December 1992.

4.4.6.3 Coordination Among Regional Plans

Critical coordination points for the Regional Airport System Plan are shown in Table 4-19 and explained below.

1. The Washington state GMA requires that county-wide policies include a process for siting facilities of countywide or statewide significance. Concurrent work by the Regional Council, Port of Seattle, and the Washington State Air Transportation Commission (under ESHB 2609) is part of the siting process to be identified by each of the countywide planning organizations operating under the GMA.

   The regional commercial air transportation capacity planning effort (Flight Plan Project) addresses near-term needs (e.g. 2000) and a time horizon of 30 years (2020) and beyond (2050), while the GMA operates on a 20-year horizon.

2. The HCT non-project EIS should address possible interactive effects, if any, to airport system alternatives. This might affect HCT system-level rankings and alignment decisions.

3. High-speed ground transportation (HSGT) is a component of one of the Flight Plan system alternatives (part of an intermodal and demand management approach). The HSGT report will be used by the Regional Council in its regional airport system plan deliberations beginning in December 1992. If HSGT routes bypass the urban centers, then station locations must be coordinated with both HCT and airport locations. The High Speed Ground Transportation Commission will report to the Legislature in October 1992.

4. The State Implementation Plan for air quality requires forecasts of future regional traffic (annual vehicle miles traveled, VMT). Unacceptable levels could be a basis for restricting future highway funding proposals. Airport actions will affect these forecasts, but will not be known until after the significant target date in the federal Clean Air Act (CAA) (1996). Airport siting decisions can be recognized in the SIP after these decisions have been made.

5. Selection and phasing of a regional commercial air transportation alternative rests, in part, on forecasted air travel needs. These forecasts are to be reviewed from a statewide perspective, in time for use by the Regional Council beginning in December 1992.

6. The HCT station locations should consider access to existing and possible airports. Employees of the new or enlarged activity centers surrounding airports may be more likely to use HCT than air travel passengers. The Joint Regional Policy Committee is addressing this as it considers HCT alignments through south King County.

7. The regional HCT plan and the regional air transportation system decision must be compatible. This does not mean that air transportation system decisions are dependent upon the outcome of the HCT program. This is discussed in this FEIS in Section 4.3. The Regional Transportation Plan provides a means of ensuring integration.

8. The National Highway System (NHS) is to be approved by the Federal Highway Administration on 30 June 1993. The Regional Council is to prepare the NHS element for this region by 30 April 1993. Improved intermodal connections are a major objective of the NHS, especially access to major airports.

9. Air quality conformity does not require site-level modeling of the airport system alternatives under consideration for possible regional adoption. At the regional level, the total vehicle miles traveled (VMT) each year includes miles traveled on the ground to and from the airport(s) or to jobs related to air carrier service.

   The VISION 2020 Growth and Transportation Strategy will be amended to include a selected regional commercial air transportation capacity solution. Site level modeling of impacts would follow this action. This non-project FEIS might be reviewed as a result of siting and project- level analysis and EISs. This could result in an FEIS Addendum or Supplement.

10. Local comprehensive plans and processes to resolve regional airport siting issues would need to be reconciled. As part of this process, local comprehensive plans and the airport master plans must be compatible. ESHB 2609 requires specific products from the Washington State Air Transportation Commission (WSATC).

11. An evaluation of air transportation system options is required within a broader transportation systems planning context. The WSATC scope of work includes: identification of multimodal and intermodal relationships, identification of a role for systems planning, evaluation of modal relationships and tradeoffs, coordination with HSGT, recommendations for coordination of air and surface transportation, and policy recommendations for system planning and modal coordination at the state and regional levels.

12. The Regional Transportation Plan must be in full compliance with the broad new requirements of the federal ISTEA by October 1993.

13. The Regional Transit Authority has the responsibility for presenting the Regional Transit Plan, including a finance plan, to voters. The earliest that this vote is expected to occur is November 1993. If the ballot is successful, the RTA would build and run the rapid transit part of the regional system.

14. The final High Capacity Transit Project level EIS is expected to be completed in November 1993.

15. The GMA requires that within one year of adoption of its comprehensive plan, each city or county that is required or chooses to plan under the act shall enact development regulations that are consistent with and implement the comprehensive plan.

16. A site-specific project EIS over the system level alternative has been identified. Date and timing for EIS are unknown.

Table 4-19

CALENDAR OF RELATED PLANNING DECISIONS

	Date	Product	Statute	Explanation #
1992	July	Countywide Planning Policies adopted	(GMA)	(1)
	Sept.	**Complete RASP non-project FEIS**	**Flight Plan**	
	Sept.	Joint Regional Policy Committee issue non-project DEIS on HCT	(RCW 81.104)	(2)
	Oct.	High Speed Ground Transportation Commission Report to Legislature	(HSGT)	(3)
	Nov.	Complete 1992 revised State Implementation Plan for air quality	(CAAA)	(4)
	Dec.	**Review of Flight Plan forecasts**	**(ESHB 2609)**	**(5)**
1993	Feb.	HCT Phasing recommendation	(HCT)	(6)
	Feb.	Adopt HCT system plan	(RCW 81.104)	(7)
	March	**RASP Amendment**		**(See Note)**
	April	National Highway System	(ISTEA)	(8)
	June	VISION 2020 air quality conformity analysis	(CAAA)	(9)
	July	Local Comprehensive Plans	(GMA)	(10)
	July	**Report: WSATC transportation system evaluation of air transportation options**	**(ESHB 2609)**	**(11)**
	Oct.	Revise Regional Transportation Plan	(ISTEA)	(12)
	Nov.	Regional Transit Authority (earliest date for ballot)	(RCW 81.104)	(13)
	Nov.	Complete HCT project-level EIS	(RCW 81.104)	(14)
1994		Revise local regulations consistent with comprehensive plans	(ISTEA, GMA)	(15)
19____		Site-specific project EISs for selected Flight Plan Project alternative	SEPA	(16)

Key: CAAA Clean Air Act Amendments

HCT High Capacity Transit planning by the Joint Regional Policy Committee and the possible three-county Regional Transit Authority (RCW 81.104)

GMA State Growth Management Acts of 1990 and 1991

ISTEA Federal Intermodal Surface Transportation Efficiency Act of 1991

HSGT High-Speed Ground Transportation Commission (state statute of 1991)

2609 ESHB 2609 passed in 1991 (re: the Washington State Air Transportation Commission)

Note: The RASP is prepared by the Regional Council as part of the required Regional Transportation Plan. The Regional Council is the Metropolitan Planning Organization (MPO) for King, Kitsap, Pierce and Snohomish counties under federal statute (and designation by the Governor). The relationship in this state of the RASP, ISTEA, and state statutes is complex and evolving. At the national level, the MPOs are seeking clarifying amendments to federal legislation governing the Airport Improvement Program administered by the FAA to require integrated planning between FAA, airport operators, and the MPO. The Regional Council also serves as the Regional Transportation Planning Organization (RTPO) under the state GMA.

4.4.6.4 Air Transportation Capacity Planning Technical Coordination

For purposes of system-level regional airport planning, the impact analyses in this FEIS depend in part on the baseline scenario of existing plans (version (a), below). This scenario is combined in this FEIS with a supplemental analysis of transportation, noise, air quality, and land-use impacts that can be attributed to a range of airport facility siting options.

The local governments and the Regional Council are working together to meet the goals of the new statutes and deadlines, especially under the GMA. As part of this effort, three sets of regional working growth forecasts (which divide regional forecasts among 850 local areas) have been developed. Each of these covers years 2000, 2010 and 2020.

These three scenarios describe:

(a) the likely results of existing comprehensive plans (Existing Plans Scenario), and

(b) two refinements--based on local planning--of the VISION 2020 Growth and Transportation Strategy adopted by the region in 1990. The two refinements include: 90 miles and 150 miles of HCT, respectively.

As the regional airport decision and local planning under the GMA (assisted by these scenarios) become more final, a new iteration of comprehensive growth forecasts will be prepared, by the local governments and the Regional Council. This may be in early 1993.

The two refinement scenarios include these elements: (a) Seattle is the regional center with nine to 20 urban centers regionwide, (b) 15 and 25 percent of the households, and 50 and 75 percent of the jobs, respectively, would be in centers, (c) design is compact with residential uses close to transit stations, and (d) high capacity transit links the centers with each other.

Future airport facility actions would induce changes (e.g., land use) that are not accounted for in the described forecasting strategy. Subsequent forecasts would take these decisions into account. Therefore, the probable consequences of future airport siting are identified below without the benefit of these future forecasts.

1. Level of Regional Growth

At the most general level, the growth in commercial air transportation activity is accounted for in the Regional Council population and employment forecasts. Rather than inducing additional regional growth, the airport alternatives serve growth that is already anticipated. The actual location of growth directly induced by any new airport sites, and an assessment of related impacts, is part of the subsequent site-level analyses.

In its deliberations of the economic impacts of the alternatives, the PSATC noted that it is also likely that many travelers to this region will find alternate modes of transportation, if necessary, in the event of no action. Finally, funds spent locally by air travelers might be spent on other activities in the region if no action were taken. Two thirds of the air travelers either begin or end their trips in this region. This retention of economic benefits should be kept in mind when interpreting indirect jobs due to airport investments or growth impacts attributed to specific infrastructure investments like airports.

The growth forecasting models are calibrated to growth trends in previous decades when air carrier facilities and other infrastructure were adequate and did not constrain growth. The Regional Council population and employment forecasts are used in local and regional planning programs for the four-county area (King, Pierce, Kitsap and Snohomish counties), as well as Flight Plan.

2. Distribution of Growth

The Regional Council modeling sequence works with the level of economic and population growth for the region as a whole, and then the distribution of growth within the region.

a. Modeling Sequence

New jobs expected to be located near to any new airport activities are not accounted for in the three sets of working forecasts being considered under the GMA planning process. Hence, the location of induced and site-specific growth will be fully addressed in later site-level EISs rather than in this non-project FEIS. The Surface Transportation and Land Use sections of this FEIS (Sections 4.3 and 4.4, respectively) estimate site impacts in terms of jobs, acreage, travel needs and congestion. This is a basis for comparing the regional alternatives which are not site specific.

Once a system-level regional airport decision is made, the Regional Council models can then be used to help study siting questions deferred here to the needed siting studies and site-level EISs.

b. Likely Impacts of Continued GMA Planning

Depending upon the long-term response to flight track noises outside of the composite noise contours nearest the airports (or even confined to airport property), increased air traffic could contribute to some long-term pressure for residential development outside of the noise-impacted areas. It is difficult to gauge this possibility; however, we can use Sea-Tac Airport as a reference point for the possible supplemental sites. The supplemental sites would have perhaps 10 to 30 percent as much commercial air traffic in 2020 as Sea-Tac has now (From Table 4-17: 100 to 300 operations per day, compared to an average of 940 at Sea-Tac). This varies by regional alternative and by site options.

Encouraging more dispersed development may contradict some of the leading goals of the Growth Management Act (GMA). The GMA discourages sprawl, but it also values the quality of life within the urban communities. The tradeoff between sprawl and noise is a major challenge to be resolved within the GMA process. The GMA does provide a process for considering fully contained new communities outside of the urban growth boundary, and requires an urban growth boundary amendment.

Sprawl or new communities will be encouraged if airports are located outside the present urban areas where urbanization has not yet occurred. The introduction of Stage 3 aircraft by the year 2000 is expected to reduce the amount of land area within the worst noise impact contours (65 Ldn) at Sea-Tac. This is expected even as the number of aircraft operations increases (See Section 4.1). Combined with all of the other actions in the Mediated Noise Agreement of 1990, this could reduce noise at Sea-Tac by 50 percent. (The source for this estimate is the 1990 Agreement.)

This FEIS includes a presentation of impacts within the noise contours and of single event noise under the dispersed flight tracks (see Section 4.2.1). It identifies possible mitigation of noise impacts (see Section 1.3.1). And it works toward a long-term integrated approach to land-use planning, airspace planning, and airport system planning (see Section 4.10).

(1) Sea-Tac Airport

Location of all air carrier service at the present Seattle-Tacoma International Airport is most consistent with the implicit assumption in the Regional Council's working forecasts for the Existing Plans Scenario (April 1992). However, these forecasts are a technical exercise and should not be interpreted as setting policy. The policy question under the GMA and resulting local planning processes is how future growth (e.g., the Existing Plans scenario) might be altered to meet the goals of the GMA, and in a manner that accounts for long-term air carrier and other regional needs.

(2) Multiple Airport System (two airports)

The location of increased airport services at supplemental airports within the GMA 20-year urban growth boundaries would result in increased single-event noise over growing populations outside of King County and still in the urban region. This could result in pressure for a more dispersed residential growth pattern.

This result is moderated with multiple airport alternatives that do not cap service at Seattle-Tacoma International Airport. With more limited local service at the supplemental sites, the induced land-use effect is reduced proportionate to the lowering of expected commercial aircraft operations. (In one case, capped Sea-Tac capacity could theoretically result in 13 million annual passengers at a supplemental airport site by the year 2020, for example, rather than 3 million annual passengers.)

(3) Multiple Airport System (three airports)

See previous comment. In addition, if McChord or Fort Lewis military activity were to be scaled down in future decades, the conversion to a commercial airport could serve to anchor the level of economic activity previously supported by military activities. The expected short-term trend at McChord and Fort Lewis is to grow as other bases close and the national military strategy evolves in the wake of the Cold War and loss of some military sites in the Far East.

(4) Replacement Airport

This alternative would relocate some future growth from south King County to possible locations in central Pierce County (or to more rural areas in Skagit or Lewis County). The magnitude of this shift over the next 30 years could be comparable to the change that took place surrounding Sea-Tac since 1942. Sea-Tac International Airport has evolved as a replacement airport for most commercial air transportation service originally sited at Boeing Field. When selected, the site midway between Seattle and Tacoma was a remote one. In fifty years, Sea-Tac has grown to a level of 16 million annual passengers. A replacement airport location would have to accommodate the growth induced by moving the current level of airport activity to a new location, as well as the additional growth forecasted for future years (e.g., 30 million annual origin and destination passengers in 2020).

The loss in the King County area of the relocated jobs is a third major consideration. New airport-related jobs (direct, indirect, and induced) in the year 2020 could double in King County (Table 4-20) or drop to approximately 4,320, and could represent over 60,000 in either Pierce or Thurston counties, or other counties receiving a new replacement airport. The present level of these direct jobs in King County is 32,100. (Flight Plan Draft Final Report, Working Paper No. 8, pp. C-3 and C-42). A larger number of visitor-related jobs could also be affected.

(5) No Action

If the anticipated level of growth in this region is constrained by inadequate infrastructure, including airports, then the accepted 1991 population and employment forecasts could be affected. If growth continues without adequate infrastructure capacity, the impacts will be worsened and in the broad sense, could include rising prices in areas where services are available. If air passenger demand continues, then noise impacts of more crowded operations could impact residential property values in a negative way (See Section 4.4.2.1.3). While the results of economic models may differ, one result from the Flight Plan Project forecasts the following airport-related job dependencies. The no-action alternative would most jeopardize the airport-related jobs to be added by year 2020 (from Table 4-20: 12,300-28,500 jobs). For the most part, regional population and employment forecasts used in the GMA process assume adequate major infrastructure will be in place.

The no-action alternative at Sea-Tac assures increased flight track occurrences over presently populated areas, even as the modeled 65 Ldn contour diminishes around Sea-Tac (due to the conversion to quieter Stage 3 aircraft).

Table 4-20

NO-ACTION AND ADOPTED GROWTH FORECASTS

Jobs	1990	Added by 2020
Airport Related		
Direct/Indirect	16,300	[12,300 - 20,000][1]
Induced	15,800	[12,000 - 28,500]
Subtotal	32,100	24,300 - 48,500
Visitor Related		
Direct/Indirect	49,300	54,900 - 85,000
Induced	34,200	39,300 - 60,900

Source: Flight Plan Draft Final Report, Working Paper No. 8, page C-3, January 1992

Notes: [1] No-action would most affect the enclosed range of figures for jobs added by 2020 under the action alternatives.

Working Paper 8, Table V-1 indicates that with a replacement airport, direct and indirect jobs in King County could be reduced from 32,100 to (roughly) 4,320.

Growth in activities surrounding the existing Sea-Tac airport would be clearly affected as would other geographically dispersed industry sectors that are dependent upon reliable air service. These include aerospace, the high-tech industries, the forest and paper industries, and the growing service industry.

Early in its work the PSATC was advised by consultants that the most important effect of transportation facilities on productivity is in reducing bottlenecks and enhancing flexibility. Extra capacity provides the ability to respond to unforeseen events. The results are not linear; that is, there is no precise measure of the economic activity that will or will not be created by providing "excess" capacity. (Flight Plan Phase II Report, p. 102). Please see Sections 2.2.2 and 2.2.3 for a discussion of forecasting uncertainty and assumptions.

4.5 PUBLIC SERVICES AND UTILITIES

4.5.1 Overview

Public services and utilities generally include water supply and sewer systems, solid waste disposal, fire and police protection, and health and social services. Impacts to schools are addressed in Section 4.1.2.6 and impacts to roadways and ground transportation are discussed in Section 4.3.

The level of analysis is intended to be broad in scope with sufficient detail to compare the system alternatives at the regional level. Specific impacts to public services at the site-level and plans for mitigating the impacts will be discussed in project-level environmental impact statements (EISs) to be prepared in the future.

4.5.2 Affected Environment/Existing Conditions

To analyze the impacts the various system alternatives would have on public services and utilities, and to identify the possible mitigation measures, it is important to understand the process for siting major public facilities and for determining standard levels of service. All state agencies are to comply with the Growth Management Act (GMA) (RCW 36.70A.103). For information on the relationship between public services/utilities and GMA, refer to Appendix B. Complicating the analysis of public services is the fact that some government agencies' policies and regulations are not yet consistent with GMA. Ports and other special districts' comprehensive plans are not specifically mentioned in the GMA with the exception that sewer and water comprehensive plans must be in conformance with and approved by local jurisdictions. Also, federal requirements must be accounted for.

4.5.2.1 Water Supply and Sewer

Water purveyors can be special districts, jurisdictions, or private parties. Sewers are provided by special districts, jurisdictions, or regional agencies such as Metro in King County. Port districts have the authority to develop their own water and sewer services if needed; however, ports normally contract for water and sewer services with existing special districts and jurisdictions. Sewer and water district plans encompass 20 years, are updated every 6 years, and must be approved by local jurisdictions (RCW 56.08.020 & RCW 56.16.010). The public water supply plans applicable to the Puget Sound region are:

Snohomish County
- Groundwater Management Plan (GWMP)
- Coordinated Water System Plan (CWSP)
- Everett Comprehensive (Comp) Water Plan

King County
- Seattle Comp Plan
- Metro 2020
- GWMPs for Redmond, Issaquah, Vashon, and Regional Water Association (RWA)-south
- Pipeline #5
- CWSPs

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Pierce County
- Tacoma Comp Plan Update
- County CWSP

Thurston County
- Thurston County CWSP
- Thurston County GWMP

Water supplies could become critical, as is currently evident in this drought year. The lead time for new water permits from the State Department of Ecology is approximately one to two years for small projects, and much longer for larger water supplies. Water supplies for the Puget Sound area were addressed in a report entitled "VISION 2020, A Water Supply Perspective of the Growth Management Strategy for the Central Puget Sound Basin", October 1990. The report states that for the Preferred Alternative developed for the VISION 2020 Regional Growth Strategy. The primary impact upon the water supply plans will be the water supply transmission and distribution networks and the schedules in which they are completed. However, the strategies will probably have little impact upon the aggregate quantity of water.

The water purveyors providing water to municipal airports should have comprehensive water plans that meet the needs of the airports. When the specific needs are known for the specific facility, the water and sewer comprehensive plans can be updated.

Sea-Tac

Three water districts currently supply potable water in the Sea-Tac Airport area. All districts receive their water supply from the City of Seattle; each district has mutual agreements with adjacent districts to share water in emergencies such as heavy fire flow demands or water shortages. The City of Seattle also supplies Boeing Field (King County International Airport).

The Sea-Tac study area is currently served by four sewer districts, each with a comprehensive plan to aid them in future planning and coordination with other service districts and regulatory agencies. The King County International Airport sewer system is tied to Metro.

Currently, sewer trunk lines in the Sea-Tac Planning Area (as previously defined by King County) are reported to be adequate for conveying existing waste water flows. All the sewer districts have capital improvement programs that are updated annually to accommodate changes in the capital facilities required.

Northern Site Options

Sewer and water service are provided at the Arlington Airport and neighboring vicinity. Some sewer service near the airport is piped to Marysville for treatment. Both the Arlington and Marysville wastewater treatment systems have limited capacity.

Public water service is provided to most of the Paine Field area by the Mukilteo Water District, the Alderwood Water District, and the cities of Everett, Edmonds and Lynnwood. Nearly all of the water provided by these suppliers is purchased from the City of Everett and originates from its Spada Lake Reservoir system located in the Sultan Basin watershed.

Public sewer service is provided in the area by the cities of Everett, Lynnwood and Edmonds, and Olympus Terrace Sewer District. The airport is directly served by Olympus Terrace Sewer District.

Southern Site Options

The McChord Air Force Base maintains its own sewer system. Sewage is carried to Fort Lewis Military Reservation where it is treated. Approximately 10 wells provide water for the base. No public water mains are on base. The Coordinated Water System Plan (CWSP) for Pierce County anticipates development of groundwater systems in conjunction with an expanded transmission and distribution grid that will allow districts to share their resources.

Pierce County provides sewer service in the Central Pierce area. The County maintains a 24-inch sewer interceptor that extends south from 176th Street East south down Meridian Avenue (Highway 161). Firgrove Water Company provides water service in the area. The company maintains a 12-inch main along Meridian Avenue past the site. Both Firgrove and Pierce County provide the Central Pierce Site with water and sewer service.

Water service is not provided on the military portion of the Fort Lewis site. On the portion of the site south of the reservation, water is provided by well systems. East of the site, water is supplied by the Richardson Water Company which maintains a 12-inch main along the highway.

Around the Loveland site, water service is provided by community water systems or private wells. East of the site, east of the National Park Highway (Mountain Highway), water is supplied by the Richardson Water Company which maintains a 12-inch main along the highway.

No sewer systems or sewer mains are located near the Olympia/Black Lake site. There is a 12-inch water main along Lathrop Road that is operated by a private water company in the area.

Water supply for the Grant County Airport is adequate and is supplied by the City of Moses Lake from ground water wells. A new two million gallon storage tank on the Airport is planned. The City also operates a waste water treatment facility on the airport as part of its larger facility. There are training facilities on the Airport operated by Big Bend Community College, and a small park area.

4.5.2.2 Education

The land use decisions of jurisdictions will cause some school districts to provide new facilities while other decisions addressing industrial and commercial needs will cause the school population to shift. Because school district boundaries could overlap jurisdictions and because special districts are not specifically required to plan by the GMA, the state's Department of Community Development (DCD) expects that school districts will collaborate with cities and counties to ensure school needs and capital facilities plans are incorporated into local comprehensive plans. At present, school facilities and services are partially based

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on school population projections from the state's Superintendent of Public Instruction and Office of Financial Management. These growth projections are provided for counties and school districts for six-year periods.

School planning depends on city and county comprehensive plans and demographics. Plans should include new facilities, new capacity, and what facilities need to be vacated or improved. Some school districts experience a range of demographic shifts which cause some schools to close and others to open. Well established neighborhoods comprised mainly of older families often have an insufficient school age population to support high school facilities. In addition, most families are having fewer children.

In both rural and urban settings, the type and location of school facilities depends on where the local jurisdiction decides to locate jobs and housing. In addition to the siting of new schools in the land use element of local plans, the impacts to existing schools should be addressed in the capital facilities element of comprehensive plans and investment strategies. For information on noise impacts to schools please see Section 4.1.2.6.

4.5.2.3 Waste Disposal

Waste disposal within communities is planned for through Solid Waste Management Plans (SWMPs) (RCW 70.95) and Solid Waste Advisory Committees (SWACs) (RCW 70.95.165). The SWACs are citizen advisory committees with representatives from citizen groups, recycling and environment interests, businesses, agriculture, and local governments. SWMPs are based on 20-year land use decisions and are updated every five years, and are to be incorporated into the land use and capital facilities elements of comprehensive plans.

4.5.2.4 Fire

Sea-Tac

Four fire districts provide fire protection and emergency medical services in the Sea-Tac area. All four districts are members of the King County Interlocal Mutual Aid Program, which allows each district to call on any other county district for assistance. In addition, each has first-alarm agreements with neighboring districts. This means that in the event of a major alarm, neighboring districts are notified at the same time as the jurisdictional district is notified.

The Port of Seattle Aviation Division has responsibility for fire fighting at Sea-Tac International Airport. The Port of Seattle has entered into mutual-aid agreements and back-up arrangements with King County and with local districts.

The King County International Airport has its own fire service. If supplemental coverage is needed, it is provided by Seattle, King County, Tukwila, and Boeing. The City of Seattle has a fire station at the Northeast corner of the field.

Northern Site Options

Several fire protection districts, including Fire Districts 1, 2, and 11 along with the cities of Everett, Mukilteo, Lynnwood and Edmonds, provide fire protection for the Paine Field area. A total of nine fire stations are located in the Paine field area. In addition, both Snohomish County and the Boeing Company maintain well-equipped and professionally manned fire stations at Paine field to provide fire protection for all property under their respective ownerships. Both of these stations have special equipment for handling aircraft accidents and petroleum fires. In addition, the airport has a backup agreement with the City of Everett.

Fire service for the Arlington Airport and vicinity is provided by the City of Arlington. Two fire stations, one near the downtown core and one on airport property, respond to emergency assistance calls in the area, depending on the nature of the call.

Southern Site Options

Fire protection at the Central Pierce site is provided by Fire District #9 and Fire District #21. Fire District #9 maintains a station at 172nd Street East and 110th Avenue East immediately east of Thun Air Field. Fire District #21 maintains a station at 188th Street East and 78th Avenue East and another station just south of the Paul Bunyan Rifle Range near 188th Street East and Highway 161. Because the Loveland area is not developed, only basic fire services are provided to support rural activities.

McChord Air Force Base maintains its own fire units. One fire station near the flight line serves the entire base. Its primary purpose is to respond to aircraft fire emergencies. The fire department also provides backup for Fort Lewis and the residential community of American Lake Gardens just south of the base.

Because the airport site option at Fort Lewis Military Reservation is remote, fire service is not readily available in the area. The southeast portion of the Fort Lewis Air Field, located in unincorporated Pierce County, is served by local fire districts.

Fire service in the area of Olympia/Black Lake is provided by District #11. The district is primarily volunteer. The nearest fire station is located at approximately 93rd Avenue and Lathrop Road.

Grant County

The Grant County Airport in Moses Lake was previously operated by the United States Air Force with most facilities and services already installed. The Port of Moses Lake now operates the airport.

4.5.2.5 Police

Sea-Tac

The Port of Seattle provides police services for Sea-Tac International Airport. The King County Police Department provides police protection to the neighborhoods surrounding Sea-Tac. The King County Police Department does not have a mutual agreement with the Port, but there is informal cooperation with other local jurisdictions on an incident-by-incident basis.

Multiple Airport System - Northern Site Options

Police services for the Arlington Airport and vicinity are provided by the City of Arlington. Police operations are centered in the central business district. Police protection in incorporated areas around Paine Field is provided by the cities of Everett, Mukilteo, Edmonds and Lynnwood. In unincorporated areas, the Snohomish County Sheriff's Department provides protection.

Multiple Airport Systems - Southern Site Options

McChord Air Force Base maintains its own police units. On base Security Police provide the police services. Military prisoners are brought to Fort Lewis for holding and sentencing. Because the airport site option at Fort Lewis Military Reservation is remote, police service is not readily available in the area. Police protection in unincorporated Pierce County is provided by the Pierce County Sheriff's Department.

Police services at the Olympia/Black Lake site option are provided by the Thurston County Sheriff's Department. The City of Tumwater occasionally provides mutual-aid assistance.

Grant County

The Grant County Airport in Moses Lake was previously operated by the United States Air Force with most facilities and services already installed. The Port of Moses Lake now operates the airport. Police services are operated by the Port of Moses Lake with mutual support agreements with the City of Moses Lake and Grant County.

4.5.3 Significant Impacts

The local demand for public services (including fire, police, water, and sewer service) would increase for each of the Flight Plan alternatives, including no-action. Due to the forecasted growth in passengers, the actual net demand for public services and utilities will depend upon specific types, densities and locations of commercial, light industrial, office space and other land uses. Because of the GMA concurrency requirement, adequate services must be provided (either developed or substantially planned for) before a new facility is developed. The GMA requires that public facilities and services "be adequate to serve development at the time the development is available for occupancy and use without decreasing current service levels" (RCW 36.70A.020(12)). Transportation improvements or strategies are required to be "concurrent with development" and this is defined as "in place at the time of development, or that a financial commitment is in place to complete the improvements or strategies within six years" (RCW 36.70A.070(6)).

Results would vary by location. The total cost of public services and utilities could be generally lower where there is existing infrastructure and where fewer new facilities are required. But, it is often less expensive to install new utilities in an undeveloped area than to upgrade facilities in an area that has inadequate utilities because of the costs of retrofitting and the removal of insufficient systems.

In general, of the locations considered for new airport facilities, the Sea-Tac and Paine Field areas have the most developed public service and utility infrastructure and would require fewer new services. Arlington, McChord, and the Central Pierce locations have somewhat limited infrastructures and would require substantial improvements. Fort Lewis, Loveland, and Olympia/Black Lake have very limited services, if any, and would require building entirely new infrastructure systems.

The location of industrial and commercial land uses such as airports affects school districts. Existing schools in close proximity to industrial, commercial, and airport uses generally experience declining enrollments due to the migration of homeowners to more residential and suburban neighborhoods. New schools are generally sited to serve residential units. School populations would increase in those areas where housing units are provided to support the work force needed at an airport and other induced development resulting from compatible commercial and industrial uses. For example, student population near Sea-Tac in the Highline School District is increasing at a rate of approximately 1 percent a year even though the district surrounds the Sea-Tac Airport. For more information on employment induced by airport development under each option, refer to Land Use, Section 4.4.2.3 and for noise impacts on schools see Section 4.1.2.6.

4.5.3.1 Sea-Tac Airport

The Sea-Tac area has the most public services available to accommodate expanded airport facilities of any of the site options. The public service impacts would be less because many facilities are already in place and may have sufficient service levels to meet increased needs.

With Broad System Management

There are no significant environmental impacts to most public services at Sea-Tac. Section 4.1 addresses the noise which may impact the surrounding communities. Required improvements can likely be accommodated in capital improvement plans and accounted for in the Capital Facilities Element and Public Utilities Elements of comprehensive plans.

Impacts on school enrollment in surrounding communities may be affected by airport development. A disincentive for residential development could occur because of noise impacts and adjacent commercial and industrial development.

If new development occurs faster in water deficient areas than new water supplies can be found, it is possible to delay or deny building permits (RCW 19.27.097). For instance, substantial new development may impact the Seattle Water System which provides wholesale water service to most of urbanized King County. The shortage of water for municipalities and water districts connected to the Seattle water system could impact development. For example, residential development could begin to concentrate more in areas with water surpluses.

All public services would require some expansion to accommodate direct and induced levels of activity at Sea-Tac Airport. The existing level and range of services available would minimize the additions required compared to less developed airport options; therefore, the impacts are not considered significant provided enough water is available.

With New Third Dependent Air Carrier Runway

The difference in activity levels would not result in significant differences in the demand for services. The impact analysis contained in the previous section on Sea-Tac Airport generally pertains to this option as well.

With Remote Airport

The south Seattle/Renton area has public services to meet the needs of Boeing Field. Utilities and public services may be sufficient to meet the needs of an expanded facility at Boeing; however, if it is determined that services should be upgraded, the impacts could be greater than in the Sea-Tac area.

The services at Boeing Field could be expanded without significant impacts. The school districts that may be affected are Renton 403, South Central 406, Highline 401, and adjacent districts.

The Moses Lake area has public services to meet the needs of Grant County Airport. Public services and utilities may be sufficient to meet the needs of an expanded facility; however, additional public services and utilities would be necessary to facilitate the expanded development associated with a commercial airfield. These impacts would be much greater than those in the Sea-Tac or Boeing Field areas.

4.5.3.2 Two-Airport System

Under a multiple airport system, if Sea-Tac doesn't have its capacity increased, the possibility exists for relatively more traffic to occur at the supplemental airport, thus raising utilities/public services impacts at these sites.

The Arlington area has public services to meet the needs of the existing Arlington Airport. Utilities and public services may be sufficient to meet the needs of an expanded facility; however, if it is determined that services should be upgraded, the impacts would be greater than in the more developed areas such as McChord, Paine Field or Sea-Tac. Arlington School District 16 and surrounding districts would need new facilities, sewer capacity would need to be increased, and other public services expanded.

The Air Force provides adequate services to meet the needs of McChord Air Force Base. Public utilities and services to a non-military civilian airport facility could be provided by

Pierce County or the local jurisdictions adjacent to McChord AFB, or possibly, although unlikely, an interlocal agreement could be arranged between the Air Force and the civilian airport to receive services from McChord AFB. Utilities and public services may be sufficient to meet the needs of an expanded facility; however, if it is determined that services should be upgraded, the impacts would be greater than in the more developed areas of Sea-Tac or Paine Field. Almost every public facility would need major expansion if an interlocal agreement for services cannot be formulated.

Public services and utilities to a non-military civilian airport facility could be provided by Pierce County or the local jurisdictions adjacent to Fort Lewis, or possibly, although unlikely, an interlocal agreement could be arranged between the Army and the civilian airport to receive services from Fort Lewis in the absence of an intergovernmental service agreement. Almost every public facility would need major expansion. As part of the Fort Lewis Military reservation, the area is outside any planned service area for public services. Development of an airport would require substantial development of new or greatly expanded infrastructure systems.

All public services would require expansion to accommodate direct and induced levels of activity at the Central Pierce location. A full range of services is available, however, and could provide some of the capacity needed for a supplemental airport. Several school districts would be affected; Puyallup 3, Franklin Pierce 402, Sumner 320, Orting 344, Bethel 403, and adjacent districts. Existing services would not be adequate for the proposed airport options in unincorporated Pierce County. Almost every public facility would need major expansion.

The Loveland site is in an area of Pierce County that is rural and developing. Services are limited. Public utilities and services could be provided by Pierce County or the local jurisdictions, or possibly, although unlikely, an interlocal agreement could be arranged with Fort Lewis for services. Almost every public facility would need major expansion in the absence of an intergovernmental agreement for services.

If a supplemental airport were located at Paine Field, the public services and utilities could be expanded without significant impacts. All public services would require some expansion to accommodate direct and induced levels of increased activity at Paine Field. The existing level and range of services would minimize the additions required, compared to less developed airport options.

In Thurston County, public services in the area of the Olympia/Black Lake option are limited. No sewer or sizeable water systems are in the area. Most residents have their own wells and septic systems. Because the site option area is located outside of Thurston County's Long-range Urban Growth Area boundary, only limited public services are planned. Development of an airport would require substantial development of new or greatly expanded public services infrastructure.

Water Supply and Sewer

Groundwater supplies in northern Snohomish County near Arlington are limited and would probably not be sufficient to serve an airport and surrounding activities. The North

Snohomish Coordinated Water Supply Plans (CWSP) anticipate a water transmission line to the Arlington area to tie into the City of Everett system and the Sultan River supply. Substantial improvement and expansion would be required to provide adequate sewage treatment capacity.

Both a new public water supply and sewage treatment facilities would be required at McChord AFB to serve the airport. Activities in the airport vicinity could be served to some extent by existing supply and treatment systems.

Education

The school districts that may be affected are Arlington 16, Lakewood 306, Marysville 25, and adjacent districts.

Development of an airport would require substantial development of new or greatly expanded infrastructure systems. The school district mostly affected is Bethel 403 with adjacent districts accommodating some of the growth.

Fire

Any substantial growth in the Arlington area, as the result of an expanded airport, would require additions to the fire services with more stations and equipment.

Any substantial growth in the McChord area would require additions to fire services with more stations and equipment. Services to duplicate the base's own fire service would be necessary.

At Central Pierce, based on conceptual drawings, the one runway option would displace the fire station at 188th Street and Highway 161 maintained by Fire District #21. The two runway option would displace both of the stations maintained by Fire District #21. Under the replacement airport option, all three fire stations would be displaced.

Police

Any substantial growth in the Arlington area, as the result of an expanded airport, would require additions to the police services with more stations and equipment.

Any substantial growth in the McChord area would require additions to police services with more stations and equipment. Services to duplicate the base's own police station would be necessary.

4.5.3.3 Three-Airport System

The locations above, as well as Paine Field, are considered for a three-airport system. Because air traffic would be dispersed among more locations, each supplemental airport would have less volume than under a two-airport system and only one runway would be needed at each location. The lower traffic volume would also result in correspondingly lower demands for services at each location. However, the total regional cost of supplying services would differ depending on the combination of sites chosen. For example, using two supplemental sites which already have developed services might be less expensive than newly constructing one supplemental airport that requires a completely new service infrastructure.

The services at Paine Field could be expanded with relatively insignificant impacts. All public services would require some expansion to accommodate direct and induced levels of increased activity at Paine Field. The existing level and range of services would minimize the additions required, compared to less developed airport options. The school districts that would be affected with Paine Field option would be Mukilteo 6, Everett 2, Edmonds 15, and adjacent districts.

4.5.3.4 Replacement Airport

As part of the Fort Lewis Military reservation, the area is outside any anticipated service area for public services. Development of an airport would require substantial development of new or greatly expanded public services and utilities infrastructure.

Planning for three runways at Fort Lewis would require substantial public service improvements. The GMA requires that urban level services be provided within the urban growth boundary or within fully contained new communities established in accordance with GMA. New airport facilities would need to comply with GMA concurrency and consistency requirements.

All public services would require significant expansion to accommodate direct and induced levels of activity at the Central Pierce location. In addition to those impacts already identified in the three airport system option, the three-runway option would displace both of the stations maintained by Fire District #21; therefore, under the replacement airport option, all three fire stations would be displaced.

4.5.3.5 No Action

The impact analysis contained in the previous section on Sea-Tac Airport with Broad System Management (Section 4.5.3.1.1) pertains to this option.

4.5.4 Mitigation Measures

Any possible mitigation procedures needed for public services would be the same for all sites. A level of service would be established for fire, police, and other public services by the local jurisdiction. Special district, water and sewer comprehensive plans, and regional plans would be incorporated in the jurisdictional comprehensive plan. The jurisdictional comprehensive plan would be coordinated and made consistent with county and regional plans. If the level of services for public utilities and services are determined to be adequate by the local jurisdiction and by other agencies for regional plans, there would be no impacts and consequently, no mitigation measures. The concurrency requirements of the GMA are intended to meet most of the requirements of mitigation.

State-level revenues, generated by statewide air travel capacity (involving siting of facilities of regional and statewide significance), could be provided through state legislation to help local governments meet their concurrency requirements under the GMA.

The state's Department of Community Development (DCD) has drafted a *Capital Facilities Plan Preparation Guide*, April 6, 1992, which can be used to help develop capital facility plans. Under the provisions of the GMA, schools can and should incorporate their capital needs in the capital facilities element of jurisdictional comprehensive plans to ensure concurrency. Several school districts in King County have submitted their capital plans to the county so impact fees can be collected to mitigate the impacts of development immediately. This procedure addresses and may fully accommodate impacts of development.

The process by which regional and state needs for major facilities are integrated into local comprehensive plans is important. The DCD is reviewing the comprehensive plan process and procedural criteria are being developed. Until the DCD publishes the final criteria, a typical process for the siting of public facilities would be as follows:

- Local communities would make land use decisions taking into consideration local, regional, state-wide, and federal needs, incorporating locally adopted levels of service. Public facilities would be identified by federal agencies, taken from the list prepared by the Office of Financial Management and needs identified by local and regional agencies. Siting of public facilities is required in the land use element of Comprehensive Plans (See Appendix B)

- The capital facilities element of Comprehensive Plans would be made consistent with the land use element, and address existing capacity and new requirements. Special district plans are to be incorporated. Funding would be identified.

- The utilities element would be made consistent with the land use element.

- The Comprehensive Plan would be made consistent with regional plans.

Because federal, state, and regional needs are not necessarily identified at the same time that local comprehensive plans are developed, the process for incorporating regional needs into comprehensive plans would take place when comprehensive plans are amended. Comprehensive plans can be amended once a year (RCW 36.70A.130). All required elements must be considered at the same time to ensure consistency.

Mitigation measures will vary proportionally with the impacts and will depend on adopted levels of service, and design and construction standards. In general, impacts to public services and utilities would be easier to mitigate at site options that have existing infrastructure.

4.5.5 Unavoidable Adverse Impacts

No unavoidable adverse impacts to public services have been identified at the regional level. Additional studies at the site-specific level will examine, in detail, impacts to public services and utilities and the costs associated with necessary mitigation.

4.6 NATURAL ENVIRONMENT

4.6.1 Overview

Two broad categories of the natural environment are addressed here. These are: Wetlands and Water, and Plants and Animals. The first category includes impacts to marshes, swamps, and open water; water quality; flooding and water quantity increases; drainage; and groundwater. The second category includes impacts to birds, fishes, and other animals, as well as to vegetation. The interrelationship between these two broad environmental categories is also acknowledged. Specific impacts at airport sites will be examined in detail in subsequent project-level environmental impact statement (EISs).

4.6.2 Affected Environment

4.6.2.1 Wetlands and Water

Wetlands serve a wide range of physical and biological functions important for surface and ground water quality and quantity control, and for wildlife habitat. These functions include erosion and sedimentation control, stormwater detention and flood flow attenuation, biofiltration and water quality enhancement, groundwater recharge, and habitat for a wide range of animals.

Because of these changes in the definition and regulation of wetlands, the web of regulations has expanded to include local as well as federal purview. A growing emphasis on local regulation of wetlands, in compliance with the state's Growth Management Act, and increased public awareness of the benefits of wetlands, has resulted in a high degree of variability statewide in the extent and stringency of wetland protection laws. Local governments in the Puget Sound basin are currently developing wetland protection programs based on a variety of available models. These local programs augment existing federal regulations defined by Section 404 of the Clean Water Act.

In addition to local and Section 404 regulations, Washington State's Department of Ecology has direct permitting authority over any wetlands associated with a "Shoreline of the State" under the State Shoreline Management Act. State guidelines for wetlands review under SEPA include avoidance of wetland impacts, and recommended mitigation standards. The current basis for Ecology review of wetland impacts is Governor Gardner's Executive Order 90-04 (April 21, 1990), which mandates Ecology to protect wetlands through SEPA to the "extent legally permissible".

The most predominant types of wetland in the region are palustrine freshwater wetlands. This category includes all vegetated freshwater marshes, swamps and bogs and open water areas that are less than 6 feet in depth. Palustrine wetlands support trees, shrubs and/or emergent vegetation and can also include open water areas. Based on a review of the National Wetland Inventory, county soil surveys and local resource inventories, all of the wetlands located on or directly adjacent to airport site options examined in Flight Plan are palustrine freshwater wetlands. A review of the Department of Natural Resources' Natural Heritage Program data base indicates that there are no exceptionally high-quality, natural heritage wetlands located near any of the site options (with the exception of Olympia/Black Lake).

Wetland resources in the vicinity of the site options are briefly summarized along with vegetation and wildlife in Section 4.6.2.2. This preliminary inventory of wetlands has not been verified by on-site analysis, which typically results in the identification of additional small to medium-sized wetlands not included in the National Wetlands Inventory. Additional, detailed site analysis will be required in the site-specific EIS phase of individual projects (see Section 1.1.3). In general, wetland resources in the vicinity of the site options sites are limited.

4.6.2.2 Vegetation and Wildlife

The landscape of the Puget Sound basin is a complex mosaic of natural and disturbed habitats, including forests, shrublands, wetlands, agricultural lands, and urban development. Wildlife diversity is related to the structure and species diversity within the vegetative communities, the size of the stands, and the contiguity with other habitats. Wetland areas and forested areas with well-developed shrub layers are likely to have the greatest numbers of wildlife species. On the other hand, urban areas are likely to support the fewest species. The wildlife diversity of any of the site options depends on the existing level of disturbance and the availability of different vegetative communities.

Most streams that drain directly or indirectly into Puget Sound support anadromous fishstocks unless natural barriers (e.g., falls, cascades etc.) or man-made barriers (dams, impassible culverts, etc.) exist in downstream reaches. Even streams that do not provide anadromous fish access to areas within the immediate site option areas might provide spawning and rearing habitat downstream of the site. In addition, many perennial streams also support resident populations of trout and coolwater fishes.

The Washington State Department of Fisheries' Catalog of Washington Streams and Salmon Utilization provides general descriptions of most western Washington rivers and streams. These descriptions include discussions of salmon usage, limiting factors, beneficial improvements, and habitat needs for the major basins and sub-basins. In addition, it contains maps which indicate stream lengths and total or partial fish barriers along with a list of species utilizing or believed to be found in each stream. In addition, the catalog must be augmented because it was published in 1975 and does not address non-salmon species such as trout, steelhead, or coolwater fishes.

4.6.2.3 Existing Conditions

The Washington State Department of Wildlife and the Natural Heritage Program were contacted for information on threatened, endangered, and sensitive plant and animal species. Results of their data searches are included below with description of existing conditions at each possible location.

Sea-Tac

The vicinity of Sea-Tac International Airport has been highly disturbed with residential, commercial, and industrial development, in addition to the existing airport facilities. However, there are a few remaining stands of deciduous and coniferous trees in the vicinity. Several small wetlands with open water are located both north and south of the present runways. A larger wetland complex to the west of the airport extends off site and includes forested, shrub, emergent and open water features. There are also some shrublands and open grassland areas in parks, a golf course, and abandoned residential zones. Mammals likely to occur in these habitats include a variety of small rodents, squirrels, shrews, moles, rabbits, raccoons, opossums, red foxes, and coyotes. The forested and shrubby areas provide habitat for a variety of songbirds. Migratory and wintering waterfowl utilize wetlands with open water. The golf course supports numerous Canada geese and gulls. Raptors in this vicinity may include red-tailed hawk, Cooper's hawk, and great horned owl. No threatened, endangered, or sensitive species of plants or animals are known to occur in the vicinity of Sea-Tac International Airport.

Northern Site Options

The dominant land use in the vicinity of the Arlington Airport is agricultural, including both crops and pastures. There are some forested areas just east of the airport and to the southwest near Smokey Point. A large forested, shrub and emergent wetland complex is located off site to the north of the airport, as well as two small wetlands on site. The wetland area to the north is associated with an extensive system of palustrine wetlands that drain to Portage Creek and the Stillaguamish River to the north. The agricultural lands support a variety of small rodents and rabbits, and larger mammals, such as coyotes and deer, may use these areas for occasional foraging. These open fields are likely to have a relatively low diversity of birds, although several species preferring grassland habitats could be present. Migratory waterfowl have been reported in moderately dense concentrations north and south of the airport, where they are likely to forage in open fields. The forested areas may support a moderate diversity of mammals and birds, although small stand size and isolation from other forests may limit the diversity. No threatened, endangered, or sensitive species of plants or animals are known to occur in the vicinity of Arlington Airport.

Much of the land around Paine Field has been significantly disturbed by urban development. However, there are some remaining areas of natural vegetation, including shrublands and wooded areas with second-growth coniferous and broadleaf trees. There are also large wetland areas with open water, emergent, forested and scrub/shrub habitats immediately to the south and east of Paine Field. This variety of cover types provides habitat for many of the common species of mammals and birds in the Puget Sound region. A breeding location for the bald eagle (*Haliaeetus leucocephalus*) has been reported west of the north end of Paine Field (Natural Heritage Data System, Department of Wildlife - Nongame Program). The bald eagle is federally- and state-listed as a threatened species.

Southern Site Options

The central Pierce County site includes a mixture of wooded areas with some open pasture land and a few scattered wetland areas. Wetlands on the site are primarily small scrub/shrub and emergent areas. A larger forested wetland is located in the central portion of the site. There is some commercial and residential development along Highway 161, and a small airport, Thun Field, is located on the eastern portion of the site. Wildlife on this site is probably comparable to that in the Arlington vicinity, except for a lack of waterfowl near the Central Pierce site. There is an unconfirmed report of a fisher (*Martes pennanti*) south of Thun Field. The fisher is a candidate for federal and state listing as threatened or endangered.

The site on McChord Air Force Base is highly disturbed by the existing runway and ground facilities. Some small linear wetland areas may be associated with the Morey Creek and Clover Creek drainages on the eastern edge of the site. No other wetlands have been identified immediately adjacent to the existing airfield. However, there are some remaining coniferous forest areas interspersed with open grasslands, particularly in the southern portion of the base. These habitats support a moderate diversity of small mammals and birds. Coyotes and deer are likely to be common, and black bears have been seen on the Air Force Base. Bald eagles are present in the Spanaway Lake vicinity, just southeast of this site, and on American Lake, to the west. The western gray squirrel (*Sciurus griseus*) has been reported in the vicinity of McChord Air Force Base. The western gray squirrel is a candidate for state listing as threatened or endangered. The white-top aster (*Aster curtus*) has also been reported from the McChord Air Force Base (Washington Natural Heritage Program, Washington Department of Natural Resources). The white-top aster is a federal and state candidate species for threatened or endangered status. It is endemic to natural prairies of the southern Puget Sound region.

The Fort Lewis vicinity is dominated by dry coniferous forest, but other habitats in the area include wet coniferous forest, wet and dry broadleaf forests, several small isolated wetlands, moist and dry thickets, and natural prairies. The area under consideration is relatively undisturbed, except for a few roads crossing the site. Because of the variety of habitats present, the relatively natural existing conditions, and the proximity to large areas of wildlife habitat to the east, this site probably has the greatest diversity of plants and animals of any of the sites options. Western gray squirrels are known to occur on Fort Lewis. The western bluebird, a state candidate species, is also known to occur on Fort Lewis in the vicinity of the proposed airport. The Oregon vesper sparrow and streaked horned lark are reported to be present in the vicinity of the proposed airport. These species are listed as monitor species by the State of Washington. On Fort Lewis they are likely to be found in the natural prairies. The white-top aster is also known to occur in natural prairies on Fort Lewis. The small-flowered trillium (*Trillium parviflorum*) has been reported from the vicinity of the proposed airport.

The Loveland site is northeast of the Fort Lewis site, east of State Road 7. This site has some forested habitats similar to those described above for Fort Lewis, and it probably has some natural prairie and oak woodland habitats. A complex of emergent and scrub/shrub wetlands occurs in the northwestern portion of the site. Based on the initial review of the site, these wetlands appear to be isolated from other surface waters. Portions of this site are used for agriculture, and there are several residential areas and some commercial development along State Road 7. Because this area is continuous with other relatively undisturbed regions of Fort Lewis, its wildlife diversity is likely to be similar to that elsewhere on the Fort. As with the preceding site, populations of western gray squirrel, western bluebird, and white-top aster have been reported in the vicinity of the Loveland site.

The Olympia/Blake Lake site provides habitat for the spotted frog and the Olympic mud minnow. The option area is also used as a diurnal migration route to and from the pastures and wet meadows that extend along the Black and Chehalis Rivers. Gulls are also attracted to the area for use as feeding grounds during the rainy season.

Remote Site

The Moses Lake site is significantly disturbed by a large, existing airport on the north edge of the town of Moses Lake. With regard to vegetation and wildlife, this site is quite different from the other sites under consideration. It is located in the eastern part of the state, in the rain shadow of the Cascade Mountains. Sagebrush is the dominant natural vegetation in this semi-arid region, but stream channels and marshes support a variety of riparian and emergent vegetation. However, there are no wetlands located on or immediately adjacent to the existing airport. Much of the land around Moses Lake has been converted to irrigated agricultural use, with a corresponding decrease in the diversity of mammals and birds that are likely to be present. The Gloyd Seeps Unit of the North Columbia Basin State Wildlife Area, which includes extensive wetland areas, is located about one mile northeast of the site, and the Moses Lake reservoir is about one mile southwest of the site. These areas support substantially greater populations of wildlife, particularly migratory waterfowl, than the surrounding shrubland and agricultural lands.

4.6.3 Significant Impacts

Potential impacts to wetland, wildlife and vegetation and overall changes in the natural environment would vary for the different site options. In general, development of new site options would cause more impacts to the natural environment and greater relative change.

The Puget Sound region is home to several species of threatened or endangered plants and animals, some of which may occur on one or more of the site options evaluated in this EIS. The confirmed existence of an endangered species or designated critical habitat for an endangered species would require additional site-specific biological investigations to assess the potential impact on the species. A potential for a significant impact on an endangered or threatened species might eliminate a site from further consideration. Impacts on wildlife on any site will depend on the extent and types of habitat that would be disturbed and on the availability of comparable habitats within a reasonable distance of the site.

Water quality in wetlands and fish-bearing streams can also be impacted by post-construction airport operations. Stormwater run-off from additional roads, parking lots, and other impervious surface areas will result in an increase in pollutant loading to wetlands and streams unless stormwater treatment facilities are included in the project.

An increase in the amount of impervious surface areas in potential recharge areas such as wetlands limits the groundwater recharge capabilities in the area. The resulting reduced low flows decrease the rearing habitat thereby reducing the carrying capacity of the stream and elevating water temperatures. Higher water temperatures increase the stress levels in fish resulting in a higher susceptibility to disease and mortality, as well as a reduction in feeding and subsequent growth rates. An increase in peripheral commercial and industrial development will further impact the surface water quality in the area from run-off. These impacts would be particularly severe in areas where significant commercial and industrial development does not already exist.

Siting an airport also has significant water quantity implications regarding streams and fish resources. Increasing the amount of impervious surface area would result in increased stream flows during storm events. Unless appropriate stormwater detention facilities are created, these increased flows can cause excessive scouring and erosion in the streams. Scouring and erosion destroy spawning areas by removing gravel and increasing the amount of fine sediments in the streambed; reduce rearing habitat by filling in pools and removing instream and/or streamside cover; and stress fish with increased suspended sediments. Benthic invertebrate populations reduced by altered hydrology are an important food source for fish. The cumulative effects of these impacts result in a decreased carrying capacity and lower fish production of the stream. In some instances, such as Des Moines Creek, high flows during major storm events are also believed to be responsible for displacing juvenile fish from the stream.

Encroachment into floodways and floodplains can cause significant impacts to both the project site if facilities are not properly flood-proofed and off-site areas that could be impacted by flood waters displaced by filling for the new project.

4.6.3.1 Sea-Tac Airport

With Broad System Management

Because there would be no new construction, this option would not require any loss of existing wetlands, vegetation and wildlife habitat. The additional disturbance due to increased numbers of flights would have an undetermined impact on small birds and mammals.

With New Third Dependent Air Carrier Runway

Construction of a new dependent runway on the west side of Sea-Tac International Airport would result in the loss of some wetland and shrubland habitat. No threatened or endangered species of plants or animals are known to occur in this vicinity. The additional disturbance due to increased numbers of flights would have an undetermined impact on small birds and mammals.

With Remote Airport

Development of a remote airport at either Boeing Field or Moses Lake could have some impact on wetlands and wildlife, depending on the specific site selected for development. Development of a previously undisturbed site could have a significant adverse impact on wetlands, vegetation and wildlife, whereas expansion of an existing facility might have relatively little effect.

The Moses Lake site is not known to have any threatened or endangered species. However, the Gloyd Seeps Unit of the North Columbia Basin State Wildlife Area, which includes extensive wetland areas, is located about one mile northeast of the site, and the Moses Lake reservoir is about one mile southwest of the site. There could be seasonal concentrations of migratory waterfowl in this wildlife area and on the reservoir, increasing the possibility of collision of aircraft with flocks of waterfowl.

The Moses Lake alternative would also require construction of a high-speed ground transportation connection between Sea-Tac and Moses Lake. If a rail connection were to follow the Interstate 90 corridor or existing railways, any additional impact on wetlands and upland habitats or wildlife would be studied in the rail project EIS.

The area around Boeing Field is highly developed with commercial and industrial uses. There are no wetlands located in the area, and it has little, if any, value as wildlife habitat. This alternative would likely have no significant adverse impacts on wildlife or fish.

4.6.3.2 Two-Airport System

Development of a supplemental airport could have some impact on wetlands and wildlife, depending on the specific site selected. Sites having diverse vegetative cover types, extensive wetlands with more than one vegetative category, and adjacent large areas of relatively undisturbed wildlife habitat would be most valuable to the greatest number of wildlife species. Sites of this type would also be most vulnerable to the disturbance resulting from construction and operation of an airport facility.

Of the supplemental airport locations that have been discussed, Arlington, Paine Field and McChord have existing airports. Each of these sites has wooded areas, wetlands and agricultural or open land in the near vicinity. There are no known threatened or endangered species in the vicinity of the Arlington site. The construction of new facilities would have relatively little direct impact on wetlands, vegetation or wildlife at these 3 sites above. Operation of commercial air traffic at Arlington could have an undetermined impact on migratory waterfowl that utilize areas north and south of the existing airport. Commercial air traffic at McChord could potentially disturb the bald eagles that nest in Spanaway Marsh and utilize the region of Spanaway Lake or the eagles nesting near American Lake.

Northern Site Options

The Arlington site is bounded on the north by Portage Creek and associated wetlands which is in the Stillaguamish River drainage, and on the south by the Middle Fork of Quilceda and Edgecomb Creeks which are in the Snohomish River Drainage. Although these creeks and wetland areas would not be directly impacted by construction of an airport, long-term and cumulative impacts caused by the increased impervious surface area, potential contamination by pollutants, and peripheral land development is likely to impact water quality and/or quantity in them. Portage Creek supports populations of coho, chum, and pink salmon, and possibly trout and cool water species. The Middle Fork of Quilceda and Edgecomb Creeks support coho salmon, and possibly chum salmon and/or other ubiquitous fish species. Although these creeks would not be directly impacted by construction activities, the long-term operations of an airport could impact the water quality and quantity of these waterways.

Southern Site Options

Development of a two-runway airport at the Central Pierce site would result in the permanent loss of more than two square miles of relatively undisturbed habitat and some forested and scrub/shrub wetland. No threatened or endangered species of plants or animals are known to occur on this site, although some of the species mentioned below for Fort Lewis could be present. There is an unconfirmed report of a fisher, a candidate species, in the vicinity of this site. The site is not a known migration corridor for birds or mammals.

No streams are located near the Central Pierce site although the upper Clover Creek watershed may be affected by stormwater run-off. Clover Creek is located within the McChord Airport area. However, a fish barrier located about three miles downstream of the site blocks access for coho salmon which spawn in the lower reaches. Efforts are currently underway to provide salmon access to the area, and coho fingerlings are being planted in the upper reaches for rearing. Expansion of airport facilities and associated developments in the area would further impact the water quality and quantity of the stream.

Development of a two-runway airport at the eastern edge of Fort Lewis would result in the permanent loss of two to three square miles of relatively undisturbed forested habitat with some interspersed natural prairies and some scattered isolated wetlands. Several sensitive, threatened, or endangered species of plants and animals may be present in the Fort Lewis vicinity. A pair of bald eagles (*Haliaeetus leucocephalus*) has a nest in the Spanaway Marsh region, northwest of the proposed airport site. Other bald eagles nest on American Lake near the northwest end of Fort Lewis. The bald eagle is listed as a threatened species by the Washington Department of Wildlife and the U.S. Fish and Wildlife Service.

Most of Fort Lewis has been designated as critical habitat for the endangered northern spotted owl (*Strix occidentalis caurina*). This area is unlikely to have nesting habitat for the owls, but it serves as a corridor connecting populations in the Cascades and the Olympic Peninsula. Other sensitive species in the Fort Lewis vicinity include the western gray squirrel, western bluebird, Oregon vesper sparrow, streaked horned lark, white-top aster, and small-flowered trillium.

The Fort Lewis site is bounded on the south by Muck and South Creeks and extensive associated wetlands, which support populations of coho and chum salmon. While structures and associated impervious surfaces are not anticipated in the creek basins, development could impact the water quality and quantity of these creeks and their associated wetlands. Muck Creek currently experiences low flow and high water temperature problems during summer months and development would worsen these conditions. The extension of the vegetation control zones south of the runways would eliminate portions of the Muck Creek and associated wetland canopy. Canopy removal would result in higher water temperatures and reduce the input of terrestrial insects to the creek, thereby reducing food availability for fish. The proposed runway safety areas would potentially impact the floodplain of Muck Creek.

Because the Loveland site is very close to the Fort Lewis site, regional impacts on the vegetation and wildlife are likely to be similar. There has been more previous development on the Loveland site, but there are still remaining areas of good wildlife habitat and more wetlands than on the Fort Lewis site. The threatened and endangered species mentioned above for the Fort Lewis site may also utilize some of the habitats in the Loveland area. This site is somewhat farther from the closest known bald eagle nest, and construction on this site would probably cause less disturbance to those birds than construction on Fort Lewis. Because of the existing residential, commercial, and agricultural areas, this site is likely to be less valuable to wildlife than the Fort Lewis site. The site is not a known migration corridor for birds or mammals.

An Olympia/Black Lake Option would result in considerable displacement of undisturbed wooded and wetland areas. These areas provide habitat for the spotted frog and Olympic mud minnow. In addition, the area is used as a diurnal waterfowl migration route to and from the pastures and wet meadows that extend along the Black and Chehalis River valleys. Gulls are also attracted to the area for use as feeding grounds during the rainy season. The development of the Olympia/Black Lake option would significantly disrupt this migration route as well as result in a large incidence of bird strikes or collisions of bird flocks and aircraft. There are often thousands of birds flying at altitudes varying from the surface to 2,000 feet.

Development of the Olympia/Black Lake site would impact fisheries in Salmon Creek, Allen Creek, and Bloom's Ditch. Site development would require culverting or moving portions of these creeks which currently provide spawning and rearing habitat for coho salmon, steelhead and cutthroat trout, and other indigenous species. In addition, the Olympic mud minnow which is listed by the U.S. Fish and Wildlife Service and the Washington Department of Wildlife (WDW) as a candidate for endangered species designation is also found throughout the area.

WDW estimates that the Olympia/Black Lake site development would impact about 80 acres of wetland. These wetlands provide valuable rearing habitat for resident fishes and help to maintain flows in the above mentioned creeks during summer low flow periods. Site development would further impact coho salmon and cutthroat trout production in these creeks which are already limited by low summer flows and high temperatures. Washington State Department of Fisheries indicates that development of this location has the greatest potential impact to fish life and habitat because of the direct impact and loss of area streams and wetlands, and the vulnerability and sensitivity of the Black River.

4.6.3.3 Three-Airport System

Potential impacts at Sea-Tac International Airport are discussed in Section 4.6.3.1. With a three-airport system, each of the two supplemental airports would require only one runway as compared with the two runways considered for the two-airport system. For the supplemental airports, expansion of existing facilities might have relatively little impact on wetlands, vegetation or wildlife, while development of an undisturbed site could have a significant adverse impact. Actual land area impacted for each airport would be somewhat less with one-runway than with a two-runway design.

Development of supplemental one-runway airports at Arlington, McChord, Central Pierce, Fort Lewis, or Loveland would have impacts similar to those described above. Because of the current level of development at Paine Field, the incremental effect of facilities for a one-runway airport is not likely to cause any significant impact on vegetation or wildlife. No direct impacts to wetlands are anticipated because all of the wetlands are located outside the proposed construction zone for the supplemental airport facilities. Several steep, short-run drainages exist north and to the west of Paine Field (including Big Gulch) which probably do not support significant populations of salmon. Flood Insurance Rate Maps were not prepared for Paine Field. The occurrence of floodplains and floodways on the site was not determined. Few significant flood prone areas, if any, are expected on the site since no major surface waters occur.

4.6.3.4 Replacement Airport

Under the Replacement Airport Alternative, Sea-Tac Airport would be closed and replaced with a new, three-runway airport at another location. Two locations are identified for possible study as a replacement airport—Fort Lewis and Central Pierce County. This alternative is likely to have the greatest impact on habitats and wildlife as a result of building a major airport in a relatively undisturbed site. Potential impacts to wetlands, wildlife and habitats on the Fort Lewis and Central Pierce sites have been discussed above under the Two-Airport System Alternative (Section 4.6.3.2). A three-runway airport at either of these sites would likely cause greater impacts to wildlife than a two-runway airport because of the larger extent of land disturbance and the more intense level of air traffic operations.

4.6.3.5 No Action

Under the No Action Alternative, no improvements or management actions would be taken to increase the capacity of the regional airport systems. This alternative would have no direct impact on wetlands, vegetation or wildlife. However, the sites that could have been developed as airport facilities could be available for some other type of commercial or industrial development, which could lead to impacts on natural habitats and wildlife similar to those described above.

4.6.4 Mitigation Measures

The preferred sequence of approaches to mitigation is avoidance of impacts, minimization of impacts, and compensatory mitigation. Complete avoidance of impacts to wetlands could also be achieved with the Broad Systems Management alternative for Sea-Tac Airport. Under that alternative, additional facilities would not be built but passenger handling ability would be moderately increased through travel and demand management techniques. However, this alternative could result in some additional disturbance to wildlife usage in the area due to the increased numbers of aircraft using the airport.

Impacts of the other alternatives could be minimized by using procedures during construction and operation that would tend to reduce the adverse effects on wetlands, vegetation and wildlife. There are several possible actions that could reduce the degree of impact of expanding air travel capacity:

- Selection of sites that are already developed or otherwise disturbed would reduce the extent of natural habitat that would be lost.

- Within any given site option, the actual layout of the facilities could be planned to avoid the most valuable wildlife habitats. In particular, wooded areas and wetlands should be left undisturbed to the extent possible.

- Proper timing of construction activities might reduce direct wildlife impacts. To avoid disturbance of bird nests or mammal dens with young, initial site clearing and grading should not be done during the spring and early summer.

- For sites with threatened or endangered species of plants or animals, additional site-specific biological assessment work would be necessary to more adequately define the anticipated activities and potential for significant adverse impacts to those species. Such issues would be addressed in project-level studies. Specific mitigation proposals would be developed as necessary for the affected species.

- At the site level, address runoff volume and quality in drainage plans (Airport operators, local governments).

- Develop in VISION 2020 a regional natural systems element that is supportive of local comprehensive plans (local governments working through the Regional Council).

- Review water quality issues at the site level (U.S. Fish and Wildlife Service, Ecology, Corps of Engineers).

<u>Compensatory Mitigation</u>

If neither avoidance nor minimization of impacts is adequate for protection of wetlands, wildlife and habitats on the sites selected, compensatory mitigation efforts would be explored. The preferred form of compensatory mitigation would be to create a new habitat comparable in size and function to that destroyed in the construction and as close to the construction site as possible. However, wetland mitigation too close to the airport may attract birds and potentially create a safety hazard. The mitigation site should be in an area with comparable soil and drainage characteristics, in order to be capable of supporting the vegetation to be planted.

On-site analysis will be required to determine the level of wetland quality and the feasibility and design objectives of wetland mitigation. Ecology recommends wetland replacement ratios ranging from 1.0:1 (one acre of replacement wetland for each acre impacted) for open water habitats to 3.0:1 for forested wetland systems, and protecting wetlands with buffers ranging from 25 to 300 feet depending on the quality of the wetland. Replacement sites often are unsuccessful and have not been attempted in sizes larger than several acres. Additional local requirements may apply. Special care will be required in the design of a mitigation project if threatened or endangered species are involved.

Most impacts to surface waters due to excess stormwater runoff or impacts to water quality can be mitigated using Best Management Practices (BMPs). BMPs include constructing stormwater management facilities and other techniques to detain excess runoff, remove pollutants from stormwater, and reduce sedimentation and erosion. Mitigation of these impacts would consist of providing positive drainage, such as a ditch or storm sewer, to surface waters such as a lake or stream. The occurrence of a receiving water near a site would minimize the potential impacts and costs for mitigation. The cost of BMPs varies between sites depending on existing runoff characteristics and drainage patterns, area of new impervious surfaces proposed, existing drainage infrastructure, and permitting requirements.

An industrial waste treatment system (IWS) is also necessary to prevent pollutants from fueling, maintenance, and de-icing areas, as well as runways, from entering area streams. Sea-Tac presently maintains an IWS. The system is designed to treat fuel spills in the highest risk areas (including the tank farm, the ramps, and the parking garage). It separates the fuel (which is then sent for recycling) and sends the remaining waste water directly to Puget Sound. Industrial waste systems at other airport sites would be considered at the site-specific level.

Groundwater impacts could occur due to infiltration from detention facilities. Lining stormwater ponds effectively mitigates these impacts. However, low flow impacts are commonly mitigated by constructing infiltration ponds. Balancing mitigation of these groundwater impacts may require costly designs and additional mitigation, such as waste treatment systems. Sites with low recharge or that are not susceptible to pollutant impacts would be preferred.

Mitigation costs will depend on the site options selected. In general, developing new site options will require more capital input for mitigation than site options with existing airport facilities. If the project site cannot be mitigated or if mitigation is not adequate, the project may not be able to proceed.

4.6.5 Unavoidable Adverse Impacts

Some loss of wildlife habitat, wetlands and fisheries is unavoidable under any alternative except the no-action and broad system management alternatives. Further analysis will be done at the site-specific level to determine unavoidable adverse impacts related to each system alternative.

4.7 EARTH

4.7.1 Overview

Since earth impacts are very site-dependent, the level of analysis in this FEIS is broadly based. Soil types existing at each of the site options are discussed as well as preliminary estimates of the amount of grading and excavation that would be required to implement the various system alternatives at the site options (See Table 4-21). Construction impacts due to grading, excavation and fill; the location of earth sources or earth disposal sites; impacts to local topography; and other specific earth-related impacts will be examined in project-level studies to be conducted in the future.

4.7.2 Affected Environment

Typically, the Puget Sound region consists of one or more soils types or series (referred to as an association). The following is a brief description of the range of soils found in the Puget Sound region which could be impacted under the Flight Plan project:

- **Alderwood-Everett Association** soils typically develop on glacial till material. These soils are generally characterized as moderately well drained, having seasonal ground-water tables well below the surface with a low-to-moderate erosion hazard. Normally, the surface layer and upper part of the subsoil are gravelly sandy loam. The lower part of the subsoil is very gravelly sandy loam. These soils have the natural ability to support heavy loads. The main limitations of the Alderwood-Everett Association soils, for urban development are: seasonal soil wetness, depth to hardpan, and steepness of slope.

- **Norma-Lynnwood-Custer** soils tend to be poorly drained and found on outwash plains. The main limitations to urban development are soil wetness and ponding.

- **Mukilteo Series** soils tend to be very poorly drained and may present development limitations due to ponding.

In general, the Puget Sound region tends to have suitable soils for development. The exception is the Arlington area, which includes poorly drained soils that may impose some limitations on construction (soils would have to be removed or extensive drainage systems constructed). All of the site options appear to have soils that would allow for airport construction. Additional soils analysis for each location will need to be conducted to determine specific soil types, suitability and potential impacts. Replacement airports would require the largest quantities of fill materials. The supplemental airport option would require significantly less.

4.7.3 Significant Impacts

All soil surfaces are subject to natural forces of chemical physical weathering that result in erosion. The susceptibility to erosion is dependent on the physical characteristics of the soil, vegetative cover, topography (slope), and the intensity and duration of storms. Stormwater runoff is the greatest single factor affecting erosion in the Puget Sound region. Removal of the vegetative cover increases the erosion rate. Erosion would be minimal on most locations due primarily to the low gradient.

Grading and excavations would be required to varying degrees for each of the options available. Fill, excavation, and site grading would change the local topography. Preliminary estimates on the amount of fill required for the various alternatives are as follows in Table 4-21. (Note, these are only preliminary estimates. Further analysis would be conducted during site specific environmental review processes.)

Table 4-21. Estimated grading and excavation quantities (cubic yards: yd^3)

Sea-Tac (new dependent air carrier runway)	13,682,000 yd^3
Arlington with runway extension	100 acres light grading
New dependent air carrier runway	500 acres light grading
Paine Field with existing airport	400,000 yd^3
Central Pierce Replacement airport	36,000,000 yd^3
Two-runway airport	17,000,000 yd^3
One-runway airport	9,120,000 yd^3
McChord with existing airfield	745 acres light grading
New dependent air carrier runway	800 acres light grading
Fort Lewis replacement airport	36,000,000 yd^3
Olympia/Black Lake supplemental airport	
Two-runway airport	19,280,000 yd^3
One-runway airport	6,400,000 yd^3

4.7.3.1 Sea-Tac

Soils in the Sea-Tac area are primarily within the Alderwood-Everett Association and are suitable for development.

Since no new development would occur under the system management options, there would be no impacts to earth under this alternative. Extensive fill would be necessary to build the new air carrier runway at Sea-Tac. The source of fill material has not been identified and would be determined in project-level studies. No other impacts to earth have been identified. Use of Boeing Field or Grant County Airport near Moses Lake would not significantly impact earth resources at either site.

4.7.3.2 Two-Airport System

Impacts to earth resources at Sea-Tac Airport are discussed above.

North Site Options

The Arlington area is composed of poorly drained Norma-Lynnwood-Custer Association (south of 172nd Street). These soils may impose some limitations on construction (soils would have to be removed or extensive drainage systems constructed). Also, the Arlington airport is located on the Tulalip sole-source aquifer designated by the EPA. This designation does not preclude development, but does establish a process whereby the EPA reviews all federally assisted projects. These reviews are to ensure that proper design, construction, and operational controls are used to protect the aquifer from contamination which could cause significant adverse affects on the public health.

If a second airport was not sited in either Arlington or in the south, one runway at Paine Field might be used as a second airport within the Two-Airport Multiple Airport System. In this case, soils at the Paine Field location generally belong to the Alderwood-Everett Association. In addition, some soils are from the Mukilteo Series. These soils are better for development than those at the Arlington Airport.

South Site Options

In general, there would not be as many impacts on earth for the southern airport sites. The McChord area has a thick blanket of partially consolidated glacial deposits consisting mainly of sand and gravel. The soils tend to be excessively drained, gravelly sandy loams and suitable for construction. Soils at the Fort Lewis and Loveland locations are similar to those underlying the McChord site. Soils at the Central Pierce site belong to the Alderwood-Everett Association. The Olympia/Black Lake site option soils generally belong to the Alderwood-Everett Association.

The McChord, Fort Lewis, and Loveland airport site options are located above the Clover Chamber's Creek aquifer, an important groundwater resource for south and east Pierce County. A petition has been filed with the EPA for designation as a sole-source aquifer, and is expected to be granted within a year. The implications of this designation are discussed above for the Arlington site.

4.7.3.3 Three-Airport System

Impacts to earth resources at the Sea-Tac Airport would be similar to those discussed in Section 4.7.3.1. However, one runway would be developed in the north and one in the south.

North Site Options

Impacts to Arlington would be similar to those discussed in Section 4.7.3.2, Two-Airport System, except not as severe since only one runway would be developed.

Soils at the Paine Field location generally belong to the Alderwood-Everett Association. In addition, some soils are from the Mukilteo Series. These soils are better for development than those at the Arlington Airport.

South Site Options

Impacts to earth resources at the southern airport site options would be similar to those discussed in Section 4.7.3.2, Two-Airport System.

4.7.3.4 Replacement Airport

If an airport were built to replace the existing Sea-Tac Airport, it would likely be developed in southern Puget Sound region, not in Fort Lewis or Central Pierce. The new airport would have three-runways which would require extensive grading at either site. Construction of an airport at the Central Pierce site would require removing and disposing of material contained in the Hidden Valley Landfill.

4.7.3.5 No-Action

If improvements to the existing airport system do not take place, earth resources in the Puget Sound region would not be significantly affected. Areas that would have been considered for airport development would be available for other projects, or would remain in their current uses.

4.7.4 Mitigation Measures

Avoiding all sensitive areas with potential geologic hazards would eliminate significant impacts to earth resources. Modern construction practices and minimizing earth movement during rainy seasons should control most earth impacts. Site specific impacts and mitigation will be addressed in project level studies.

4.7.5 Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to earth resources are expected at the regional level. However, site-specific impacts could result from moving large quantities of earth. These issues will be examined in project-level EISs.

4.8 ENERGY OVERVIEW

Energy consumption is related to aircraft operations and ground travel to and from the airport. Energy planning is not a requirement of the Growth Management Act. The following information provides a general overview to be detailed further in site-specific studies. It also may help work toward the goals of the Washington Energy Strategy Committee (Washington's Energy Strategy, Draft, 3 August 1992). The Committee recommends work toward a comprehensive state-level least-cost transportation plan.

4.8.1 Comparison of Modes

A possible long-term policy issue for the state is the tradeoffs between modes of transportation (rail, air, and highways). This issue is raised by the Washington State Air Transportation Commission. Background information at the national level is provided as part of this non-project FEIS for regional commercial air transportation.

Of total transportation energy used in the United States in 1988, 72.9 percent was consumed by highway mode while the non-highway modes (air, water and rail) accounted for 20.7 percent. Highway energy use has increased 2.4 percent per year since 1984, due largely to trucking increases. The ability for regional air carrier capabilities to connect with air and sea travel modes may be an energy efficient alternative to trucking, depending upon per-unit energy consumption under each mode. This is examined below.

On a per passenger-mile basis, almost all passenger modes have experienced improved efficiencies since 1982. The greatest improvement was in intercity rail (AMTRAK). Among all freight modes, heavier trucks were the only mode to have an increase in energy intensity on a per vehicle-mile basis. This is due to the use of larger trucks hauling larger loads, not necessarily an inefficiency in transporting goods.

Table 4-22 indicates the comparative energy efficiencies (measured in British thermal units--Btu's) of different modes of transportation for 1988. We may assume an average travel distance of roughly 25 miles to the airport(s) and an average air travel distance of 500 to 1000 miles. (The average domestic trip length in 1991 was 807 miles.) With these working assumptions, the ground travel component of air travel accounts for perhaps 2 to 5 percent of total energy consumed by air passengers.

These general figures indicate that intercity Amtrak is the most efficient on a per mile basis, while general aviation is the least efficient by a considerable margin. (General aviation is more competitive when we recall that the more direct travel routes reduce overall mileage per passenger.) The remaining modes are clustered fairly closely together. Per passenger-mile figures for auto and for air carrier transportation are remarkably similar.

The total energy use (trillions of Btu's) for these modes is shaped by the numbers of vehicles, the vehicle miles traveled, the passenger miles and load factors, and the energy consumed per vehicle mile. Energy use by mode is summarized in Table 4-23.

Nationwide, auto travel consumes over five times the fuel of air carrier while serving seven times the passenger miles traveled. Commercial air transportation consumes 30 times more fuel than intercity Amtrak and rail transit, while serving roughly 20 times the passenger miles. On an international basis, up to 13 to 14 percent of the world's annual consumption of transportation fuel is for aviation (some estimates say 5 to 12 percent). This was 176 million tons in 1990. (International Energy Agency, cited by Robert Egli, Environment, November 1991).

4.8.2 Ground Travel Fuel Consumption

Within the central Puget Sound region, fuel consumption by ground transportation reflects the travel distances and speeds to airport services under each of the regional alternatives. These figures are directly proportional to mileage figures reported in the Surface Transportation section of the FEIS (see Section 4.3) and to the pollution emission figures reported in the Air Quality section (see Section 4.2).

Fuel consumption factors within the regional transportation models are specific to speeds and type of highway facility, but generally are between 10.0 and 14.5 miles per gallon. Fuel consumption in 2010 is estimated roughly 150,000 gallons to 200,000 gallons per day at the low end to perhaps 200,000 to 300,000 gallons per day at the high end. The access assumption is that 75 percent of air passengers would use single-occupancy vehicles.

Table 4-22

ENERGY EFFICIENCY BY MODE (British Thermal Units--BTUs)

Mode	Per Vehicle-Mile	Per Passenger-Mile
Auto	6,275	3,598
Transit	39,121	3,415
Air		
(Air Carrier)		4,814
(General Aviation)		11,966
Rail transit		
(Intercity Amtrak)		2,462
(Rail Transit)		3,585

(Source: Transportation Energy Data Book: Edition 11, Stacy Davis and Patricia Hu, Office of Transportation Technologies, U.S. Department of Energy, January 1991, Table 2.14.

Table 4-23

TOTAL ENERGY USE BY MODE

Mode	Vehicles (thousands)	Passenger Miles (millions)	Energy Use (trillion Btu)
Auto	141,252	2,492,805	8,968.6
Transit	579.5	127,679	159.2
Air			
(Air Carrier)		334,235	1,608.9
(General Aviation)	210.3	12,100	148.5
Rail			
(Intercity Amtrak)	2.2	5,686	14.0
(Rail Transit)	11.4	11,772	42.2

(Source: Davis and Hu, Table 2.13)

From the above tables, it can be seen that intercity rail (Amtrak) requires approximately two-thirds the fuel required by automobile, on a passenger-mile basis. This fact would generally support systems providing rail access to airport facilities, assuming that air carrier passengers would begin to show a preference for this alternative. This generally has not been the case in other regions, partly due to the inconvenience of luggage handling and waiting periods.

4.8.3 Aircraft Fuel Consumption

Typical fuel usage by aircraft are summarized in Table 4-24. A landing takeoff (LTO) cycle is comprised of one aircraft landing at the airport and then taking off from the airport, and is used for air quality analysis.

Table 4-24

AIRCRAFT FUEL CONSUMPTION

Aircraft	Fuel Usage Lbs. per LTO	Fuel Usage Lbs. per Minute of Delay
Boeing 737-300	799	32
Airbus 320	799	32
Boeing 757	1367	53
BAe146	543	21
MD-80	969	36
Fokker 100	271	11
Boeing 767	1542	62

(Source: Correspondence, Mestre Greve Associates, 5 June 1992)

4.8.4 Mitigation

Technologies for increasing fuel efficiencies include engine improvements (ultra-high bypass engines--UHB--such as the prop-fan), drag reduction (through laminar flow turbulence control and active flight controls), and reduction of aircraft structural weight with new materials. The combination of advanced engine core technology with UHB engines has been predicted by some analysts to provide up to 40 percent improvement in fuel efficiency.

Attractiveness of some of these actions appears to depend upon large increases in energy prices, perhaps a two- or three-fold increase up to $1.50 per gallon. (Gosling, Kanafani and West, Potential Roles of New Technology in the California Aviation System, May 1990, p. 41).

Within the airline industry, high load factors (more efficient scheduling) would result in greater energy efficiencies. This is related to fluctuating energy costs which are only one of several market factors influencing complex airline scheduling decisions. Airline fuel prices have dropped dramatically in recent years, but now are climbing (over the short term, 12 percent in the first quarter of 1992).

The Washington Energy Strategy Committee recommendation addresses the relationship between land use, air quality and transportation:

> "The Committee recommends development of a **comprehensive state-level least cost transportation plan**, borrowing from the techniques we use to guide investments in the electricity sector. In electricity planning, this technique is used to project demand; to identify "least cost" alternatives for meeting demand, including consideration of environmental factors; to guide investments in supply or efficiency measures; and to monitor successes and failures. The Committee has not taken such a comprehensive approach in transportation, and would encourage adoption of this approach to reduce congestion, improve air quality, reduce energy use, and promote community revitalization." (Washington Energy Strategy, Draft, 3 August 1992)

Potential Regional and Site-Specific Actions

(a) Implement new federal and state transportation planning requirements (Regional Council and local governments)

(b) Implement the multimodal aspects of the federal Intermodal Surface Transportation Efficiency Act (ISTEA) legislation. (Regional Council, the State, and local governments)

(c) Work toward greater airport capacity and efficiency of operations, and continue to develop multimodal passenger and cargo handling capabilities. (Port of Seattle)

4.9 PUBLIC SAFETY OVERVIEW

4.9.1 Introduction

Safety actions are evaluated at the site level. This non-project FEIS addresses broader safety issues from the systems level, and reports on national trends for air carrier, commuter and general aviation aircraft.

The level of risk of aircraft accidents is an important question related to the location or expansion of air carrier facilities, particularly in urban areas. Aircraft accidents are rare compared to the amount of travel involved. Accidents are attributed to several reasons, including pilot error, mechanical defects, poor weather conditions, improper airspace management, etc. Accidents may occur at or near airports, or they may occur en route. Accident information is maintained by the Research and Special Programs Administration (RSPA) of the U.S. Department of Transportation and reported by the National Transportation Safety Board (NTSB). This information is briefly presented here.

The reader is cautioned that because the number of accidents is small, the percentage distribution assigned to causes can vary significantly from year to year. The NTSB defines an accident as flight events which "as a result of the operation of an aircraft, any person (occupant or non-occupant) receives fatal or serious injury or any aircraft receives substantial damage."

4.9.2 General

The number of aircraft operations in the region will increase in the future. In addition to the 50 percent increase in air carrier operations by 2020, general aviation also is expected to increase at a rate slightly above the rate of population growth.

National statistics show that a large share of all aircraft accidents involve short landings, missed takeoffs, or runway overruns. These are addressed at the site level. For example, the FAA imposes height restrictions for buildings near airports. Nearly all of the commercial aircraft runway events are contained within 1,000 feet of the ends of the runways (on airport property). Eighty-three percent of undershoots (between 1978 and 1987) occurred within 1,000 feet of the runway end and all were within 1600 feet. Over ninety-three percent of overruns were within 1000 feet of the runway and all were contained within 1600 feet. (Advisory Circular 150/5300-13, Appendix 8, and Location of Commercial Aircraft Accidents/Incidents Relative to Runways, July 1990, DOT/ FAA/AOV 90-1). These accidents/incidents tend to cluster around the extended centerline of the runway. Of 500 incidents between 1978 and 1987, approximately half were identified as relevant for inclusion in the cited DOT study, and 87 of these occurred during landing or takeoff, but are not included in the previous results. Several of these involve landings or takeoffs "in the vicinity of the airport", some at distances greater than 6000 feet.

As a standard airport design feature, runways are required by FAA to include an obstacle-free zone (OFZ) and a runway safety area. These are defined in Advisory Circular 150/5300-13, Appendix 8.

A range of safety measures is monitored annually for all aircraft. This includes general aviation aircraft. Nationally, the number of incidents declined in all categories between June of 1991 and 1992. For example, the number of near midair collisions (this occurs when one plane passes within 500 feet of another) dropped 10 percent (from 388 to 350, and still lower than the 1990 figure of 500). (Source: Aviation Safety Statistics: Monthly Report for June 1992, Office of the Associate Administrator for Aviation Safety, August 11, 1992).

The following subsections report on commercial aircraft. In this presentation, the "hours flown" vary for (a) large planes, (b) scheduled commuter planes, and (c) non-scheduled commuter flights (e.g., charter planes). In 1988 large planes flew 11.1 million hours. Scheduled commuter planes flew 2.1 million hours. Non-scheduled commuter planes flew 2.8 million hours. These total figures should be kept in mind when comparing accident rates per 100,000 hours flown for each of these categories.

4.9.3 Air Carrier

Internationally, the overall accident trend (including in-flight) for large U.S. registered planes relative to total flight hours diminishes yearly. For major airlines, large private aircraft, and scheduled helicopter service, the accident rate in 1988 was 0.251 per 100,000 hours flown, a 24.2 percent decrease over the 1987 rate (0.331). The 1988 rate was also lower than the overall rate of 0.301 for the ten-year period between 1978 and 1987. Nevertheless, the three fatal accidents involved resulted in 285 fatalities (statistically this included the sabotage of a Boeing 747 over Lockerbie, Scotland, and the loss of 270 lives).

This improving trend in accidents per hours flown is offset by the increasing total amount of travel hours each year. The number of accidents between 1984 and 1988 varied with a low of 7 and high of 29.

For the 1983-1988 period, more than one-fourth of all accidents were due to in-flight encounters with weather, and an additional one-eighth were due to equipment failures or malfunctions. Other major causes were on-ground collisions with objects (8.1 percent), in-flight loss of control (5.6 percent) and in-flight collisions with objects (4.8 percent). The distribution of accidents by phase of operation for 1978-88 is takeoff (19.4 percent), cruise (19.4), landing (14.5), approach (9.7), climb (8.9), descent (8.9), taxi (7.3), standing 6.5), not reported (4.8), and other (0.8). (All data selected from the most recently published figures in the "Annual Review of Aircraft Accident Data," National Transportation Safety Board, NTSB/ARC-91/01).

While the accident rate has declined, the maintenance record apparently has been questioned in at least one respect at the federal level. In 1991 the General Accounting Office reported that airframe repairs had been completed on only 28 of over 1,300 aging aircraft operated by 17 U.S. air carriers. The worldwide commercial fleet has 4,100 planes, with an average age of 10.5 years (cited in Parade Magazine, June 14, 1992--original source on order).

In 1988 the number of accidents (29) compared to the number of operations (15.2 million arrivals and departures) results in a ratio of 1.9 accidents per one million operations. Statistically, this might imply one accident every two years for the level of air carrier operations forecasted for this region in 2020 (326,000). Of the 29 accidents for U.S. registered planes in 1988, three involved fatalities.

4.9.4 Commuter Aircraft

For scheduled commuter aircraft the accident rates are higher than for the larger air carrier aircraft reported above. The average was 31.5 for the period 1978 through 1987. The accident rate per 100,000 hours flown for 1988 is 0.911 (compared to 0.251 for air carrier). This is less than half of the rate for the preceding ten-year period (the rate in 1978 was 4.685 per 100,000). Of the 19 accidents in 1988, two were fatal, involving 21 fatalities. Major causes were: airframe/component/system failure/malfunction (21.1 percent), hard landing (10.5 percent), on-ground collision (10.5 percent) and loss of power (10.5 percent). The distribution of these events for 1978-1988 was as follows: approach (28.7 percent), landing (17.6), takeoff (13.9), taxi (10.2), cruising (7.4), climb (6.5), descent (5.6), maneuvering (1.9), standing (4.6), other (2.8), not reported (0.9).

In 1988 a comparison of total accidents (19) to the total number of operations (5.8 million) results in a ratio of 3.3 accidents per million operations. For the Puget Sound region this might imply one accident every two years for the level of commuter operations forecasted for the year 2020. Of the 19 accidents nationwide in 1988, two involved fatalities.

4.9.5 Non-Scheduled Commuter Aircraft

For non-scheduled commuter aircraft (e.g., charter flights), the accident rate compared to hours flown is higher than for scheduled commuter flights. (Supporting material is estimated by the National Transportation Safety Board, based on data obtained by the Federal Aviation Administration in its surveys of general aviation activities).

The average accident rate for the 1978-87 period is 4.71 per 100,000 hours flown, and 3.38 per 100,000 for 1988. The 1988 fatal accident rate of 0.95 is the lowest since 1984. The distribution of all accidents is somewhat similar to that for scheduled commuter operations: takeoff (21.0 percent), cruise (20.7), landing (20.4), approach (11.8).

4.9.6 Comparison of System Alternatives

The safety criterion does not yield a clear ranking of alternatives. The most effective safety measures--improved aircraft and navigation technology--apply to all alternatives. However, these highlights are evident.

- The no-action alternative is the least safe, in that it allows congestion at Sea-Tac Airport to continue unabated.
- The Sea-Tac site options offer varied safety implications. The use of Boeing Field as a remote airport entails continued airspace interactions with Sea-Tac. The Moses Lake remote airport site would improve safety in that it removes some flights from the complex regional airspace.
- Improved technology (including the new ATC features at the Auburn regional facility) benefit air passengers in all instances. Demand management would offer safety benefits by moderating peak period traffic.
- The replacement airport alternative would simply move operations to a new site. The Central Pierce site is adjacent to military operations, but (unlike Sea-Tac) is offset from the north-south approaches to McChord Air Force Base. This statement also applies to the southern supplemental airport site options.
- The multiple airport systems remove some congestion from Sea-Tac, but require airspace management decisions to minimize issues of overlapping airspace midway between Sea-Tac and any of the supplemental airport sites. Northern supplemental sites involve airspace coordination with Whidbey Naval Air Station and with Vancouver, B.C., airspace.

4.9.6.1 Present Conditions

The periodic loss of one of the two runways at Sea-Tac (44 percent of the time, due to weather) involves a safety consideration as airline operations continue to increase. Therefore, the different regional alternatives for handling growing air carrier demand involve the growing need to review related airspace. Overall, the Puget Sound airspace is confined by the Cascade Mountains to the east and the Olympic Mountains to the west. This limits site availability to a north-south alignment within a region that is highly urban. Sites with less congested airspace are those located most remote from the user populations. The resulting issue is one of airspace interaction between existing Sea-Tac operations and candidate supplemental airports or Boeing Field.

Sea-Tac operations are coordinated with the overlapping Boeing Field airspace through unique site-specific procedures that allow concurrent approaches during conditions when the cloud ceiling is below 2,500 feet. Without this procedure, the addressed safety concerns would reduce the airspace capacity.

4.9.6.2 The Future

The above information does not result in a precise comparison of the regional airport system alternatives presented in this FEIS. A large share of aircraft accidents occur on airport property. This factor could be affected by the selection of a particular regional airport system alternative if the system involves complicated ground taxiing or complex airspace interactions during bad weather. Solutions to these potential issues will be a major focus of site-specific studies.

Beyond this, it can be inferred that regional airspace coordination (see Section 4.10) must be part of any long-range regional system, and that aircraft technology is an important element of public safety. Improved safety might involve a tradeoff with noise concerns. Improved navigation equipment, for example, improves approaches and landings, but at the same time has ambivalent noise benefits. For example, a Microwave Landing System enables more precise adherence to a wider range of possible flight tracks and the possible use of curved flight tracks (e.g., the curved noise corridor in the south-flow condition over the Duwamish into Seattle-Tacoma International Airport).

But, due to improved efficiency, MLS also enables a larger number of flights (i.e., noise events) to use a given airport facility. Improved technology might *not necessarily* lead to an improved noise environment surrounding Seattle-Tacoma International Airport. Curved flight tracks north of Sea-Tac would result in more flights over the Duwamish corridor and directed past the West Seattle community. It *could* result in more frequent use of flight tracks that are more removed from populations.

Note: The MLS was recommended by the Noise Mediation Agreement as a means of reducing noise rather than as a means of increasing efficiency and flights at Sea-Tac. The initial MLS approach routes at Sea-Tac involve a new noise track displaced one mile east from existing tracks. This does not cross the noise threshold recognized by the FAA (pursuant to the National Environmental Policy Act), but is noted here in an FEIS prepared under the State Environmental Policy Act. MLS is not standard airport equipment, and some critics raise as a new safety issue the unknown effects of radiation on human populations.

4.9.7 Mitigation

Statistically, the risk of air accidents increases with the number of aircraft operations. Improved (a) personnel and training, (b) equipment and (c) airspace management can mitigate accident risks. Equipment and management are addressed here.

4.9.7.1 Equipment

It is shown above that the accident trend per passenger-mile is steadily improving. In the Puget Sound region, system improvements include technology (improved computer memory and capability with the Host Computer system at the Seattle Air Route Traffic Control Center), reassignment of airspace control, and installation of the Four-Post Plan.
With regard to technological improvement within the airline industry, on-board safety features are constantly improved to reduce accidents due to human errors. It is beyond the scope or competence of this FEIS to evaluate these improvements, but they can be briefly identified here. One example is the possible installation of on-board collision warning systems (Traffic Alert Collision Avoidance Systems). The need for better communication between the aircraft and the Air Traffic Control (ATC) will be supplied through digital systems using satellites and improved radar systems with datalink capabilities between air and ground.

This will enable continuous modification of routes (flight profiles), on-board problem diagnostic systems which can exchange information with ground maintenance centers, and continual communication of flight progress with airline dispatch centers. (General information used in this summary is extracted from the Final Report of New Technology in the California Aviation System, G. Gosling, A. Kanafani, J. West, Institute of Transportation Studies, Berkeley, May 1990).

The ATC modernization programs for ground and air needs are up to eight years behind schedule nationally, but have been installed for the Seattle area. In 1994, Sea-Tac's regional center near Auburn will become the first of the nation's 22 air traffic control hubs to replace aging radio-telephone-microwave links with faster and more reliable equipment. (The entire national system will cost $1.6 billion and will significantly improve air safety.)

The South Aviation Support Area (SASA), when completed, will also serve safety concerns by improving maintenance. Sea-Tac is a national leader in technologies that permit takeoffs and landings in low visibility conditions. This includes use of state-of-the-art surveillance radar and surface detection equipment to monitor vehicles on the ground, use of "heads up" radar on some planes, and use of bright taxiway control systems (expected to be operational in October 1992). Improvements are underway to reduce further the chance of incursions of planes and ground vehicles onto a runway where they do not belong.

4.9.7.2 Management

The FAA decision to implement the Four-Post Plan without preparing a NEPA EIS was sustained by the Ninth Circuit Court of Appeals. The Four-Post Plan provides greater stability of routes (as runway availability changes during changing weather conditions) and eliminates crossing arrival and departure streams where these used to intersect (over Ephrata in Eastern Washington). The Four-Post Plan also provides greater separation of flight tracks. This Plan helps achieve safety goals that could in the future be assured by capital investment or airline scheduling (Final Environmental Assessment, FAA, Volume I, p. 12).

The Four-Post Plan is intended to rovide for both present needs and increased demand (ibid., p. 11). It enables a 30 percent increase in arrival capacity, from 42 to 56 per hour, during the bottleneck south-flow condition at Sea-Tac International. Flight track noise mitigation, linked to any new dependent air carrier runway construction, could trade some of this capacity for new capacity to be provided by possible third runway construction. This could alter flight tracks over affected and populated areas, but outside of the conventional noise contours.

With regard to potential accidents on the ground, the Federal Aviation Administration can combat "rejected takeoff incidents" by requiring better equipment (the tested Takeoff Performance Monitoring System) and training. It can also adjust rules governing takeoff limits and runway lengths. A proposal for the latter is under consideration (Air Transport World, June 1992) and could affect weights of new planes landing on shorter runways, or the use or lengths of proposed new dependent air carrier runways.

4.9.7.3 General Aviation

Not reported here is the number of general aviation accidents. (This FEIS deals with commercial air transportation capacity.) General aviation accounts for two-thirds of aircraft operations in our region. As one measure of general aviation safety, the number of accidents per 100,000 hours in flight has decreased from 30 in 1965 to 7 in 1989. The figures for helicopters are 55 and 7, respectively. (Included in Analysis of Helicopter Accident Risk Exposure Near Heliports, Airports, and Unimproved Sites, February 1992, DOT/FAA,RD-90-9).

A regional airspace study is recommended here (see Section 4.10) and is planned by the Federal Aviation Administration. (Conversation with Dave Field, Manager of Planning Programs and Capacity Branch, Northwest District, FAA, June 30, 1992).

4.10 AIRSPACE MANAGEMENT

Long-term air carrier service is one part of a larger air traffic systems management issue facing the region. Over the long term this could involve airspace management, distribution of all air traffic to existing and/or new airports, and related ground transportation. Responsible agencies include the FAA, the airport operators, possibly the state DOT, the local governments and the Regional Council. Research toward ways to set broad policies for aviation, other modes of transportation and for the community is underway at the national level. Significant contributors are the Government Accounting Office (Improvement Needed in Federal Planning (testimony before the House Subcommittee on Aviation, 19 February 1992), the National Association of Regional Councils (Recommendations for Strengthening FAA's Airport Improvement Program, testimony before the House and Senate Aviation Committees, 16 April 1992), and the Transportation Research Board (Airport System Capacity: Strategic Choices, 1990).

In Washington State, the HSGT Commission is reviewing intermodal transportation issues as these relate to their narrower mission. In addition, the state and regional planning authorities acting under new federal legislation (the 1990 Intermodal Surface Transportation Efficiency Act) are responsible for intermodal transportation planning and priorities involving federal funds.

Flight Plan analysis and related public review comments in the Puget Sound region point to the long-term need, following a RASP amendment, to more comprehensively consider the implications of the following kinds of specific airspace issues:

- The mutual interactions of air carrier traffic and general aviation traffic--which accounts for two-thirds of all air operations in the region--in metropolitan airspace, as this relates to the distribution of total air traffic to available or new dependent air carrier runways in the region.

  Note: Any major changes to airport roles would be subject to the exclusive approval of the Federal Aviation Administration (FAA). The FAA is responsible for Instrument Flight Rules at all airports. The hierarchy of airspace authorities includes the Air Transportation Center, approach and departure, the towers (five-mile radius of the airport), and ground control. Tower operations are shaped in part by letters of agreement between the towers (e.g., Renton and Sea-Tac).

  Interactions with Vancouver, B.C., airspace (within the United States) and with military air station controls (Whidbey Island Naval Air Station) are also involved.

- The interactions between civilian and military traffic, especially as this affects or may be affected by air carrier decisions and mitigation opportunities (e.g., to minimize net noise impacts at Paine Field and south of Sea-Tac).

- Interactions between Sea-Tac and Boeing Field (addressed in the Flight Plan Draft Final Report, 17 January 1992, Working Paper No. 1). Potential issues are the continued use of special approach procedures as traffic increases, and the possible system benefits under the no-action alternative of either approving curved flight tracks (if the MLS proves itself) or of redistributing general aviation away from Boeing Field at times of increasing congestion.

- Possible amendments to the Four-Post Plan, which broadly distributes approaches and departures to and from Sea-Tac Airport over the metropolitan region (as a noise mitigation action). This involves collaboration between the airport operators and the FAA.

  Note: The Four-Post Plan was upheld as not requiring an EIS under the National Environmental Policy Act--NEPA (Ninth Circuit Court, 9 April 1992, No. 90-70253). Noise impacts were within the FAA noise threshold, and the purpose of Four-Post was found to be increased efficiency for the current level of activity, rather than to serve growth. The Environmental Assessment (EA) does acknowledge that expansion of Sea-Tac operations is not likely without the Four-Post Plan (EA, p. 6).

  The relationships between all major airspace and airport actions, and ground transportation and community preservation and development, is a discussion advanced in this air carrier non-project FEIS.

- The flight track implications of new technology such as the MLS and GPS.

  Note: While requested under the 1990 Sea-Tac Mediated Agreement, the Environmental Assessment for MLS has been completed under NEPA by the FAA acting as the responsible agency.

- The relationship between flight tracks and the noise capacity of the impacted communities on the ground.

- Air carrier mitigation actions as they might affect the system of airports, for example, restrictions on the use of a possible third runway at Sea-Tac (e.g., to maintain a year-round two-runway airport capacity), or possible mitigating amendments to the Four-Post Plan.

It appears that within the constraints of the two nearby mountain ranges (the Olympics to the west, and the Cascades and Mount Rainier to the east) the airspace issues still are flexible enough that they can be shaped around runway decisions that should be made first. Under this assumption, the governing factor in system capacity expansion would be siting, not airspace. For example, amendments to the Four-Post Plan are a probable refinement to airspace configuration which do not have to be made before runway decisions are made at Sea-Tac or at other possible supplemental airport sites.

Amendments to Four-Post can be a mitigating action benefiting communities not located beyond the standard mitigation noise contours (65 Ldn). (See Sections 4.1.2.1.1 and 4.1.2.1.2 for a discussion of cumulative noise contours and single event noise flight tracks).

Potential Regional and Site-Specific Mitigation Actions

- Assemble the general aviation community to refine the general aviation element of the Regional Airport System Plan. (Regional Council)
- Limit practice IFR approaches by general aviation aircraft during peak IFR traffic periods. Divert practice IFR approaches to relief airports located outside of heavy air traffic areas. (The adopted 1988 Regional Airport System Plan recommends these actions, consistent with local airport master plans.)
- Continue to give priority to air carrier IFR operations over general aviation and commuter service during peak periods in heavily used airspace.
- Work together to distribute regional air traffic including traffic from military operations. This might moderate net noise impacts as air carrier service increases in the region. (For example, relocation of the National Guard unit from Paine Field to either Whidbey Island Naval Air Station or Fort Lewis, co-location and operation of smaller Air Force planes at Fort Lewis, and limiting C-141 touch-and-go training to Moses Lake.)

BIBLIOGRAPHY

Abey-Wickrama, I., et al. 1969. "Mental hospital admissions and aircraft noise," *Lancet*. 2(633): 1275-1277.

Beranek, Leo L. 1981. *Noise and Vibration Control*, McGraw-Hill Book Company, New York.

Bowlby, W. and R.L. Wayson. 1990. "Use of Microcomputers to Perform Airport Emission Inventories," *Journal of Transportation Engineers*, 116(3): 328-337.

Bradley, J.S. 1986. "Speech intelligibility studies in classrooms," *Journal of Acoustical Society of America*, 980(3):846-854.

Broch, J.T., 1971. "Acoustic Noise Measurements," Bruel & Kjaer Instruments.

Bronzaft, A.I. and D.P. McCarthy. 1975. "The effect of elevated train noise on reading ability," *Environmental Behavior* 7(4):517-527.

Clark, A.I., A.E. McIntrye, J.N. Lester, and R. Perry. 1985. "Air Quality Impact Assessment at an Airport," *Environmental Pollution, Series B: Chemistry and Physics*, 9(1): 1-27.

Clark, A.I. et al. 1985. "Air Quality Measurement in the Vicinity of an Airport," *Environmental Pollution, Series B: Chemistry and Physics*, 6(4): 245-261.

Cohen, S. G.W. Evans, D.S. Krantz, and D. Stokols. 1980. "Physiological, motivational, and cognitive effects of aircraft noise on children: moving from the laboratory to the field," *Amer. Psychol.* 35(3):231-243.

Cohen, S., D.S. Krantz, G.W. Evans, D. Stokols, and S. Kelly. 1981. "Aircraft noise and children: longitudinal and cross-sectional evidence on adaptation to noise and the effectiveness of noise abatement," *J. Pers. Soc. Psychol.* 40(2):331-345.

Cohen, S., D.S. Krantz, G.W. Evans, and D. Stokols. 1981. "Cardiovascular and behavior effects of community noise," *Amer.Sci.* 69(5):528-535.

Crook, M.A. and F.J. Langdon. 1974. "The effects of aircraft noise in schools around London Airport," *J. Sound Vib.* 34(2):221-232, 1974.

Cunniff, Patrick F. 1977. *Environmental Noise Pollution*, John Wiley & Sons, New York.

Davis, S. and P. Hu. 1991. *Transportation Energy Data Book*: Edition 11. U.S. Department of Energy, Office of Transportation Technologies.

de Neufville, R. March 1986. *Multi-Airport Systems in Metropolitan Regions.*

Dunholter, Paul H. 1991. "The Process of Developing a National Aircraft Noise Standard," presented at the South East Asia Clean Environment Conference, Bali Island Indonesia.

Energy Strategy Committee. August 1992. *Washington's Energy Strategy, Draft.*

Environmental Protection Agency. 1979. *Noise Effects Handbook.* Environmental Protection Agency, Office of Noise Abatement and Control, October, Revised July 1981.

Environmental Protection Agency. July 1991. *Mobile 4.1 (Mobile Source Emission Factor Model).* U.S. Environmental Protection Agency, Office of Mobile Sources.

Environmental Protection Agency. 1974. *Information of Levels on Environmental Noise Requisite to Protect Public Health and Welfare With an Adequate Margin of Safety.* U.S. Environmental Protection Agency, Office of Noise Abatement and Control.

Environmental Protection Agency. 1971. "Effects of Noise on People," Environmental Protection Agency, Office of Noise Abatement and Control.

Federal Aviation Administration. 1990. *Final Environmental Assessment: Proposed Changes to Air Traffic Arrival and Departure Routes at Seattle-Tacoma International Airport.*

Federal Aviation Administration. June 1992. *Final Environmental Impact Statement for the MLS Demonstration Program at Seattle-Tacoma International airport.*

Federal Aviation Administration. February 1992. *FAA Aviation Forecasts: Fiscal Years 1992-2003.* FAA Document AP092-1.

Federal Aviation Administration. Office of Aviation Policy and Plans. June 1992. *Seattle-Tacoma Hub Forecast, Draft.*

Federal Aviation Administration. March 1985. *Aviation Noise Effect.* FAA Office of Environment and Energy, FAA-EE-85-2.

Federal Aviation Regulations. 1983. Part 150, "Air Noise Compatibility Planning," 1983.

Fidell, Sanford, S. Theodore, and D.M. Green. 1988. "A Theoretical Interpretation of the Prevalence Rate of Noise-Induced Annoyance in Residential Populations," *Journal of Acoustical Society of America* 0001-4966/88/122109-05.

Fidell, Sanford and D.S. Barber. 1991. "Updating a Dosage-Effect Relationship for the Prevalence of Annoyance Due to General Transportation Noise," *Journal of Acoustical Society of America* 0001-4966/91/010221-13.

Fiedell, Sanford, M. Harris, and N. Reddinguis. 1988. "Detailed Design Specification for a Prototype Assessment System for Aircraft Noise," BBN-R-6599, Bolt Bernek and Newman, 1988.

Flythe, Mary C. 1982. *Federal Aviation Administration-Integrated Noise Model (INM), Version 3, User's Guide*. Department of Transportation, FAA-EE-81-7.

Gattoni, F. and A. Tarnopolsky. 1973. "Aircraft noise and psychiatric morbidity," *Psychol. Med.* 3(4):516-520.

Hall, Fred, L. Susan, E. Birnie, S. Martin Taylor, and J.E. Palmer. 1981. "Direct Comparison of Community Response to Road Traffic Noise and to Aircraft Noise," *Journal of Acoustical Society of America*, December 1981.

Hand, D.J., A. Tarnopolsky, S.M. Barker, and L.M. Jenkins. 1980. "Relationships between psychiatric hospital admissions and aircraft noise: a new study. in Tobias, J.V., G. Jansen, and W.E. Ward (eds.). *Noise as a public health problem*. American Speech Language Hearing Association, pp.277-282.

Harris, Cyril M., 1957. *Handbook of Noise Control*, McGraw-Hill Book Co.

Harris, Cyril M., 1979. *Handbook of Noise Control*, 2nd Edition, McGraw-Hill Book Co.

Herridge, C.F. and B. Chir, 1972. Aircraft noise and mental hospital admission. *Sound*. 6:32-36.

Horonjeff, Richard D., S.R. Teffeteler, F. Sanford, and D.M. Green, "Awakening Due to Intermittent and Continuous Noise Exposure," Bolt Beranek and Newman, Inc.

International Civil Aviation Organization. 1988. *International Standards and Recommended Practices, Environmental Protection, Annex 16, Volume I*, Aircraft Noise.

International Civil Aviation Organization. 1985. *Airport Planning Manual, Part 2*, Land Use and Environmental Control.

Jenkins, L.M., et al. 1979. "Comparison of three studies of aircraft noise and psychiatric hospital admissions conducted in the same area," *Psychol. Med.* 9(4): 681-693.

Jenkins, L., A. Tarnopolsky, and D. Hand. 1981. "Psychiatric admissions and aircraft noise from London Airport: four year, three hospitals' study," *Psychol. Med.* 11(4): 765-782.

Karagodina, I.L., S.A. Soldatkina, I.L. Vinokur, and A.A. Klimukhin. 1969. "Effect of aircraft noise on the population near airports," *Hyg. Sanit.* (USSR) 34(4-6):182-187.

Knipschild, P., H. Meijer, and H. Salle. 1981. "Aircraft noise and birth weight," *Int. Arch. Occup. Environ. Health.* 48:131-136.

Ko, NWM. 1979. "Responses of teachers to aircraft noise." *J. Sound Vib.* 62(2):277-292.

Kryter, K.D. 1982. "Rebuttal by Karl D. Kryter to Comments by T.J. Schultz," *Journal of Acoustical Society of America.*

Kryter, K.D. 1983. "Response of K.D. Kryter to Modified Comments by T.J. Schultz on K.D. Kryter's Paper, 'Community Annoyance from Aircraft and Ground Vehicle Noise'," *Journal of Acoustical Society of America.*

Kryter, K.D. 1985. *The Effects of Noise on Man.* 2nd ed. New York: Academic Press, pp.390-24.

Kryter, K.D. 1968. *Journal of Acoustical Society of America,* 43:354.

Kryter, K.D. 1970. *The Effects of Noise on Man,* Academic Press, New York.

Kryter, K.D. 1982. "Community Annoyance from Aircraft and Ground Vehicle Noise," *Journal of Acoustical Society of America,* October 1982.

Leibich, R.E. and M.P. Cristoforo. 1988. "Use of Audibility Analysis to Minimize Community Noise Impact of Today's Smaller Generation Facilities Located Near Residential Areas," CONF-880403-3, Argonne National Laboratory.

Meecham, W.M. and H.G. Smith. 1977. "Effects of jet aircraft noise on mental hospital admissions," *Br.J. Audiol.* 11(3):81-82.

National Association of Noise Control Officials. 1981. *Noise Effects Handbook.* New York.

National Transportation Safety Board. April 1991. Annual Review of Aircraft Accident Data: U.S. Air Carrier Operations Calendar Year 1988. Publication NTSB/ARC-91.

Naugle, D.F. and D.L. Fox. 1981. "Aircraft and Air Pollution," *Environmental Science and Technology*, 15(4): 341-395.

Olin, R.G., A. Ahlbom, I. Lindberg-Navier, S. Norell, and B. Spannare. 1987. "Occupational Factors Associated with Astrocytomas: A Case-Control Study." *American Journal of Ind. Medicine*, 11:615-625.

Otterson, S. Personal conversation regarding input data for Mobile 4.1, Department of Ecology, Washington, July 1992.

Paid, G. 1992. Personal conversation regarding vehicle emission factors, Puget Sound Regional Council.

Pearsons, K.S. and R. Bennett. 1974. *Handbook of Noise Ratings*. NASA CR-2376.

Port of Seattle, Puget Sound Council of Governments. 1990. *Phase I Forecasts*.

Port of Seattle, Puget Sound Council of Governments. 1991. *Phase II Report: Development of Alternatives* (and Appendices).

Port of Seattle, Puget Sound Council of Governments. 1992. *Phase III Draft Final Report* (and Appendices).

Puget Sound Council of Governments. 1988. *Regional Airport System Plan*.

Puget Sound Council of Governments. 1990. *VISION 2020 Final Environmental Impact Statement*.

Puget Sound Regional Council. April 1992. *Puget Sound Subarea Forecasts: Calibration and Forecasts*.

Schultz, Theodore J. 1982. "Comments on K.D. Kryter's Paper, 'Community Annoyance from Aircraft and Ground Vehicle Noise'," *Journal of Acoustical Society of America*.

Schultz, Theodore J. 1978. "Synthesis of Social Surveys on Noise Annoyance," *Journal of Acoustical Society*, 64.

Segal, H.M. and P.L. Hamilton. 1990. *EDMS, A Microcomputer Pollution Model for Civilian Airports and Air Force Bases*. Federal Aviation Administration, Office of Environment and Energy.

State of California. 1971. *Supporting Information for the Adopted Noise Regulations for California Airports*. Report No.WCR 70-3(R).

State of California. 1976. *Guidelines for the Preparation and Content of Noise Elements of the General Plan," Office of Noise Control*. California Department of Health.

State of California. 1990. "California Airport Noise Regulations," Chapter 6, *California Administrative Code.*

State Environmental Policy Act Rules, Chapter 197-11 WAC.

State of California. 1990. *Guidelines for the Preparation and Content of Noise Elements of the General Plan*. Office of Noise Control, California Department of Health.

Tarnopolsky, A., D.J. Hand, S.M. Barker, and L.M. Jenkins. "Aircraft noise, annoyance, and mental health: a psychiatric viewpoint," ibid, pp.588-593.

Tracor. 1970. "Community Reaction to Aircraft Noise," Tracor Document T-70-AU-7454-U.

Transportation Research Board Special Report 226. 1990. *Airport System Capacity: Strategic Choices.*

Tsani-Bazaca, E., et al. 1982. "Ambient Concentrations and Correlations of Hydrocarbons and Halocarbons in the Vicinity of an Airport," *Chemosphere*, 11:11-23.

U.S. Department of Transportation, Federal Highway Administration. *1991 Intermodal Surface Transportation Efficiency Act* (ISTEA).

U.S. Department of Transportation, Federal Aviation Association. 1991. Port of Seattle and Airlines. *Seattle-Tacoma International Airport Capacity Enhancement Plan.*

U.S. Bureau of the Census. *1990 U.S. Census.*

U.S. Environmental Protection Agency. *1990 Clean Air Act Amendments* (CAA).

State of Washington (1940). *Growth Management Act.*

Washington State Air Transportation Commission. June 1992. *Governance Authority and Key Policy Issues.*

Wayson, R.L. and W. Bowlby. 1988. "Inventorying Airport Air Pollutant Emissions," *Journal of Transportation Engineering*, 114(1):1-20.

Zwicker, Eberhard. 1987. "Meaningful Noise Measurement and Effective Noise Reduction," *Noise Control Engineering Journal.*

GLOSSARY

Capacity	Refers to the capability of an airport, or its components, to process air traffic efficiently over a period of time. For this project, the focus is airfield capacity, which is measured by the number of aircraft operations (i.e., either takeoff or landing) that can be accommodated within a specific time period without substantial delay. Capacity can be exceeded, but the result is longer delays.
Concurrency	One of the main requirements of the state's Growth Management Act which mandates that adequate infrastructure be in place or scheduled to be provided in order for development to occur.
Consistency	One of the main requirements of the state's Growth Management Act mandating that development regulations (zoning, subdivision, and other controls) be consistent with the comprehensive plans for an area. City and county comprehensive plans must also be coordinated and consistent.
Delay	When the hourly or daily capacity of an airport is exceeded delay occurs. This increases the time that an aircraft takes to move from its origin to destination. Commercial aviation delays increase costs and lower efficiency and convenience for the air traveler.
Demand Management	Using an existing airport facility to handle demand through efficiency measures. These measures may include flying larger aircraft, requiring higher occupancy levels on flights, and travelling during non-peak hours to reduce delays.
Dependent Runway	A runway which is not physically separated by enough distance from another runway for traffic on either runway to be independent of each other.
FAA	Federal Aviation Administration; the branch of the U.S. Department of Transportation responsible for regulating all commercial and private aviation.

GMA — The Washington State Growth Management Act of 1990. The 1990 Act requires all cities and counties in the state to do some planning and calls for the fastest growing counties to plan extensively in accordance with state goals. Supplemented in 1991 by the State Legislature.

HCT — High Capacity Transit; the general term used to describe modes of ground transportation capable of carrying substantially more passenger volumes than private automobiles. HCT includes light and heavy rail and bus systems.

IFR — Instrument Flight Rules; navigation method implemented when weather decreases visibility to the point that pilots must rely on instruments to maneuver. IFR conditions require greater separation between aircraft on arrival and significantly lower an airport's capacity.

Induced Land Use — Increased levels of local growth and activity as a result of a specific project or development. The hotel and commercial area near Sea-Tac Airport is a good example of induced airport-related land use.

Infrastructure — A general term used to describe many types of public facilities including water and sewer systems, roads and freeways, and schools. Infrastructure systems are usually expensive to build and operate, and are funded by taxes or use fees.

Ldn — A cumulative Day/Night Noise Level measurement which combines the loudness of each overflight, the duration of these events, the total number of overflights and the time of day the events occur into one single scale -- with a 10-decibel weight added to nighttime noise levels (a doubling of impact).

MAP — Millions of Annual Passengers; commonly used to measure demand for air transportation.

Multiple Airport Systems — Multiple commercial airports serving the same region. There are two predominant system types. One system has two or more airports with similar capacity levels and service (such as New York's system). The other system type contains a primary airport supported by one or more supplemental airports (such as San Francisco and Los Angeles area airport systems).

Non-Attainment — Areas that do not meet state or federal air quality standards for specific air pollutants. Non-attainment classification can limit approval for new sources of air pollutant emissions and require plans be implemented to achieve compliance.

Operations — Refers to aircraft activity at an airport. A takeoff or landing is a single operation.

PSAPCA — Puget Sound Air Pollution Control Agency; authorized by State Department of Ecology and the EPA to enforce air pollution regulations for King, Snohomish, Pierce, and Kitsap Counties. PSAPCA also issues some of its own standards that are stricter than the underlying state or federal requirements.

PSATC — Puget Sound Air Transportation Committee; a thirty-nine member steering group comprised of citizens, local and elected officials, members of the business community, and other interested citizens charged with developing a recommended plan for the central Puget Sound air transportation system.

PSRC — Puget Sound Regional Council, replaces the Puget Sound Council of Governments. An intergovernmental agency established pursuant to state and federal regulations and covering King, Snohomish, Pierce, and Kitsap counties as well as most of their municipalities. PSRC is responsible for regional transportation planning and has additional authority under the Growth Management Act. PSRC also provides regional land use planning data and analysis.

Remote Airport — Includes the coordination of service at Sea-Tac Airport and another airport connected to Sea-Tac by high-speed ground transportation.

Replacement airport — An airport that would completely replace Sea-Tac capable of providing full domestic and international service. The capacity of the replacement airport would be sufficient to accommodate future passenger and air cargo traffic well beyond the year 2020.

SEL — Single Event Sound Exposure Level; used to describe the maximum noise level occurring at any one time.

Sole-Source Aquifer — An area designated by the EPA as having an aquifer that supplies at least 50 percent of the drinking water supply with no economically feasible alternative available. Designation as a sole-source aquifer requires EPA review and approval of all federally financed projects.

Stage II or III — Refers to aircraft noise characteristics which are regulated by FAA Federal Aircraft Regulation 36. Stage II aircraft (like the Boeing 727) are older and produce considerably more noise than newer Stage III aircraft (like the Boeing 767). The FAA has mandated that all Stage II aircraft be phased out of service by about 2000.

Supplemental Airport — An additional one- or two-runway airport designed to relieve demand at Sea-Tac Airport. The supplemental airport could be an existing airport or a new site.

VFR — Visual Flight Rules; navigation method used when weather and visibility do not effect the pilot's ability to see. During VFR conditions, less separation is required between aircraft approaching an airport.

LIST OF ABBREVIATIONS

DCD	Washington State Department of Community Development
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
GMA	Growth Management Act
GPS	Global Positioning Systems
HCT	High-Capacity Transit
ISTEA	Intermodal Surface Transportation Efficiency Act
LDN	Day/Night Cumulative Noise Level
MAP	Million Annual Passengers
MLS	Micro-wave Landing Systems
MPO	Metropolitan Planning Organization
NEPA	National Environmental Policy Act
OFM	Office of Financial Management
PSATC	Puget Sound Air Transportation Committee
PSCOG	Puget Sound Council of Governments
PSRC	Puget Sound Regional Council
RASP	Regional Airport System Plan
RCW	Revised Code of Washington

RTP	Regional Transportation Plan
RTPO	Regional Transportation Planning Organization
SEL	Single Event Sound Exposure Level
SEPA	State Environmental Policy Act
SIP	State Implementation Plan

Appendix A

Puget Sound Air Transportation Committee Findings and Recommendations

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APPENDIX A

PUGET SOUND AIR TRANSPORTATION COMMITTEE (PSATC) FINDINGS AND RECOMMENDATIONS

PSATC FINAL RECOMMENDATIONS

After two-and-one-half years of study and extensive public review, the Puget Sound Air Transportation Committee (PSATC) on June 17, 1992 recommended a phased three-airport system using Sea-Tac, Paine Field, and a site in either Pierce or Thurston County as its preferred alternative for dealing with the area's future air travel needs. Committee Chairman Robert Wallace forwarded the advisory recommendation and Committee findings to the Puget Sound Regional Council (PSRC) and the Port of Seattle Commission for action (See Figure A-1). A discussion of potential agency decisions and courses of action can be found in Section 3.8.

The specific recommendations of the PSATC include the addition of a dependent air carrier runway at Seattle-Tacoma International Airport before the year 2000, the introduction of scheduled air carrier service to Paine Field before the year 2000, and the identification of a Pierce County location for a two-runway supplemental airport for development by the year 2010. The Committee stipulated a preference for developing the latter site in conjunction with existing military facilities or, failing that, finding a suitable site in Thurston County.

The PSATC recommendation acknowledges the importance of demand management techniques and mitigation measures in developing a multiple-airport system.

Under the multiple airport system recommendation, Sea-Tac would serve as the primary airport providing the largest share of airline service for domestic and international flights. Paine Field and the Pierce County site would serve as supplemental airports and provide convenient alternatives for population areas around Everett in the north and Tacoma and Olympia on the south. Such a siting arrangement also would eliminate the need for a surface transportation link between those locations and Sea-Tac.

The supplemental airports would provide direct commuter service to cities in Washington and the Pacific Northwest and direct jet service to California and western hubs such as Salt Lake City and Denver. Both airports would handle approximately 3.4 million annual passengers by the year 2020. The remaining projected passengers --38.3 million-- would use Sea-Tac.

The PSATC recommendation calls for the timely phase-in of each supplemental airport to meet increasing capacity needs. It is anticipated that Paine Field would go into commercial operation first followed by the development of an airport in either Pierce or

Figure A-1

PSATC Motion to Transmit Final Recommendations to the Sponsoring Agencies

WHEREAS, the Puget Sound Air Transportation Committee (PSATC) was formed by the Puget Sound Regional Council (formerly the Puget Sound Council of Governments) and the Port of Seattle to undertake a study and provide an advisory recommendation to address the Puget Sound region's air transportation capacity needs, and;

WHEREAS, regional population growth will increase demand for commercial air transportation to a level which exceeds the capacity of Seattle-Tacoma International Airport before the year 2000, and;

WHEREAS, aircraft arrivals at Seattle-Tacoma International Airport already exceed capacity during periods of poor weather, resulting in increased delays, and;

WHEREAS, the PSATC over a two year period conducted a comprehensive three-phased study to define and evaluate alternative regional airport systems and site options, which confirmed future air passenger demand, presenting the region with the need for airport capacity decisions in the near term (by the year 2000) and in the longer term (2020 - 2050), and;

WHEREAS, the PSATC completed a draft preferred system and siting alternative with other secondary alternatives on December 4, 1991, and considered the results of continual public review since committee inception and an extensive public review process conducted between January 7, 1992 and March 23, 1992 regarding their advisory recommendation, and;

WHEREAS, the complete work of PSATC stresses the region's need to prepare to meet future demand and acknowledges the importance of (a) reasonable demand management techniques, (b) mitigation measures and (c) phasing of regional and site specific decisions and actions addressing airport operational capacity and the impact and benefits to the served regional community;

NOW THEREFORE BE IT RESOLVED, that the Puget Sound Air Transportation Committee has completed its deliberations; and hereby transmits its findings and recommendations to the Puget Sound Regional Council and the Port of Seattle, calling for the phased implementation of a Multiple Airport System including the addition of a dependent air carrier runway at Seattle-Tacoma International Airport before the year 2000 and the introduction of scheduled air carrier service to Paine Field before the year 2000, and the identification of a two-runway supplemental airport site in Pierce County for development by the year 2010 in collaboration with the military, and, failing that, the identification of a suitable location in Thurston County.

Thurston counties as demand warrants. Paine Field was recommended for service first since a majority of the region's population is located north of Sea-Tac.

The intent of the Flight Plan Project was to examine a selection of feasible airport sites in King, Pierce, Snohomish, and Kitsap counties. However, the Committee also chose to examine a "test" site in Thurston County as a contingency in the event a viable Pierce County location could not be found. The test site, which came to be known as the "Olympia/Black Lake" site, was selected for study in part because it afforded an opportunity to study the potential impacts of implementing commercial airline service in a new area.

An explanation of the other system alternatives examined in Flight Plan may be found in Section 3.0. Section 4.0 offers extensive environmental analyses of the various alternatives.

VISION STATEMENT

The goal of the PSATC was to find a system alternative that met the criteria outlined in the Committee's "Vision Statement" for the air transportation needs of the Puget Sound Region to the year 2020 and beyond. The purpose of the statement drafted by the Committee and approved by the sponsoring agencies was to provide a broad context in which to evaluate the system alternatives and site options. It laid out a broad vision of an airport system which would be in place 30 years hence:

> *We have an integrated air, land, and sea transportation system that will serve the region's travel needs worldwide to the year 2050 and thereafter. The transportation system enhances the livability and environmental integrity of the Pacific Northwest, is convenient and accessible to its users, promotes the economic vitality of the state, and serves as a gateway to all domestic and world markets. This transportation system is recognized worldwide as a leading model of transportation development.*

The vision statement was shaped by the conviction that commercial aviation is an increasingly important link between Puget Sound and the rest of the world. Taking advantage of the growth in international trade and service-related business requires a well-run aviation system with adequate capacity and facilities. Puget Sound is one of the nation's leading trade regions. The shipment of goods and services through Sea-Tac Airport has helped to make Washington State the nation's leader in per capita dollar value of international trade. While seeking system alternatives that would provide adequate capacity well into the next century, the Committee sought also to strike a balance between economic benefits and environmental protection.

PSATC FINDINGS IN SUPPORT OF A THREE-AIRPORT SYSTEM

The PSATC concluded that a phased three-airport system best balanced the economic benefits of providing for future air transportation needs with safeguarding the environment and the region's quality of life. Adding a third runway at Sea-Tac, opening Paine Field to commercial service and developing a commercial airport in Pierce County would meet the PSATC's vision in the following ways:

Environmental Quality and Livability

The federal government has mandated that all aircraft operating at U.S. airports must be the quieter "Stage 3" type planes within the next 10 years, allowing more flights at Puget Sound region airports while reducing average daily aircraft noise below current levels at Sea-Tac.

The recommended alternative also will help reduce aircraft noise impacts at Sea-Tac below those that would be experienced if we did nothing at all. Doing nothing, for example, would increase landing and takeoff delays, adding to noise impacts.

A three-airport system, by providing more convenient airport access to a larger number of people, would most likely reduce the total vehicle miles needed to reach an airport. Such a system would also reduce flight delays and, consequently, cut air pollution. Sea-Tac, Paine Field, and military bases in Pierce County (McChord AFB, or Ft. Lewis) each are close to the region's centers of population.

The recommended alternative would help reduce increases in traffic congestion on the area freeways by providing an airport closer to the homes of most people north and south of the Seattle metropolitan area. Sea-Tac and Paine Field are also proposed stopping points for the proposed regional light-rail transit system.

Airports located within the urban area decrease sprawl and preserve open space-- both primary goals of the state Growth Management Act. Using existing airports, rather than developing new ones in new locations, also tends to reduce the potential impact of airport development on wetlands and wildlife habitat.

Regional Economic Vitality

The recommended alternative strengthens our region's ability to compete for important domestic and international trade-related business by providing adequate airport capacity for travelers and shippers to the year 2020 and beyond. Such business supports expected new jobs and income for the region's residents. A multiple airport system also distributes economic benefits throughout the region.

Phased-in development of a three-airport system also represents wise use of scarce financial resources. Phasing in the components of PSATC's recommended alternative --a third runway at Sea-Tac and introduction of commercial service to Paine Field, followed by airport development in Pierce County-- avoids over-building of airport facilities.

The recommended alternative is the least expensive because it greatly reduces yearly airline delay costs while incurring only moderate capital costs. By using existing facilities to the greatest extent possible, capital costs needed for achieving a given amount of capacity are held to a minimum.

Using existing jet-capable runways reduces the amount of time required to implement the recommended multiple airport system.

Integrated Transportation System

Sea-Tac, Paine Field, and potential Pierce County locations are close to harbors, rail lines, and the Interstate Highway network. Sea-Tac and Paine Field are also under consideration as stops on the proposed regional light-rail transit system.

The recommended alternative provides greater airport accessibility to travelers and shippers, increasing the efficient movement of people and goods between areas of the Puget Sound Region and other parts of the United States, and the world.

PSATC FINDINGS CONCERNING THE OTHER SYSTEM ALTERNATIVES

Other system alternatives examined by the PSATC were not recommended for a variety of reasons. Although each possesses certain advantages and disadvantages, the Committee concluded that a three-airport system with a third runway at Sea-Tac offers the greatest overall benefits. The Committee's conclusions concerning each of the other alternatives are presented below.

No Action

Even the most conservative estimates indicate Sea-Tac Airport will reach its efficient capacity -- the number of aircraft that can be accommodated without undue delay -- by the year 2000. Projected population growth in the region and the ensuing increase in demand for passenger airline service will increase the number of flights vying for limited runway capacity. By 2000, delays exceeding one hour may become common for some flights, especially during peak travel times and inclement weather conditions.

Aircraft delays constrict the free movement of people and goods to and from our region. Delays expand travel times and costs, which may discourage employers from expanding their businesses or locating in the region altogether. The result is the loss of both new job opportunities and the potential for adding higher paying jobs. Because the Puget

Sound economy is one of the nation's most dependent on domestic and international trade, the PSATC found that constrictions on our air transportation system would negatively affect the regional economy and quality of life. The impacts would also adversely impact those who never or rarely fly.

Failure to take any action could lead to more negative environmental impacts. Increasing air-traffic delays mean that more and more aircraft spend more and more time flying over the region at lower speeds. Such inefficiency in flight operations adds to aircraft noise and polluting aircraft emissions. More important, air traffic congestion caused by limited airfield capacity will decrease the margin of safety for airline passengers.

Sea-Tac Airport with Broad System Management

Each of the components of the broad system management alternative would provide important capacity and safety enhancements for Sea-Tac airport. They are worth further consideration. However, the committee found that this alternative would do little to adequately meet future air traffic demand. The three components of this alternative would be able to accommodate a maximum of 38 million air passengers per year compared to the 45 million forecasted by the year 2020. The system would be completely inadequate to handle the number projected for mid-century. Although the PSATC chose not to recommend this alternative as the only course of action, the committee did incorporate some of its components into its final recommendations.

Demand Management

A review of demand management strategies reveals that several measures are already being implemented at Sea-Tac Airport. Specifically, the Flight Plan forecasts assume that the average aircraft size will increase and that the number of aircraft in use will increase at a slower rate than the increase in passengers. Airlines have practiced yield management, a ticket-pricing strategy designed to maximize profits, which tends to increase aircraft load factors (how full a plane is), and as a result, also works to hold down increases in the number of planes in use. The Federal Aviation Administration also operates a nationwide "central flow control system," which is a modified form of slot rationing that controls airport congestion in the air by holding aircraft on the ground at departing airports until there is a landing "slot" at the destination airport. Lastly, the effect of general aviation operations has been reduced to a minimum at Sea-Tac Airport. General aviation currently makes up only about 5 percent of total aircraft operations since most general aviation flyers use either Boeing Field or smaller surrounding airports.

Other demand management strategies also are being studied. These include variable pricing on aircraft gates and space in the terminal building. Variable landing fees also could be used to shift more flights to off-peak times. (However, adding flights to evening or early morning hours could adversely affect surrounding neighborhoods with higher aircraft noise levels.) These strategies have been factored into projections that forecast the 38 million passenger limit already mentioned.

Demand management does not increase operational capacity, but may best be used as part of a balanced action package and as a short-term strategy to buy time while capacity improvements are made. Demand management is a valuable tool in helping airports to operate more efficiently, but seldom can it be used as a sole solution. Complex airline economics and limited ability of airports to regulate airline schedules and operating procedures make more severe demand management techniques, such as controlling airline load factors or moving certain classes of users off the airport, less feasible under Federal laws.

For example, moving commuter airlines to another airport or eliminating commuter service would hurt smaller Washington communities that do not have enough people to support direct airline service (use of fewer and larger commuter planes, however, is assumed in the forecasts). These communities depend on commuter flights to move passengers and goods throughout the region, The United States and the world.

Regulating load factors also is a course marked with pitfalls. Although airlines try to fill each plane with passengers and cargo, it is not financially feasible to hold an airplane on the ground until all seats and cargo space are filled. Not only is such regulation impossible under current federal regulations, its effect on travel and cargo schedules would be chaotic.

The PSATC acknowledged that demand management techniques were important and merited consideration in any approved course of action but concluded demand management could not alone solve airport capacity problems.

New Technologies

Like demand management, new technologies will play an important role in making the most efficient use of existing airport facilities. However, the PSATC found that none of the technology options it examined would be able to provide significant capacity for the long-term.

Aircraft improvements such as super-sized and tiltrotor aircraft are a long way from economical commercial use. Due to the uncertainty involved with such technologies, the PSATC chose not to recommend relying on them to meet our future air travel demand. As mentioned under demand management above, the shifting towards larger-sized planes is already assumed in the Flight Plan forecasts.

Improved navigational aides such as microwave landing systems (MLS), global positioning systems (GPS), Flight Management Systems (FMS), etc. will be important for increasing safety, mitigating noise impacts, and enhancing capacity. However, the overall capacity benefits are minimal. They are able to marginally increase capacity by decreasing the amount of space required between planes in flight (while maintaining the same degree of safety). However, even as the technologies become increasingly advanced, there is a point beyond which aircraft separations cannot be further reduced.

The limiting factor is the wake of turbulent air created behind aircraft from which other aircraft need to be separated for safe flight.

As a side note, non-aviation related new technologies such as teleconferencing and advanced telecommunications were also examined. It is unclear what effect these would have on air travel demand. Researchers have examined a range of possibilities that could either slow or increase the growth in intercity business travel. A slowing could occur if such technologies are used in place of actual trips. However, experts indicated to the PSATC that they could also lead to an increase in air trips since the ability to make more personal contacts at remote locations may lead to the eventual desire to meet these contacts face-to-face.

High-Speed Ground Transportation

By 2020, the Flight Plan forecasts assume that flights between Sea-Tac and Portland, Vancouver, B.C., and Bellingham will account for approximately 80,000 annual aircraft operations. Even if it is assumed that a high-speed ground transportation system would replace all of these operations, there would still be a shortfall of 64,000 operations per year from the forecasted 524,000.

Yet, the PSATC thought that it was unrealistic to assume that such a system would completely replace air service between the points it serves. While not quite as fast as the new high-speed rail systems, the "high-speed" Amtrak line between Washington, D.C. and New York City, and Boston has been quite successful. Nonetheless, the market continues to support a substantial amount of air service between these cities. Thus the assumption used by the PSATC which is more in line with the northeast corridor experience, but is still quite optimistic, is that high-speed ground transportation would reduce the amount of air service between Sea-Tac and Portland, Vancouver, B.C., and Bellingham by half (40,000 operations per year). Under this scenario, there would be a capacity shortfall at Sea-Tac in 2020 of 104,000 operations per year.

In addition, it was found that this alternative, which could cost in excess of $3 billion, was the most expensive of all the system alternatives studied (along with the remote airport at Moses Lake) and could not be realistically implemented for at least 15 to 20 years. For these reasons, the PSATC chose not to recommend the high-speed ground transportation alternative as a long-term solution to our air travel needs, but did support further study of it by other agencies and groups such as the Washington State High-Speed Rail Commission.

Sea-Tac with a New Air Carrier Runway

A third air carrier runway at Sea-Tac Airport would significantly increase the airport's capacity, especially during bad weather conditions. It would allow the airport to handle up to 480,000 take-offs and landings per year with minimal delay (Sea-Tac's current capacity with minimal delay is 380,000 take-offs and landings each year).

A third runway would not only provide future capacity benefits, it would also be useful today. Even under current operational levels, during bad weather Sea-Tac experiences significant delays. By allowing two staggered landing streams in inclement conditions, a third runway would greatly reduce aircraft delay.

However, by itself, a third Sea-Tac runway would not be able to meet the capacity needs of our region to the year 2020. For this reasons, the PSATC chose not to recommend this alternative as the only course of action. However, it is considered an important element in the recommended three-airport multiple airport system especially since it resolves the existing limited bad weather arrival capacity at Sea-Tac. Under the PSATC's recommended alternative, operational demand at Sea-Tac with a new runway would remain below the 480,000 capacity level.

Sea-Tac in Conjunction with a Remote Airport

The PSATC made the assumption that once Sea-Tac reached capacity, the additional growth in aircraft operations would occur at the remote airport. This is because the airlines likely would not move to such a remote facility until delay costs at Sea-Tac became high enough. Under this scenario, the combination of Sea-Tac and a remote airport at Moses Lake would provide adequate capacity through the year 2020. However, Sea-Tac would continue to have a capacity shortfall during bad weather which would result in moderate to severe delays. The severity of the delays depends on how many operations are relocated to the remote airport.

Implementation of a remote airport at Moses Lake was found to be the most expensive of all of the alternatives (more than $3 billion) largely due to the need to build a high-speed ground link. Right-of-way acquisition, tunneling, and engineering difficulties with building the system over the Cascade Mountains would all contribute to the high costs.

Even with a high-speed ground link, due to the steep grade of the mountain pass, the extreme curves of the route, the harsh weather conditions, and the headway between vehicles, it would likely take about two hours to make the trip between Moses Lake and the Puget Sound Region. This additional travel time would make the transportation of people and goods into and out of our region more costly and much less convenient.

A remote airport at Boeing Field could provide only limited capacity enhancement to Sea-Tac. The problem with using Boeing Field for commercial passenger airline service is that it has significant airspace conflicts with Sea-Tac due to the proximity of the two airports and the alignments of their runways. While general aviation has been minimized at Sea-Tac, these types of operations at Boeing Field still interact with air carrier operations at Sea-Tac. The current airspace interaction caused by these factors has resulted in the development of air traffic control procedures that are unique to this region. In certain visual flight rules (VFR) conditions, an extra air traffic controller in the Boeing tower maintains visual separation between Boeing and Sea-Tac traffic. This helps accommodate present traffic volumes safely, but future effectiveness with commercial traffic into Boeing is highly uncertain. Since it is a newly developed, site-specific procedure, the possibility of it being abandoned by the Federal Aviation Administration is greater than for standard procedures commonly applied to other airports. These uncertainties create an element of risk which diminishes the attractiveness of investing in commercial service at Boeing Field.

Another factor considered by the PSATC is that in many regards, Boeing Field already operates as a reliever airport for Sea-Tac. Many of the smaller general aviation planes that otherwise would be located at Sea-Tac choose to use Boeing Field instead. Also, Boeing Field is already heavily used and does not have adequate capacity to provide for future increases in commercial air travel demand without moving general aviation users to another airport.

For the above reasons, the PSATC chose not to recommend the remote airport system alternative.

<u>Two-Airport Multiple Airport System</u>

The PSATC found that, apart from the recommended three-airport system, a two-airport system would provide the largest future capacity for expanding air traffic demands (630,000 to 980,000 operations per year, depending on the configuration of the primary and supplemental airports). This would be adequate to meet the forecasted air travel demands to 2020 with some reserve for years beyond. Capital costs for this alternative range between $430 million and $1.2 billion, depending on the sites and configurations used.

Like the three-airport system, this two-airport alternative would moderate overall vehicle miles traveled by passengers to reach an airport. Since automobiles are the primary contributors of pollutant emissions, reducing vehicle miles required to reach an airport would help to avoid further degradation of air quality and increases in traffic congestion. These advantages of multiple-airport system are even more pronounced the closer airports are located to major population centers.

A multiple airport system also distributes the economic benefits of airport activity throughout the region and increases access to existing residents and businesses located near the supplemental sites. Multiple sites lead to an increase in accessibility for travelers and shippers, thus providing greater opportunities for new job growth.

The PSATC found multiple airport systems to be the most promising for the above reasons. The committee recommended a three-airport system because of its greater benefits.

<u>Replacement Airport</u>

By definition, a replacement airport would be built large enough to accommodate our region's air travel demand through the year 2020 and well beyond. The replacement airport envisioned in Flight Plan could be able to handle 750,000 take-offs and landings and 64 million passengers per year. It would have the lowest airline delay costs of any of the system alternatives.

However, the high capacity and low delays come at a significant cost in dollars and impact to the environment. Other than the remote airport system at Moses Lake and the High-Speed Rail component of the Broad System Management Alternative, this is the most expensive alternative ($1.5 - $2 billion dollars). Although aircraft delays are low, it would have a greater negative impact on regional air quality than any of the other alternatives. This is due to the fact that no replacement airport sites exist which are close to the region's centers of population. The large number of miles that passengers would need to drive to reach the airport would contribute greatly to increased vehicular emissions. In addition, a new airport in a currently undeveloped area would lead to an increase in urban sprawl and a loss in open spaces.

The great distance of the potential replacement airport sites would also cause significant increases in travel times and travel costs for air passengers.

For the above reasons, the PSATC chose not to recommend the replacement airport alternative.

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Appendix B

Public Agency Decisions and Institutional Needs

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APPENDIX B

PUBLIC AGENCY DECISIONS and INSTITUTIONAL NEEDS

Introduction

This appendix provides a detailed discussion of the following institutional factors that must be addressed in developing a regional action package for long term regional commercial air transportation:

- Decisions by public agencies (the Regional Council and the airport operating agencies),
- The Growth Management Act and federal airport planning,
- Institutional needs, especially the siting features of the Growth Management Act as compared to local circumstances,
- Existing airport state statutes and selected federal airport legislation,

Decisions by Public Agencies

The relationship among regional airport system planning, the state Growth Management Act (GMA) process, and other authorities is complex. A general discussion is provided below. (For a detailed calendar of decision dates, see Section 4.4.6.)

The Puget Sound Regional Council

The Puget Sound Regional Council is the regional planning and decision making body for growth and transportation issues in King Kitsap, Pierce, and Snohomish Counties. The Regional Council replaced the Puget Sound Council of Governments (PSCOG) in October 1991. Under federal transportation law, the Council is the Metropolitan Planning Organization (MPO) with responsibilities for regional transportation planning and programming of federal tranportation funds in the four counties. It is also, based on Washington State law and the affirmation of its members, the Regional Transportation Planning Organization (RTPO) for the four counties.

Under the Washington State Growth Management Act the Regional Council shall certify that transportation elements of local comprehensive plans are consistent with the Regional Transportation Plan and conform with the comprehensive planning provisions of state law. The Regional Council will amend VISION 2020 to reflect countywide planning policies, multi-county planning policies, and local comprehensive plans prepared under the Growth Management Act (GMA).

The Regional Council is responsible for the preparation of the Regional Airport System Plan (RASP) update, in which the Flight Plan EIS is an important input. The RASP is to be integrated with broader transportation and growth management planning activities now required under state and federal legislation. (These are identified and addressed in Section 4.4.6 of this FEIS.) Permit actions will be addressed in the project EISs and are not addressed in this FEIS.

The Puget Sound Regional Council can amend the RASP only with the approval of its full Assembly, which is scheduled to meet in March 1993. Amendments to the RASP must be reviewed by the Regional Council's Transportation Policy Board and approved by the Executive Board prior to General Assembly action. Action on the RASP would constitute an amendment to the VISION 2020 Growth and Transportation Strategy (the Regional Transportation Plan, RTP) collectively adopted by the local government members of the Puget Sound Council of Governments (PSCOG) in 1990.

Multimodal planning and setting funding priorities are a requirement of the RTP under the federal Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA). The designation of responsibility to decide project priorities for federal funds and the ability to move funds between federal categories (e.g., from highways to mass transit) are two very important new features of this statute.

It is important to note that any airport sites outside of the planning jurisdiction of the Regional Council (King, Kitsap, Pierce, and Snohomish counties) would depend upon additional intergovernmental processes not addressed in this FEIS. (See Sections 3.7 and 4.4.6.)

Operating Agencies

To implement physical capacity improvements at Sea-Tac International Airport, the Port of Seattle would have to prepare a site-specific EIS and could then amend the 1985 master plan for Seattle-Tacoma International Airport.

Depending upon the alternative selected by the Regional Council, compatible siting studies and master plan amendments could be required for supplemental airport sites north and south of Sea-Tac. These studies would be carried out by airport operators.

Early site protection efforts in Pierce County would lead to a formal request to the Air Force for a joint operating agreement (JOA) at McChord Air Force Base, and their possible decision to complete an environmental impact statement (EIS) under NEPA (under the guidelines in The Plan for the Joint Use of Military Airfields, March 8, 1984).

Growth Management Act (GMA)

Under the GMA, comprehensive plans may not preclude essential public facilities such as airports. However, these plans might not be required to actually site airport facilities. Countywide policy plans prepared under the GMA are required to include policies for siting facilities of countywide and statewide significance. They are to supply "a framework from which county and city comprehensive plans are developed and adopted." They are to provide a process for addressing airport needs (RCW 36-70A-200).

The GMA sets new planning requirements for cities and counties and authorizes planning by Regional Transportation Planning Organizations (RTPOs). The Regional Council is the designated RTPO for the central Puget Sound Region. The RTPOs are responsible for certifying that the transportation elements of local comprehensive plans are consistent with the regional transportation plans.

The local comprehensive plans are required to include coordinated capital facilities elements. This element should include facilities supporting any airport siting decisions made through the ongoing GMA process. This should be coordinated with the funding elements of the RTP maintained by the Regional Council. The GMA requires consistency among local comprehensive plans (to be adopted in July 1993) and will guide a range of subordinate public service plans (e.g., water, sewer, fire). The GMA also requires local regulations (e.g., land use and zoning) to conform with the comprehensive plans prepared under the GMA. Local regulatory consistency is required beginning in July 1994. Growth Planning Hearing Boards have been formed at the state level to hear appeals against plans which are challenged as being inconsistent with the GMA.

The GMA and Federal Airport Planning

The relationship between planning under the state's GMA and ongoing airport planning under the Federal Aviation Administration (FAA) statutes and guidelines is still evolving. Some of the factors involved are:

- The general relationship between local airport master plans and state airport systems is addressed in FAA circulars (AC Nos. 150/5070-6A and 5050-3B, respectively).

- Private airlines have nearly always triggered airport expansion. Under current law, including the 1978 Airline Deregulation Act, access to airports cannot be legally denied by the airport proprietor. The airport proprietor is in the lead decision role to determine how to accommodate this request, but cannot be compelled to actually make new investments.

- The National Plan of Integrated Airport Systems (NPIAS) is a 10-year plan that is updated by the FAA every two years based on state, regional, and local airport plans. The NPIAS generally governs such factors as broad criteria, airspace, Air Transportation Control centers (ATCs), navigational aids, and airport design standards.

- The GMA addresses the need for major public facilities, but this stops short of actual siting requirements (previous section).

One possible outcome would require FAA airport planning to be consistent with local comprehensive plans. This is the philosophy behind the GMA. The state GMA would govern local and state airport system plans for new facilities as they are approved and then incorporated into the State Aviation System and NPIAS. This sequence does not resolve the question of how to proceed if new airport facilities are needed and responsible entities decline to site them.

The relationship between federally funded airport system planning and the collaborative features of the state GMA was partly addressed by the State Legislature in ESHB 2609 (1992). This requires near-term airport planning and action dates to be the same as key GMA decisions. For example, the state airport system policy plan is required to be completed in July 1993, the same date that local comprehensive plans under the GMA are to be adopted.

Institutional Needs

Broad institutional needs of the state will be addressed by the Washington State Air Transportation Commission in its governance studies. For this region, the 1988 Regional Airport System Plan (RASP) FEIS assumed that the 1988 regional policies would be followed by site-specific studies by 1993. Site-specific studies are not included in this FEIS but are deferred to the project EISs.

The institutional structures needed to complete all of the possible airport siting studies and decisions needed for various regional airport system-level alternatives are not yet established. However, the new GMA provides local and regional organizations the ability to accomplish these tasks. The structure could be interlocal agreements between existing entities.

Depending upon the general location of any proposed new airports, the local siting studies could be done individually or jointly by:

- local airport operators acting under the Municipal Airports Act (RCW 14.08),
- countywide structures working under the GMA and most likely with assistance from Regional Council acting as the MPO and RTPO,
- a combination of the previous two points,
- the military acting under NEPA (for some of the Pierce County site options), or
- a new authority developed specifically to perform such studies.

In 1991 the Governor's Growth Strategies Commission recommended the formation of a state Siting Council to resolve some state siting issues.

Important Planning Factors

The Growth Management Act provides a planning framework that mandates coordinated planning between governmental jurisdictions, including cities, counties, regional organizations, and the State of Washington.

(a) Growth Management Act

The 1991 GMA requires county-wide and multicounty policies in the King, Snohomish and Pierce County areas. The Regional Council will determine its role with respect to multicounty policies in October 1992. Coordination required under GMA *could* serve as the vehicle for siting studies in Snohomish and Pierce counties under several of the system alternatives.

The adopted countywide planning policies in King and Pierce counties, and the draft countywide policies in Snohomish County, include policies for siting public capital facilities of a countywide or statewide nature. The following are some of the key points from these policies:

- King County

  Proposed facilities must support the existing and future land-use pattern while mitigating negative impacts. The King County Growth Management Planning Council will establish a process which includes: incentives to host jurisdictions, selection of a coordinating agency, public involvement, and consideration of alternatives.

- Snohomish County

  Snohomish County Tomorrow will establish a process creating shared responsibility by communities contributing to the need for a facility, a uniform site review process, and a Site Review Committee of affected state and local agencies to be convened by the host community, project sponsor or nearby local governments.

- Pierce County

  The county and cities will adopt a policy and a process based on facility requirements and impacts, compatibility with the countywide policy plan and comprehensive plans, and possible state justification of proposed locations.

(b) Other Issues

Each regional airport system alternative is tied to extremely difficult institutional issues. These were identified by the PSATC and raised during the public review process. The review process allowed under SEPA (this non-project EIS followed by project EISs) allows responsible agencies to fully address these issues at a later date. Section 3.8 discusses possible scenarios reflecting these institutional issues.

Because of institutional uncertainties, the PSATC considered more than one regional alternative as a possible regional strategy (Working Paper No. 10). Significant issues bearing on the alternatives are:

- King County

  The Sea-Tac Aircraft Noise Mediation Agreement (31 March 1990) suggests that *full implementation* of all of the contained agreements *could* result in an overall noise reduction of approximately 50 percent in terms of average day/night

  sound levels (Ldn) in the communities surrounding the airport (p. 2). (Ldn is a 24-hour weighted average day-night noise measure. See Section 4.1.)

- Snohomish County

  A major concern in the Snohomish County area relates to the Paine Field candidate site under the multiple airport system alternatives reviewed in Section 3.0. Rezones for residential use and home purchases followed the County's 1979 approval of Paine Field as a general aviation airport. Complex relationships exist among this action, an earlier 1978 negotiation process, the non-exclusionary conditions under which earlier federal transfer of airport management to the County occurred (Quitclaim Deed of 11 May 1948) and later federal construction grants, a 1983 community plan amendment, a 1989 county council action, and the siting requirements of the GMA.

  The 1978 document addresses aircraft types, while the 1979 agreement addresses noise levels and acknowledges the conditions attached to the transfer of operations from the federal government to Snohomish County.

  In 1979, the Paine Field Mediation Panel Recommendations outlined actions designed to further the following objectives:

  > It is recognized that the Snohomish County Airport (Paine Field) is an established public facility and an essential element in the State of Washington's transportation system, and that future options be preserved to enable Paine Field to be modern, efficient and safe. However, great care should be taken by the Board of Snohomish County Commissioners (now the Snohomish County Council) and by the Snohomish County Airport Commission to encourage airport development plans compatible with county-wide land use goals, guidelines and policies with comprehensive zoning.
  >
  > The development of Paine Field will be predicated on the recognition that it resides within an established community and will be sensitive to the quality of life for which surrounding residents strive. The residents will in turn

understand that they live in the influence-area of an established airport (Paine Field Mediation Panel Recommendations Adopted 23 January 1979).

Both the residential community and the Airport Commission will work together to develop a meaningful system of continued resident, pilot, and business-interest dialogue in the development of the field.

Paine Field will remain light aircraft oriented with the role defined "General Aviation", adopted by the Board of Snohomish County Commissioners April 11, 1978, and in compliance with the covenants in deeds and grants of the U.S. Government. Other aviation activities that would be encouraged to continue and expand would be aircraft-related industries, business and corporate aviation, public service aviation, air taxi and commuter service.

- Pierce County

  New military strategies following the collapse of the Soviet Union now concentrate many kinds of units with the Military Airlift Command at McChord (more airlift transport planes and attack planes). The Air Force is also developing closer training and operating ties with the Army at adjacent Fort Lewis. The military is working toward an airlift capability from the continental United States. This enhanced military role creates major coordination issues for any joint use of existing or expanded facilities by commercial airlines. The Flight Plan Project retained McChord as a site option that should be investigated because it might be or become feasible between now and the year 2020.

Existing Airport State Statutes

Under the Municipal Airports Act (RCW 14.08 and 14.12), port districts operating airports can act outside of their own jurisdictions. This must be done jointly, by mutual agreement where the property of other ports is involved.

Snohomish County operates Paine Field and is embarking on a federally supported two-year master plan update. The scope of this update might be too narrow to provide a site selection analysis for a possible supplemental airport. Such a site selection analysis would need to occur under the multiple airport alternatives in this non-project FEIS.

In Pierce County, the siting of a supplemental airport would entail similar work by local governments, and would also entail coordinating with McChord Air Force Base and Fort Lewis, or both.

Selected Federal Airport Legislation

Noise Legislation

The Aviation Safety and Noise Abatement Act (ASNA) of 1979 requires airport operators to develop noise compatibility programs (Section 104). Operators may take measures to abate incompatible land uses, including:

- Implementing a preferential runway system;
- Restricting types or classes of aircraft based on noise characteristics;
- Soundproofing;
- Using flight procedures to control the operation of aircraft to reduce exposure of individuals to noise in the area surrounding the airport; and
- Acquiring air rights, easements, and development rights.

This federal legislation influences what is possible in this region (and the discussion in Sections 3.2.2, 4.1.4 and 4.10 of this FEIS).

The Secretary of Transportation may approve or disapprove these programs. One criterion is whether the measures place an "undue burden" on interstate or foreign commerce. In its dealings with the airlines, the Port of Seattle has an exemption based on its 1990 Mediated Agreement (Aviation Noise and Capacity Act of 1990). It is not clear how the Act relates to possible expansion of service at Paine Field and the 1979 Mediated Agreement.

New Funding Legislation

Federal funding for airports is provided by the Airport and Airways Trust Fund established in 1970. The Trust Fund generally covers 90 percent of eligible costs and is supported primarily by a 10 percent tax on passenger airline tickets. This national fund produces three billion dollars per year. These funds are administered by the FAA.

The new Aviation Noise and Capacity Act of 1990 enables public agencies which control commercial service airports to impose a Passenger Facility Charge of $1.00, $2.00 or $3.00 for each paying passenger of an air carrier enplaning (this is an industry term referring to originating passengers and those making connections from arriving planes) at such an airport. These funds can be used to finance projects for that airport "or any other airport which the agency controls" (the Act, Section 9110). The legislation does not presently allow a multiple airport system under divided authority to transfer Passenger Facility Charges from one airport to another.

Two alternatives are apparent:

- Relaxing the federal statute to allow for fund transfers between different airport authorities within a regional airport system; or

- Creating new institutional structures such as a new regional airport authority or a coalition of countywide airport districts (theoretically possible under RCW 14.08.290 and 302).

Supporting Discussion

Federal legislation and court cases over the years have helped define the role of parties that are important when considering aircraft noise: community, airport operator, Federal Aviation Administration (FAA), airlines and airline manufacturers. Legislation that is

significant to the role of the community and the airport operator is the Aviation Safety and Noise Abatement Act of 1979 (ASNA) and the Aviation Noise and Capacity Act of 1990 (ANCA).

ASNA directed the U.S. Secretary of Transportation to develop a process to assist airport operators and communities in developing and implementing noise mitigation programs. As a result of this act, the FAA enacted Federal Aviation Regulation FAR Part 150. Although participation is voluntary, the Part 150 regulation sets forth the conditions under which the "Part 150" planning process must be conducted should an airport operator or other public agency choose to do so. The process is basically an exercise in compatible land-use planning. Working with surrounding jurisdictions, an airport defines the noise impact on various land uses and develops a noise mitigation plan called a "noise compatibility program."

If approved by the FAA, this program is eligible for federal funding. An important component of the Part 150 process is the public consultation requirements, which result in the airport, community and industry representatives working together to develop a plan that can then be presented at a public hearing, formally adopted by the airport policy board and submitted to the FAA for approval. Once a plan is approved, if the airport sponsor wishes to continue qualifying for federal funding, it must update the plan at regular intervals or when changes at the airport are predicted to change the noise exposure.

Part 150 noise compatibility plans have been developed and approved for a number of airports, including Sea-Tac, and include a variety of mitigation measures. These include but are not limited to insulation programs, acquiring homes and relocating the residents to quieter areas, noise abatement aircraft routings and takeoff procedures, berms or barriers, noise and flight track monitoring systems, acquiring avigation easements, etc. Generally, restrictions on the use of an airport based on noise levels have not been included in a Part 150 program submitted for federal approval. This may change somewhat as an effect of passage of the Aviation Noise and Capacity Act of 1990 (ANCA).

ANCA added further definition of the federal role and airport operator responsibilities. This act provided a schedule for the elimination of the existing and noisier Stage 2 aircraft by the end of 1999, with some provision for exemptions until 2003. It also requires that airports implementing their own Stage 2 phase-out conduct a public consultation process and submit the planned program to the FAA for review. FAA approval is not required.

To protect airline investment in Stage 3 equipment and to avoid a random pattern of uncoordinated airport noise restrictions that would make compliance very difficult, ANCA requires that airport operators wanting to restrict the use of Stage 3 aircraft, must either obtain a voluntary agreement from the airlines or must receive permission from the FAA through an extensive and potentially costly process. The ability of an airport to collect Passenger Facility Charges is tied to its compliance with these regulations.

At the time of the passage of this act, a number of airports had already developed and implemented programs to either phase out Stage 2 aircraft or to restrict the use of some Stage 3 aircraft. In general, pre-existing programs, such as Sea-Tac's, Boston's and Denver's noise budgets and John Wayne Airport's access program, were allowed to continue operation even though they would likely be considered too restrictive to Stage 3 aircraft.

It is important to note that airport operators and their communities can be as creative as they wish in developing noise programs. If an airport decides to develop mitigation measures using a process other than the Part 150 process, it may do so. Sometimes this can offer the community and airport more flexibility in the options it pursues. Sea-Tac's Noise Mediation Project is an example of such a case in which the airport used innovative techniques to study noise impacts and develop noise programs in addition to the more standard methods used in a typical Part 150 study. An airport deciding on such a course must heed the requirements of ANCA and must not unreasonably interfere with interstate commerce, discriminate among classes of users or try to intrude in areas that are the sole jurisdiction of the federal government (i.e., flight procedures). The drawback is that these programs may not be eligible for federal funding.

Sea-Tac Airport has pursued a Part 150 process and other planning processes to develop and implement noise programs. In the 1970's, King County and the Port completed the Sea-Tac Communities Plan; in 1985, the FAA approved the airport's Part 150 Noise Mediation Project for a stronger set of noise restrictions at Sea-Tac. At the present time, Sea-Tac is in the process of updating its Part 150 Noise Compatibility Plan with revised Noise Exposure Maps and amendments to the insulation program. If there is a future decision to pursue a dependent runway, another revision to the noise exposure maps and noise compatibility plan would be required.

Appendix C

Noise Assessment Study

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APPENDIX C

NOISE ASSESSMENT STUDY

INTRODUCTION

This Appendix summarizes the results of the analysis of the potential noise impacts associated with each of the airport system alternatives under consideration. It has been updated in response to comments concerning the Draft Environmental Impact Statement (DEIS) and to reflect new data that has recently become available. To effectively evaluate and explain potential noise impacts well into the future, this study utilized methods and criteria that consider noise impacts much farther from the airport sites than is usual for traditional airport noise studies. The methods and data assumptions were selected to be conceptually uncomplicated and capable of treating all systems alternatives as equally as possible.

The study utilized standard industry-wide methods of computer modeling and noise assessment analysis such as the 65 Ldn criteria. Supplemental noise assessment criteria were also included so that the potential noise impacts could be more thoroughly evaluated. The analysis identified the population that would be exposed to a less significant level of aircraft noise (55 Ldn) and to a level of single event noise (80 SEL). Populations that would be newly exposed to noise (55 and 65 Ldn) were also evaluated.

This Appendix is divided into the following sections:

* Summary of Results
* Description of Noise
* Noise Assessment Methodology
* Aircraft Operational Assumptions
* Noise Metrics
* Noise Assessment Guidelines
* Evaluation Criteria
* Noise Contour Analysis
* Population Impacts

SUMMARY OF RESULTS

The noise analysis compared the total population that would be exposed to various noise assessment criteria for each of the airport system alternatives. The noise assessment criteria used in the analysis included: (1) population exposed to cumulative noise levels in excess of 55 Ldn, (2) population that would be newly exposed to cumulative noise levels in excess of 55 Ldn, (3) population exposed to cumulative noise levels in excess of

65 Ldn, (4) population that would be newly exposed to cumulative noise levels in excess of 65 Ldn, and (5) population that would be exposed to single event SEL noise levels in excess of 80 SEL. The Ldn noise metric, used by the FAA and EPA, is the most prominent noise metric used in the assessment of aircraft noise impacts.

The results of the analysis are summarized in Table C-1 for each of the system alternatives. This table shows the range of total population in the year 2020 exposed to noise for each of the above criteria.

In assessing the relative difference in noise impacts between the system alternatives, it is important to point out the inherent difference between the community response to noise associated with an airport that has existed for many years and the response to noise that will occur at a new airport. It is very difficult to compare the relative noise impacts between these two different environments and the criteria used in this analysis attempts to account for the difference. Each of the noise assessment criteria is important in the evaluation of an airport alternative.

> The most important conclusion from the noise analysis is that the future noise environment for all of the system alternatives represents a significant improvement over that which exists around Sea-Tac today. The aircraft that are forecast to be operating at these airports in 2020 are significantly quieter and will result in reductions in both the overall Ldn noise levels as well as the single event SEL levels. For example, approximately 66,000 people currently reside in Sea-Tac's existing 65 Ldn noise contour. By 2020, the population within Sea-Tac's 65 Ldn noise contour will be below 25,000 people no matter what course of action is taken.
>
> The realitive impacts of the system alternatives are dependent upon the actual airport sites. The impacts of the system alternatives can vary when different airport sites are considered and the comparison generally reflects a mid-range of impacts.
>
> The alternative that is rated the most favorable is the replacement airport alternative. This would only be true for a new airport site located in rural areas where the population around the proposed site is projected to be minimal. For sites with a significant population near the airport site, this alternative is not considered favorable.
>
> System Alternatives that include the dependent runway at Sea-Tac are considered less favorable if mitigation is not included. If measures such as restricting use of the runway to daytime use and for arrival traffic only are imposed, then the potential noise impacts from this alternative are reduced. With restricted use of the new runway, a multiple airport system that involves a new air carrier runway at Sea-Tac is rated more favorably than a multiple airport system without improvements to Sea-Tac. This is because it reflects a balance of some growth at Sea-Tac with limited growth at supplemental airport sites. No increase of capacity

Table C-1
2020 Populations within 2020 Noise Contours

System Alternatives	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*	Population Newly Exposed to 80 SEL (000)*
NO ACTION **						
Existing Sea-Tac No Action (Unconstrained Sea-Tac Only)	175		25		120	
EXISTING SEA-TAC AIRPORT SYSTEM						
Existing Sea-Tac w/System Management (Constrained)**	135		12		120	
Sea-Tac w/New AC Rwy (Unconstrained Sea-Tac Only) **	162		22		120	
Sea-Tac In Conjunction With A Remote Airport	• • • • • • • • • • • • • • • • • • • •	• • • • •	See Text	• • • • •	• • • • •	• • • • •
TWO AIRPORT SYSTEMS						
Existing Sea-Tac + Supp(1 Rwy)**	139-172	4-37	12.1-13.5	0.1-1.5	129-186	9-67
Existing Sea-Tac + Supp(2 Rwy)	140-174	5-39	12.1-13.9	0.1-1.9	134-200	14-81
Sea-Tac with new AC Rwy + Supp(1 Rwy)	166-177	2-13	20-20.2	0-0.2	141-199	9-67
Mitigated Sea-Tac with new AC Rwy + Supp(1 Rwy)	(139-150)	(2-13)	(15.1-15.3)	(0-0.2)	(130-188)	(9-67)
Sea-Tac with new AC Rwy + Supp(2 Rwy)	165-181	1-17	20-20.1	0-0.1	146-213	14-81
Mitigated Sea-Tac with new AC Rwy + Supp(2 Rwy)	(138-154)	(1-17)	(15.1-15.2)	(0-0.1)	(135-202)	(14-81)
THREE AIRPORT SYSTEMS						
Existing Sea-Tac + 2 Supp(1 Rwy)	149-176	14-41	12.3-12.9	0.3-0.9	164-240	45-120
Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	168-180	5-26	18.2-19.1	0-0.2	177-252	45-120
Mitigated Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	(142-163)	(5-26)	(15.1-15.3)	(0-0.2)	(166-241)	(45-120)
REPLACEMENT AIRPORT SYSTEM						
Replacement	81 - 101	81 - 101	3.8 - 4.7	3.8 - 4.7	86 - 108	86 - 108

** Denotes systems that include alternatives which do not meet system capacity demands at Sea-Tac would result in more significant increase in growth and noise at the supplemental airport sites.

None of the alternatives stand out as far superior to any of the others in terms of noise impacts. Each of the airport system alternatives result in similar level of noise impacts. While these noise levels are a significant improvement over the aircraft noise levels that exist in Seattle today, it is expected that some level of adverse community response to aircraft noise would still be experienced with any of the alternatives.

DESCRIPTION OF NOISE

Decibels. The purpose of this subsection is to present properties of sound that are important for technically describing sound in the airport setting. Sound can be described in terms of the pressure (amplitude) and frequency (similar to pitch). The sound pressure is a direct measure of the magnitude of a sound without consideration for other factors that may influence its perception.

A standard unit of measurement of sound is the decibel (dB). The range of sound pressures that occur in the environment is so large that it is convenient to express these pressures on a logarithmic scale. Decibels are the pressure of a sound relative to a reference pressure. The logarithmic scale compresses the wide range in sound pressures to a more usable range of numbers in a manner similar to the Richter scale for earthquakes. For example, a sound level of 70 dB has 10 times as much acoustic energy as a level of 60 dB while a sound level of 80 has 100 times as much acoustic energy as 60 dB.

The frequency of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency for young adults is 20 Hz to 16,000 Hz. The prominent frequency range for aircraft noise is between 50 Hz and 5,000 Hz. The human ear is not equally sensitive to all frequencies with some frequencies judged to be louder for a given signal than another. As a result of this, various methods of frequency weighting have been developed, with the A-weighting (dBA) scale the most prominent of these scales.

The A-weighted decibel scale (dBA), widely used in community noise analyses, performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear. Many research studies reveal that when individuals make relative judgments of the "loudness" or "annoyance" of a noise, their judgments correlate reasonably well with the A-weighted sound levels of these noises. The advantages of the A-weighted decibel are that it is widely accepted, has shown good correlation with community response, and is easily measured. Most community noise metrics are based upon the dBA scale.

In terms of human response to noise, a sound 10 dBA higher than another is judged to be twice as loud; and 20 dBA higher four times as loud; and so forth. Everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud). Examples of various noise levels in the dBA scale in different environments are shown in Figure C-1.

NOISE ASSESSMENT METHODOLOGY

The following presents background information on the methodology and criteria used in the assessment of aircraft noise impacts for each system alternative.

The description, analysis, and reporting of community sound levels from aircraft are made difficult by the complexity of human response to sound and the myriad of sound-rating scales and metrics that have been developed for describing acoustic effects. For example, community noise is generally not constant but varies with time. Therefore, some type of statistical metric is necessary to mathematically express a varying noise level that can be correlated to community response. As a result of the complexity of describing noise, several noise metrics have been developed to account for characteristics of noise such as loudness, duration, time of day, and cumulative effects of multiple noise events.

Noise is known to have several adverse effects on health and does cause disruption in human activities. The identified adverse effects of noise on people include hearing loss (not a factor with community airport noise), communication interference, sleep interference, physiological responses and annoyance.

Many factors influence how a sound is perceived and whether or not it is considered annoying to the listener. This includes not only physical characteristics of the sound but also secondary influences such as sociological and external factors. Factors that describe human response to sound in terms of both acoustic and non-acoustic factors are presented in Table C-2 and rating scales have been developed to account for the factors that affect human response to sound. Based upon these identified adverse effects of noise and the factors that influence annoyance, noise metrics and criteria have been established to help protect the public health and safety and prevent disruption of certain human activities.

A number of different noise criteria were examined in this study of the noise environment at each of the alternative sites. It was desirable to utilize nationally accepted metrics that would best predict the potential community response to aircraft noise in the neighborhoods surrounding the airport sites and were defensible in their application to the aircraft noise issues in the Puget Sound area.

SOUND LEVELS AND LOUDNESS OF ILLUSTRATIVE NOISES IN INDOOR AND OUTDOOR ENVIRONMENTS

(A-Scale Weighted Sound Levels)

dB(A)	OVER-ALL LEVEL Sound Pressure Level Approx. 0.0002 Microbar	COMMUNITY (Outdoor)	HOME OR INDUSTRY	LOUDNESS Human Judgement of Different Sound Levels
130	UNCOMFORTABLY	Mil. Jet Aircraft Take-Off with After-burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110	LOUD	Turbo-Fan Aircraft @ Take Off Power @ 200 Ft. (90)	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dB(A) 16 Times as Loud
100	VERY	Jet Flyover @ 1000 Ft. (103) Boeing 707. DC-8 @ 6080 Ft. Before Landing (106) Bell J-2A Helicopter @ 100 Ft. (100)		100 dB(A) 8 Times as Loud
90	LOUD	Power Mower (96) Boeing 737, DC-9 @ 6080 Ft. Before Landing (97) Motorcycle @25 Ft. (90)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 Ft. (89) Prop. Airplane Flyover @ 1000 Ft. (88) Diesel Truck, 40 MPH @ 50 Ft. (84) Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 MPH @ 25 Ft. (77) Freeway @ 50 Ft. From Pavement Edge, 10:00 AM (76 +or- 6)	Living Room Music (76) TV-Audio, Vacuum Cleaner	70 dB(A)
60		Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70) Electric Typewriter @ 10 Ft. (64) Dishwasher (Rinse) @ 10 Ft. (60) Conversation (60)	60 dB(A) 1/2 as Loud
50	QUIET	Large Transformers @ 100 Ft. (50)		50 dB(A) 1/4 as Loud
40		Bird Calls (44) Lower Limit Urban Ambient Sound (40)		40 dB(A) 1/8 as Loud
	JUST AUDIBLE	(dB(A) Scale Interrupted)		
10	THRESHOLD OF HEARING			

SOURCE: Reproduced from Melville C. Branch and R. Dale Beland <u>Outdoor Noise in the Metropolitan Environment</u>, Published by the City of Los Angeles, 1970, p.2.

Figure C-1

Examples of Typical Sound Levels

Table C-2
Factors that Affect Individual Annoyance to Noise

- Primary Acoustic Factors
  - Sound Level
  - Frequency
  - Duration
- Secondary Acoustic Factors
  - Spectral Complexity
  - Fluctuations in Sound Level
  - Fluctuations in Frequency
  - Rise-time of the Noise
  - Localization of Noise Source
  - Background Noise Levels
- Non-acoustic Factors
  - Physiology
  - Adaptation and Past Experience
  - How the Listener's Activity Affects Annoyance
  - Predictability of When a Noise will Occur
  - Is the Noise Necessary?
  - Individual Differences and Personality

Source: C. Harris, 1979

The foundation to an airport site review noise study is the accurate prediction of airport noise levels. The noise environment at each of the airport sites was determined through the employment of an airport noise computer model.

The noise environment is commonly depicted in terms of lines of equal noise levels, or noise contours. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. Testing the reasonableness of the computer model results using on-site noise measurements is one of the most effective methods of ensuring valid noise contours. In essence, noise measurements "fine tune" the noise model to the conditions and characteristics specific to the conditions in the Puget Sound area. The following paragraphs detail the methodology used in the computer modeling of these results into noise contours.

Computer Modeling. Contour modeling is a very key element of the noise study. Generating accurate noise contours is largely dependent on the use of a reliable, validated, and updated noise model. It is imperative that these contours be accurate for the meaningful planning and implementation of a noise control program. There are several noise contour computer models in use. The FAA's Integrated Noise Model (INM) is most commonly used to model commercial airports and was used for this study.

The airport noise contours were generated using the INM Version 3.9. The original version was released in 1977, and the present Version 3.9 was released in May 1987 with an updated aircraft data base. (FAA-EE-81-17). The INM is a large computer program developed to plot noise contours for airports. The program is provided with standard aircraft noise and performance data for over 80 aircraft types that can be tailored to the characteristics of the airport in question. ("Federal Aviation Administration -Integrated Noise Model (INM), Version 3", Department of Transportation, FAA-EE-81-7 October 1982.)

One of the most important factors in generating accurate noise contours is the collection of precise data. The INM program requires the input of the physical and operational characteristics of the airport. Physical characteristics include runway coordinates, airport altitude, and temperature. Operational characteristics include various types of aircraft data. This includes not only the aircraft types and flight tracks, but also departure procedures, arrival procedures and load factors that are specific to the operations at the airport. Aircraft data needed to generate noise contours include:

* Number of aircraft operations
* Types of aircraft
* Day/night time distribution
* Flight tracks
* Flight profiles
* Typical operational procedures
* Noise abatement departure & arrival procedures, if any

Testing the reasonableness of the computer model results using existing field noise measurements is one of the most effective methods of ensuring valid noise contours. The noise model used in the study has been calibrated from the noise measurement data from Sea-Tac. This calibrated computer model can then be used to predict the noise environment as a result of any of the alternative options under consideration.

It is important to note that the FAA conducted field testing for the latest version of the noise model at Sea-Tac ("FAA Integrated Noise Model Validation: Analysis of Carrier Flyovers at Seattle-Tacoma Airport", FAA Office of Environment and Energy, FAA-EE-82-19, November 1982). A small number of Stage 3 aircraft were measured as part of that study. The model has been found to very closely match the characteristics of operations and meteorological effects that are present in the Puget Sound area. Very little adjustments to the model assumptions were necessary.

The Port of Seattle has an established permanent noise monitoring system that measures the Ldn noise levels at eleven locations around the airport. The measurement system is also capable of determining the noise levels from individual aircraft events. In addition, the Noise Mediation Study has monitored the noise levels at forty additional sites around the Sea-Tac Airport. This measurement data has been continuously used in the update of the data assumptions to the computer model to ensure that the model accurately reflects the aircraft noise environment.

The INM allows for the input of temperature and humidity. However, this option does not make any adjustments to the data and has no effect on the model results.

AIRCRAFT OPERATIONAL ASSUMPTIONS

The noise environment for each airport was analyzed for the year 2000, 2010 and 2020 operational conditions. Various background information is necessary in order to model the noise environment around the airports. This data includes the following summary information:

* Aircraft Activity Levels
* Fleet Mix
* Time of Day
* Runway Use
* Flight Path Utilization

<u>Aircraft Activity Levels</u>. The analysis is based upon 2020 operational conditions with additional interim analysis at the 2000 and 2010 time period. The aircraft operational levels were derived directly from the Flight Plan Study. The 2020 operations are based on 45 millions of Annual Passengers (MAP). The 2020 aircraft operations for each airport are summarized in Table C-3. These operations consist of air carriers and commuter aircraft, with some general aviation and military aircraft. This Table reflects the assumption that operational controls at the supplemental airports will cause local passenger levels per aircraft to be the same as at the primary airport. This is the case at such airports as John Wayne and Long Beach in California.

<u>Fleet Mix</u>. The aircraft that are projected to operate at the various airports include most types of commercial and commuter aircraft that operate within the United States. These range in size from the Boeing 747 aircraft used for long haul international flights to small single engine Cessna planes used for local commuter flights. The types of aircraft that are expected to operate at each of the airports are dictated by the Puget Sound's aviation demands and are designed to match those needs.

The fleet mix distribution for aircraft operating at these airports in 2020 is presented in Table C-4. This table presents the different types of air carrier, commuter, general aviation and military aircraft that operate at the airport. The analysis assumes an all Stage 3 fleet mix, and a fleet mix that is primarily composed of the quieter Stage 3 aircraft. This would be expected for the post 2010 time frame.

Table C-3

ANNUAL COMMERCIAL OPERATIONS (Air Carrier & Commuter) 2020

	Alt.	Airport System Siting Options	ANNUAL COMMERCIAL OPERATIONS (X1000) Seatac	Paine	Arling	Pierce	McCord	OBL	TOTAL
**	1	Sea-Tac without Commuter R/W	356						356
	2	Sea-Tac with Commuter R/W	386						386
**	3	Alternate 1 + Arlington 1 R/W	356		112				468
	4	Alternate 1 + Paine 1 R/W	356	133					489
	5	Alternate 1 + McChord 1 R/W	356				133		489
**	6	Alternate 1 + Central Pierce 1 R/W	356			112			468
**	7	Alternate 1 + Olympia/Black Lake 1 R/W	356					112	468
	8	Alternate 1 + Arlington 2 R/W	356		133				489
	9	Alternate 1 + Paine 2 R/W	356	133					489
	10	Alternate 1 + McChord 2 R/W	356				133		489
	11	Alternate 1 + Central Pierce 2 R/W	356			133			489
	12	Alternate 1 + Olympia/Black Lake 2 R/W	356					133	489
	13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	456		33				489
	14	Sea-Tac w/Dependent R/W + Paine 1 R/W	454	35					489
	15	Sea-Tac w/Dependent R/W + McChord 1 R/W	456				33		489
	16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	455			34			489
	17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	456					33	489
	18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	456		33				489
	19	Sea-Tac w/Dependent R/W + Paine 2 R/W	454	35					489
	20	Sea-Tac w/Dependent R/W + McChord 2 R/W	456				33		489
	21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	455			34			489
	22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	456					33	489
	23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	356		60	73			489
	24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	356	67		67			489
	25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	356		72			61	489
	26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	356	78				55	489
	27	Alternate 13+ Central Pierce 1 R/W	430		23	34			486
	28	Alternate 14+Central Pierce 1 R/W	416	35		34			485
	29	Alternate 13+Olympia/Black Lake 1 R/W	453		23			13	488
	30	Alternate 14+Olympia/Black Lake 1 R/W	439	35				13	487
	31	Central Pierce 3 R/W				500			500
	32	Central Pierce/Fort Lewis 3 R/W				500			500
**	33	Alternate 1 + Demand Management	356						356
**	34	No Action (Unconstrained Sea-Tac Only)	436						436
**	35	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	456						456

Table C-4

Aircraft Fleet Mix

		PRIMARY AIRPORT AIRCRAFT FLEET MIX		SUPPLEMENTAL AIRPORT AIRCRAFT FLEET MIX	
AIRCRAFT CATEGORY	AIRCRAFT TYPE	PERCENT OF TOTAL BY CATEGORY	PERCENT OF TOTAL BY TYPE	PERCENT OF TOTAL BY CATEGORY	PERCENT OF TOTAL BY TYPE
Commuter		24%		24%	
	SF340		24%		24%
Small Jet		35%		50%	
	MD80		17%		25%
	B737-300		17%		25%
Medium Jet		21%		16%	
	B757		21%		16%
Large Jet		15%		10%	
	B767		15%		10%
Jumbo Jet		5%		0%	
	B747		5%		0%

Source: P & D Technologies

Stage 3 refers to the FAA's Federal Aircraft Regulations 36 that categorizes jet aircraft based upon noise levels. Stage 3 refers to the newer generation of quieter aircraft. Stage 2 refers to the older louder aircraft. Recently, the FAA has mandated the phase out of Stage 2 aircraft by approximately the year 2000.

Time of Day. In the Ldn metric, any operations that occur after 10 p.m. and before 7 a.m. are considered more intrusive and are weighted by 10 dBA. Therefore, the number of nighttime operations is very critical in determining the Ldn noise environment. The number of nighttime operations per aircraft type was assumed to be the same as is currently operating at Sea-Tac. The analysis assumes that 15 percent of the air carrier operations occur during the nighttime hour and that 8 percent of the commuter operations occur during the nighttime hour. Based upon this Time of day weighting, the LEQ(24) noise contours would be 3.8 dBA less than the Ldn noise level.

Runway Use. An additional important consideration in developing the noise contours is the percent of time each runway is utilized. The runway direction that is utilized by an aircraft is dictated by the speed and direction of the wind. From a safety and stability stand point, it is desirable, and usually necessary, to arrive and depart an aircraft into the wind. When the wind direction changes, the operations are shifted to the runway that favors the new wind direction.

The Puget Sound region generally has two types of weather patterns that result in wind directions from either the south or from the north. South flow refers to aircraft arriving and departing to the south. North flow refers to aircraft arriving and departing to the north.

Sea-Tac air traffic control (ATC) maintains hourly records in terms of south flow versus north flow runway use. For the year of 1989 the airport was in south flow 63% of the hours of the day. For modeling purposes, the 63% figure was used for all of the airport sites under study.

Flight Path Utilization. Air traffic control (FAA) has established paths for aircraft arriving and departing the Sea-Tac, Paine Field and McChord airspace. These paths have been developed from ATC procedure requirements and specific noise abatement procedures that have evolved over a number of years. These paths are not precisely defined ground tracks, but represent a broad area over which the aircraft will generally fly. These paths were used for this study. For example twenty-one flight tracks were used for both Sea-Tac and Paine Field. Sea-Tac aircraft flight paths include the 4-Post plan that was implemented by the FAA in 1990. The Paine Field tracks were based upon recently obtained radar flight tracking data from existing turbo jet aircraft operations. New airport sites assume straight arrival and departure paths. The flight tracks used for Sea-Tac and Paine Field are shown in Figures C-2 and C-3 respectively.

The Flight Plan Project Phase III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

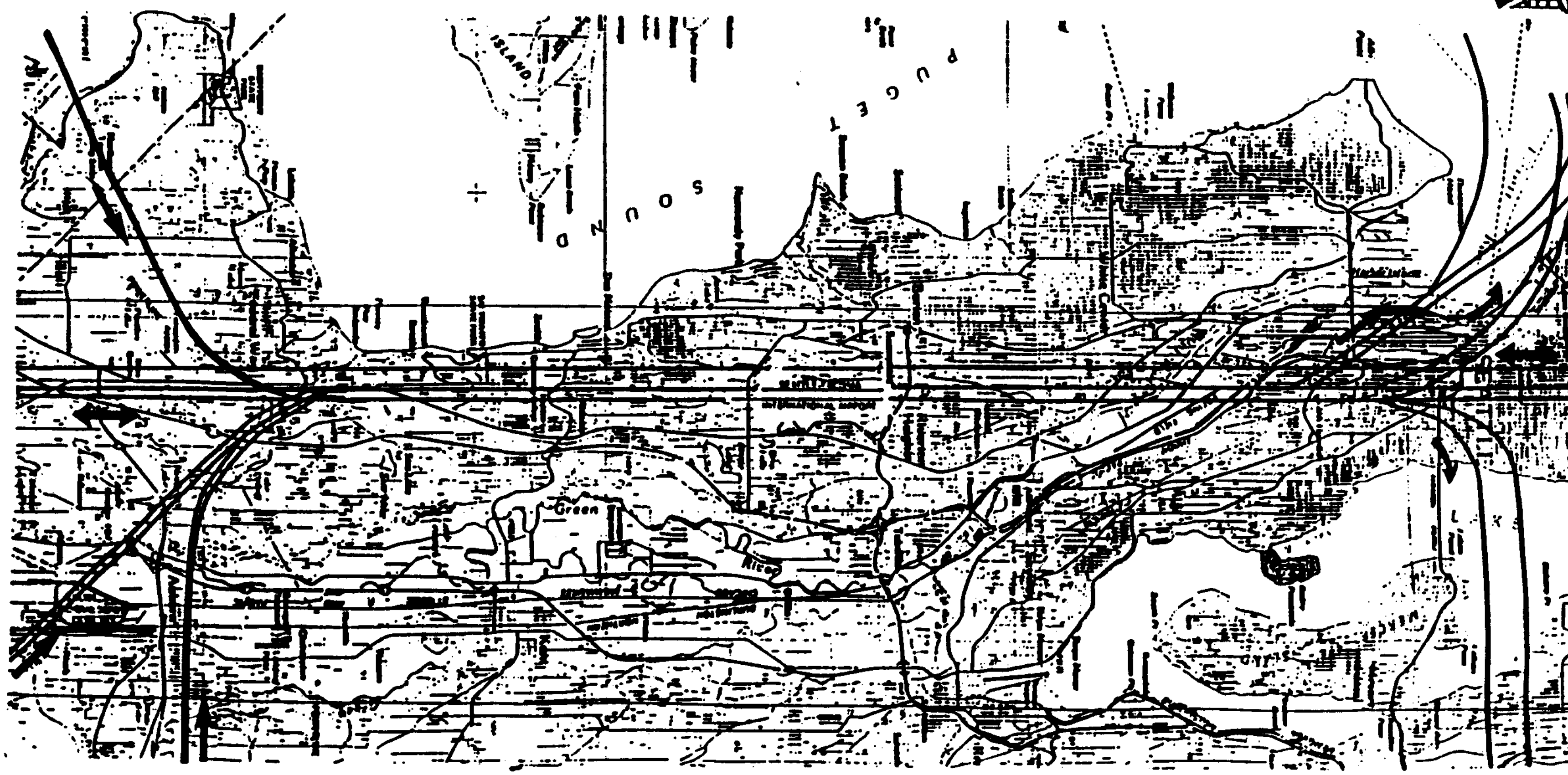


Figure C-2

SEA-TAC PRIMARY FLIGHT TRACKS

The Flight Plan Project Phase III

Mestre Greve Associates

AR 038478

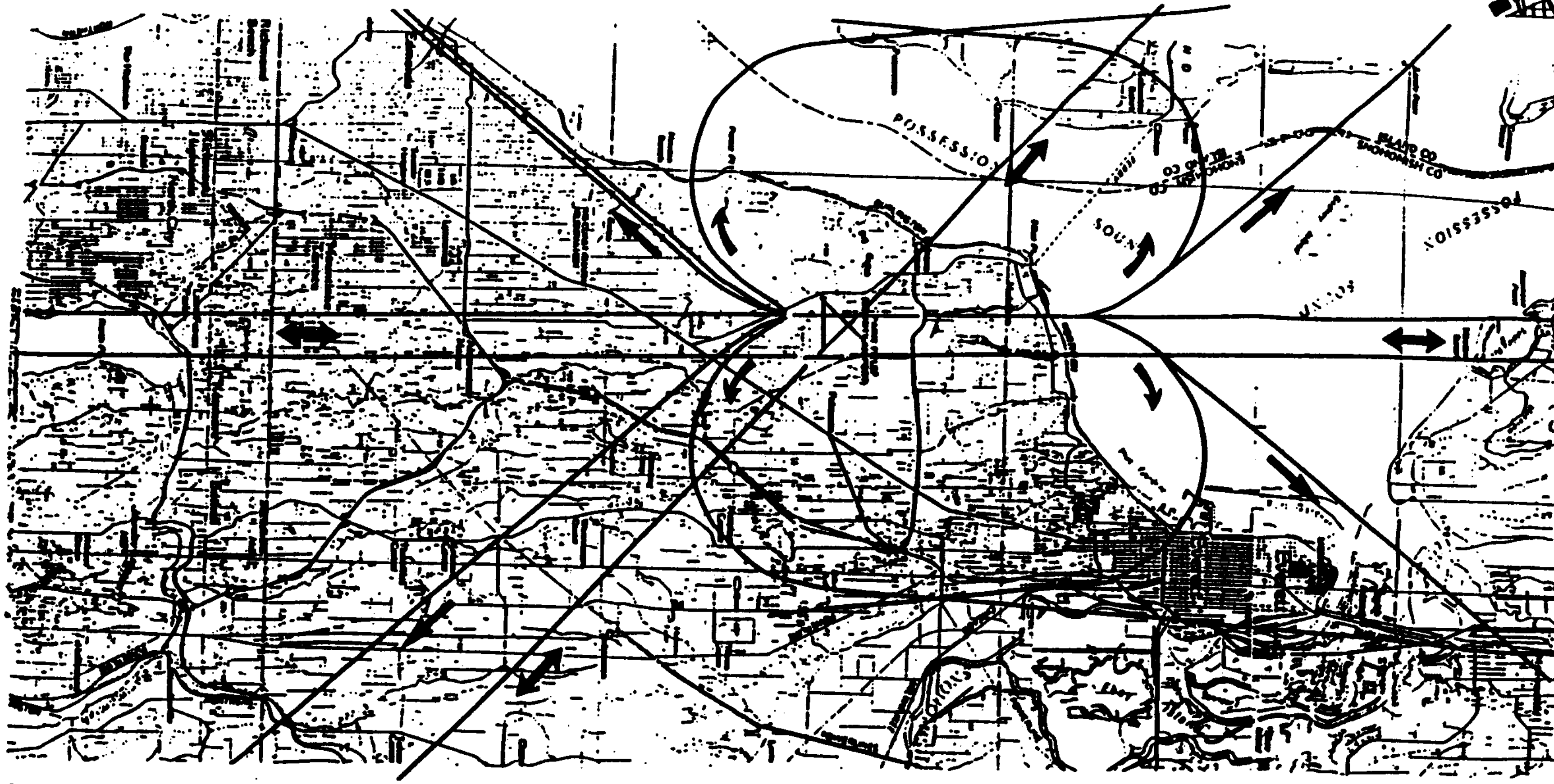


Figure C-3

0 8333 16666 24999

PAINE FIELD PRIMARY FLIGHT TRACKS

NOISE METRICS

Many factors influence how a sound is perceived and whether or not it is considered annoying to a listener. This includes not only physical characteristics of the sound (i.e., loudness, frequency & duration) but also nonacoustic factors (i.e., activity interference & listener expectation). Sound rating scales (noise metrics) are developed to attempt to account for these factors that affect human response to sound.

Community noise is generally not constant and varies with time. Under conditions of non-constant noise, some type of statistical metric is necessary to mathematically express a varying noise level in order to correlate to community response. As a result, several noise metrics have been developed for the analysis of adverse effects of community noise on people.

Noise metrics can be divided into two general categories: "cumulative" and "single event". Cumulative metrics average the total combined noise over a specific time period (which is typically 24-hours for airport noise). These metrics are useful because they combine the total noise throughout the day into a single number rating system. They are the primary methods used in the assessment of aircraft noise in relationship to most noise/land use compatibility criteria.

Single event metrics describe the loudness of a single flyover regardless of the time of day or the number of such events. Single event levels are very useful supplemental predictors when assessing community response to aircraft noise. They can be used in describing the noise levels associated with interference with activities such as speech or sleep. The following paragraphs present summary descriptions of the most prominent noise metrics used to describe aircraft noise.

Cumulative Noise Metrics. Cumulative noise metrics have been developed to account for the identified health effects of noise and the community response to that noise. They are useful because these scales attempt to combine the loudness of each event, the duration of these events, the total number of events and the time of day these events occur into one single number rating scale. Many cumulative metrics are based on the observation that the potential for a noise to impact people is dependent on the total acoustical energy content of the noise. The two predominate scales, Equivalent Noise Level (LEQ) and the Day Night Noise Level (Ldn) are based on this observation. These scales are described in the following paragraphs.

LEQ is the sound level corresponding to a constant sound level containing the same total energy as a time-varying signal over a given sample period. This is graphically illustrated in the center of Figure C-4. LEQ is the "energy" average noise level during the time period of the sample. LEQ can be measured for any time period, but is typically measured for 1 hour. This is also referred to as the Hourly Noise Level (HNL). LEQ can also be expressed as the energy sum of all the noise events that occur during a specific time period divided by duration of that time period.

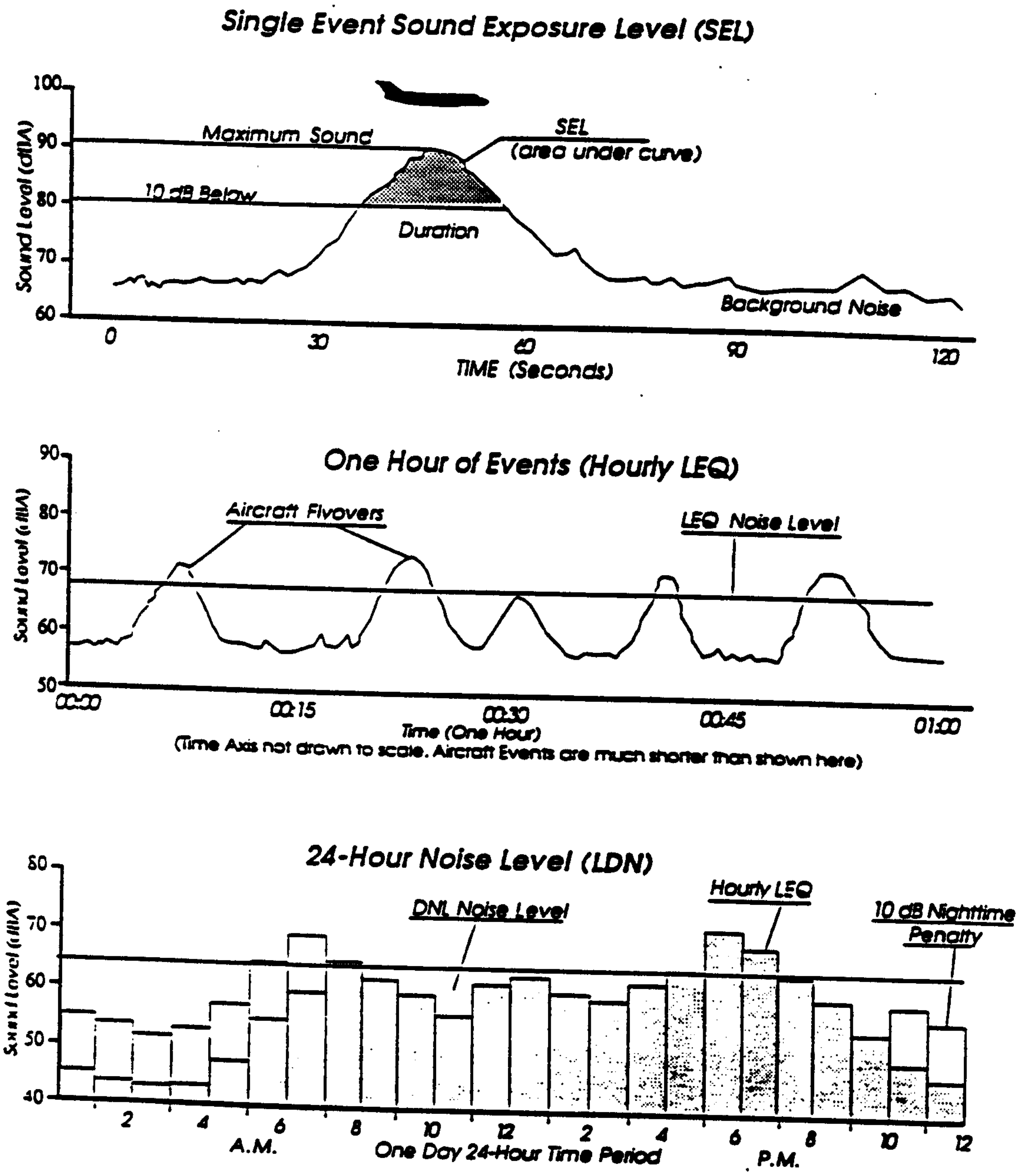


Figure C-4

SEL, LEQ and LDN Illustrations

Ldn is a 24-hour, time-weighted annual average noise level. It is a measure of the overall noise experienced during an entire day. The time-weighted refers to the fact that noise that occurs during certain sensitive time periods is penalized for occurring at these times. In the Ldn scale, those events that take place during the night (10 pm to 7 am) are penalized by adding 10 dB to nighttime events. This penalty was selected to attempt to account for increased human sensitivity to noise during the quieter evening hours, when people are most likely to be at home, and sleep is the most probable activity.

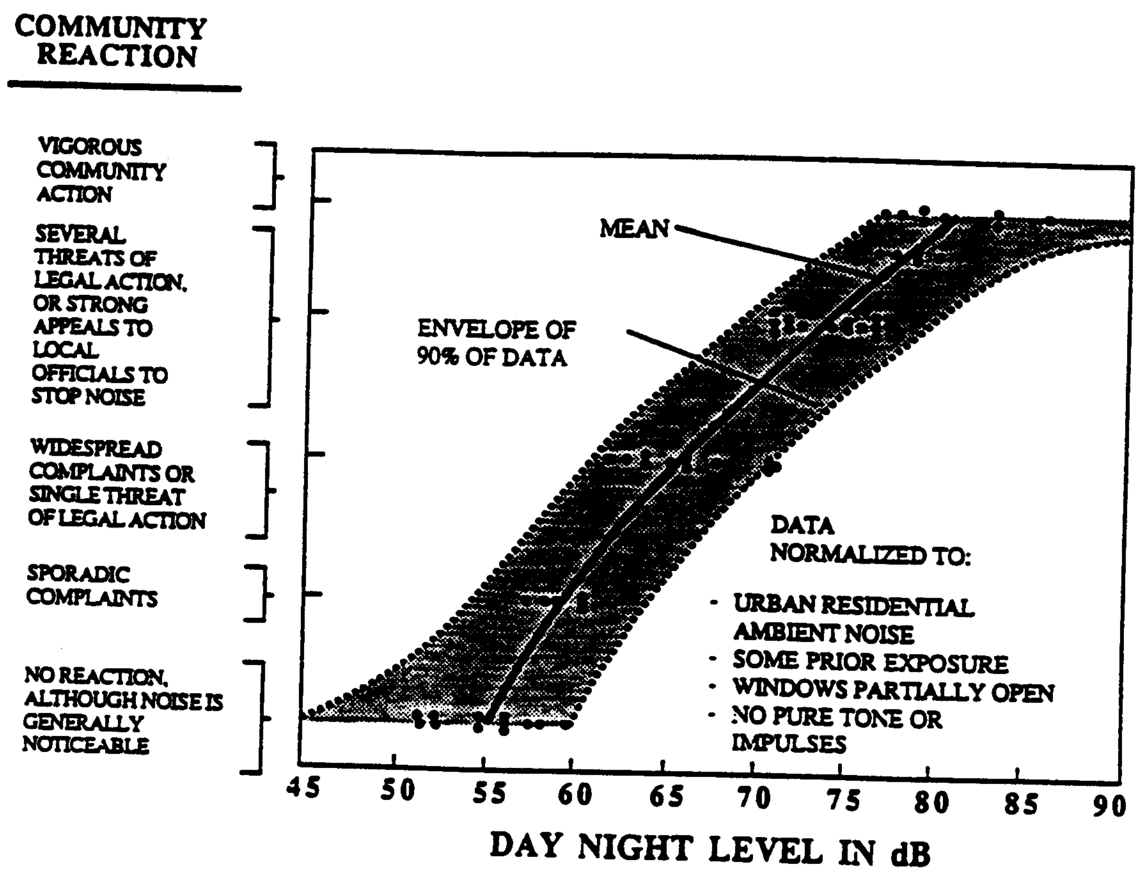
Referring again to Figure C-4, the bottom of the Figure illustrates how hourly LEQs are summed and weighted to compute the daily Ldn level. The Ldn is the energy average of the weighted hourly LEQs. The Ldn scale is specified by the Federal Aviation Administration (FAA) and the Environmental Protection Agency (EPA) for the assessment of noise and land use compatibility conflicts around airports.

Extensive research using the Ldn index has been conducted on human responses to exposure of different levels of aircraft noise. Community noise standards are derived from tradeoffs between the impacts expressed in community response surveys and economic considerations for achieving these levels. Examples of the results of these surveys are expressed in Figure C-5 in terms of community reaction versus Ldn noise level. These charts are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response.

The Ldn noise level can be used as an indicator for when significant impacts from noise and when annoyance from aircraft noise is likely to occur. The EPA has identified 55 Ldn as the highest noise level requisite to protect the public health and welfare with an adequate margin of safety. This includes both residential land use with outdoor use areas and recreational areas. This criteria does not constitute EPA regulations or standards. Rather, it is intended to identify a goal of safe levels of environmental noise exposure without consideration for economic cost for achieving these levels.

The consultant recommends that 55 Ldn be an important criteria for the evaluation of the potential noise impacts around new airport development sites and,while it is not economically feasible as a mitigation in developed areas, it be considered in evaluating the noise impacts around existing airport sites for comparative purposes. 55 Ldn best reflects a noise environment that is indicative of a desired goal for the noise environment within the communities of Puget Sound.

The Federal Aviation Administration and most government agencies throughout the country utilize 65 Ldn as the criteria to indicate compatibility of aircraft noise with residential land use. This level reflects a balance between a desired sound environment and the economic costs for meeting this level. Note that when examining Figure C-5, adverse community reaction still occurs at 65 Ldn. A population exposed to noise levels in excess of 65 Ldn would be considered significantly impacted by noise. Therefore, this criteria is important in the evaluation of noise impacts from all of the airport sites.



Source: Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, United States EPA, Office of Noise Abatement and Control, March, 1974.

Figure C-5 *Example of Community Reaction to Aircraft Noise*

Single Event Noise Metrics. As an aircraft approaches, the sound of the aircraft begins to rise above ambient noise levels. The closer the aircraft gets the louder it is until the aircraft is at its loudest point. Then as the aircraft passes, the noise level decreases until the sound level again settles to ambient levels. Such a flyover history is plotted in the top half of Figure C-4. The highest noise level reached during the flyover is, not surprisingly, called the "Maximum Noise Level," or Lmax. It is to this noise level that people instantaneously respond when an aircraft flyover occurs.

Another metric that is reported for aircraft flyovers is the Sound Exposure Level (SEL). Referring again to Figure C-4, the shaded area or the area within 10 dBA of the maximum noise level is the area from which the SEL is computed. The SEL is mathematically equivalent to the noise level if the total noise energy from the event was compressed into one second. This metric takes into account both the maximum noise level of the event as well as the duration of the event. The SEL is important because it can be used to compare with such health effects of noise such as sleep disturbance and speech interference.

While it has been demonstrated that cumulative noise metrics correspond well with overall community ratings of the noise environment, a number of researchers have suggested supplementing the Ldn analysis with single event data. While the total noise exposure as described by the cumulative noise metric serves as the basis for a person's judgment of the noise environment, it is often a single event interference with some activity that people will use to express their immediate concern over noise. In such cases, single event metrics can be used to supplement the analysis.

Sound Exposure Level (SEL) is a "single event" descriptor of an individual overflight and is often used to supplement the Ldn analysis. An SEL level of 80 dBA corresponds to the level at which sleep disturbance and speech interference start to occur in the general population. A single event SEL of 80 dBA was thus selected as one of the evaluation criteria for this study.

The results from community response information obtained from studies around Sea-Tac were used as supplemental information. Experience at Sea-Tac showed that the 55 Ldn and 80 SEL are good indicators of the overall cumulative noise level at which complaints and annoyance from aircraft start to occur.

NOISE ASSESSMENT GUIDELINES

Noise has been defined as unwanted sound and it is known to have several adverse effects on people. From these known effects of noise, criteria have been established to help protect the public health and safety and prevent disruption of certain human activities. This criteria is based on such known effects of noise on people as hearing loss (not a factor with community noise), communication interference, sleep interference, physiological responses and annoyance.

The public reaction to different noise levels varies from community to community. Extensive research has been conducted on human responses to exposure of different levels of aircraft noise. Community noise standards are derived from tradeoffs between community response surveys and economic considerations for achieving these levels. From these surveys governmental agencies have developed noise assessment criteria.

The purpose of this sub-section is to present criteria regarding the compatibility of various land uses with environmental noise. Noise/Land Use guidelines have been produced by a number of agencies including the Federal Aviation Administration and the Environmental Protection Agency. A number of these guidelines are summarized below.

Federal Aviation Administration. As a means of implementing the Aviation Safety and Noise Abatement Act of 1979, the FAA adopted Regulations on Airport Noise Compatibility Planning Programs. As part of the FAA sponsored Federal Aviation Regulations (FAR) Part 150 Noise Control program, the FAA published noise and land use compatibility guidelines to be used for land use planning with respect to aircraft noise. These guidelines represent recommendations to local authorities for determining acceptability and permissibility of land uses. The guidelines specify maximum amount of noise exposure (in terms of the cumulative noise metric Ldn) that will be considered acceptable to or compatible for people in living and working areas. These noise levels are derived from case histories involving aircraft noise problems at civilian and military airports and the resultant community response. Residential land use is deemed acceptable for noise exposures up to 65 Ldn.

The FAA has also developed guidelines (Order 5050.4) for the environmental analysis of airports. Federal requirements dictate that increases in noise levels over 1.5 Ldn in noise sensitive land uses within the 65 Ldn contour are considered significant and require further environmental analysis (1050.1 Directive 12.21.83).

Environmental Protection Agency. The Environmental Protection Agency (EPA) has developed compatibility guidelines for the assessment of noise compatibility and land uses planning. The 55 Ldn is described as the requisite level with an adequate margin of safety for areas with outdoor uses, this includes residences, and recreational areas. The EPA guideline does not constitute a standard, specification or regulation but identifies safe levels of environmental noise exposure without consideration for economic cost for achieving these levels.

Single Event Guidelines. Single event analysis refers to the noise levels associated with single overflights of an aircraft. There are no noise and land use compatibility standards in terms of single event noise levels, however, disturbances from aircraft noise (i.e., speech and sleep interference) can be related to a single event noise level. Single event noise levels are often a good supplemental predictor of annoyance from aircraft noise. When annoyance occurs can generally be predicted from speech interference and sleep disturbance data.

An 80 SEL represents a level at which communication interference starts to occur in the outdoor environment and complaints start to become more acute. This is particularly true for summer time, when the weather is mild and people are more likely to be outdoors. Indoor noise levels are reduced by about 10 dBA relative to outdoor noise levels with windows and doors open. With windows closed, typical construction reduces the indoor noise levels by 20 dBA. Sleep interference criteria shows that, with windows closed, sleep disturbances typically start to occur with an outdoor SEL of 80 dBA.

This has generally been found to be the case with the majority of the noise complaint areas around Sea-Tac. Most residential communities around Sea-Tac voicing complaints experience typical peak SEL noise levels of 80 or greater. Peak single event noise levels of 80 SEL is used as the single event criteria for this study.

EVALUATION CRITERIA

As stated in previous sections, the evaluation of the potential noise impacts for each of the airport system alternative sites involved the use of various noise assessment criteria. These criteria were presented in previous sections and they are further explained below.

> Residential population exposed to aircraft noise of 55 Ldn or greater. A noise level of 55 Ldn and greater indicates the population to which the aircraft noise will be noticeable and some degree of annoyance or adverse community response would be expected to occur. The EPA has identified 55 Ldn as the requisite noise level for residential land use. It is the level below which social surveys have shown that most residences consider the noise environment to be acceptable. Experience at Sea-Tac showed most areas (but not all),where noise complaints occurred were exposed to Ldn levels of 55 or greater.
>
> For a new airport site the 55 Ldn is the most important criteria. This level represents that area in which future residential land use development may require the start of some level of land use protection. This is not to say that no homes should be located within the 55 Ldn noise contour, but that the desired goal should be to minimize the number.
>
> There are a number of reasons why the 55 Ldn is an important criteria. First, we know from studies at other airports and experience at Sea-Tac that a degree of annoyance or adverse community response can be expected to occur at the 55 Ldn. (The EPA identified 55 Ldn as a goal for residential areas, without consideration for technical or economic feasibility.) Generally, in a densely populated urban environment, it is not economically feasible to insulate every home within the 55 Ldn contour nor is it desirable from a neighborhood integrity standpoint to buy homes on such a large scale. At a new airport site, however, it may indeed be possible to consider early zoning and other land use control measures to avoid significant residential land use impacts.

Residential population newly exposed to 55 Ldn or greater. A newly exposed population consists of those people experiencing new exposure to aircraft noise as a direct result of the alternative. Studies have shown that people newly exposed to aircraft noise initially experience a much stronger adverse reaction than those who have had a long term exposure to the same level. This fact, coupled with the information provided on the use of the 55 Ldn criteria, provides a basis for using this as an important evaluation criteria. This category reflects the population around a new airport or an airport that previous had very few operations and is therefore likely to notice the addition of new aircraft noise and exhibit a higher level of annoyance.

Residential population exposed to aircraft noise of 65 Ldn or greater. The 65 Ldn indicates the population that is significantly impacted by aircraft noise. The FAA noise assessment criteria is 65 Ldn for the compatibility of residential land use with aircraft noise levels. It is likely that for a new airport site, existing homes will need to be either purchased or insulated within the 65 Ldn contour.

Residential population newly exposed to aircraft noise of 65 Ldn or greater. A population that is newly exposed to aircraft noise has been shown to show higher annoyance to aircraft noise than a population that has had a long term exposure to the noise. This criteria will indicate the most highly noise impacted population. This area will most likely need special action, such as buy-out or insulation.

Residential population exposed to single event aircraft noise of 80 SEL or greater. The 80 SEL single event noise contour is an indicator for when speech interference and sleep disturbance start to occur. The 80 SEL single event contour is therefore a good indicator of where single event disturbance is likely to result in annoyance from aircraft operations for a segment of the population. Experience at Sea-Tac has shown that most noise complaints occur in areas where the SEL noise level exceeds 80 dBA.

NOISE CONTOUR ANALYSIS

Noise contour maps for the 55 and 65 Ldn, and 80 SEL, were generated for each of the airport alternatives using the FAA's Integrated Noise Model. Noise contour maps for each of the airport development alternatives are presented later in this Appendix. These contours are typically presented for the largest amount of million annual passengers (MAP) assumed for each airport development scenario (i.e., 1 runway, 2 runway or 3 runways) and for other MAP levels that are typical of the remaining alternatives. These contours present the 55 and 65 Ldn as well as the 80 SEL contour and are based upon the assumptions presented previously. The noise contours are presented in Figures C-6 through C-37. The amount of land in terms of square miles that is within each year 2020 Ldn noise contour for each alternative is presented in Table C-5.

Table C-5

Size of LDN Noise Contours (Square Miles) 2020

Does Not Include Mitigation Measures for Sea-Tac w/Dependent R/W

Alt.		Airport System Siting Options	Seatac Airport 55 LDN	Seatac Airport 65 LDN	North Airports 55 LDN	North Airports 65 LDN	South Airports 55 LDN	South Airports 65 LDN
1	**	Sea-Tac Only with Existing Runways (Constrained)	30.9	5.1				
3	**	Alternate 1 + Arlington 1 R/W	30.9	5.1	12.8	1.8		
4		Alternate 1 + Paine 1 R/W	30.9	5.1	14.6	2		
5		Alternate 1 + McChord 1 R/W	30.9	5.1			15.7	2.2
6	**	Alternate 1 + Central Pierce 1 R/W	30.9	5.1			12.8	1.8
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	30.9	5.1			12.8	1.8
8		Alternate 1 + Arlington 2 R/W	30.9	5.1	17.6	2.3		
9		Alternate 1 + Paine 2 R/W	30.9	5.1	15.1	2.3		
10		Alternate 1 + McChord 2 R/W	30.9	5.1			15.8	2.3
11		Alternate 1 + Central Pierce 2 R/W	30.9	5.1			17.6	2.4
12		Alternate 1 + Olympia/Black Lake 2 R/W	30.9	5.1			17.6	2.3
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	35.9	6.5	5.5	0.7		
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	35.9	6.5	5.5	0.8		
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	35.9	6.5			6.7	1
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	35.9	6.5			5.5	0.7
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	35.9	6.5			5.5	0.7
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	35.9	6.5	6.9	0.8		
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	35.9	6.5	6	0.9		
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	35.9	6.5			7	1.1
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	35.9	6.5			6.9	0.9
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	35.9	6.5			7	0.8
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	8.2	1.1	9.3	1.3
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	30.9	5.1	6	0.9	8.7	1.2
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	30.9	5.1	9.1	1.2	8.2	1.1
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	30.9	5.1	6	0.9	7.7	1
27		Alternate 13+ Central Pierce 1 R/W	34.7	6.4	4.3	0.6	5.5	0.7
28	†	Alternate 14+Central Pierce 1 R/W	34.5	6.4	6	0.9	5.5	0.7
29		Alternate 13+Olympia/Black Lake 1 R/W	35.4	6.5	4.3	0.6	3.3	0.5
30		Alternate 14+Olympia/Black Lake 1 R/W	35.3	6.5	6	0.9	3.3	0.5
31		Central Pierce 3 R/W					59.2	8.5
32		Central Pierce/Fort Lewis 3 R/W					59.2	8.5
33	**	Alternate 1 + Demand Management	30.9	5.1				
34	**	No Action (Unconstrained Sea-Tac Only)	46.3	8.4				
35	**	Sea-Tac w/Dep R/W (Unconstrained Sea-Tac Only)	41.3	8.1				

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

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The primary time period for analysis was 2020, which is representative of the long term noise environment. An analysis of the years of 2000 and 2010 were also completed to present the projected noise environment during the interim time periods. The analysis of the interim years was completed for Sea-Tac and the north airports site options only, in that an airport site to the south is not anticipated until the post 2010 time frame. Table C-6 presents the square mileages of the LDN contours for these alternatives in the years 2000 and 2010.

The aircraft fleet forecast to be operating in the post 2000 time frame is composed of all Stage 3 aircraft. Stage 3 refers to the quietest category of aircraft as defined by the FAA Federal Aircraft Regulation 36 which regulates the noise levels generated by jet aircraft. FAA certification of Stage 3 aircraft is based on engine weight and noise. The federal government has recently passed legislation that mandates the phasing out of the louder Stage 2 aircraft by the year 2000. The analysis assumes that the aircraft fleet will continue the trend of quieter aircraft after 2000 as the older and loudest of the Stage 3 aircraft are retired from the fleet due to aging. This includes such aircraft as the DC10, L1011, B747-200 and retrofitted B727s. In terms of perceived loudness, most individuals will perceive new Stage 3 aircraft to be 1/4 as loud as a typical Stage 2 aircraft.

The aircraft that are assumed to operate in the post 2010 time frame generate similar noise levels as those of the quietest of the new generation aircraft that are being built today. The post 2010 contour analysis assumes all Stage 3 aircraft such as the MD80, MD90, B737-300, B757, B767, MD-11, B747-400 as well as other new generation aircraft.

Given the 25 to 30 year life span for commercial aircraft, these aircraft would be expected to still be in service by 2020. Although these aircraft are significantly quieter than many of the current fleet of aircraft such as the B727, they still generate noticeable levels of noise. New aircraft currently under development utilize similar technology that is expected to result in noise levels similar to the Stage 3 generation of quieter aircraft. Any significant future reductions in noise will require new developments in engine technology or noise control and therefore are not anticipated by this study.

Single event noise contours for aircraft types and procedures expected to be in operation in post 2000 were generated and mapped. The departure noise levels were used because aircraft departures generate the highest single event noise level. The aircraft selected to represent the single event noise levels is the McDonnell Douglas MD-82. The MD80 series aircraft was the first narrowbody Stage 3 commercial aircraft, and while quieter than Stage 2 aircraft, does not include the latest engine technology associated with the new generation of Stage 3 aircraft. The MD82 aircraft was used for the single event analysis to present a worst case analysis. The MD82 is representative of the loudest aircraft expected to be in operation through the early part of the 21st century. The associated contour maps present a composite of the singe-event noise levels to all of the

Table C-6

Year 2000 and Year 2010 Area and Population Estimates

	Year 2000		Year 2010	
	55 LDN	65 LDN	55 LDN	65 LDN
Area Impacts (Sq. MI.)				
Sea-Tac				
NO ACTION (Unconstrained Sea-Tac Only)	55.1	12.1	34.0	5.9
SEA-TAC WITH NEW AC RWY (Unconstrained Sea-Tac Only)	-	-	35.6	6.2
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	49.8	11.1	33.4	6.1
MITIGATED SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	-	-	32.0	5.5
Paine				
SEA-TAC WITH NEW AC RWY + PAINE(1 RWY) + SUPP(1 RWY)	4.3	0.6	4.8	0.7
Arlington				
SEA-TAC WITH NEW AC RWY + ARLINGTON(1 RWY) + SUPP(1 RWY)	2.6	0.4	3.4	0.5
Population Impacts				
Sea-Tac				
No Action (Unconstrained Sea-Tac Only)	190,700	39,500	128,700	14,900
SEA-TAC WITH NEW AC RWY (Unconstrained Sea-Tac Only)	-	-	132,600	15,000
SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	172,400	35,500	124,300	14,600
MITIGATED SEA-TAC WITH NEW AC RWY + 2 SUPP(1 RWY)	-	-	122,700	12,400
Paine				
SEA-TAC WITH NEW AC RWY + PAINE(1 RWY) + SUPP(1 RWY)	6,100	0	8,800	0
Arlington				
SEA-TAC WITH NEW AC RWY + ARLINGTON(1 RWY) + SUPP(1 RWY)	1,800	0	2,500	0

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primary flight tracks and are intended to reflect typical single-event noise levels in different communities.

The contour analysis presents impacts for a third dependent runway at Sea-Tac with and without noise mitigation measures. Without mitigation, the operational assumptions for a dependent runway at Sea-Tac include both arrivals and departures and nighttime operations. One third of the operations are assumed for the new runway. Under the mitigation assumption, the runway would handle daytime arrivals only.

POPULATION IMPACTS

The noise contour analysis was used to determine the population that would be exposed to certain noise levels. Population data is from the Puget Sound Regional Council (PSRC) which maintains a population data base by travel analysis zones (TAZs). For King, Pierce, Snohomish, and Kitsap Counties there are nearly 800 TAZs. TAZs are similar in size to census tracts and thus tend to be smaller in urbanized areas and larger in rural areas. The noise contour maps were entered into the PSRC computer data base. The computer calculated the percentage area of each TAZ covered by a given contour and multiplied by the total TAZ population to obtain the proportionate population within the noise contour. These proportionate population figures were then summed to obtain the total population within each contour. Suitable population data by sub area was not available for Thurston County. Instead, a population density figure for the county was multiplied by the area under each noise contour to provide a general estimate of the impacted population.

The noise contours are based on operational assumptions for the years 2000, 2010 and 2020. The population analysis is based on PSRC population projections or by Thurston Regional Planning Council and State Office of Financial Management data for each year under study. In order to present a worst case analysis, protective zoning and land use planning practices are assumed not to be employed around the selected airport site(s).

Projected population data indicate that people will be living around nearly all of the airport sites. The most densely populated areas are expected to be around Sea-Tac and Paine Field Airports. The least densely populated area would be around Olympia/Black Lake and Arlington. Also, no private homes are located to the south of the McChord or Fort Lewis sites because that area is part of the Fort Lewis Army Base.

The results of the 2020 population analysis for each of the airport site alternatives are presented in Tables C-7A and C-7B. Figures in Table C-7A assume that no mitigation measures would be in place for a third dependent runway at Sea-Tac, while Table C-7B presents the impacts if the runway were to be mitigated. These tables presents the range in populations for each of the assessment criteria. Population impacts for the years 2000 and 2010 for Sea-Tac and the northern airport sites are presented in Table C-6. Data for southern airport sites are not included since it was assumed that such an airport would not be implemented until after the year 2010.

Table C-7A

Population Summaries within 2020 Noise Contours

Does Not Include Mitigation Measures for Sea-Tac w/Dependent R/W

Alt		Airport System Siting Options	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	**	Sea-Tac Only with Existing Runways (Constrained)	135		12.0		120
3	**	Alternate 1 + Arlington 1 R/W	152	17	12.7	0.7	156
4		Alternate 1 + Paine 1 R/W	172	37	13.5	1.5	186
5		Alternate 1 + McChord 1 R/W	164	29	13.0	1.0	176
6	**	Alternate 1 + Central Pierce 1 R/W	163	28	13.2	1.2	173
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	139	4	12.1		129
8		Alternate 1 + Arlington 2 R/W	158	23	12.7	0.7	173
9		Alternate 1 + Paine 2 R/W	174	39	13.9	1.9	200
10		Alternate 1 + McChord 2 R/W	165	30	13.0	1.0	186
11		Alternate 1 + Central Pierce 2 R/W	173	38	12.8	0.8	193
12		Alternate 1 + Olympia/Black Lake 2 R/W	140	5	12.1		134
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	169	5	20.2		168
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	177	13	20.0		199
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	177	13	20.1		189
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	177	13	20.1		186
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	166	2	20.0		141
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	170	6	20.0		186
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	178	14	20.0		213
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	177	13	20.1		198
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	181	17	20.0		206
22		Sea-Tac w/Dependent R/W + Olym./Blk Lake 2 R/W	165	1	20.0		146
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	165	30	12.8	0.8	206
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	176	41	12.9	0.9	240
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	149	14	12.3		164
26		Alternate 1 + Paine 1 R/W + Olym./Blk. Lake 1 R/W	161	26	12.5	0.5	195
27		Alternate 13+ Central Pierce 1 R/W	175	17	18.2		221
28	†	Alternate 14+Central Pierce 1 R/W	180	26	18.2		252
29		Alternate 13+Olympia/Black Lake 1 R/W	168	5	19.0		177
30		Alternate 14+Olympia/Black Lake 1 R/W	174	14	19.1		206
31		Central Pierce 3 R/W	101	101	4.7	4.7	106
32		Central Pierce/Fort Lewis 3 R/W	81	81	3.8	3.8	86
33	**	Alternate 1 + Demand Management	135		12.0		120
34	**	No Action (Unconstrained Sea-Tac Only)	175		25.0		120
35	**	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	162		22.0		120

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

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Table C-7B

Population Summaries within 2020 Noise Contours

Includes Mitigation Measures for Sea-Tac w/Dependent R/W

Alt		Airport System Siting Options	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 90 SEL (000)
1	**	Sea-Tac Only with Existing Runways (Constrained)	135		12.0		120
3	**	Alternate 1 + Arlington 1 R/W	152	17	12.7	0.7	156
4		Alternate 1 + Paine 1 R/W	172	37	13.5	1.5	186
5		Alternate 1 + McChord 1 R/W	164	29	13.0	1.0	176
6	**	Alternate 1 + Central Pierce 1 R/W	163	28	13.2	1.2	173
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	139	4	12.1	0.1	129
8		Alternate 1 + Arlington 2 R/W	158	23	12.7	0.7	173
9		Alternate 1 + Paine 2 R/W	174	39	13.9	1.9	200
10		Alternate 1 + McChord 2 R/W	165	30	13.0	1.0	186
11		Alternate 1 + Central Pierce 2 R/W	173	38	12.8	0.8	193
12		Alternate 1 + Olympia/Black Lake 2 R/W	140	5	12.1	0.1	134
13	M	Sea-Tac w/Dependent R/W + Arlington 1 R/W	142	5	15.3	0.2	157
14	M	Sea-Tac w/Dependent R/W + Paine 1 R/W	150	13	15.1	0.0	188
15	M	Sea-Tac w/Dependent R/W + McChord 1 R/W	150	13	15.2	0.1	178
16	M	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	150	13	15.2	0.1	175
17	M	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	139	2	15.1	0.0	130
18	M	Sea-Tac w/Dependent R/W + Arlington 2 R/W	143	6	15.1	0.0	175
19	M	Sea-Tac w/Dependent R/W + Paine 2 R/W	151	14	15.1	0.0	202
20	M	Sea-Tac w/Dependent R/W + McChord 2 R/W	150	13	15.2	0.1	188
21	M	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	154	17	15.1	0.0	195
22	M	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	138	1	15.1	0.0	135
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	165	30	12.8	0.8	208
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	176	41	12.9	0.9	240
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	149	14	12.3	0.3	164
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	161	26	12.5	0.5	195
27	M	Alternate 13+ Central Pierce 1 R/W	154	17	15.3	0.2	210
28	M†	Alternate 14+Central Pierce 1 R/W	163	26	15.3	0.2	241
29	M	Alternate 13+Olympia/Black Lake 1 R/W	142	5	15.1	0.0	166
30	M	Alternate 14+Olympia/Black Lake 1 R/W	151	14	15.2	0.1	197
31		Central Pierce 3 R/W	101	101	4.7	4.7	108
32		Central Pierce/Fort Lewis 3 R/W	81	81	3.8	3.8	86
33	**	Alternate 1 + Demand Management	135	0	12.0	0.0	120
34	**	No Action (Unconstrained Sea-Tac Only)	175	0	25.0	0.0	120
35	**	Sea-Tac w/Dep R/W (Unconstrained Sea-Tac Only)	157		20		120

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

M Denotes mitigation measures included for Dependent R/W

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The total population for the year 2020 located within each noise contour is presented in Tables C-8 through C-10 for Sea-Tac, North Airports and South Airports respectively. Table C-8A assumes that no mitigation measures would be in place for a third dependent runway at Sea-Tac, while Table C-8B presents the impacts if the runway were to be mitigated.

Table C-8A

Population Estimates for Sea-Tac 2020

Does Not Include Mitigation Measures for Sea-Tac w/Dependent R/W

Alt		Airport System Siting Options	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	**	Sea-Tac Only with Existing Runways (Constrained)	135		12		120
3	**	Alternate 1 + Arlington 1 R/W	135		12		120
4		Alternate 1 + Paine 1 R/W	135		12		120
5		Alternate 1 + McChord 1 R/W	135		12		120
6	**	Alternate 1 + Central Pierce 1 R/W	135		12		120
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	135		12		120
8		Alternate 1 + Arlington 2 R/W	135		12		120
9		Alternate 1 + Paine 2 R/W	135		12		120
10		Alternate 1 + McChord 2 R/W	135		12		120
11		Alternate 1 + Central Pierce 2 R/W	135		12		120
12		Alternate 1 + Olympia/Black Lake 2 R/W	135		12		120
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	164		20		132
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	164		20		132
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	164		20		132
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	164		20		132
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	164		20		132
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	164		20		132
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	164		20		132
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	164		20		132
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	164		20		132
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	164		20		132
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	135		12		120
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	135		12		120
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	135		12		120
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	135		12		120
27		Alternate 13+ Central Pierce 1 R/W	158		18		132
28	†	Alternate 14+Central Pierce 1 R/W	154		18		132
29		Alternate 13+Olympia/Black Lake 1 R/W	163		19		132
30		Alternate 14+Olympia/Black Lake 1 R/W	160		19		132
31		Central Pierce 3 R/W					
32		Central Pierce/Fort Lewis 3 R/W					
33	**	Alternate 1 + Demand Management	135		12		120
34	**	No Action (Unconstrained Sea-Tac Only)	175		25		120
35	**	Sea-Tac w/Dep R/W (Unconstrained Sea-Tac Only)	162		22		120

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

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AR 038495

Table C-8B

Population Estimates for Sea-Tac 2020

Includes Mitigation Measures for Sea-Tac w/Dependent R/W

Alt		Airport System Siting Options	Total Population 55 LDN (000)	Population Newly Exposed to 55 LDN (000)	Total Population 65 LDN (000)	Population Newly Exposed to 65 LDN (000)	Total Population 80 SEL (000)
1	**	Sea-Tac Only with Existing Runways (Constrained)	135		12		120
3	**	Alternate 1 + Arlington 1 R/W	135		12		120
4		Alternate 1 + Paine 1 R/W	135		12		120
5		Alternate 1 + McChord 1 R/W	135		12		120
6	**	Alternate 1 + Central Pierce 1 R/W	135		12		120
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	135		12		120
8		Alternate 1 + Arlington 2 R/W	135		12		120
9		Alternate 1 + Paine 2 R/W	135		12		120
10		Alternate 1 + McChord 2 R/W	135		12		120
11		Alternate 1 + Central Pierce 2 R/W	135		12		120
12		Alternate 1 + Olympia/Black Lake 2 R/W	135		12		120
13	M	Sea-Tac w/Dependent R/W + Arlington 1 R/W	137		15		121
14	M	Sea-Tac w/Dependent R/W + Paine 1 R/W	137		15		121
15	M	Sea-Tac w/Dependent R/W + McChord 1 R/W	137		15		121
16	M	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	137		15		121
17	M	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	137		15		121
18	M	Sea-Tac w/Dependent R/W + Arlington 2 R/W	137		15		121
19	M	Sea-Tac w/Dependent R/W + Paine 2 R/W	137		15		121
20	M	Sea-Tac w/Dependent R/W + McChord 2 R/W	137		15		121
21	M	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	137		15		121
22	M	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	137		15		121
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	135		12		120
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	135		12		120
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	135		12		120
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	135		12		120
27	M	Alternate 13+ Central Pierce 1 R/W	137		15		121
28	M†	Alternate 14+Central Pierce 1 R/W	137		15		121
29	M	Alternate 13+Olympia/Black Lake 1 R/W	137		15		121
30	M	Alternate 14+Olympia/Black Lake 1 R/W	137		15		121
31		Central Pierce 3 R/W	0		0		0
32		Central Pierce/Fort Lewis 3 R/W	0		0		0
33	**	Alternate 1 + Demand Management	135		12		120
34	**	No Action (Unconstrained Sea-Tac Only)	175		25		120
35	**	Sea-Tac w/Dep R/W (Unconstrained Sea-Tac Only)	157		20		120

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

M Denotes mitigation measures included for Dependent R/W

Mestre Greve Associates

AR 038496

Table C-9

Population Estimates for North Airports 2020

Alt		Airport System Siting Options	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*
1	**	Sea-Tac Only with Existing Runways (Constrained)					
3	**	Alternate 1 + Arlington 1 R/W					
4		Alternate 1 + Paine 1 R/W	17	17	1	1	36
5		Alternate 1 + McChord 1 R/W	37	37	2	2	67
6	**	Alternate 1 + Central Pierce 1 R/W					
7	**	Alternate 1 + Olympia/Black Lake 1 R/W					
8		Alternate 1 + Arlington 2 R/W					
9		Alternate 1 + Paine 2 R/W	23	23	1	1	54
10		Alternate 1 + McChord 2 R/W	39	39	2	2	81
11		Alternate 1 + Central Pierce 2 R/W					
12		Alternate 1 + Olympia/Black Lake 2 R/W					
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W					
14		Sea-Tac w/Dependent R/W + Paine 1 R/W	5	5			36
15		Sea-Tac w/Dependent R/W + McChord 1 R/W	13	13			67
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W					
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W					
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W					
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	6	6			54
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	14	14			81
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W					
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W					
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W					
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	9	9			36
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	21	21			67
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	11	11			36
27		Alternate 13+ Central Pierce 1 R/W	24	24	1	1	67
28	†	Alternate 14+Central Pierce 1 R/W	4	4			36
29		Alternate 13+Olympia/Black Lake 1 R/W	13	13			67
30		Alternate 14+Olympia/Black Lake 1 R/W	4	4			36
31		Central Pierce 3 R/W					
32		Central Pierce/Fort Lewis 3 R/W					
33	**	Alternate 1 + Demand Management					
34	**	No Action (Unconstrained Sea-Tac Only)					
35	**	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)					

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

Mestre Greve Associates

AR 038497

Table C-10

Population Estimates for South Airports 2020

Alt		Airport System Siting Options	Total Population 55 LDN (000)*	Population Newly Exposed to 55 LDN (000)*	Total Population 65 LDN (000)*	Population Newly Exposed to 65 LDN (000)*	Total Population 80 SEL (000)*
1	**	Sea-Tac Only with Existing Runways (Constrained)					
3	**	Alternate 1 + Arlington 1 R/W					
4		Alternate 1 + Paine 1 R/W					
5		Alternate 1 + McChord 1 R/W					
6	**	Alternate 1 + Central Pierce 1 R/W	29	29	1	1	57
7	**	Alternate 1 + Olympia/Black Lake 1 R/W	28	28	1	1	53
8		Alternate 1 + Arlington 2 R/W	4	4			9
9		Alternate 1 + Paine 2 R/W					
10		Alternate 1 + McChord 2 R/W					
11		Alternate 1 + Central Pierce 2 R/W	30	30	1	1	66
12		Alternate 1 + Olympia/Black Lake 2 R/W	38	38	1	1	74
13		Sea-Tac w/Dependent R/W + Arlington 1 R/W	5	5			14
14		Sea-Tac w/Dependent R/W + Paine 1 R/W					0
15		Sea-Tac w/Dependent R/W + McChord 1 R/W					0
16		Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	13	13			57
17		Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	13	13			53
18		Sea-Tac w/Dependent R/W + Arlington 2 R/W	2	2			9
19		Sea-Tac w/Dependent R/W + Paine 2 R/W	0	0			
20		Sea-Tac w/Dependent R/W + McChord 2 R/W	0	0			
21		Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	13	13			66
22		Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	17	17			74
23		Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	1	1			14
24		Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	21	21	1	1	53
25		Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R/W	20	20	1	1	53
26		Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	3	3			9
27		Alternate 13+ Central Pierce 1 R/W	2	2			9
28	†	Alternate 14+Central Pierce 1 R/W	13	13			53
29		Alternate 13+Olympia/Black Lake 1 R/W	13	13			53
30		Alternate 14+Olympia/Black Lake 1 R/W	1	1			9
31		Central Pierce 3 R/W	101	101	5	5	108
32		Central Pierce/Fort Lewis 3 R/W	81	81	4	4	86
33	**	Alternate 1 + Demand Management					
34	**	No Action (Unconstrained Sea-Tac Only)					
35	**	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)					

** Denotes systems that include alternatives which do not meet system capacity demands

† Alternative Recommended by PSATC on June 17, 1992

Mestre Greve Associates

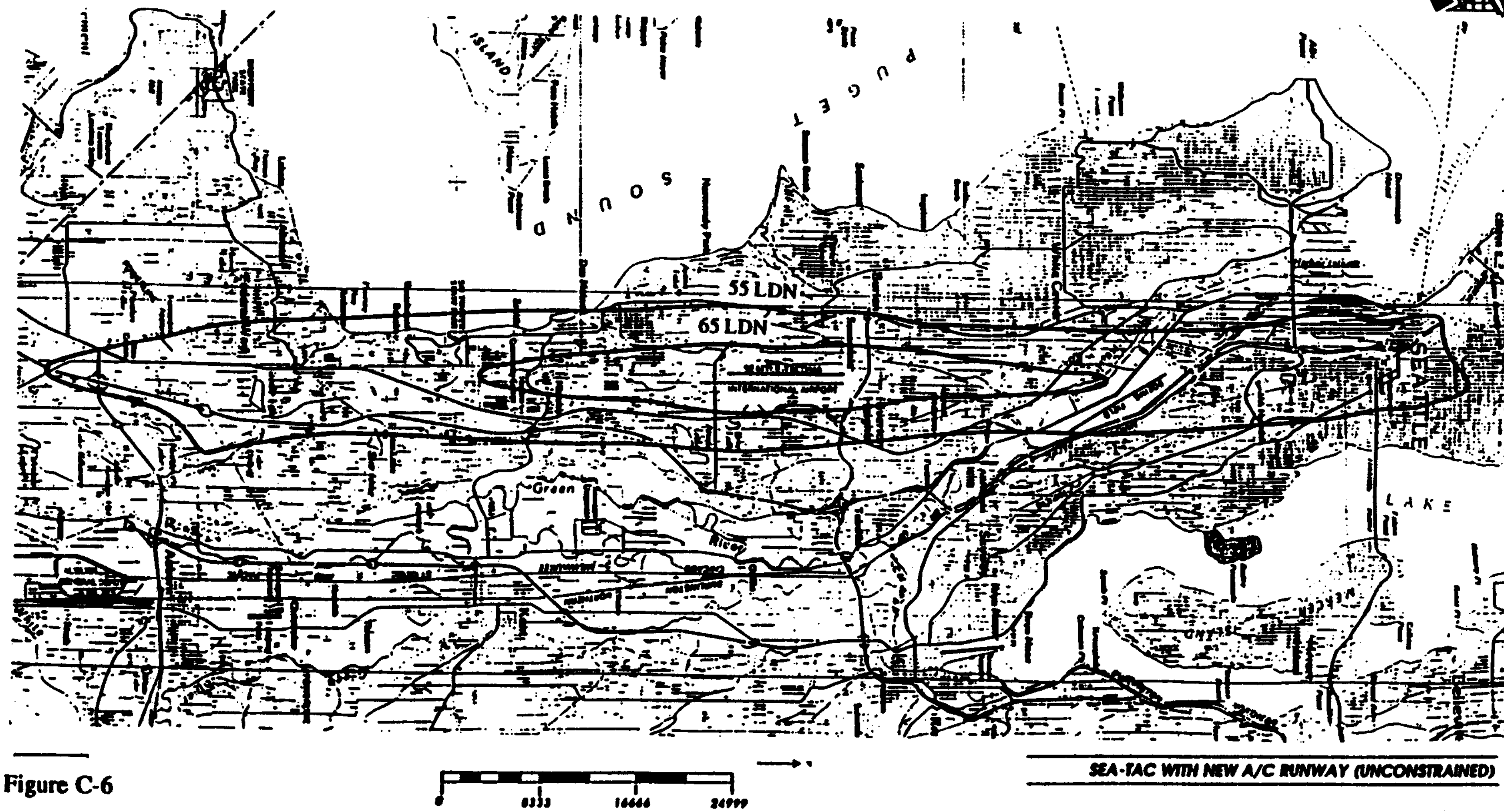

Figure C-6

SEA-TAC WITH NEW A/C RUNWAY (UNCONSTRAINED) 202

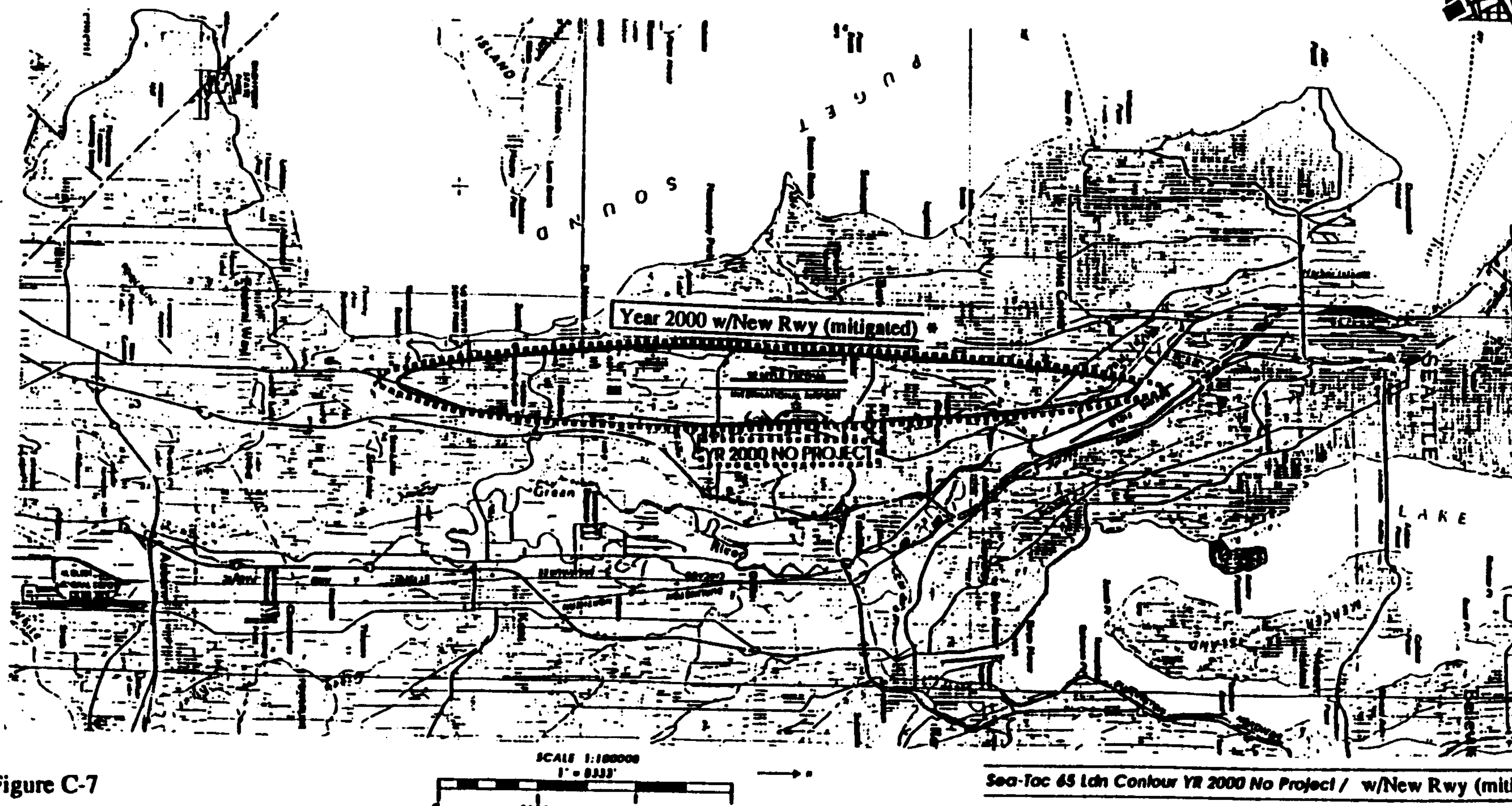

Figure C-7

Sea-Tac 65 Ldn Contour YR 2000 No Project / w/New Rwy (mitigated
* Alternative 28

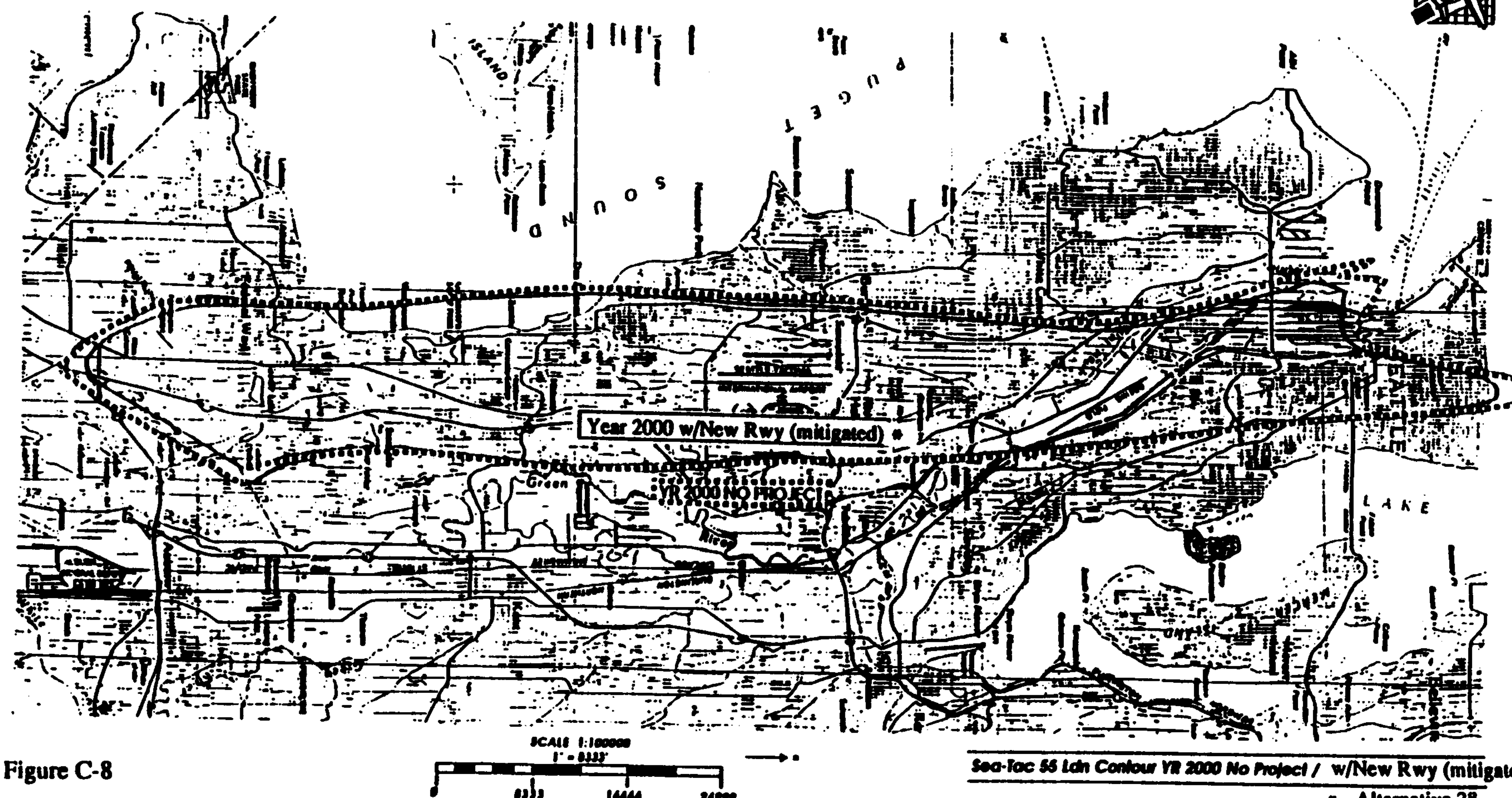

Figure C-8

Sea-Tac 55 Ldn Contour YR 2000 No Project / w/New Rwy (mitigated)

* Alternative 28

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PUGET SOUND AIR TRANSPORTATION COMMITTEE

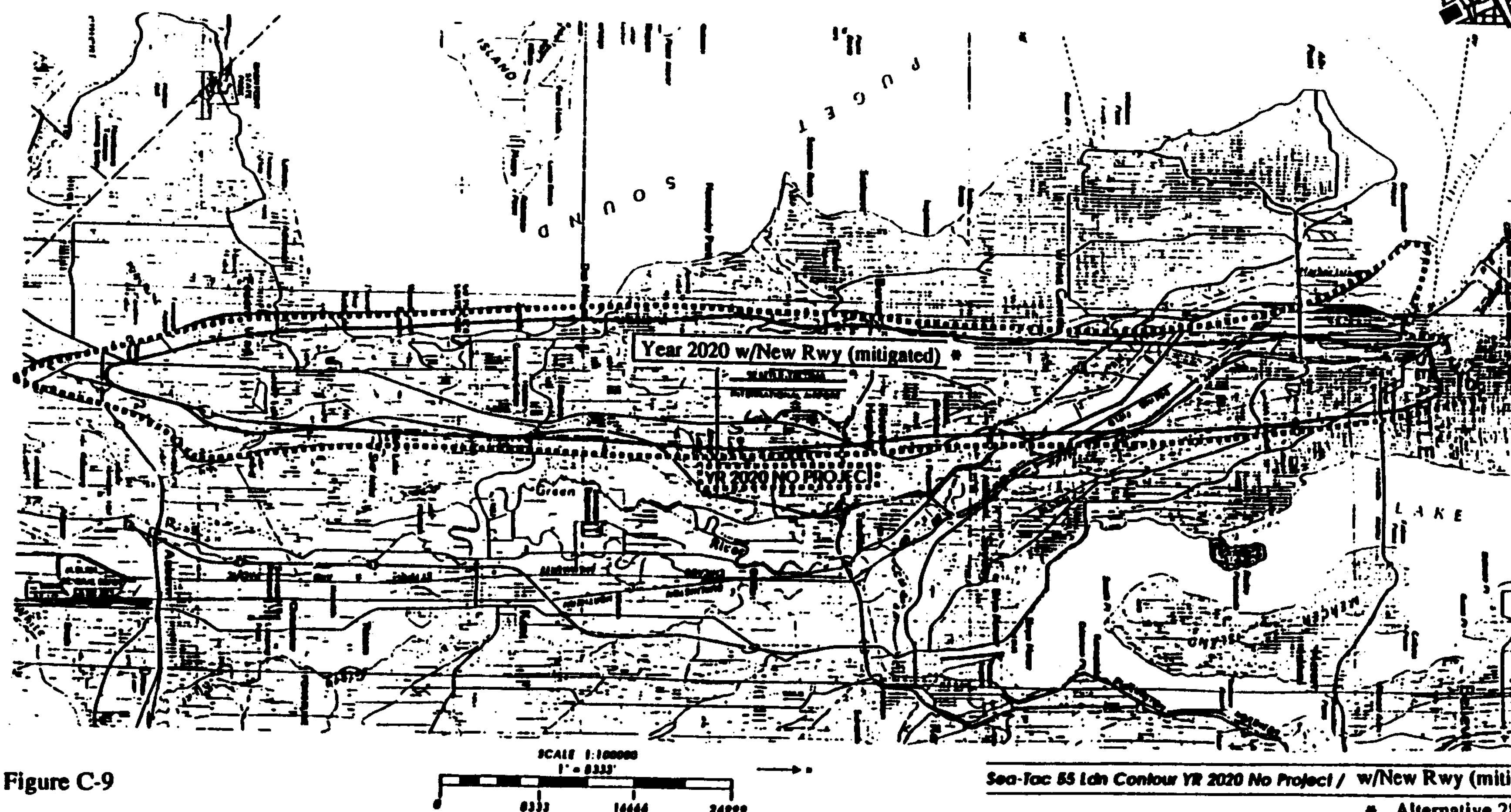


Figure C-9

Sea-Tac 55 Ldn Contour YR 2020 No Project / w/New Rwy (mitigated

* Alternative 28

The Flight Plan Project Phase III

Mestre Greve Associates

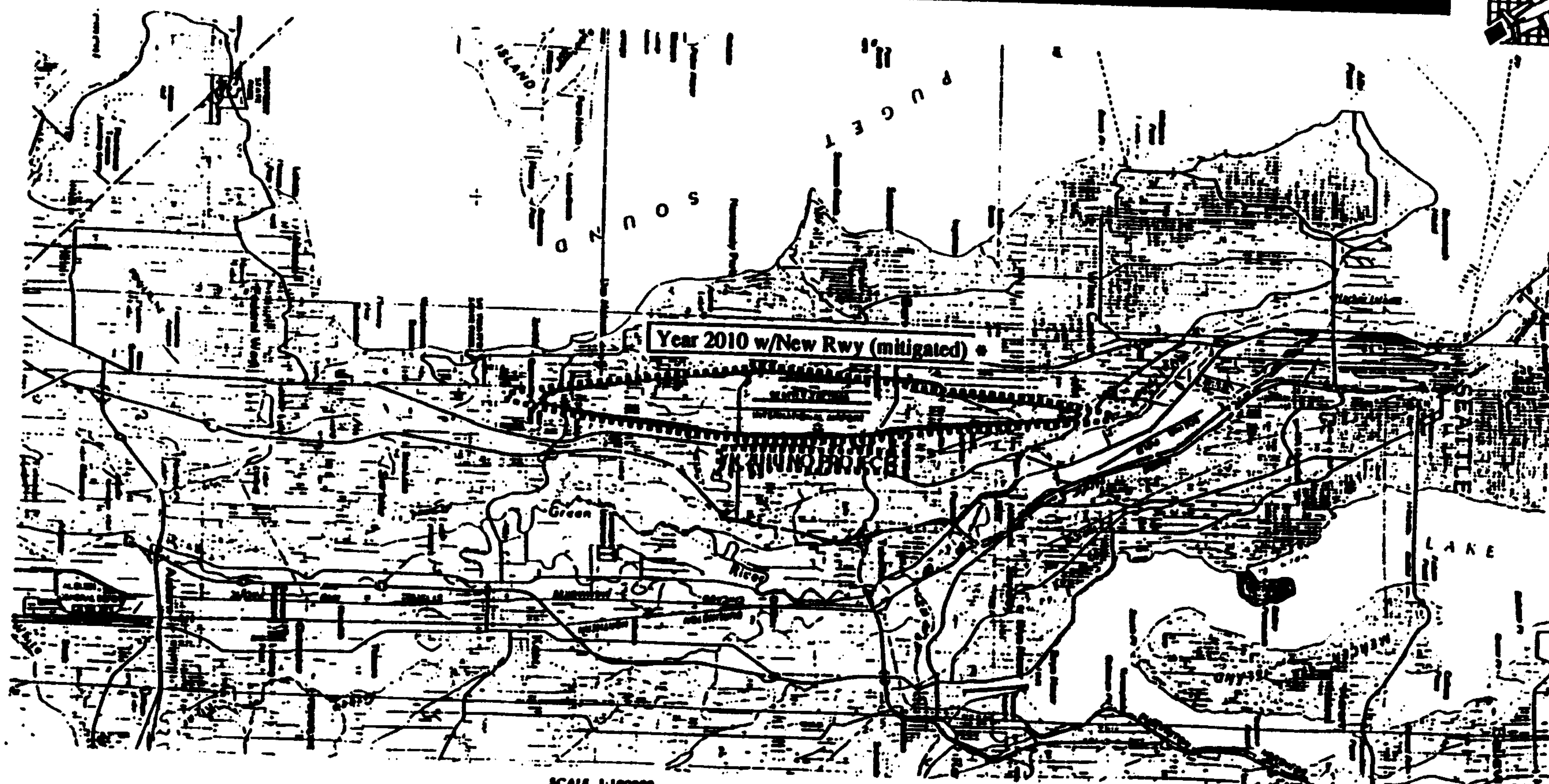


Figure C-10

SCALE 1:100000
1" = 8333'
0 8333 16666 24999

Sea-Tac 65 Ldn Contour YR 2010 No Project / w/New Rwy (mitigated)

* Alternative 28

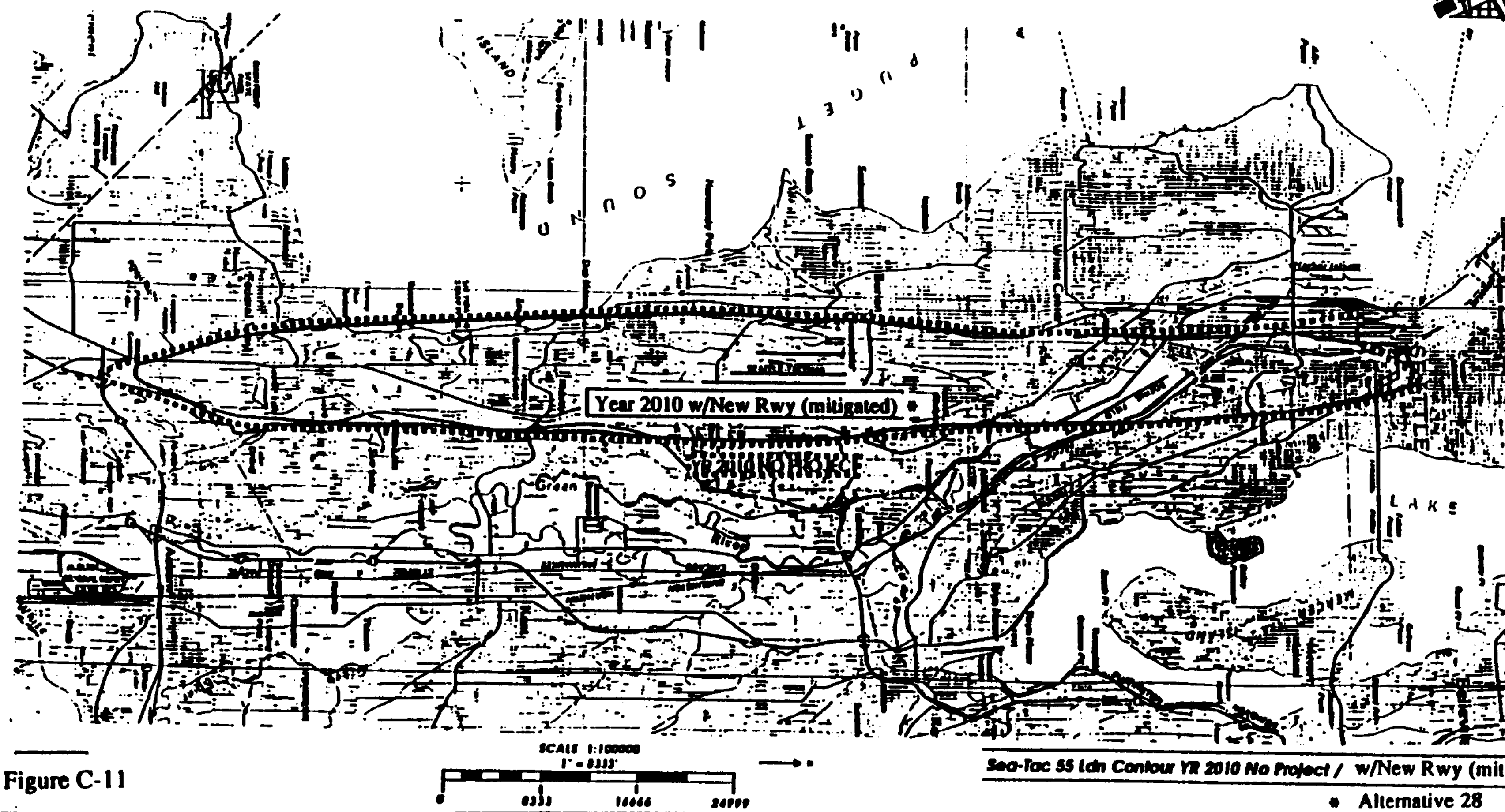


Figure C-11

Sea-Tac 55 Ldn Contour YR 2010 No Project / w/New Rwy (mitigated)

* Alternative 28

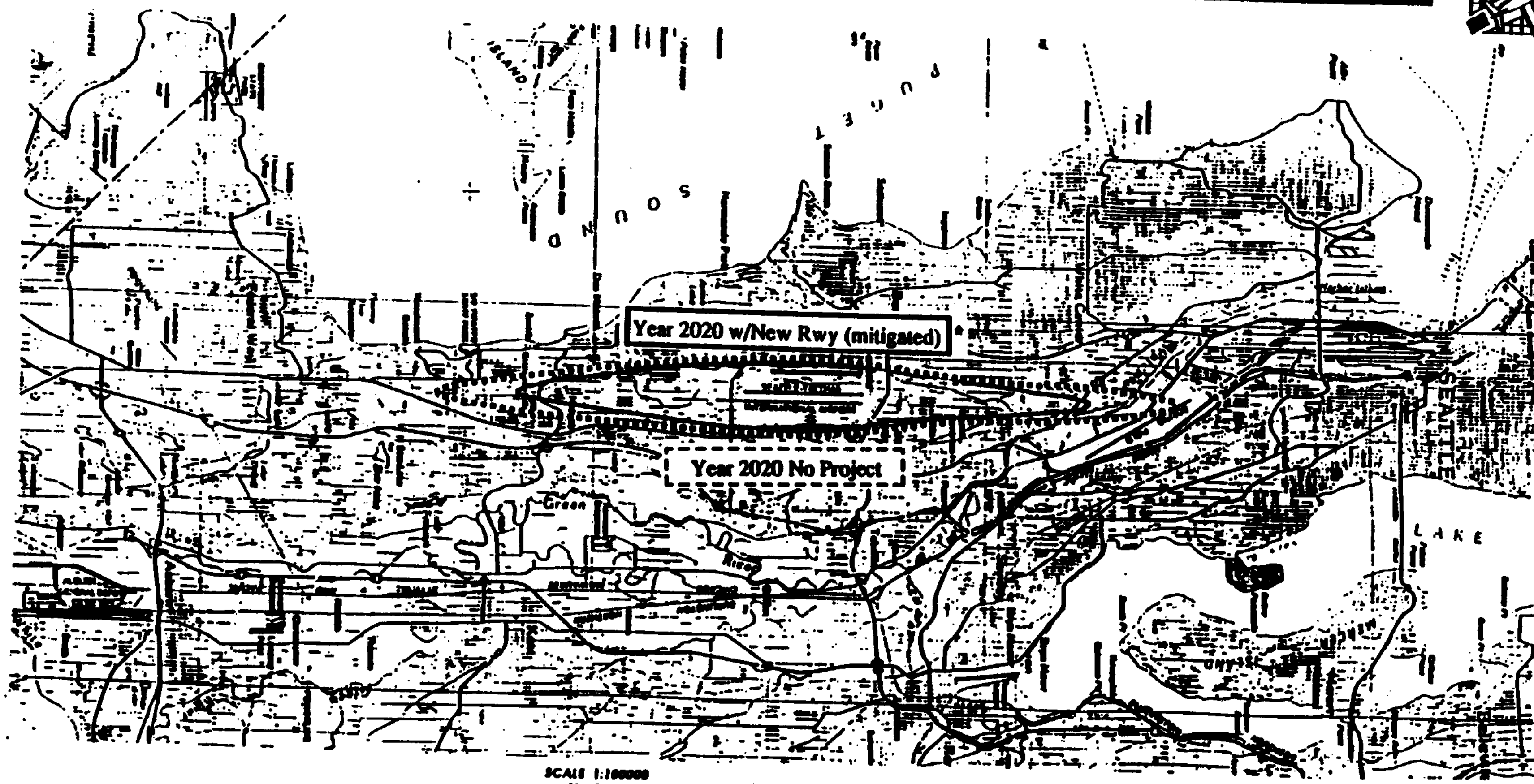


Figure C-12

Sea-Tac 65 Ldn Contour YR 2020 No Project / w/New Rwy (mitigated)

* Alternative 28

The Flight Plan Project Phase III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

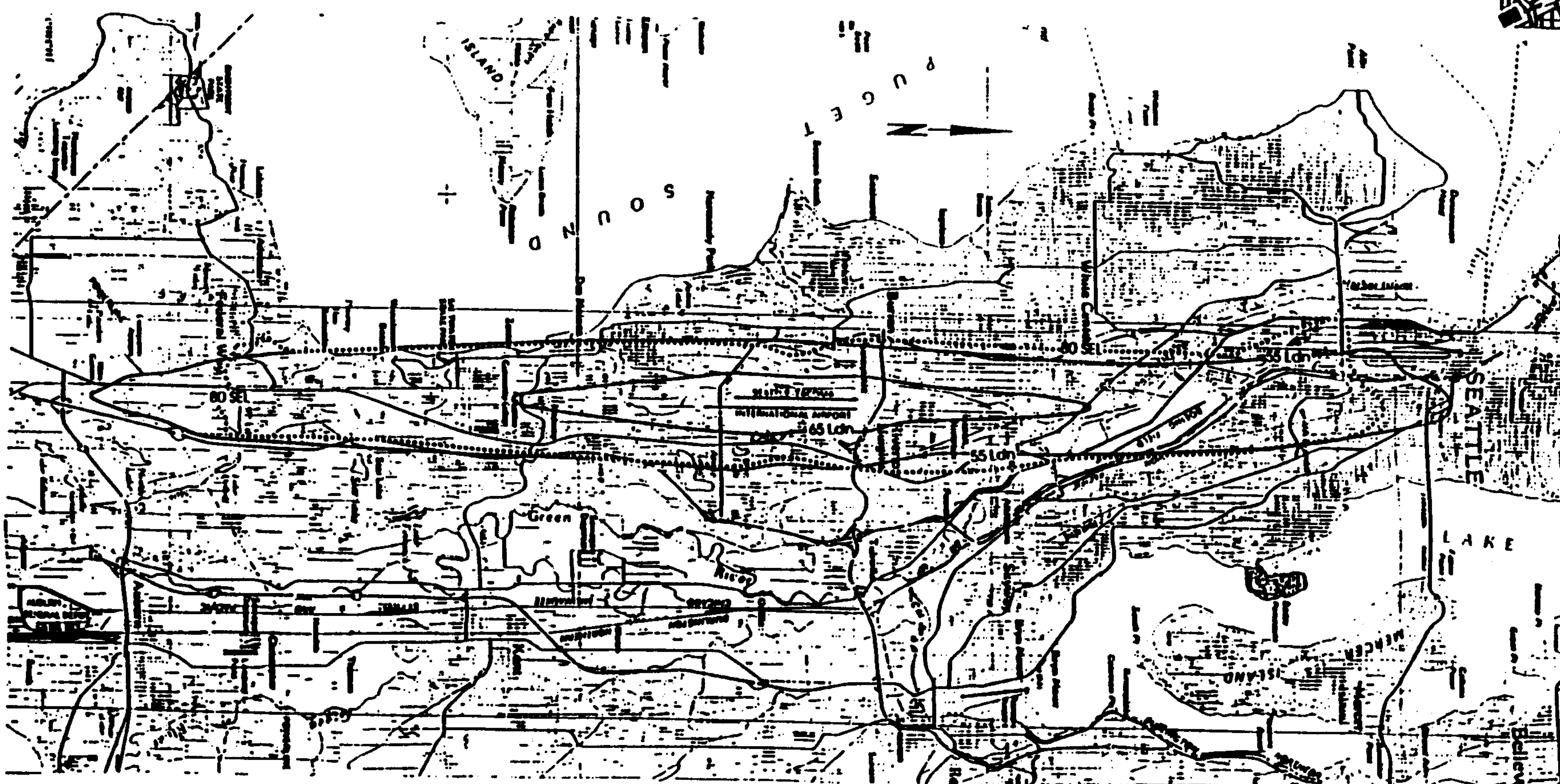


Figure C-13

2020 Sea-Tac Without Commuter R/W - 32 MAP

Alternatives 1, 2 through 12

The Flight Plan Project Phase III

Mestre Greve Associates

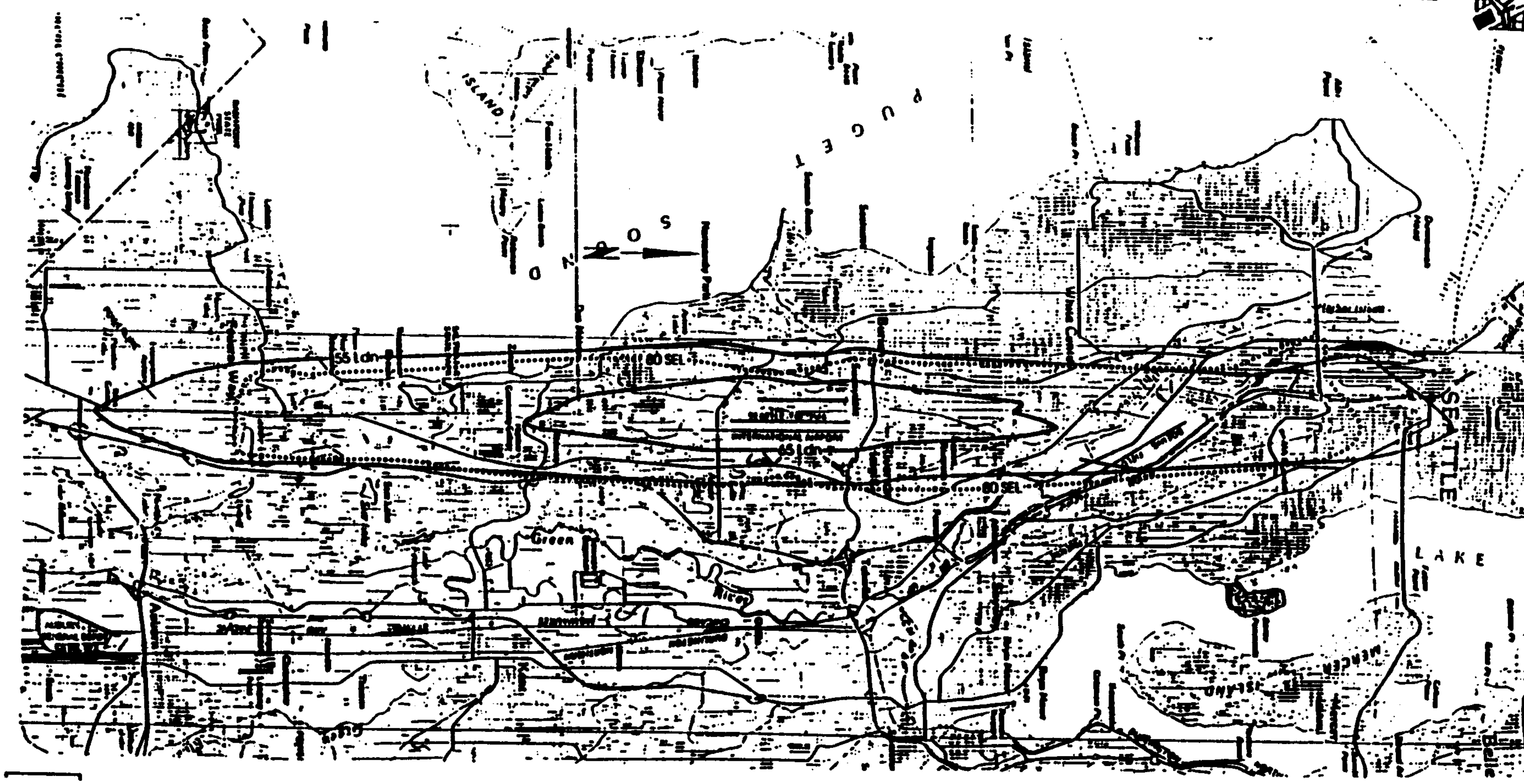


Figure C-14

2020 Sea-Tac With New Air Carrier R/W - 38.3 MA

Alternative 2(

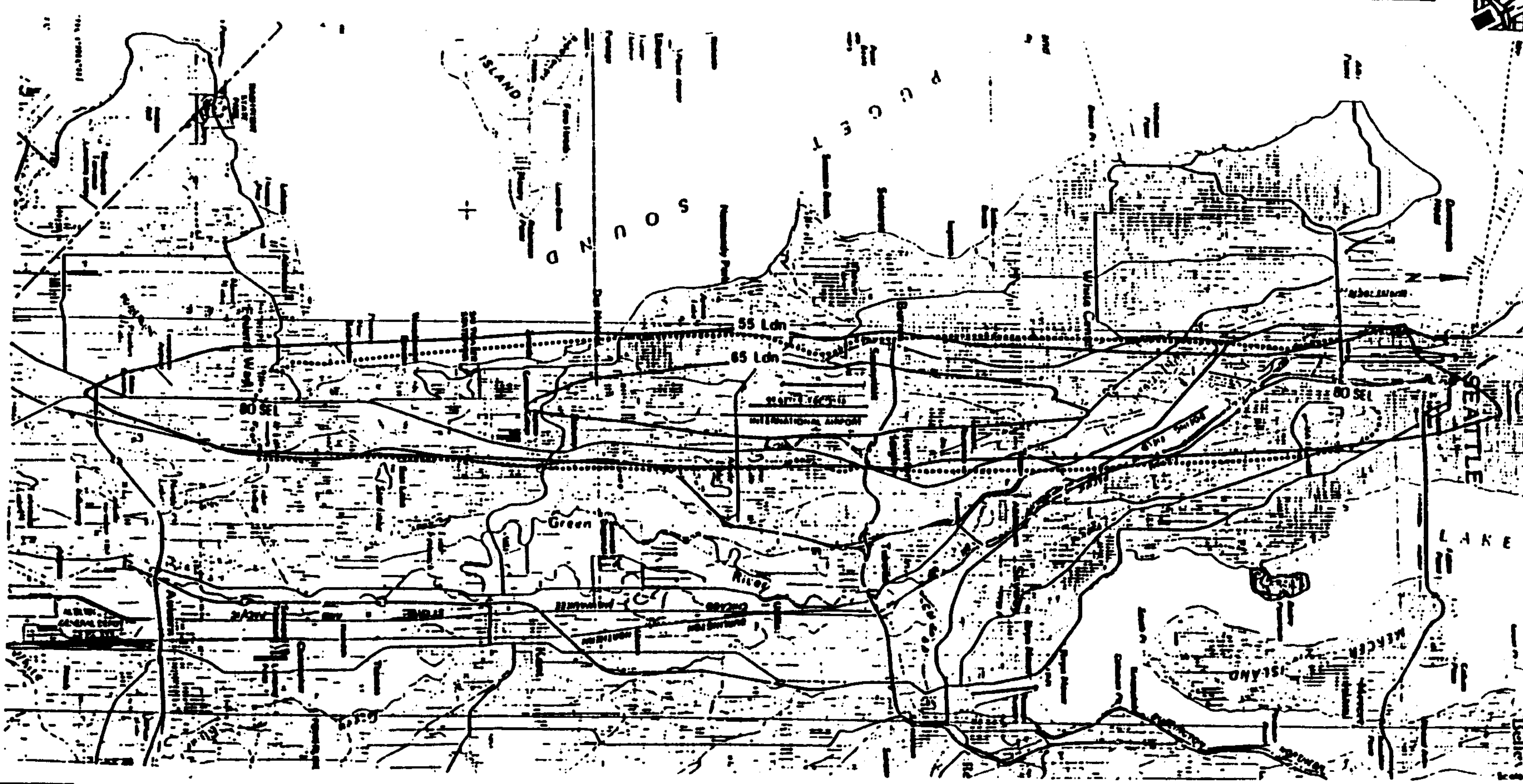


Figure C-15

2020 Sea-Tac With New Air Carrier R/W - 41.8 M/

Alternatives 13 through :

The Flight Plan Project Phase

Mestre Greve Associat

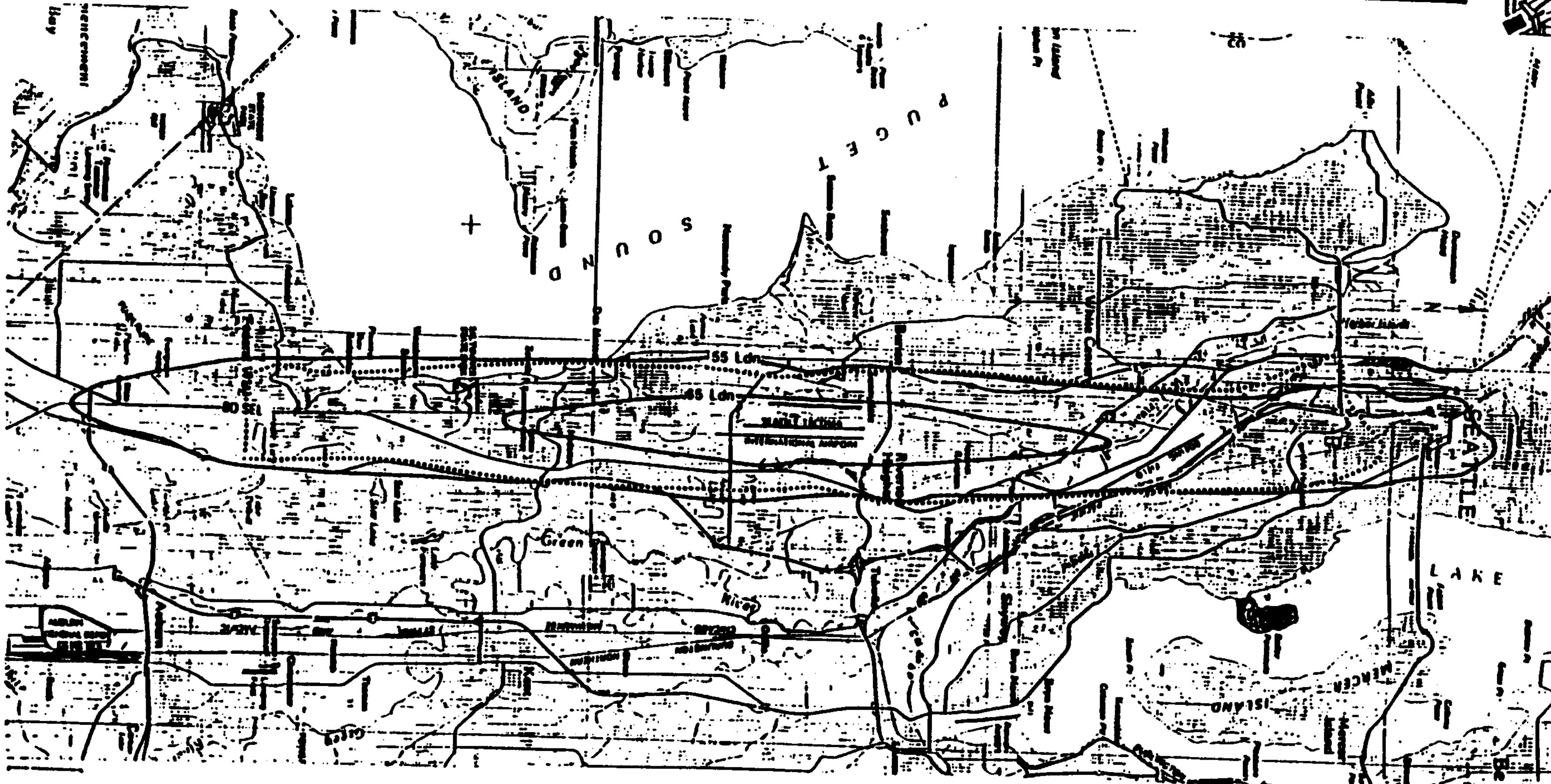


Figure C-16 · Dependent Air Carrier R/W used only for arrivals & only during daylight hours

2020 Sea-Tac With New Air Carrier R/W - 41.8 MA

Alternatives 13 through 2

AR 038509

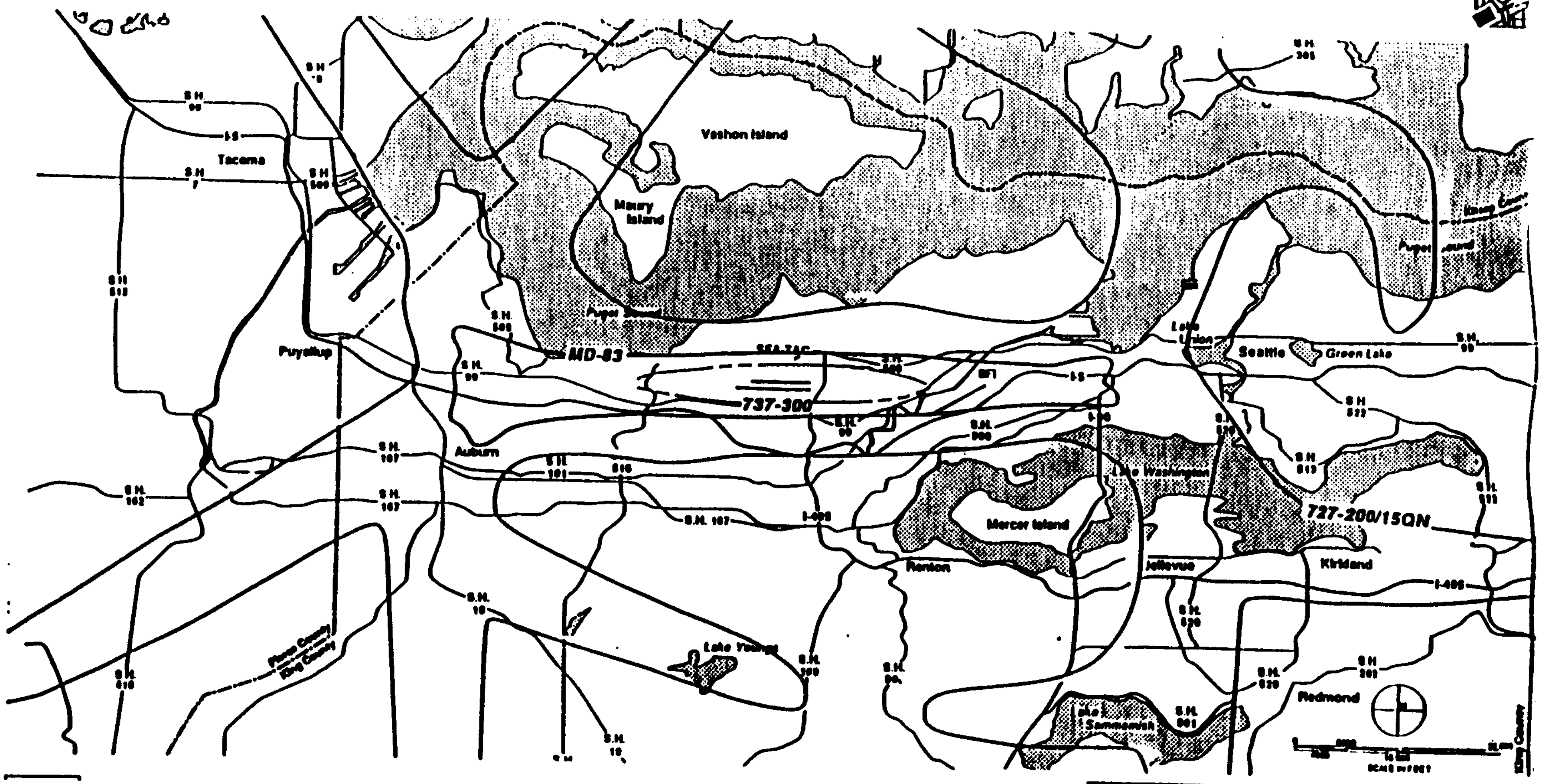


Figure C-17

Composite 80 SEL Noise Contours (727-200,737-300 & MD-

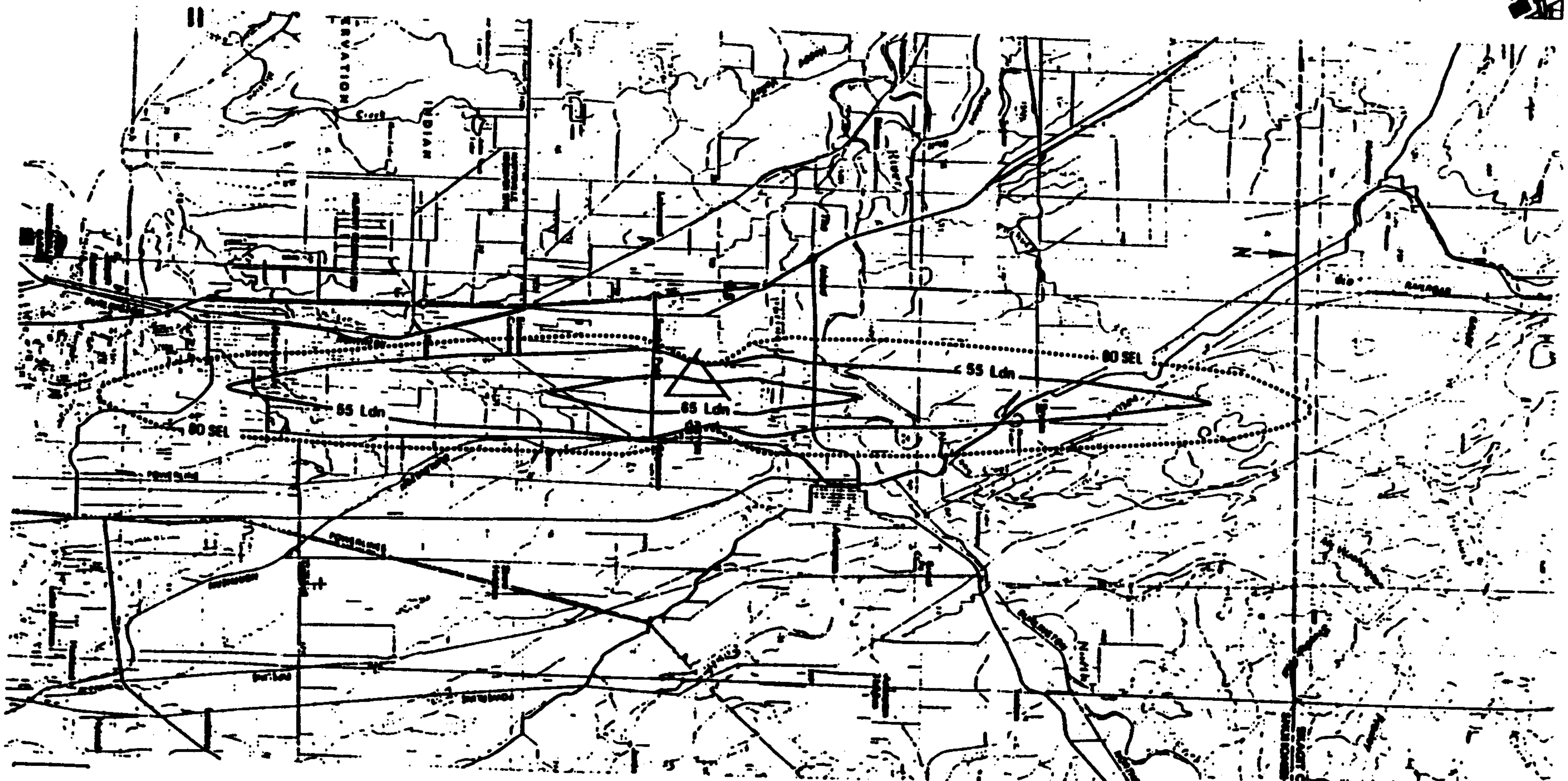


Figure C-18

2020 Arlington Supplemental Airport 1 R/W - 10.9 M

Alternativ

AR 038511

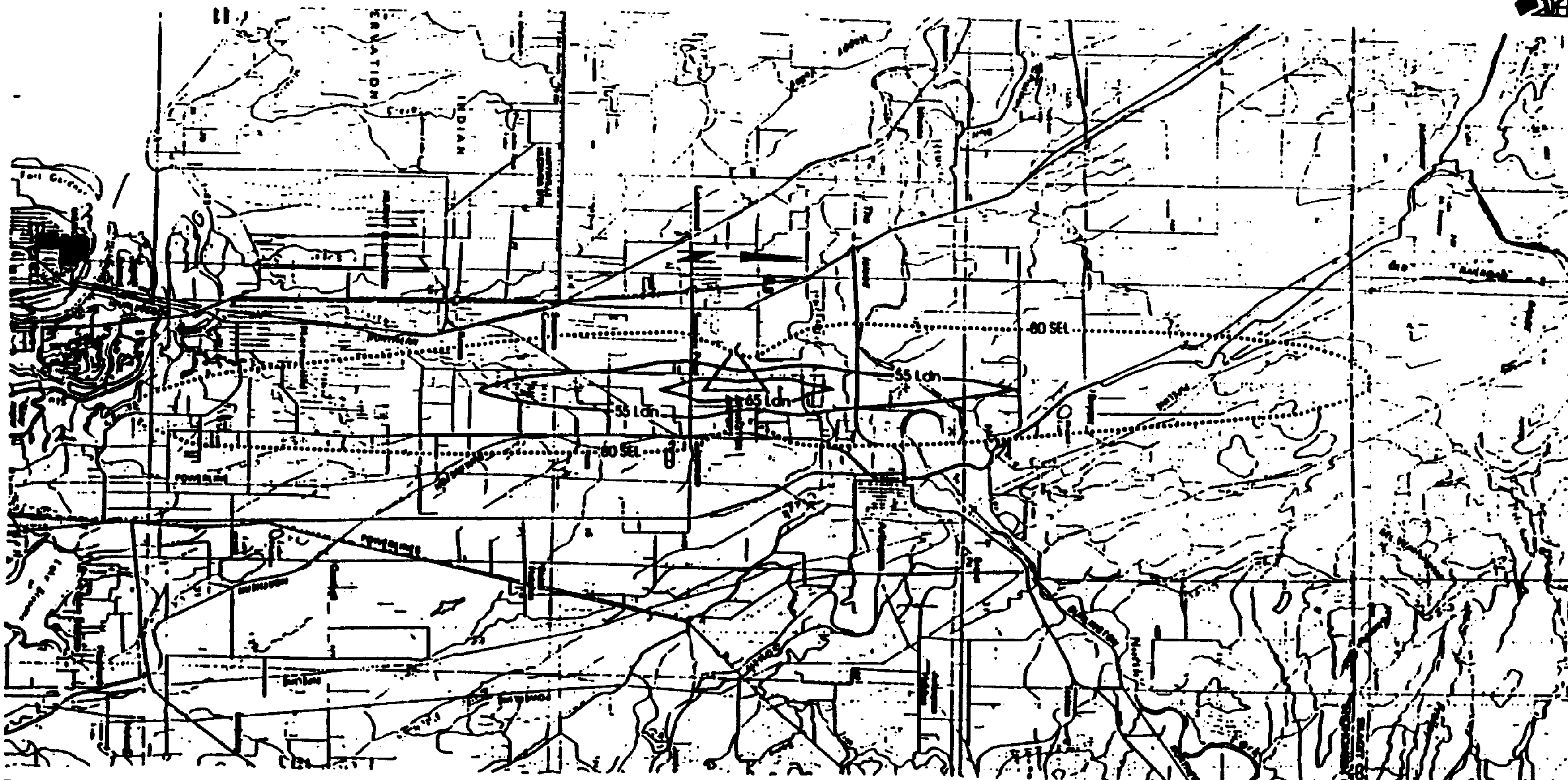


Figure C-19

2020 Arlington Supplemental Airport 1 R/W - 2.2 MA

Alternatives 27 & 2

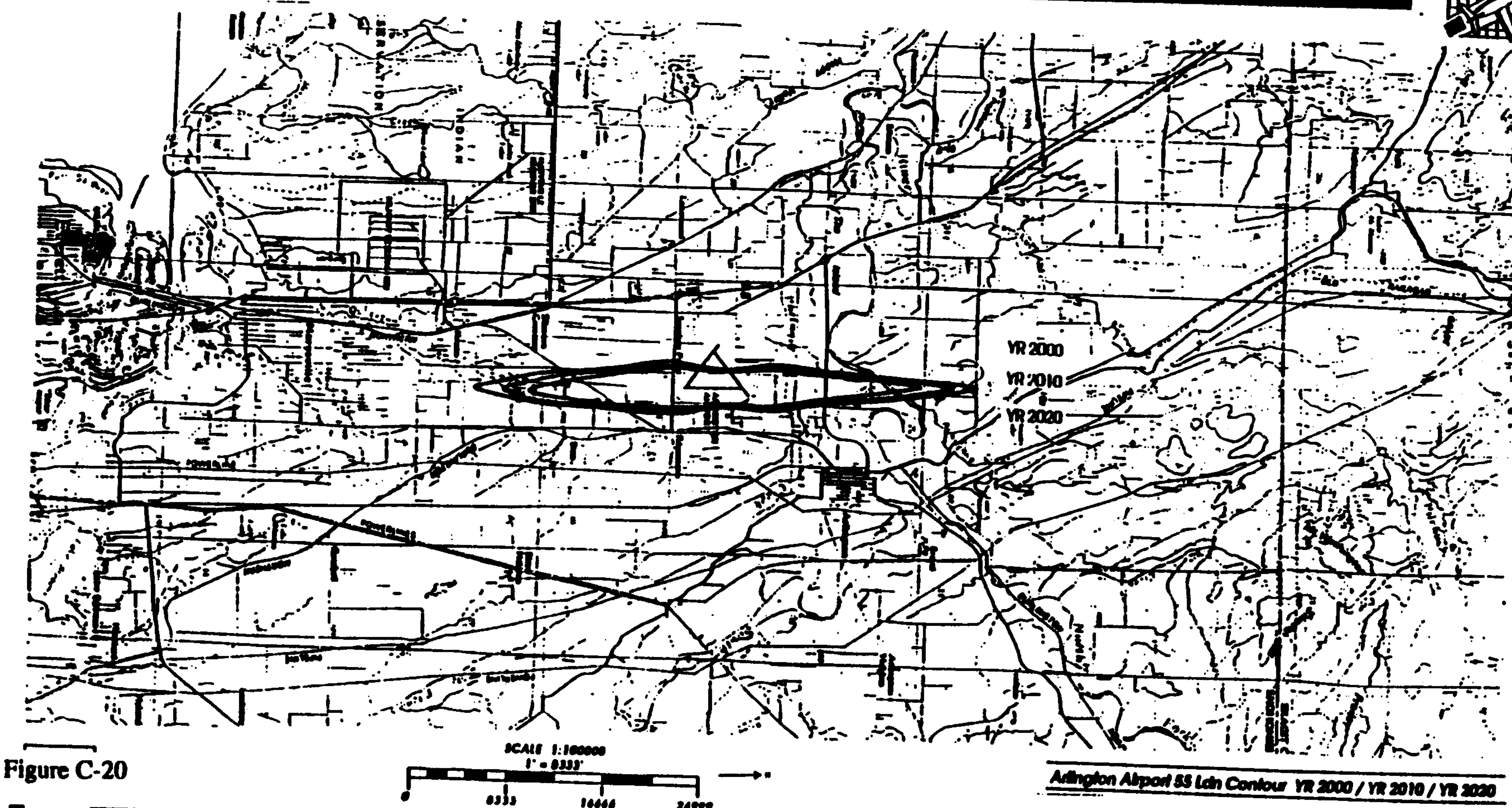


Figure C-20

Arlington Airport 55 Ldn Contour YR 2000 / YR 2010 / YR 2020

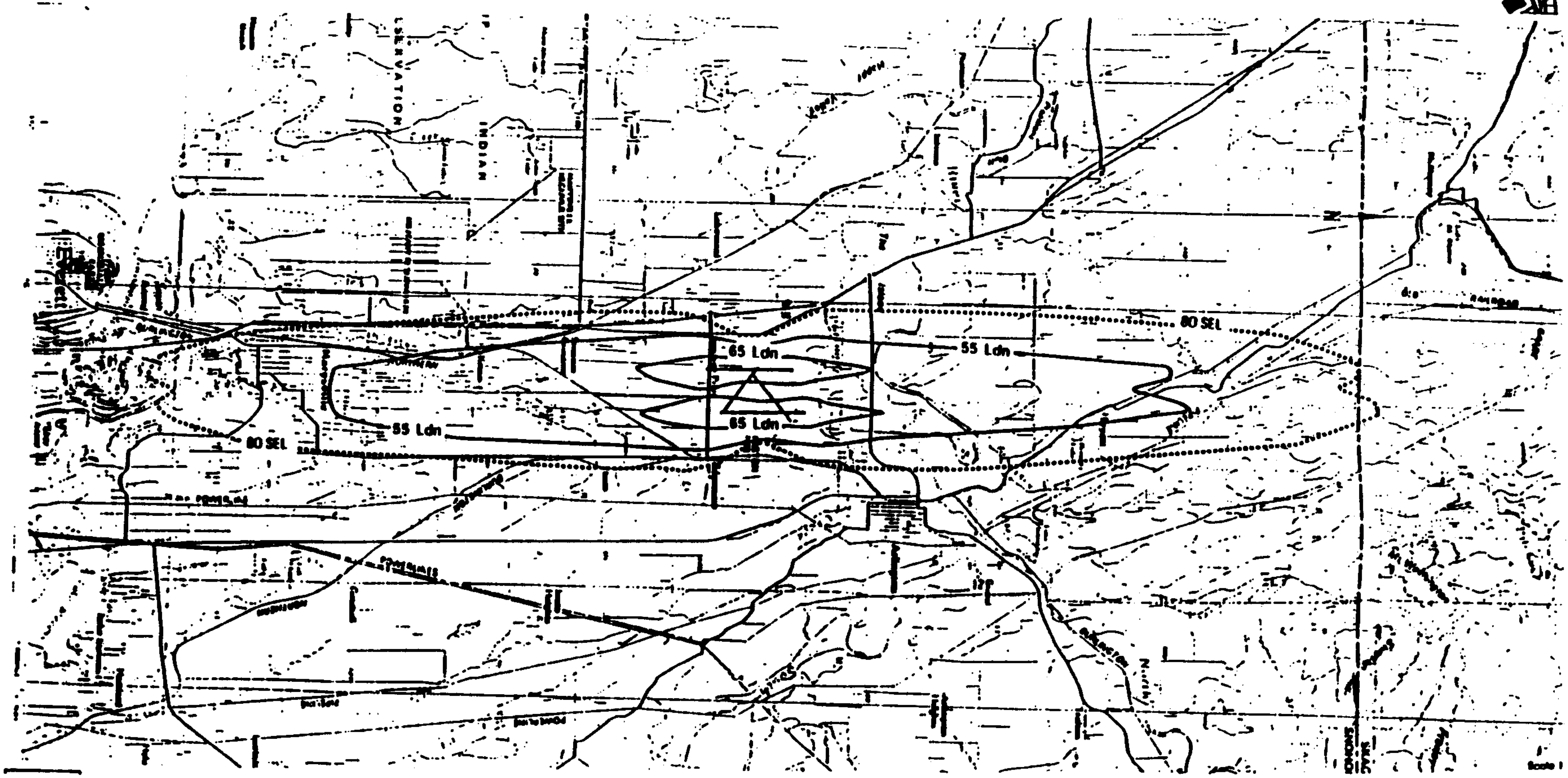


Figure C-21

2020 Arlington Supplemental Airport 2 R/W - 13.0 M

Alternative

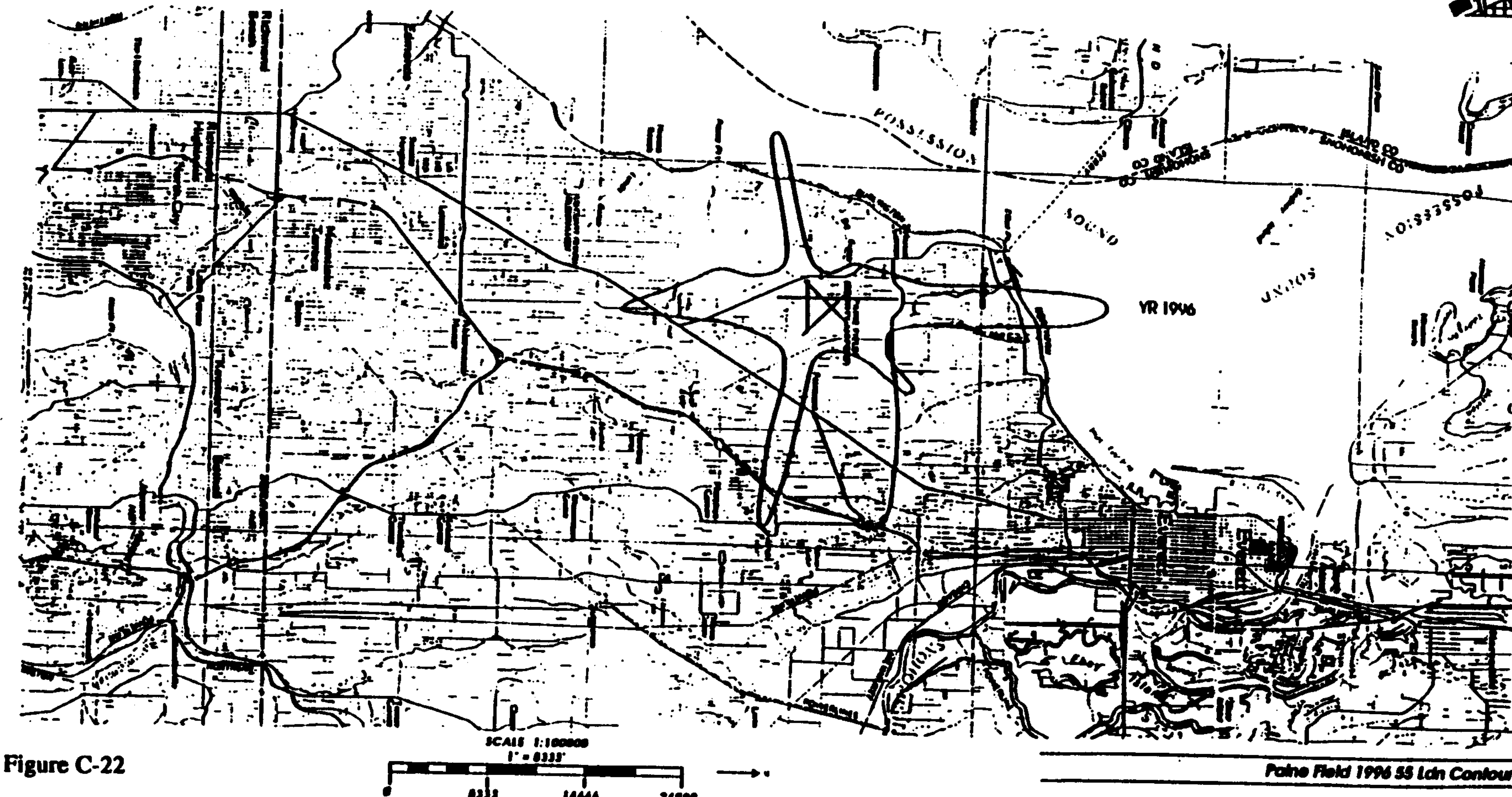


Figure C-22

Paine Field 1996 55 Ldn Contour

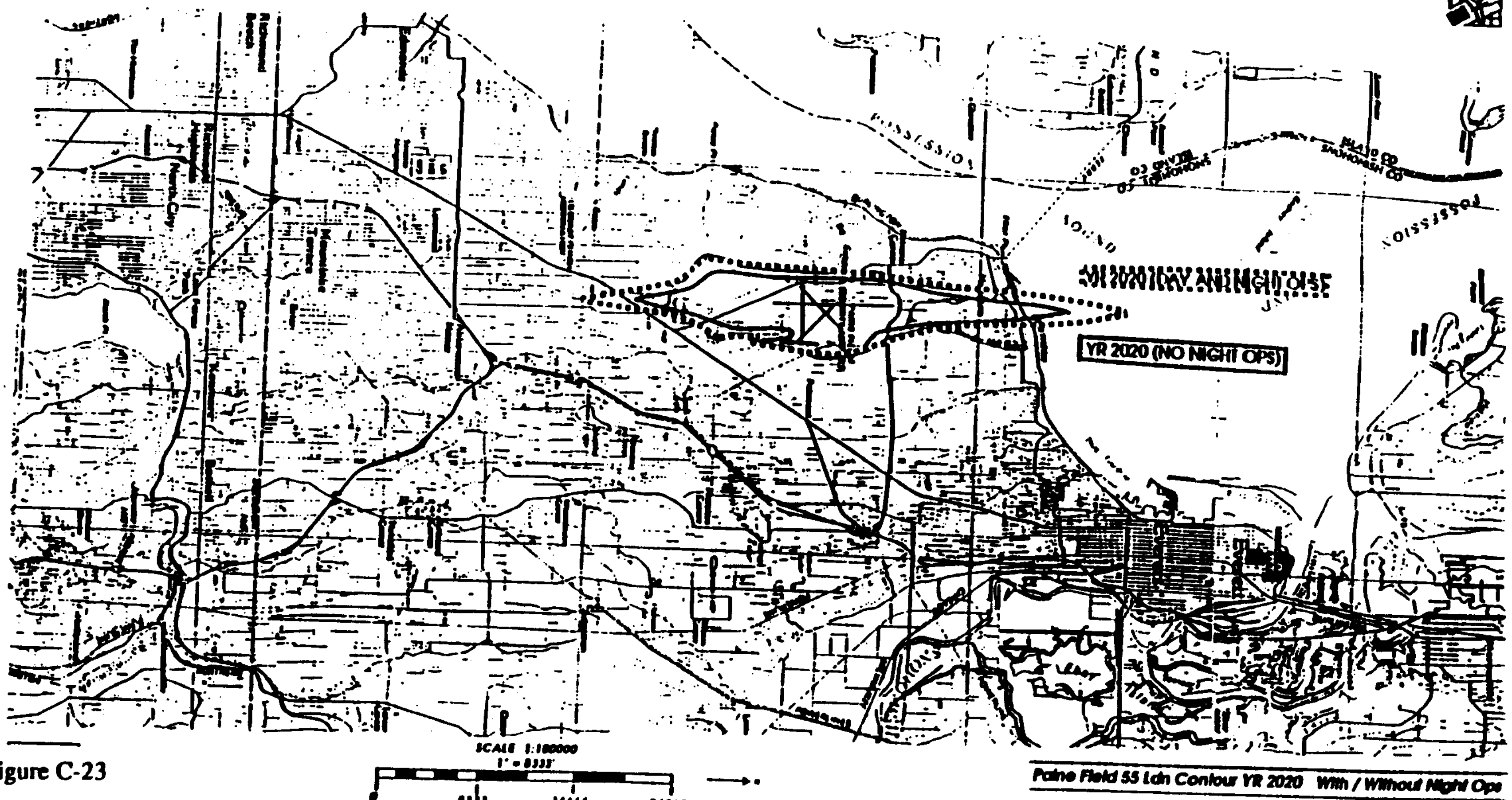


Figure C-23

Paine Field 55 Ldn Contour YR 2020 With / Without Night Ops

Alternative 2B

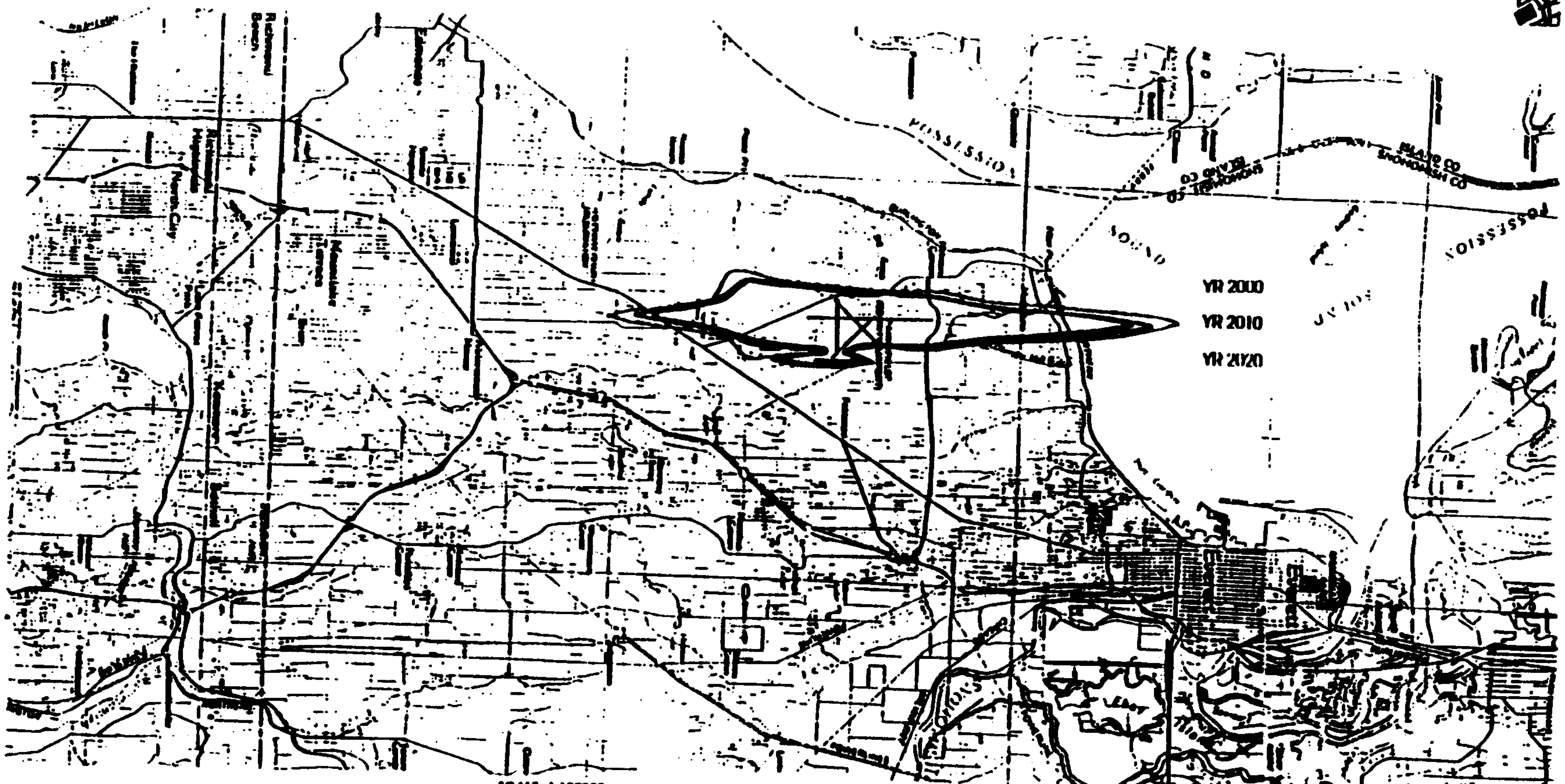


Figure C-24

SCALE 1:100000
1" = 8333'
0 8333 16666 24999

Paine Field 55 Ldn Contour YR 2000 / YR 2010 / YR 20

Alternative 2B

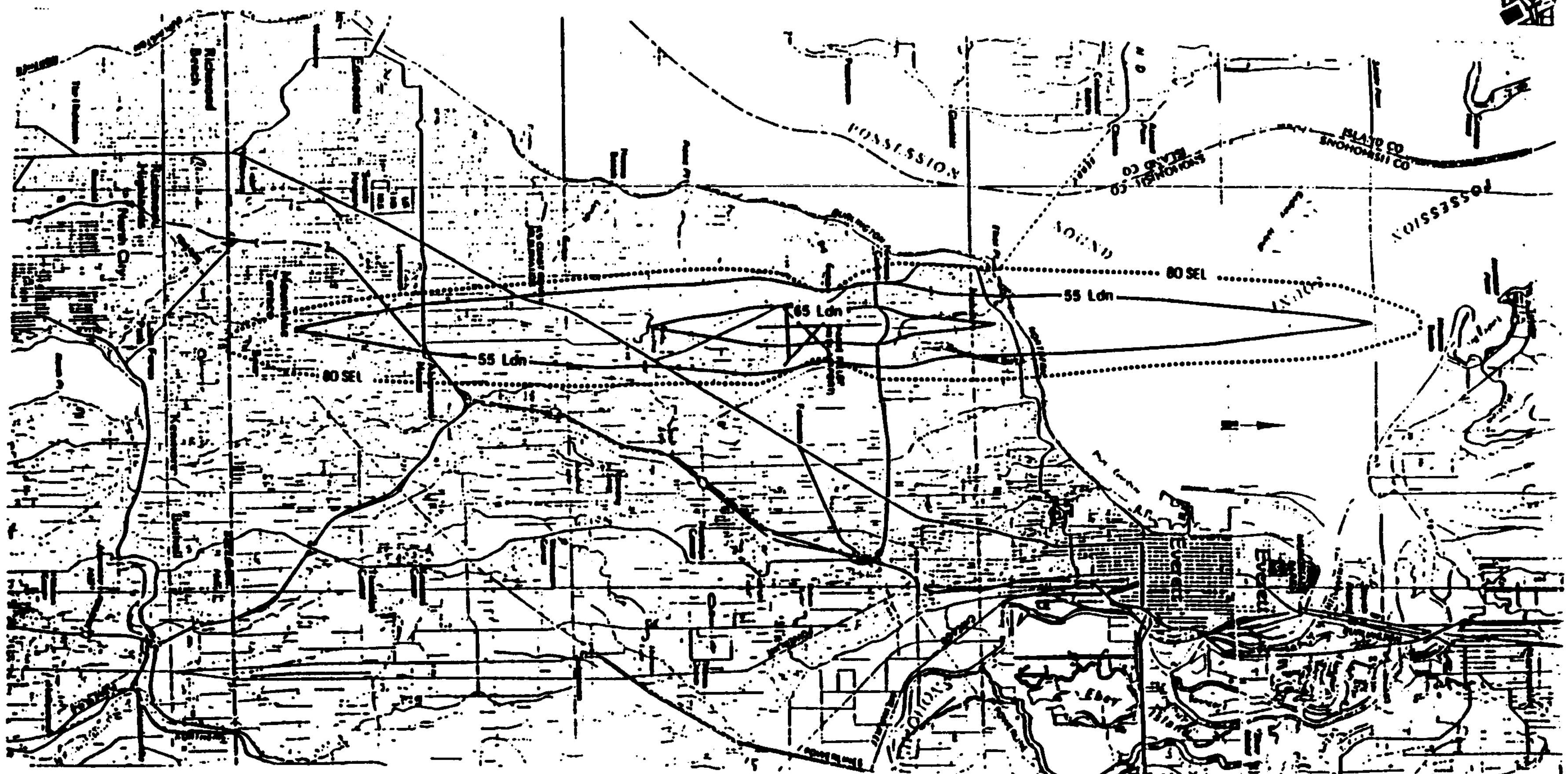


Figure C-25

2020 Paine Supplemental Airport 1 R/W - 13.0 M
Alternative

The Flight Plan Project Phase
Mestre Greve Associate

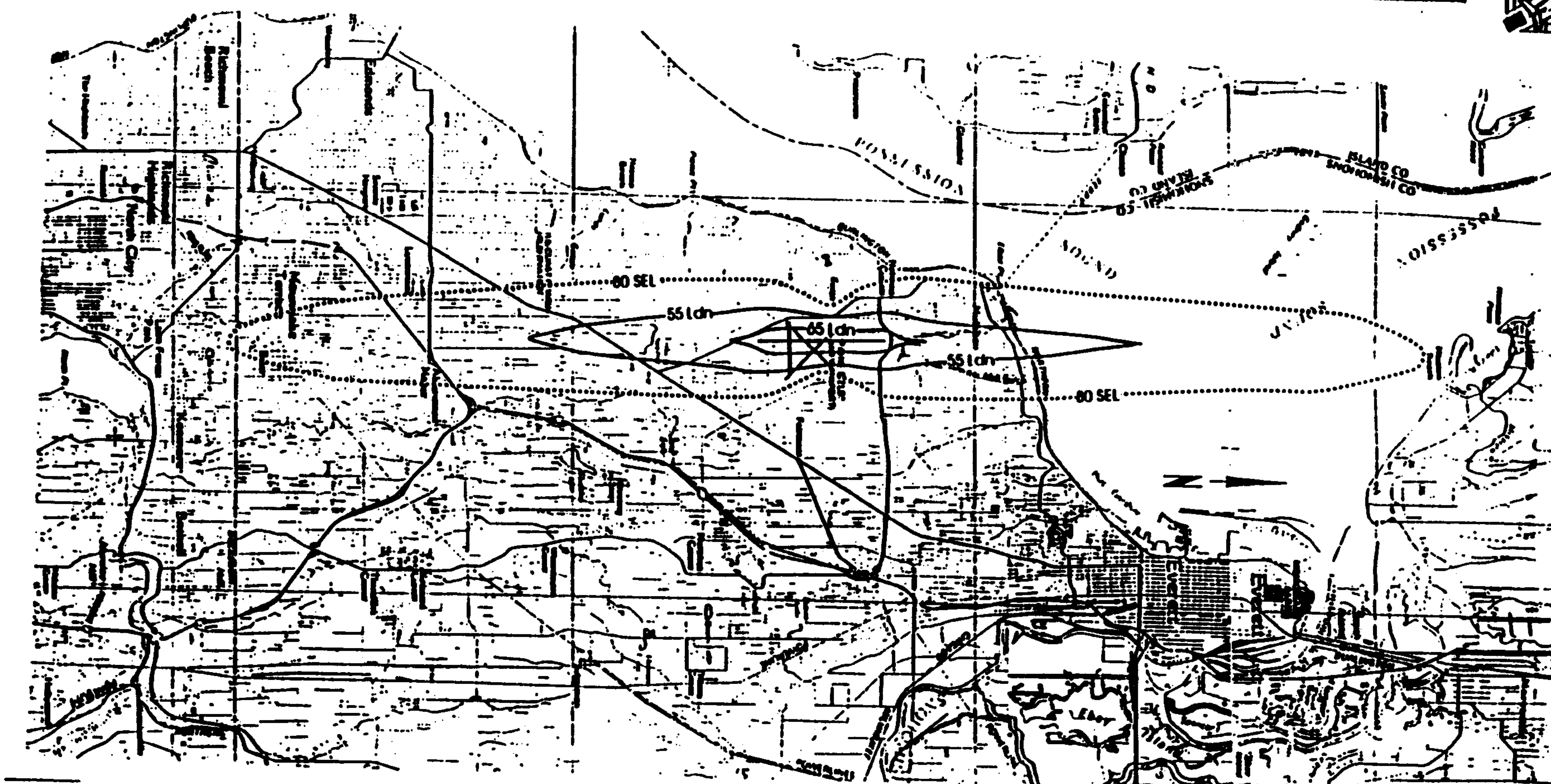


Figure C-26

2020 Paine Supplemental Airport 1 R/W - 3.4 MA

Alternatives 14, 28 & 3

AR 038519

The Flight Plan Project Phase III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

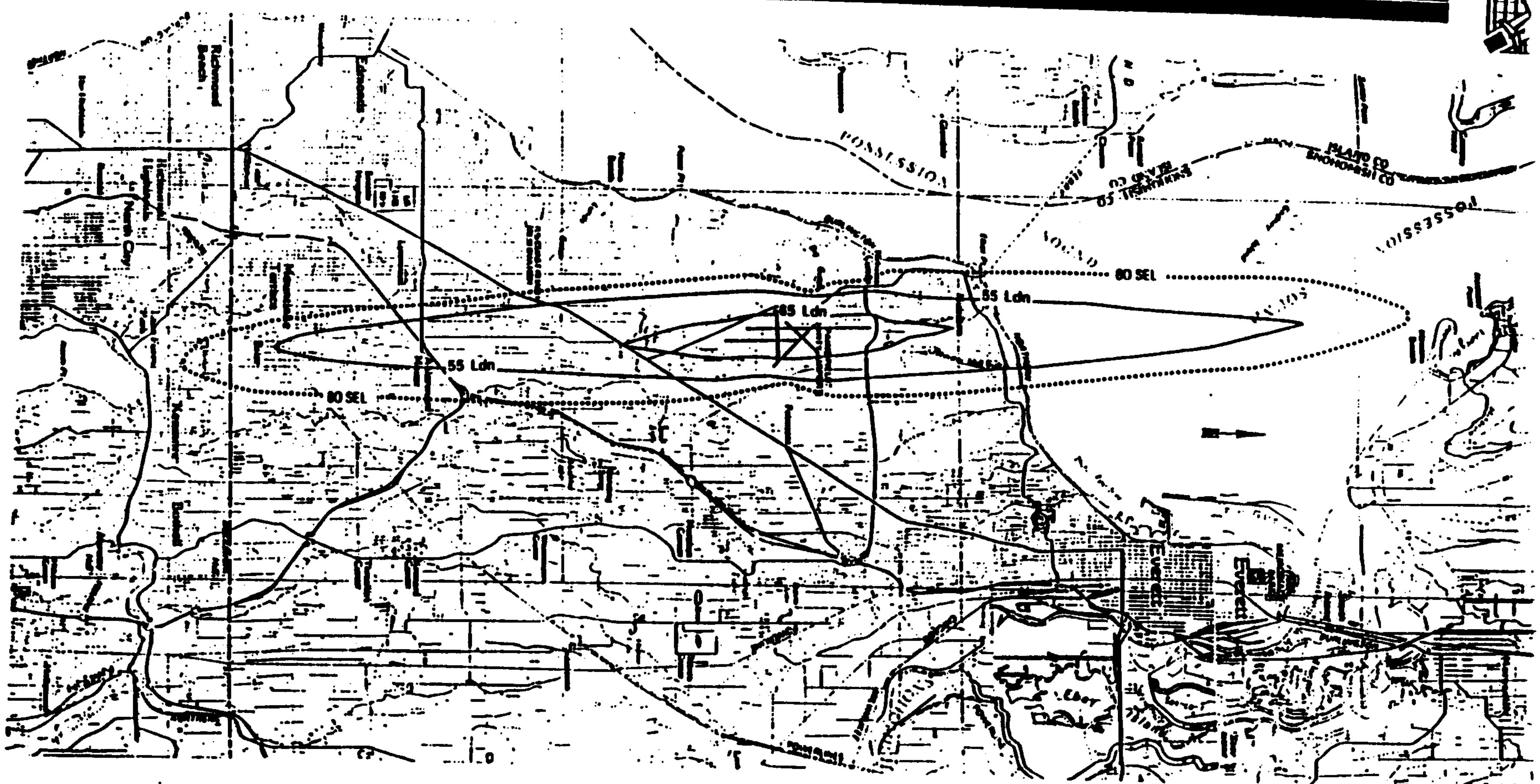


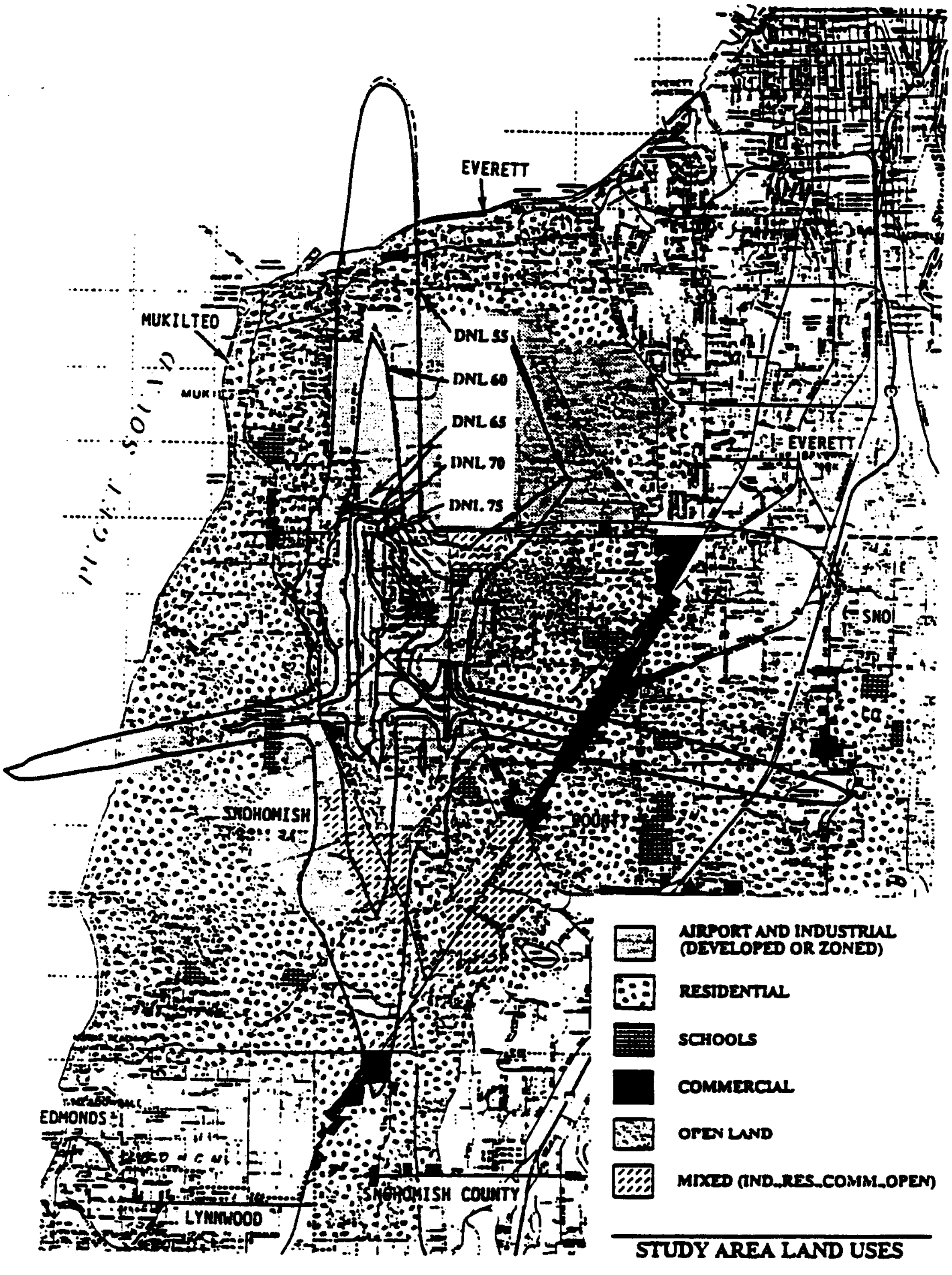
Figure C-27

2020 Paine Supplemental Airport 2 R/W - 13.0 M

Alternative

The Flight Plan Project Phase

Mestre Greve Associat



DAY-NIGHT LEVEL (DNL) FOR COMBINED AIRPORT FLIGHT AND ENGINE GROUND RUN-UP OPERATIONS PROPOSED ACTION (1996) CONDITIONS AND NO-ACTION (1996) CONDITIONS

Source: Draft Environmental Impact Statement for the Boeing Everett Facility Expansion, City of Everett, 1991

Figure C-28

AR 038521

The Flight Plan Project Phase III

PUGET SOUND AIR TRANSPORTATION COMMITTEE

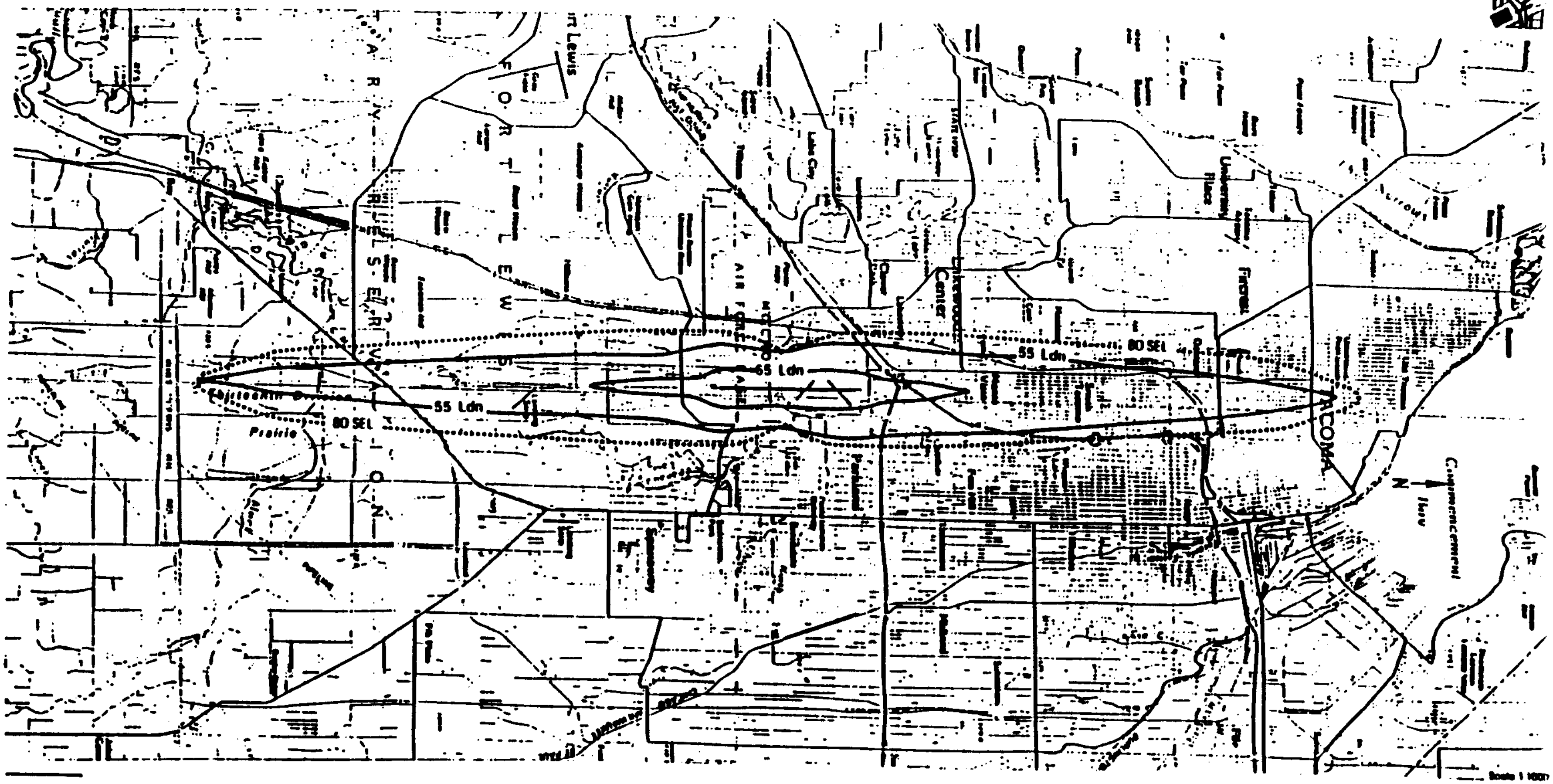


Figure C-29

2020 McChord Supplemental Airport 1 R/W - 13.0 K

Alternativ

The Flight Plan Project Phase

Mestre Greve Associat

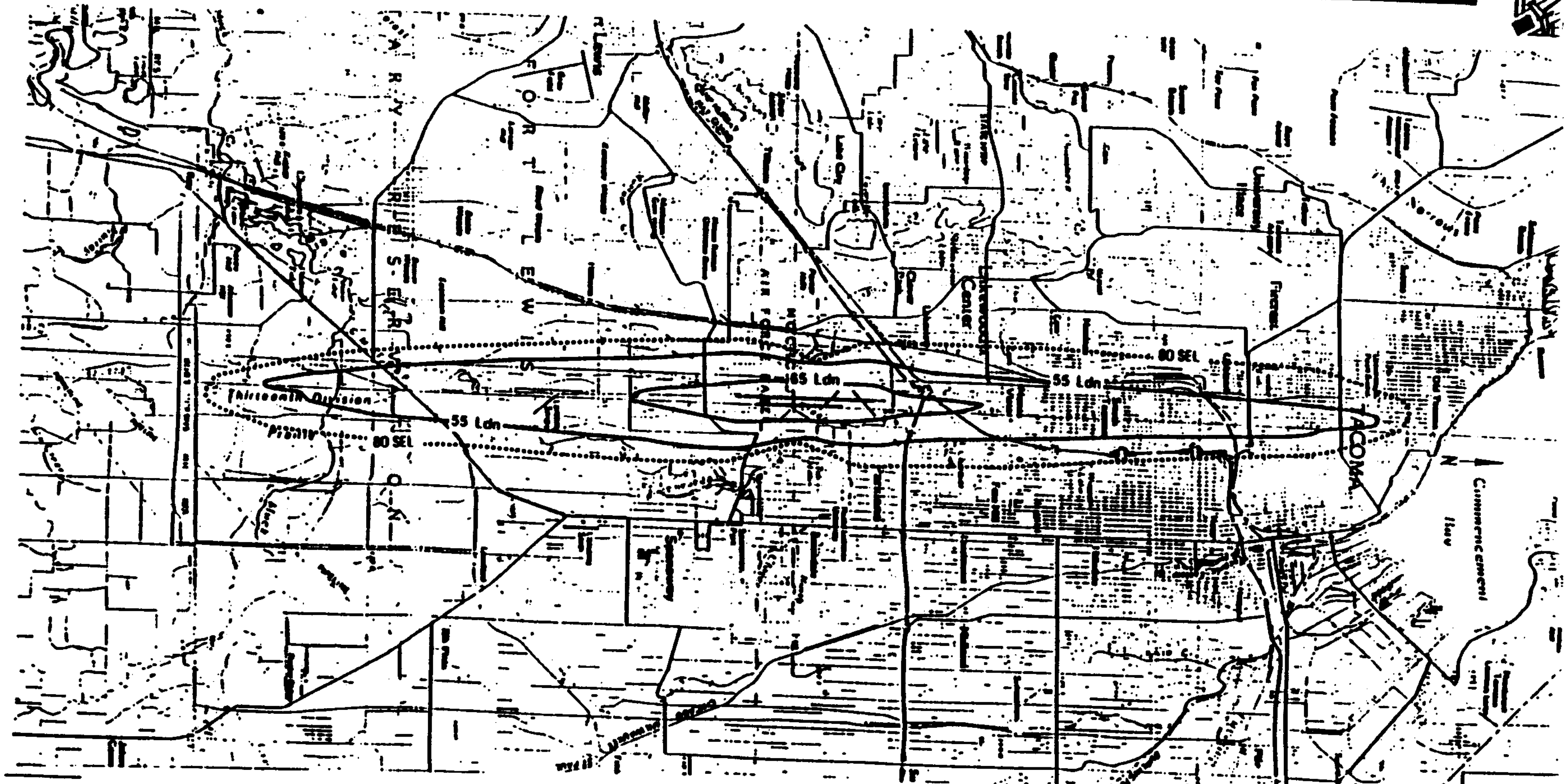


Figure C-30

2020 McChord Supplemental Airport 2 R/W - 13.0 M

Alternative I

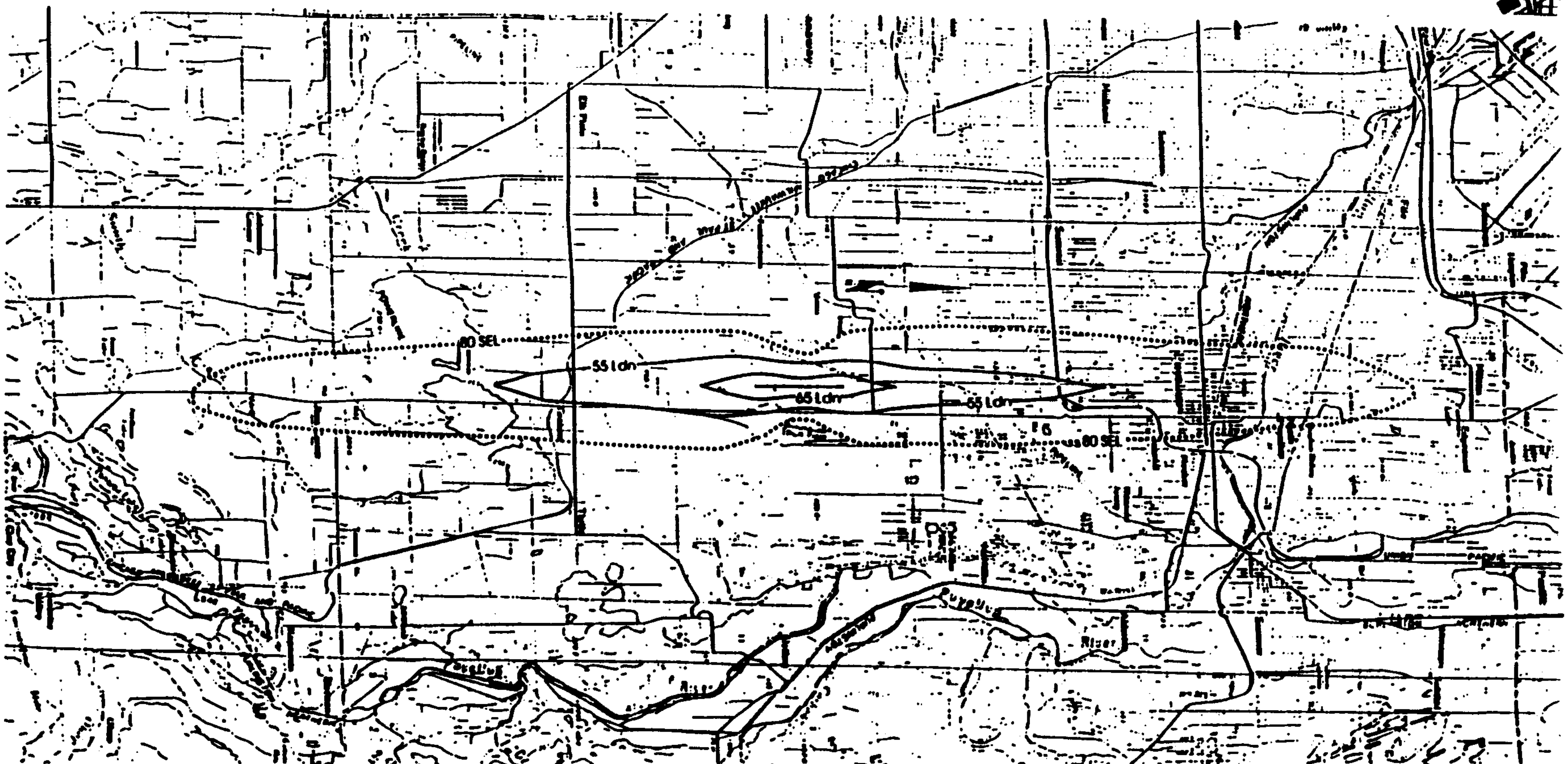


Figure C-31

2020 Central Pierce Supplemental Airport 1 R/W - 3.3 M/

Alternatives 16, 27 & 2

The Flight Plan Project Phase

Mestre Greve Associate

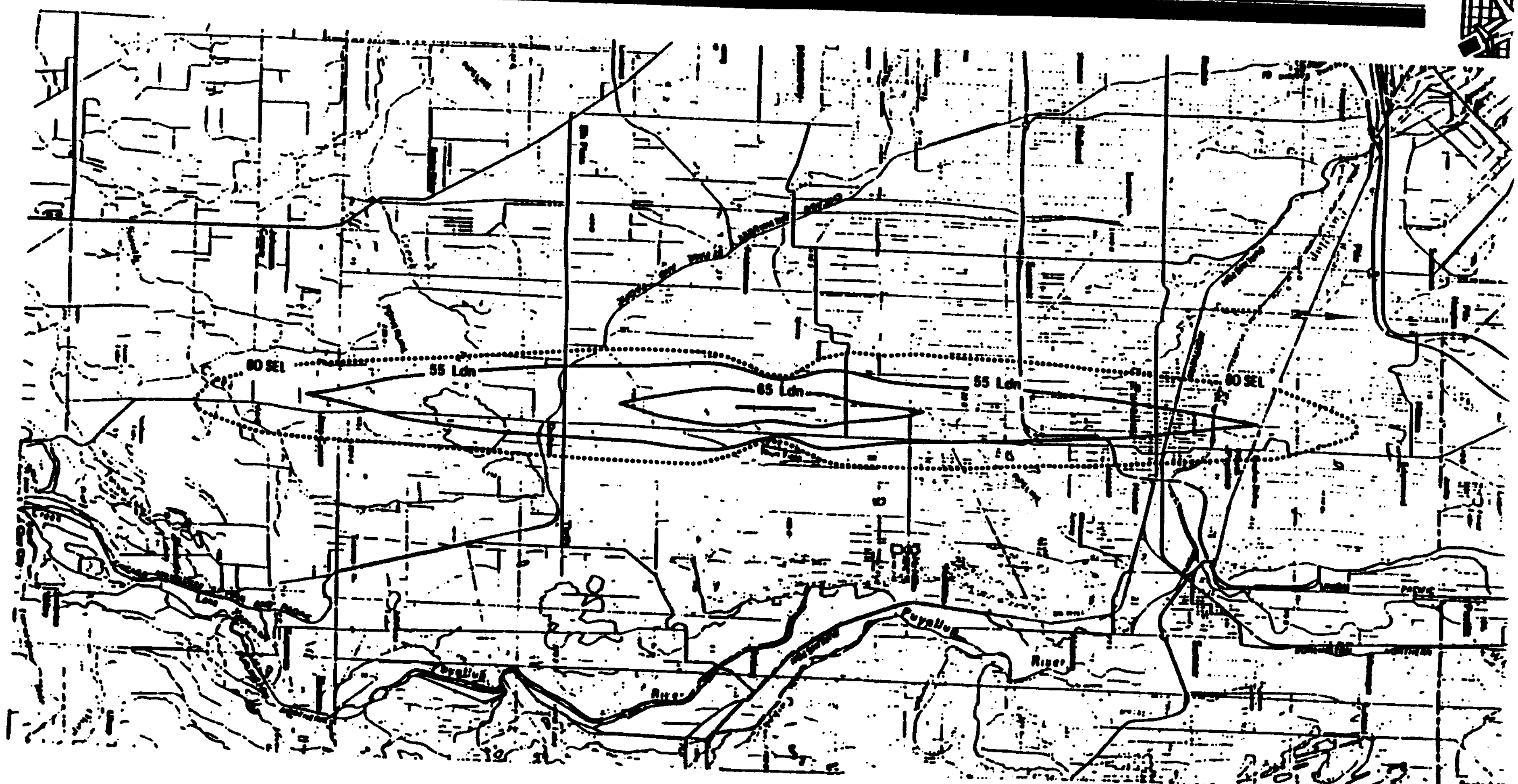


Figure C-32

2020 Central Pierce Supplemental Airport 1 R/W - 10.9 M.

Alternative

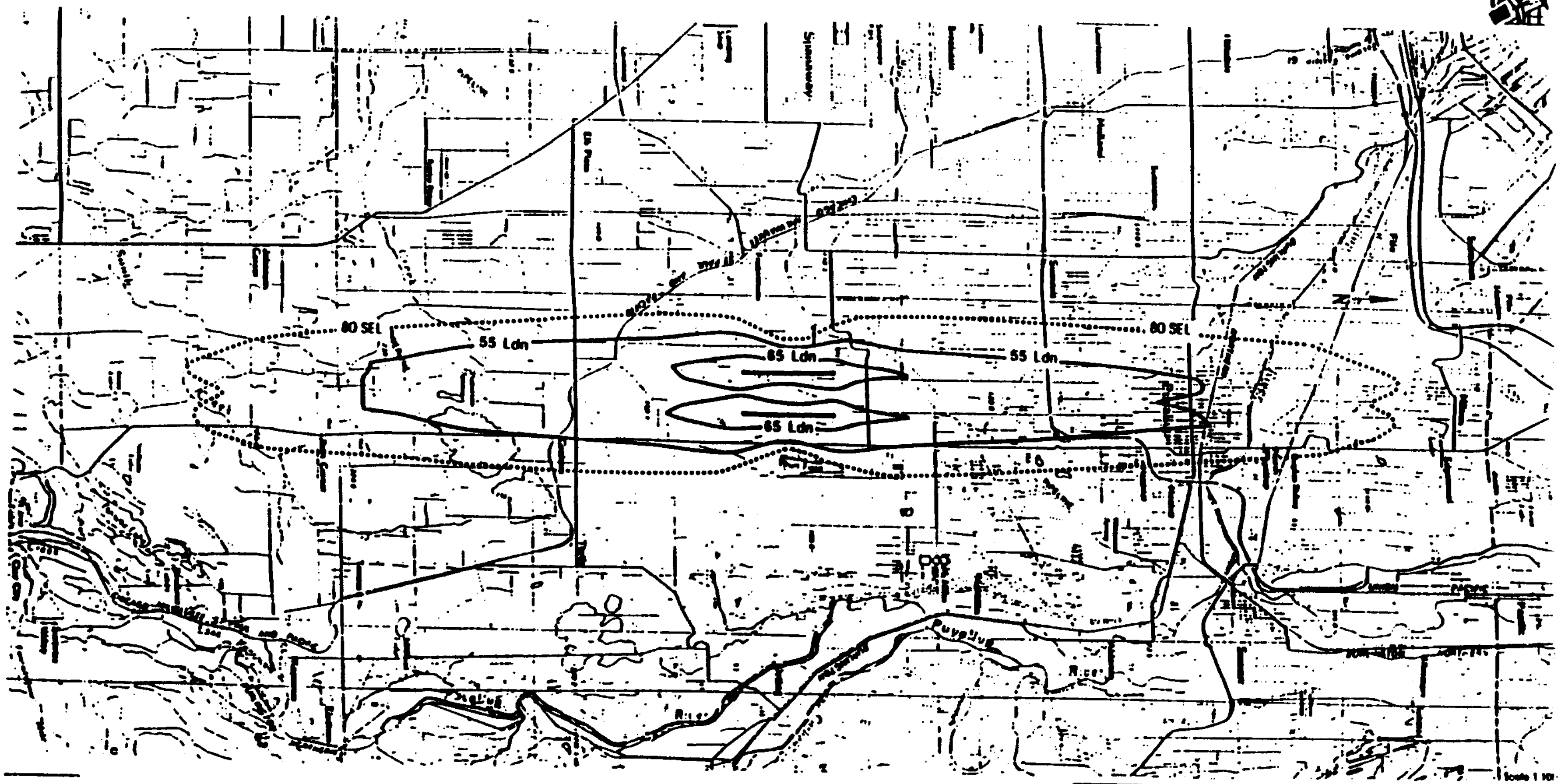


Figure C-33

2020 Central Pierce Supplemental Airport 2 R/W - 13.0 M/
Alternative

AR 038526

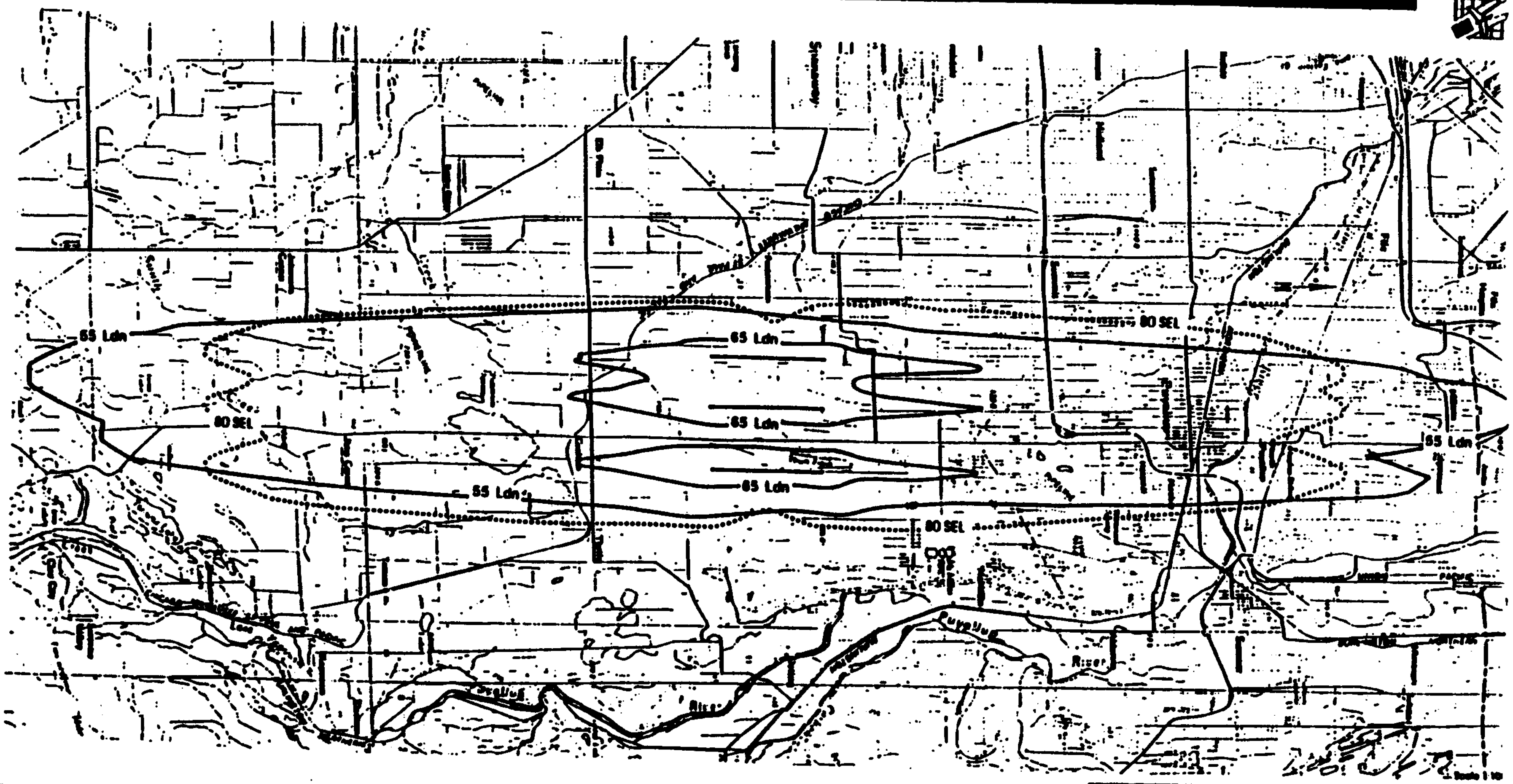


Figure C-34

2020 Central Pierce Replacement Airport 3 R/W - 45.0 M

Alternative

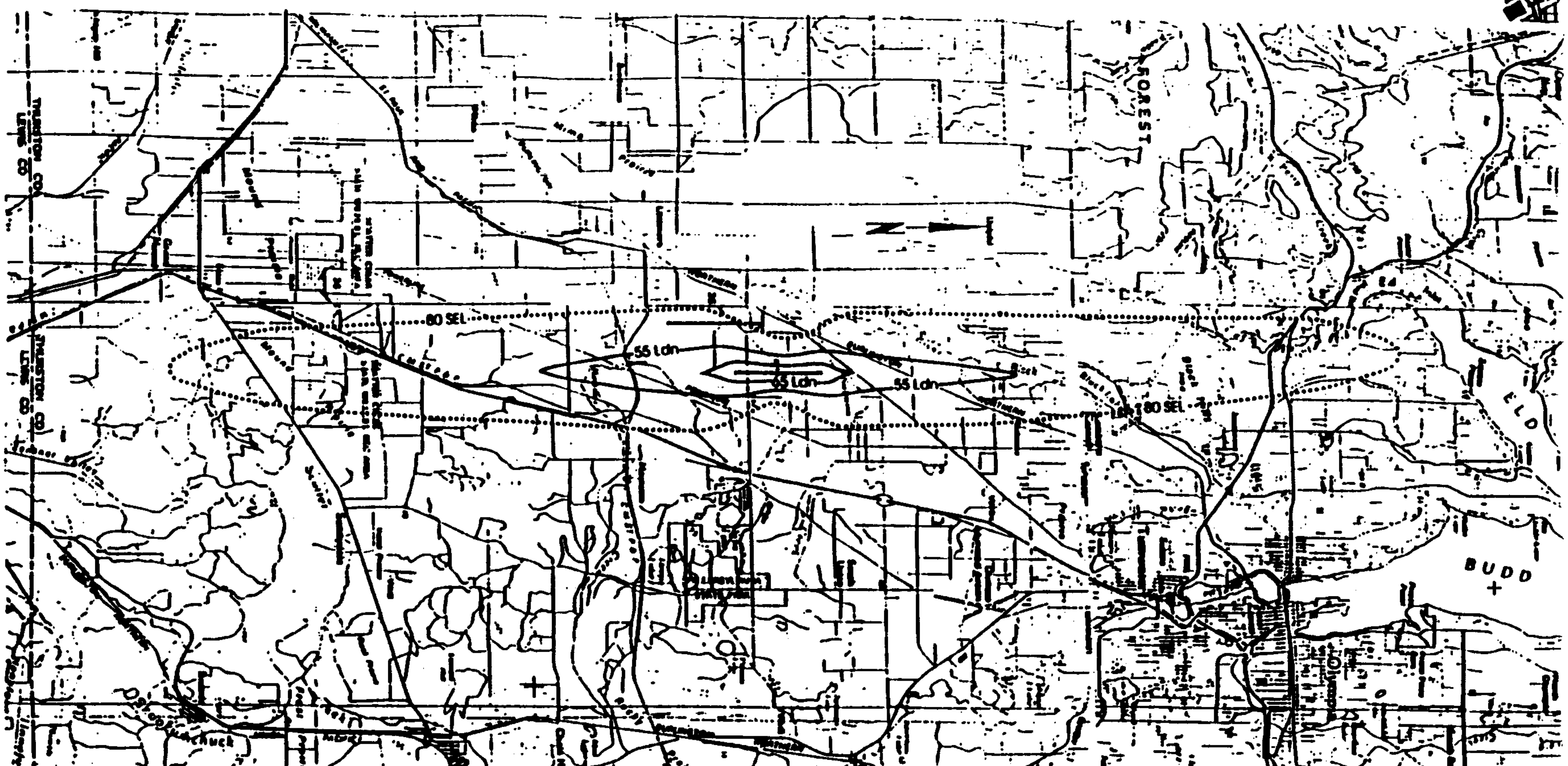


Figure C-35

Olympia/Blacklake Supplemental Airport 1 R/W - 1.3 M

Alternatives 29 & 3

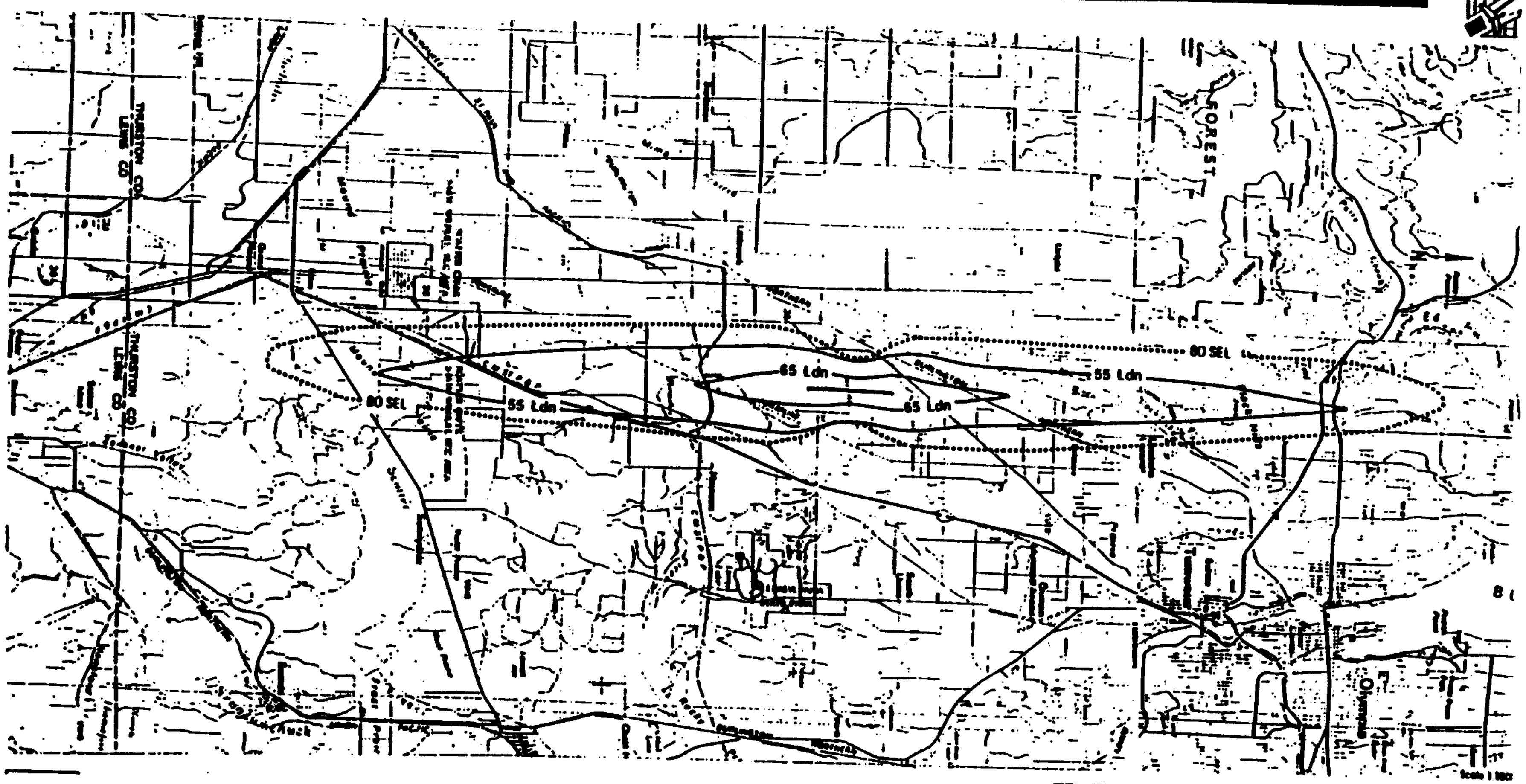


Figure C-36

2020 Olympia/Blacklake Supplemental Airport 1 R/W - 10.9 M

Alternativ

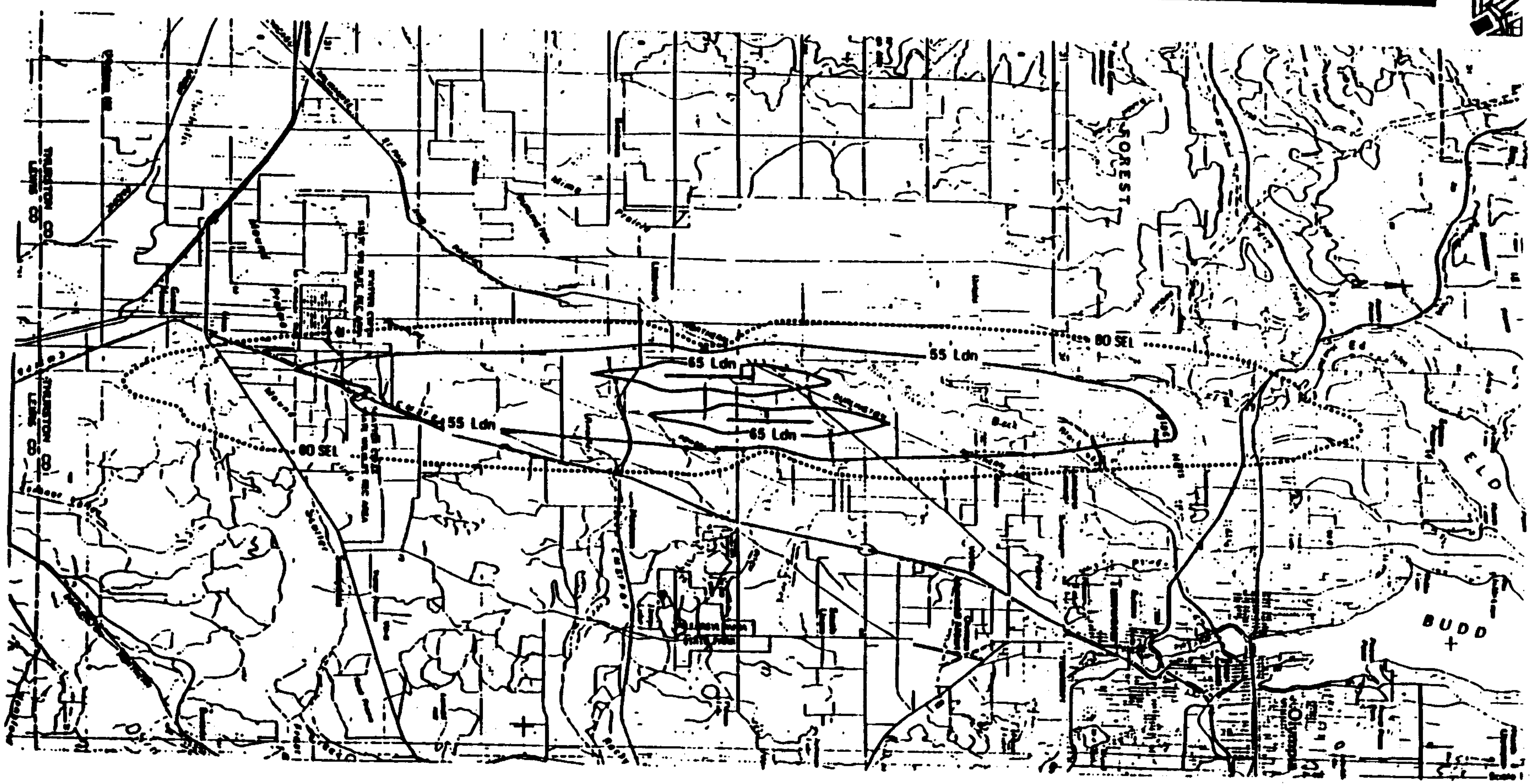


Figure C-37

2020 Olympia/Blacklake Supplemental Airport 2 R/W - 13.0 M

Alternative

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Appendix D

Air Quality Assessment

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APPENDIX D

AIR QUALITY ASSESSMENT

INTRODUCTION

The purpose of this Appendix is to present the potential air quality impacts attributable to each of the airport system alternatives. The potential impacts of the alternatives are compared relative to the impacts on the regional air quality emissions within the Puget Sound area. The report discusses the potential future air pollutant emissions based on the general trend of jet aircraft emissions and on the airport-related vehicular emissions. Both the aircraft and vehicular traffic air pollutant emission levels were used in the comparison of each system alternative on the impacts on the regional air quality.

This Appendix presents background information on issues important to the assessment of air quality impacts, projects the emissions for each of the sources of pollutants attributable to airport operations, and determines the total contribution to the regional air quality for each of the system alternatives. The material in this Appendix has been updated in response to comments concerning the Draft EIS (DEIS) and reflects data which has recently become available.

This Appendix is divided into the following sections:

* Summary of Results
* Background Information on Air Quality
* Emissions Calculations
* Total Airport Emissions
* Mitigation Measures

SUMMARY OF RESULTS

The summary results of the air quality analysis are presented in Table D-1. This table presents an emission inventory of selected pollutants for each of the system alternatives. This data is presented for carbon monoxide (CO) emissions, Hydrocarbon emissions (HC), and the nitrogen oxides (NOx) emissions. CO emissions are best used to indicate the impacts from vehicular traffic because the CO emissions in the Puget Sound area are primarily the result of vehicular traffic. The NOx emissions are best used to indicate the impacts from both traffic and aircraft operations combined because both these sources contribute to the secondary pollutants of which NOx is an important factor.

Table D-1

Emissions Comparison for Each System Alternative 2020
(Tons/Day)

Alternatives	***Traffic Emissions***			***Aircraft Emissions***			***Total Emissions***		
	CO (Tn/dy)	***NOX (Tn/dy)***	***HC (Tn/dy)***	***CO (Tn/dy)***	***NOX (Tn/dy)***	***HC (Tn/dy)***	***CO (Tn/dy)***	***NOX (Tn/dy)***	***HC (Tn/dy)***
NO ACTION **									
Existing Sea-Tac No Action (Unconstrained Sea-Tac Only)	16	2.9	1.9	20	5.8	5.9	36	8.7	7.8
EXISTING SEA-TAC AIRPORT SYSTEM									
Existing Sea-Tac w/System Management (Constrained)**	16	2.9	1.9	9	3.7	2.8	25	6.5	4.6
Sea-Tac w/New AC Rwy (Unconstrained Sea-Tac Only) **	17	3.1	2.0	9	5.0	2.5	26	8.1	4.5
Sea-Tac In Conjunction With A Remote Airport	• • • • • • • • • • • • • • • • • • • See Text • • • • • • • • • • • • • • • • • • •								
TWO AIRPORT SYSTEMS									
Existing Sea-Tac + Supp(1 Rwy)**	15-26	2.7-4.8	1.8-3.1	10-11	4.6-4.6	3-3.2	25-37	7.3-9.4	4.8-6.3
Existing Sea-Tac + Supp(2 Rwy)	15-28	2.7-5.2	1.8-3.4	10-11	4.6-4.6	3-3	25-39	7.3-9.8	4.8-6.4
Sea-Tac with new AC Rwy + Supp(1 Rwy)	17-20	3.1-3.7	2-2.4	10-11	4.8-4.8	3-3.1	27-31	7.8-8.5	5-5.6
Sea-Tac with new AC Rwy + Supp(2 Rwy)	17 - 21	3.1 - 3.8	2 - 2.5	10-11	4.8-4.8	3-3.1	27 - 32	7.8 - 8.6	5 - 5.6
THREE AIRPORT SYSTEMS									
Existing Sea-Tac + 2 Supp(1 Rwy)	14 - 21	2.5 - 3.8	1.6 - 2.5	10-11	4.6-4.7	3-3.1	24 - 32	7.2 - 8.5	4.7 - 5.6
Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	16-18	2.8-3.4	1.9-2.2	8-10	4.5-4.8	2.2-3	23-29	7.3-8.1	4.1-5.2
REPLACEMENT AIRPORT SYSTEM									
Replacement	51	9.4	6.1	7	4.7	2.1	59	14.1	8.3

** Denotes systems that include alternatives which do no meet system capacity demands.

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The important findings from the air quality analysis and the basis for these findings are listed below:

The results show that for the system alternatives that meet forecast demand, the three-airport system alternative with and without the dependent runway at Sea-Tac result in less pollutants. This is because the emissions are less with these system alternative as a result of a reduction of vehicular travel distances and a reduction in aircraft delays. The three-airport system alternative with the dependent runway at Sea-Tac shows some slight preference because it has lower aircraft delays as well as reduced travel distances.

A multiple airport system locates more airport sites throughout the region so the average driving distance to the airport(s) is less. Supplemental airport site options such as Paine Field and McChord that are located closer to the population centers are more favorable than site options such as Arlington or Olympia/Black Lake that are located further from populated areas.

The emissions from aircraft operations are less with alternatives that include the dependent runway at Sea-Tac as a result of the reduction in aircraft delays that will occur when the airport is not operating at capacity.

Of those alternatives that meet forecasted demand, the replacement-airport alternatives showed the least amount of aircraft emissions because the aircraft delays are significantly less as a result of the elimination of Sea-Tac. However, this alternative was rated the worst in terms of overall air quality because the very long travel distances to the potential airport site options involve large amounts of vehicular emissions.

Airport related CO emissions are projected to constitute less than 4% of the total regional CO emissions in the four county area in the year 2020. Increased transit use and other transportation demand management techniques as well as airport emissions mitigation measures have the potential to further reduce commercial aviation contribution to regional air quality impacts.

The air quality impacts from all of the alternative airport systems can be partially mitigated through transportation measures and improvements. Those site options that are located near the proposed regional light rail transit line (Sea-Tac and Paine Field) show the most potential for trip reduction through increased transit use.

BACKGROUND INFORMATION ON AIR QUALITY

Criteria Pollutants and Health Effects

Air pollutants are divided into two categories. The first is primary pollutants. These are the pollutants that are directly emitted from a source. Primary pollutants include carbon monoxide, nitrogen oxides, hydrocarbons, sulfur oxides, and particulates. The other category of pollutants is secondary pollutants. Secondary pollutants are those pollutants that result from chemical reactions between other pollutants in the atmosphere. Ozone is a secondary pollutant that is not directly emitted by any source but is a result of reactions between nitrogen oxides and hydrocarbons.

The nature of the pollutants emitted from airports is the same as those emitted from other transportation projects. Carbon monoxide, sulfur and nitrogen oxides, and unburned hydrocarbons are common pollutants emitted from the combustion processes. Six criteria pollutants regulated by federal standards are ozone, carbon monoxide, particulates and nitrogen dioxide, sulfur dioxide and lead. They are described below.

Ozone (O3) is a colorless gas which comes from the reaction of hydrocarbons and oxides of nitrogen in the presence of sunlight. Although ozone is the air contaminant for which standards are set, its precursors, hydrocarbons and nitrogen oxides, are the pollutants which must be controlled. Ozone results in eye irritation and damage to lung tissues, reduced resistance to colds and pneumonia, and aggravates heart disease, asthma, bronchitis and emphysema.

Carbon monoxide (CO) is a colorless, odorless and toxic gas produced by incomplete combustion of carbon-containing substances. The highest ambient concentrations of carbon monoxide occur near congested roadways and intersections during periods of low temperatures, light winds, and stable atmospheric conditions. CO has been shown to interfere with oxygen transport in the blood, produce cardiovascular disease, and decrease visual perception. CO has also been associated with lower birth weight and increased deaths of infants in highly polluted areas.

Particulate matter which is composed of particles 10 microns or less in diameter is referred to as PM10 , and is the inhalable subgroup of total suspended particulates (TSP). Suspended particles aggravate chronic heart and lung disease and often transport toxic elements such as lead, arsenic, and nickel, which can enter respiratory, digestive and lymphatic systems.

Hydrocarbons (HC) result from the release of unburned fuel or incomplete combustion of fuel. HC plays a very important role in determining regional air quality. HC react with nitrogen oxides in the presence of sunlight to form ozone and nitrogen dioxide. The amount of ozone formed is more related to the amounts of HC released than to any other pollutant.

Sulfur dioxide (SO2) is a nonflammable, non explosive, colorless gas. It reacts in the atmosphere to form sulfur trioxides (SO3) and sulfuric acid. SO2, sulfuric acid, and other inorganic sulfates have been shown to produce asthma which decreases human respiratory function both at the acute and chronic levels. SO2 also contributes to acid deposition.

Nitrogen oxides (NO, NO2 & NOx) result from the high temperature oxidation of nitrogen present in air. In the presence of moisture, NO can form particulates by coalescing, thereby reducing visibility and contributing to acid deposition. NO2, like sulfur dioxide, is also a bronchoconstrictor that can cause irritation and injury to the lungs. NOx is also a factor in the generation of secondary pollutants such as ozone.

<u>Air Quality Standards</u>

The Federal Clean Air Act, as amended in 1977, required states to have State Implementation plans (SIP) to achieve established air quality goals. The result is the National Ambient Air Quality Standards (NAAQS). The Federal Clean Air Act requires that urban areas which do not meet standards for carbon monoxide (CO) and/or photochemical oxidants (ozone) must implement transportation plans to achieve the standards for these pollutants. Washington State and the Puget Sound region have adopted ambient air quality standards.

The Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) in the Clean Air Act of 1970. These standards have been established for both the primary and secondary pollutants: ozone, carbon monoxide, particulates and nitrogen dioxide, sulfur dioxide and lead. Areas that exceed these standards are considered non attainment areas and a plan must be developed to ultimately bring the area into compliance. CO is one of the major air pollutant problems within the Puget Sound Region. For the Puget Sound area, CO is primarily a problem associated with motor vehicles.

The Clean Air Act, Title II, Part B, directs the EPA to establish aircraft emission standards throughout the United States. The Code of Federal Regulations volume 40, part 87 contains engine emission standards that apply only to large commercial passenger jets. The FAA is responsible for implementing the standards through engine certification data provided by the manufacturers. These regulations do not extend to piston powered, smaller turbofan or military aircraft.

<u>Existing Air Quality</u>

Three agencies have air quality jurisdiction in the Puget Sound region: the United States Environmental Protection Agency (EPA), Washington State Department of Ecology and the Puget Sound Air Pollution Control Agency (PSAPCA). Each Agency has established its own standards. Unless the state or local agency has adopted a more stringent standard, the EPA standards apply.

The Department of Ecology and PSAPCA maintain a network of monitoring stations throughout the Puget Sound area. In general, these stations are located where agencies believe there might be an air quality problem. Other stations are located in more remote areas to measure regional or background air pollution levels. These stations measure particles, carbon monoxide, sulfur dioxide, arsenic, lead, and ozone. Of these substances, carbon monoxide is predominantly generated by transportation sources.

Of the 6 criteria pollutants discussed below, the Puget Sound Region is in attainment with three of them: Sulfur Oxides, nitrogen oxides and hydrocarbons. A downward trend in the ambient concentration of air pollutants generated by motor vehicles, especially carbon monoxide, has been observed in the Puget Sound area over the past decade. The replacement of older vehicles with newer cleaner ones, and vehicles meeting the requirements of the Inspection and Maintenance (I/M) program have been the major factors for reducing the carbon monoxide emissions. Carbon monoxide emissions have been reduced by 13% in Seattle due to the I/M program, however increasing traffic levels may begin to erode these gains after the year 2000. (Environment 2010, State of Washington, Oct. 1989).

The Puget Sound Air Pollution Control Agency uses the national Pollutant Standards index to report daily air quality. (1990 Air Quality Data Summary, PSAPCA, September 1991). The values provide a way to summarize the air quality for the entire year. The range of conditions are described as good, moderate, unhealthful and very unhealthful. Any pollutant measurement exceeding the short term national primary standard causes the Index value to be in the unhealthful or worse category. The 1990 results were:

Everett:	166 good, 197 moderate and 2 unhealthful days
Seattle:	239 good, 126 moderate and zero unhealthful days
Tacoma:	289 good, 75 moderate and 1 unhealthful days

The Puget Sound region is designated a "non attainment" area for carbon monoxide, ozone, and particulate matter. In 1990 the CO non-attainment areas were in Seattle (downtown and University District), Bellevue (downtown), and Tacoma (downtown). In 1987 the Puget Sound region attained the ozone standard, but monitored data during the summer of 1990 indicated the region may have been out of compliance with the standard.

In 1988 there were exceedances of the PM10 standard at four of twelve monitoring stations that measure this pollutant category. Three of the stations were located in Tacoma and had a total of six days of exceedances. The other station was the Seattle/Duwamish location that exceeded the standard two days. In 1991 here were no exceedances of the PM10 standard at any of the monitoring stations.

In 1988 eight stations measured carbon monoxide levels greater than the eight hour standard. Four of those stations were located in Seattle and the others were located in Everett, Bellevue, Tacoma, and Bremerton, Everett exceeded that standard eight days while the other stations had three or less days of exceedances. In 1991, only two stations, Tacoma and Everett, experienced exceedances of the eight hour carbon monoxide standard for one day each. In 1991 there were no exceedances of the ozone, sulfur oxide and nitrogen oxide standards at any of the monitoring stations.

Current aircraft operations at Sea-Tac Airport are a major source of air pollutant emissions in the local area. Based on a Department of Ecology emissions inventory (May 1991), Sea-Tac Airport contributes approximately 8% of the carbon monoxide and 5% of the nitrogen oxide emissions in King County. This includes vehicular operations in the local area and aircraft operations below 3,000 feet, as well as other on-airport emissions.

EMISSIONS CALCULATIONS

The main sources of air pollutants attributable to airports are aircraft traffic, motor vehicles, boilers, and fueling operations. Aircraft and motor vehicles together comprise a majority of the airport emissions. Other emissions due to tank farms, ground support vehicles, boilers and training fires are minor sources at the airport.

Aircraft Emissions

The quantity of pollutants emitted into the atmosphere from aircraft operations is a function of the type of aircraft and engine, mode of operation, and how long the engine is operated in each mode. Large jet aircraft operations produce the largest amount of airport pollutants. Small aircraft also contribute in the summation of an airport's emissions.

Aircraft engines emit CO, hydrocarbons, NOx, SOx, and particulates as by-products from the combustion process. The emission rates are determined by engine types. More CO and hydrocarbons are produced at low engine power settings, such as idling or at start-up because of incomplete combustion. The amount of NOx produced during start-up is small compared to that produced during takeoff. SO2 is a result of the oxidation of sulfur compounds in the aircraft fuel. Aircraft fuel is usually highly refined and contains only about 0.1% sulfur. Particulate matter emitted from the aircraft engines, particularly turbine engines, is extremely small in diameter ranging between 0.04 and 0.12 microns.

Aircraft emissions by mode of operation can be divided into idle, taxi, climb and approach. Climb and approach emissions, which are calculated from ground level up to 3500 feet, are the major source of nitrogen oxide emissions, and takeoffs contribute about 25% of the total aircraft NOx emissions. Sulfur oxide and particulate emissions are more evenly divided among the four aircraft modes with climb and approach still being the most significant contributing mode. Aircraft taxi and idle queues on the ground are the major source of carbon monoxide and hydrocarbons.

The Emissions and Dispersions Modeling System (EDMS) computer model, developed by the FAA and U.S. Air Force, was utilized to assess the projections of aircraft pollutant emissions. The number of operations per day and the length of time each type of

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aircraft spends in the queue mode was also required. All aircraft operations were estimated according to each of the airport development alternatives. These alternatives and the total pollution concentration levels are presented in Table D-2. Operations data including fleet mix was obtained from the P&D Aviation - Allocation of Passengers and Aircraft Operations, August 1991. The operational data is presented in Table C-3 of Appendix C, "Noise Assessment Study." Data on aircraft delays for each of the airport development alternatives was also provided by P&D Technologies.

The results of the emission inventory for aircraft operations are presented in Table D-2. The results indicate that the aircraft emissions are similar for all alternatives. This would be expected in that the alternatives are based on the same levels of aircraft activity. The exception is that the emissions are less for those alternatives that do not meet system capacity demand for 2020 (Alternatives 1, 2, 3, 6, 7 and 34). Emissions levels for these alternatives are less because the number of operations are less.

Of all the alternatives which meet the system capacity demand, the difference between the alternatives is the amount of aircraft delays that may occur under each scenario. The replacement-airport alternatives result in the least emissions. This is because the replacement-airports have the least amount of aircraft delays of any of the system alternatives. The three-airport Alternative results in the next smallest emissions, especially for those options that include a third dependent runway at Sea-Tac Airport. This is due to the operational efficiency that would result from the runway.

Note that the analysis assumes that delay emission reduction measures are included as part of all of the system alternatives. These measures reduced the potential emissions by more than one half. It would not be reasonable to assume that for the very high delays that are forecast for many of the alternatives, every minute of delay would result in a minute of aircraft engine idling emissions. Economic factors and regulation by air quality districts would tend to minimize the amount of time that aircraft are idling. Types of measures that can be used to reduce delay emissions include gate holds and using tractors to tow aircraft to holding areas. Therefore, a significant level of delay emission reduction measures are already included in this analysis.

The highest aircraft emissions are anticipated to result from the No Action Alternative. The higher level of emissions are a result of large delays at Sea-Tac that would be anticipated to occur as the airport operated at capacity.

Global Aircraft Emissions. At the global level, the International Energy Agency (Paris) reports that 160 million tons of aviation fuel were burned in 1988, and 176 million tons in 1990. This is 13 or 14 percent of the world's annual consumption of transportation fuel. In 1990, this resulted in 550 million tons of carbon dioxide, 220 million tons of water, 3.5 million tons of nitrogen oxides and 0.18 million tons of sulfur dioxide. Soot, carbon monoxide and hydrocarbon emissions are less significant. For more information on energy, see Section 4.8. At least 60 percent of these emissions takes place above 3.75 miles (Environment, R A. Egli, November 1991).

Table D-2

Aircraft Emissions (Year 2020)
(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
1	** Sea-Tac Only with Existing Runways (Constrained)	9.4	3.7	0.4	0.1	2.8
3	** Alternate 1 + Arlington 1 R/W	11.3	4.6	0.4	0.1	3.2
4	Alternate 1 + Paine 1 R/W	10.4	4.6	0.4	0.1	3.0
5	Alternate 1 + McChord 1 R/W	10.4	4.6	0.4	0.1	3.0
6	** Alternate 1 + Central Pierce 1 R/W	11.3	4.6	0.4	0.1	3.2
7	** Alternate 1 + Olympia/Black Lake 1 R/W	11.3	4.6	0.4	0.1	3.2
8	Alternate 1 + Arlington 2 R/W	10.5	4.6	0.4	0.1	3.0
9	Alternate 1 + Paine 2 R/W	10.4	4.6	0.4	0.1	3.0
10	Alternate 1 + McChord 2 R/W	10.4	4.6	0.4	0.1	3.0
11	Alternate 1 + Central Pierce 2 R/W	10.5	4.6	0.4	0.1	3.0
12	Alternate 1 + Olympia/Black Lake 2 R/W	10.5	4.6	0.4	0.1	3.0
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	10.7	4.8	0.4	0.1	3.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	10.4	4.8	0.4	0.1	3.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	10.6	4.8	0.4	0.1	3.1
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	10.5	4.8	0.4	0.1	3.1
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	10.7	4.8	0.4	0.1	3.1
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	10.6	4.8	0.4	0.1	3.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	10.4	4.8	0.4	0.1	3.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	10.4	4.8	0.4	0.1	3.0
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	10.5	4.8	0.4	0.1	3.1
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	10.6	4.8	0.4	0.1	3.1
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	10.6	4.6	0.4	0.1	3.1
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	10.5	4.6	0.4	0.1	3.0
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	10.6	4.7	0.4	0.1	3.1
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	10.5	4.6	0.4	0.1	3.0
27	Alternate 13+ Central Pierce 1 R/W	8.4	4.6	0.4	0.1	2.4
28	† Alternate 14+Central Pierce 1 R/W	7.6	4.5	0.4	0.1	2.2
29	Alternate 13+Olympia/Black Lake 1 R/W	10.3	4.8	0.4	0.1	3.0
30	Alternate 14+Olympia/Black Lake 1 R/W	9.1	4.7	0.4	0.1	2.6
31	Central Pierce 3 R/W	7.4	4.7	0.4	0.1	2.1
32	Fort Lewis/ Central Pierce 3 R/W	7.4	4.7	0.4	0.1	2.1
33	** Alternate 1 + Demand Management	9.4	3.7	0.4	0.1	2.8
34	** No Action (Unconstrained Sea-Tac Only)	20.2	5.8	0.7	0.2	5.9
35	** Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	8.8	5.0	0.4	0.1	2.5

** Denotes alternatives which do no meet system capacity demands.
† Alternative Recommended by PSATC on June 17, 1992

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One airline that has published its total impacts is British Airways. It reports 11.7 million tons of carbon dioxide, 4.6 million tons of water, 8,000 tons of hydrocarbons, 18,000 tons of carbon monoxide and 22,000 tons of sulfur dioxide. British Airways ranked seventh in the world in revenue passenger miles in 1991 (Air Transport World, June 1992)

This non-project FEIS acknowledges these global totals, but such data are not the focus of this FEIS. The applicable federal air quality regulations and data apply to aircraft emissions below 3000 feet.

<u>Motor Vehicle Emissions</u>

An inventory of vehicular emissions relating to the airport was also completed. Vehicle emissions are based on vehicle miles traveled and are a function of airport location and passenger volume. Emissions by vehicles are a major component of the emissions associated with airports. Estimates of the emissions relating to estimated vehicular traffic to and from each of the airport development alternatives were projected. The vehicle miles traveled per day were based on the Flight Plan O/D (Origin/Destination) passenger forecast and the average trip lengths for passengers traveling to each of the airports. The average trip length was determined from the PSRC travel area zones and is presented in the traffic analysis (Section 4.3). Note that emissions associated with employee trips are not included in this estimate, but are discussed in Section 4.3. Air quality impacts due to employee trips are beyond the scope of this EIS, but will be examined in site-level studies.

Carbon Monoxide, Nitrogen Oxide, and Hydrocarbon emission factors for the years of 2000, 2010, and 2020 were calculated using the Mobile 4.1 computer model. The model uses vehicle type, vehicle operating mode, vehicle age, mileage accrual rate, region (high or low altitude), and temperature along with other data to calculate emission factors. Mobile 4.1 is being used by states in the preparation of the highway mobile source portion of the 1990 base year emission inventories required by the Clean Air Act Amendments of 1990. It should be noted that emission factors calculated for years beyond 1993 using Mobile 4.1 do not include the effects of the Clean Air Act Amendments of 1990. Therefore, the emission factors calculated for years past 1993 by Mobile 4.1 will most likely be higher than what the emission factors will be with the Clean Air Act Amendments.

For the three years that emission factors were generated (2000, 2010, 2020), it was assumed that there would be an Inspection and Maintenance program in place. There is currently an Inspection and Maintenance program in force in the area. However, the program is going to be expanded in the next few years. Because the data required to model the new Inspection and Maintenance program is not available, the existing Inspection and Maintenance was modeled. The actual data used for the Inspection and Maintenance program are the same as those being used by the Washington Department of Ecology for their highway mobile source portion of the 1990 base year emission inventory.

Because Mobile 4.1 does not model Sulfur Oxide or Particulate emission factors EMFAC7D was used to calculate these emission factors. EMFAC7D was created by the California Air Resources Board to model motor vehicle emission factors for the State of California. Although it was developed for the State of California, EMFAC7D does represent the best available methodology for calculating Sulfur Oxide and Particulate emission factors for the Puget Sound Region. The emission factors used in the analysis are presented below.

Motor Vehicle Emission Factors

	Emission Factor (grams/mile)				
Year	CO	NOx	SOx	Part.	HC
2000	11.40	1.75	0.33	0.22	1.21
2010	9.28	1.65	0.33	0.22	1.10
2020	9.18	1.68	0.33	0.22	1.10

The emissions are projected for the year 2020. The total projected vehicular emissions are presented in Table D-3A. Table D-3B supplements the data in Table D-3A and updates the vehicular emissions for ten sample alternatives based on updated passenger mile figures prepared by the Puget Sound Regional Council as part of this FEIS (See Section 4.3) The results show that the vehicular emissions for most scenarios are comparable. The least amount of emissions would be generated by the three-airport Alternatives. In general, the two and three-airport systems have the advantage of two or three airport locations. Since passengers are located closer to more airports, shorter average traveled trip lengths are anticipated. Site options such as Paine Field and McChord that are located closer to the population areas are more favorable then site options such as Arlington or Olympia/Black Lake that are located further from population areas. Note also that given the complexity of the vehicular travel demand, this data should not be used to draw precise comparisons between alternatives but only for rough comparison of general trends.

The highest vehicular emissions would be generated by the replacement-airport alternative. This is because the average traveled trip lengths for the replacement-airport site options are much longer than those for all other airport alternatives. For example, the average trip length to Sea-Tac is 25 miles, while the average trip length to Central Pierce is 45 miles.

Table D-3A

Vehicle Traffic Emissions (Year 2020)

(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
1	** Sea-Tac Only with Existing Runways (Constrained)	15.6	2.9	0.6	0.4	1.9
3	** Alternate 1 + Arlington 1 R/W	20.4	3.7	0.7	0.5	2.4
4	Alternate 1 + Paine 1 R/W	14.8	2.7	0.5	0.4	1.8
5	Alternate 1 + McChord 1 R/W	20.4	3.7	0.7	0.5	2.4
6	** Alternate 1 + Central Pierce 1 R/W	20.1	3.7	0.7	0.5	2.4
7	** Alternate 1 + Olympia/Black Lake 1 R/W	26.1	4.8	0.9	0.6	3.1
8	Alternate 1 + Arlington 2 R/W	21.2	3.9	0.8	0.5	2.5
9	Alternate 1 + Paine 2 R/W	14.8	2.7	0.5	0.4	1.8
10	Alternate 1 + McChord 2 R/W	20.4	3.7	0.7	0.5	2.4
11	Alternate 1 + Central Pierce 2 R/W	21.4	3.9	0.8	0.5	2.6
12	Alternate 1 + Olympia/Black Lake 2 R/W	28.2	5.2	1.0	0.7	3.4
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	17.7	3.2	0.6	0.4	2.1
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	16.7	3.1	0.6	0.4	2.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	18.4	3.4	0.7	0.4	2.2
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	18.4	3.4	0.7	0.4	2.2
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	20.3	3.7	0.7	0.5	2.4
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	17.7	3.2	0.6	0.4	2.1
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	16.7	3.1	0.6	0.4	2.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	18.3	3.4	0.7	0.4	2.2
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	18.4	3.4	0.7	0.4	2.2
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	20.3	3.7	0.7	0.5	2.4
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	16.2	3.0	0.6	0.4	1.9
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	13.7	2.5	0.5	0.3	1.6
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	19.2	3.5	0.7	0.5	2.3
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	16.3	3.0	0.6	0.4	2.0
27	Alternate 13+ Central Pierce 1 R/W	16.5	3.0	0.6	0.4	2.0
28	† Alternate 14+Central Pierce 1 R/W	15.5	2.8	0.6	0.4	1.9
29	Alternate 13+Olympia/Black Lake 1 R/W	18.4	3.4	0.7	0.4	2.2
30	Alternate 14+Olympia/Black Lake 1 R/W	17.1	3.1	0.6	0.4	2.0
31	Central Pierce 3 R/W	51.2	9.4	1.8	1.2	6.1
32	Fort Lewis/ Central Pierce 3 R/W	51.2	9.4	1.8	1.2	6.1
33	** Alternate 1 + Demand Management	15.6	2.9	0.6	0.4	1.9
34	** No Action (Unconstrained Sea-Tac Only)	19.6	3.6	0.7	0.5	2.4
35	** Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	19.6	3.6	0.7	0.5	2.4

** Denotes alternatives which do no meet system capacity demands.

† Alternative Recommended by PSATC on June 17, 1992

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Table D-3B (Supplement)

Vehicle Traffic Emissions (Year 2020)

(Based upon Updated Traffic Forecasts from PSRC for Selected Alternatives)

(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
8	Sea-Tac w/o RW + Arlington 2 R/W	22.0	4.0	0.8	0.5	2.6
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	19.2	3.5	0.7	0.5	2.3
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	20.5	3.8	0.7	0.5	2.5
23	Sea-Tac w/o RW + Arlington 1 R/W + Cen. Pierce 1 R/W	17.5	3.2	0.6	0.4	2.1
24	Sea-Tac w/o RW + Paine 1 R/W + Cen. Pierce 1 R/W	15.3	2.8	0.5	0.4	1.8
25	Sea-Tac w/o RW + Arlington 1 R/W + Olym./Blk. Lake 1 R	20.7	3.8	0.7	0.5	2.5
28	† Sea-Tac W/Dep. RW + Paine 1 RW + Central Pierce 1 R/W	17.7	3.2	0.6	0.4	2.1
32	Fort Lewis/ Central Pierce 3 R/W	51.6	9.4	1.9	1.2	6.2
34	No Action (Unconstrained Sea-Tac Only)	15.6	2.9	0.6	0.4	1.9
35	Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	17.0	3.1	0.6	0.4	2.0

† Alternative Recommended by PSATC on June 17, 1992

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Boilers

Air pollution from boilers varies greatly depending on the fuel used, and the manner in which the boiler is operated. The least polluting fuel is the natural gas oil used as back-up fuel. Boilers are used to power heat exchangers in terminal buildings and other equipment. The emission levels generated from boilers are insignificant and are beyond the scope of this FEIS.

Fueling Operations

Hydrocarbon emissions during operations vary in degrees depending on the type of fuel and the efficiency of the operation. The fuel requirements for piston and turbine engines differ widely. Piston engines requires a high octane type of gasoline, while jet engines use much heavier fuel, usually Jet-A fuel or aviation kerosene. Aviation gasoline used for piston engine powered aircraft is much more volatile than Jet-A fuel. However, the emission levels generated from fueling operations are insignificant when compared with aircraft and traffic emissions and are beyond the scope of this FEIS.

TOTAL AIRPORT EMISSIONS

Table D-4 presents the total airport emission levels from both aircraft and motor vehicles. Of all the alternatives which would meet the system capacity demand, the three-airport Alternatives numbered 24 and 28 generate the least emissions.

The major contributions of the total CO emissions for these alternatives are vehicular traffic. CO is a good indicator pollutant for vehicular activity. CO emissions increase with increased vehicular usage and with increased congestion. Air quality problems local to roadways are usually the result of CO emissions.

Vehicular and aircraft emissions of NOx are important because they contribute to the regional air quality. NOx is an important pollutant in the formation of Ozone. With the introduction of high by-pass engines into the aircraft fleet, NOx is also becoming the pollutant of primary concern local to airports.

The replacement-airport alternatives generate the highest emissions for CO, NOx, SOx and particulates. Although the replacement-airport alternatives have the least aircraft emissions, the major contributions of these total emissions are due to the traffic emissions. The traffic emissions for these alternatives are the highest due to the longest distance traveled lengths.

Comparison to Regional Emissions

The Department of Ecology is currently preparing an emission inventory for the Puget Sound Region State Implementation Plan (SIP). This data was not ready in time for inclusion in this FEIS, but should be available in early Fall 1992. These emissions can be compared to the total regional emissions for the Puget Sound area that was prepared

Table D-4

Total Aircraft and Vehicular Emissions (Year 2020)
(Tons/Day)

Alt #	Airport System Siting Options	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
1	** Sea-Tac Only with Existing Runways (Constrained)	25.0	6.5	0.9	0.5	4.6
3	** Alternate 1 + Arlington 1 R/W	31.6	8.3	1.2	0.6	5.7
4	Alternate 1 + Paine 1 R/W	25.3	7.3	1.0	0.5	4.8
5	Alternate 1 + McChord 1 R/W	30.8	8.4	1.2	0.6	5.5
6	** Alternate 1 + Central Pierce 1 R/W	31.4	8.3	1.2	0.6	5.6
7	** Alternate 1 + Olympia/Black Lake 1 R/W	37.4	9.4	1.4	0.8	6.3
8	Alternate 1 + Arlington 2 R/W	32.5	8.6	1.2	0.6	5.6
9	Alternate 1 + Paine 2 R/W	25.2	7.3	1.0	0.5	4.8
10	Alternate 1 + McChord 2 R/W	30.8	8.4	1.2	0.6	5.5
11	Alternate 1 + Central Pierce 2 R/W	31.9	8.6	1.2	0.6	5.6
12	Alternate 1 + Olympia/Black Lake 2 R/W	38.8	9.8	1.4	0.8	6.4
13	Sea-Tac w/Dependent R/W + Arlington 1 R/W	28.3	8.0	1.1	0.6	5.2
14	Sea-Tac w/Dependent R/W + Paine 1 R/W	27.1	7.8	1.0	0.5	5.0
15	Sea-Tac w/Dependent R/W + McChord 1 R/W	29.1	8.2	1.1	0.6	5.3
16	Sea-Tac w/Dependent R/W + Cent. Pierce 1 R/W	29.0	8.2	1.1	0.6	5.3
17	Sea-Tac w/Dependent R/W + Olym./Blk. Lake 1 R/W	31.0	8.5	1.2	0.6	5.6
18	Sea-Tac w/Dependent R/W + Arlington 2 R/W	29.8	8.3	1.1	0.6	5.4
19	Sea-Tac w/Dependent R/W + Paine 2 R/W	27.1	7.8	1.0	0.5	5.0
20	Sea-Tac w/Dependent R/W + McChord 2 R/W	28.7	8.1	1.1	0.6	5.2
21	Sea-Tac w/Dependent R/W + Cen. Pierce 2 R/W	31.0	8.6	1.1	0.6	5.6
22	Sea-Tac w/Dependent R/W + Olym./Blk.Lake 2 R/W	30.9	8.5	1.2	0.6	5.5
23	Alternate 1 + Arlington 1 R/W + Cen. Pierce 1 R/W	28.1	7.8	1.0	0.5	5.2
24	Alternate 1 + Paine 1 R/W + Cen. Pierce 1 R/W	25.8	7.4	0.9	0.5	4.8
25	Alternate 1 + Arlington 1 R/W + Olym./Blk. Lake 1 R	31.3	8.5	1.1	0.6	5.6
26	Alternate 1 + Paine 1 R/W + Olym./ Blk. Lake 1 R/W	26.8	7.6	1.0	0.5	5.0
27	Alternate 13+ Central Pierce 1 R/W	24.9	7.6	1.0	0.5	4.4
28	† Alternate 14+Central Pierce 1 R/W	25.3	7.7	0.9	0.5	4.3
29	Alternate 13+Olympia/Black Lake 1 R/W	28.7	8.1	1.1	0.6	5.2
30	Alternate 14+Olympia/Black Lake 1 R/W	26.2	7.8	1.0	0.5	4.7
31	Central Pierce 3 R/W	58.6	14.1	2.2	1.3	8.3
32	Fort Lewis/ Central Pierce 3 R/W	59	14.1	2.2	1.3	8.3
33	** Alternate 1 + Demand Management	25.0	6.5	0.9	0.5	4.6
34	** No Action (Unconstrained Sea-Tac Only)	35.8	8.7	1.4	0.7	7.8
35	** Sea-Tac w/New AC R/W (Unconstrained Sea-Tac Only)	25.8	8.1	1.1	0.6	4.5

** Denotes alternatives which do no meet system capacity demands.
† Alternative Recommended by PSATC on June 17, 1992

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by PSRC as part of the Vision 2020 study that was completed in 1990/91. The Vision 2020 study forecasts the total mobile (Vehicle) CO, NOx and HC emissions for year 2020. These forecasts in vehicle emissions were compared with the vehicle emissions for each of the system alternatives. The results in terms of percentage of regional tons per day are presented in Table D-5.

This table presents the range of vehicle emissions for each of the system alternatives under study. The results show that these emissions estimates for the airport related vehicular travel account for less than 4 percent of the regional total for CO, NOx, and HC emissions for system alternatives that include multiple airport uses. The replacement alternatives comprise a much higher percent of the regional vehicular emissions.

Interim Year Analysis

The primary time period for analysis was 2020, which is representative of the long term trends in pollutant emissions for the Flight Plan alternatives. An analysis of the years 2000 and 2010 was also completed to present the emissions during the interim time periods. The analysis of the interim years was completed for Sea-Tac and the north airports sites only, in that an airport site to the south is not anticipated until after 2010. The results of the interim year analysis is presented in Table D-6. If a southern airport site was developed first, the results would be similar as those presented for the northern airports.

Peak Hour Emissions

Air pollutants are not released evenly throughout the day. There is usually one hour where there are more emissions than the other hours. The emissions that take place during this hour are known as the peak hour emissions. The peak hour emissions are calculated by estimating the amount of the daily activity that occurs during the peak hour. It was assumed that 10 percent of the daily vehicular traffic occurs during the peak hour and therefore, 10 percent of the traffic emissions would occur during the peak hour. It was also assumed that 8 percent of the daily aircraft operations occur during the peak hour and therefore 8 percent of the aircraft emissions from operations occur during the peak hour. However, because the peak in operations results in an increase in the delay times it was assumed that the peak hour aircraft emissions during delays would be 15 percent of the daily aircraft emissions from delays. Table D-7 presents the summary peak hour airport emission levels from both aircraft and motor vehicles for each of the system alternatives.

For Sea-Tac, the current peak hour of aircraft operations occurs between 9 am and 11 am. This is anticipated to not change in the future. Peak hour traffic emissions usually occur between 7 am and 9 am or 4 pm and 6 pm during the periods of heaviest traffic. It is important to note that the peak hour emissions for aircraft and traffic do not occur at the same time.

Table D-5
Comparison to Regional Mobile Emissions 2020
(Vision 2020)

Alternatives	*Alternatives % of Regional Mobile Emissions* CO	NOX	HC
VISION 2020 REGIONAL VEHICULAR EMISSIONS Tons per day	1260	190	132
NO ACTION	1.3%	1.5%	1.4%
EXISTING SEA-TAC AIRPORT SYSTEM	1.3 -1.4 %	1.5 - 1.6%	1.4 - 1.5%
TWO-AIRPORT SYSTEMS	1.2 -2.2%	1.4 - 2.7%	1.4 - 2.6%
THREE-AIRPORT SYSTEMS	1.1 - 1.7%	1.3 - 2.0%	1.2 - 1.9%
REPLACEMENT AIRPORT SYSTEM	4.0%	4.9 %	4.6%

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Table D-6
Total Aircraft and Vehicular Emissions for Interim Years (2000 & 2010)

Airport Alternative	*CO* (Tn/dy)	*NOx* (Tn/dy)	*SOx* (Tn/dy)	*Part* (Tn/dy)	*HC* (Tn/dy)
YEAR 2000					
Aircraft Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	4.4	2.8	0.2	0.1	1.5
Sea-Tac w/Dependent R/W + Paine 1 R/W	4.4	2.8	0.2	0.1	1.5
No Action (Unconstrained Sea-Tac only)	6.3	3.3	0.3	0.1	2.1
Sea-Tac w/Dependent R/W (Unconstrained Only)	5.0	3.2	0.3	0.1	1.7
Vehicular Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	11.0	1.7	0.3	0.2	1.2
Sea-Tac w/Dependent R/W + Paine 1 R/W	10.3	1.6	0.3	0.2	1.1
No Action (Unconstrained Sea-Tac only)	14.2	2.2	0.4	0.3	1.5
Sea-Tac w/Dependent R/W (Unconstrained Only)	14.2	2.2	0.4	0.3	1.5
Total Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	15.4	4.5	0.5	0.3	2.6
Sea-Tac w/Dependent R/W + Paine 1 R/W	14.6	4.4	0.5	0.3	2.5
No Action (Unconstrained Sea-Tac only)	20.4	5.4	0.7	0.4	3.6
Sea-Tac w/Dependent R/W (Unconstrained Only)	19.2	5.4	0.7	0.4	3.2
YEAR 2010					
Aircraft Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	5.6	3.5	0.3	0.1	1.3
Sea-Tac w/Dependent R/W + Paine 1 R/W	5.6	3.5	0.3	0.1	1.3
No Action (Unconstrained Sea-Tac only)	9.4	4.2	0.4	0.1	2.7
Sea-Tac w/Dependent R/W (Unconstrained Only)	6.3	4.0	0.3	0.1	1.8
Vehicular Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	12.4	2.2	0.4	0.3	1.5
Sea-Tac w/Dependent R/W + Paine 1 R/W	11.1	2.0	0.4	0.3	1.3
No Action (Unconstrained Sea-Tac only)	15.5	2.8	0.6	0.4	1.8
Sea-Tac w/Dependent R/W (Unconstrained Only)	15.5	2.8	0.6	0.4	1.8
Total Emissions					
Sea-Tac w/Dependent R/W + Arlington 1 R/W	17.9	5.7	0.7	0.4	2.7
Sea-Tac w/Dependent R/W + Paine 1 R/W	16.6	5.5	0.7	0.4	2.6
No Action (Unconstrained Sea-Tac only)	24.8	6.9	0.9	0.5	4.6
Sea-Tac w/Dependent R/W (Unconstrained Only)	21.8	6.7	0.9	0.5	3.7

Note, only the northern airport site options were evaluated for the year 2000 and 2010 since a southern airport is not anticipated to operate until after 2010.

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Table D-7

Peak Hour Emissions Comparison for Each System Alternative 2020

Alternatives	*Traffic Emissions* CO (Tons/ Peak Hr)	NOX (Tons/ Peak Hr)	HC (Tons/ Peak Hr)	*Aircraft Emissions* CO (Tons/ Peak Hr)	NOX (Tons/ Peak Hr)	HC (Tons/ Peak Hr)
NO ACTION **						
No Action (Unconstrained Sea-Tac Only)	1.6	0.3	0.2	2.2	0.5	0.6
EXISTING SEA-TAC AIRPORT SYSTEM						
Existing Sea-Tac w/System Management (Constrained)**	1.6	0.3	0.2	1.0	0.3	0.3
Sea-Tac w/New AC Rwy (Unconstrained Sea-Tac Only) **	1.7	0.3	0.2	0.8	0.4	0.3
Sea-Tac In Conjunction With A Remote Airport	• • • • • • • • • • • See Text • • • • • • • • • • •					
TWO AIRPORT SYSTEMS						
Existing Sea-Tac + Supp(1 Rwy)**	1.5-2.6	0.3-0.5	0.2-0.3	1-1.1	0.4-0.4	0.3-0.3
Existing Sea-Tac + Supp(2 Rwy)	1.5-2.8	0.3-0.5	0.2-0.3	1-1	0.4-0.4	0.3-0.3
Sea-Tac with new AC Rwy + Supp(1 Rwy)	1.7-2	0.3-0.4	0.2-0.2	1-1	0.4-0.4	0.3-0.3
Sea-Tac with new AC Rwy + Supp(2 Rwy)	1.7 - 2.1	0.3-0.4	0.2-0.3	1-1	0.4-0.4	0.3-0.3
THREE AIRPORT SYSTEMS						
Existing Sea-Tac + 2 Supp(1 Rwy)	1.4 - 2.1	0.3-0.4	0.2-0.3	1-1	0.4-0.4	0.3-0.3
Sea-Tac with new AC Rwy + 2 Supp(1 Rwy)	1.6 - 1.8	0.3-0.3	0.2-0.2	1-1	0.4-0.4	0.2-0.3
REPLACEMENT AIRPORT SYSTEM						
Replacement	5.1	0.9	0.6	0.6	0.4	0.2

** Denotes systems that include alternatives which do no meet system capacity demands.

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MITIGATION MEASURES

The most significant reductions in regional and local air pollutant emissions are attainable through programs which reduce the vehicular travel associated with the project. Support and compliance with the Vision 2020 plan is the most important measure to achieve this goal. The plan includes improvement of mass transit facilities, implementation of vehicular usage reduction programs, and transportation demand management programs. This plan has been designed to reduce project trips to reduce the traffic congestion and the total emissions. Any airport development plan will require the development of mitigation measures as part of the environment process. The air quality impacts from any of the alternative airport systems can be mitigated through transportation measures and improvements such as these. Those sites that are located near the proposed light rail line (Sea-Tac and Paine Field) show the most potential for vehicular transportation control measures.

Appendix E

Supplemental Responses to Questions and Concerns Raised During Public Review of the Draft Programmatic Environmental Impact Statement (DEIS)

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APPENDIX E

SUPPLEMENTAL RESPONSES TO QUESTIONS AND CONCERNS RAISED DURING PUBLIC REVIEW OF THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

INTRODUCTION

Nearly 2100 letters were received in response to the Flight Plan Draft Programmatic Environmental Impact Statement (DEIS) and on the draft recommendations of the Puget Sound Air Transportation Committee (PSATC). All of the letters which were postmarked by the close of the comment period on March 23, 1992, as well as verbatim transcripts of all 11 of the Flight Plan public hearings, are reproduced in three "supplements" to the Flight Plan Final Non-Project (Programmatic) Environmental Impact Statement (FEIS). "Supplement 1" contains comments and hearings from Snohomish and Island Counties, "Supplement 2" contains comments and hearings from King County and areas outside the Puget Sound Region, as well as comments from state agencies, and "Supplement 3" contains comments and hearings from Pierce, Kitsap, and Thurston Counties.

EXPLANATION OF RESPONSES TO PUBLIC COMMENTS

Issues raised in the comments on the DEIS and the PSATC's draft recommendations are responded to in one of three ways: 1) By cross-referencing from the letters in the comment Supplements to the appropriate section of the FEIS which addresses the concern, 2) By cross-referencing to a set of specific supplemental responses which are presented in this Appendix, or 3) with the note "comment acknowledged." The cross-references and responses are numeric or alphabetical "codes" which are generally located in the left hand margin of the comment letters (or transcripts) or where space was limited, at the top or bottom of the letter.

* The first type of response uses a numeric code which corresponds to numbered sections of the FEIS. Every attempt has been made to refer commentors to the portion of the FEIS which best addresses the issue raised. However, for further information or clarification on a topic, the reader is encouraged to review other sections of the Final EIS which are within the same subject area cross-referenced. (Please see FEIS Table of Contents)

* The second type of response is to questions or points which were of a very specific nature and therefore not addressed directly in the FEIS text itself. These types of responses, which are presented below, use an alphabetical code beginning with "R-" (R-A, R-B, R-C, etc.). In some cases, the cross references in the supplements may begin with "RES-."

* Comments or parts of comments which are responded to with the note "Comment Acknowledged" did not directly apply to the environmental analysis completed in the DEIS and therefore required no further response. Most of these express personal

opinions on the PSATC's draft recommendations or express a point of view that does not apply to the technical evaluation. However, these comments are included in the supplement books as part of the public record and for review by agency decision makers.

SUPPLEMENTAL RESPONSES

R-A: Many comments received were beyond the scope of the analysis conducted for the Flight Plan Programmatic EIS. These included issues which were too site-specific to be analyzed in the EIS or which were unrelated to the Flight Plan environmental analysis (such as financing and cost issues).

This programmatic EIS is intended to evaluate and compare on a broad level the environmental impacts of various solutions (also known as "system alternatives") to the forecasted long-term air travel needs of the Puget Sound Region. Programmatic studies are general in nature and are not intended to address all of the concerns that would be raised in choosing and evaluating an actual site to implement a given system alternative (Please see Section 1.1.3). For a discussion of the environmental impacts of each alternative at a regional level, please refer to the appropriate subject area of Section 4.0.

Many of the site-specific public comments raised detailed issues and concerns about the alternatives identified in the Draft Programmatic EIS. Further studies and environmental impact statements will be prepared at a "project-level" of analysis in order to examine site-specific impacts. Many of these types of comments received will be useful for developing the scope of issues to be addressed in future EISs.

Examples of issues which were site-specific and therefore beyond the scope of general analysis completed for this programmatic level FEIS included those listed below. Although not dealt with at the site-specific level of detail, many of the concerns raised in these types of comments are addressed at the broad regional level. Please consult the Table of Contents for the appropriate sections of this FEIS.

* The precise locations and layouts of new airports or of airport improvements
* The size and specific configurations of any acquisition areas needed for new airports or for airport improvements
* Exact size and location of additional airport facilities such as passenger terminals, automobile parking, cargo terminals, etc. which may be needed to support any of the system alternatives
* Specific operational procedures for aircraft at any new airport or airport improvement
* Housing and relocation programs for people living within any potential acquisition areas
* Construction impacts to airport neighbors and the environment and

potential strategies for mitigating these

* Other construction-related questions such as source of materials and precise construction techniques
* The nature and extent of noise mitigation programs (or changes to existing programs) at any airport
* Specific runoff and flooding control plans
* Changes to flight tracks and airspace configuration
* Licensing, permitting, and conformance with standards related to implementation of any system alternative at a particular site
* Specific governance and funding plans for new airports or airport improvements or for mitigation of airport-related impacts
* Extent of localized highway and road impacts and plans for new construction and/or mitigation
* Specific impacts to transit and other ground transportation modes
* Site-related social, historical, and archeological impacts
* Scenic/aesthetic and lighting/glare impacts due to any new construction or developments
* Airline scheduling, routing, and market concerns
* Complete inventories of all impacted species and or habitats at precise sites
* Precise impacts and improvement plans for public services and utilities
* Potential fuel handling and other airport-related ground operational procedure changes
* Speculative future changes in governmental regulations or standards

Comments which addressed economic impacts were not related to the environmental analysis and also were beyond the scope of this Programmatic EIS. However, many of these issues were addressed in the Flight Plan Working Paper #8, "Economic Benefits and Strategic Economic Issues" which can be found in the Puget Sound Air Transportation Committee Draft Final Report and Technical Appendices (Including Draft Programmatic Environmental Impact Statement), Puget Sound Regional Council and the Port of Seattle, January 1992. A related report prepared independent of Flight Plan is The Economic and Social Importance of Air Transportation for Washington, Discussion Draft, Washington State Air Transportation Commission, May 1992.

R-B: "Why is it necessary or practical to operate 65 to 70 percent of Sea-Tac aircraft take-offs and landings to the south?"

At any given time, the direction in which aircraft take-off and land at any airport depends on wind direction. To increase the safety and efficiency of flight, aircraft take-off and land into the wind. At Sea-Tac Airport, the predominant wind direction over the course of a year is from the south, thus aircraft land and take-off to the south (referred to as "south flow") much of the time. However, on a seasonal or daily basis, the predominant wind direction may be from the north and the airport will be operating in "north flow."

AR 038558

R-C: "When was the Sea-Tac disaster plan conceived, updated, and last tested?"

The Sea-Tac "Aircraft Plan" is a set of emergency procedures which is used in the event of an airplane crash. It has been in effect for several decades and is updated every year.

The last "full-scale" test of the plan was made in November 1990 in which a mock-up of an aircraft, victims, and crash site was used by Port of Seattle and local emergency personnel to practice the procedures. In addition, every quarter the plan is "table-top" tested. This means that the appropriate emergency responses are reviewed and drilled in a conference room. Please see Section 4.9 for a discussion of safety issues relating to aircraft operations.

R-D: Several comments were made regarding the relationship of the Puget Sound Air Transportation Committee's Flight Plan Project to aviation system planning at the state level.

In late 1990, the State Legislature and Governor Gardner created the Washington State Air Transportation Commission (WSATC). The Mission adopted by the Commission is to "Determine and recommend long-range statewide air transportation policies through a comprehensive examination of issues and present findings to the legislative transportation committee." One of the specific tasks outlined in the Mission Statement is to "consider data and conclusions of appropriate studies by other agencies and states." A component of this, which was mandated by legislation ESHB 2609 passed in 1992, is a review of the Flight Plan forecasts. An interim report discussing the results is scheduled for completion in December 1992. The Puget Sound Regional Council will be taking the WSATC's review into consideration when it takes action on the Regional Airport System Plan (RASP) (scheduled for March 1993). The Commission's final report to the legislature is scheduled for December 1994.

Since the WSATC is dealing with aviation issues for the state as a whole, its scope of study is more general than that of the PSATC. Regional-level studies such as Flight Plan and subsequent site-specific studies focus on air transportation at a more local level. For further discussion of the WSATC, please see Section 4.4.6 and Appendix B.

R-E: Several letters raised concerns with the Flight Plan environmental review process or asked for an extension of the public comment period on the Draft Environmental Impact Statement (DEIS).

Early in the Flight Plan Project, the Puget Sound Council of Governments (now Puget Sound Regional Council) and the Port of Seattle determined that the system alternatives being studied by the advisory Puget Sound Air Transportation Committee (PSATC) would likely have significant environmental impacts. As a result, pursuant to the State Environmental Policy Act (SEPA), the agencies released a SEPA determination of significance on possible later agency actions.

The agencies requested comments on the scope of the Environmental Impact Statement (EIS) on October 31, 1990. The notice was sent to the Flight Plan Project mailing list and to others who potentially might be affected, and was published in the major daily newspapers throughout the region. It listed the times and places for six public scoping meetings which were held throughout the region and provided the address to which scoping comments could be mailed. Over seventy-five scoping comments were received.

In January 1992, the Puget Sound Regional Council and the Port of Seattle released the Flight Plan Draft Programmatic EIS. The document was attached to the draft recommendations of the PSATC and mailed to nearly ninety public agencies and governments. A notice of availability was published in the major daily newspaper throughout the region. The notice was also sent to the Flight Plan mailing list, to numerous newspapers and radio and television stations, and to over 200 community groups and councils. In addition, 860,000 newspaper inserts describing the Flight Plan Project and how to comment on either the Draft EIS or the PSATC's draft recommendations were distributed in the region's major daily newspapers. There was also a great deal of media attention on the project.

Originally, forty-five days were scheduled for public comment on the DEIS with eight hearings to be held in King, Pierce, Snohomish, Kitsap, and Thurston Counties. In response to public requests, the sponsoring agencies extended the original public comment period an additional thirty days and held three more public hearings in Federal Way, Tumwater, and Everett.

Nearly 2100 letters were received from citizens, organizations, public agencies, elected officials, and local governments in response to the call for public comments. In addition, over 650 people testified at the eleven public hearings. (See also Section 1.4)

R-F: Several comments raised concerns with both current air quality conditions around Sea-Tac Airport and how the Flight Plan Alternatives would be made to conform with the State Implementation Plan (SIP).

An enhanced discussion of existing regional air quality conditions is presented in Section 4.2.2.1 of this FEIS. As outlined in response R-A above, strategies for compliance with specific air quality conformity plans and standards are beyond the scope of the Flight Plan analysis. However, these are very important issues which will be examined in project-level EISs to be completed at a later date.

R-G: Several comments raised questions about the 1979 Aviation Safety and Noise Abatement Act (ASNA) and Sea-Tac Airport's Noise Mediation Agreement.

Please See Appendix B.

R-H: Several comments raised questions regarding the estimated number of passengers that would use supplemental airport(s) under the multiple airport system option and if the passenger levels would be sufficient to support commercial airline service.

An estimate of the number of passengers that would use each of the airports in a multiple airport system was made by disaggregating the 45 million annual regional passengers forecasted for the year 2020 (Section 2.2) to each airport site option. This was done by defining airport market areas which were based on ground travel time and determining how many origin and destination (O & D) passengers would be generated by each market area.

The last step was to assign the O & D passengers from each market area to airports based on service considerations. The assumption was made that supplemental airports would capture seventy-five percent of the short haul (less than 700 miles) passengers and one-half of the medium haul (700 - 1100 miles) passengers within their market areas. The rest of the short and medium haul, as well as all of the long haul passengers would go to Sea-Tac since service frequency and number of non-stop destinations served would be greater. All connecting passengers are assumed to remain at Sea-Tac. No more passengers were allocated to an airport than its airfield could handle. A complete discussion of this process and the results can be found in Working Paper #5, "Allocation of Passengers and Aircraft Operations" in the <u>Puget Sound Air Transportation Committee Draft Final Report and Technical Appendices (Including</u>

Draft Environmental Impact Statement), Puget Sound Regional Council and Port of Seattle, January, 1992. The results are also presented in the summary matrix in Section 1.3.

The allocation method used in Flight Plan represents the best estimate for how many passengers can be expected at each of the airports in a multiple airport system. It is based on the experience of other multiple airport systems around the United States. The passenger levels indicate that there are substantial sub-markets for passenger airline service to the north and south of Sea-Tac. The PSATC recommendation for commercial service to begin in the north before the year 2000 and in the south around 2010 are based on an estimate of when each of the sub-markets will be viable. The date service begins and the frequency of flights at start-up depends on actual airline operational and marketing decisions.

R-I: Several comments asked questions regarding the capacity benefits of a third dependent runway at Sea-Tac and how it would be operated.

The Federal Aviation Administration (FAA) sets standards and regulations for how runways can be operated based on the distance between them. The two existing runways at Sea-Tac are separated by 800 feet and are referred to as "dependent" runways. During good weather conditions, this distance is great enough to allow for two streams of arriving traffic. The "dependent" classification means that aircraft do not land side-by-side, but are staggered between the two streams. During bad weather, which occurs approximately 45 percent of the time, only one stream of arriving traffic can be accommodated safely. This is the primary capacity constraint of the existing airfield.

A third dependent runway would be separated from the existing easternmost runway (the one closest to the terminal) by approximately 2500 feet. Under FAA standards, this would be great enough to allow for two staggered streams of traffic in bad weather. The result is that Sea-Tac's bad weather arrival capacity would be increased to the level of its current fair weather capacity. It is important to note that even with improved navigation equipment, it is most likely that the minimum separation for independent operations (two unstaggered streams of traffic) will not be reduced below 3000 feet. For more information, please see: Precision Runway Monitoring System: A Key Opportunity in System Delay Reduction through Increased Airport Capacity, Federal Aviation Administration, November, 1989.

Although the runway would be sufficiently long to accommodate both landings and take-offs of many aircraft types, it would likely be used primarily for landings during bad weather. The actual length and separation of a third dependent runway, as well as how it would be operated in conjunction with the two existing runways will be examined in project-level studies. (See also Section 2.3)

R-J: Several comments raised concerns about potential impacts to operations of the Boeing and Tramco Companies if commercial airline service were started at Paine Field.

Both Boeing and Tramco have issued statements in support of commercial airline service at Paine Field. In a letter dated April 7, 1992, the Boeing Manager of Corporate Public Affairs states: "If Washington is to remain viable and prosper economically from international commerce, we need additional airport capacity such as the [PSATC's] 'Preferred Alternative' for Sea-Tac and Paine Field. Boeing supports increased airport capacity and we consider the 'Preferred Alternative' to be the most workable plan that has been offered. This support is conditioned on mitigation measures which ensure our ability to continue operations at our maximum potential." Tramco states: "...Tramco supports the 'multiple airport system' (the 'preferred alternative') as the most viable position presented by the PSATC. Tramco's support is conditioned however upon a detailed Snohomish County Airport environmental impact statement on this expansion and appropriate mitigation measures to minimize impact. Tramco's support is also qualified with the understanding that this 'preferred alternative' be structured so that it will not detrimentally affect Tramco's proposed future operations at Paine Field."

Project-level studies will address both companies' concerns that commercial airline service be compatible with their operations, and will also look at environmental impacts in detail at the site-level.

Copies of the Boeing and Tramco statements are available for review at the Port of Seattle's Aviation Planning Department.

R-K: One comment asked for clarification concerning the need for property acquisition if a third runway is built at Sea-Tac.

The third runway studied in Flight Plan would be located on the edge of existing Sea-Tac Airport property along 12th Avenue South. Currently, most of this area is approximately between 50 and 100 feet lower than the airfield. In order to accommodate the additional earth required to fill and raise the area, a preliminary estimate shows that property would need to be acquired out to 9th Avenue South. This represents the minimum amount of land needed for construction since additional property could potentially be acquired for a buffer zone.

R-L: One comment raised concerns that public health and safety be addressed along with economic issues in the PSATC study process.

In response to this and other comments, a public safety section (Section 4.9) has been added to the Flight Plan Final EIS. In addition, an enhanced discussion of health impacts due to noise and air quality are addressed in Sections 4.1.2.1 and 4.2.2.2 respectively.

R-M: One comment asked whether there would be sufficient airspace around Sea-Tac to safely allow for a "side-step" maneuver to a third runway (a potential noise mitigation measure which is discussed in Section 4.1.4) and without increasing holding times for aircraft.

The operational details of how a side-step maneuver would be accomplished are beyond the scope of this EIS. It is presented here as a potential noise mitigation measure which may warrant further study. This and other mitigation measures will be examined in detail in project-level studies (See also R-A above).

R-N: Several comments asked what the current load factor (number of seats filled per aircraft) is at Sea-Tac and why additional airport capacity is needed if planes are not 100 percent full.

Load factors vary depending on what city a flight is to or from, time of day, time of week, seasons, and from year to year. They also may differ between airlines. The average load factor across all scheduled airlines for all of 1991 at Sea-Tac is around 60 percent. Since this is an average figure, it does not fully address the types of variations mentioned above.

Attempting to raise load factors is an issue that was addressed in Flight Plan under the "Demand Management" alternative. One of the important findings was that the airlines are practicing "yield management" which is a set of revenue-maximizing strategies that tend to increase load factors over what they would be otherwise. It was also found that airport operators are very limited in their ability to influence load factors since the airlines are a private industry which is under the jurisdiction of the federal government. Yet, controls could be applied at the gates before the airplanes are under FAA jurisdiction. Another possibility is the use of slot-based landing fees, provided that the intent and rate structure are carefully defined not to discriminate against classes of airline users. The PSATC's final recommendations acknowledged the importance of demand management techniques as part of the preferred multiple airport system.

For more information, please see Section 3.2.1 of this FEIS and "Working Paper #4, Demand Management" in the PSATC Draft Final Report and Technical Appendices (Including Draft Environmental Impact Statement), Puget Sound Regional Council and Port of Seattle, January, 1992.

R-O: Several comments addressed how airport capacity improvements would be funded.

As mentioned in R-A above, funding and cost considerations are outside the scope of this FEIS. However, Flight Plan did examine these issues in "Working Paper #11, Capital Costs and Funding," in the PSATC Draft Final Report and Technical Appendices, Puget Sound Regional Council and Port of Seattle, January, 1992.

R-P: Several comments dealt with the tradeoffs of increasing airport capacity within the developed urban area as opposed to a rural area.

This issue is addressed in Sections 1.3.4 and 4.4 as one of the land use trade-offs that decision makers must consider.

R-Q: Several comments dealt with citizen involvement in the Flight Plan Project and in the EIS process.

Please see section 1.4 for a discussion of the public review and participation process and R-E above.

R-R: Several comments asked questions about the relationship of the Puget Sound Air Transportation Committee (PSATC) to its sponsoring agencies (The Puget Sound Regional Council and the Port of Seattle).

Sections 1.1 and 1.2 explain that the PSATC was assembled as a broad group to study our region's long-term air travel needs and to recommend a solution. It completed that charge and forwarded its advisory recommendations to the sponsoring agencies on June 17th, 1992. Regional planning authority still remains with the Puget Sound Regional Council (PSRC) and authority over Sea-Tac remains with the Port of Seattle. No institutional changes have been made as a result of Flight Plan.

R-S: The question was raised, "How can [noise] contours be done for the 3rd runway without new SIDS [Standard Instrument Departures] and STARS [Standard Instrument Arrivals].

Since a third Sea-Tac runway does not exist, the FAA does not have SIDS and STARS available for such a facility. However, assumptions can be made about what the likely flight paths would be for a third runway. For the purpose of the Flight Plan analysis, the current four-post plan flight tracks were used for both the existing Sea-Tac airfield and with a third runway. For a further discussion of flight tracks and of the other operational considerations accounted for in the noise modeling, see Section 4.1.2.4 and "Appendix C, Noise Assessment Study." Further analysis of flight tracks and noise impacts will be conducted in project-level studies.

R-T: One comment asked why noise contours at Paine Field appear to be the same size as those at Sea-Tac.

Both single event (SEL) and cumulative (LDN) noise contour maps for the Flight Plan alternatives are presented in "Appendix C, Noise Assessment Study"of this FEIS. The maps reveal that in all cases, the 55 and 65 LDN noise contours for Paine Field are smaller than those for Sea-Tac, largely due to the lesser number of aircraft operations that are expected to occur at Paine. In one case, LDN contours generated for Paine Field with 13 million annual passengers (MAP) begin to approach the size of some of the Sea-Tac contours. However, the PSATC's preferred alternative did not call for this many passengers, but only about 3.4 MAP. Also, the SEL contours at both airports are about the same size since they represent the noise impact of a single aircraft. SEL depends more on the aircraft type than on the airport used.

R-U: One comment asked for clarification of the number of people living within the existing 65, 70 and 75 LDN noise contours at Sea-Tac.

The DEIS used the Sea-Tac 1990 Noise Exposure Map Update as the basis for analyzing existing noise conditions at Sea-Tac Airport. Since that time, new data has become available as part of the 1991 Noise Exposure Map Update. These figures are presented in this FEIS in Section 4.1.2.2. It is important to note that the figures represent the number of people impacted by a given noise level or greater. Thus, the number for 65 LDN includes residents in the 70 and 75 LDN, and the number for 70 LDN includes residents in the 75 LDN.

R-V: One comment asked why noise levels would be reduced at Sea-Tac due to Stage 2 aircraft being replaced with Stage 3, but not at supplemental airports.

The primary difference between the changes in noise impacts at Sea-Tac as opposed to supplemental airports is that Sea-Tac has and will have a significantly larger number of jet aircraft operations than the supplemental sites. Since most of the supplemental sites currently do not have many jet operations, adding a given number of these operations would have a greater relative impact than would adding the same number at Sea-Tac --regardless if they are Stage 2 or Stage 3 aircraft. The result is that the replacement of Stage 2 with Stage 3 aircraft will cause Sea-Tac's noise to reduce even with increased operations, but introducing more operations at a supplemental will increase its noise impact. However, the noise impact at a supplemental is less with Stage 3 aircraft than it would be otherwise with Stage 2 aircraft.

R-W: Several comments asked about the number of acres of wetlands that would be impacted by adding a third dependent runway at Sea-Tac.

Wetlands impacts at the broad system level of a third runway are presented in Section 4.6.3.1. Specific impacts to wetlands will be addressed in subsequent project-level studies.

R-X: Several comments asked why the Flight Plan environmental review was not combined with the environmental review for the Microwave Landing System (MLS) installation and the South Aviation Support Area (SASA) projects at Sea-Tac Airport.

Both MLS and SASA are specific, site-level projects dealing with current and short-term needs at Sea-Tac Airport and are independent of the recommendations of Flight Plan. The MLS is a test project for a new type of landing system designed to improve approach paths, while SASA is a proposed addition of aircraft support and maintenance facilities south of the airport.

The Flight Plan Project was a regional study which looked at a range of system alternatives for meeting forecasted long-term air travel demand (Section 1.1). While it evaluated different options that could potentially be implemented at Sea-Tac, it examined numerous other sites and did not focus on Sea-Tac only. Thus, the Flight Plan study was much broader in scope than either the MLS or SASA studies. Site-level impacts resulting from any future capacity enhancements at Sea-Tac or at other airports will be examined in project-level studies. In addition, MLS is a possible component of the new technologies which are discussed as part of the Broad System Management Alternative (Section 3.2.1). Meanwhile, the environmental documentation for the MLS and SASA projects is hereby incorporated by reference in this final EIS.

R-Y: Several comments asked for an explanation of how aircraft in the future will have lower single event noise levels (SELs) than today.

Section 4.1.2.4 explains that as today's Stage 3 aircraft are replaced with new, and even quieter Stage 3 aircraft, SEL levels will be reduced. Figure 4-1 graphically compares the SEL noise generated by a range of both Stage 2 and Stage 3 aircraft.

R-Z: One comment asked whether hypersonic aircraft would be based at Sea-Tac in the future based on the following quote from Working Paper #8, "Economic Benefits and Strategic Economic Issues:" "It is not unrealistic to expect that within 20 years, advances in aviation will place U.S. businesses within three hours' delivery time of virtually any part of the world."

The quote is a broad statement of future trends which deals with delivery from the U.S. as a whole, and not from Sea-Tac in particular. It is part of an overall section that discusses just-in-time delivery methods and other emerging global distribution phenomena used in conjunction with air transportation. It is intended to show that aviation will play an increasingly strong role in the world economy and does not imply hypersonic aircraft.

The Flight Plan environmental analysis does not assume that hypersonic aircraft (not yet developed) will operate at Sea-Tac during the next 30 years. Speculation on the levels of impacts such aircraft would have is beyond the scope of this FEIS.

R-AA: One comment asked what percentage of Sea-Tac's current passengers come from Snohomish County.

A survey of passengers prepared for the Puget Sound Air Transportation Committee in November 1991 indicated that 8 percent of Sea-Tac's current origin and destination (O & D) passengers are from Snohomish County. O & D passengers are those who begin or end the air portion of their trip in the Puget Sound Region and does not include connecting passengers.

R-AB: Several comments asked about which "noise control measures" at Sea-Tac (discussed in "Appendix 1, Noise Assessment Study" of the DEIS) would help reduce future noise impacts.

The "noise control measures" refer to the techniques which are part of the Sea-Tac Noise Mediation Agreement now in effect at the airport. These include an accelerated phase-out of Stage 2 aircraft (2001 vs. the federally mandated 2003), night-time limitations on Stage 2 aircraft, a noise "budget," and noise abatement arrival and departure procedures. For more information on these and other noise control procedures, please contact the Port of Seattle's Noise Abatement Office.

Potential noise mitigation measures which may be applied to the Flight Plan alternatives are discussed in Section 4.1.4. (See also Section 4.1.3.4.)

R-AC: Several comments questioned whether the Flight Plan LDN and SEL noise analysis represents the worst case scenario from a Stage 3 aircraft perspective.

The noise analysis assumes that the oldest of the Stage 3 aircraft will be replaced with even quieter Stage 3 aircraft after the year 2000. This assumption considers the fact that aircraft have a typical life span of only 25 to 30 years. In addition, although newer Stage 3 aircraft are quieter than older Stage 3 aircraft, the difference in noise is not significant enough to warrant additional analysis using an all "older" Stage 3 fleet.

For the SEL metric, the MD-82 aircraft was chosen since it is representative of the loudest aircraft expected to be in operation through the year 2020. Please see Section 4.1.2.4 for more information on the noise contour analysis.

R-AD: One comment asked for clarification on the amount of induced land use that would occur within an airport's "influence area."

Induced land use is discussed in Section 4.4.2.3. It is important to note that the "influence area," which extends 1.5 to 3 miles from an airport, represents the general area in which the stated amounts of induced land use changes would occur. It does not imply that all of the area within 1.5 to 3 miles will undergo a change due to commercial air transportation activity.

R-AE: Several comments asked how 65 LDN represents a "balance between a desired sound environment and the economic costs for obtaining this level."

The LDN metric is discussed in Section 4.1.2.1.1. The "balance" represents a value judgement the federal government has made between meeting a given sound level (65 LDN) and paying for it. Analysis of such a judgement is beyond the scope of this FEIS. However, in order to fully present airport noise impacts, the Flight Plan analysis (which is prepared according to the State Environmental Policy Act) includes not only the 65 LDN contour, but also the 55 LDN and 80 SEL contours (See Section 4.1.)

R-AF: Several comments raised concerns with the economic analysis completed for Flight Plan in Working Paper #8, "Economic Benefits and Strategic Economic Issues."

As explained in R-A above, regional economic issues are beyond the scope of the Flight Plan Final EIS. However, potential impacts to property values and property tax revenues are discussed in Section 4.4.2.1.3.

R-AG: One comment asked what was meant by the statement that aircraft in the year 2020 will be "significantly quieter."

Significantly quieter refers to the lessening of noise levels per airplane (both in LDN and SEL) as Stage 2 aircraft operating today are replaced with Stage 3 over the next decade. Please see R-Y above and Section 4.1.2.4.

R-AH: One comment asked on what basis it was assumed that mitigation measures at supplemental airports would be able to reduce noise impacts approximately 10 percent.

At this broad level of analysis, the primary mitigation measure tested for supplemental airports was to prohibit night time aircraft operations. Such restrictions are in place at several supplemental airports around the country including California's Burbank and John Wayne Airports. An LDN noise contour generated with no night time operations is presented in "Appendix C, Noise Assessment Study." Detailed analysis of mitigation measures is beyond the scope of this FEIS and will be examined in project-level studies.

R-AI: One comment asked what the operational assumptions were for a third dependent runway at Sea-Tac.

As explained in R-A above, the specific operational uses of any new airport or airport improvement are beyond the scope of this FEIS. For the purposes of the noise analysis, as a worst case scenario, it was assumed that 33 percent of Sea-Tac's operations would be handled by a third runway. However, it is likely that the actual level of use may be less than that, especially if the mitigation measure of restricting the runway to day time arrivals only were implemented.

R-AJ: Several comments asked about how the Washington Noise Control Act and the King County Noise Ordinance were accounted for in the Flight Plan noise analysis.

Aircraft noise is under the authority of the federal government. Aircraft operations are exempt from both the Washington Noise Control Act and the King County Noise

Control Ordinance. WAC 173-60-050 (4B) specifically exempts sounds originating from aircraft in flight and sounds that originate at airports which are directly related to flight operations.

R-AK: One comment asked why generation of the SEL noise metric assumes that all of the noise energy from a single aircraft operation is collapsed into one second.

As explained in "Appendix C, Noise Assessment Study," the SEL metric takes into account both the duration of an aircraft overflight as well as the maximum noise level reached. In order to account for these two variables in a single measure, it is mathematically necessary to combine them in some way. One second is the conventional amount of time chosen to define the SEL metric.

R-AL: One comment requested hourly Equivalent Noise Level (LEQ) charts for Sea-Tac now, in 2000 and in 2020.

As explained in "Appendix C, Noise Assessment Study," hourly LEQs are the variable noise energies occurring throughout the day. Due to the broad level of analysis completed for Flight Plan (Section 1.1.3), generation of hourly LEQs is beyond the scope of this FEIS. However, LDN and SEL noise contours are presented in Appendix C to facilitate comparison of the Flight Plan system alternatives. Detailed study of how noise varies throughout the day will be completed in project-level studies.

R-AM: One comment requested a citation of sources which were used by the Federal Aviation Administration (FAA) in determining the compatible LDN level of noise for people living and working within the vicinity of airports.

Section 4.1.2.1.1 discusses the LDN metric and full citations of research on noise metrics are provided in the Bibliography of this FEIS (please see Table of Contents).

R-AN: One comment requested a reference to where "standard aircraft noise and performance data" can be found for the Federal Aviation Administration's (FAA) Integrated Noise Model (INM) Version 3.9 which was used to generate the Flight Plan noise contours.

As listed in "Appendix C, Noise Assessment Study" of this FEIS, information on the INM and standard aircraft noise and performance data can be found in the following document: Federal Aviation Administration - Integrated Noise Model (INM), Version 3, Department of Transportation, FAA-EE-81-7, October, 1982.

R-AO: One comment requested information on the temperature and altitude assumptions which were used to generate the Integrated Noise Model (INM) Noise Contours for Sea-Tac Airport.

As explained in "Appendix C, Noise Assessment Study" of this FEIS, temperature and humidity do not make any adjustments to the noise model data and have no effect on the model results. It is important to note, however, that the Federal Aviation Administration (FAA) conducted field testing for the latest version of the noise model at Sea-Tac. The results of the analysis, including airport characteristics and meteorological data, are presented in the following document: FAA Integrated Noise Model Validation: Analysis of Carrier Flyovers at Seattle-Tacoma International Airport, FAA Office of Environment and Energy, FAA-EE-82-19, November, 1982.

R-AP: One comment asked what aircraft types and flight tracks were used in the Integrated Noise Model to generate the Flight Plan noise contours and whether variations in aircraft weights were accounted for.

Table C-4 "Appendix C, Noise Assessment Study" of this FEIS lists the aircraft fleet mix assumptions which were used in the noise analysis. Flight tracks are discussed in Section 4.1.2.4 and flight track maps for Sea-Tac and Paine Field are presented in Appendix C as Figures C-2 and C-3. Aircraft weight variations are part of the INM model and served as inputs in generating the Flight Plan noise contours.

R-AQ: One comment asked whether the FAA's 1982 validation of the Sea-Tac Integrated Noise Model (See R-AO above) considered Stage 3 aircraft.

"Appendix C, Noise Assessment Study" of this FEIS explains that Stage 3 aircraft were included in the validation.

R-AR: One comment asked for clarification of why a maximum of 489,000 operations per year was used in the DEIS noise analysis and why Alternative #28 indicates 35,000 operations at Paine Field (Table A-1 of "Appendix 1, Noise Assessment Study" in the DEIS).

Data in Table A-1 are for commercial aircraft operations only (air carriers and commuters) and do not include general aviation or military operations. Combined commercial and general aviation noise impacts at specific airport sites are beyond the scope of this FEIS and will be addressed in project-level studies. The data in Table A-1 have been reproduced as Table C-3, in Appendix C, "Noise Assessment Study" of this FEIS.

R-AS: One comment questioned whether the Flight Plan air quality analysis assumed that aircraft experiencing ground delay would spend all of their time idling and therefore artificially raise the stated air quality impacts of the "no build" alternatives.

Appendix D, "Air Quality Assessment" in this FEIS explains that the Flight Plan air quality analysis does not assume that aircraft delayed on the ground would spend all of their time idling. Rather, delay emission reduction measures such as holding aircraft at the gate and using tractors to move aircraft to holding areas are included in the analysis.

R-AT: Note: Cross-reference code "R-AT" was not used to respond to any comment.

R-AU: One comment asked for detailed descriptions of jet fuel spills at Sea-Tac Airport in 1985 and 1986 into Des Moines and Miller Creeks and the clean-up efforts involved.

Impacts to streams based on implementation of any of the Flight Plan alternatives are discussed in Section 4.6.3. Detailed descriptions of past fuel spills are beyond the scope of this FEIS. Spill mitigation will be addressed in project-level EISs. For more information on these spills and the clean-up efforts, please contact the Port of Seattle Aviation Division.

R-AV: Several comments asked whether specific plant and animal species, types of habitats, wetlands, and soil types listed in the DEIS were verified with on-site investigations.

Sections 4.6.2, 4.6.3, and 4.7.1 explain that on-site investigations were not made. Broad level analysis using existing data (See Section 1.1.3) was completed. Site-specific impacts to these components of the environment will be explored in project-level studies.

R-AW: One comment requested further information on how the amount of fill needed for a third dependent runway at Sea-Tac was estimated and whether the volume represents compact or loose fill.

Preliminary filling and excavation estimates for all alternatives were prepared by examining topographic maps of each of the sites. As explained in R-A above, calculation of precise quantities of earth to be moved is beyond the scope of this FEIS and will be examined in site-specific studies. The estimates presented in Section 4.7 are for compacted fill.

R-AX: One comment asked whether any terminal, air cargo, or maintenance facilities are currently planned for the westside of the Sea-Tac airfield.

No such facilities are currently planned for the westside. Specific developments to the Sea-Tac Airport site are beyond the scope of this FEIS.

R-AY: One comment asked how induced commercial land uses were accounted for in the Flight Plan analysis.

A revised discussion of induced land use from a regional perspective is presented in Section 4.4.2.3. Estimates of land use types and amounts are broadly-based to reflect the (non-project) programmatic level of analysis conducted for Flight Plan (Section 1.1.3). Detailed analysis of induced land use impacts will be conducted in project-level studies.

R-AZ: One comment asked why hotel development in the Sea-Tac Airport vicinity appears to have been constricted by local circulation patterns (DEIS, pg 3-51).

The statement in the DEIS is a generic observation of apparent hotel development trends in the vicinity of Sea-Tac as compared to what might reasonably be expected at other new commercial service airport sites. As explained in R-A above, it is beyond the scope of this FEIS to analyze indepth local circulation patterns.

R-BA: One comment asked how an airport could induce parklands as listed in the DEIS at pg. 3-52.

Inclusion of parklands in the discussion of induced land use was a typographical error. The revised discussion of induced land use (Section 4.4.2.3) has dropped this reference.

R-BB: One comment asked for clarification of how commercial air transportation at military sites could potentially impact the military's mission (other than possible airspace conflicts) as discussed in the DEIS .

Specific impacts to the military mission at any of its installations or air bases is dependent on the actual siting of new commercial air transportation facilities and is therefore beyond the scope of this non-project (programmatic) FEIS (See R-A above). However, potential impacts at a broad level of analysis could include the loss of current military training areas if they are converted to commercial airport facilities and possible security conflicts of placing civilians in close proximity to military operations. See Section 4.4.3.2. and Appendix B for more discussion on military site options examined in Flight Plan.

R-BC: One comment asked for clarification of the number of acres of induced land uses that are estimated to occur at various site options.

A revised discussion of induced land use is presented in Section 4.4.2.3. The amount of induced land use at any given site depends on the type of airport system alternative implemented there. Section 4.4.2.3 more clearly presents the level of impact under each of the various system alternatives.

R-BD: Several comments raised concerns about whether existing airport impacts and cumulative impacts of the various components of the system alternatives were examined.

As explained in Section 1.1.3, the FEIS does not present a preferred alternative, but examines a set of alternatives and the associated impacts. The various alternatives represent the likely range of future outcomes for the region's air transportation system. Throughout Section 4.0, existing airport impacts are discussed as are the combined impacts of the individual components of the system alternatives. See R-X above for a similar discussion of cumulative impacts relating to planned improvements at Sea-Tac Airport. The relationship to Flight Plan of other planning activities is discussed in Section 4.4.6 and in Appendix B.

R-BE: One comment raised concerns that a wide-enough range of alternatives was not examined in Flight Plan.

As explained in Section 1.1.3, this FEIS more clearly presents a wide range of system level alternatives designed to meet the broad program objectives (Section 1.1.2.). Section 3.0 presents the alternatives examined.

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R-BF: Several comments asked why the Flight Plan environmental analysis was done under the Washington State Environmental Policy Act (SEPA) as opposed to the National Environmental Policy Act (NEPA) guidelines.

Since the Flight Plan Project itself did not require a federal permit or action, the environmental analysis was done under state guidelines (SEPA). Although federal grant money was received by the sponsoring agencies to help complete the study, the money did not represent a commitment by the federal government to any course of action. It is anticipated that some of the subsequent project-level studies will be conducted under NEPA since federal participation will be necessary.

R-BG: Several comments requested information on the Flight Plan environmental scoping process.

Please see R-E above.

R-BH: Several comments raised concerns with the distribution and notification of availability of the Flight Plan Draft EIS.

Please see R-E above.

R-BI: One comment asked how the 380,000 aircraft operations per year capacity of Sea-Tac Airport was determined (Section 2.3.1).

An aircraft operation is defined as either one takeoff or one landing. The 380,000 operations per year capacity figure for Sea-Tac represent the airport's "annual service volume (ASV)." ASV is a yearly average of the number of operations that can be accommodated in both good and bad weather with minimal delays. It represents the best estimate of yearly capacity and does not assume that the airport is operating at its maximum hourly capacity 24 hours a day. Annual operations can rise above the ASV, but only with increasingly severe delays.

ASV is calculated using a formula discussed in FAA Advisory Circular 150/5060-5. The derivation of Sea-Tac's ASV using the formula can be found in "Appendix I, Capacity and Delay Methodologies" of the Puget Sound Air Transportation Committee

Phase II: Development of Alternatives, Appendices, Puget Sound Council of Governments and Port of Seattle, June 1991.

R-BJ: **One comment requested information on the percentage of air carrier and commuter aircraft operations at Sea-Tac as compared to the percentage of passengers served by both types of operations for the years 1981-1991. Load factors for both types of aircraft were also requested.**

A commuter airline generally can be thought of as one that operates aircraft with fewer than 75 seats per airplane. Commuters at Sea-Tac include United Express and Horizon Airlines.

Data for passenger volumes and aircraft operations by airline can be found in the Sea-Tac Airport Activity Reports for 1989, 1990 and 1991 (soon to be released). Data for before 1989 and data on load factors are not readily available. Copies of airport activity reports can be obtained from the Port of Seattle Aviation Planning Department.

R-BK: **One comment asked for a list of technological advances that could be used to reduce aircraft separations and if these technologies can increase airport capacity. The same comment also requested a list of demand management techniques already being employed at Sea-Tac.**

Both technological advances and demand management are discussed under the "Broad System Management" alternative in Section 3.2.1.

R-BL: **Note: Cross-reference code "R-BL" was not used to respond to any comment.**

R-BM: **Note: Cross-reference code "R-BM" was not used to respond to any comment.**

R-BN: One comment asked what the advantages and disadvantages are of establishing airline service at a supplemental airport before constructing a third runway at Sea-Tac and what the projections are for use of a supplemental airport.

For a discussion of the tradeoffs involved with different phasing schemes for a multiple airport system, please see Section 3.8.3.3. R-H and the impacts summary matrix in Section 1.3 discuss the projections for passengers and aircraft operations at supplemental airports within a multiple airport system.

R-BO: Note: Cross-reference code "R-BO" was not used to respond to any comment.

R-BP: One comment asked what the relationship is between auto emissions and vehicle miles versus passenger miles and what effect mode-split assumptions have on projected auto emissions.

For the broad regional level of analysis conducted for Flight Plan (Section 1.1.3), a worst-case scenario in terms of air quality analysis was used. For purposes of calculation in Section 4.3 (Ground Transportation), it was assumed that all of the origin and destination air passengers would use personal vehicles to reach an airport. As discussed in Section 4.3.4, encouragement of transit use and other ground travel modes is an important potential mitigation measure for transportation impacts. Detailed analysis of mode-splits will be examined in project-level studies. Please see Sections 4.2.3 and 4.3.2.3 for further discussion of vehicle and passenger miles traveled.

R-BQ: One comment questioned whether aircraft have to comply with the Washington State Clean Air Act based on the statement in the DEIS that "Under the Washington State Clean Air Act, transportation projects will have to conform to clean air standards."

The DEIS statement is referring to ground transportation projects which would include any improvements needed in ground access to airports. Emissions from aircraft engines themselves are under the separate authority of the federal government.

R-BR: One comment asked what new interchange was planned to move traffic from State Highway 526 to the Paine Field area.

As discussed in R-A above, specific improvements to local access are beyond the scope of this FEIS and will be examined in detail in project-level studies.

R-BS: One comment asked about the definitions of the terms "Aircraft operations per day" and "Flights per day."

Aircraft operations refers to either one takeoff or one landing of an aircraft and is the unit of reference used in the technical analyses for this FEIS. The term "flights" is more generic and is sometimes used in non-technical discussions. It is generally defined as both a takeoff and a landing (two operations).

R-BT: One comment asked what the passenger and operation levels would be under the various alternatives.

Please see the impacts summary matrix in Section 1.3 and R-H above.

R-BU: One comment asked whether non-commercial operations were included in the noise impact analysis.

The Flight Plan noise analysis (Section 4.1) was based on commercial aircraft operations only (air carriers and commuters) and did not include general aviation operations. Combined commercial and general aviation noise impacts at specific airport sites are beyond the scope of this FEIS and will be addressed in project-level studies.

R-BV: One comment asked on what basis the assumption was made that a high-speed ground transportation system would be able to divert 40,000 aircraft operations per year.

The Flight Plan Project did not make any assumptions about what the actual ridership would be of a high-speed ground transportation system, but rather looked at what effect such a system might have on the region's air transportation system. The discussion of High-Speed Ground Transportation (HSGT) in Appendix A explains that the 40,000 diverted operations were based on assuming that HSGT would capture 50 percent of the year 2020 airline operations between Sea-Tac, Portland, Bellingham, and Vancouver, B.C. (Total estimated annual operations between these cities equals 80,000 in 2020) Section 4.3.2.2 discusses other current planning efforts for high-speed ground transportation.

R-BW: One comment asked whether upgraded heavy rail was considered as part of the Flight Plan High-Speed Ground Transportation alternative.

Section 3.2.1.3 discusses the generic high-speed ground transportation alternative and acknowledges that upgraded heavy rail such as the Amtrak line between New York and Washington, D.C. could possibly be used.

R-BX: One comment asked how much it would cost to build a replacement airport and what the environmental impacts would be.

The environmental impacts of a replacement airport are evaluated throughout Section 4.0 of this FEIS. A discussion of costs can be found in Working Paper #11, "Capital Costs and Funding," in the Puget Sound Air Transportation Committee/The Flight Plan Project, Draft Final Report and Technical Appendices (Including Draft Programmatic Environmental Impact Statement), Puget Sound Regional Council and the Port of Seattle, January 1992. The Working Paper indicates that a replacement airport would cost approximately $2 billion.

R-BY: One comment asked whether the preferred alternative discussed in the Draft EIS called for one or two runways at a southern supplemental airport and whether the impacts were evaluated for a two-runway supplemental airport.

Section 1.1.3 explains that this FEIS has been revised to not present a "preferred alternative." However, the final recommendations of the PSATC are presented for review in Section 1.5 and in Appendix A. The supplemental airport recommended for Pierce (or Thurston) County by the PSATC would start out with one runway and would have enough room to expand to two runways. A southern airport with one runway in conjunction with Paine Field and a third runway at Sea-Tac would meet projected demand through Flight Plan's year 2020 planning horizon. However, since the PSATC wanted to provide for possible needs beyond 2020, they recommended the capability for expansion to two runways. The range of impacts of a two-runway airport in the south are evaluated throughout Section 4.0.

R-BZ: Note: Cross-reference code "R-BZ" was not used to respond to any comment.

R-CA: Note: Cross-reference code "R-CA" was not used to respond to any comment.

R-CB: Please see R-BY above.

R-CC: One comment pointed out that the Central Pierce County site was not discussed under the "preferred alternative" for several of the impact sections.

Section 1.1.3 explains that this FEIS has been revised to not present a "preferred alternative." However, as part of the revision, the impacts of the Central Pierce County site option are discussed more clearly throughout Section 4.0.

R-CD: Several comments questioned the validity of using Paine Field as a potential supplemental airport.

It is possible that the Paine Field site option or any other site option considered in this FEIS may not be implemented. However, based on a number of factors discussed in Appendix A, the PSATC concluded that limited use of Paine Field for commercial airplane operations was one of the more reasonable options of the list considered.

R-CE: One comment mentioned that closure of Sea-Tac could potentially have positive rather than negative impacts.

The statement in the DEIS that "closure of Sea-Tac would have severe economic impacts on surrounding communities" applies primarily to airport-related businesses, employees of such businesses and commercial property values in the Sea-Tac area. It is acknowledged that closure of Sea-Tac could have positive economic benefits on residential properties close to the airport. Please see Section 4.4.2.1.3 for a discussion of property value impacts.

R-CF: One comment asked "since the new dependent runway provides benefits only in limited visibility conditions, and the sidestep maneuver is a 'visual procedure' please explain how this operational process is affected by airport expansion."

Section 4.1.4.4 discusses a "side-step" approach procedure to a third dependent runway at Sea-Tac as a potential noise mitigation measure. Limited visibility in this case applies to aircraft which are operating more than four nautical miles from the airport. A side-step procedure possibly could be used during marginal weather conditions and involves both an instrument and a visual approach. Beyond approximately 4 nautical miles, the aircraft would be relying on its instruments to approach the airport. At approximately 4 nautical miles, the aircraft would break out of the clouds and would be able to site the airport and complete a visual approach in which it steps over from its instrument approach to an instrument runway to land on a parallel runway. Please see R-I above for further discussion of a third dependent runway at Sea-Tac.

R-CG: One comment asked for existing SEL noise contours for Sea-Tac, Paine Field, and McChord.

Existing SEL contours have not been generated since the focus of this FEIS is on the impacts of future alternatives. A discussion of existing noise levels is presented in Section 4.1.2.2.

R-CH: One comment requested how many 80 SEL events would be experienced within an average hour, average day, and average month.

It is important to note that since SEL refers to single aircraft overflights, the number of 80 SEL events experienced within the 80 SEL contour is equal to the number of aircraft operations. Please see Table C-3, "Appendix C, Noise Assessment Study" for information on yearly commercial aircraft operations for each of the alternatives. Monthly, daily, and hourly average operational levels are beyond the scope of this FEIS.

R-CI: One comment asked for clarification of the statement in the DEIS that various noise factors are "weighted accordingly."

The noise analysis of this FEIS does not weight the individual noise factors (ie, 55 LDN, 65 LDN, 80 SEL, newly exposed populations). Data for each factor are presented without any type of numeric weighting or ranking.

Appendix F

Final Environmental Impact Statement (FEIS) Distribution List

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APPENDIX F

EIS Distribution List

Cities and Towns

City of Algona
City of Arlington
City of Auburn (2)
City of Bainbridge Island
Town of Beaux Arts Village
City of Bellevue
City of Black Diamond
City of Bonney Lake
City of Bothell
City of Bremerton
City of Brier
City of Buckley
Town of Bucoda
Town of Carbonado
City of Carnation
Town of Clyde Hill
City of Coupeville
Town of Darrington
City of Des Moines
City of DuPont
City of Duvall
Town of Eatonville
City of Edmonds
City of Enumclaw
City of Everett
City of Federal Way
City of Fife
Town of Fircrest
City of Gig Harbor
Town of Gold Bar
Town of Granite Falls
Town of Hunts Point
Town of Index
City of Issaquah
City of Kent
City of Kirkland
City of Lacey
City of Lake Forest Park
City of Lake Stevens
City of Langley
City of Little Rock
City of Lynnwood
City of Marysville
City of Medina
City of Mercer Island
City of Mill Creek
Town of Milton
City of Monroe
City of Moses Lake
City of Mountlake Terrace
City of Mukilteo
City of Normandy Park
City of North Bend
City of Oak Harbor
City of Olympia
City or Orting
City of Pacific
City of Port Orchard
City of Poulsbo
City of Puyallup
Town of Rainier
City of Redmond
City of Renton
City of Roy
Town of Ruston
City of SeaTac
City of Seattle
Town of Skykomish
City of Snohomish
City of Snoqualmie
Town of South Praire
City of Stanwood
Town of Steilacoom
Town of Sultan
City of Sumner
City of Tacoma
Town of Tenino
City of Tukwila (2)
City of Tumwater
Town of Wilkeson

Cities and Towns (Continued)

City of Woodway
Town of Yarrow Point
Town of Yelm

Counties

Grant County
Island County
King County
Kitsap County (2)
Pierce County
Snohomish County (6)
Thurston County

Indian Tribes

Chehalis Tribe
Duwamish Tribe
Mukleshoot Tribe
Nisqually Tribe
Puyallup Tribe
Suquamish Tribe
Tulalip Tribe

Airport Managers

Arlington Municipal Airport
Boeing Field
Fort Lewis
McChord Air Force Base
Olympia Airport
Paine Field (2)
Pangborn Memorial Airport
Renton Field
Thun Field

Ports

Port of Bremerton
Port of Chelan County
Port of Edmonds
Port of Everett
Port of Olympia
Port of Shelton
Port of Tacoma
WA Public Ports Association

Transit Agencies

Community Transit
Everett Transit
Intercity Transit
Island Transit
Kitsap Transit
Metro
Pierce Transit
Snohomish County Transportation Authority (SNO-TRAN)

Utilities

Des Moines Sewer District
Puget Sound Power and Light
Rainier Vista Sewer District
Seattle City Light
Seattle Water Department
Snohomish County PUD
Tacoma City Light
Tacoma Water Department
Thurston County PUD

Federal Agencies

Bonneville Power Administration
Bureau of Indian Affairs
Congressional Delegation (11)
Dept. of Housing and Urban Dev.
Economic Development Administration
Environmental Protection Agency
Federal Aviation Administration
Federal Highways Administration
Fish and Wildlife Service
United States Air Force
United States Army
United States Army Corp of Engineers
United States Coast Guard
United States Navy
Urban Mass Transp. Administration

State of Washington

Department of Community Development
Department of Ecology (2)
Department of Employment Security
Department of Energy (2)
Department of Fisheries
Department of Natural Resources
Department of Parks and Recreation
Department of Social and Health Ser.
Department of Trade and Econ. Dev.
Department of Transportation:
  Aeronautics Division
  District 1
  District 3
  Headquarters
  Marine Division
Department of Wildlife (2)
High Speed Ground Trans. Commission
Legislative Transportation Committee (2)
Office of Archeology and Historic Pres.
Office of the Governor
Planning, Research, and Public Trans.
Transportation Improvement Board
Utilities Transportation Commission
WA State Air Transportation Commission
Washington Trans. Policy Institute

Regional Agencies & Organizations

Central Puget Sound Econ. Dev. Dist.
King County GMPC
Kitsap Regional Planning Council
Pierce Co. Countywide Planning
Policy Steering Committee
Puget Sound Air Pollution Control Agency
Skagit Council of Governments
Snohomish County Tomorrow
Thurston Regional Planning Council

Chambers of Commerce

Bellevue Chamber of Commerce
Everett Area Chamber of Commerce
Greater Federal Way Chamber of Comm.
Greater Seattle Chamber of Commerce
Olympia Chamber of Commerce
Southwest King Co. Chamber of Comm.
Tacoma/Pierce Co. Chamber of Comm.

Others

Aircraft Noise Coalition
Associated General Contractors
Highline Community Hospital
Keep Thurston Livable
Kitsap Co. Assoc. of Realtors
Kitsap County EDC
Madison/Jackson Econ. Dev. Association
Metro - Environmental Division
Ravenna Bryant Comm. Association
Regional Commission on Airport Affairs
Save Our Communities
Seattle Community Council Federation
Seattle/King Co. Assoc. of Realtors
Seattle/King Co. EDC (2)
South King Co. Board of Realtors
Snohomish County Board of Realtors
Snohomish County Citizens for
Improvement Transportation (SCCIT)
Snohomish County EDC
Tacoma/Pierce Co. Board of Realtors
Tacoma/Pierce Co. Econ. Dev. Board
Thurston County EDC
Transit Alliance
WA Transportation Policy Institute
WA Airport Managers Association
WA Pilots Association

Libraries

Auburn Public Library
Bellevue Public Library
Bellingham Public Library
Enumclaw Public Library (2)
Everett Public Library (2)
Evergreen State College Library
Government Research Assist. Library
Highline Community College Library
King County Library System (17)
Kitsap Regional Library (4)
Lacey Timberland Library
Lake Forest Park Library
Metro Library
Mukilteo Library
Municipal Research & Services Center
Olympia Timberland Library
Pacific Lutheran University Library
Pierce County Library (9)
Port of Seattle Aviation Comm. (2)
Puyallup Public Library
Renton Public Library
Roy City Library (2)
Seattle Pacific University Library (2)
Seattle Public Library (11)
Seattle University Library
Snohomish Public Library
Sno-Isle Regional Library (9)
Tacoma Public Library
Tumwater Timberland Library
University of Puget Sound Library
University of Washington
Government Document Library
Vashon Public Library
Washington State Energy Office
Washington State Library
WSDOT Library

Schools

Arlington School District No. 16
Edmonds School District
Evergreen State College
Everett School District No. 2
Federal Way Public Schools
Highline Community College
Highline Public Schools
Highline School District No. 401
Marysville School District No. 25
Mukilteo School District No. 6
Northshore School District
Shoreline Public Schools
South Central School District No. 406
Tumwater School District No. 33

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Appendix G

Additional Flight Plan Documents

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Appendix G

Additional Flight Plan Documents

Resources used in this preparation of this FEIS are list in the Bibliography. Flight Plan reports available from the Regional Council Information Center are:

Phase I: Demand Forecasts, July 1990

Phase II: Development of Alternatives (and Appendix), June 1991

Phase III: Draft Final Report (and Appendices), January 1992

- Appendix A: Evaluation Methodology
- Appendix B: Operation/Technical Elements
- Appendix C: Economic/Financial Elements
- Appendix D: Institutional Elements
- Appendix E: Draft Programmatic Environmental Impact Statement

Public Comments: Supplemental Volumes, Spring 1992

- Volume 1: Snohomish and Island Counties
- Volume 2: King County
- Volume 3: Thurston, Pierce, and Kitsap Counties

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Appendix H

List of Contributors

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APPENDIX H
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Part Ex NOs. 1066 - 1076

missing 1066, 1070

Deleted entries for No. 1068
1069
1071
1073

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